Unless otherwise stated, all photos are courtesy of ECODIT.

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Preface

Welcome to the third edition of the State of the Environment report in Lebanon, with a slightly revised title "State and Trends of the Lebanese Environment" in line with global calls to not only understand the current situation but also assess current trends and future environmental change. Funded by the Lebanese Government/Ministry of Environment (MOE) in coordination with the United Nations Development Programme (UNDP), this edition follows two earlier versions, the first issued in 1995/1996 with funding from the Mediterranean Technical Assistance Programme through the World Bank and the second in 2001/2002 with funding from the Lebanese Government in coordination with UNDP.

This SOER is part of the Program of Work of the MOE for the years 2010-2012, prepared in line with the Ministerial Declaration of the Government of Development and Improvement. Together with other studies and reports, such as the World Bank funded Country Environmental Analysis and the Cost of Environmental Degradation, they aim at strengthening the Ministry with the tools needed to analytically diagnose the state of the environment in Lebanon, and accordingly better formulate policies, plans and programs towards environmental mainstreaming.

Composed of a total of ten chapters grouped into four sections, the report unfolds with a brief introduction followed by a chapter on Environmental Governance (Section I). Then proceeds Section II on "State of the Environment" covering the four environmental media: Water Resources, Air Quality, Biodiversity and Forests, and Land Resources. "Environmental Priorities" are then discussed in Section III, with a focus on: Haphazard Urbanization, Solid Waste and Energy Crisis. The report finally concludes with an outlook titled "The Future Today" where two scenarios are compared: Market First (or Business as Usual) and Sustainability First.

Prepared by ECODIT under the technical supervision of both the MOE and UNDP, this report benefited from the contribution of many experts, as listed in the various chapters. The review involved a number of professionals from both the public and the private sectors, in line with the participatory approach adopted by the current Government, and highlighted in the title of the Program of Work of the MOE for the years 2010-2012.

To all readers, professionals and businessmen, students and researchers, academicians and reporters, politicians and decision-makers, and environmentalists at large, happy reading from the Ministry of Environment team… and remember your opinion matters; so please send your feedback to soer@moe.gov.lb.

Mohammad Naji Rahal
Minister of Environment
June 2011

Foreword

This is the third "State and Trends of the Lebanese Environment" report that has been published to date and the second that UNDP is proud to have collaborated on with the Lebanese Ministry of Environment. This edition not only provides an overview of the current condition of natural resources and environmental management in the country, but also gives an analysis of past and future developments across multiple different sectors. The overall impression left by the report is alarming; although there has been commendable progress in many areas over the last decade, trends do not indicate a sustainable future for Lebanon without strong political will to further integrate environmental considerations across all sectors. It is crucial for politicians, policy makers, decision-makers at both the national and local levels, entrepreneurs, academics, journalists and citizens alike to be aware of the necessity to change our development approach to one that will safeguard Lebanon's future generations.

Robert Watkins
UNDP Resident Representative
June 2011

Acknowledgment

The State and Trends of the Lebanese Environment (SOER) is the coordinated product of countless hours of interviews and research, editing, reviewing, reediting, proofreading, translation, and text layout. At ECODIT, the SOER team was comprised of nine specialists who bring a wealth of competencies and knowledge in the fields of environmental management and policy, urban planning, construction, air quality, biodiversity, agricultural sciences, hydrogeology and karst, solid waste, energy, and water. Lead and contributing authors are listed at the beginning of each chapter.

During the preparation of the 2010 SOER, ECODIT consulted with and sought information and interpretations from 77 individuals from various organizations and government agencies. The Ministry of Environment, UNDP and ECODIT then identified and mobilized 34 reviewers including ministry staff, UNDP staff and projects, as well as outside peer reviewers. These reviewers provided invaluable input to the overall report and precision to relevant sections of the report. Their input helped significantly augment the quality of the final product. The names of all reviewers and contributors are listed alphabetically at the beginning of each chapter.

ECODIT expressly acknowledges the unwavering support of Manal Moussallem, Senior Environment Advisor at UNDP-MOE, for her guidance and tireless commitment to the SOER process and to facilitating the compilation of the 2010 SOER by the ECODIT team.

Karim El-Jisr
2010 SOER Team Leader
Director of ECODIT Liban SARL

ECODIT

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1 Introduction

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With funding from the Lebanese Ministry of Environment (MOE), the United Nations Development Program (UNDP) contracted ECODIT, a Lebanese environmental consulting and management firm, to prepare the 2010 State of the Environment Report (SOER). Two versions of the SOER were prepared previously; in 1995, with grant funding from the World Bank / METAP, and in 2001 with MOE funding and in coordination with the Lebanese Environment and Development Observatory project[1]. The report seeks to provide a comprehensive, reliable and scientifically credible, policy-relevant, up-to-date assessment of, and outlook for, the state of the Lebanese environment. *See Box 1.1 on how the Arab people perceive the state of the environment.*

Box 1.1 How do Arab people perceive the state of the environment?

The Arab Forum for Environment and Development conducted in 2006 a public survey on environmental trends in the Arab World. According to the survey, 71% of the respondents in Lebanon said that the state of the environment in their country had deteriorated during the past ten years, and 53% of them attributed this to insufficient public expenditure on the environment (AFED, 2006).

1.1 BACKGROUND

Environmental reporting supports environmental management. While such assessments were practiced in one form or another long before the 1970s, it was at the United Nations Conference on the Human Environment (Stockholm, 1972) that environmental assessment entered the formal glossary of environmental stakeholders. Environmental assessments are today conducted by many stakeholders to meet disparate objectives as numerous as the stakeholders themselves.

There are different types of environmental assessment including State of the Environment (SOE), Integrated Environmental Assessment and Reporting (IEA), Environmental Impact Assessment (EIA), Strategic Environmental Assessment (SEA), and Corporate Environmental Assessment and Reporting. Common to these is the need for policy responses for effective environmental management and/or sustainable utilization of natural resources. Whereas State of the Environment reporting remains the most common type of reporting, SOERs have evolved in the last two decades, concomitantly with advances in global and regional environmental reporting. For example, UNEP has been compiling and publishing the Global Environment Outlook (a.k.a., GEO) leaning on the resources and expertise of hundreds of authors, contributors, reviewers and collaborating centers from around the world. Separately, the World Bank has been preparing so called *Country Environmental Analysis* reports to evaluate the state of key environment sectors and funding needs (see Box 1.2 on Lebanon's draft CEA report).

[1]LEDO was hosted at MOE, managed by UNDP, and implemented with EU funding (1999-2001)

Box 1.2 Country Environmental Analysis - Lebanon

The World Bank prepared a Country Environmental Analysis for Lebanon, concomitantly with the preparation of the Lebanon 2010 SOER. The two reports have different objectives but cover many common issues, including the state of solid waste and wastewater management. The CEA is a tool to determine the gap between the cost of mitigation (demand for funds) and government financing (supply of funds) and a platform for recommending policy reforms in priority sectors including institutional.

Source: World Bank CEA, draft Version 9, December 2010

Whereas SOER tends to provide an assessment that is predominantly static and unidirectional, Integrated Environmental Assessment approaches environmental reporting more holistically. IEA reporting integrates social, economic and environmental issues in the analyses, to support sustainable development needs around the world. IEA reporting acknowledges human-environment interactions and the impacts they have on each other over time. It incorporates environmental assessment into the whole process of environmental policy planning, pulling together the impact of policies from different sectors over time and the existing opportunities to promote sustainable livelihoods and options. Finally, it provides a baseline inventory of available resources which can be used to formulate sustainable development policies. IEA reporting encourages all stakeholders to ask whether enough is being done to conserve natural resources, promote sustainable development practices, reduce poverty, and improve the state of the environment.

1.2 METHODOLOGY

The MOE, UNDP and ECODIT worked hand in hand to prepare this report (July 2010 – June 2011). Under its contract with MOE/UNDP, ECODIT conducted the following tasks:

1) Reviewed published milestone reports and studies
2) Developed tentative SOER structure
3) Collected and reviewed other reports and databases
4) Analyzed the feasibility of integrating environmental indicators into SOE reporting

5) Prepared the draft SOER in consultation with MOE and UNDP
6) Revised and edited the draft SOER based on comments received from MOE and UNDP
7) Produced the final SOER in English
8) Translated the report into French and Arabic
9) Formatted and designed the SOER report in all three languages
10) Prepared concise and user-friendly presentations (three languages)
11) Submitted the FINAL SOER and PowerPoint Presentations (three languages)

The SOER team included the following nine subject-matter specialists:

1) Karim El-Jisr, SOER Project Director
2) Zuhier El-Hassan, Water Expert
3) Capricia Chabarekh, Air Quality Specialist
4) Ghassan Jaradi, Biodiversity and Forests Expert
5) Rita Stephan, Environment and Land Management Specialist
6) Antoine Fischfisch, Urban Planning Specialist
7) Joy Jadam, Solid Waste Specialist
8) Naji Tannous, Energy Expert
9) Issam Bou Jaoude, Hydrogeology and Karst Specialist

As part of the review process, MOE, UNDP and ECODIT mobilized about 35 reviewers including ministry staff, UNDP project staff, and outside peer reviewers. The names of lead authors, contributors, and reviewers are listed at the beginning of every chapter. In total, the SOER team conducted more than 60 interviews and consulted more than 250 references and 50 websites to produce this report. For wider dissemination, the report is available in English, French and Arabic, as well as in PowerPoint presentation format.

The title of this report was revised from *State of the Environment Report* to *State **and Trends** of the Lebanese Environment,* in line with global calls to not only understand the current situation but also assess current trends and future environmental change. Appreciating the state of the environment is important but falls short of providing an overall assessment of where the country is heading. For example

- *Environmental Governance*: What is preventing enforcement of environmental laws and regulations? Why does non-compliance persist for so long without accountability?
- *Water:* Is Lebanon's water balance critical? What is the extent of groundwater depletion and how will current abstraction rates affect water availability in the next decade? How will climate change affect water availability in the coming decades?
- *Air Quality:* Why is it so difficult to assess air quality and how far has Lebanon come in terms of air quality monitoring and the dissemination of air quality data? Is such data impacting policy formulation?
- *Biodiversity and Forests:* How many plant species did we lose in recent years and how many will be lost in the coming years if the current state continues, if current pressures are not mitigated? Are we doing enough to protected biodiversity and forests?
- *Land Resources:* Is Lebanon depleting its natural resources? How can the country better manage and control quarries? How severe is soil erosion and what can be done to minimize abuses of the coastal zone?
- *Haphazard Urbanization:* How much construction is going on and what will happen to our mountains and other natural areas if the current rate of construction continues unimpeded? Are urban planning and construction laws compatible with environmental conservation?
- *Solid Waste Crisis:* How much trash do we produce everyday and where will this all go if we do not curb generation, improve waste recovery, and incentivize waste recycling? Is Lebanon's handling of hazardous waste improving?
- *Energy Crisis:* How is economic growth affecting energy consumption and, by extension, greenhouse gas emissions? How is the market responding to advances in renewable energy technologies and how can Lebanon overcome barriers to harvesting renewable energy?

These are difficult questions that the current report seeks to address.

1.3 POPULATION DATA

As explained in the 2001 SOER, Lebanon's last population census was conducted in 1932. All population estimates have since been based on surveys and extrapolations. The most reliable source of population data in Lebanon therefore remains the Central Administration of Statistics (CAS). CAS conducted in 1996 a national survey (not a *census*) of population data and living conditions and revised their data in 2008. According to the 2008 update, Lebanon's resident population in 2007 was 3.7 million, excluding an estimated 425,000 Palestinian refugees (CAS, 2008 and UNRWA, 2008). The total population in 2008 including refugees was therefore about 4.2 million. Compared to the year 1996, the total population (including refugees) increased by about 170,000, which is equivalent to an annual growth rate of about 0.4 percent. In reality, the real growth rate is probably higher but it is inhibited by concurrent emigration. See population distribution by mohafaza in Table 1.1.

Population growth in Lebanon, as with many of the other demographic parameters, is uncertain. The World Bank quotes a current rate of 1.2 percent per annum (WB, 2009a). In the National Land Use Master Plan (SDATL), the population will grow from 4,005,025 in 1997 to 5,230,000 in 2030, or 0.92 percent per annum (CDR-NLUMP, 2004). The Ministry of Energy and Water (MOEW) assumes a growth rate of 1.75 percent between 2007 and 2009 (MOEW, 2010). All these estimates remain significantly lower than the region (2.5% in Syria and 2.4% in Jordan in 2009). Real growth is difficult to determine with a higher level of certainty due to Lebanese emigration which is rooted in its history, during peace time as well as during conflict.

Table 1.1 Lebanon's resident population in 2007

Mohafaza	*Percent of Total*	*2007*
Beirut	9.61%	361,366
Mount Lebanon*	39.49%	1,484,474
North Lebanon	20.32%	763,712
South Lebanon	17.55%	659,718
Beqaa	13.03%	489,865
Lebanon	100%	3,759,135

Source: CAS, 2008

*Includes the southern suburbs of Beirut that are administratively part of Mt Lebanon

**Excludes Palestinian refugees (approximately 425,000 (UNRWA 2008)

1.4 LEBANON'S ADMINISTRATIVE REGIONS

Lebanon is divided into six administrative regions (called *Mohafaza*) and 25 sub-regions (called *Caza*), not including Beirut. Each *Caza* is made up of many cadastral zones (called *Manateq iikarieh*). There are about 1,500 cadastral zones in Lebanon. The largest Mohafaza is the Bekaa and the smallest is the capital Beirut. In 2003, the Parliament approved Law 522 (dated 16/07/2003) to establish two new Mohafazas by splitting the Mohafaza of the North into North and *Akkar* and the Bekaa into Bekaa and *Hermel*, bringing the total number of Mohafazas to eight. The corresponding application decrees however were never developed and the political will to implement the administrative division seems lacking.

See current administrative regions and surface areas in ***Map 1***.

1.5 READER'S GUIDE

The 2010 SOER is organized in four sections and 10 chapters, as follows:

SECTION I Introduction	Chapter 1 Introduction
	Chapter 2 Environmental Governance
SECTION II State of the Environment	Chapter 3 Water Resources
	Chapter 4 Air Quality
	Chapter 5 Biodiversity and Forests
	Chapter 6 Land Resources
SECTION III Environmental Priorities	Chapter 7 Haphazard Urbanization
	Chapter 8 Solid Waste
	Chapter 9 Energy Crisis
SECTION IV The Outlook - Towards 2020	Chapter 10 The Future Today

Each chapter may be consulted as a stand-alone document. It contains unique indicators, a full list of relevant laws and regulations, and cited references. To minimize redundancies, the SOER team has used cross-referencing extensively. Tables, figures, boxes and original photos were used to diversify the text and produce a user-friendly report. In an effort to mainstream a short list of indicators, the SOER team have selected indicators in consultation with MOE and CAS. For ease of reference, these indicators are consolidated in ***Annex 1*** at the end of this chapter.

To facilitate navigation in this report, Table 1.2 provides a crosswalk between the 2001 and 2010 SOER. In particular, the table presents the outline of the 2001 SOER (left column) and shows the corresponding location of that chapter in the 2010 SOER (right column). Noteworthy improvements include the integration of environmental pressures (described under "Economic Sectors" in 2001) with the state of the environment (presented under "State of the Environment" in 2010). Also, the current chapter on water resources approaches water issues from "source to sink", and therefore integrates wastewater issues and opportunities for water reuse into one chapter (by contrast, the 2001 SOER described water resources and wastewater separately).

Table 1.2 Crosswalk between the 2001 SOER and the 2010 SOER

Structure of 2001 SOER	*Location in 2010 SOER*
I. Introduction	Chap 1. Introduction
II. Economic Sectors (Pressures)	
1. Population	Chap 1. Introduction and Chap 3. Water
2. Agriculture	Chap 5. Biodiversity and Chap 6. Land Resources
3. Industry	Chap 3. Water Resources Chap 4. Air Quality and Chap 8. Solid Waste
4. Construction	Chap 6. Land Resources and Chap 7. Haphazard Urbanization
5. Transport	Chap 4. Air Quality and Chap 9. Energy Crisis
6. Tourism and Recreation	Chap 3. Water and Chap 5. Biodiversity and Forests
7. Energy	Chap 9. Energy
III. State of the Environment (State)	
8. Water	Chap 3. Water Resources
9. Air	Chap 4. Air Quality
10. Biodiversity and Natural Heritage	Chap 5. Biodiversity and Forests
11. Land and Soil	Chap 6. Land Resources
III. Environmental Management (Response)	
12. Land Management	Chap 6. Land Resources and Chap 7. Haphazard Urbanization
13. Solid Waste Management	Chap 8. Solid Waste
14. Wastewater Management	Chap 4. Water Resources

In line with UNEP guidelines for integrated environmental reports, the 2010 SOER includes a chapter on The Future Today. It provides a snapshot of the overall state of the environment, contains valuable reference numbers, and a glimpse of the future based on two outlook scenarios: Market First (business as usual) and Sustainability First. The two scenarios attempt to predict the future state of the environment if current trends in resource depletion, pollution, urbanization, etc. continue over the time horizon 2011-2020. Finally, this report presents nine maps and 15 annexes.

The SOER is a public document that must be shared with various audience groups, in Arabic, English and French as needed. There is sufficient information and analysis in this report to inform and engage schools and universities, other research centres, business groups and banks, lawmakers, international development organizations, non-governmental organizations and other professionals.

Happy Reading!

REFERENCES

CAS, 2008	Statistical Yearbook 2007, Central Administration of Statistics, 2008
CDR-NLUMP, 2004	National Land Use Master Plan of Lebanon, Prepared by Dar Al Handasah and Institut d'Amenagement et d'Urbanisme de la Région d'Ile De France, for CDR 2004
MOEW, 2010	National Water Sector Strategy: Supply/Demand Forecasts, DRAFT, MOEW , November 2010
UNRWA, 2008	http://www.unrwa.org/etemplate.php?id=65
WB, 2009a	World Bank Water Sector Public Expenditure Report, Draft 2009

Mohafaza	Number of Caza	Number of Municipalities	Area (km²)
Bekaa	5	155	4,258.3
North Lebanon	7	239	1,973.1
Mount Lebanon	6	341	1,970
Nabatiyeh	4	117	1,099.5
South Lebanon	3	141	923.8
Beirut	-	1	21.2
Total *	25	994	10,246.2

* Total Area (10,246 km²) is the land area of the Lebanese territory. It is calculated using GIS based on NLUMP (2004) Geodatabase.

State & Trends of the Lebanese Environment | **Map 1 - Administrative Regions**

DISCLAIMER: This map was prepared by ECODIT based on National Land Use Master Plan (2004). Every effort has been made to ensure the accuracy of the information displayed on this map. The international boundaries are approximate. MOE/UNDP/ECODIT do not assume any responsibility for any decision that may arise from the use of the map.

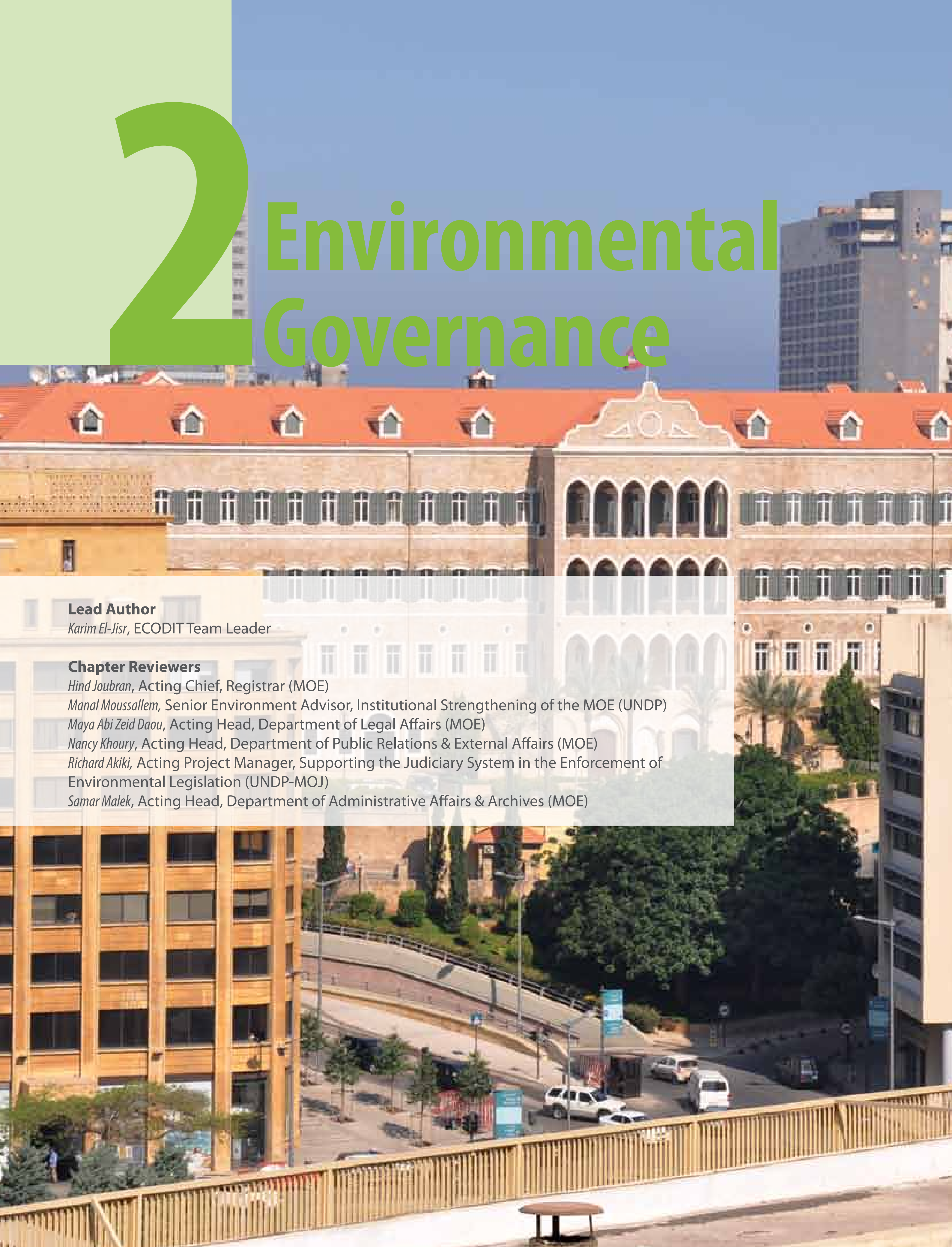
ANNEX 1 ENVIRONMENTAL INDICATORS USED IN THE 2010 SOER

Chapter	*Indicators*	*Value*	*Year*	*Source*
Environmental Governance	Environmental Performance Index EPI	EPI Rank 90 EPI Score 57.0	2010	http://epi.yale.edu/
Water (incl. Wastewater)	Access to safe drinking water	67.0%	2004	Living Conditions, 2004, CAS
	Access to water networks	78%	2009	World Bank, Water Sector: Public Expenditure Report, Draft, 2009
	Annual water demand per sector (%)	Agriculture: 60% Domestic: 29% Industry: 11%	2010	Country Environmental Analysis, Draft, World Bank, 2010
	Expenditure on Wastewater Management	$27,446,518	2005	CDR Progress Report, 2007
	Connection to sewerage systems	36.6% 60%	1996 2010	CAS Census of Building and Households, 1996-1997 MOEW, 2010
Air Quality (incl. Climate Change)	Ambient Concentration of air pollutants in urban/rural areas (Air pollution Index / Public information)	*In GBA* NO_2 58µg/m^3 SO_2 3.1 ppb O_3 - PM_{10} 63.38µg/m^3 $PM_{2.5}$ 20.4µg/m^3	2010 2006 - 2010 2010	AQRU Conference, 2011 Afif et al. 2008 - Saliba & co-researchers (in progress)
	Consumption of Ozone Depleting substances	CFCs 0 MT HCFC 826 MT Methyl Bromide 84 MT	2010 2009 2009	NOU, 2010
Biodiversity & Forests	Forest area	136,300 ha	2005	FAO, 2005
	Protected Areas as percent of territory	220 km^2 (2.1% of the Lebanese terrirtoy)	2010	ECODIT 2010
Land Resources	Land affected by desertification	59.3 %	2000	NRP for reforestation
	Land use	Roads: 0.09% Rivers: 0.05% Water Bodies: 0.12% Unproductive land: 4.79% Wetland: 0.05% Grassland: 30.98% Scrubland: 11.94% Woodland: 13.32% Agricultural Area: 32.5% Artificial area: 6.17%	1998	MOE/NCSR/CERMOC, 2002
	Number of rehabilitated quarries	2	2010	MOE and HAS
Urbanization	Population density (incl. refugees)	400 Inhabitants/Km^2	2007	CAS 2008, UNRWA 2008
	Urbanization rate[2]	87%	2005	At a glance: Lebanon Statistics, UNICEF 2007
	Urban population growth rate	2.2%		
Solid Waste	Generation of Municipal Solid Waste	1.57 Million tons of waste per year	2010	SWEEP-NET 2010
	Destination of Household waste (%)	Landfill: 51%, Open dumps: 32%, Composting: 9%, Recycling: 8%	2010	
Energy	Annual primary energy consumption per capita	1.13 (TOE[*])	2004	Statistical yearbook 2000-2005; CAS 2006
	Annual electricity consumption per capita	2,745 (KWh/capita)		
	Renewable energy of total energy production	2.7 %	2007	Annuaire Statistique, CAS 2008

[3] Percentage of the total population living in urban areas

[i] LEDO was hosted at MOE, managed by UNDP, and implemented with EU funding (1999-2001)

[ii] Percentage of the total population living in urban areas



2 Environmental Governance

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ABBREVIATIONS & ACRONYMS

AECID	Spanish Agency for International Cooperation
AFD	Agence Française de Développement
AFED	Arab Forum for Environment and Development
ALBA	Académie Libanaise des Beaux-Arts
AUB	American University of Beirut
CAS	Central Administration of Statistics
CBD	Convention on Biological Diversity
CBO	Community Based Organizations
CDR	Council for Development and Reconstruction
CEA	Country Environmental Analysis
CERMOC	Centre d'Etudes et de Recherche sur le Moyen-Orient Contemporain
COM	Council of Ministers
EFL	Environmental Fund for Lebanon
EIA	Environmental Impact Assessment
EU	European Union
FFEM	French Global Environment Facility
GEF	Global Environment Fund
GiZ	German International Cooperation
GOL	Government of Lebanon
GPL	Green Party of Lebanon
ILO	International Labor Organization
IRI	Industrial Research Institute
LARI	Lebanese Agricultural Research Institute
LCEC	Lebanese Center for Energy Conservation
LCPC	Lebanese Cleaner Production Center
LEP	Lebanese Environmental Party
LEPAP	Lebanon Pollution Abatement Project
MENA	Middle East and North Africa
MOC	Ministry of Culture
MOE	Ministry of Environment
MOEHE	Ministry of Education and Higher Education
MOET	Ministry of Economy and Trade
MOEW	Ministry of Energy and Water
MOF	Ministry of Finance
MOFAE	Ministry of Foreign Affairs and Emigrants
MOI	Ministry of Industry
MOIM	Ministry of Interior and Municipalities
MOJ	Ministry of Justice
MOND	Ministry of National Defense
MOPH	Ministry of Public Health
MOPWT	Ministry of Public Works and Transport
MOSA	Ministry of Social Affairs
MOT	Ministry of Tourism
MOTC	Ministry of Telecommunication
MOYS	Ministry of Youth and Sports
MP	Member of Parliament
NERC	National Emergency Response Committee
NGO	Non-Governmental Organization
NLUMP	National Land Use Master Plan
OMSAR	Office of the Minister of State for Administrative Reform
SEEL	Supporting the Judiciary System in the Enforcement of Environmental Legislation
SELDAS	Strengthening/State of the Environmental Legislation Development and Application System in Lebanon
SOER	State of the Environment Report
TEDO	Tripoli Environment and Development Observatory
UNDP	United Nations Development Program
UOB	University of Balamand
USAID	United States Agency for International Development
USEK	Université Saint Esprit Kaslik
USJ	Université Saint Joseph

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Environmental governance is a relatively new concept. Simply put, it involves governance and the environment *--see definition in Box 2.1.* For this report on the state and trends of the Lebanese environment, environmental governance is assessed based on a review of six major components (called the puzzle): (1) environmental institutions, (2) environmental laws and regulations, (3) environmental research and development, (4) access to environmental information and data, (5) access to environmental funding, and (6) advocacy and public participation. Environmental governance in Lebanon will need to improve markedly over the next decade to improve Lebanon's Environmental Performance Index (EPI)[1]. In 2010, Lebanon scored 57.9/100 on the EPI scale and ranked 90 among 163 listed countries.

Box 2.1 What is environmental governance?

Environmental governance refers to the processes of decision-making involved in controlling and managing the environment and natural resources. Principles such as inclusivity, representation, accountability, efficiency, and effectiveness, as well as social equity and justice, are the foundations of good governance.

Source: SOER, Department of Environmental Affairs, Republic of South Africa. http://soer.deat.gov.za/27.html

[2]The 2010 EPI ranks 163 countries on 25 performance indicators tracked across ten policy categories covering both environmental public health and ecosystem vitality. These indicators provide a gauge at a national government scale of how close countries are able to establish environmental policy goals (http://epi.yale.edu/)


Lebanese Parliament located in Beirut central district


View of the Presidency of the Council of Ministers (Grand Serail) also located in the heart of the capital

2.1 ENVIRONMENTAL INSTITUTIONS

In the last two decades since the end of the 1975-1990 Civil War, Lebanon has seen a qualitative and quantitative growth in environmental institutions. The following overview of key environmental institutions and organizations in the country focuses on the legislative body, the executive body, and the judiciary system.

2.1.1 Legislative Body

Lebanon's legislative body, represented by the Lebanese Parliament, holds 128 seats and is organized into dozens of specialized committees (www.lp.gov.lb). Of interest is the *Parliamentarian Committee for Environment* which has 12 permanent Members of Parliament (MPs). The Committee meets at irregular intervals to discuss and review draft legislation and issues related to the environment –discussion issues have included *inter-alia* the need to upscale MOE resources, air pollution from the transport sector, the Naameh landfill, road safety, Sukleen contracts, forest fires, pollution in the Litani River and Qaroun Lake, and miscellaneous other environmental development issues. While active, this body can and should do more to accelerate the approval of key legislation, respond to public opinion and participate in targeted environmental debates immune from partisanship. Equally important, the Committee is expected through Parliament to oversee the work of the executive body including contract decisions and public expenditure in green sectors.

2.1.2 Executive Body

Lebanon's executive body is represented by the Council of Ministers (COM) and is headed by the Presidency of the Council of Ministers (www.pcm.gov.lb). The COM enacts regulations in the form of decisions (henceforth denoted COM Decision Number) and decrees. The size of the ministerial cabinet is flexible but has over the last decade comprised 30 ministers, including the Minister of Environment. Lebanon has seen regular cabinet reshuffles since the publication of the 2001 SOER. The following paragraphs focus on the structure and mandate of the Ministry of Environment as well as intergovernmental and other environmental committees.

Ministry of Environment

The MOE was established by Law 216/1993. It is the second youngest ministry in Lebanon (the youngest ministry is the Ministry of Industry which was established in 1997). Initially based in a small alley in Antelias north of Beirut, the ministry relocated to the heart of the capital in December 2004 where it is currently based.

Box 2.2 CEA, SOER and NEAP

The *Country Environmental Analysis* (prepared by the WB) is a tool to determine the gap between the cost of mitigating environmental degradation, and government funding. The *State of the Environment Report* is an objective compendium on the state of the environment with some analysis of environmental trends and the future today. In principle, the SOER should be updated every five years. The *National Environmental Action Plan* is a planning tool that defines Lebanon's environmental priorities and key entry points for mitigating environmental pollution and degradation. The NEAP is a roadmap for environmental programming and activities. The three documents (CEA, SOER and NEAP) provide some information overlap but have different objectives and periodicity.

View of the Lebanese Ministry of Environment located in the heart of the capital Beirut since 2004

The mandate of the MOE was amended by Law 690/2005 and the long-awaited restructuring of the ministry was enacted four years later by Decree 2275 (dated 15/06/2009). This decree defines the function and responsibilities of each unit including staff size and qualifications. A detailed organizational structure according to Law 690/2005 and Decree 2275/2009 is presented in ***Annex 1***. The ministry prepared a work plan for the period 2010-2012 in line with the government declaration and with a focus on multilateral environmental agreements ratified by the GOL (see targeted list in ***Annex 2***). The work plan is a prelude to updating the National Environmental Action Plan which was prepared in 2005-2006 but was never officially endorsed (see Box 2.2 for a comparison of the NEAP, the CEA, and the SOER). The work plan comprises 10 themes and requires intimate coordination with relevant ministries, and public and private sector groups:

1) Strengthening environmental inspection and enforcement (in partnership with the MOJ, MOIM and the MOF)
2) Adapting to the impacts of climate change on natural resources (in partnership with the MOEW, the MOA, the MOPWT and the MOI)
3) Managing air pollution (in partnership with the MOPWT, the MOEW, the MOI and the MOF)
4) Sustainable management of land and soil (in partnership with the MOPWT the MOIM, the MOND, the MOEW, and the MOA)
5) Preserving and promoting Lebanon's ecosystem capital (in partnership with the Ministry of Information, the MOA, the MOT, the MOC, the MOTC, the MOFAE, the MOIM, and the MOF)
6) Promotion of hazardous and non-hazardous waste management (in partnership with the CDR, the MOIM, the MOF, the MOPWT, and the MOA)
7) Promoting environmentally-friendly products (in partnership with the MOA, the MOI and the MOET)
8) Promoting eco-job opportunities (in partnership with the MOEHE, the Civil Service Board, the NCSR, the MOYS and the academic sector)
9) Striving to improve the work environment in order to protect environmental health (in partnership with the MOL, the MOPH, and the MOSA)
10) Strengthening the role of the Ministry of Environment (in partnership with the OMSAR and the Civil Service Board)

Like all public administrations, the MOE needs human resources including employees and volunteers. Staff size and competencies are critical to the ministry's ability to discharge its mandate, in a timely and cost-effective manner. MOE's staff size has been increasing slowly, from just three staff in 1993 (date MOE was established) to 33 in 2001 and 60 in 2010 (including technical and administrative employees). This is still far below the prescribed staff size stipulated in Decree 2275/2009 (182 full-time employees). Human resources at MOE are bolstered by cooperation projects with international development partners. Specifically, over the period 2001-2010, the ministry received 87 service contractors through international projects (bilateral funding). They helped implement many activities and functions related to legislation, research, training, monitoring and environmental awareness.

In 2010, the ministry made significant headway insofar as seeking GOL approval for hiring new employees (civil servants) and approving a technical assistance program from the Italian Government (see details in Box 2.3). Such initiatives will bolster MOE's capacities but should be measured against the concomitant rate of employee resignations (at least 25 staff left MOE between 2001 and 2010). Reasons for resignation may include lack of professional advancement and promotion, pursuit of higher-paid jobs, and/or career change. In fact, the current salary scale for civil servants has been and continues to be a contentious issue inside the GOL. Even after factoring in all the potential benefits (overtime pay, other compensations, bonuses, transportation and social security allowances --not exceeding 75 percent of the base salary), civil servants on average still earn less than their colleagues in the private sector including research institutions. Scrutiny by the Central Inspection Board, while critical for ensuring public sector performance, may also affect staff morale and discourage personal drive and commitment. Staff resignation and turnover is not limited to the MOE but happens to various degrees in other government agencies also. It erodes institutional memory.

Notwithstanding staff size, MOE faces other challenges related to budget and disbursement, procurement, and improving public access to it (phone access is difficult, website needs revamp, and public parking near the ministry is very limited). MOE's public environmental archives continue to grow but access to them are limited by opening hours; the popularity of such archives and walk-in libraries in general continues to drop in favor of internet-based research. On the budget front, and according to records at the Ministry of Finance, MOE's annual budget increased from LBP1.375 billion ($0.9 million) in 1993 to LBP3,975 billion ($2.65 million)[2] in 2001. The MOE budget in 2010 was LBP7.325 billion ($4.88 million).

Other Committees and Intergovernmental Agencies

The Ministry of Environment and the Parliamentarian Committee for Environment deal with many other agencies some of which have a dedicated environmental unit. Noteworthy examples include the Council for Development and Reconstruction (Department of Land Use Planning and Environment) and the Ministry of Public Works and Transport (Directorate General of Roads and Buildings / Department of Environment and Traffic). Additionally, the MOE is a member of several intergovernmental agencies such as the Higher Council of Urban Planning (member), the National Council for Quarries (chaired by MOE), and the Higher Council for Hunting (also chaired by MOE). These councils are mentioned in relevant sections of the 2010 SOER.

Box 2.3 Increasing MOE staff size

MOE received the approval of the Civil Service Board (Ref 3070/B dated 9/7/2009 and 23/11/2010) and the Council of Ministers (COM Decision 50 dated 25/10/2010) to recruit 23 employees. The ministry started to recruit these in 2009 but procedures are slow and hampered by political tension and discourse. Separately, the Italian Cooperation signed a €2.5 million agreement* with MOE, part of which will be spent on hiring 20 technical staff for a period of one year as well as seconding Italian experts to the ministry (estimated cost is €680,000).

**Source: Decree 4760 dated 2 August 2010*

Equally important, Lebanon has so called regional Industrial Permitting Committees (including MOI, MOE, MOPH and MOPWT-Urban Planning) and Health Councils at the Mohafaza level. The Health Councils comprise the Governor as well as representatives from the ministries of Environment, Public Health, Industry, and Urban Planning. At the syndicate level, the Order of Engineers and Architects and the Syndicate of Lawyers have dedicated environmental committees. Collectively, these councils and committees help mainstream the environment in all sectors of the economy. On the party level, Lebanon has two political parties dedicated to the environment. The Green Party of Lebanon was established in 2004 followed by the Lebanese Environmental Party in 2005 (see brief in Box 2.4).

National Emergency Response Committee

In response to recurrent national and international disasters, the GOL established the National Emergency Response Committee (NERC) (COM Decision 103/2010 dated 29/11/2010 amended by COM Decision 104/2010 dated 13/12/2010). The committee comprises 22 members representing the ministries of National Defence, Interior and Municipalities, Public Health, Public Works and Transport, Telecommunications, Environment, Energy and Water, Education and Higher

[2]Excluding LBP5 billion ($3.3 million) for reforestation which is equivalent to 20 percent of the approved National Reforestation Plan budget

Box 2.4 Lebanon's two environmental parties

Green Party of Lebanon (GPL)
Founded in 2004 and politically active since August 2008, the GPL is a formal political party that advocates for the protection of the environment, sustainable development, and human rights. It is one of few independent green parties in the MENA region and the first political party in Lebanon to focus exclusively on *green politics*. Since 2008, the party has expanded membership (1,500 members in 2011) and improved its visibility during polls (environmental campaigns, environmental advertisements, etc.). The political bureau of the GPL lobbies MPs for greener legislation. For example, the Party helped draft and is currently backing the promulgation of the draft *Environmental Prosecutor Law* by parliament. Another priority of the Party is the *Beirut River Project*, a project designed by the Party and presented to the GOL for implementation. The Project aims to revive an economically deprived area of the capital while also resolving an enduring environmental issue (pollution of Beirut River). www.greenpartylebanon.org

Lebanese Environmental Party (LEP)
Founded by seven Lebanese environmental activists (mostly from civil society) in 2005 the LEP counts today 68 members. The Party is a pilot body in planning strategies and preparing policies. They helped prepare several strategies related to water management, transport, quarries, prevention of oil pollution on the seashore, solid waste, and renewable energies. A public interest body, the LEP seeks to influence government policy and thus collaborated with the MOE in formulating the 2010-2012 Work Plan. http://lepinlebanon.com/

Education, and Information as well as the Civil Defence and the Lebanese Red Cross. The NERC will develop (1) a general framework for combating disasters, (2) a detailed contingency plan to respond to threats from various types of disaster (i.e., earthquakes, floods, forest-fires, landslides, weapons of mass destruction, wars, and radioactive threats), and (3) an emergency management plan when a disaster occurs. The Swiss Embassy approved $800,000 in funding through UNDP to provide "Support to the Prime Minister's Office - Strengthening Disaster Risk Management Capacities in Lebanon." Managed by the Prime Minister's Office, the project will provide technical assistance to the NERC to develop policies and strategies, as well as plan for disaster preparedness and response.

Municipalities
Lebanon has about 994 municipalities which are organized according to Legislative-Decree 118 dated 30 June 1977. Municipal councils are elected by their constituency and consist of 9, 12, 15, 18, 20 or 24 (Beirut and Tripoli only) members depending on the size of the constituency. Municipalities are local administrations charged with the day-to-day management of all public works located inside their jurisdiction (municipal boundaries). Specific responsibilities are wide and diverse including (Article 49) landscaping and beautification works, water and wastewater networks, street lighting, waste disposal, internal roads, recreational facilities, as well as urban planning in coordination with the Directorate General of Urban Planning. Revenues include municipal taxes and other fees levied by the municipality as well as transfers from the Independent Municipal Fund. Unfortunately, despite significant administrative autonomy, municipalities in Lebanon face chronic shortages in municipal finances and revenues. Their capacity to manage funds is also limited by administrative skills such as the use of information technology and procurement systems. A number of municipalities in Lebanon have received significant support, including direct financing, for specific activities such as standardizing and automating municipal procedures (USAID), solid waste management (EU-OMSAR), and reforestation (MOE and GiZ-EFL).

2.1.3 Judiciary System

Although Lebanon's judiciary system is not specialized in environmental matters, it has in recent years acquired resources to investigate and arbitrate environmental issues more effectively. The judiciary system, consisting of judges and prosecutors, helps stop or curtail environmental abuses and crimes around the country provided that such abuses and crimes are detected and reported. The judiciary system is critical to enforcing environmental laws and regulations and policies.

In an effort to support the judiciary system in the enforcement of environmental legislation, the World Bank funded a project to review and analyze environmental court cases in Lebanon (2007-2010). Implemented by the ministries of Justice and Environment and managed by UNDP, the project "Supporting the Judiciary System to the Enforcement of Environmental Legislation" (SEEL) compiled a database of 469 *published* environmental jurisprudence cases (based on the review of about 100,000 published cases), as well as close to 6,000 *unpublished* cases and 200 cases from France for comparison purposes. Expectedly, the number of cases increased over the last decades indicating an upward trend in the frequency of environmental problems and in environmental consciousness.

The MOJ/MOE/UNDP project also introduced environmental law in the curriculum of the Judicial Training Institute. Subject to funding availability, the World Bank may extend the project for another three years to assess legislative needs, improve training centers, institutionalize a joint review committee between the ministries of Environment and Justice, and seek out twinning arrangements between corresponding institutions in Lebanon and France for cross-learning and peer-to-peer exchange.

Environmental Prosecution

Lebanon does not have general prosecutors who are specialists in the environment. To fill this gap, the Ministry of Justice has been designating one general prosecutor in each governorate to look into environmental cases. These prosecutors are not environmental specialists per se and can be replaced at will. To support their work, the SEEL project compiled a database of environmental experts to serve as a repository of expertise for jurisprudence cases. In 2010, and based on a first draft prepared by the Green Party of Lebanon, the MOE produced a draft law to institutionalize the *general prosecutor for the environment* pursuant to Environment Law 444/2002 (see details in Section 2.3.1). These prosecutors would be familiar with environmental issues and able to prosecute environmental cases more effectively, and with the support of external subject-matter experts as needed. According to Article 2 of the draft law, the environmental prosecutor would prosecute environmental crimes and violations related to forests, protected areas, biodiversity, air quality, water, soil, noise, quarries, classified establishments, municipal commons, government estates and international waters. Of interest to environmental prosecution and accountability is the analysis conducted by SELDAS (see project description in Section 2.2.3) that identified legal avenues for protecting people who have been affected by an environmental crime. The analysis is incorporated in ***Annex 3*** for reference.

Environmental Police

The final stage in the judiciary system is enforcement. Lebanon has no environmental police (ditto for the tourism sector) and therefore faces great challenges when it comes to enforcement of laws and regulations. So far, it has been the responsibility of the municipal police (petty cases only) and the Internal Security Forces (larger cases) to enforce decisions and court case rulings regarding environmental abuses and pollution. All too often, the work of the municipal police and ISF is restricted by patron-client relationships. To address this weakness, the MOE drafted a decree (currently discussed with the MOIM) to institutionalize Lebanon's environmental police (pursuant to Article 8 of Law 690/2005), according to which the police may fall under the authority of the "Service of Regional Departments and Environmental Police" in cooperation with the MOIM. This police force is expected to help curb environmental crimes and execute legal rulings, provided they remain impartial, are immune to patron-client relationships and have the necessary tools and equipment at their disposal including vehicles, digital cameras, GPS instruments, noise meters…

2.2 ENVIRONMENTAL LAWS AND REGULATIONS

The process of law and policy making in Lebanon is not well defined. While government agencies including the Lebanese Parliament and the Council of Ministers prepare and release a battery of laws and regulations, procedures are not clear and inconsistent. For example, some draft regulations may require many years before enactment (e.g., EIA decree) while others are enacted in record time (e.g., health care waste decree). Upstream policy formulation is often lacking. Frequent cabinet reshuffles further delay and jeopardize policy making as new governments and ministers tend to shelve previous policies, or policies still in the making, and start all over with a new team of advisors. This stop-and-go approach has indisputably also affected the state of environmental affairs in the country. The following sections glean over key laws and regulations starting with the Lebanese Constitution and Multilateral Environmental Agreements.

2.2.1 The Lebanese Constitution

There is no direct reference to the environment in Lebanon's Constitution (1923). However, Article 15 of the Constitution valorizes the private property and bans any form of land acquisition except for the public interest (subsequently broadly interpreted as the provision of public services including roads, electricity, and water). The perception that the private property enjoys absolute protection under the Lebanese constitution has so far impeded sustainable land use planning, selected conservation efforts, and the delineation and demarcation of protected areas. A closer examination however of the urban planning law in effect (Law 69/1983) and the revised construction law (Law 646/2004) reveals several provisions that either restrict or totally ban construction on private lands under certain conditions. See detailed analysis of urban planning and construction laws, as well as other regulations, in Chapters 6 (Land Resources) and 7 (Haphazard Urbanization).

2.2.2 Multilateral Environmental Agreements

The next echelon in environmental legislation is Multilateral Environmental Agreements (MEAs) including conventions and treaties. Lebanon, a full voting member in the United Nations General Assembly since 1945, has acceded to and ratified more than a dozen conventions and treaties related to the environment *–see targeted list in* ***Annex 2***. Some of these conventions and treaties, not all, carry serious reporting obligations on the Lebanese Government, usually represented by the Ministry of Environment. Examples include the UNFCCC in response to which Lebanon has so far produced two national communications (for baseline years 1994 and 2000) and the CBD in response to which Lebanon has produced four national reports (1998, 2003, 2006, and 2009). Ratification of these conventions has also secured Lebanon millions of dollars in funding from international development organizations including multilateral funding instruments (Multilateral Fund under the Montreal Protocol) and bilateral organizations (see illustrative list in Section 2.5).

2.2.3 Milestone Environmental Laws and Regulations

This SOER cites a plethora of environmental laws and regulations as well as other legislation affecting the environment, listed chronologically at the end of each chapter (including this chapter). In an effort to identify and analyze existing legislation affecting the environment in Lebanon, the MOE implemented an EU-funded project in partnership with the UNESCO-Cousteau Ecotechnie Chair at the University of Balamand and with the technical assistance of Earth Link and Advanced Resources Development (ELARD) (January 2003 – September 2005) --see project description and output in Box 2.5. The following examples highlight a targeted selection of milestone laws and regulations approved and enacted in the last decade (since the 2001 SOER). They are all instrumental to environmental governance and management.

- **Chapter 2 (Environmental Governance): Environment Law 444/2002.** Approved by parliament in 2002, the law is an overarching legal instrument for environmental protection and management. It has defined 11 environmental principles.

Environmental principles according to Article 4 of Law 444/2002:

1. Precaution (cleaner production techniques)
2. Prevention (best available technologies)
3. Polluter-Pays-Principle (polluters pay for pollution prevention and control)
4. Biodiversity conservation (in all economic activities)
5. Prevention of natural resources degradation
6. Public participation (free access to information and disclosure)
7. Cooperation between central government, local authorities, and citizens
8. Recognition of local mores and customs in rural areas
9. Environmental monitoring (pollution sources and pollution abatement systems)
10. Economic incentives to encourage compliance and pollution control
11. EIA process to control and mitigate environmental degradation

Like most laws, Environment Law 444/2002 requires application decrees, some of which are complex and have stirred protracted political debate. In total, Law 444/2002 needs 36 application decrees to achieve full implementation. Naturally, this is not expected to happen overnight and probably not in the next decade (2011-2020). However, the following three decrees warrant immediate attention:

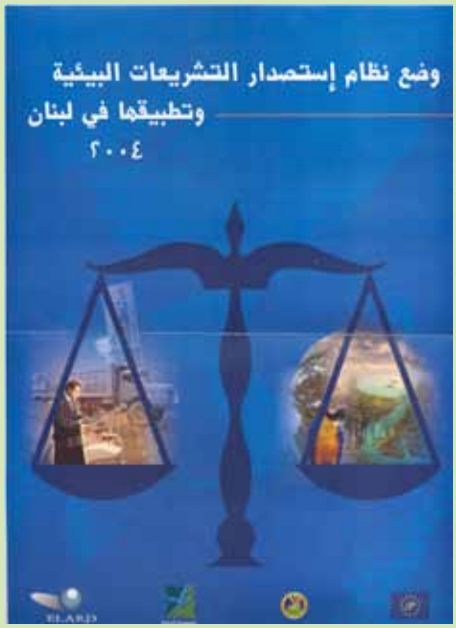
Proposed Decree	*Reference in Law 444/2002*	*Status (as of 01/01/2011)*
National Environmental Council	Chapter 2, Article 6-7	Approved by Council of State
National Environmental Fund	Chapter 3, Article 8-11	Draft sent to MOF for review
Environmental Impact Assessment	Chapter 4, Article 21-23	Approved by Council of State

It should be noted that the first draft Environment Impact Assessment decree was prepared almost a decade ago in the framework of a regional project funded by the Mediterranean Environmental Technical Assistance Program (METAP) and implemented by the World Bank. Despite unreasonable delays in passing the decree, MOE has been enforcing the EIA in many sectors by mainstreaming the EIA process into the permitting procedure of several line ministries including Public Works & Transport, Industry, and Tourism.

Box 2.5 Strengthening the Environmental Legislation Development and Application System in Lebanon (SELDAS)

The SELDAS project engaged many stakeholders including parliament, the Constitutional Council, line ministries (Justice and Education), bar associations, universities and NGOs. It helped raise awareness about environmental legislation development, application and liability, and promoted environmental law education in several universities. The project culminated in the production of the book *State of the Environmental Legislation Development & Application System in Lebanon* (SELDAS). This 500-page compendium of selected laws and regulations (published before 31/12/2003) is divided into 14 chapters:

1. Construction and the environment
2. Land use and the environment
3. Transport and the environment
4. Energy and the environment
5. Industry and the environment
6. Agriculture and the environment
7. Tourism and the environment
8. Water and wastewater
9. Air
10. Noise
11. Soil
12. Biodiversity and natural heritage
13. Solid waste
14. Cross-cutting legislation



SELDAS can be downloaded in PDF from the Ministry of Environment website and copies are available at the Ministry of Environment. http://www.moe.gov.lb/Books/Pages/seldas%20book.aspx

Source: EU/UOB/MOE/ELARD, 2005

- **Chapter 3 (Water): Law 221 and 241/2000** which reorganized Lebanon's 21 water authorities and over 200 local water committees into four new Water Establishments plus the Litani River Authority. In 2005, the COM enacted four decrees (14596, 14602, 14600 and 14598) defining the mandate and bylaws of each water establishment including personnel size and structure. Although little has been achieved to date insofar as incorporating the local water committees into the new water establishments, this development marks an important paradigm shift in Lebanon's handling of the water sector and will eventually improve service delivery and the protection of water resources. *See full analysis in Chapter 3 on Water.*
- **Chapter 4 (Air Quality): Decision 8/1 dated 30 January 2001** defined environmental limit values for stack emissions and effluent discharge from classified establishments, wastewater treatment plants, and hospitals. The decision disaggregates stack emission limit values by industrial sector (e.g., power plants and generators, cement, glass, aluminum, batteries, agro-foods, and incineration) and for new and existing industries.
- **Chapter 5 (Biodiversity and Forests): Law 92/2010** banning all land uses inside burnt forests to prevent future acts of arson. In the last decade, Lebanon has witnessed a spate of forest fires that reached devastating proportions in 2007. Concomitantly with the preparation of needed forest fire fighting strategies and action plans, Parliament approved the law in the hope that it will deter some arsonists from burning forests to harvest fuel wood or alter land uses.
- **Chapter 6 (Land Resources): Decree 2366/2009** approved the National Land Use Master Plan that was prepared in 2002-2004. This master plan is Lebanon's first attempt to unify and organize land use holistically and while respecting basic premises including decentralization, economic growth, and environmental protection. Land use planning is very complex, and impacted by century-old legislation and mores. Realigning Lebanon's regional master plans (about 99 decreed so far and 85 approved but not decreed), even partially, will require many years of hard work and more importantly goodwill and appreciation of the public good. *See targeted analysis of the Master Plan in Chapter 6.*
- **Chapter 7 (Haphazard Urbanization): Decree 8803/2002** and its amendments related to the quarry sector. Lebanon's

quarry sector is notoriously chaotic and devastating to environmental resources and landscapes. The long-awaited National master Plan for Quarries was promulgated in 2002 (and amended twice in 2006 and 2009). While enforcement is still ludicrous, this decree and MOE's presidency of the National Council for Quarries may signal a new era in the sector.

- **Chapter 8 (Solid Waste): Decree 8006/2002** amended by Decree 13389/2004 which categorized health care waste and set guidelines for health care waste management. The decrees have unequivocally improved HCWM services and increased awareness of the issue. *See full analysis in Chapter 8 on Solid Waste.*
- **Chapter 9 (Energy): Law 132/2010** related to the oil and gas activities in Lebanese territorial waters. Lebanon has been investigating for years the suspected presence of oil and gas deposits in its waters and approved the law in anticipation of future exploration and extraction activities as well as potential conflict over the demarcation of territorial and economic waters with neighboring countries. Environmental safeguards and the EIA process are prominently featured in Law 132/2010 (Articles 6, 7, 32, 54).

2.3 ENVIRONMENTAL RESEARCH AND DEVELOPMENT

Lebanon has a dynamic research community that brings together both public and private institutions. This research community however is constrained by limited funding and oftentimes works in a vacuum, disconnected from the environmental research needs of the surrounding society. There is no easy way to bridge research initiatives with the environmental issues and problems facing Lebanon but several examples attest to great advances in research and development that have led to tangible environmental results. The following paragraphs showcase the work of key institutions, including public and private, as well as recent advances in environmental monitoring (see Box 2.6).

Box 2.6 Environmental Monitoring –some examples

Environmental monitoring requires skills and sustained resources. Since 2004, an inter-agency agreement involving the Beirut Municipality, the American University of Beirut, Saint Joseph University and the National Council for Scientific Research has institutionalized air quality monitoring in the GBA.

In 2009, and with AECID funding, Spanish Tragsatec produced one of the most inspiring and fact-filled ecological study of the Palm Islands Nature Reserve and formulated guidelines for its management.

Also in 2009, USAID launched the *Litani River Basin Management System* (LRBMS). This $8 million project will assist the Litani River Authority in implementing long-term water monitoring that is based on routine collection of water data for information-based decision-making processes.

In 2010, Lebanon signed a project agreement with the Government of Greece to improve environmental monitoring systems and capabilities in the country. The $1.64 million agreement will cover air quality, biodiversity and coastal resources.

2.3.1 Industrial Research Institute (1955)

Established in 1955, the Industrial Research Institute (IRI) is a Lebanese not-for-profit institution dedicated to industrial research and scientific testing and analysis. Although the institution was in 1955 declared of public utility (Legislative-Decree 10059 dated 17/8/1955) and in 1997 linked to the Ministry of Industry (Law 642 dated 2/6/1997), it continues to enjoy administrative and financial autonomy and, unlike ministries, can expand and restructure itself as needed as well as hire and fire at will. For example, with grant funding from the European Commission and the Austrian Government through UNIDO, the MOE established in 2002 the Lebanese Cleaner Production Center (LCPC). Recognizing the need to provide an enabling environment for LCPC activities, the Center was in 2004 formally relocated to the premises of the Industrial Research Institute located in Hadath where it provides technical assistance and advice to private industries on cleaner production methods. Another unique branch of IRI is its sophisticated and well trained laboratory which has to date earned accreditation for more than 300 testing methods used in a dozen lab units. In terms of staffing, IRI has about 127 people, 50 percent of which work in the lab.

2.3.2 Lebanese Agricultural Research Institute (1957)

Established in 1957, the Lebanese Agricultural Research Institute (LARI) is a public institution dedicated to research for the development and advancement of the agricultural sector in Lebanon. It falls under the aegis of the Ministry of Agriculture (Decree 16766/1957 amended by Decree 6474/1967 and Law 71/1 of 1971) but continues to enjoy administrative and financial autonomy. The institute has eight experimental stations (Tel Amara, Tourbol, Kfardan, Kfarchakhna, Abdeh, Sour, Fanar and Lebaa) most of them located in agricultural

View of the Industrial Research Institute located in the Lebanese University campus, Hadath

areas. LARI, supported by UNDP, FAO, WB and other international organizations, conducts research projects on (1) olive propagation, (2) cereal and grain legume development, (3) pasture and forage production, (4) barley development program, and (5) male sterile insect technology for biological control. Hand-in-hand with the farming community, LARI conducts other activities including production of best quality seeds, diagnosis of animal diseases, production of vaccines, food quality control, soil analysis, and development of appropriate feed composition for plant protection. LARI operates 48 compact weather stations evenly distributed throughout the country and has started to provide weather data to famers through an SMS service. All weather data is available on www.fieldclimate.com (username and password needed).

2.3.3 National Council for Scientific Research (1962)

Established in 1962 (Law dated 14/9/1962) as a central science and policy-making public institution under the authority of the Prime Minister, the National Council for Scientific Research has significant administrative and financial autonomy. Its functions are advisory (national science policy, government proposals, surveys and inventories of on-going research) and executive (initiates, encourages and coordinates selected research activities through its Scholarship Grant Program and Research Grant Program). In the period 2006 to 2007, NCSR sponsored 120 studies including 21 in the environmental sector (17%). The council has four subsidiary centers: (1) National Center for Remote Sensing, (2) National Center for Atomic Energy, (3) National Center for Geophysical Research, and (4) National Center for Marine Sciences.

2.3.4 Tripoli Environment and Development Observatory (2000)

Established in 2000, the Tripoli Environment and Development Observatory (TEDO) is today a formal observatory incorporated in the Federation of Municipalities of Al-Fayhaa based on COM Decision 18 dated 9/12/2004 and boasts seven full-time employees. The observatory monitors key environmental factors in Tripoli, El Mina and Beddawi, and has an air pollution lab that is equipped with fixed and mobile air quality monitoring equipment. TEDO is the only observatory of its kind in Lebanon and it has been successfully institutionalized long after the initial funding ended.

2.3.5 Lebanese Center for Energy Conservation (2011)

Established in 2002, the Global Environment Facility funded the Lebanese Center for Energy Conservation (LCEC) which is currently hosted at the Ministry of Energy and Water and managed by UNDP. The LCEC was registered as an organization in 2011 (Attestation No. 172 dated 27/1/2011) to address end-use energy conservation and renewable energy at the national level. The Center provides policy and technical support to the MOEW to promote energy efficiency and renewable energy at the consumer level. LCEC is a financially and administratively independent and operates under the direct supervision of the Minister of Energy and Water.

2.3.6 Environmental Diplomas, Degrees and Research Centers

Good environmental governance requires good environmental professionals; people who understand the environment in all its facets, and appreciate the interconnectedness of environmental issues and sectors. Also in the last decade, Lebanese universities have seen a gradual increase in environmental diploma courses and degrees, and the number of environmental students is rising slowly but surely. Student data from leading universities show that the American University of Beirut, Université Saint-Joseph, University of Balamand, Lebanese University, Université

Saint-Esprit de Kaslik, Notre Dame University, Lebanese American University and the Arab University are graduating dozens of students from environment-related majors (sciences, engineering, health, etc.).

Most of these universities have established environmental centers with full-time staff. A survey conducted for this SOER counted at least 16 centers and institutes, most of which were established since the 2001 SOER was published. Over the long-term however, the continued appeal of environmental majors in Lebanese universities will depend on the job market. Lebanon needs to create and institutionalize many more green jobs in the coming decade to sustain the flow of fresh graduates. To assess the job market situation, the International Labor Organization (ILO) and UNDP commissioned a nationwide study to assess green job potentials. Preliminary results show that renewable energy, waste, and agriculture (Integrated Pest Management and organic agriculture) have the potential to offer the greatest number and diversity of green jobs (ILO-UNDP 2011, unpublished).

See ***Annex 4*** for a full list of environmental degrees (updated December 2010) and ***Annex 5*** for a list of environment-related research centers and institutes in universities in Lebanon.

2.4 ACCESS TO ENVIRONMENTAL INFORMATION AND DATA

At the core of environmental management lies environmental data and access to it (see Box 2.7 on the Aarhus Convention). Without reliable data, it is difficult and oftentimes futile to articulate policies and project proposals. While it is true that Lebanon generates more environmental data today than it did 10 years ago, much of these data are hard-wired in environmental reports that are neither publicized nor inventoried. There is no portal system of environmental studies, and guidelines and protocols on public disclosure are missing. By comparison, several international organizations upload all non-confidential reports on their websites or online portals (Arab Forum for Environment and Development, USAID, World Bank, etc.). The absence of such a portal system at the CDR and ministries is leading to redundancies in the collection of environmental data. Equally important, there is no readily available database on environmental monitoring. Environmental monitoring data related to air quality (in particular emissions) and water (surface, groundwater and marine) is still lacking. This impairs the quality of EIAs studies which remains predominantly qualitative.

Box 2.7 Aarhus Convention 1998

Lebanon has yet to sign and ratify the 1998 Aarhus Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters. This milestone convention was developed by the United Nations Economic Commission for Europe (UNECE) to promote and enhance access to environmental information. Accession is open to non ECE countries.

Despite these deficiencies, the state of environmental data in Lebanon has improved contrary to routine critiques from all segments of society (students, managers, legislators, etc.) that data is lacking. In an effort to facilitate access to information, the MOE published in 2005 a compendium *Paths to Environmental Information – Contacts & Sources* which presents a baseline list of recognized experts, institutions and websites related to key environmental themes. The MOE also prepared a draft decree on access to information in the framework of the EC-funded SEA project. The following examples show a quantum leap in data quality and availability compared to the 2001 SOER. Nevertheless, much more can be done to improve data generation, structure and accessibility.

2.4.1 Central Administration of Statistics

Established in 1979, the Central Administration of Statistics (CAS) is a public administration within the Presidency of the Council of Ministers (COM). It is organized according to Decree 1793/79 and Decree 2728/80 and today boasts 100 full-time employees. CAS collects data from many sources in Lebanon including ministries, institutions, ports, airports, etc. Under the UN Fundamental Principles of Official Statistics and the EU Statistics Code of Practice, the Center produces (1) social (residents in Lebanon, households, employment rate, etc.), (2) economic (industrial foreign trade including imports and exports, sea transport: loaded/unloaded cargo, air transport: total landings, public finance: total internal and external VAT collection amounts, etc.), and (3) *environmental* (water resources, rainfall series, forest fires, etc.) statistics at the national level.

Before 2000, CAS used to publish Monthly Statistical Bulletins, free of charge. Today, in addition to monthly bulletins available on CAS's website in excel format www.cas.gov.lb, the Center compiles yearly data, generates statistics and publishes Statistical Yearbooks. Statistical

Yearbooks consist of nine parts related to the *environment*, human resources, agriculture, industry, business register, construction, transport, post, financial sector, prices and foreign trade. The yearbooks are available online (and hard copies), also free of charge.

2.4.2 National Land Use Master Plan Geodatabase

The National Land Use Master Plan (CDR-NLUMP, 2004) developed a national geodatabase (known as a spatial database) which is a database designed to store, query, and manipulate geographic information and spatial data using ArcGIS software. The geodatabase was produced by Dar Al-Handasah (Shair and Partners) and IAURIF (the consortium that was awarded the contract to prepare the Master Plan). Many institutions supplied data to buttress and consolidate the database, including:

1) Directorate General of Geographic Affairs (Ministry of National Defense or MOND), provided the topographic maps (1960–1963)
2) National Council for Scientific Research, in cooperation with the MOE, provided the Land Use Land Cover Map (2002)
3) Central Administration of Statistics, provided socio-economic and housing data at the cadastral level (1996 and 2002)
4) Ministry of Public Works and Transport, provided the road network (2002)
5) Directorate General of Urban Planning (MOPWT) provided decreed and approved urban master plans

The national geodatabase is available in two projections: Lambert and Stereographic. It includes 16 themes each of which contains several shapefiles (group of files that contain a set of points, arcs, or polygons that hold tabular data and spatial attributes). *See full structure of the national geodatabase developed under the project in **Annex 6.***

2.4.3 Council for Development and Reconstruction

Since the mid 1990s, the Council for Development and Reconstruction (CDR) publishes every year a progress report that presents a detailed summary of investments in four sectors (physical, social, basic services, and productive and other sectors), and assesses works completed as well as pipeline contracts. The reports are available online at www.cdr.gov.lb and can be viewed free of charge. CDR maintains a list of private companies accredited to conduct environmental studies.

2.5 ACCESS TO ENVIRONMENTAL FUNDING

As mentioned in Section 2.2.2, ratification of major environmental conventions and treaties by the GOL has secured sizable grants and program funding from the international community. Leading development organizations include the Global Environment Fund (GEF operates through implementing agencies such as UNDP, UNEP and the World Bank), the Agence Française de Développement (AFD), the Canadian International Development Agency (CIDA), the European Union (EU), the French Global Environment Facility (FFEM), the German International Cooperation (GiZ), the Italian Cooperation in Lebanon, the Japanese Government, the Norwegian Government, the Spanish Agency for International Cooperation (AECID), the US Agency for International Development (USAID), and many others.

War and conflict have an expediting effect on international funding, as experienced after the war in July 2006 and the conflict in Nahr El Bared in May 2007. For example, GiZ invested about €4.5 million to setup the Environmental Fund for Lebanon (EFL) to help organizations mitigate war-related environmental degradation. Coordinated by the MOE and CDR, the EFL project selected 17 interventions as part of a first call for proposals (2008-2010). Beneficiaries included municipalities, NGOs and firms and contributions ranged from €38,000 to €300,000 (a second call for proposals was launched in 2010 and is discussed in Chapter 3 of the SOER). Total post-war funding by the international community in the environmental sector reached an estimated $50 million. The Lebanon Recovery Fund (LRF), which was established at the request of the GOL to enable donors to provide rapid assistance and funding in the aftermath of the July 2006 war, recently agreed to host the Eastern Mediterranean Oil Spill Restoration Trust Fund, described in UN Resolution 65/147 (see details in Chapter 9 on Lebanon's energy crisis).

Looking ahead, Lebanon urgently needs to mobilize and sustain environmental funding over the long term starting with fully expending the budget allocated to the MOE based on a clear and transparent work planning process. Several funding instruments are in the early stages of design and bode well for the future of environmental development in the country, provided there is political will for success. For example, MOE drafted a decree to setup the National Environmental Fund pursuant to Law 444/2002 (Articles 8, 9, 10 and 11).

According to this decree, the fund would have a legal identity, financial and administrative autonomy, and would fall under the mandate of the Ministry of Environment. Funding and fund replenishment would come from several sources including provisions in the GOL's annual budget, environmental fees, grants, fines and compensations, and interest on deposits. Building on the EFL experience to date and the anticipated launch of the National Environmental Fund, the World Bank is assessing the feasibility of designing and implementing the Lebanon Pollution Abatement Project (LEPAP, to the tune of $35 million) to improve environmental performance from point-sources (industries only) leading to environmental compliance with Lebanese emission and discharge standards.

Also at the government level, the Central Bank of Lebanon launched in 2010 a mechanism to promote green financing. The bank has developed so called green loans for environmental projects with favorable financing conditions. Regionally, Lebanon is playing a lead role in the establishment of the Arab Environment Facility, which was announced at the 2003 World Environment Day in Lebanon. Lebanon is expected to host the facility under the aegis of the League of Arab States. Corporate Social Responsibilities (CSR) represents another avenue for funding environmental projects and shouldering the costs of environmental conservation and sustainable development. Lebanon is experiencing a spate of CSR initiatives (e.g., Happy Planet by BankMed) but most of these initiatives have yet to produce long-lasting results.

2.6 ADVOCACY AND PUBLIC PARTICIPATION

Advocacy is speaking on behalf of someone. Environmental advocacy is presenting information on nature and environmental issues that is decidedly opinionated and encourages its audience to adopt more environmentally sensitive attitudes. Demands by non-governmental organizations and other civil society organizations to benefits sharing, to their right to know, to a cleaner environment, to safe drinking water, to public parks and green spaces are all examples of advocacy initiatives.

A quick review of the number of Non-Governmental Organizations (NGOs) and Community Based Organizations (CBOs) in Lebanon attests to the burgeoning activity of civil society. According to MOE records, there are more than 300 NGOs in Lebanon with environmental objectives which are registered at the Ministry of Interior and Municipalities. The number of CBOs is probably even higher but such grassroots organizations normally do not seek formal government recognition.

The majority of the environmental NGOs have a broad spectrum of activities but some have in recent years developed niche competencies and capabilities in selected fields including *reforestation* (Jouzour Loubnan, Friends of the Cedars of Bsharre Committee, etc.), *forest fire prevention* (Association for Forest Development and Conservation), *forest management and restoration* (Friends of the Tannourine Cedars Nature Reserve, Mada, T.E.R.R.E.), *organic farming and slow food* (Greenline Association), *protected area designation and management* (Friends of Horsh Ehden, Al Shouf Cedars Society, Association for the Protection of Jabal Moussa, etc.), and *trail development* (Lebanon Mountain Trail Association, Baldati, etc.). These NGOs, and many others, advocate specific conservation needs and have spearheaded a number of programs with verifiable impacts on the ground. The MOE has and continues to support environmental NGOs subject to funding availability (see Box 2.8 on MOE's grant system). Civil society in Lebanon should not only be expected to design and implement conservation projects, subject to their areas of interest and geographic focus. Article 19 of the Environment Law 444/2002 recognizes the inherent right of the public to participate in decision making. The most structured form of public participation is public hearings and consultations organized in the context of EIA and SEA studies. The MOE has prepared a draft decree to organize and formalize public participation in projects that require EIAs and/or SEAs. The draft decree states that public meetings and hearings should be organized by the project proponent in coordination with the concerned municipality or Kaemakam and after completing the environmental study. The project proponent

Box 2.8 MOE Grants Program for NGOs

MOE has been disbursing funds to NGOs to support civil society initiatives in the environmental sector. In the absence of any formal guidelines, these grants were initially disbursed randomly and frequently motivated by patron-client relationships. To protect the grant system from partisan influence and other forms of political pressure, MOE and MOF enacted Decree 14865 (dated 1/7/2005) to define NGO eligibility criteria, application procedures, and performance evaluation requirement. Exercising the decree is contingent on the formal approval of the annual budget by the Government.

must deliver a copy of the environmental study at least two weeks before the hearing and is responsible for covering all expenses related to the hearing. Ensuing deliberations should be incorporated in the final study.

Other forms of public participation include televised debates and documentaries (Akhdar / Azrak on FTV, Tahkik on MTV, etc.), radio interviews, and submission of editorial pieces to newspapers and magazines. Several leadings newspapers feature regular weekly columns on the environment and heritage (Al Nahar, Assafir, Al Mustaqbal, etc.). In an effort to encourage environmental reporting, the MOE honored environmental reporters during celebrations on World Environment Day. More recently, the advent of social media tools has created unlimited opportunities for public expression. The following examples present three popular magazines that cover environmental issues in Lebanon and the region.

Environment and Development Magazine
The magazine is the first pan-Arab environmental news magazine in Arabic, changing the public perception of environment in the Middle East. Launched in Beirut in June 1996, the *monthly* magazine is now on newsstands in most Arab countries. Environment & Development is a strong regional authoritative voice on environmental policies, well respected and listened to. The magazine supports more than 300 environment clubs in schools, has a regular supplement entitled The Young Environmentalist, and publishes a quarterly wall chart entitled The Green Bulletin. http://www.mectat.com.lb/

البيئة والتنمية

World Environment Magazine
The magazine and online TV is dedicated to cover worldwide environmental issues and improvements such as global warming, water scarcity, waste management, sustainable development, energy efficiency, eco tourism activities, eco living tips, etc. Through articles and interviews, WE Magazine aims to educate and promote awareness to environmental issues. WE Magazine is addressed to decision-makers and businessmen in the environment field by offering specialized technical news in English. *Four issues* (5,000 hard copies and 10,000 soft copies) are distributed *yearly* in MENA regions including Lebanon, gulf area and Europe. http://www.worldenvironment.tv/

Beyond Magazine
Launched in April 2010 in Beirut, *Beyond* Magazine provides information on Lebanese and global environmental issues. It is a quarterly magazine, published in English and Arabic; its pages are full of features, news, fascinating photos and interviews with decision-makers, environmental specialists and other relevant players. http://www.beyond-magazine.com/

So long as law enforcement is painfully lacking in Lebanon, and accountability is sporadic, Lebanese citizens and the media have a fundamental role in monitoring environmental activities and crimes.

2.7 UNDERSTANDING AND PROMOTING ENVIRONMENTAL GOVERNANCE –THE PUZZLE

The previous sections provided a quick overview of selected environmental institutions, environmental laws and regulations, environmental research, environmental information, environmental funding, as well as environmental advocacy and media. Each component has witnessed improvements and setbacks over the past decade and will continue to play out in the next decade. This report argues that all the components must be strengthened collectively to improve environmental governance which will, in turn, improve policy-making related to managing the environment and natural resources. The pieces of the puzzle therefore make up a dynamic system (see Figure 2.1). To sustain and improve environmental governance, it is assumed that Lebanon enjoys a certain level of economic and political stability, and security. War and conflict have a destabilizing effect on countries including its economy and the environment. (The cost of environmental degradation due to the July 2006 war and related findings are featured in relevant sections of this SOER).

Recognizing the challenges ahead, the EU is seriously examining the feasibility of funding an €8 million program *Support to Reform of Environmental Governance* (StREG) slated to start in 2012 and extend over four years. The overall objective of StTREG is to improve the environmental performance of the Lebanese public sector by reforming environmental governance through four complementary angles: legal, administrative, financial and technical. The contracting authority will be the Presidency of the Council of Ministers and the beneficiary will be the Ministry of Environment.

Figure 2.1 The pieces of the environmental governance puzzle

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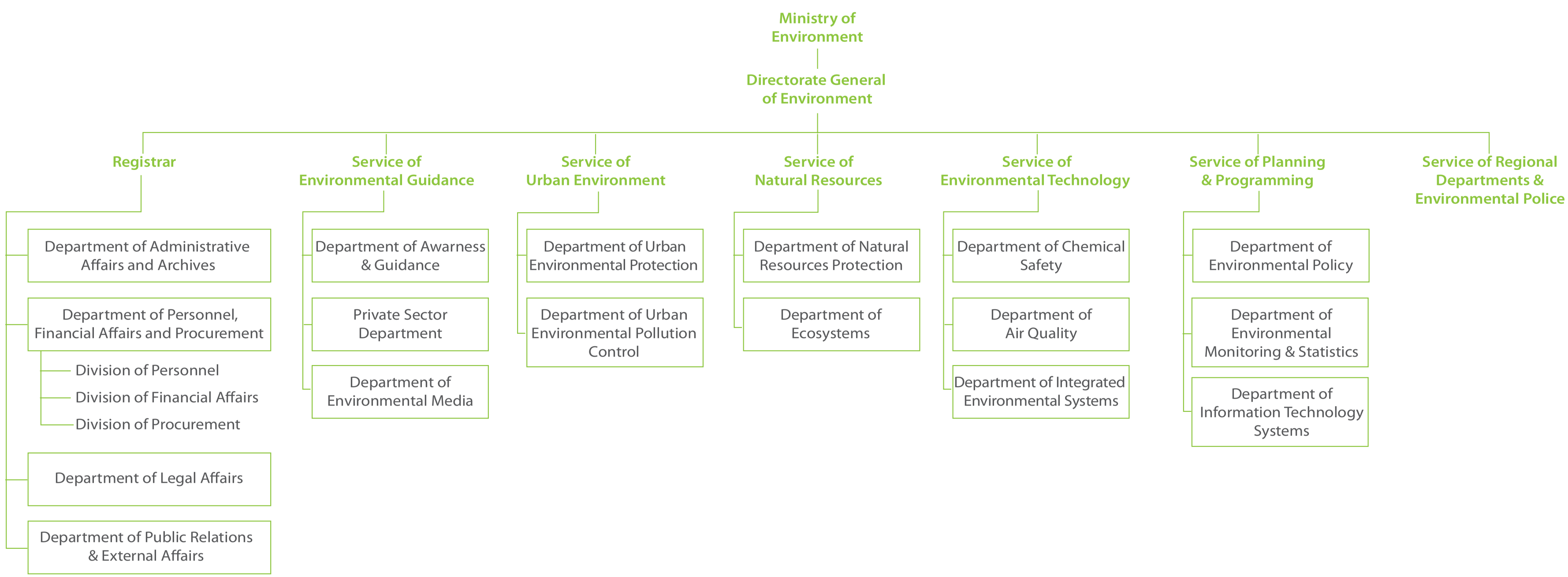
ILO-UNDP, 2011	Assessment of Green Jobs in Lebanon (in progress). Prepared by the International Labor Organization and UNDP, 2011 (unpublished).
MOE Work Plan 2010-2012	http://www.moe.gov.lb/Documents/MoE%20PoW%202010-2012%20(English%20Draft).pdf
MOJ/MOE/UNDP 2010	واقع البيئة في المحاكم اللبنانية, UNDP and Ministry of Justice, 2010.
UNMACC 2009	Quarterly Report for the Period of October-December 2008, UN Mine Action Coordination Centre (UNMACC) - South Lebanon, January 2009

CITED LEGISLATION RELATED TO ENVIRONMENTAL GOVERNANCE

نوع النص	الرقم	التاريخ	عنوان النص
قانون		١٩٦٢/٠٩/٠٤	إنشاء مجلس وطني للبحوث العلمية
مرسوم اشتراعي	١١٨	١٩٧٧/٠٦/٣٠	قانون البلديات
مرسوم	١٧٩٣	١٩٧٩/٠٢/٢٢	إنشاء ادارة عامة تدعى ادارة الاحصاء المركزي
مرسوم	٢٧٢٨	١٩٨٠/٠٢/٢٨	تنظيم ادارة الاحصاء المركزي وتحديد ملاكها والشروط الخاصة للتعيين في وظائف هذا الملاك وسلسلة رتبها ورواتبها وتحديد التعويضات وشروط التصنيف
قانون	٢١٦	١٩٩٣/٠٤/٠٢	إحداث وزارة البيئة
قانون	٦٤٢	١٩٩٧/٠٦/٠٢	إحداث وزارة الصناعة
قانون	٦٤٢	١٩٩٧/٠٦/٠٢	احداث وزارة الصناعة
قانون	٦٦٧	١٩٩٧/١٢/٢٩	إحداث وزارة البيئة
قانون	٢٢١	٢٠٠٠/٠٥/٢٩	تنظيم قطاع المياه
قانون	٢٤١	٢٠٠٠/٠٨/٠٧	تعديل القانون ٢٢١
قانون	١/٨	٢٠٠١/٠١/٣٠	المواصفات والمعايير المتعلقة بملوثات الهواء والنفايات السائلة المتولدة عن المؤسسات المصنفة ومحطات معالجة المياه المبتذلة
قانون	٣٧٧	٢٠٠١/١٢/١٤	تعديل القانون ٢٢١
قانون	٤٤٤	٢٠٠٢/٠٧/٢٩	حماية البيئة
مرسوم	٨٠٠٦	٢٠٠٢/٠٦/١١	تحديد أنواع نفايات المؤسسات الصحية وكيفية تصريفها
مرسوم	١٣٣٨٩	٢٠٠٤/٠٩/١٨	تعديل المرسوم رقم ٨٠٠٦ تاريخ ٢٠٠٢/٦/١١ تحديد انواع نفايات المؤسسات الصحية وكيفية تصريفها
مرسوم	١٤٥٩٦	٢٠٠٥/٠٦/١٤	النظام الداخلي في مؤسسة مياه بيروت وجبل لبنان
مرسوم	١٤٦٠٢	٢٠٠٥/٠٦/١٤	النظام الداخلي في مؤسسة مياه لبنان الشمالي
مرسوم	١٤٦٠٠	٢٠٠٥/٠٦/١٤	النظام الداخلي في مؤسسة مياه لبنان الجنوبي
مرسوم	١٤٥٩٦	٢٠٠٥/٠٦/١٤	النظام الداخلي في مؤسسة مياه البقاع
قانون	٦٩٠	٢٠٠٥/٠٨/٢٦	تحديد مهام وزارة البيئة وتنظيمها
مرسوم	٢٢٧٥	٢٠٠٩/٠٦/١٥	تنظيم الوحدات التابعة لوزارة البيئة وتحديد مهامها وملاكها وشروط التعيين الخاصة في بعض وظائفها
مرسوم	٢٣٦٦	٢٠٠٩/٠٦/٢٠	الخطة الشاملة لترتيب الاراضي اللبنانية
قانون	١٣٢	٢٠١٠/٠٩/٠٢	الموارد البترولية في المياه البحرية
قانون	٩٢	٢٠١٠/٠٣/١١	المحافظة على المساحات الخضراء المحترقة وعدم تغيير وجهة استعمالها

ANNEX 1 ORGANIZATIONAL STRUCTURE OF THE MINISTRY OF ENVIRONMENT



Source: Adapted from Decree 2275/2009

ANNEX 2 MULTILATERAL ENVIRONMENTAL AGREEMENTS RATIFIED BY THE GOL

(Listed Chronologically)

Year	Name of Convention, Treaty & Protocol	Adhesion, Signature, Accession, Ratification	Law/Decree Date
2008	Amendments to Barcelona Convention	Adhesion	Law No.34 16/10/2008
2006	Cartagena Protocol on Biosafety	Adhesion	Law No.31 16/10/2008
2005	Kyoto Protocol to the United Nations Framework Convention on Climate Change aiming to fight Global Warming	Adhesion	Law No.738 15/5/2006
2004	Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade	Adhesion	Law No.728 15/5/2006
2004	Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic-ACCOBAMS	Adhesion	Law No.571 5/02/2004
2002	Agreement on the Conservation of African-Eurasian Migratory Water Birds (AEWA)	Adhesion	Law No.412 13/6/2002
2001	Stockholm Convention on Persistant Organic pollutants for adoption by the conference of plenipotentiaries	Signature: 22/5/2001 Accession	Law 432 08/08/2002
1999	Beijing Amendment of Montreal Protocol	Adhesion	Law No.758 11/11/2006
1999	Convention on Wetlands of International Importance especially as Waterfowl Habitat-Ramsar	Adhesion	Law No.23 1/3/1999
1994	United Nations Convention to Combat Desertification-Paris	Ratification	Law No.469 21/12/1995
1992	United Nations Framework Convention on Climate Change-Rio de Janeiro	Ratification	Law No.359 11/8/1994
1992	Convention on Biological Diversity-Rio de Janeiro	Ratification	Law No.360 11/8/1994
1992	Amendment to the Montreal Protocol on Substances that deplete the Ozone Layer-Copenhagen	Adhesion	Law No.120 3/11/1999
1990	Amendment to the Montreal Protocol on Substances that deplete the Ozone Layer-London	Adhesion	Law No.253 31/3/1993
1989	Basel Convention on the Control of Transboudary Movements of Hazardous Wastes and their Disposal-Basel	Ratification	Law No.387 21/12/1994
1987	Montreal Protocol on Substances that deplete the Ozone Layer-Montreal	Adhesion	Law No.253 31/3/1993
1986	Convention on Early Notification of a Nuclear Accident-Vienna	Ratification	Law No.566 24/7/1996
1986	Convention on Assistance in Case of a Nuclear Accident-Vienna	Ratification	Law No.575 24/7/1996
1985	Vienna Convention for the Protection of the Ozone Layer-Vienna	Adhesion	Law No.253 30/3/1993
1982	Protocol Concerning Mediterranean Specially Protected Areas-Geneva	Adhesion	Law No.292 22/2/1994
1982	Convention of the Sea (Mont –Diego Bay) – Jamaica	Adhesion	Law No.295 22/2/1994
1980	Protocol for the Protection of the Mediterranean Sea against Pollution from Land-based Sources-Athens	Adhesion	Law No.292 22/2/1994

Year	Name of Convention, Treaty & Protocol	Adhesion, Signature, Accession, Ratification	Law/Decree Date
1976	Protocol Concerning Co-operation in Combating Pollution of the Mediterranean Sea by Oil and Other Harmful Substances in Cases of Emergency-Barcelona	Signature: 16/2/1976 Accession	Decree law No.126 30/6/1977
1976	Convention for the Protection of the Mediterranean Sea against Pollution-Barcelona	Signature: 16/2/1976 Accession	Decree law No. 126 30/6/1977
1976	Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft-Barcelona	Signature: 16/2/1976 Accession	Decree law No. 126 30/6/1977
1973	International Convention for the Prevention of Pollution from Ships-London	Adhesion	Law No.13 28/5/1983
1972	UNESCO Convention on the Protection of Cultural & Natural Heritage	Adhesion	Law 19 30/10/1990
1971	Treaty on the Prohibition of the Emplacement of Nuclear Weapons and other Weapons of Mass Destruction on the Seabed and the Ocean floor and in the Subsoil-London-Moscow-Washington	Ratification	Decree No. 9133 7/10/1974
1969	International Convention relating to Intervention on the High Seas in cases of Oil Pollution Casualties-Brussels	Ratification	Decree No. 9226 12/10/1974
1969	International Convention on Civil Liability for Oil Pollution Damage-Brussels	Ratification	Law No. 28/73 12/10/1973
1963	Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and in Underwater	Ratification	Law No. 59/64 30/12/1964
1963	Convention on Civil Liability for Nuclear Damage-Vienna	Adhesion	Law No. 565 1/8/1996
1954	International Convention for the Prevention of Pollution of the Sea by Oil-London	Adhesion	Law No. 68/66 16/11/1966

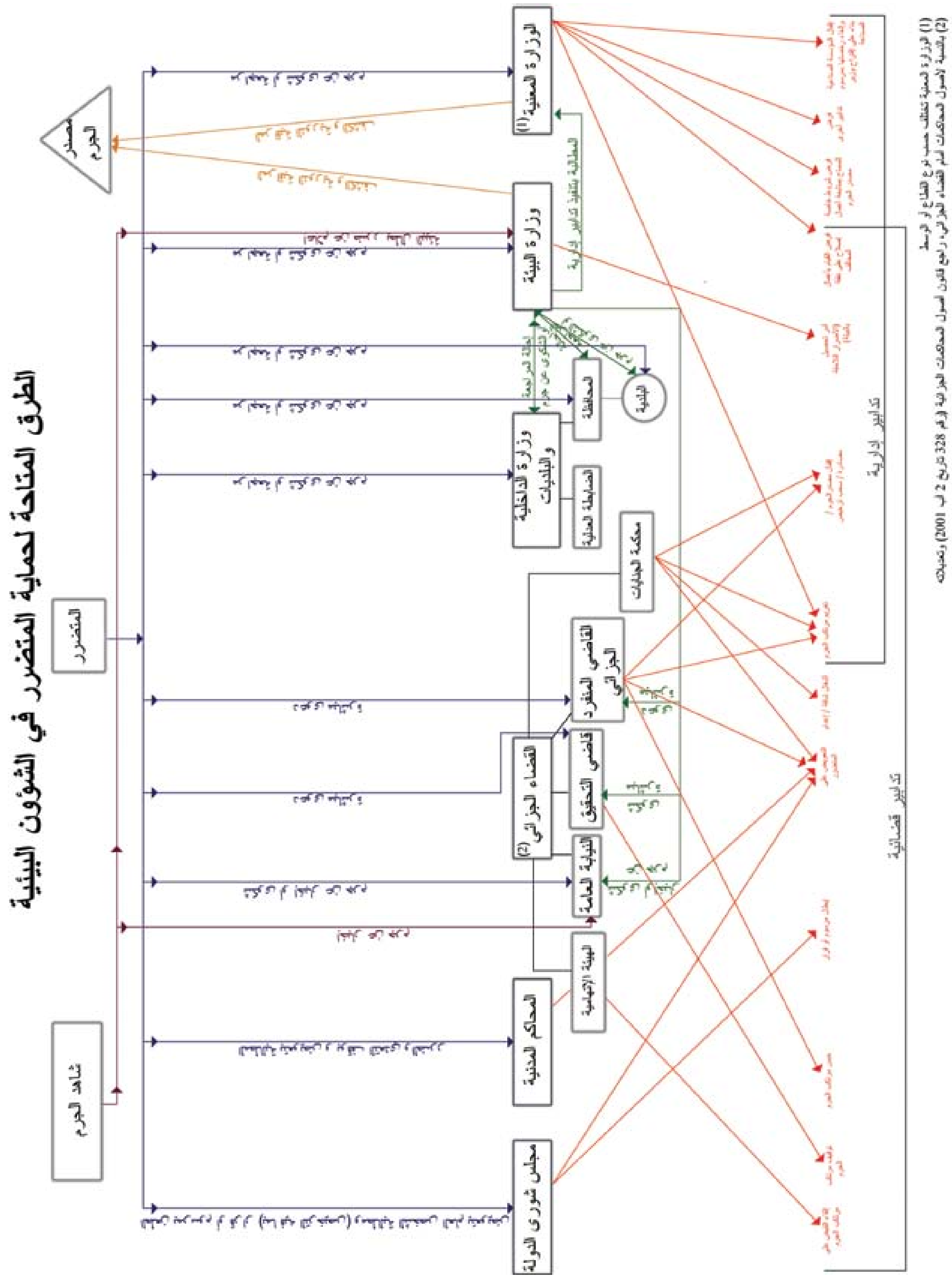
Notes:

Signature of a treaty is an act by which the State expresses its interest to the treaty and its intention to become a Party. Treaty signature is not binding. **Accession** is the usual method by which a State, which has not taken part in the negotiations, signed the treaty and is subsequently consent to be bound by its terms. **Ratification** is an act by which the State expresses its definitive consent to be bound by the treaty. It must then respect the provisions of the treaty and implement it by a Law within the statutory allowed period. The date corresponds to the date of publication in the Official Gazette in Lebanon. **Adhesion** is the usual method by which a State, which has not taken part in the negotiations and has not signed the treaty, subsequently adheres to the treaty by law and is consent to be bound by its terms.

Source: Based on pers. comm. Nancy Khoury, Department of Public Relations and External Affairs, MOE

ANNEX 3 LEGAL AVENUES FOR PROTECTING ENVIRONMENTAL VICTIMS

الطرق المتاحة لحماية المتضرر في شؤون البيئة



Source: EU/UOB/MOE/ELARD, 2005

ANNEX 4 UNIVERSITY LEVEL ENVIRONMENTAL PROGRAMS OFFERED IN LEBANON

University	Major	Degree
American University of Beirut (AUB)	Ecosystem Management	Master of Science
	Environmental and Water Resources Engineering	Master of Engineering; Philosophiae Doctor
	Environmental Health	Bachelor of Science & Master of Science
	Environmental Policy Planning	Master of Science
	Environmental Sciences	Master of Science
	Environmental Technology	Master of Science
	Landscape Design and Ecosystem Management	Bachelor of Science
	Urban Design	Master of Urban Design
	Urban Planning and Policy	Master of Urban Planning and Policy
Notre Dame University (NDU)	Landscape Urbanism	Master of Architecture
	Geographic Information System	Bachelor of Science
	Environmental Science	Bachelor of Science
Université Saint-Esprit Kaslik (USEK)	Chimie de l'environnement	Master
	Qualité et traitement des eaux	Master
	Océanographie et environnement marin	Master
Lebanese American University (LAU)	Civil and Environmental Engineering	Master of Science
Université Saint Joseph (USJ)	Environnement et Aménagement du Territoire	Licence, Master Recherche et Doctorat
	Sciences et gestion de l›environnement	Master
	Eau et environnement	Ingénieur
	Sciences de l›eau	Master Recherche et Doctorat
University Of Balamand (UOB)	Environmental Sciences	Bachelor of Science and Master of Science & Philosophiae Doctor
	Public Health and Development Sciences	Bachelor of Science
	Environmental Engineering	Master of Science
	Urbanisme	Master
	Aménagement du Paysage	Master
Beirut Arab University (BAU)	Environmental Science	Bachelor of Science, Master of Science & Philosophiae Doctor
	Urban Planning	Master of Science
	Urban Design	Master of Science
Université Libanaise (UL)	Expertise et traitement en environnent	Master Professionnel et Recherche
	Gestion et conservation des ressources naturelles (biodiversité)	Master Professionnel
	Phyto-écologie	Master Professionnel
American University of Technology (AUT)	Water Resources and Geo-Environmental Sciences	Bachelor of Science
	Environmental Health	Bachelor of Science

Note: Hagazian, Sagesse, Hariri Canadian University, and American University of Sciences and Technology currently offer no environmental degrees or diploma courses.

Source: Compiled by ECODIT for 2010 SOER

	Faculty	Educational Requirements
	Faculty of Agricultural and Food Sciences	3 years following Lebanese Baccalaureates
	Faculty of Engineering and Architecture	5 years following Lebanese Baccalaureates & 3 years following Master degree
	Faculty of Health Sciences	3 years following Lebanese Baccalaureates & 2-3 years following Bachelor degree
	Faculty of Arts and Sciences	2-3 years following Bachelor degree
	Interfaculty	2-3 years following Bachelor degree
	Faculty of Engineering and Architecture	2-3 years following Bachelor degree
	Faculty of Agricultural and Food Sciences	3 years following Lebanese Baccalaureates
	Faculty of Engineering and Architecture	2-3 years following Bachelor degree
	Faculty of Engineering and Architecture	2-3 years following Bachelor degree
	Faculty of Architecture, Art & Design	2-3 years following Bachelor degree
	Faculty of Natural and Applied Sciences	3 years following Lebanese Baccalaureates
	Faculty of Natural and Applied Sciences	3 years following Lebanese Baccalaureates
	Faculté des sciences	2-3 years following Bachelor degree
	Faculté des sciences	2-3 years following Bachelor degree
	Faculté des sciences	2-3 years following Bachelor degree
	School of Engineering	2-3 years following Engineering degree
	Faculté des lettres et des sciences humaines	3 years following Lebanese Baccalaureates, 2-3 years following Bachelor degree and 3 years following Master degree
	Faculté des sciences	2-3 years following Bachelor degree
	École supérieure d›ingénieurs de Beyrouth	5 years following Lebanese Baccalaureates
	École supérieure d›ingénieurs de Beyrouth	2-3 years following Bachelor degree & 3 years following Master degree
	Faculty of Sciences	3 years following Lebanese Baccalaureates, 2-3 years following Bachelor degree & 3 years following Master degree
	Faculty of Health Sciences	3 years following Lebanese Baccalaureates
	Faculty of Engineering	2-3 years following Bachelor degree
	Académie Libanaise des Beaux-Arts (ALBA)	2-3 years following Bachelor degree
	Académie Libanaise des Beaux-Arts (ALBA)	2-3 years following Bachelor degree
	Faculty of Sciences	3 years following Lebanese Baccalaureates, 2-3 years following Bachelor degree and 3 years following Master degree
	Faculty of Architectural Engineering	2-3 years following Bachelor degree
	Faculty of Architectural Engineering	2-3 years following Bachelor degree
	Faculté des sciences	2-3 years following Bachelor degree
	Faculté des sciences	2-3 years following Bachelor degree
	Faculté des sciences	2-3 years following Bachelor degree
	Faculty of Applied Sciences	3 years following Lebanese Baccalaureates
	Faculty of Applied Sciences	3 years following Lebanese Baccalaureates

ANNEX 5 ENVIRONMENTAL CENTERS AND INSTITUTES IN UNIVERSITIES IN LEBANON

(Listed alphabetically by university name)

Center Name	*University*	*Research Area*
Academic Observatory for Construction and Reconstruction in Lebanon	ALBA	• Monitoring set of indicators on construction process and sustainable planning • Technical support to decision makers in the form of expert missions, consulting services, training, or other specific tasks in urban planning and development projects • Advocacy, lobbying and awareness rising in the fields of good governance, and sustainable planning
Environment and Sustainable Development Unit	AUB	Research on sustainable rural livelihoods
Nature Conservation Center for sustainable futures (IBSAR)	AUB	Biotechnology research, identification, characterization, and monitoring of biodiversity, landscape conservation, sustainable use of biodiversity
Environmental Engineering Research Center	AUB	Investigation on chemical, physical and biological contaminants associated with water, air, and solid wastes
Water Resources Center	AUB	Database for water resources studies
Aerosol Research Lab	AUB	• Research on aerosol dynamics, chemistry, combustion, computational fluid dynamics, instrumentation, and controls • Study research: tobacco smoke, urban and indoor air pollution and its sources, and fundamental problems in aerosol transport phenomena
Environment Core Laboratory	AUB	• Testing services for waste water, groundwater, soils, hazardous waste, sludges, leachates, compost, food, drinks, beverages, biological tissues. • Testing services for drinking water including physical, chemical, and microbiological analysis in addition to organic and inorganic analysis
Analytical Atmospheric Laboratory	AUB	• Research on ambient air pollution (pollutant levels and chemical composition)
Environmental Chemistry Laboratory	USEK	• Testing of physical and chemical properties of water, organic micro-pollutants, wastes, mud kinds and contaminated soils. • Specific analysis of compounds, such as polycyclic aromatic hydrocarbons (PAH). • Analysis of pharmaceutical substances and hormones in the aquatic environment.
Water Energy and Environment Research Center	NDU	Water resources management, international environmental conflict resolution and energy value
Center for Chemical Research and Analysis	USJ	Air quality
Regional Center for Water and Environment	USJ	Hydrology, drainage and treatment and water quality
Laboratory for Cartography	USJ	• Archiving, preservation and consultation of cartographic and aerial photos of Lebanon and the Middle East. • Teaching cartography and GIS • Research unit for teachers and students
Remote Sensing Laboratory	USJ	• Processing and analysis of satellite images, modeling and GIS. • Provision of technical assistance for research projects on: estimation of leaf water equivalent of snow pack Mediterranean and its flow in a karst environment (experiments in the catchments area of the Nahr Beirut), geological mapping using remote sensing and GIS applied to hydrology (case of the watershed of the Nahr Beirut) and modeling volume of geological basins of the Nahr Beirut Antelias (application to groundwater resources)
Geographic Information System (GIS) Centre	UOB	GIS: application development, database design, data acquisition, data conversion/development, geo-coding, geo-processing, training, map design, project planning and management, and spatial analysis
Institute of the Environment	UOB	Scientific research, loss of biodiversity, coastal management failure of food supplies, sustainable development and mismanagement of natural resources

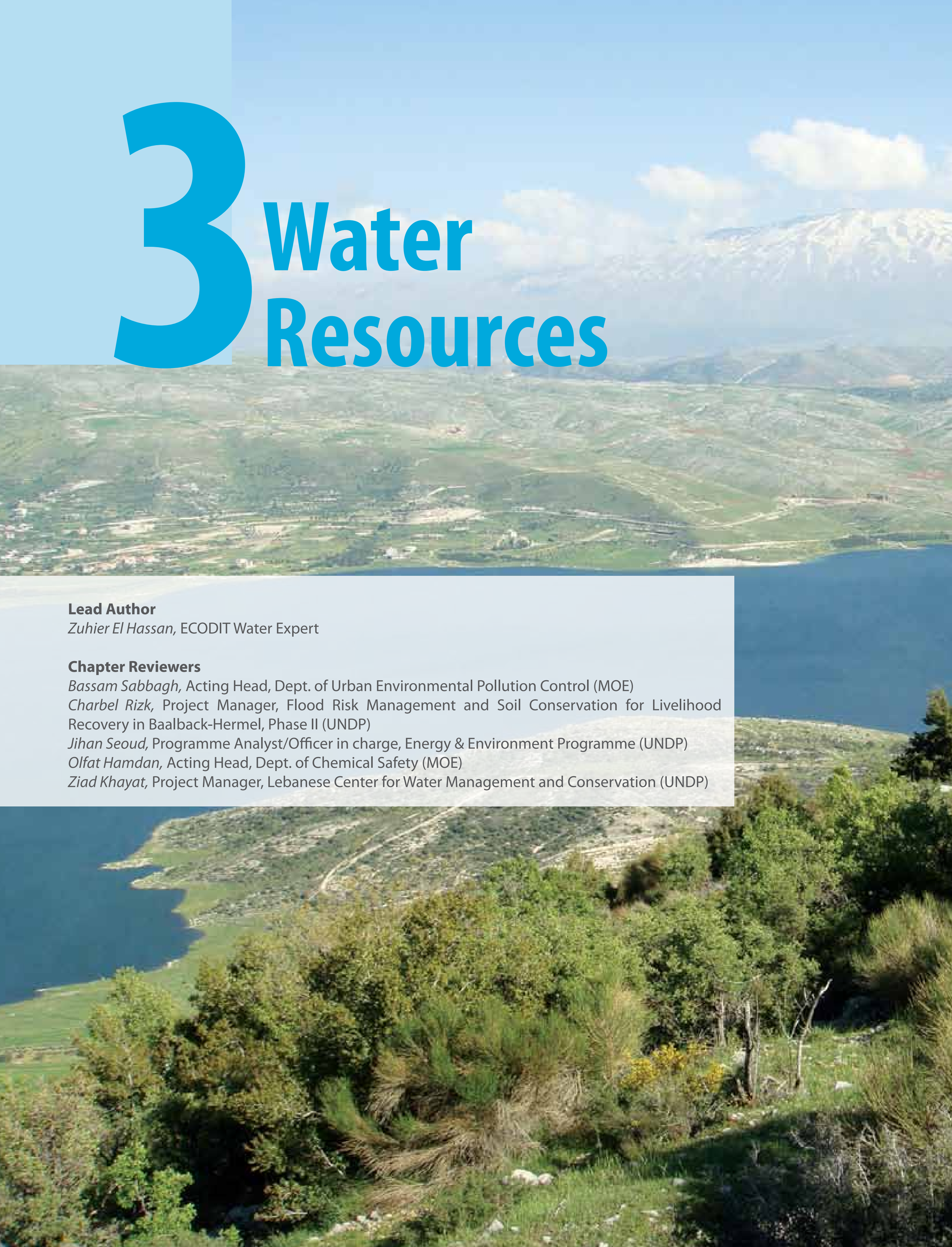
Abbreviations: ALBA Académie Libanaise des Beaux-Arts, AUB American University of Beirut, NDU Notre Dame University, USEK Holy Spirit University of Kaslik, USJ Université Saint-Joseph, UOB University of Balamand.

Source: Compiled by ECODIT for SOER 2010

ANNEX 6 STRUCTURE OF NATIONAL LAND USE MASTER PLAN GEODATABASE

Theme	Content as Shapefiles
Administrative Limits	Mohafaza, Caza, national border, sea border, mohafaza centers, chebaa limit, population, municipalities, islands, etc.
Economic Activities	Enterprises, decreeted industries, industries: ceramics, leather, chemical, food, metal, paper, etc.
Electrical & Telephone	Beirut suburbs electrical, mobile phones coverage, electric network, electric substation, fixed telephone coverage, power plant, etc.
Industrial Pollution & Quarries	Aggregates quarries, potential quarries, rock quarries, sand quarries, water polluting industries, air polluting industries, technological risks, etc.
Land cover	Agriculture_1967, forest_1967, landuse_1998, Land use Caza, landuse_Greater_Beirut_1998, etc.
Landscape Heritage	Beaches, historical sites, mountains areas, cliffs, cornices, natural landscapes, remarkable villages, etc.
Morphological Zones	Morphological zones, Agglomerations of: Baalbek, Sour, Nabatieh, Saida, Chtoura Zahle, Tripoli, etc.
National Master Plan	Areas Vocations, agriculture landscapes vocation, cornices vocations, cultural entities vocation, landscape valleys vocation, etc.
Natural Resources	Caves, Karst, faults 200k, biocorridors, geology 200k, hydrogeology, natural reserves, pedology 200k, rivers, rainfalls, springs, watersheds, protected areas, protected valleys, etc.
Natural Risks	Coastal flood, earthquake, erosion, flood, forest fire, etc.
Services Facilities	Academic schools, red cross, research centers, administrative and public services caza centers and villages, universities, hospitals, social associations, etc.
Sewage and Solid Waste	Industrial sea outfalls, sewage treatment plants, sewer sea outfalls, etc.
Topography	Contours 50m, TIN, slope, etc.
Transport	Airport, Beirut airport runways, railroads, roads, seaport, traffic intensity, etc.
Urban Structure Planning	Decreed schemes, un-decreed schemes, main urban agglomerations, main urban centers, major towns, urban areas 1963, etc.
Water Management	Buildings wells, existing lakes, irrigation perimeters, Litani authority boundary, hill lakes, water authorities, water treatment plants, etc.

Section II: State of the Environment



3 Water Resources

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ABBREVIATIONS & ACRONYMS

a.s.l.	Above sea level
AFD	Agence Française pour le Développement
AUB	American University of Beirut
BOD	Biological Oxygen Demand
BOOT	Build-Own-Operate-Transfer
BOT	Build Operate Transfer
CAS	Central Administration of Statistics
CDR	Council for Development and Reconstruction
CNRS	National Council for Scientific Research
EU	European Union
GBA	Greater Beirut Area
GDP	Gross Domestic Product
GiZ	German International Cooperation
LRA	Litani River Authority
MOEW	Ministry of Energy and Water
MOPH	Ministry of Public Health
NGO	Non Governmental Organization
NH_4	Ammonium
NLUMP	National Land Use Master Plan
NO_3	Nitrate
NWSS	National Water Sector Strategy
P_2O_5	Phosphorus Oxide
RHIA	Rafic Hariri International Airport
RWE	regional water establishments
STP	Sewage Treatment Plants
TDS	Total Dissolved Solids
TSE	Treated Sewage Effluent
TWA	Tripoli Water Establishment
UFW	Unaccounted for Water
USAID	United States Agency for International Development
WB	World Bank

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Water is one of the most precious resources in Lebanon. Unsustainable water management practices, increasing water demand from all sectors, water pollution (see Box 3.1), and ineffective water governance are key obstacles facing Lebanon's water sector. Meeting the country's water demand over the medium and long-term poses a significant challenge to the Government of Lebanon.

This chapter describes the impacts of rapid population growth, urbanization, economic growth and climate change on water resources. It describes the current situation including the availability of water resources and sources of pollution, and then assesses key responses to water issues. Opportunities for improving the water sector are presented under the Outlook section.

Box 3.1 What is *Water pollution*?

Water pollution is the contamination of water bodies including lakes, rivers, seas and groundwater. It is a major global environmental concern and one of the leading worldwide causes of deaths and diseases. Around 20% of the world's population has no source of safe drinking water (UN 2010).

3.1 DRIVING FORCES

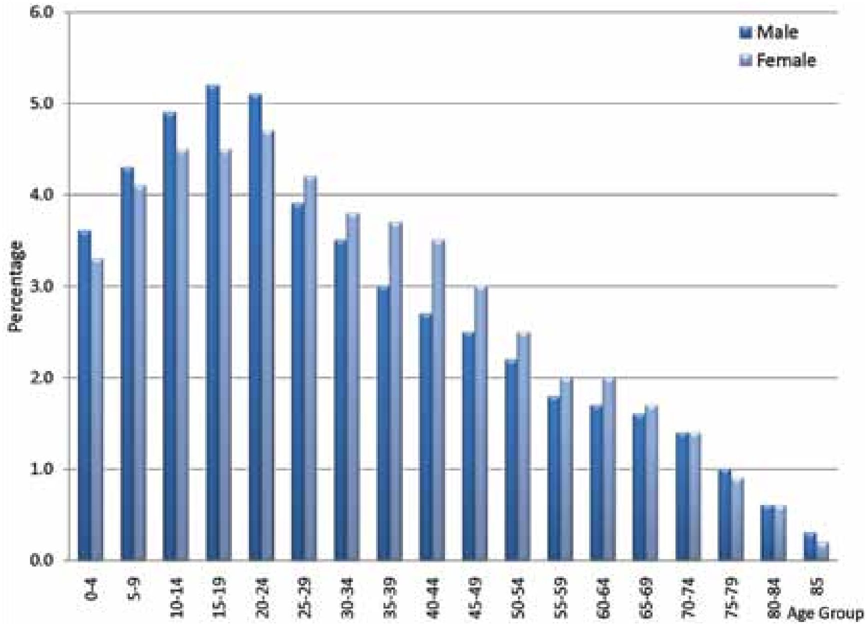
The driving forces affecting the quality and quantity of water resources in Lebanon are population growth and age structure, urbanization, economic growth and, more recently, climate change.

3.1.1 Population Growth

Population growth drives demand for water resources, energy, housing, transport, employment, and all other infrastructure. Although population impacts the environment and fragile ecosystems in many ways, population statistics in Lebanon remains unreliable at best. In assessing water resources, it is important to consider the total population in Lebanon (including refugees) and not just the resident population to capture the full impact on water resources. CAS records show that Lebanon's total population increased from about 4 million in 1996 to almost 4.2 million in 2007 –a net growth of about 170,000 people. This is not consistent with reported annual growth rates (1% to 2.5% depending on source), probably because of the concomitant rate of emigration. In 2006 alone, the number of people who left the country during and after the war, and did not return, was estimated at around 150,000.

An additional source of pressure on water resources is the age structure of Lebanon's population. Half of Lebanon's population is less than 29 years of age while 44 percent are under 25 years of age (Figure 3.1). Even if consumption rates stay constant, it can be expected that the number of new housing units will increase dramatically, from 843,600 in 2004 to 1,321,600 by 2030 (CDR-NLUMP, 2004). More housing means more networks and ancillary water infrastructure.

Figure 3.1 Age sex structure of population



Source: CAS 2008

For a more detailed analysis of the population distribution and growth rates, please refer to Chapter 1 (Section 1.3). Further pressure on water resources comes from tourism. According to the Ministry of Tourism website, 1.8 million visitors came to Lebanon in 2009. Whether they come for recreation, business or medical treatment, tourists consume more water than residents (400L/c/d for tourists compared to 150L/c/d for residents) but over a short time period.

3.1.2 Urbanization

Lebanon is a heavily urbanized country, with 88 percent of the population living in urban areas. This is the highest rate amongst Lebanon's neighbours including Syria (54.6%) and Jordan (78.5%). Additionally, 45 percent of Lebanon's population live in urban agglomerations of 1 million people or more, compared to 32 percent for Syria and 18 percent for Jordan (WB 2010a). See size and evolution of agglomerations in Table 3.1.

Table 3.1 Resident population per size of agglomeration

Size of Agglomeration	*1970*		*1997*	
Less than 1,000 inhabitants	391,440	18.41%	259,840	6.5%
1,000 to 2,000	246,945	11.61%	285,730	7.14%
2,000 to 5,000	187,260	8.81%	481,830	12.05%
5,000 to 10,000	68,415	3.22%	313,730	7.84%
10,000 to 100,000	136,005	6.4%	330,830	8.27%
More than 100,000	1,096,260	51.56%	2,328,040	58.20%
Total	2,126,325	100%	4,000,000	100%

Source: Dar Al Handasah – IAURIF 2004

Half of the country's urban population live in the Greater Beirut Area, GBA (WB 2009a). It is estimated that Lebanon's urban areas will grow by 10 square kilometres per year over the next 30 years (CDR-NLUMP, 2004). It should be noted that GBA comprises the city of Beirut and the southern and northern suburbs, which are the coastal part of Baabda caza, and coastal parts of the Metn caza. The cazas of Baabda and Metn are administratively part of Mount Lebanon.

This rate of urbanization has stressed water resources. As establishments have tried to meet growing demand in coastal cities, where the majority of Lebanese live, there has been an over reliance on pumping of wells and boreholes. This has resulted in a sever lowering of the water table in some aquifers, and salt water intrusion in coastal aquifers. The loss of coastal freshwater resources has led to shortages in supply of drinking water. The GBA, during the summer months, receives only three hours supply each day.

The growing urbanization has also resulted in the production of increased levels of untreated wastewater and solid waste, particularly in the coastal region. The cost of environmental degradation of random discharge of untreated sewage is estimated at 1 percent of GDP (WB 2010a). Lebanon's mountain public debt presents a formidable challenge for building, completing and operating wastewater collection and treatment systems to stop untreated effluent flowing into freshwater resources and coastal marine waters.

3.1.3 Economic Growth

Lebanon's economic development has been the main driver of urbanization in the country. During the 19th century Lebanon was largely an agrarian country. Throughout the 20th century the contribution of the services sector to overall economic growth, and to a lesser extent industry, increased in Beirut and the other major cities in Lebanon (Owen *et al.* 1998). Even after the Civil War, the contribution of the services sector to the economy continued its historical growth. The main drivers of this growth were construction (and reconstruction), tourism, and banking. Although the percent contribution of the agricultural sector to total GDP appears to be dropping (from 6 percent in 2005 to 5 percent in 2009 – see Table 3.2), the sector continues to be the largest water consumer in the country –about 60 percent of total freshwater goes for agriculture (WB 2010a).

Table 3.2 Sector, value added (% GDP)

Sector	*2005*	*2006*	*2007*	*2008*	*2009*
Agriculture	6	7	7	5	5
Industry	21	20	22	21	18
Services	72	73	70	73	78

Source: WB 2010a

Lebanon is categorised as a high middle income country (WB 2009a). Lebanon's GDP per capita increased from $5,356 in 2005 to $8,157 in 2009. It is recognised that as per capita incomes improve, water consumption increases. In the NLUMP, the increase in domestic water consumption was related directly to population growth, estimated at 30 percent by 2030; as well as the growth in daily consumption for personal use, which was estimated to increase by 10 percent by 2030 (MOE-UNDP 2011). While the NLUMP looks at a number of growth scenarios, under the middle scenario, to meet domestic water demand in 2030, Lebanon will have to supply 420 million cubic metres per year compared to the 280 million cubic metres per year supplied by the water authorities in 2005 (MOE-UNDP 2011).

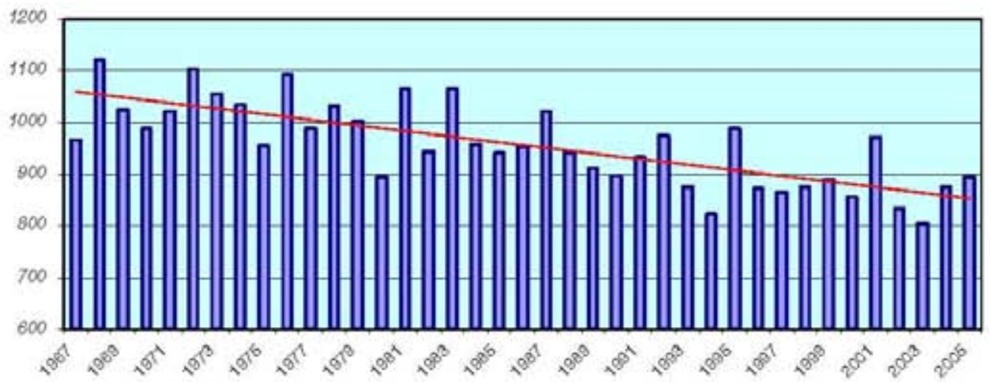
The WB estimates that as a result of this pattern of economic growth, agricultural demand on water resources will grow by one percent per year over the next 20 years, while domestic and industrial demands will grow by five percent per year. Industrial demand will triple due to the continued growth of tourism, while domestic demand will be driven by income and population growth (WB, 2009a).

3.1.4 Climate Change

Global warming will affect precipitation. This will be reflected in changes to "freshwater availability and quality, surface water runoff and groundwater recharge" (GEO 4, UNEP, 2007). Most of the studies dealing with this issue conclude that it is too early to discern a change in precipitation (MOE-UNDP 2011). The studies that have looked at the eastern Mediterranean region have revealed "…no detectable trend in precipitation or a major shift in the rainy season in the region over the last century" (MOE-UNDP 2011). Shaban, however, argues that Lebanon is witnessing signs of decreasing precipitation and increasing drought and desertification. Figure 3.2 shows a clear trend and a substantial decline in precipitation between 1966 and 2005. The study relied on data collected between 1966 and 1978, from 70 gauging stations distributed all over Lebanon, of with 66 percent are located in the western part of the country. For the period 1978-1997, the data was obtained from 11 gauge stations, while the number of stations after 1997 increased to 24 (Shaban 2009).

Lebanon's snow cover is vital to the country's water cycle and to replenishing aquifers

Figure 3.2 Precipitation 1967 – 2005 (mm)

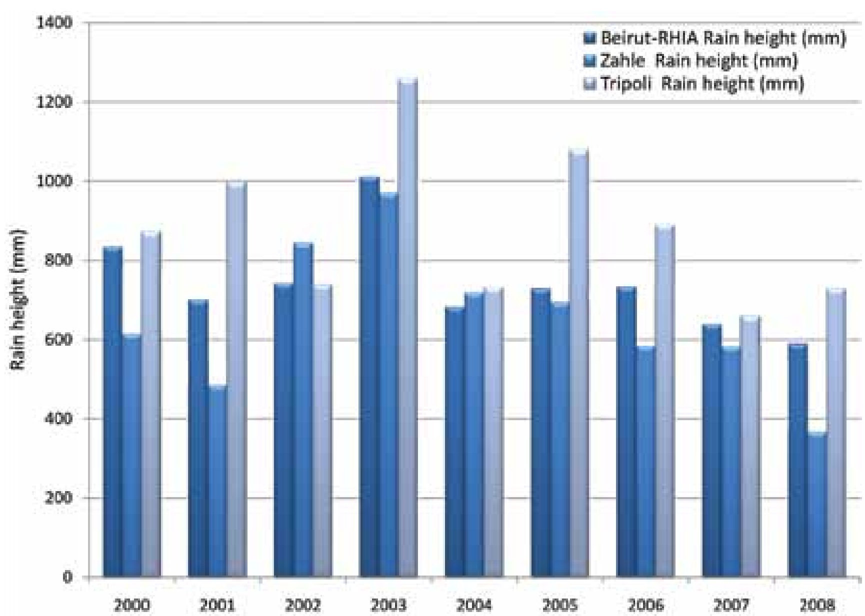


Source: Shaban 2009

In the last decade since the publication of the 2001 SOER, precipitation levels have been trending down. Because this is a very short time series, no conclusions can be drawn. The data in Figure 3.3 is presented for reference only.

Another factor affecting water availability is the inter-annual variability in rainfall in the drier inland regions of Lebanon. The coastal areas of Lebanon receive between 600 and 800 mm per year of rainfall, while the mountains receive between 1000 and 1400 mm per year. The inland Bekaa region receives between 200 and 600 mm per year while the south of Lebanon receives between 600 and 1000 mm per year. In the inland regions, it has been observed that inter-annual variability in mean rainfall ranges from less than 30 percent to over 200 percent, while in the coastal regions it ranges between 60 and 80 percent (MOE/ECODIT 2002). If, as most climate experts predict, the dry areas will become drier as the earth continues to warm up, the Litani River basin is going to see less rain in the future, which will have a substantial impact on water resources for irrigation because

Figure 3.3 Rainfall series in Beirut, Tripoli (Coastal Lebanon) and Zahle (Inland) (2000-2008)



Source: CAS 2009

the Litani River is the lifeline for agriculture in the Bekaa and South Lebanon.

Snow coverage and density have been declining. Lebanon's area is about 70-75 percent mountainous terrain. Historically, all the mountain regions were covered in snow at altitudes above 1,200 m during the winter. It should be noted that Lebanon does not have the capacity to measure the volume of snow cover with any degree of confidence, but some institutions such as the Regional Center for Water and Environment at USJ is conducting research related to snow cover and snowline. One of the most informative research papers related to snow was published in 2009 (Shaban 2009) according to which, before the 1990s, dense snow covered more than 2,000 km^2 of the mountains with an average of 2,280 km^2. The average dense snow cover has decreased to approximately 1,925 Km^2. Furthermore, the average time the dense snow remains before it starts to melt has decreased from an average of 110 days before 1990 to an average of 90 days after 1990.

As precipitation and snow coverage have decreased, *so have river flows in Lebanon*. The average yearly flow of Lebanon's rivers has decreased from 246 million m^3/year in 1965, to approximately 186 million m^3/year in 2005 (Shaban 2009). In the same period, average discharge from fresh water springs decreased from 104 million m^3/year to 49 million m^3/year. Equally, the surface area of the Qaroun Lake, the main lake in Lebanon, shrank from 5.14 km^2 (1965-1990) to 4.35 km^2 (1990-2005), equivalent to a 15 percent drop (Shaban 2009).

Groundwater discharges have also declined. The majority of the aquifers are karstic limestone formations categorised according to era of formation: Jurassic, Cenomanian, Turonian, Eocene, Miocene, Neogene. Shaban studied, for the period between 1987 and 2005, 193 Cenomanian wells in four regions, and 122 Jurassic wells in another four regions (see results in Tables 3.3 and 3.4). There is evidence of water table levels dropping. The Cenomanian and Jurassic aquifers in the Litani River basin (Bekaa) have dropped between 20 to 25m and 5 to 10m respectively. Furthermore, many wells and boreholes in the coastal cities have experienced irreversible saltwater intrusion.

Reduced precipitation, inter-annual variability, receding snow cover and declining groundwater discharge provide indisputable evidence of the impact of climate change on water resources. While it is difficult to predict future trends, the Second National Communication to the UNFCCC has developed projections of the impact of climate change on water resources availability (see Box 3.2).

Box 3.2 Future Projections of Climate Change on Water Resource Availability

Future projections are alarming. Lebanon's Second National Communication to the UNFCCC dealt with climate change in three periods: 1961 to 2000, 2025 to 2044, and 2080 to 2099. The report showed precipitation decreasing and losses due to evapo-transpiration increasing with global warming. If the temperature rise is 1C°, current total water resources estimated at between 2,800 Mm^3 and 4,700 Mm^3, will decrease by 250 Mm^3 per year. If the temperature rise is 2C°, resources will decrease by 450 Mm^3 per year.

The effect of global warming on snow, which is vital for water resources in Lebanon, is devastating. It is predicted that with a rise of 2C°, the snow cover in the mountain area above Ibrahim River will decrease by 50 percent. River flow patterns will be impacted greatly. River peak flow would shift from the end of April to the end of February. River flows would increase between December and February, and as snow melt decreases from April to June, river flows will dramatically decrease during periods of high demand for irrigation water.

Climate change is going to pose serious challenges for policy makers in Lebanon. The need to augment water resources to meet water sector demands and ecosystem maintenance and adaptability requirements will become urgent in the near and medium terms. Global warming is going to impact on all water resources, in terms of available volumes, the time of year they will peak and their quality.

Source: MOE-UNDP 2011

Table 3.3 Cenomanian well discharge rates (L/S)

City	Amchit		Beirut		Nabatieh		Zahle	
Year	1984	2005	1984	2005	1984	2005	1984	2005
Discharge	29	20	28	14	30	21	34	26

Source: Shaban 2009

Table 3.4 Jurassic well discharge rates (L/S)

City	Rachaya		Ajaltoun		Bikfaya		Qobaiyat	
Year	1987	2005	1987	2005	1987	2005	1987	2005
Discharge	30	23	30	24	34	25	30	26

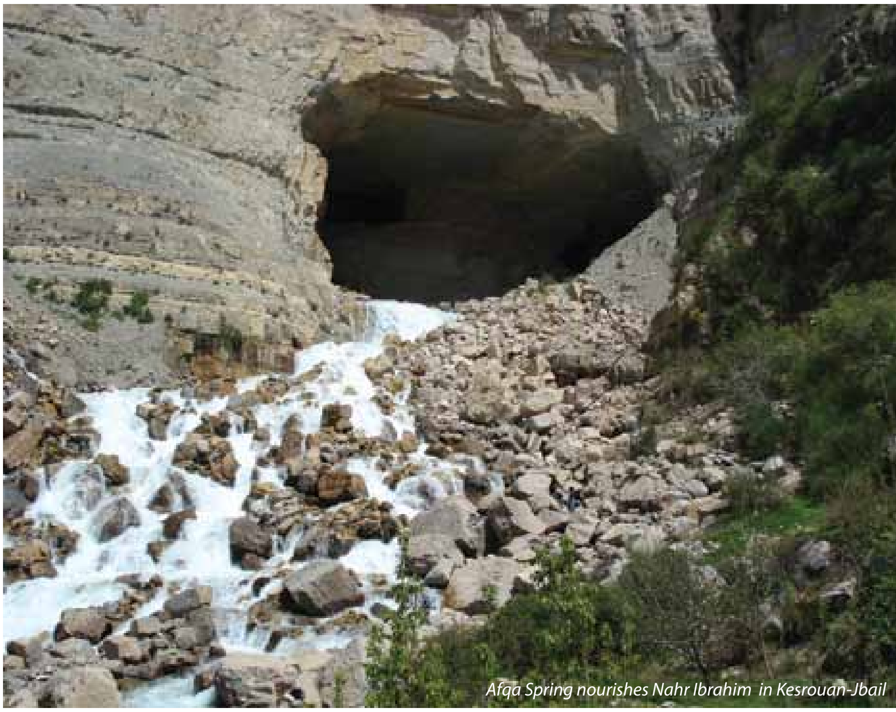
Source: Shaban 2009

3.2 CURRENT SITUATION

Lebanon's water resources are under stress. Available water including rivers and springs, storage dams and groundwater (estimated at 2,000-2,700 million m^3 per year) exceed projected water demand (about 1,800 million m^3 in 2035) but widespread pollution and substandard water infrastructure are restricting the Government's ability to meet water demands in the future.

3.2.1 Water Resources Availability

Some reports and studies put the average annual precipitation flows at 8.6 billion m^3 (MOE/ECODIT, 2002 & MOEW, 2010a). Other studies put it at 9.7 billion m^3 (CDR-NLUMP, 2004) of which one billion m^3 is due to snow (see Table 3.5). Most of these reports reference sources from the mid 1990s, while DAR –IAURIF use a source from 1989 (Mudallal 1989).



Afqa Spring nourishes Nahr Ibrahim in Kesrouan-Jbail

Table 3.5 Annual available resources (Million cubic metres Mm^3)

Source	***Mm$^{3(1)}$***	***Mm$^{3(2)}$***	***Mm$^{3(3)}$***	***Mm$^{3(4)}$***
Precipitation*	8,600	8,600	8,200	9,300
Evapo-transpiration	(4,500)	(4,300)	(4,100)	(4,500)
Losses	**(1,400)**	**(1,700)**	**(1,333)**	**(2,400)**
-Rivers to neighbours	(700)	(670)	(648)	
-Groundwater	(700)	(1030)	(685)	
Total Renewable Resources	**2,700**	**2,600**	**2,767**	**2,400**
-Surface Water	2,200		2,200	2,000
-Ground Water	500		567	400
Net Exploitable Resources	**2,700**	**2,000**	**2,767**	**2,400**

Sources: 1) MOEW, 2010b, 2) MOE/ECODIT, 2002, 3) MOEW, 2010c and 4) Fawaz, 1992

Note: Rain occurs for 90 to 100 days between October and April

Credit: ALES

Underground lake inside Ain Lebne cave in Aaqoura (Mount Lebanon)

The above data (Table 3.5) must be treated with caution because it is all based on measurements dating from the 1960s and 1970s. The case for setting up a modern and functional hydrometric network for measuring all hydrological parameters cannot be stated strongly enough. There is a pressing need to generate and consolidate continuous data relating to precipitation, river flows, soil infiltration and groundwater recharge, as well as losses to evaporation and evapo-transpiration. The undermining reality of all data on water resources is that Lebanon's four water establishments, combined, are currently exploiting less water resources than what is potentially exploitable (see Table 3.6).

Table 3.6 Exploited resources according to source type (Mm³/year)

Source	BMLWE	NLWE	SLWE	BWE	Total
Surface water (springs)	174	175	82	206	**637**
Groundwater (wells)	198	163	141	193	**695**
Storage (dams & lakes)	15		20	10	**45**
Total	**387**	**387**	**243**	**409**	**1,377**

Abbreviations: **BMLWE** Beirut and Mount Lebanon Water Establishment, **NLWE** North Lebanon Water Establishment, **SLWE** South Lebanon Water Establishment, and **BWE** Bekaa Water Establishment

Source: MOEW 2010a

Currently, water as defined by "present renewable resources per capita" in Lebanon is just over 1,100m³/capita/year, dangerously near the international benchmark of 1,000m³/capita/year, below which indicates water resources stress (WB 2009a). The MOEW puts the total renewable resources (drinking, industrial and irrigation) per capita per year at 926m³ and predicts it will drop to 839m³ by 2015 (MOEW 2010b).

Rivers

Lebanon has 16 perennial rivers and 23 seasonal rivers and total annual river flow is about 3,900 million m³, of which an estimated 700 million m³ flow into neighbouring countries. Seventy five percent of the flows occur between January and May, 16 percent between June and July and nine percent between August and October (Comair 2010). Accurate river flow data is hard to obtain in Lebanon, partially due to the impact of war and conflict on the country's river hydrometric systems and much of the data has been recycled over and over again. Monitoring river flows is the responsibility of the MOEW (Decree 5469 dated 07/09/1966) and is being carried out by the Litani River Authority (LRA). This report presents primary data obtained from LRA for two short time series, from 1971 to 1975 (five years) and from 2005 to 2009 (four years) (Table 3.7). Lebanon's highest river flows are Nahr el Litani, Nahr Ibrahim, and Nahr el Assi. Only two rivers do not discharge into the Mediterranean Sea (El Assi and Hasbani).

Water Storage

Lebanon has two dams, the Qaroun dam on the Litani River, and Chabrouh dam which captures rain runoff and runoff from Laban Spring. Their respective storage capacity is 220 million m³ and 8 million m³ (static storage capacity). Presently, only 30 million m³ is being utilised from the Qaroun Dam for water supply and irrigation and the rest is used to generate electricity. MOEW has a programme of building dams and lakes (discussed in Section 3.4.1). In many arid and semi-arid countries, most water supplied for domestic purposes comes from dams. Dams are built to secure supplies during the dry season or during periods of low rainfall. Paradoxically, by failing to build dams, Lebanon has ensured the variability of flow of its rivers which helps protect and maintain aquatic ecosystems that rely on the natural variability of river flows throughout the year.

Springs

Most of the surface water used to secure supply comes from captured spring sources. Lebanon has some 2,000 springs. Their total yearly yield exceeds 1,200 million m³, (MOEW, 2010b) however, less than 200 million m³ is available during the summer period. The total annual exploited volume is 637 million m³ (MOEW, 2010b). Lebanon also has a number of freshwater marine springs. Exploitation of these marine springs would present major technical challenges, leading to low cost effectiveness at the current stage. This resource could be considered on the long term when economic conditions become more favourable (MOEW 2010b).

Groundwater

Over 50 percent of irrigation water comes from underground wells and boreholes while 80 percent of potable water comes from groundwater sources. In addition, private wells have increased greatly in the last few years (see Tables 3.8 and 3.9). MOEW notes that this has been due to population growth, economic development and urban expansion (MOEW 2010b).

Table 3.7 Flow data for 16 perennial rivers of Lebanon (1971-1975 and 2005-2009)

River name	*River length (km)*	*Average Annual Vol*		*Average Flow*		*Maximum Flow*		*Minimum Flow*	
		(71-75) Mm³	(05-09) Mm³	(71-75) m³/s	(05-09) m³/s	(71-75) m³/s	(05-09) m³/s	(71-75) m³/s	(05-09) m³/s
El Kabir	58	259.20	283.86	9.07	9.13	48.47	190.80	1.52	1.42
Ostuene	44	-	46.96	-	1.59	-	6.89	-	0.00
El Bared	24	132.77	120.05	4.22	3.82	23.98	18.86	0.15	0.45
Abou Ali	45	148.60	206.57	4.62	6.58	25.23	32.53	0.56	1.11
El Jaouz	38	32.26	44.61	1.03	1.43	11.43	17.88	0.00	0.00
Ibrahim	30	208.55	329.16	6.63	10.49	65.52	79.11	0.14	0.25
El Kalb	38	154.08	189.32	4.90	6.07	29.34	66.95	0.23	0.00
Beirut	42	47.90	81.80	1.53	2.64	25.10	49.89	0.00	0.04
Damour	38	-	166.93	-	5.38	-	51.04	-	0.13
El Awali	48	393.70	252.88	12.54	8.05	51.66	32.17	1.89	1.61
El Zahrani	25	19.20	17.50	0.62	0.56	10.57	4.45	0.00	0.00
El Assi	46	326.40	275.54	11.03	8.70	13.84	12.36	8.78	5.99
Al Qasmieh	-	151.65	131.30	4.84	4.21	47.63	46.64	0.84	0.02
Litani	170	-	167.83	-	5.38	-	43.61	-	0.01
Wazzani	-	-	71.89	-	2.30	-	19.48	-	0.52
Hasbani	21	38.35	28.66	1.23	0.92	9.90	14.93	0.00	0.02

Notes:

(1) Al Qasmieh is part of the lower Litani River (downstream of the Qaroun Dam)

(2) River lengths are approximate

(3) 2005-2009 is a low rainfall period compared to other records

Source: Data provided by LRA to ECODIT for 2010 SOER

Aquifers are being over exploited and the data available from the MOEW supports the anecdotal evidence of wells drying up or increasing in salinity. According to MOEW records, there are more unlicensed private wells than there are licensed ones (22,500 versus 20,324). The regulation of these illegal wells is an ongoing concern, and undermines the Government's ability to control freshwater extraction from aquifers. Analysis of total yield shows that licensed private wells produce 29 percent of total abstraction, unlicensed wells 28 percent, and public wells 42 percent.

Table 3.8 Annual yield of licensed private wells

Mohafazat	Number	Water Use (Mm³/year)			Total Yield (Mm³/year)
		Domestic	Irrigation	Industry	
Beirut	1,680	5.14	1.23	0.77	7.14
Mt. Lebanon	10,718,	19.56	34.23	20.54	74.33
Nth. Lebanon	2,966	6.50	34.23	20.54	61.27
Sth. Lebanon	2,282	1.67	14.58	2.50	17.08
Bekaa	2,678	1.47	19.55	1.47	22.49
Total	**20,324**	32.67	103.82	45.82	182.31

Source: MOEW 2010b

Table 3.9 Annual yield of illegal private wells

Mohafazat	Number	Water Use (Mm³/year)			Total Yield (Mm³/year)
		Domestic	Irrigation	Industry	
Beirut	1,500	4.65	1.10	0.69	6.44
Mt. Lebanon	4,500	8.21	14.37	8.62	31.2
Nth. Lebanon	7,000	15.33	19.16	12.78	47.27
Sth. Lebanon	5,000	15.51	31.94	5.48	52.93
Bekaa	4,500	2.46	32.85	2.46	37.77
Total	**22,500**	46.16	99.42	30.03	175.61

Source: MOEW 2010b

Table 3.10 Annual yield of public wells (operated and maintained by Water Establishments)

Water Establishment	Number	Total Yield (Mm^3/year)
Beirut and Mount Lebanon	138	76
North Lebanon	98	42
South Lebanon	269	87
Bekaa	135	55
Total	640	260

Source: MOEW 2010b

In an effort to update groundwater data, and with grant funding from the Italian Government to the tune of €1.7 million, the MOEW and UNDP will tender in 2011 the project *Groundwater Assessment and Database in Lebanon*. The project will update the last national groundwater assessment conducted in 1970 (UNDP in collaboration with the MOEW), considered comprehensive and accurate at the time. In particular, the project will (1) conduct a baseline assessment of available data and gaps through field surveys and hydrogeological reconnaissance, (2) design and implement a hydrogeological monitoring program of water quality and quantity, (3) create a an integrated database with remote access, and (4) assess groundwater resources using GIS, 3D flow model and groundwater basin budgets and safe yield prediction. The project will also identify potential sites for aquifer storage and recovery.

Wetlands

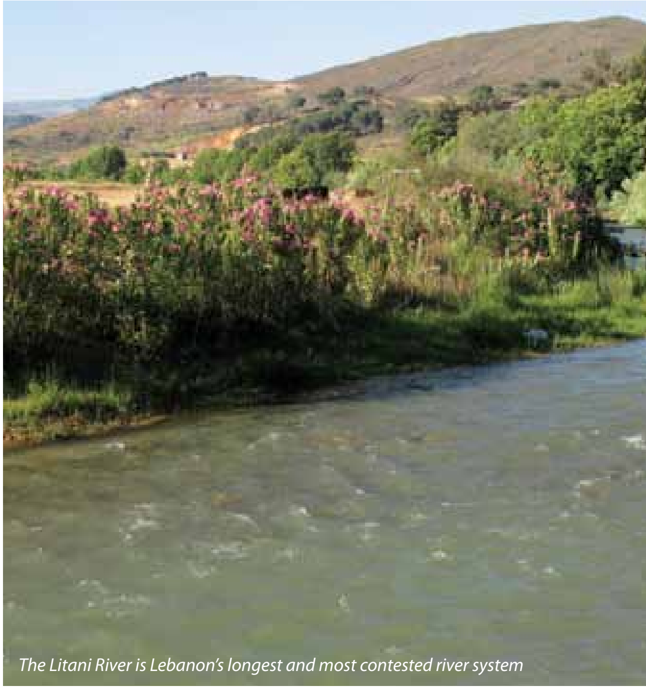
Wetlands are important ecosystems and water reservoirs. They are areas where water covers the soil, or is present either at or near the surface of the soil all year or for varying periods of time during the year. Water saturation determines how the soil develops and the types of plant and animal communities living in and on the soil. The most significant wetland in Lebanon is located in Ammiq, just north of the Qaroun Lake, on private land in the Bekaa Valley which is one of Lebanon's primary agricultural areas. Covering up to 250ha during the wet season, Ammiq Wetland supports a dynamic ecosystem and lies on one of the most important bird migration routes in the world. It is widely reported that these wetlands used to extend north to Zahle, before the advent of modern agricultural practices and large scale drainage schemes. Recognizing its importance, the MOE executed between 2002 and 2006 the project Conservation of Wetlands and Coastal Zones in the Mediterranean (MedWetCoast Project), which was funded by the French Global Environment Facility and managed by UNDP. Other wetlands in Lebanon include the Yammouneh Lake in north Bekaa (most of which was drained as part of large-scale irrigation schemes) and Hima Kfar Zabad in West Bekaa (which was the focus of a project for promoting sustainable agriculture, funded by EFL-GiZ and implemented by the Society for the Protection of Nature in Lebanon).

3.2.2 State of Water Resources

Rivers, springs and groundwater continue to be adversely impacted by raw sewage and other wastes, both domestic and industrial, being discharged without any regulation or control from establishments. While all the water resources are being impacted by bacteriological contamination, in the agricultural areas the runoff and infiltration of residues from fertilizers and pesticides is exposing them to further environmental degradation. Furthermore, runoff from urban areas may contain heavy metals and hydrocarbons which could impact the quality of receiving waters.

Rivers and springs

The majority of Lebanon's rivers have unacceptable levels of raw sewage contamination as reflected in the high levels of total coliform and E.Coli counts. The situation is identical in the coastal rivers and the inland rivers. The water quality data presented in Table 3.11 was consolidated from multiple sources to show the extent of pollution in the rivers and springs. In terms of biological contamination, the drinking water requirement is nil count per colony (Decree 1039/1999).



The Litani River is Lebanon's longest and most contested river system

Table 3.11 Quality parameters for selected rivers in the dry season

River	BOD_5 (mg/L)	NO_3 (mg/L)	TDS (mg/L)	SO_3 (mg/L)	Total Coliform (c/100mL)	E. Coli (c/100mL)
Kabir	14.4	3	270	20	900	20
Bared	28.2	2.8	225	28	610	17
Abou Ali	39.3	3.4	280	22	26,500	3,000
Ibrahim	62.8	1	150	8	3,500	200
Antelias	53.2	3	300	30	28,000	6,000
Damour	21.3	3	200	38	490	15
Awali	33.4	7	210	22	710	1
Qasmieh	22.5	5.5	250	21	80	0
Limit Value	**Nil***	**50***	**600***	**250***	**500****	**100****

Notes: Reported values are averages for period Jul-Aug-Sep 2004
* WHO (2006) standards for drinking water quality
**MOE Decision 52/1-1996: requirement for bathing water quality including sea, rivers and lakes
Source: Houri et al. 2007

Other studies have assessed water quality in particular rivers. See for example water data for Zahrani River (2006) and Kabir River (2001-2002) in Tables 3.12 and Table 3.13, respectively. The study of Kabir River and its tributaries and selected springs within its basin was based on 41 sampling points from its source right down to the Mediterranean Sea. The river constitutes the natural border between Lebanon and Syria. It was found to be heavily contaminated by raw sewage.

Table 3.13 Bacteriological analysis of Kabir River (83 samples)

Parameter	Mean Value	Max. Value	Min Value	MOE Std*
Total Coliform (C/100 mL)	540,091	26,999,800	0	500
Feacal Coliform (C/100 mL)	78,438	1,890,000	0	100

**MOE Decision 52/1-1996: requirement for bathing water quality including sea, rivers and lakes*
Source: Hamze et al. 2005 (data from 2001-2002)

The Upper Litani Basin (i.e., Litani River and tributaries, Qaroun Lake and Canal 900) has been the focus of many water quality sampling programs and assessment reports. USAID has been particularly active in funding these assessment and follow-on works. For example, in 2003, they financed the Water Quality Assessment of the Upper Litani River Basin and Lake Qaroun, followed by the Basin Management Advisory Services project (BAMAS, 2005-2007), and the Litani River Basin Management Support Program (LRBMS, 2009-2012). The LRBMS has made noteworthy strides towards building the capacities of the LRA in providing long-term water quality monitoring. In particular,

Table 3.12 Bacteriological analysis of Zahrani River

Parameter	Result	MOE Std* (C/100 mL)
Total Coliform (C/100 mL)	500	500
Feacal Colifrom (C/250 mL)	350	100
Feacal Streptococcus (C/250 mL)	80	100

**MOE Decision 52/1-1996: requirement for bathing water quality including sea, rivers and lakes*
Source: ELARD 2006

the program tasked the American University of Beirut in 2010 to conduct a comprehensive water quality survey of the Upper Litani Basin in coordination with LRA (USAID, 2011). The objectives of the water quality survey were to update the water quality data generated in 2005 under BAMAS, and recommend interventions for improved practices and mitigation/control measures for the main sources and types of pollution. In total, AUB and LRA collected 149 samples over a period of 22 days (summer 2010) as follows:

Sampling Location	*Number of Samples*
Litani River and its tributaries	26
Qaraoun Lake	10
Irrigation Canal 900	7
Groundwater springs and wells	43
Sewage effluents from residential areas near the river	12
Industrial wastewater effluents discharging into the river	7
Agricultural soils bordering the river and irrigation canal	36
River and lake sediments	8

Targeted surface and lake water results are summarized in Tables 3.14 and compared to previous results obtained in 2005. The 2010 sampling campaign shows a tenfold increase in BOD values in surface waters, compared to values in 2005. Sources of BOD into the Litani basin include the discharge of untreated sewage from homes and industries, as well as leachate from nearby municipal solid waste dump sites. TDS values and pH also increased (more alkaline). Microbiological load in the form of fecal coliform count were lower than in 2005 possibly because the sampling occurred during summer characterized by prolonged exposure to sunlight UV radiation. The results show a different trend for lake water. While TDS and pH increased, BOD load did not change markedly but fecal contamination increased tenfold. In terms of pollution from agricultural runoff, both surface and lake water showed a significant drop in phosphate and nitrate levels. The campaign also detected trace metals (arsenic, nickel, mercury and chromium) in river and lake sediment samples, reflecting and confirming continued exposure to industrial pollution.

Table 3.14 Litani River Basin water quality

Indicator	BAMAS 2005 (summer)			LRBMS 2010 (summer)			Drinking Water Standard	
	Min	Mean	Max	Min	Mean	Max	LIB-NOR*	EPA
Surface Waters								
TDS (mg/l)	88	290.96	706	187	502	1979	<500	<500
pH (pH units)	6.57	7.09	7.68	7.27	7.93	8.66	6.5-8.5	6.5-8.5
BOD (mg/l)	2	48.46	624	2.50	547	2530	NA	NA
Nitrates (mg/l as N)	3	13.46	62	0.10	1.23	4.90	45*	<10
Phosphates (mg/l)	0	11.75	197	0	8.58	72	NA	NA
Fecal Coliform (CFU/100ml)	0	223,487	1,500,000	1	71.61	400	0	0
Cadmium (mg/l)	NA	NA	NA	0.005	0.01	0.079		<0.005
Lake Water								
TDS (mg/l)	120	160	196	221	235	256	<500	<500
pH (pH units)	6.5	7	7.5	8.2	8.27	8.32	6.5-8.5	6.5-8.5
BOD (mg/l)	<2	2.57	4	2.0	2.65	3.30	NA	NA
Nitrates (mg/l as N)	16	21	62	0.8	0.93	1.2	45*	<10
Phosphates (mg/l)	0.01	0.13	0.35	0	0.09	0.24	NA	NA
Fecal Coliform (CFU/100ml)	0	17	450	0	160	400	0	0
Cadmium (mg/l)	NA	NA	NA	0.0007	0.01	0.021		<0.005

Note: Drinking water standard is LIBNOR NL1611999 in Decree 1039 (dated 02/08/1999)

Source: Based on USAID, 2011

Not only is the Litani River suffering sewage contamination, fertilizers and pesticides used in the agriculturally rich Bekaa valley are flowing into the open watercourses and infiltrating into the groundwater. In addition to raw sewage, there are a number of uncontrolled dumpsites that produce leachate that seeps into rivers and aquifers. In the case of the Litani River, the Zahle dumpsite has been contained and transformed into a sanitary landfill; therefore at least one source of severe contamination has been stopped but many more remain. It should be noted that the Litani River and its tributaries has been the focus of many studies and testing campaigns but very little has been achieved so far to effectively control pollution sources.

In an effort to develop a sound business model for mitigating pollution into the Litani River, the MOE and UNDP commissioned the preparation of a Business Plan for Combating Pollution of the Qaraoun Lake (MOE/UNDP/ELARD, 2011). The analysis was used to determine the measures needed to alleviate pollution from various sources. The business plan examines the proposed responses to the identified pressures, and describes the enabling environment (institutional, legal and financial), as well as current and future initiatives for pollution abatement in the Litani basin.

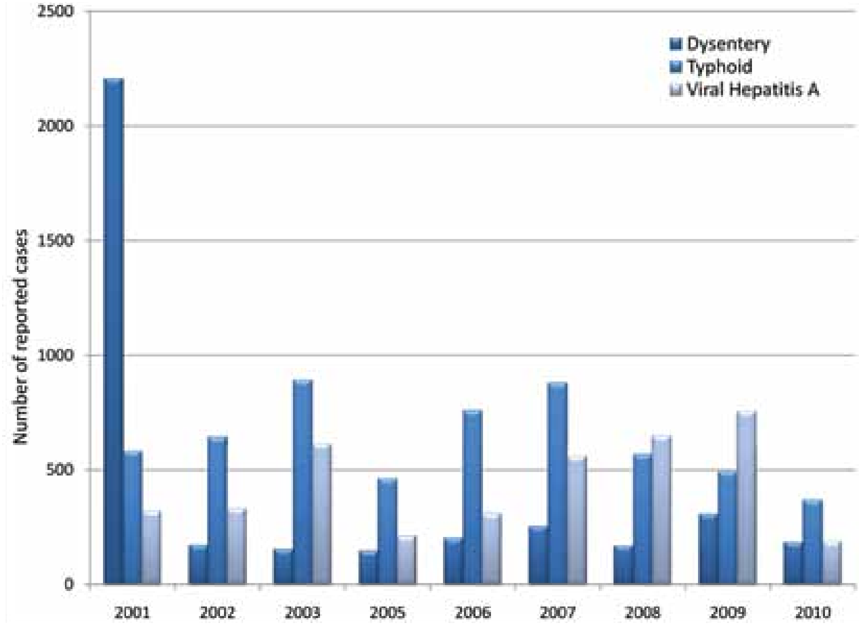
Groundwater

The majority of aquifers in Lebanon are karst limestone structures. Karst is a terrain with distinctive landforms and hydrology created from the dissolution of soluble rocks, principally limestone (USGS, 2010). Karst features are characterized by springs, caves, sinkholes, and a unique hydrogeology system. One of the drawbacks of the karst limestone aquifers is the high level of fissures and fractures in their formation, allowing ready transmission of pollutants from domestic and industrial waste discharges. They also allow transmission of diffuse sources (fertilizers and pesticides) and are prone to salt water intrusion.

Since the main sources of drinking water are wells and springs, it is reasonable to expect high incidences of waterborne diseases to reflect pollution stress in these sources. Over the last 10 years, waterborne diseases have been generally trending down although the number of reported cases of Hepatitis A spiked during the period 2006-2009. See overall trend for Hepatitis A, Dysentery and Typhoid in Figure 3.4 (data in 2004 not available). The highest number of reported cases for all three diseases was North Lebanon.

Lebanese speleologist on an exploration of the underground river in the grotto of Jeita (candidate site for the new 7 wonders)

Figure 3.4 Number of reported cases of waterborne diseases in Lebanon (2001-2010)



Source: MOPH 2010

Groundwater quality data is fragmented and not centralized. Some of these data are generated by EIA studies, development organizations and environmental research institutes, and relevant ministries in response to public health concerns or apparent disease outbreaks. There is an urgent need to consolidate such data into a centralized data system to appraise decision makers and municipal authorities as well as support future SOERs, EIAs and other environmental studies. As reported earlier, USAID has funded several water quality assessments in the Upper Litani Basin (2003, 2005 and 2010). According to the 2010 sampling campaign, TDS levels in groundwater were acceptable as compared to the Lebanese and EPA standards. Interestingly, only 16 percent of groundwater samples (compared to 35% in 2005) showed fecal contamination, an indication that the increased coverage of sewer systems in the Bekaa region has reduced the exposure of groundwater aquifers to progressive contamination and shifted the pollution to lake water. Nitrate levels in the groundwater remain high and very close to the permissible limit in drinking water in Lebanon (see Table 3.15).

Urban expansion, and the ever increasing need to irrigate crops as wet periods shorten, has led to an explosion in the use of wells in Lebanon. Aquifers that are over extracted can suffer increasing salinity, as evidenced by increased concentrations of sodium and chloride. In 2001, 31 samples from wells in the Bekaa Valley and the coastal zone showed elevated levels of sodium and chloride (El Fadel *et al.* 2000 *in* MOE/

Table 3.15 Groundwater analysis in the Upper Litani Basin (2005 and 2010)

Indicator	*BAMAS 2005 (summer)*			*LRBMS 2010 (summer)*			*Drinking Water Standard*	
	Min	*Mean*	*Max*	*Min*	*Mean*	*Max*	*LIBNOR**	*EPA*
TDS (mg/l)	NA	NA	NA	170	385	863	<500	<500
pH (pH units)	6.54	6.9	7.22	6.98	7.76	8.72	6.5-8.5	6.5-8.5
Nitrates (mg/l as N)	3	48	171	0.2	6.7	41	45	<10
Phosphates (mg/l)	0	0.3	12	0.1	1.2	6.43	NA	NA
Fecal Coliform (CFU/100ml)	0	42.8	400	0	39.2	400	0	0

Note: Drinking water standard is LIBNOR NL1611999 in Decree 1039 (dated 2/8/1999)

Source: USAID 2011

ECODIT 2002). In 2001, 21 recently completed wells in the Baalbeck region were sampled, and only seven had levels of chloride lower than the MOE standard of 25 mg/L (WB 2002). In 2006, 20 wells and springs were sampled in the West Bekaa, an area directly north of the Qaroun Lake, of which only three had chloride concentrations less than the MOE standard (Fidawi 2010). Generally, coastal wells are subject to severe salt water intrusion, and many are being put out of operation. This is confirmed by MOEW (Baroud, 2010), CDR, the water establishments, and a number of studies (Shaban, 2009). This situation is particularly acute in Beirut area.

Coastal Marine Water

Coastal waters in Lebanon receive untreated sewage from at least 53 major sewage outfalls (number of outfalls was reported in the 2001 SOER and has not been updated) spread along

Lebanon's 240 km coastline, of which 16 lie within the Beirut area. Coastal waters receive an estimated 162 Mm^3/year of untreated sewage (equivalent to 276,000 m^3/day), which is equivalent to 65 percent of the total sewage load in Lebanon. About 70 percent of Lebanon's population, plus hundreds of thousands of tourists each year contribute to this sewage stream. Although Lebanon has made progress in building Sewage Treatment Plant (STP) along the coast, none except for the Ghadir plant is operating at design capacity. *See overview of treatment plants in Section 3.4.2.* In addition to outfalls, rivers also carry upstream pollutants from various activities and sectors to the sea including agricultural runoff, and sewage. Houri (2007) estimated the extent of the pollution load coming from Lebanon's perennial rivers during the dry season (see Table 3.16).

Table 3.16 Pollutant loading from coastal rivers in the dry season

Parameters	*BOD (g/s)*	*Nitrate (g/s)*	*Phosphate (g/s)*	*Sulfate (g/s)*	*E.COLI (CFU/s)*	*Coliform (CFU/S)*
Value	664.5	69.3	6.17	479.1	16,708	114,889

Notes: g/s = Grams per second

Source: Houri et al. 2007

Sewage outfall discharging into the sea near Antelias

In addition to untreated sewage from cities and towns, coastal waters are also affected by large seafront dumpsites in Tripoli (still active but contained), Bourj Hammoud (closed but not rehabilitated), Beirut (closed and rehabilitated), Saida (active and causing severe environmental pollution) and Sour (active). *See analysis of dumpsites in Chapter 8 Solid Waste.* Additional pollution into coastal waters stems from coastline thermal power plants (Beddawi, Zouk, Jieh and Zahrani) and the overwhelming presence of heavy industries along the coast. The BOD load from industrial wastewater is estimated at 5,000 tonnes per year (WB, 2010b). As reported in the 2001 SOER, waters near industrial sites show high levels of the heavy metals Arsenic, Lead, Zinc and Chromium. The highest levels were found near the Dora industrial complex, due mainly to the significant tannery industry located there. Chromium levels may have dropped since because several tanneries have closed. Very little has been achieved insofar as treating industrial wastewater before discharge into the municipal streams, rivers and sea. *See current progress and pipeline initiatives related to industrial sewage treatment in Section 3.4.2.*

Bathing Water

Lebanon's public beaches are shrinking, partly due to infringements on the public maritime domain. Coastal erosion, mainly in north Lebanon, is also affecting beach quality and access. Bathing water is affected by several pollution streams mentioned earlier (sewage outfalls, thermal plants, industries, etc.) and therefore the need to monitor its quality is pronounced. The National Centre for Marine Sciences (NCMS), which is one of four subsidiary branches of the Lebanese National Centre for Scientific Research (see Chapter 2), runs several seawater quality monitoring programs. With funding from the World Health Organization, the NCMS profiled five public beaches in Lebanon (Heri in North Lebanon, Byblos in Mount Lebanon, Ramlet el Bayda in Beirut, Saida and Sour in South Lebanon). The analysis campaigns extended three years (January 2008-Decemebr 2010) during which the research team collected 136 samples from fixed sampling locations from all five beaches. The analysis covered physical, chemical, hydrological and microbiological parameters. Expectedly, the test results showed very high bacteriological contamination in Beirut and Saida, affected by sewage outfalls and dumpsites, but good bacteriological water quality in Heri, Byblos and Tyre. *See summary of test results in Table 3.17.*

Table 3.17 Profile of five beaches in Lebanon

Public Beaches	*Heri Beach*	*Byblos Bahsa Beach*	*Ramlet-el-Bayda Beach*	*Saida Beach*	*Tyr Beach*
Length (m)	700	250	1065	673	2030
Depth (m)	20	30	20-60	90	210
Sewage outfalls	None	None	2 outfalls	2 outfalls	None
River discharge	Yes	No	No	No	Yes
Land uses and activities	Cement plant; beach resorts; agricultural fields	Beach resorts; main road; agricultural fields; public toilets (summer)	Beach resorts	Coastal highway; agricultural fields; open dumpsite nearby	Tyre Coastal Nature Reserve; beach resorts and kiosks; Rachidieh refugee camp; agricultural fields
Sampling period	Jan 2008-Dec 2010	Jan 2008-Dec 2010	Jan 2008-Dec 2010	Nov 2009-Dec 2010	Nov 2009-Dec 2010
Number of Samples	36	36	36	14	14
Fecal coliform (CFU/100ml)					
95th percentile	19	13	55,742	19,455	78
90th percentile	11	9	22,182	10,475	41
Fecal streptococci (CFU/100ml)					
95th percentile	137	132	45,123	3,525	194
90th percentile	77	73	19,342	2,189	109
Bacteriological Water Quality	Good	Good	**Poor**	**Poor**	Good
Phosphate (PO_4) min-avg-max (µM/l)	0.13-0.46-0.89	0.10-0.19-0.30	0.39-1.52-3.93	0.17-0.52-1.27	0.12-0.20-0.28
Nitrate (NO_3) min-avg-max (µM/l)	0.14-0.31-0.97	0.24-1.32-3.72	0.73-3.58-14.15	0.96-2.66-6.05	0.52-4.72-21.21
Algae	No	No	-	Yes	No

Note: MOE standard for fecal contamination in bathing water is 100 (CFU)/100ml (based on MOE Decision 52/1 of 1996)

Source: National Centre for Marine Sciences, 2011

3.2.3 Water Demand

3.2.3.1 Current Water Demand

Current demand estimates vary depending on source and assumptions. The most critical input parameters to estimating water demand include population, per capita water consumption, network efficiency, total irrigated area, irrigation consumption and industry demand. Table 3.18 shows three different demand estimates which range from 1,473 to 1,530 million m^3 per year. These demand estimates are compatible with currently exploited resources (Section 3.2.1.1).

Looking at the annual picture of demand and supply masks how dire the situation has become during the dry period. Table 3.19 shows demand and supply by sector during the four months from July to October. Depending on which source is used, the deficit ranges from 220 to 388 million m^3.

Table 3.18 Estimates of current annual demand (Mm^3)

Sector	*2010*[1]	*2010*[2]	*2010*[3]
Domestic	501	467	505
Industrial	150	163	158
Agriculture	900	900	810
Total Demand	1,515	1,530	1,473
Sources and assumptions:	(1) Comair, 2010	(2) WB, 2009a	(3) MOEW, 2010a
Population	4.5 million	4.2 million	4.5 million
Per capita consumption	200 L/d	140 L/d	180 L/d
Network efficiency	70%	65%	52%
Irrigated area	145,000 Ha	103,000 Ha	90,000 Ha
Irrigation consumption	8,000 m^3/ha	9,000 m^3/ha	9,000 m^3/ha
Industry demand	30% domestic	35% domestic	31% domestic

Table 3.19 Estimates of current demand during the period July-October (Mm^3)

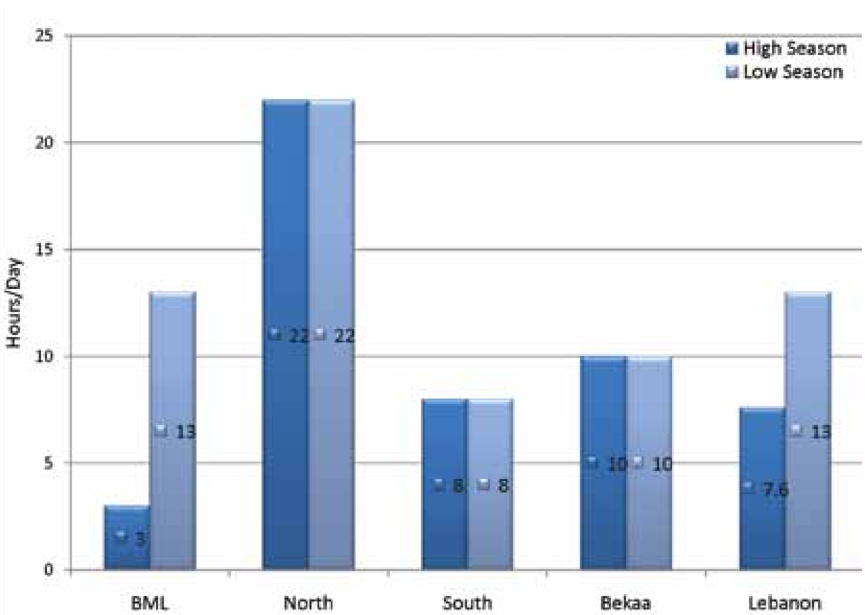
Sector	*2010*[1]	*2010*[2]	*2010*[3]
Domestic	250	233	253
Industrial	60	65	63
Agriculture	675	765	567
Total Demand	985	1,063	883
Total Supply	765	675	650

Sources and notes:

(1) Comair 2010 (population for 2010).
(2) WB 2009a. Water needs: 0.5 x domestic + 0.4 x industrial + 0.85 x irrigation. Supply 0.45 x annual supply.
(3) MOEW 2010a (demand forecasts)

The data show that without any supply- and demand-side measures, such as augmenting existing exploitable resources, reducing network losses or improving efficiency, natural population growth alone will increase the prevalence of water deficits in the future. For potable water, the deficit between demand and supply has manifested itself in rationing of supply. The situation is particularly acute in Beirut and Mount Lebanon, where water supply drops from 13 hours during the wet season to only 3 hours during the dry season (see Figure 3.5). Summer rationing is less severe in other regions.

Figure 3.5 Continuity of water supply by Water Establishment



Source: WB 2009a

Water rationing and intermittent supply encourages residents to buy water from private cisterns

3.2.3.2 Water Transmission and Distribution

A consistent documentation of network assets is only available for the Beirut and Mount Lebanon WE. The other WEs only have records of transmission mains but not distribution networks. The total length of the documented network in BMLWE is 5,880 km of which 1,550 km account for large diameter transmission mains (MOEW 2010b). Table 3.20 shows the age of the existing water network in Beirut and Mount Lebanon; 26 percent of the transmission network and 23 percent of the distribution network were built after the year 2000.

Table 3.20 Age of transmission and distribution water networks in Beirut and Mount Lebanon

Age (years)	*Transmission (%)*	*Distribution (%)*
<10	26	23
10-20	15	15
20-30	6	11
30-40	15	8
40-50	16	5
>50	5	2
Unknown	17	36

Source: MOEW 2010b

Water supply network coverage varies among Water Establishments between 62 and 87 percent. According to CAS, almost 85 percent of buildings in 2004 were connected to water networks but at least 7 percent were equipped with private water wells (CAS 2006). *See connection rates for all cazas in* ***Annex 1***. The resulting coverage at national level is therefore higher than the 75 percent MENA average (e.g., Syria 60%; Qatar 70%; Jordan 98%) but much lower than the 100 percent best practice threshold (e.g., Bahrain 100%). However, around 50 percent of the transmission and distribution pipelines require special attention given their age and the limited maintenance activities and surveillance (MOEW 2010b). Intermittent water supply has economic repercussions on households –see analysis of connection rates and household budget that goes to water in Box 3.3.

Box 3.3 Socio-economic costs of intermittent water supply

Water rationing is not the only problem affecting water supply. When the connection rate for drinking water per water establishment is factored into the water situation, it becomes evident that many Lebanese do not rely on the public water supply networks for their drinking water needs. Records show that about 22 percent of households (and 18% of the population) are not connected to public water supply systems (see Figures 1 and 2). Yet, over 70 percent of total household expenditure on water goes to private suppliers of water, distributed as follows: 35 percent water gallons (18L containers), 21 percent water tankers, and 16 percent small water bottles (see Figure 3).

Figure 1 Household connection rates

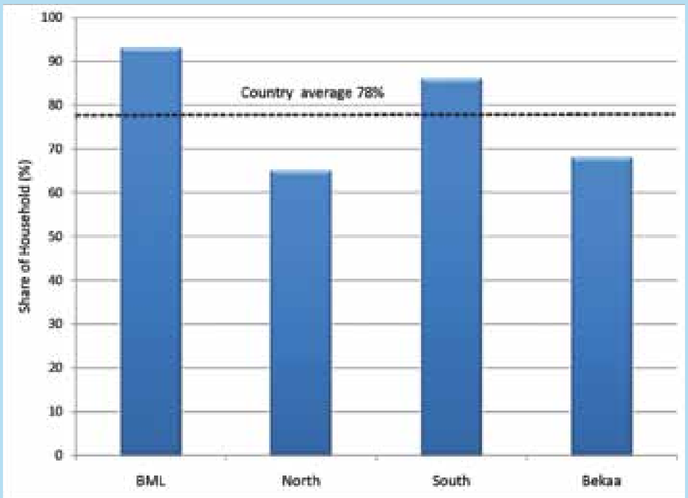


Figure 2 Population connected by Water Establishment

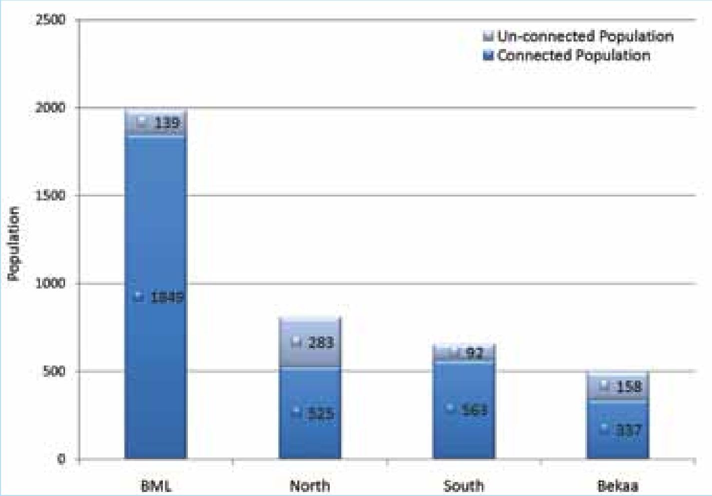
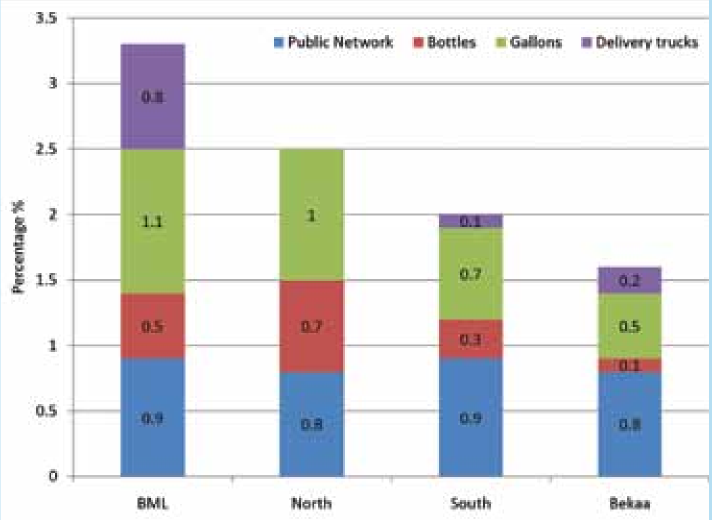


Figure 3 Percentage share of household budget that goes to water by WE & water source



Despite the stress water resources are under, current demand is not being met by public resources, and the community is bearing significant additional costs with private provision of drinking water. From a public health perspective, not all the private providers of water are regulated strictly, and so the risk to public health is real. Moreover, the social and economic impact on the community, particularly the lower socio-economic groups, is quite severe. The unit price of public water supply ranges from \$0.3 to \$0.8 /m^3 (depending on the region), compared to \$3 to \$6 /m^3 for water tankers and \$400 to \$500 /m^3 for small bottles.

The annual cost to the community, above the water charges that are paid to the water establishments, is \$307 million or 1.3 percent of annual GDP. This is higher than the total annual expenditure in the sector (including O&M), which is estimated at 0.5 percent of GDP. So, the Government has the scope to invest in the sector on the condition that it secures sufficient supplies and of quality that would win the confidence of the community.

Source: Based on WB 2009a

3.2.3.3 Projected Water Demand

Lebanon has entered into a period of water stress whereby its total exploited resources (about 1,500 million m^3) do not meet current annual demand, and that projected demand after 2020 will start exceeding exploitable renewable resources of 2,000 to 2,500 million m^3. This is the projection of the World Bank (Table 3.21). The projections of the MOEW are more optimistic (Table 3.22 and Table 3.23).

Table 3.21 Annual water demand 2010 -2030 Mm^3 and share of total

Sector	2010		2020		2030	
Domestic	467	31%	767	37%	1258	44%
Industrial	163	11%	268	13%	440	16%
Irrigation	900	58%	1020	50%	1120	40%
Total	**1,530**	**100%**	**2,055**	**100%**	**2,818**	**100%**

Assumptions: *Annual population growth* 2.5%; *Per capita water consumption* 140 L/d; *Network Losses* 35%; *Irrigated area* growing from 90,000 Ha to 140,000 Ha in 2030; *Irrigation demand* decreasing from 9,000 m^3/Ha to 8,000 m^3/Ha; Industrial demand equals 35% of domestic demand.

Source: WB 2009a

Table 3.22 Annual water demand in Mm3 by sector (2010 -2035)

Sector	2010	2015	2020	2025	2030	2035
Domestic	505	460	427	467	512	562
Industrial	152	138	128	140	154	169
Tourism	6	8	10	13	16	21
Irrigation	810	877	935	983	1,021	1,050
Total	**1,473**	**1,483**	**1,500**	**1,603**	**1,703**	**1,802**

Assumptions: *Annual population growth* 1.75% starting at 4.425 million,; *Per capita water consumption* 180 L/d urban and 160 L/d rural; *Network Losses* 48% in 2010, 30% in 2020, 20% in 2035; *Irrigated area* growing from 90,000 Ha to 150,000 Ha in 2035; *Irrigation demand* decreasing from 9,000 m^3/Ha to 7,000 m^3/Ha in 2035; Industrial demand equals 30% of domestic demand; *Tourist consumption* 400/L/d; *Consumption growth* 1% per annum. *Water conservation measures* 3L/c/d.

Source: MOEW 2010a

Table 3.23 Annual water demand in Mm3 by Water Establishment (2010 -2035)

Sector	2010	2015	2020	2025	2030	2035
BML	373	373	374	407	443	482
Nth Lebanon	351	354	358	381	403	424
Sth Lebanon	256	242	234	251	268	285
Bekaa	493	513	533	563	589	612
Total	**1,473**	**1,483**	**1,500**	**1,603**	**1,703**	**1,802**

Source: MOEW 2010a

3.2.4 Wastewater Generation

Wastewater generation from households and industries is affecting water resource quality almost everywhere in Lebanon. While data on industrial wastewater networks and flows is scant and fragmented, the CAS produced in 1996-1997 data on household wastewater connections and updated these data in 2004. According to CAS, only 52 percent of buildings were connected to sewage networks in 2004 and therefore at least 48 percent rely on sceptic tanks most of which are permeable or are deliberately drained to prevent overflow. Nationwide, the highest rate of sewage connection was recorded in Beirut (96%), followed by Tripoli and Baabda (each 91%) and Zahle (83%). The lowest connection rates were in Batroun (1%), followed by Bent Jbeyl (4%) and Jbail (10%). *See connection rates for all cazas in **Annex 1**.* Table 3.24 shows the approximate domestic sewage loads discharged into the sea and water courses.

Table 3.24 Estimated domestic wastewater generation

Mohafaza	Population	Domestic WW Mm^3/ year	BOD Load (tonnes/ year)
Beirut	361,366	25.1	10,040
Mount Lb	1,484,474	93.8	37,525
North Lb	763,712	50.2	20,092
Bekaa	489,865	33.6	13,428
South Lb	416,842	29.4	11,751
Nabatiyah	242,876	17.1	6,854
Total	**3,759,135**	**249.2**	**99,690**

Notes: Based on 2007 population

Source: WB, 2010b

Pollutant levels in treated wastewater must comply with MOE standards stipulated in Decision 8/1 (dated 30/01/2001) before discharge into public sewers, surface water and/or the sea. Industrial wastewater, estimated at 43 million m^3 per year, is even more problematic because they contain an array of inorganic pollutants which can be toxic to ecosystems and biota. Industrial wastewater is very diverse from phosphogypsum slurry discharged into the sea to Olive Mill Wastewater from approximately 492 surveyed olive mills discharged into public sewers and streams during the olive pressing season. Lebanon is a signatory to the Barcelona Convention and its amendments including the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources (also known as the LBS Protocol). In response to the LBS Protocol, the MOE prepared in 2005 a Sectoral Plan for the Reduction of Pollution of the Mediterranean Sea from Land Based Sources.

3.3 KEY ACTORS, LAWS AND REGULATIONS

The following section describes key regulations and policy issues related to the water sector. Each legal text cited here is also listed chronologically at the end of the chapter. For a more complete analysis of environmental legislation related to water and environment, please refer to Chapter 8 of SELDAS (EU/UOB/MOE/ELARD, 2005). To review environmental jurisprudence cases related to water, wastewater and sea water in Lebanon and other similar countries, please refer to Chapter 8 of SEEL (MOJ/MOE/UNDP, 2010).

3.3.1 Legal and Institutional Framework for Water and Wastewater

The institutional framework for the water sector in Lebanon is characterised by a myriad of ministries, water establishments, public agencies, municipalities, etc. Key actors in the water sector often duplicate each other's work, other times complement each other, always operating through weak links of communication and responsibility, which have led to a lack of policy focus, with no *one* institution taking the effective lead of the sector. Table 3.25 shows a simplified allocation of responsibilities in the water and wastewater sectors.

Table 3.25 Key players and responsibilities in the water and wastewater sectors

Function	MOEW	RWEs	LRA	CDR	MOE	MOPH	Other
Planning	X	X		X			
Licensing and permitting (inc. EIAs)	X				X		X
Capital Investment	X	X		X			X
Infrastructure construction	X	X		X			X
Operation & maintenance	X	X					
Financing (national)	X	X		X			
Financing (external funding)	X			X			
Regulations and guidelines	X				X	X	
Water quality / quantity monitoring	X		X		X		
Hydro-power plants	X		X				

Notes: "Other" includes Council for the South, Municipalities, other ministries and agencies

The following sections attempt to show how the crowded institutional framework and policy environment is impacting on the management of water resources.

Ministry of Energy and Water

The Ministry of Energy and Water (MOEW) is responsible for the water sector under Law 221 dated 26 May 2000. According to Article 2 of this law, the Ministry has the following responsibilities:

1) Monitor, control and measure water resources, and determine needs and use of water resources
2) Monitor the quality of water resources and set relevant quality standards for water resources
3) Establish public plans for the utilisation and distribution of water resources, as well as prepare the master-plan for water and wastewater to be endorsed by the COM through the MOEW
4) Design, build and put into operation major water facilities such as dams, mountain lakes, underground conveyors, river stream correction works and water supply networks and the like
5) Implement artificial recharge of groundwater when required and regulate the volumes of groundwater extracted
6) Protect water resources from pollution and waste by issuing laws, rules and regulations and their application and enforcement
7) License wells and all water extraction from rivers and public water resources according to applicable laws and regulations
8) Conduct continuous hydrological, geological and hydro-geological research, study, data gathering and mapping pertaining to the water sector
9) Provide tutelage and oversight of all public institutions working in the working sector according to Law 221 and the laws governing these institutions
10) Enhance the operational performance of regional water establishments and monitor their performance according to approved benchmarks
11) Set the standards and benchmarks the RWE's will need to abide by in their design and operation of water supply, irrigation and wastewater systems
12) Conduct all land expropriations for MOEW and RWE's in conformity with existing laws
13) Provide advice in the licensing of mines and quarries when such mines and quarries impact on water resources
14) Conduct public outreach to inform them of water related issues and ways of conserving water.

Law 221/2000 was amended by Laws 241 (dated 7/08/2000) and 337 (dated 14/12/2001). These laws were promulgated to reform the water sector and clearly define the roles of MOEW and regional water establishments (RWEs), and the relationship governing them. The Law however does not explicitly grant MOEW or any other public institution the responsibility or power to *set policy*. The MOEW by its powers can *formulate* policy and provide *policy advice* to the Government of the day, but it does not have exclusive power of policy setting in the water sector.

It should be noted that MOEW has to function in a legal environment that still has laws from the 19th and early 20th centuries in currency. For example, Law 144 of 10/6/1925 defined water resources as "public domain", and surface water is still governed by this law. A code law from 26/5/1926 provides for special privileges as access rights that allowed them to be registered as private property (MSC 2005). These were and remain tradable articles to this day. The Irrigation Code of 11/2/1913 still regulates the use of irrigation water (MSC 2005).

The Ministry has been active in leading the implementation of the institutional changes introduced by Law 221/2000. Over the course of 2010, MOEW developed a National Water Sector Strategy (NWSS). During the preparation of this strategy, three separate documents were issued: (1) *NWSS Baseline* that provides a general overview of the water sector (September 2010); (2) *NWSS Baseline Supply/Demand Forecasts* that presents projections of how planned resource augmentation and other projects will meet future demand as estimated by NWSS authors (November 2010); and (3) *NWSS Baseline Sector Enabling Environment and 2011–2015 Investment Plan* (December 2010). This last document is centred on five pillars summarized in Box 3.4.

Box 3.4 The five pillars of the NWSS Investment Plan

1) Institutional and Organisational Initiatives. This pillar's main thrust is the completion of the institutional reforms defined under Law 221/2000
2) Financial and Commercial Initiatives. This pillar aims at improving the financial performance of the sector through setting more rational tariffs, facilitating private sector participation in the sector, improving institutional performance
3) Legal and Regulatory Initiatives. This pillar aims at enacting the draft Water Code, provide the legal framework for the NWSS initiatives,
4) Environmental Concerns. This pillar will mainstream environmental concerns into the water sector such as: protection of water resources and recharge zones, flood mitigation, institutionalize Strategic Environmental Assessment in the planning cycle.
5) Investment Plan 2011 – 2015. Capital Investment $5,086 million distributed as follows: $1,134m for resource augmentation, $1,394m for water supply networks, $343m for irrigation, $2,160m for wastewater systems, and $55m for enabling initiatives. Operation and maintenance $732m million distributed as follows: $552m for water supply, $104m for irrigation, and $77m for wastewater.

Regional Water Establishments

Law 221/2001 and its amendments created four Regional Water Establishments (RWEs): Beirut and Mount Lebanon Water Establishment; North Lebanon Water Establishment; South Lebanon Water Establishment; and Bekaa Water Establishment. Lebanon had 21 water establishments and over 200 local water committees, mainly active in irrigation, before Law 221 was approved. Under Clause 4 of Law 221, the RWEs were given the following responsibilities:

i. Plan, build, operate and maintain potable and irrigation water transmission and distribution networks
ii. Plan, build, operate and maintain sewage treatment plants (STP's) and networks
iii. Ensure the quality of water supplied to their communities
iv. Recommend tariffs for water, irrigation and wastewater (based on prevailing socio-economic conditions)
v. Oversee works, studies, and operation and maintenance of by private service providers

The RWE's were given autonomy and control of their human resources, as they were freed of the regulatory oversight of the Civil Service Board, which is responsible for recruitment into the civil service (Clause 6 of Law 221). Financially, the RWE are subject to Government audit periodically, and their administrative activities are subject to the Government's administrative regulator (Central Inspectorate). They have the power to recommend tariff structure and rates to MOEW, but not set them.

Law 221/2000 stipulated a 2-year transitional phase for full incorporation of the local water committees, as well as all the implementation of the other sector wide reforms associated with the Law. Unfortunately, the by-laws or regulatory decrees making the Laws effective were not issued till December 2005. Few of the reforms behind the Law have come to fruition. Many of the local committees, which are mainly active in operating potable and irrigation networks, have yet to be incorporated into the corresponding RWE.

Litani River Authority
The Litani River Authority (LRA) was established in 1954 (Law dated 04/08/1954) with the responsibility of managing the Litani River Basin. In particular, the LRA would (1) plan and operate all potable, irrigation and hydro-electrical schemes associated with the Litani River, (2) measure all surface flows throughout the country, (3) establish and operate hydroelectric power plants on the Litani River.

In 1962 it was given the power to develop and operate all water systems connected to the Litani River and Awali Rivers in the area of Lebanon between the Beirut Damascus Highway and its international border in the south. Clause 7 of Law 221 affirmed that irrigation water schemes tied to the Litani River would remain under the control of the LRA. Although Law 221 should have had an impact on the LRA, it still operates as it has for the last 30 years. Its operations are within the Bekaa Water Establishment and South Lebanon Water Establishment area, yet no perceivable change has been recorded in LRA operations or those of the recently established establishments.

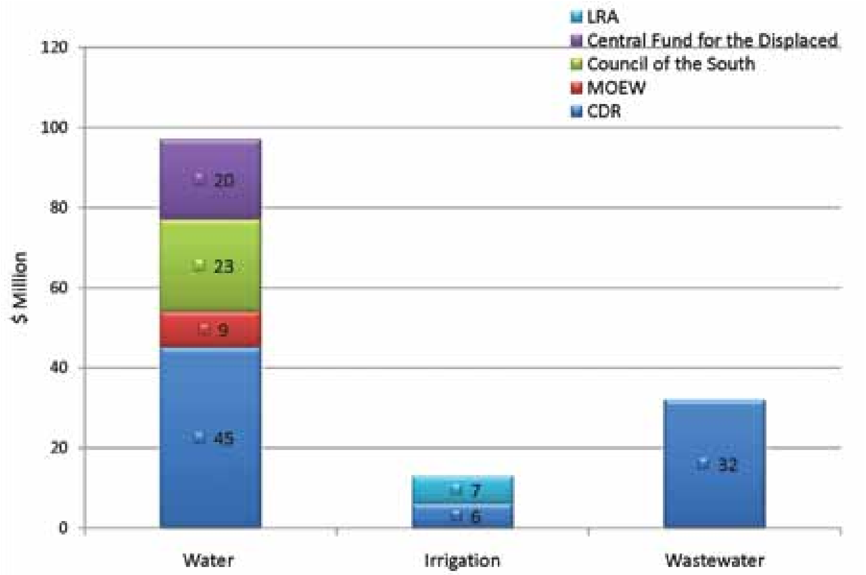
Council for Development and Reconstruction
CDR was created in 1977 (Legislative Decree No. 5 of 1977) to replace the-then defunct Ministry of Planning. CDR has the responsibility to prepare national sector plans in coordination with the different line ministries. CDR is empowered to seek international funding for these plans and then manage their execution. As different projects are completed, the ownership of facilities and assets built are in principle handed over to the respective line ministries or establishments for management and operation.

CDR has led Lebanon's capital spending in the water sector. Such capital spending has included building water supply systems throughout Lebanon, the rehabilitation and construction of water treatment facilities, rehabilitation and construction of transmission and distribution networks, finally to construction of house connections. Furthermore, it is expected that by 2015, all the major Lebanese coastal cities will have sewage treatment plants in operation. Equally, a large number of inland wastewater systems including sewage treatment plants will come into operation. Figure 3.6 shows capital expenditure in the water, irrigation and


Lebanon has five Water Establishments including the Beirut and Mount Lebanon Water Establishment

wastewater sectors by several agencies. CDR is by far the largest expenditure in the water and wastewater sectors, while the LRA is largest expenditure in the irrigation sector.

Figure 3.6 Annual capital expenditure in the water sector by agency (1994-2008)



Source: WB 2009a

Ministry of Environment
The Ministry of Environment is responsible for controlling pollution and regulating all activities that impact the environment. Its remit is wide. The ministry has several legal avenues for controlling pollution, including prevention. For example, the draft EIA decree (approval eminent) requires that all sewage treatment plants undergo full Environmental Impact Assessment studies. The ministry has set standards for treated wastewater discharged into sewers and surface waters (Decision 8/1 dated 30/1/2001). Although MOE's policing role has been absent due to shortages in human resources and funding, the recent push to setup an environmental police force is promising and will help detect and control pollution (for more details, see Chapter 2 on environmental governance).

At the river level, the ministry has designated eight rivers (Ibrahim, Jaouz, Damour, Kalb, Beirut, Awali, Arka and Assi) as natural sites and under its protection –see full list in Chapter 6. Although the ministry lacks the personnel and resources to protect rivers and riverbanks from unlicensed developments and authorized discharge, it has prepared environmental conditions for construction permits located within river banks (MOE Decision 90/1 dated 17/10/2000).

Ministry of Public Health
The Ministry of Public Health has the responsibility of maintaining health standards in the community. In relation to water resources, it monitors drinking water to ensure compliance with local and international standards. The Ministry monitors the incidence of waterborne diseases and publishes related epidemiological data.

Other Agencies
The Ministry of Agriculture is another important stakeholder in the water sector. According to Legislative-Decree 31 (dated 18/01/1955 and its amendments), the ministry studies irrigation projects and provides technical supervision during implementation. The ministry regulates also the distribution of irrigation water and ways to use it and monitors the implementation of these regulations. In practice, the role of the MOA has been marginalized, primarily because funding for large-scale irrigation schemes has come from international development organizations and lending instruments, and therefore the design and implementation of irrigation projects has primarily been the responsibility of the CDR. The MOA has however maintained some influence and control over small-scale irrigation projects including hill lakes and hill ponds through the Green Plan.

The Council for the South is very active in building water supply systems in the south and West Bekaa regions (expenditure peaked during the period 1992-2008). These systems all rely on boreholes for the supply source. Separately, the Central Fund for the Displaced, which is responsible for rehabilitating and building water supply systems in the villages of Chouf, Baabda and Aley, has contributed substantially to expenditure during the last 15 years in building water supply wells.

It should be noted that the Council for the South and the Central Fund for the Displaced have a lot of autonomy in terms of the decisions they take and the projects they execute. They inform MOEW and the RWE, and attempts at coordination are made, but coordination remains informal.

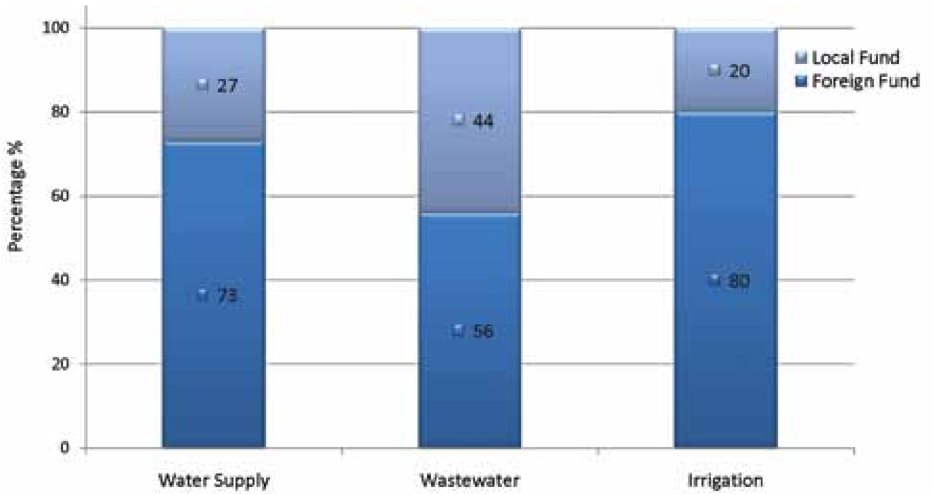
Traditionally, sewage networks have been the responsibility of the municipalities. Law 221/2000 is ambiguous on the issue of sewer lines, and there is a view that the rehabilitation and condition of sewer lines remains the responsibility of the municipality. Further confusion is caused by one of the provisions in the municipal law related to municipal taxes. Municipalities levy tax on the rental value of residential and commercial units, as well as a tax on sidewalks and sewers. The Arabic word is *majareh* which is not the same as sewers (in Arabic *majareer*). While the RWE are not yet equipped to take possession of the STP's and other sophisticated facilities, the municipalities are totally ill equipped to operate and maintain the expanding sewage networks that are coming into operation. So while collection networks are expanding, institutionally, their operation and maintenance is uncertain. It should be noted that the municipalities continue to build or upgrade sewer lines separately from MOEW, RWE and CDR.

3.3.2 Other Players and Stakeholders

Foreign Funding Agencies
Most of the capital investment in the water supply, wastewater and irrigation sectors has come from foreign funding agencies (see Figure 3.7). Foreign funding is usually provided and administered by the CDR.

The largest funders in the water sector in decreasing order of importance include the World Bank (almost 20% of total spending), the European Investment Fund and the Kuwait Fund for Arab Economic Development. In the wastewater sector, the top three funders are the European Investment Bank (35% of total spending), the Islamic Development Bank, and Japan. It is important to note here that local funding in the wastewater sector is mostly limited to networks and other civil works but not STPs. In the irrigation sector, the top funders are the World Bank (almost 80%) and the Arab Fund for Economic and Social Development (almost 20%).

Figure 3.7 Investment source of funding in water, wastewater and irrigation sectors



Source: WB 2009a

In addition to funding capital investments, several funding agencies (particularly the EU, USAID, AFD and GiZ) have been involved in funding institutional capacity building and policy type projects. The World Bank has played a leading role in driving the policy debate and reform in the water sector since the early 1990s, followed by USAID and GTZ.

Paradoxically, this myriad of funding agencies may have reinforced the fragmentation of government agencies working in the water sector. For example, while the World Bank has tended to work through CDR, USAID worked directly with the municipalities for many years by funding the construction of small-scale STPs in the south and the Bekaa without any coordination with MOEW or CDR. (USAID subsequently adopted a different approach in the wastewater sector and is currently funding the construction of four medium-sized STPs in the Litani basin, in close coordination with MOEW and the LRA). USAID has also funded the *Lebanon Water Policy Initiative* (2002-2007), which is an institutional capacity building project in close coordination with MOEW, followed by the *Lebanon Water and Wastewater Sector Support* project (2009-2013), which is assisting all four Water Establishments attain financial and operational sustainability. The French Development Agency has worked with MOEW to develop a draft Water Code, and GiZ is working with the Beirut and Mount Lebanon WE in trying to improve the establishment's capacity to operate water supply and wastewater systems.

Academic Sector

A number of universities are active in water research, most notably the American University of Beirut (Water Resources Centre), the Notre Dame University (Water Energy and Environment Research Centre) and Saint-Joseph University (Regional Centre for Water and Environment). A lot of the environmental quality data used in this report comes from articles and research published by academics and researchers. In addition to their research and data, the universities are offering water resource and environmental studies as majors (see details of majors in Chapter 2). This will allow water resource professionals to come into the sector with greater awareness of the environmental challenges facing the sector.

Private water providers

Most households pay a sizeable share of total water spending to private providers, including bottled water, gallons, bulk tanker water or private well operations. It is inevitable, with such a significant share of the drinking water market, that the bottled water companies have real influence with the Government and have interests that they actively and effectively defend. In fact, leading bottling companies are setting up new bottling plants.

The Community (End Consumers)

While some reports have described the environmental NGOs working at the grassroots level (EMWATER, 2004), community involvement in water matters is muted. The World Bank deals with this issue at length, and concludes that since the community has no avenue to hold the public water providers to account for the quality of service delivery, the community has resorted to private providers. The proliferation of private providers is not going to help the Government in regulating water extraction and thus minimise further degradation of water resources.

3.3.3 Multilateral Environmental Agreements

Lebanon is a signatory to several multilateral environmental agreements related to reducing pollution into the Mediterranean Sea (Convention for the Protection of the Mediterranean Sea against Pollution-Barcelona, ratified by the GOL in 1977 and the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-based Sources-Athens, ratified in 1994); spill prevention (International Convention for the Prevention of Pollution from Ships-London, ratified in 1983); as well as the protection of wetlands (Convention on Wetlands of International Importance-Ramsar, ratified in 1999). See targeted list of MEA ratified by the GOL in Annex 2 in Chapter 2.

3.3.4 Policy Formulation and Development

Under the legal framework governing the water sector, there are no explicit policy development and formulation powers given to the MOEW, or any other public agency or institution. The absence of an official government policy governing the water sector has plagued the sector for decades. The only clear policy initiative to date, backed up with legislation and regulations, has been Law 221/2000 and its derivatives. The law addresses the institutional setup of the sector but the impact has yet to be felt due to the following:

- Investment planning and execution has not been handed over to the RWE but remain with MOEW and CDR;
- Local irrigation committees remain responsible for operating irrigation networks;
- Project execution remains with MOEW, the CDR, the Council for the South, the Fund for the Displaced and the LRA;
- RWEs are still ill equipped and poorly staffed to coordinate and take over the projects once they are completed on the scale required; and
- The regulatory framework to police and impose standards and benchmarks, technically, fiscally and environmentally are either nonexistent or ineffectual. For example, the uncontrolled extraction of groundwater continues unabated; domestic and industrial discharges are rampant throughout the country.

If and when the National Water Sector Strategy is formally approved by the Council of Ministers, many of the issues raised above will be resolved. By putting the sector on a rational footing, and mainstreaming environmental concerns, and incorporating more recent initiatives (e.g., the Water Code, MOEW 10-Year Plan and CDR wastewater program), the NWSS has the potential to reduce and perhaps eliminate institutional overlap and inefficiencies within the sector.

Capitalizing on the formulation of the NWSS, UNDP launched in 2010 the Lebanese Centre for Water Management and Conservation (LCWMC) to provide policy support to the MOEW to optimize water resource use through an integrated approach to water management. The centre will initially (1) help update groundwater resources data nationwide by establishing a groundwater database and water library at the MOEW (see Section 3.2.1) and (2) raise awareness on the importance of water and its conservation. The long-term objective of the LCWMC is to promote sustainable water management and assist in the implementation of selected initiatives under the National Water Sector Strategy. The centre will seek funding from different development organizations and will have the flexibility to accommodate and coordinate several projects.

3.4 SELECTED RESPONSES TO WATER ISSUES

Faced with mounting water-related challenges, political uncertainties and security issues, Lebanon has invested in expanding existing water supply networks, providing wastewater collection and treatment systems, developing additional water resources, building the institutions to manage this infrastructure, and improving service delivery. Overall progress however has been predictably slow.

3.4.1 Increasing Water Resources: Dams and Lakes

It has been apparent since the mid 1990s that Lebanon's water supply sector is facing real problems in terms meeting long term demand. Accordingly, the MOEW developed a 10-Year Plan to build dams and lakes in the late 1990s. Under the Plan, 17 proposed dams would add approximately 650 million cubic metres per year to the stock of available renewable freshwater resources (Comair, 2010). Dams and lakes envisioned under the Plan were mainly for drinking water, and to a lesser extent irrigation.

The 10-Year Plan was slated to be substantially completed by 2010. To date, only the Chabrouh Dam in the upper Kesrouan has been completed (see details and lessons learned in Box 3.5). Very little progress has been made towards the construction of the remaining dams including (numbers in parentheses show total storage capacity by region):

- **North**: Noura el Tahta, Qarqaf, Bared, Iaal, El Mseilah, and Dar Beachtar (205 million m^3)
- **Mount Lebanon**: Janneh, Boqaata, Aazzounieh, and Damour (109 million m^3)
- **North Bekaa**: Aassi, Younine, and Massa (52 million m^3)
- **South Lebanon** : Ibl Es Saqi, Bisri, and Khardaleh (290 million m^3)

MOEW has estimated that the total cost of building the dams and lakes is $2.6 billion (MOEW 2010a). As discussed in Box 3.4 on the five pillars of the NWSS, the Ministry is proposing the expenditure of $1,134 million between 2011 and 2015 for resource augmentation. The main components of this program are dams and lakes proposed under the MOEW's 10-Year Plan and augmentation projects to be executed by CDR. In particular, the NWSS listed five dams and hill lakes including Brissa in Dinnieh (under construction), Boqaata in Kesrouan (ready for construction), Janneh in Jbail (detailed design) and Rahwe in Batroun (preliminary design). Once the Government approves the NWSS, it is envisaged more funding, both local and foreign, will be mobilised to complete the projects needed up to year 2015. The NWSS (Initiative 12) also aims to produce the final version of the long-awaited Water Code, which is expected to be discussed by the COM and transferred to Parliament for final approval and implementation.

Bisri Dam and Awali-Beirut Conveyor

The case for augmenting water resources cannot be more pronounced than in the GBA, an agglomeration of 1.8 million people. Currently receiving most of its water from the area of Jeita (though the Dbayeh treatment plant), MOEW and CDR have started to implement two large-scale projects that will help overcome the projected deficits in greater Beirut; the Bisri Dam, and the Awali-Beirut Conveyor. The GBA is already experiencing very severe water rationing in summer and drinking water demand is set to increase by at least 13 percent over the next 20 years based on the most optimistic assumptions (see demand in Table 3.26 and projected deficit in Table 3.27).

Box 3.5 Lessons learned from Chabrouh Dam

Located in Faraya (Kesrouan) 40 Km from Beirut, the Chabrouh Dam helped solve the chronic water shortage in the upper Kesrouan region. With a static storage capacity of 8 million m^3 and a dynamic storage capacity of 15 million m^3 (and a total cost of about $60 million), the dam is expected to meet drinking water demand until 2025. Designed to deliver 60,000 m^3 per day, today the dam reservoir delivers only 35,000 m^3 pending completion of remaining water networks in the upper Kesrouan region. The construction of this hydraulic infrastructure took about five years (August 2002 - October 2007). No EIA was submitted to the MOE for review and approval.

Location: Chabrouh Dam and Basin are located on the eastern flank of the Qana Plateau (total basin area is 12 km^2). The Qana Plateau is an 8 Km^2 semi-isolated plateau in Mount Lebanon; it rises from approximately 1600m a.s.l. and reaches a maximum elevation of 1945m a.s.l. It is circular in shape with a relatively flat top and steeply sloping sides. The base of Chabrouh Dam is located at an elevation of 1555m a.s.l. The dam's crest height is 63m, its length is 470m and width is 100m.

Investigations: Examination of Chabrouh Dam site started in the 1970's; Majdaleni (1977) argued that the presence of karst rocks in Chabrouh valley will make building such a structure and retaining the water in the basin quite difficult. In 2006, Bou Jaoude showed that the nature of the karstic terrain in the Qana plateau and the height of the water in the basin might lead to channeling of the water from the Chabrouh basin into the surrounding springs (Bou Jaoude, 2006). Leaks of up to 200 l/s were observed around the western abutments of the dam on the Qana Plateau side due to the geological formation of the area. In 2009, detailed surface geology of the Qana plateau revealed that the area is dissected by NW-SE dip-slip faults (Bou Jaoude *et al.* 2009). Hydrographs of three major springs (Hadid, Qana and Terrache) show clear karstic characteristics. A major increase in the flow of the studied springs has been documented suggesting that leaking from the Chabrouh dam basin is occurring towards those springs (Bou Jaoude *et al.* 2009).

Conclusion: Despite technical challenges, budget overruns, construction delays (linked to budgetary constraints and political wrangling), and now growing evidence of leaks (which even if unplanned help replenish aquifers), the dam represents today a much-needed water reservoir for the upper Kesrouane region and should serve as a case study for future dam projects in the country.

Source: adapted from (Comair 2010), (Majdaleni 1977) and (Bou Jaoude et al. 2006, 2009)

View of Chabrouh Dam in Kesrouan, the only dam completed based on the 10-Year Plan of the MOEW

Table 3.26 Low demand scenario for GBA

Year	Population	Domestic Consumption	Non Domestic Consumption	Total consumption	Unaccounted For Water		Total Demand
		m^3/d	m^3/d	m^3/d	%total	m^3/d	m^3/d
2010	1,700,000	255,000	76,500	331,500	30	99,450	430,950
2015	1,787,161	268,074	80,422	348,496	25	87,124	435,620
2020	1,878,791	281,819	84,546	366,364	20	73,273	439,637
2025	1,975,118	296,268	88,880	385,148	20	77,030	462,178
2030	2,076,385	311,458	93,437	404,895	20	80,979	485,874

Assumptions: *Population growth rate* of 1%; *Domestic Consumption* 150 l/c/d; *Non domestic consumption* 30% of per capita consumption.

Source: WB, 2009a

Table 3.27 Projected deficit for GBA

Year	Total Demand (From Table 3.23)	Available Resources	Deficit
	m^3/d	m^3/d	m^3/d
2010	430,950	271,000	-159,950
2015	435,620	271,000	-164,620
2020	439,637	271,000	-168,637
2025	462,178	271,000	-191,178
2030	485,874	271,000	-214,874

Source: Available resources from Montgomery Watson 2001

Hill lakes in Kfar Selouan provide much needed water for mountain agriculture

The Awali-Beirut Conveyor will transfer water from the Litani River basin to Beirut. Currently, water is diverted away from the Qaroun Lake through a series of hydroelectric plants and tunnels and residual water ends in the Awali River (Bisri) before reaching the sea. The Awali-Beirut Conveyor will allow some of this water to be taken and transferred to greater Beirut. During the dry season, the conveyor will supply water under gravity to the GBA at the rate of 250,000 m^3/day (3 m^3/s). This will meet the needs of GBA in the short to medium terms. Over the long-term, the Bisri Dam will supply an additional 500,000 m^3/day (6 m^3/s), also through the Awali-Beirut Conveyor.

Both projects are now funded by the World Bank and the Islamic Development Bank. It should be noted that these projects were anticipated by Presidential Decree 14522 (May 1970) which allocated water from the Litani and Awali (Bisri) River catchments to different regions of Lebanon.

3.4.2 Protection of Water Resources: Wastewater Systems

Although projects to augment water resources (particularly dams and lakes) are proceeding slowly, a significant number of sewage plants and systems will become operational in the next five years. In total, seven treatment plants were completed since the 2001 SOER (Tripoli, Chekka, Batroun, Jbail, Nabi Younes, West Bekaa and Nabatieh) but have yet to go online pending the completion of the corresponding networks. Only two coastal treatment plants are currently operational (Ghadir and Saida) but both plants provide preliminary treatment as the effluent is discharged into the Mediterranean Sea through dedicated sea outfalls.

At CDR, there are two programmes that deal directly with the protection of water resources and coastal waters: (1) Inland Water Resources Protection Programme, and (2) Coastal Pollution Control Programme. Considering the importance of the Litani River for agriculture and drinking water, there is sub programme for the protection of the Litani River basin. With significant international funding, CDR has been implementing Lebanon's wastewater master plan and USAID has in recent years lent support to implementing specific investments foreseen in the plan, in and around the Litani River. A complete and up-to-date list of sewage treatments plants (coastal, inland, and Litani) is presented in Table 3.28 and illustrated in ***Map 2.***

Table 3.28 Status of Lebanon's sewage treatment plants

Location (RWE)	Population Served	Capacity m^3/d	Process	Status
Main Coastal STPs				
Ghadir (BML)	250,000	50,000	PT	Operating. An expansion planned to add 850,000 people.
Jbail (BML)	50,000	9,000	B	STP complete. Networks completion in 2011
Jieh (BML)	88,000	11,900	B	Complete
Tabarja (BML)	505,000	70,000	B	Planned
Bourj Hammoud (BML)	2,200,000	330,000	PT	Planned
Saida (Sth L)	390,000	55,000	PT	Operational
Sour (Sth L)	200,000	45,000	AS	Under construction
Batroun (Nth L)	30,000	4,100	EAAS	Complete. Networks under construction
Chekka (Nth L)	15,600	1,750	EAAS	Complete. Networks under construction
Tripoli (Nth L)	1,000,000	135,000	AS	Complete. Operational mid 2011.
Abdeh (Nth L)	185,000	30,000	AS	Planned
Main Inland STPs				
Barouk (BML)	12,000	1,000	AS	Planned
Nabeh al Safa (BML)	30,000	3,000	AS	Planned
Hrajel (BML)	37,000	6,000	AS	Planned
Nabatieh (Sth L)	100,000	9,000	EAAS	Complete. Awaiting completion of network.
Litani Basin (Bekaa)				
Baalbeck	89,000	12,000	AS	Complete. Awaiting completion of network
Zahleh	120,000	18,000	TF	Ongoing
Joub Janine	77,000	10,500	EAAS	Ongoing
Saghbine	4,100	530	EAAS	Ongoing
Labwa	53,000	7,000	AS	Planned
Majdel Anjar	275,000	44,500	AS	Planned
Tibnin el Tahta	100,000	25,000	AS	Planned
Aitanit	37,500	5,000	TF	Operational
Fourzol	7,400	1,000	TF	Operational
Chmistar	13,200	1,800	TF	Ongoing
Ablah	14,630	2,000	TF	Ongoing

AS Activated Sludge, **B** Biofiltration, **EAAS** Extended Aeration Activated Sludge, **TF** Trickling Filter, **PT** Pre Treatment

Source: CDR, 2010 (Main Coastal and Main Inland) and WB, 2010 (Litani Basin)

As part the Country Environmental Analysis report for Lebanon, the World Bank estimated the cost of upgrading pre-treatment plants to secondary (Saida and Ghadir) and 10 other coastal treatment plants from secondary to tertiary (WB 2010). Tertiary treatment would present new opportunities for water reuse but would cost the GOL an estimated $45 million in capital expenditure and $61 million in O&M costs per year.

Building on these efforts, the MOEW has recently prepared and published a Strategy for the Wastewater Sector. Although not yet officially endorsed, the strategy has defined ambitious targets for wastewater collection, treatment and reuse over the short-to-medium term (2011-2015) and the long-term (2016-2020). Pertinent sector targets (2011-2020) include increasing wastewater collection and treatment from the current 60 and 8 percent respectively, to 80 percent in 2015, and 95 percent in 2020; pre-treatment of all industrial wastewater by 2020; increase the reuse of treated effluent from the current zero percent to 20 percent in 2015, and 50 percent in 2020; and full recovery of all O&M costs by 2020. Achieving these targets is based on five strategic initiatives:

1) An integrated and prioritized investment program for wastewater collection, treatment and reuse (e.g., completing networks and plants, regional wastewater master planning)

2) Legal, regulatory and policy measures (e.g., bylaws for WEs, guidelines for small-scale plants)
3) Institutional measures (e.g., asset evaluation and progress transfer to WEs, capacity building for WEs related to operation and maintenance, and for MOEW to strengthen oversight)
4) Financial measures (e.g., cost recovery mechanisms based on the polluter-pays-principle)
5) Private sector participation (e.g., testing alternative models for private sector participation and strengthening WE capacity in contract preparation and oversight).

It is expected that within the next 10 years, the wastewater master plan will be almost complete. By then, at least 80 percent of Lebanon's population would be served by wastewater systems. Sound operation and maintenance of these facilities however will depend on many factors such as achieving minimum inflow requirements while preventing the inflow of industrial wastewater connected to public sewers. Industrial wastewater characteristics differ vastly from domestic wastewater characteristics and can easily overload and impair the treatment process.

In an effort to incentivize industries to comply with discharge standards for public sewers, the Environment Fund for Lebanon selected nine pollution abatement projects as part of its Second Call for Proposals (August 2010), with grant funding from GiZ. The projects will co-finance up to 50 percent of the total cost of cleaner production measures and the construction of treatment units for industrial wastewater in industries located in Kesrouan and the Litani Basin. The selected enterprises include pulp and paper, food and beverages, metals products and textile industries. Total capital expenditure by the EFL-GiZ program will be €1.2 million.

3.4.3 Improving Service Delivery: Public Private Partnerships

Only Beirut and Mount Lebanon WE is not financially reliant on the Government for help. The other water establishments cannot cover their power needs, nor pay salaries or invest in capital investment. It must be noted, the reliance on pumping from aquifers, has meant power is the biggest expenditure on the RWE books. As a result, the World Bank has argued that spending on operation and maintenance has been well below what was required to ensure efficient operation of networks that have come into operation the last 15 years (World Bank, ERP, 2009a). Added to this, the RWE have not been able to hire suitable staff to operate supply systems. This will be compounded in the next few years as wastewater systems become operational and are handed over to the RWE, who are incapable of managing these systems. In an effort to address the underperformance of RWEs and improve service delivery, the GOL has been seeking private sector participation to support service delivery. *See for example Ondeo contract in Box 3.6.*

There are several other service contracts ongoing. For example, the Bekaa WE has relegated the operation and maintenance of its water supply network and the Baalbeck STP to a Lebanese company. This contract is funded by the World Bank and it still ongoing. MOEW also operates and maintains a number of water pumping stations on behalf of the RWE. Considering the inability of the RWE to take over the STP that will be coming into operation over the next few years, the ongoing wastewater construction contracts have provision for three to five year operation and maintenance periods after the construction phase. They also include provision for the private operators to train the RWE staff to operate and maintain wastewater treatment plants.

One of the pillars of the NWSS is to encourage private sector participation in the operations of the water sector. The NWSS recommends that while RWE efficiencies are low and tariffs have not been rationalised, management contracts could be feasible for operations of water and wastewater systems. Once the water sector performance improves and matures, more advanced forms of private sector participation in the form of lease, concession or divestiture arrangements could be considered.

3.5 EMERGING ISSUES AND OUTLOOK

Key emerging issues include options for augmenting water resources, and new approaches for water management including integrated water resource management, water demand management, protection of water recharge zones and protection from flood plains.

Box 3.6 Ondeo Management Contract in support of North Lebanon WE

In December 2002 a management contract was signed with the French water company Ondeo. Funded by AFD, the management contract allowed Ondeo to take over the management of Tripoli Water Establishment (TWE) for a period of four years. The scope of the contract allowed for the transfer of the staff to Ondeo. Contract objectives included:

1) Increase level of supply
2) Guarantee water quality
3) Cost recovery for operation and maintenance
4) Installation of water meters
5) Staff training
6) Installation of management information systems covering customer services, accounting, asset management, maintenance management

On the whole, the contract was successful. Service was increased to 22 hours every day. The water meters funded under the contract were installed, as were all the management information systems. Unaccounted for water (UFW) was reduced from 65 percent to around 40 percent. However, cost recovery was not achieved, nor was the collection rate improved despite the improvement in the billing rates (CDR, 2010). Regarding UFW, the work of Ondeo showed that the physical losses in the networks are not the main contributors to UFW. As part of improving service delivery, the contract provided for a leakage detection and repair programme throughout Tripoli. The leakage detection part of the programme did not show the same extent of leakage as had been envisaged and allowed for in the contract. It is worth noting that service levels remain at the same level as they were during the term of the contract, which reflects the enduring effect of the contract.

During the term of the contract, the relationship between the management of TWA and Ondeo was difficult, and required attention from CDR to keep the contract from failing. This was due to the fact that no legal framework existed to allow Ondeo to truly run the Establishment autonomously in order to meet the objectives the contract set. The main lesson learned from the contract is the need to establish the legislation to allow delegation of management of water authorities to private operators for the term of management contracts. If the Government can establish suitable legislation, all the parties to the contract can proceed with clarity. The lack of clarity in relation to the roles and responsibilities of parties was a major impediment during the execution of the Ondeo contract.

3.5.1 Other Water Resource Augmentation Options

3.5.1.1 Treated Sewage Effluent

There are no regulations or laws or official policy in place which allow or even encourage the possible reuse of Treated Sewage Effluent (TSE) or treated sludge. As was detailed above, over the next 10 years, at least 10 STPs will come into operation along the coast, as well as up to twenty smaller plants inland. As a result, there will be significant volumes of TSE generated that will either be suitable directly for reuse or will require further polishing for reuse in irrigation and groundwater recharge. A number of studies have investigated the availability of treated effluent and sludge and reuse options. According to CDR's master plan in 2003, the projected quantity of treated sludge will grow from 334 t/d in 2010 to 426 t/d in 2020 (WB, 2010). The study suggested very limited reuse of the treated sludge in agriculture and recommended incineration. With regards to treated effluent sludge, the outlook is more positive. It is projected that by the year 2020, TSE could meet:

- 30% of irrigation demand in south Lebanon
- 50% of irrigation demand in North Lebanon
- 13% of irrigation demand in the Bekaa (the biggest user of irrigation water)

The only project that actually has a component for effluent wastewater is the Baalbeck Water and Wastewater Project. The project will equip the plant with an off take point for farmers to access the TSE and the treated sludge. The Baalbeck plant is expected to produce TSE and sludge suitable for irrigation however the plant experienced significant delays first because the wastewater networks were not complete and, more recently, because the plant is not receiving the minimum required inflow to ensure good operation (farmers are tapping raw sewage upstream of the plant for irrigation). It is clear however that treated effluent will become an attractive source of alternative irrigation water in the future. As precipitation rates decrease and population increases, the volume of TSE relative to freshwater resources are going to increase. It is a resource Lebanon should not ignore. Guidelines for the reuse of treated effluent are being developed by FAO and the relevant ministries (Agriculture, Environment and Public Health).

3.5.1.2 Rainwater Harvesting

While MOEW's 10-Year Plan aims to create dams on Lebanon's perennial rivers, it also relies heavily on capturing seasonal water running in the many rivers that dry up during summer. In contrast to dams, rainwater harvesting aims more at creating reservoirs at the municipal and

Wastewater Treatment Plant in Saida

household level. Additionally, storm water drains can be diverted into open or closed reservoirs to create brown or grey water resources for municipal irrigation of green spaces. This water can be polished to make it suitable for irrigation of public parks, median strips and other public green spaces.

At the household level, there are public programmes in different parts of the world where governments are subsidizing or incentivising citizens in cities to install water tanks to capture water flowing off their roofs. The collected water can be used to water house gardens, and wash building staircases and cars. In fact, until the 1970s, water was commonly harvested in the rural areas of Lebanon. Water running off roofs was diverted to underground reservoirs. The water was used for drinking and irrigation of gardens and vegetable patches. Some villages had communal schemes whereby rain was diverted through open channels to large underground reservoirs. The water was then rationed to villagers. Considering the extent of household expenditure on private water resources, creating small scale schemes described above, could help reduce expenditures on private water. At the same time, it would enable households to take greater responsibility for the quality of their water and their consumption. Good housekeeping such as using double-flush toilets and aerators should also become mandatory as part of a national plumbing code.

3.5.1.3 Aquifer Recharge

The MOEW 10-Year Plan does not only look for surface water storage to augment existing resources, it calls for the use of TSE for artificial recharge of aquifers, particularly coastal aquifers as many STP's will come into operation along the coast in the next few years. The Plan estimates that 300 Mm^3/year could be added to existing resources (Comair, 2010). The MOEW has started to study this measure, and it is investigating pilot projects near Beirut, Tripoli and Baalbeck.

3.5.1.4 Metering, Leakage Detection and Repair Programmes

Metering is a priority and necessary to conserve water. Water in Lebanon at the household level is rarely metered. Installation of meters is ongoing in Tripoli, Baalbeck, Beirut and Saida. Further metering programmes are either under consideration or ongoing in all the RWE. All calculations of demand are based on design consumption rates, and not real data from RWE. Metering will help produce more accurate data on water consumption.

Metering and associated billing are powerful demand management tools, that should not be ignored. Once the consumer pays principle is adopted by RWE, consumption will drop to reflect real consumption levels. The current orifice type gauges which are supposed to allow one cubic metre a day per connection are no longer appropriate to manage demand or water supply. More tellingly, once RWE start to obtain reliable data on the effective demand, supply system investments can be rationalised. With regards to UFW, it is important that RWE ascertain the volumes of water lost in the networks. The building of dams and more storage facilities is going to be wasteful if huge volumes of the additional resources are going to be lost in network leaks. Repair of network losses is a more economically efficient way of augmenting resources than building dams.

3.5.2 Potential New Approaches

3.5.2.1 Integrated Water Resources Management

One of the main ways of managing water resources is at the river basin level (GEO 4, UNEP, 2007). At the core of Integrated Water Resources Management (IWRM) is to integrate all those activities that affect water resources within a river basin into a single framework.

> "…… integrated water resources planning and management are facilitated by policies, laws, strategies, and plans that are multi-sectoral, based on the allocation of water for all uses; protection of water quality and control of pollution; protection and restoration of lake basins, watersheds, groundwater aquifers, and wetlands; and control and management of invasive species (WB 2009b)"

Management of the sector in Lebanon is very much fragmented. The management model has not proved its effectiveness. Perhaps devolution to the river basin level would bring decision makers closer to the users and the community in general. In the Litani River Basin, the need to integrate, water supply, sewage, irrigation, land use, industry waste, agricultural practices, and tariff policy together is overwhelming. Irrigation in the Bekaa and south Lebanon is dependent on the health of the Litani River. Beirut's drinking water under the Awali Beirut Conveyor Project also depends on the quality of the Litani River water. Communities within the Litani Basin place enormous environmental loads on the River.

Although IWRM is referred to in the 10-Year Plan and NWSS, there is not enough devolution to the regional water authorities to facilitate integrated basin level management. Under both Law 221/2001 and NWSS, strategic planning at the basin level is in the hands of MOEW. Under an effective IWRM policy, basin level water authorities would be created and fully empowered to operate autonomously. No legal framework yet exists in Lebanon to bring this about. The approach remains top down, centralised decision making.

3.5.2.2 Environmental Water

The concept Environmental water should be considered if Lebanon is indeed going to go ahead and build all the dams proposed under the MOEW 10 Year Plan. Environmental water is broadly defined as any water that achieves ecological benefits (Hamstead, 2007). It can be split into two categories: planned and adaptive environmental water. Planned environmental water is the water committed to the environment by rules, regulations or laws. This can be achieved either by placing limits on extraction of water from river or ground water systems or by allocating mandatory flows in river and groundwater systems. Adaptive environmental water is the water committed to the environment as part of water access licenses (NSW SOER 2009).

Lebanon's groundwater reservoirs are seriously stressed. By setting environmental water levels, the GOL can ensure that (1) sustainable volumes of water remain in rivers or groundwater reservoirs to sustain ecosystems, and (2) natural flow patterns are maintained so they are compatible with the ecological processes and environmental needs within rivers and aquifers. Groundwater health affects many ecosystems including terrestrial vegetation, wetland ecosystems, river systems, aquifer and cave ecosystems, and terrestrial fauna. See more details in Chapter 5.

The MOEW is striving to regulate the drilling of new boreholes and the GOL should provide all the backing needed to control illegal boreholes as failure will have community wide consequences. Just as a real and effective implementation of IRWM should be considered, both MOE and MOEW should consider incorporating the concept of environmental water into water sector planning and operations. There is a need to retain sufficient environmental flows in ecosystems to allow them to continue providing environmental products and services that sustainable development demands and have the adaptability required to cope with increasing environmental stresses.

3.5.2.3 Demand Management

Along with the adoption of IWRM as the management model, and incorporation of the concept of environmental water into water resources planning and regulation, the Water Establishments need to pursue aggressive demand management measures. This includes physical measures such as:

- Introducing water metering to all sectors (domestic, industrial and irrigation)
- Mandating water saving devices in the construction sector (e.g., Lebanese Building Code)
- Working with the agricultural sector to promote efficient irrigation technology

These measures will have to be part of public information campaigns that help the community appreciate the seriousness of the stresses water resources face in Lebanon.

Proper tariff structures for water use are another important tool in demand management. It has the added advantage of allowing Water Establishments to recover their costs. As stated earlier, water meter installation programs are ongoing in most of the country. Under Initiatives 9 and 10 of the NWSS, consumption-based tariff are proposed for water supply, irrigation and wastewater. The use of meter based tariffs, particularly for domestic and irrigation water, has been shown internationally to reduce demand wherever it is introduced.

The World Bank has studied tariffs in Lebanon extensively. The Bank believes the existing block tariff "does not provide incentives for neither demand management or irrigation improvements, nor does it provide commercial incentives for Water authorities to reduce water losses and increase water production" (WB-PER, 2009, p 40). The introduction of a proper tariff for water has been under discussion for the last 15 years, but no real progress has occurred.

3.5.2.4 Protection of Water Recharge Zones

While the Inland Water Resources Protection Program (discussed in Section 3.4.2) is part of the actions required to protect recharge zones, the programme could be better targeted. The wastewater treatment plants and sewage networks under the program aim at protecting springs and rivers from untreated effluent. They do not cover entire aquifer recharge zones, which remain poorly defined and are impacted by industrial and agricultural waste. A number of studies such as the NLUMP (2004) and the MSC Environment (2005) have identified vulnerable recharge zones and the protection of recharges zones in general was incorporated in the NWSS (Initiative 15). Mainstreaming and enforcing the SEA (program and policy level) and the EIA (project level) process in all construction sectors would help prevent and/or minimize the degradation of recharge zones. Using the EPIK method to assess vulnerable karst formations would also help control pollution (see description of EPIK in Chapter 6).

3.5.2.5 Flood Plain Protection

In 2005, the National Land Use Master Plan identified areas prone to flooding and organized these areas into three zones:

1) Areas subject to shallow water table, in particular the agriculturally rich plain of Bekaa and Akkar (Lebanon's main agricultural regions);
2) Areas prone to river flooding; and
3) Areas prone to sea water flooding.

The Master Plan also noted the growth of urban centres in a number of flood plain areas and made several recommendations to mitigate flood risk: restriction of real estate developments, clearing of water courses and removal of unauthorised obstructions, combating deforestation, and enforcing the maintenance of 80 percent of all land with gardens, lawns and orchards. The need for action for flood plain protection was also taken up in the NWSS (Initiative 15) per the following recommendations:

- Establish flood plain zones
- Establish integrated flood management plans
- Study the use of flood water for groundwater recharge
- Combat desertification.

As was discussed in Section 3.1.2 the rate of urbanization in Lebanon is increasing and it infringing on natural water courses. In the rural areas, open water channels that historically allowed water to flow unrestricted into larger water courses, are being paved or are being built in. Forests and green areas are also decreasing in size, in turn restricting water retention and infiltration.

As part of post-war recovery efforts and reform initiatives, the Government of Spain through the

Lebanon Recovery Fund financed a $6.6 million project for Flood Risk Management and Water Harvesting for Livelihood Recovery in Baalback-Hermel (Phase I and II). The project targeted war- and poverty-affected areas in the region of Baalback-Hermel by introducing improved land management practices such as flood risk reduction and improved access to irrigation water. Managed by UNDP, Phase I of the project (targeting Aarsal and Fakhe) established a flood risk management plan covering an area of 94Km^2 that includes (1) the construction of stone walls and membrane-lined reservoirs to collect unused water from springs, rainfall and snow melts to prevent runoff water from reaching villages and farms, (2) the restoration of land cover to reduce soil erosion and (3) installation of efficient irrigation networks. This phase also organized public awareness campaigns on flood risk management and trained target municipalities on the maintenance of flood management structures. Phase II (still underway) aims at expanding the flood risk management plan to cover new and larger watershed areas (about 200Km^2) and reduce damages and risks caused by floods affecting the village of Ras Baalback and its surroundings.

3.5.2.6 Environmental Data and Indicators

There are many indicators used in relation to water supply. However, there are a number of indicators that are pertinent to the environmental state of water resources. ***Annex 2*** presents a candidate list of proposed indicators that should be monitored and measured in future SOER's, and availability of the data commented on. It is important that a protocol be set up and funded by GOL to enable the relevant ministries and public institutions to monitor these indicators, which should be made available to the Ministry of Environment to monitor the state of the environment, and supply valuable information to go into the periodic state of the environment reports. This will require a budget for the different ministries, RWE and other agencies to collect data on water resources, by constructing a hydrometric network to measure river flows, spring and well discharges, quality of all water resources, including marine waters, etc. The budget for such a network is insignificant compared to the cost of building a dam or any of the other major projects the Government is planning to build.

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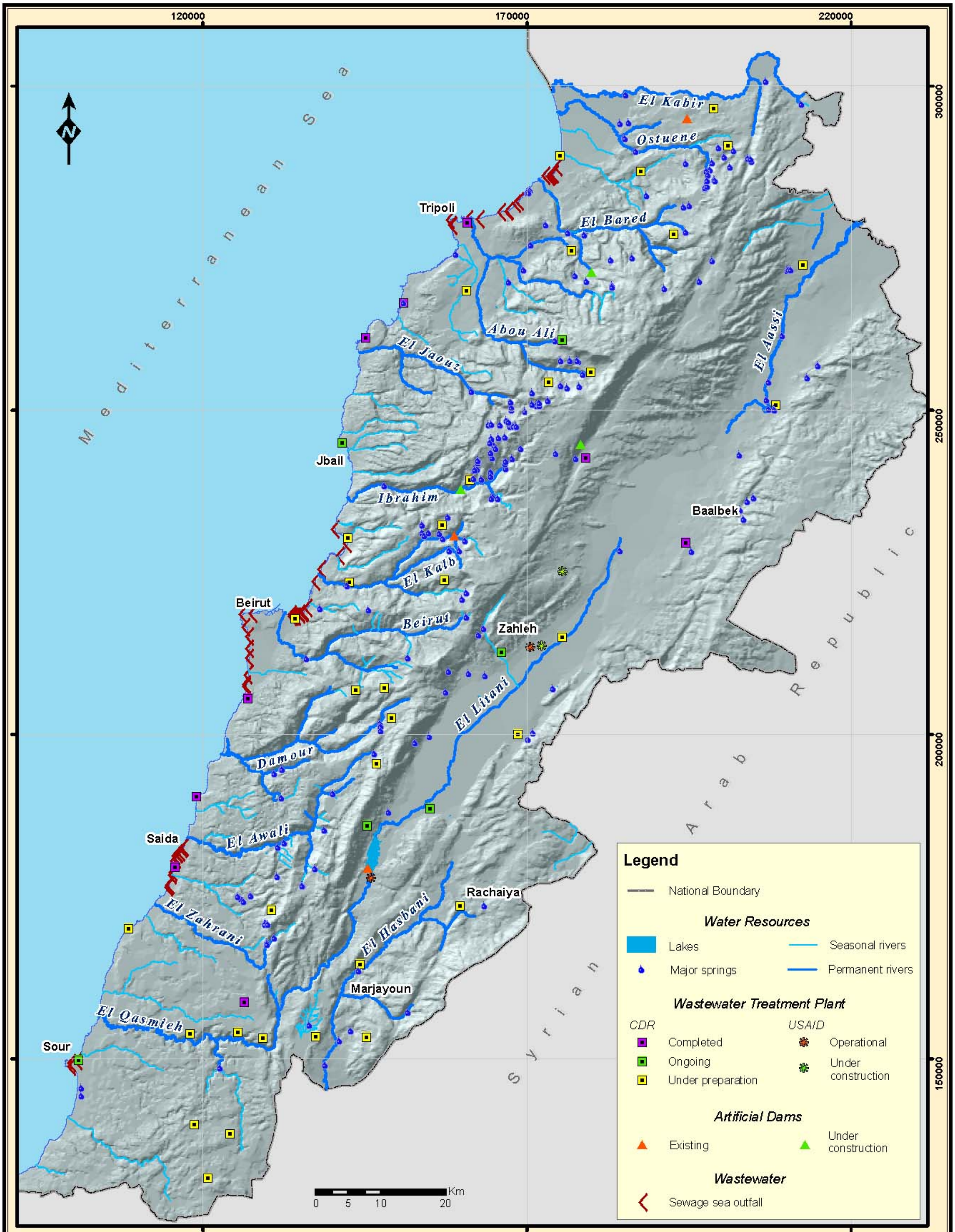
CITED LEGISLATION RELATED TO WATER RESOURCES

عنوان النص	التاريخ	الرقم	نوع النص
الأملاك العمومية	١٩٢٥/٠٦/١٠	١٤٤/س	قانون
انشاء مصلحة خاصة تدعى "المصلحة الوطنية لنهر الليطاني"	١٩٥٤/٠٨/١٤		قانون
تحديد مهام وزارة الزراعة	١٩٥٥/٠١/١٨	٣١	مرسوم اشتراعي
تنظيم وزارة الموارد المائية والكهربائية وتحديد ملاكاتها	١٩٦٦/٠٩/٠٧	٥٤٦٩	مرسوم
إنشاء مجلس الإنماء والإعمار	١٩٧٧/٠١/٣١	٥	مرسوم إشتراعي
إحداث وزارة البيئة	١٩٩٣/٠٤/٠٢	٢١٦	قانون
تحديد المواصفات والنسب الخاصة للحد من تلوث الهواء والمياه والتربة	١٩٩٦/٠٧/٢٩	١/٥٢	قرار وزير البيئة
اعطاء صفة الالزام لمواصفات تتعلق بمياه الشرب	١٩٩٩/٠٨/٠٢	١٠٣٩	مرسوم
تنظيم قطاع المياه	٢٠٠٠/٠٥/٢٩	٢٢١	قانون
تعديل القانون ٢٢١	٢٠٠٠/٠٨/٠٧	٢٤١	قانون
الشروط البيئية لرخص الابنية السكنية الواقعة ضمن حرم الانهر الخاضعة لحماية وزارة البيئة	٢٠٠٠/١٠/١٧	١/٩٠	قرار وزير البيئة
المواصفات والمعايير المتعلقة بملوثات الهواء والنفايات السائلة المتولدة عن المؤسسات المصنفة ومحطات معالجة المياه المبتذلة	٢٠٠١/٠١/٣٠	١/٨	قرار وزير البيئة
تعديل القانون ٢٢١	٢٠٠١/١٢/١٤	٣٧٧	قانون
النظام الداخلي في مؤسسة مياه بيروت وجبل لبنان	٢٠٠٥/٠٦/١٤	١٤٥٩٦	مرسوم
النظام الداخلي في مؤسسة مياه لبنان الشمالي	٢٠٠٥/٠٦/١٤	١٤٦٠٢	مرسوم
النظام الداخلي في مؤسسة مياه لبنان الجنوبي	٢٠٠٥/٠٦/١٤	١٤٦٠٠	مرسوم
النظام الداخلي في مؤسسة مياه البقاع	٢٠٠٥/٠٦/١٤	١٤٥٩٦	مرسوم
الخطة الشاملة لترتيب الاراضي اللبنانية	٢٠٠٩/٠٦/٢٠	٢٣٦٦	مرسوم

Industrial Establishments

نوع النص	الرقم	التاريخ	عنوان النص
قرار وزير البيئة	١/٧٥	٢٠٠٠/٠٩/٠٥	الشروط البيئية لرخص الإنشاء و/أو الاستثمار لمصنع دباغة
قرار وزير البيئة	١/٥	٢٠٠٠/١١/٣٠	الشروط البيئية لرخص إنشاء و/أو استثمار لمؤسسات حفظ الخضار والفاكهة (تبريد، تخليل، طهي وتعليب)
قرار وزير البيئة	١/١٦	٢٠٠١/٠٣/٢١	الشروط البيئية لرخص الإنشاء و/أو الاستثمار لمزارع الأبقار و/أو الطيور الداجنة و/أو الحيوانات الأليفة (مثل الأرانب، والخنازير، إلخ...)
قرار وزير البيئة	١/٢٩	٢٠٠١ /٠٥	الشروط البيئية لرخص إنشاء و/أو استثمار لمصانع الأجبان والألبان والزبدة وسائر منتوجات الحليب
قرار وزير البيئة	١/٦٠	٢٠٠١/٠٩/١٠	الشروط البيئية لرخص إنشاء و/أو إستثمار مصانع حجارة البناء
قرار وزير البيئة	١/٦١	٢٠٠١/٠٩/١٠	الشروط البيئية لرخص إنشاء و/أو إستثمار مصانع البلاستيك
قرار وزير البيئة	١/٣	٢٠٠١/٠١/١٢	الشروط البيئية لرخص إنشاء و/أو استثمار مصانع لمعالجة نفايات اللحوم والدواجن بواسطة الطبخ أو التخمير بالطريقة الجافة
قرار وزير البيئة	١/٤	٢٠٠١/٠١/١٢	الشروط البيئية لرخص إنشاء و/أو استثمار مسالخ
قرار وزير البيئة	١/٩٠	٢٠٠٢/٠٣/٠٤	الشروط البيئية لرخص إنشاء و/أو استثمار مصانع المطاط
قرار وزير البيئة	١/١٥	٢٠٠٢/٠٣/٠٤	الشروط البيئية لرخص إنشاء و/أو استثمار مصانع الزجاج
مرسوم	٢٢٧٥	٢٠٠٩/٠٦/١٥	تنظيم الوحدات التابعة لوزارة البيئة وتحديد مهامها وملاكها وشروط التعيين الخاصة في بعض وظائفها
قرار وزير البيئة	١/١٠٣	٢٠١٠/١٥/٠٧	الشروط البيئية لرخص إنشاء و/أو استثمار افران الخبز والحلويات الطازجة
قرار وزير البيئة	١/١٠٤	٢٠١٠/١٥/٠٧	الشروط البيئية لرخص إنشاء و/أو استثمار مؤسسات صناعة الجوهرات وتوابعها
قرار وزير البيئة	١/١٠٥	٢٠١٠/١٥/٠٧	الشروط البيئية لرخص إنشاء و/أو استثمار مؤسسات تحميص ألبن والبزورات والنقولات
قرار وزير البيئة	١/١٠٦	٢٠١٠/١٥/٠٧	الشروط البيئية لرخص إنشاء و/أو استثمار مؤسسات صناعة الملابس



State & Trends of the Lebanese Environment
Chapter 3 - Water Resources

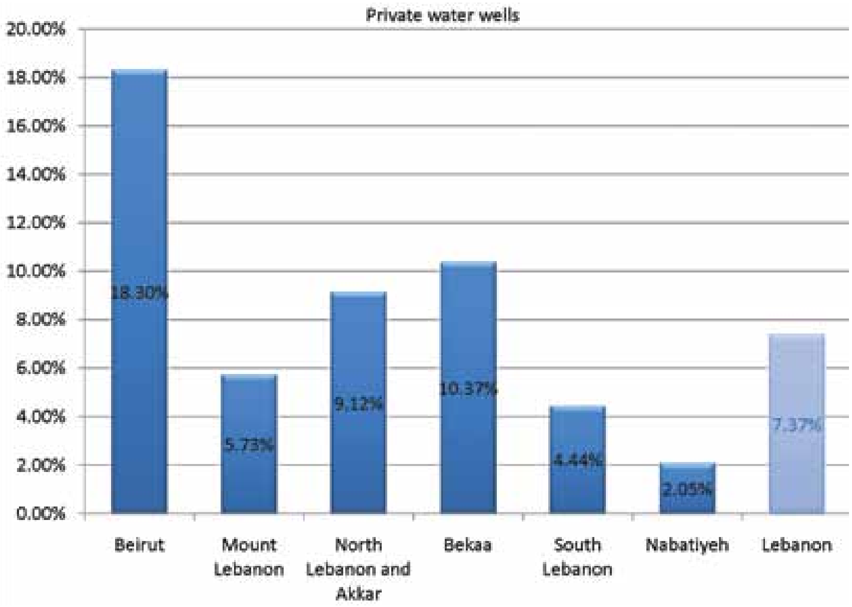
Map 2 - Water Resources and Major Water and Wastewater Infrastructure

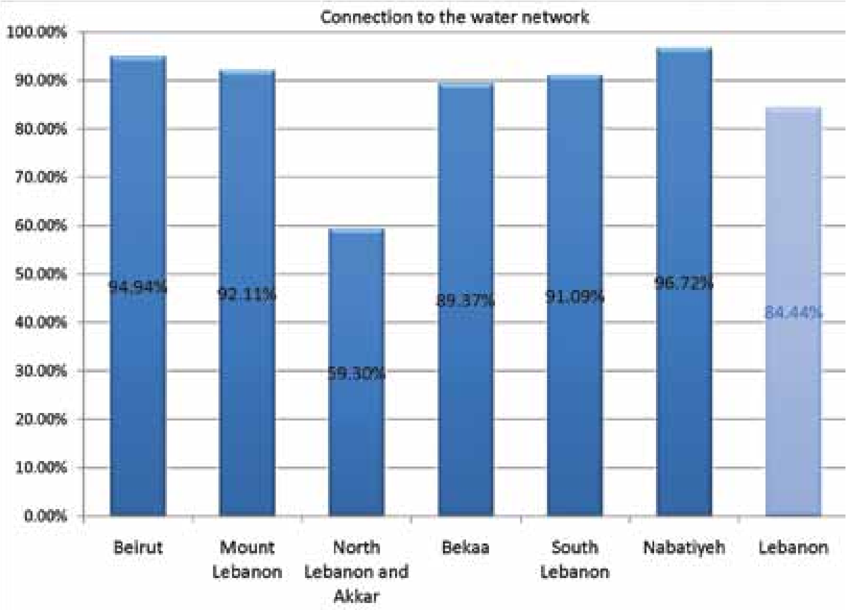
DISCLAIMER: This map was prepared by ECODIT based on CDR Progress Report, October 2009 and National Land Use Master Plan (2004). Every effort has been made to ensure the accuracy of the information displayed on this map. The international boundaries are approximate. MOE/UNDP/ECODIT do not assume any responsibility for any decision that may arise from the use of the map.

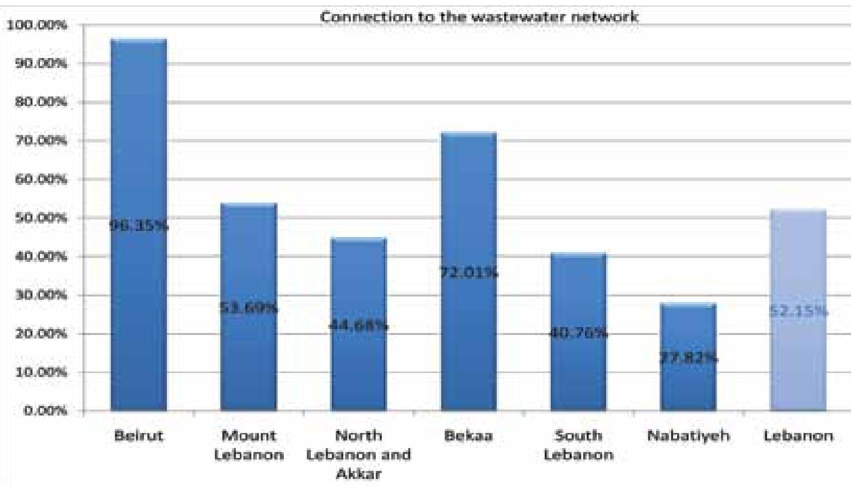
ANNEX 1 WATER AND WASTEWATER BUILDING EQUIPMENT IN LEBANON

Mohafaza/Caza	Well		Water Network		Sewage Network		Unknown
	Yes	No	Yes	No	Yes	No	
Beirut	3,163	14,118	16,407	874	16,651	630	1,055
Baabda	4,710	29,342	28,326	5,726	31,021	3,031	2,134
Metn	1,051	36,082	36,230	903	21,112	16,021	1,514
Kesrouan	508	23,576	23,657	427	5,772	18,312	789
Jbail	63	15,235	13,631	1,667	1,460	13,838	484
North Mount-Lebanon	**6,332**	**104,235**	**101,844**	**8,723**	**59,365**	**51,202**	**4,921**
Tripoli	1,772	8,045	8,700	1,117	8,956	861	533
Koura	1,040	9,577	8,281	2,336	3,030	7,587	1,144
Zghorta	623	9,734	8,077	2,280	7,675	2,682	961
Batroun	252	9,310	8,682	880	86	9,476	1,127
Aakkar	4,914	40,564	19,227	26,251	15,919	29,559	1,153
Bcharreh	4	4,436	1,331	3,109	731	3,709	222
Minieh-Dennieh	1,007	14,076	8,173	6,910	10,679	4,404	459
North Lebanon and Akkar	**9,612**	**95,742**	**62,471**	**42,883**	**47,076**	**58,278**	**5,599**
Zahleh	2,819	22,492	22,188	3,123	20,911	4,400	1,312
West Bekaa	843	12,561	12,726	678	9,989	3,415	1,148
Baalbeck	6,209	40,343	41,005	5,547	32,006	14,546	2,988
Hermel	168	7,220	6,392	996	5,706	1,682	142
Rachaya	278	6,550	6,600	228	3,029	3,799	307
Bekaa	**10,317**	**89,166**	**88,911**	**10,572**	**71,641**	**27,842**	**5,897**
Saida	1,180	24,101	23,595	1,686	14,227	11,054	1,476
Tyre	1,609	29,604	27,440	3,773	8,389	22,824	1,939
Jezine	13	6,670	6,515	168	3,135	3,548	965
South Lebanon	**2,802**	**60,375**	**57,550**	**5,627**	**25,751**	**37,426**	**4,380**
Nabatieh	352	22,631	22,349	634	8,469	14,514	1,814
Bent Jbeyl	245	15,566	15,112	699	670	15,141	1,445
Marjaayoun	573	11,931	12,163	341	2,019	10,485	1,065
Hasbaya	14	6,340	6,138	216	4,883	1,471	825
Nabatiyeh	**1,184**	**56,468**	**55,762**	**1,890**	**16,041**	**41,611**	**5,149**
Lebanon	**33,410**	**420,104**	**382,945**	**70,569**	**236,525**	**216,989**	**27,001**

Source: CAS 2006 (data from 2004)


Private water wells
20.00%
18.00%
16.00%
14.00%
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
18.30%
5.73%
9.12%
10.37%
4.44%
2.05%
7.37%
Beirut
Mount Lebanon
North Lebanon and Akkar
Bekaa
South Lebanon
Nabatiyeh
Lebanon


Connection to the water network
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
94.94%
92.11%
59.30%
89.37%
91.09%
96.72%
84.44%
Beirut
Mount Lebanon
North Lebanon and Akkar
Bekaa
South Lebanon
Nabatiyeh
Lebanon


Connection to the wastewater network
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
96.35%
53.69%
44.68%
72.01%
40.76%
27.82%
52.15%
Beirut
Mount Lebanon
North Lebanon and Akkar
Bekaa
South Lebanon
Nabatiyeh
Lebanon

ANNEX 2 PROPOSED LONG-TERM WATER INDICATORS FOR LEBANON

Water Availability and Extraction

Indicator	*Trend*	*Data availability*
Available water supply		
Storage		
Springs		
Groundwater		
Extraction levels		
Storage		
Springs		
Groundwater		

Water Consumption

Indicator	*Trend*	*Data availability*
Pattern of Consumption[1]		
Agriculture		
Industry		
Hotels		
Public institutions		
Households		
Electricity		
Others		

Measured nationally and by mohafaza

Surface water quality

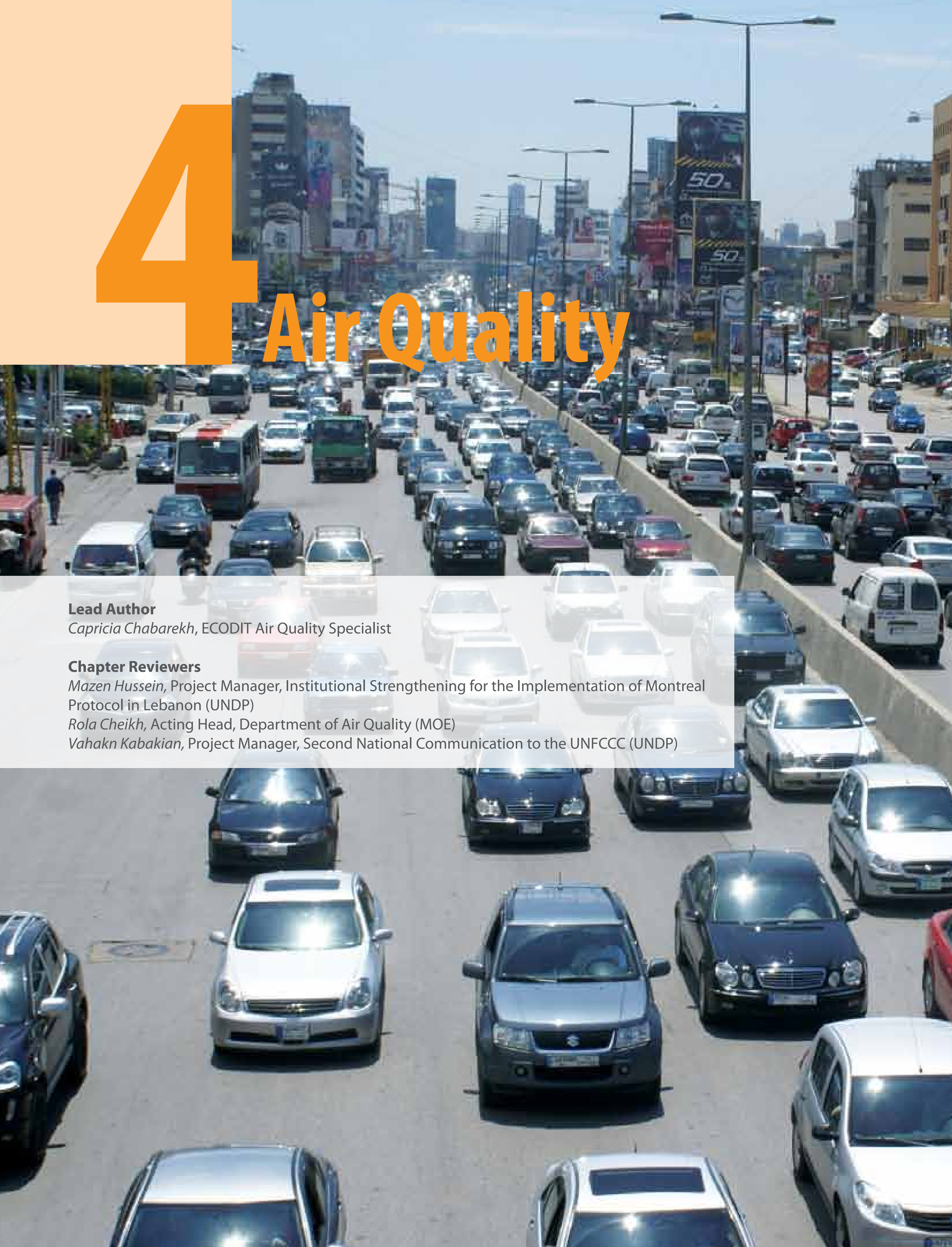
Indicator	*Trend*	*Data availability*
Rivers & springs		
Annual flow volume		
Salinity		
BOD loads		
E.Coli & T. Coliform		
Nitrates		

Ground Water Quality

Indicator	*Trend*	*Data availability*
Groundwater		
Groundwater quality		

Sea Water Quality

Indicator	*Trend*	*Data availability*
Coastal Waters		
Quality at selected sites		
Frequency of algal bloom		



4 Air Quality

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ABBREVIATIONS & ACRONYMS

AQRU	Air Quality Research Unit
AUB	American University of Beirut
CAS	Central Administration of Statistics
CDM	Clean Development Mechanism
CNRS	National Council for Scientific Research
EIA	Environmental Impact Assessment
EPA	Environment Protection Agency
GBA	Greater Beirut Area
GHGs	Greenhouse Gases
GOL	Government of Lebanon
HEFF	High Emission Factor Fuel
HFO	Heavy Fuel Oil
LCPC	Lebanese Cleaner Production Center
MOE	Ministry of Environment
MOEW	Ministry of Energy and Water
MOF	Ministry of Finance
MOI	Ministry of Industry
MOIM	Ministry of Interior and Municipalities
MOPH	Ministry of Public Health
MOPWT	Ministry of Public Works and Transport
NA	Not Available
NAAQS	National Ambient Air Quality Standards
NEAP	National Environmental Action Plan
NOU	National Ozone Unit
ODS	Ozone Depleting Substances
PCBs	Polychlorinated Biphenyls
PFCs	Per-fluorocarbons
POPs	Persistent Organic Pollutants
RE	Renewable Energy
SEEL	Supporting the Judiciary System in the Enforcement of Environmental Legislation
SELDAS	Strengthening/State of the Environmental Legislation Development and Application System in Lebanon
TEDO	Tripoli Environment and Development Observatory
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
USJ	Université Saint Joseph
WHO	World Health Organization

SYMBOLS

NH_3	Ammonia
$(NH_4)_2SO_4$; $(NH_4)HSO_4$	Ammonium sulfates; Sulfate particulates
$(NH_4)NO_3$	Ammonium Nitrate; Nitrate particulates
µg/m^3	Microgram per cubic meter (Concentration Unit)
$Al_2Si_2O_5(OH)_4$	Kaolinite
As	Arsenic
C_6H_6	Benzene
Ca	Calcium
$CaCO_3$	Calcium carbonate
Cd	Cadmium
CFCs	Chlorofluorocarbons
$CH_3C(O)OONO_2$	Peroxyacetyl Nitrate (PAN)
CH_4	Methane
Cl	Chlorine
Cl^-	Chloride
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_3^{2-}	Carbonate ions
CO_x (CO & CO_2)	Carbon Oxides
Cr	Chromium
Cu	Copper
Fe	Iron
H_2S	Hydrogen Sulfide
H_2SO_4	Sulfuric acid
HBr	Hydrobromic Acid
HC	Hydrocarbons
HCFCs	Hydrochlorofluorocarbons
HCl	Hydrochloric Acid
HCN	Hydrogen Cyanide
HNO_3	Nitric acid
HO_x (HO & HO_2)	Hydrogen Oxides
K	Potassium
K_2S	Potassium Sulfide
Mn	Manganese
N_2	Nitrogen
Na	Sodium
NH_4^+	Ammonium
Ni	Nickel
NMVOC	Non Methane Volatile Organic Compounds
NO	Nitrogen Monoxide
NO_2	Nitrogen Dioxide
NO_3^-	Nitrate
NO_x (NO & NO_2)	Nitrogen Oxides
O_3	Ozone
PAHs	Polynuclear Aromatic Hydrocarbons
Pb	Lead
$PM_{0.1}$	Particulate Matter with an aerodynamic diameter (ad) of 0.1 µm or less
PM_1	Particulate Matter with an aerodynamic diameter (ad) of 1 µm or less
PM_{10}	Particulate Matter with an aerodynamic diameter (ad) of 10 µm or less
$PM_{2.5}$	Particulate Matter with an aerodynamic diameter (ad) of 2.5 µm or less
ppb	part per billion = 10^{-9} mol
ppm	part per million = 10^{-6} mol
RO_x (RO & RO_2)	Organic Radicals
Si	Silica
SiO_2	Quartz
SO	Sulfur Monoxide
SO_2	Sulfur Dioxide
SO_4^{2-}	Sulfate
SO_x (SO & SO_2)	Sulfur Oxides
TEQ	Toxic Equivalent
Ti	Titanium
TSP	Total Suspended Particles
V	Vanadium
VOC	Volatile Organic Compounds
Zn	Zinc

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The degradation of air quality in Lebanon, estimated at $170 million per year (WB, 2004), is a growing environmental concern (see Table 4.1). While urban air quality in some industrialized countries has improved in recent decades, in Lebanon the problem persists and has become a major source of concern to public health. Air pollution (see Box 4.1) in Lebanon is affecting millions of people living in mostly urban and peri-urban areas where smog, small particles, and toxic pollutants pose serious health concerns. In addition to respiratory problems, long-term exposure to air pollution and to certain pollutants can cause cancer and damage to the immune, neurological and reproductive systems. Many recent epidemiological studies have consistently shown positive associations between levels of exposure to air pollution and health outcomes.

Box 4.1 What is "Air Pollution"?

Air pollution is contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere (WHO, 2011). It occurs when various gases, droplets, and particles are found in the atmosphere beyond their normal concentrations and/or introduced to the atmosphere by anthropogenic sources or natural phenomena.

Table 4.1 Annual costs of air quality degradation

Ambient/ Indoor air pollution	$M per year	% of GDP	Damages
Urban Air pollution-Lead	28-40	0.20	Impaired neurological development in children
Urban Air Pollution-PM_{10}	26	0.56	Respiratory illnesses including chronic bronchitis, emergency room visits, respiratory hospital visits, restricted activities, etc.
Indoor Air Pollution	10-46	0.18	Respiratory illnesses
Total Costs from Outdoor/ Indoor Air Pollution & Loss of Quality of Life	112-225	0.02	Respiratory illnesses, hospital visits, general discomfort, etc.
Average Cost of Air Pollution	**170**	**1.02**	

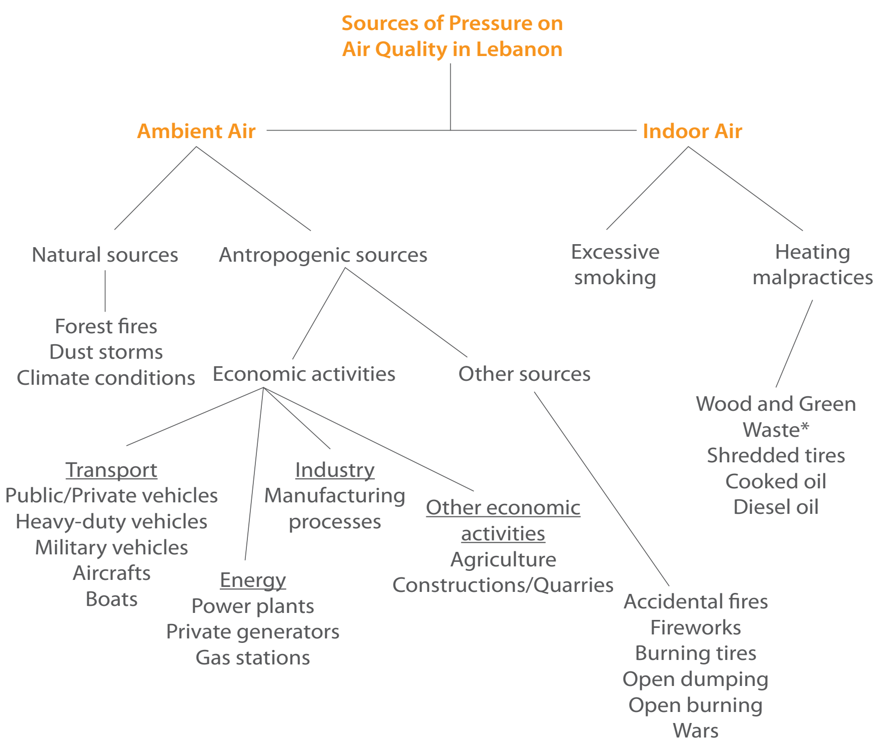
Source: WB, 2004

This chapter describes the drivers of change affecting ambient and indoor air quality (transport, energy, industry, smoking, etc.) in the country, the current situation of air pollution, major national responses to air pollution issues and air quality improvement opportunities in the future.

4.1 DRIVING FORCES

Many forces, acting together or in isolation, are impacting air quality in Lebanon. These forces may affect ambient and/or indoor air, and may stem from natural phenomena or anthropogenic activities. *See summary of driving forces in Figure 4.1.*

Figure 4.1 Driving forces affecting air quality in Lebanon



*Green wastes include grass cuttings, leaves, shrubs and tree trimmings

4.1.1 Ambient Air

Ambient air is affected by anthropogenic activities such as driving cars, burning oil and fossil fuels, industrial and manufacturing processes as well as agriculture, quarries, construction activities, open burning and many other operations. Ambient air is also affected by natural phenomena including forest fires, dust storms and climatic conditions. Everyday activities such as cleaning, painting, degreasing also release pollutants into the air we breathe- *see air pollutants classification in Box 4.2.*

Box 4.2 An overview of air pollutants

Air pollutants are divided into two categories (gas and particles) and two sub-categories (primary and secondary). Primary pollutants are those emitted directly from the source; secondary pollutants are primary pollutants that undergo chemical and photochemical reactions in the atmosphere. The main air pollutants are listed below:

Primary	*Secondary*	*Can be Primary & Secondary*
	Gaseous pollutants	
Nitrogen Oxides NOx (NO & NO_2), Sulfur Oxides SOx (SO & SO_2), Carbon Oxides COx (CO & CO_2) Hydrocarbons (HC) Volatile Organic Compounds (VOC) Chlorofluorocarbons (CFCs) Hydro-chlorofluorocarbons (HCFCs) Persistent Organic Pollutants (POPs)	Nitrogen Dioxide (NO_2) Ground level Ozone (O_3) Peroxyacetyl Nitrate (PAN) ($CH_3C(O)OONO_2$)	Sulfuric acid (H_2SO_4) Nitric acid (HNO_3) Others
	Aerosol, Particles, Particulates or Particulate Matter (PM)	
PM_{10} (with an aerodynamic diameter ad of 10 µm or less; ad≤10 µm; measured by mass - µg/m³) are primary coarse particles usually formed by erosion of soils a/o adsorption of several small particles to form an aggregate.	$PM_{2.5}$ (ad≤2.5 µm; measured by mass -µg/m³), PM_1 (ad≤1 µm; measured by number –particle/m³) and $PM_{0.1}$ (ad≤0.1 µm; measured by number –particle/m³) are secondary pollutants resulting from a conversion of gas/particle	PM_{10}, $PM_{2.5}$

Source: Compiled by ECODIT for the 2010 SOER

The chemical composition of particles (aerosols) is complex. Atmospheric aerosols constitute a mix of chemical constituents combining mineral and organic elements, including acids (nitrates and sulfates), soil or dust elements, heavy metals and other organic components (HC).

4.1.1.1 Anthropogenic Sources

The most significant sources of pollution from economic activities are the transport, energy and industry sectors.

[1]Including Benzene, Diesel, Kerosene and other petroleum products

Transport Sector

Transport involves the combustion of fossil fuels to produce energy translated into motion. In Lebanon, the transport sector (including land, air and maritime) is the main source of air pollution in the country (MOE/EU/NEAP, 2005u). It is one of the largest contributor to urban air quality deterioration accounting for 59 percent of the national NO_x emissions in 2005 (MOE/GEF/UNDP, 2010 unpublished data)—*see Figure 4.4*. The combustion of fossil fuels by the transport sector release pollutants that cause damage to (1) human health by inhalation and congestion of pollutants, (2) agriculture and sensitive ecosystems by: dry deposition of Particulate Matter (PM) and heavy metals on leaves (see example of contamination of agricultural crops in Box 4.6), wet deposition of pollutants due to acid rain, appearance of necrotic and chlorotic spots on leaves caused by tropospheric O_3, acceleration of leaf senescence, depression of photosynthetic mechanism, etc. Pollution is primarily the result of the **incomplete** combustion (non-uniform oxygen supply within the combustion chamber and lower flame temperature leads to incomplete combustion) of fuel[1] resulting in emissions of unburned HC and other pollutants including various types of particulate matter (PM_{10}, $PM_{2.5}$, PM_1, $PM_{0.1}$), soot and a variety of gases including CO_x, SO_x and NO_x. These pollutants are dispersed into the atmosphere subject to prevailing meteorological conditions where they undergo multiple chemical and photochemical reactions to form secondary pollutants including tropospheric ozone O_3 and sulphate/nitrate particulates $(NH_4)_2SO_4$ / $(NH_4)NO_3$.

The Lebanese population is excessively dependent on private cars for daily commuting. Sources estimate that the total number of vehicles in Lebanon is about 1.2 million (MOE/EU/NEAP, 2005u), equivalent to one vehicle to every four people. In reality, the fleet size is probably significantly higher since the number of vehicles removed from circulation every year is not known and many vehicles operate illegally without a license. Records from the Central Administration of Statistics (CAS) show a dramatic increase in annual vehicle registration from 40,515 vehicles in 2001 (including 25,883 cars) to 106,959 vehicles in 2008 (including 79,899 cars) –equivalent to a 15 percent annual increase in registration. Almost 70 percent of vehicles are private cars -*see annual vehicle registration in Figure 4.2 and a summary of the transport fleet in Table 4.2.*

The precursors of most air pollutants emitted from the transport sector are fuels and lubricants used in vehicles. SO_2 and Lead emissions are directly correlated to the Sulfur and Lead content in fuels. Accordingly, lead emissions in the country have gradually decreased since the introduction of unleaded gasoline in 1993 and the ban on leaded gasoline in 2001 (Law 341/2001) (Hashisho *et al.* 2001). However, the 2001 ban on Diesel oil in vehicles (not to be confused with Diesel oil in Europe with physical and chemical properties described under EN 590) and the 1995 emission standards on trucks, buses and motor vehicles (Decree 6603/1995) did not lead to significant emission reductions as trucks and buses continue to run on Diesel oil without any inspections generating significantly more pollutants (PM, soot, NO_x and CO) than gasoline.

Table 4.2 Road and non-road transport in Lebanon (2007)

Road Transport	***Some Figures***
Public Collective Transport (Buses)	3.2 million passengers per year 61,360 bus trips per year
Private Collective Transport (Buses)- Lebanese Commuting Company	13 lines 52,385 bus trips per year
Number of Registered Motorcycles	12,154
Number of Licensed Taxis	33,500
Number of Licensed Vans	4,000
Number of Red Numbers - Buses (25-55 passengers)	2,236
Number of Red Numbers - Trucks	14,000
Non-Road Transport	***Some Figures***
Boats (Beirut, Tripoli, Tyr, Saida, Jieh & Zahrani)	3,289
Aircrafts - Landings and take-offs	39,060

Note: Licensed taxis and vans carry red number plates (the number of unlicensed vehicles is unknown)

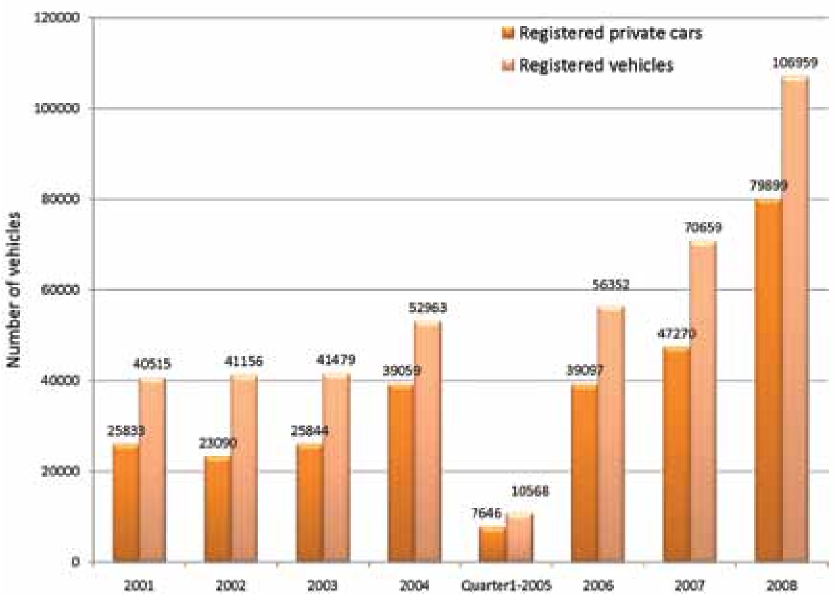
Source: CAS, 2008

Vehicle emissions are also influenced by a number of factors including age, maintenance, speed, traffic, and road conditions. Vehicle performance usually drops on bad roads. All these factors will reduce combustion efficiency resulting in higher emission of PM, HC, CO_x, SO_x and NO_x. Generally, combustion efficiency during start-up and acceleration is lowest and it is highest during moderate speeds (about 80 km/hr). Bumper traffic has an acute effect on air quality because of low combustion effect increasing levels of PM, CO and VOC emissions in tail pipes.

Energy Sector

Energy industries (thermal power plants) are one of the largest contributor to air pollution in Lebanon emitting black plumes of HC, CO, CO_2, SO_2, NO_x soot, PM, and other pollutants (MOE/EU/NEAP, 2005u). They are the largest producer of CO_2 emissions, accounting for 39 percent of national CO_2 emissions in 2005 (Figure 4.4). Thermal power plants generate 85 percent of total electricity in the country of which five plants are located in the coastal zone, while hydropower plants generate an additional 4 percent. The remaining 11 percent come from imports - *see Chapter 9 for more information on Lebanon's energy sector.*

Figure 4.2 Vehicle registration in Lebanon (2001-2008)



Source: CAS 2006, 2007, 2008, 2009

Proximity of Zouk power plant stacks to residential units

Population growth and changing lifestyles increase demand for electricity and other sources of energy. Because Lebanon's formal energy production currently does not meet demand, private backup generators produce an estimated 500MW, equivalent to 20 percent of the total production (MOEW, 2010).[2] Private generators (un-surveyed but in the thousands) are found in industries and other establishments, and may be located on balconies, in basements, empty lots, and curbsides. They usually have short stacks, are not properly maintained, generate significant noise (especially if not

[2]According to the World Bank Electricity Sector Public Expenditure Review for Lebanon (2008), self-generation represents 33 percent of total electricity production in the country.

cased or equipped with noise mufflers) and release soot and PM inside cities and between buildings.

The impact of thermal power plants on air quality is further aggravated by the sulfur content of burning High Emission Factor Fuel (HEFF) such as Heavy Fuel Oil (HFO); containing typically around 2.5 percent Sulfur by weight (MOE/EU/NEAP, 2005u). Their stacks are not equipped with effective treatment units such as Dust Collection Units, and/or Flue Gas Desulfurization (FGD) to reduce SO_x. Therefore, $SO_{2(g)}$ is the major energy pollutant causing the formation of H_2SO_4(major constituent of acid rain) as well as Sulfate particulates $(NH_4)_2SO_4$ and $(NH_4)HSO_4$. Energy industries accounted for 68 percent of national SO_2 emissions in 2005 (MOE/GEF/UNDP, 2010 unpublished data). Non-Methane Volatile Organic Compounds (NMVOC) are also generated from thermal power plants during fuel storage, loading and unloading operations. They react with NO_2 to form ground level O_3, in the tropospheric layer, a major constituent of smog and in high concentrations may cause health problems including asthma, irritation and damages of the respiratory system as well as other respiratory infections.


Plumes of smoke at Jiyeh power plant

Gas stations also affect air quality. They are a major source of NMVOC emissions during fuel loading and unloading. Such emissions are currently not measured in the country and consequently there are no measures in place to reduce NMVOC emissions from fuel stations – *see Chapter 9 for more information on gas stations.*

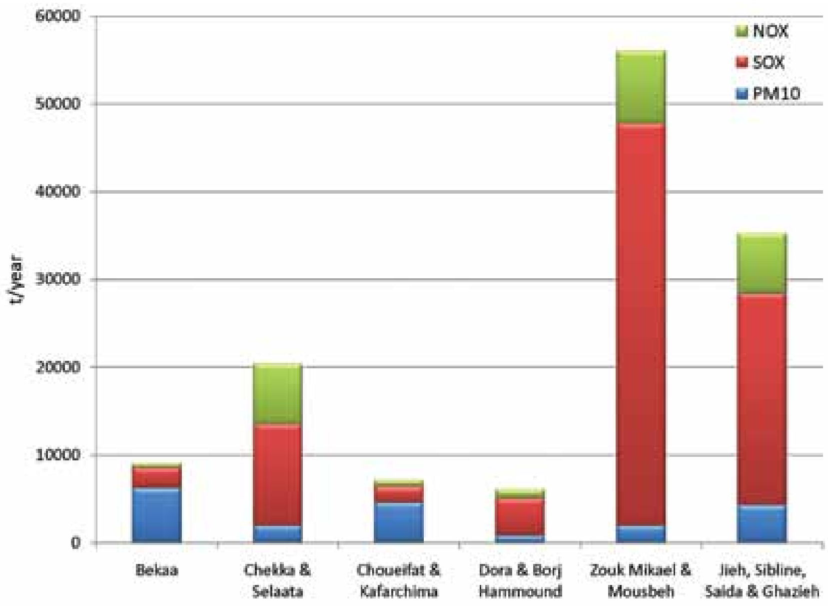
Industrial Sector

Industries in Lebanon are spread all over the country and the majority is small scale. The last comprehensive survey was conducted by the Ministry of Industry (MOI) in 2000 according to which there were 22,026 industrial establishments in the country. The majority is small-scale and employs less than five workers. According to a 2007 update conducted by the MOI, there are currently 4,033 industries that have a surface area greater than $100m^2$, employ more than five people, and consume more than 20KVA annually (data not published). These industries may have potential negative impacts on the environment but they also play an important role in the economic development of the country. Although there are 72 decreed industrial zones, the majority of industries are located outside industrial zones, in cities and villages. These industries are mostly located in urban areas where two thirds of Lebanon's population reside (CDR-NLUMP, 2004). Industries generate two types of emissions: (1) combustion emissions, and (2) process emissions. Combustion emissions are similar to those of the energy and transport sector and include HC, NMVOC, PM, Soot, CO_x, SO_x and NO_x, produced from burning oil and fuel to generate on-site electricity. However those of the manufacturing process are different depending on the process itself and the efficiency of industrial equipments, as well as the loading and unloading operations of raw materials before entering into the process .

In 1998 the METAP/World Bank estimated the air pollution loads (t/year) from industrial activities in Lebanon (based on an earlier survey conducted by MOI in 1994 according to which there were 22,205 industrial establishments). Figure 4.3 shows estimated NO_x, SO_x and PM_{10} loads in major industrial poles. The data show that Zouk Mikael and Zouk Mosbeh host the most polluting industries emitting 45,819 t of SO_x annually. This data should be treated with caution as they were generated many years ago.

Lebanon's First National Communication to the UNFCCC documented the contribution of different industries to air pollution in Lebanon. For example, NMVOC emissions are mainly produced during road asphalting; the production of sulfuric acid is the biggest source of SO_2; iron; steel mills are the major source of CO emissions; and the cement industry is the greatest producer of CO_2 (MOE/GEF/UNDP, 2002) –*see summary of air pollutants from cement industries in Box 4.3.*

Figure 4.3 Estimated air pollutant loads from industrial activities in Lebanon



Source: Adapted from WB 2010

Box 4.3 An overview of Lebanon's cement industry

In Lebanon, the cement industry represents the largest source of CO_2 emissions in the sector. Lebanon has five plants (Holcim Lebanon, Cimenterie Nationale SAL, Ciment de Sibline, Cimenterie du Moyen Orient, Societe Libanaise des Ciments Blancs) of which four are located in North Lebanon. Raw materials include silica, aluminum, iron and lime which is obtained from calcium carbonate. Other raw materials are introduced as sand, clay, shale, iron ore and blast furnace slag. The cement industry includes many processes such as mining/quarrying, crushing, grinding, and calcining, all of which generate pollutants:

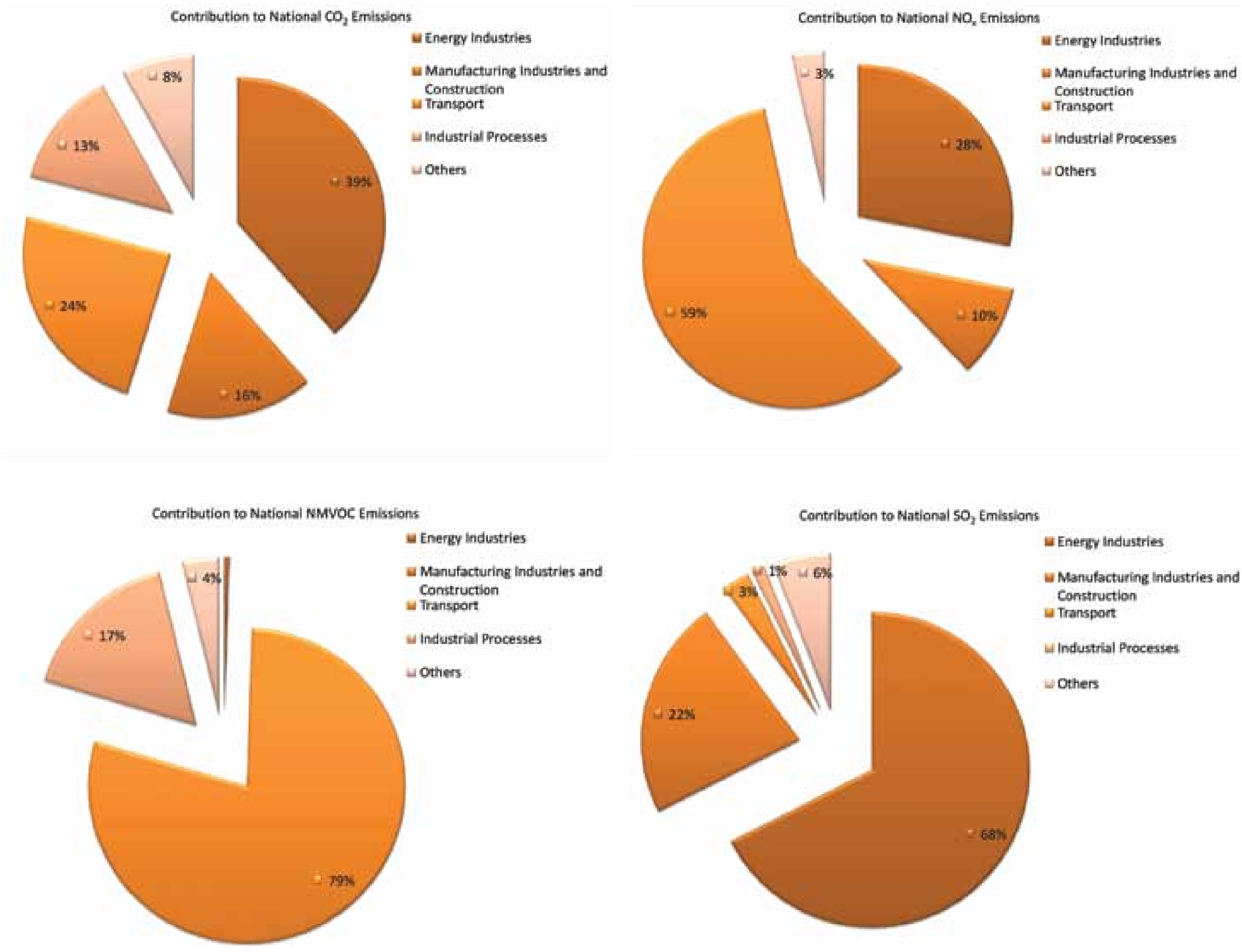
- Extraction, crushing and grinding of raw materials > particulates
- Kiln operation and cooling > particulates, CO, SO_2, NO_x, HC
- Grinding and bagging of cement > particulates

In 1997, the MOE prepared a guidance note (Decision 191/1) for the cement industry on how to protect the environment and workers from exposure to industrial pollutants. The note included conservation measures of air and water quality and kick-started a process of self-monitoring stack emissions that requires further improvements –see Section 4.4.3.

Cement factory in Sibline, one of five plants in the country

The recently published Second National Communication (SNC) to the UNFCCC provides a detailed analysis of national GHG emissions for the reference year 2000 (MOE/GEF/UNDP, 2011). As part of the preparations for the SNC, data on greenhouse gases were collected through 2006. As emissions in 2006 may have been impacted by the war that year, this SOER has retained emissions values for 2005. Figure 4.4 summarizes the contribution of energy industries, manufacturing industries and construction, transport, and industrial processes to national GHG and precursor emissions in 2005.

Figure 4.4 Contribution of economic activities to national air pollutant emissions (2005)



Source: MOE/GEF/UNDP, 2010 unpublished data

Other Sources

In addition to transport, energy and industry, the three major economic activities in Lebanon, other economic sectors also affect air quality including agriculture, construction and quarrying. Other sources of air pollution include open dumping and/or burning of municipal solid waste, burning of tires, fire and explosion accidents in poorly regulated warehouses (see Box 4.4), fireworks and wars. *See summary of pollutants by type of activity in Table 4.3.*

Box 4.4 Fire incident in Ain al-Remmaneh

On 9 November 2010, a severe fire broke out in an underground storage site in Ain al-Remmaneh (Beirut Suburb) that contained chemicals including resins (cellulose combined with halogens, used for water disinfection) and polymer packages. The fire released vast plumes of smoke over Beirut containing hazardous pollutants such as PM, HC, CO_x, Cl_2, HCl, dioxins, furans, etc. Investigation into the incident revealed that unexpected chemical reactions occurred between stocked materials that caught fire. Emissions from an open fire can represent acute (short-term) and chronic (long-term) health hazards to firefighters and nearby residents. Depending on the length and degree of exposure, these health effects could include irritation of the skin, eyes, and mucous membranes, respiratory effects, central nervous system depression, and cancer. The storage site was categorized by MOE as Class I Establishment according to Decree 4917/1994 and must be separated from residential areas according to Legislative Decree 21/l/1932. Moreover, these establishments require a permit from the Governor. The Ain Al-Remmaneh storage site was operating illegally, without a permit, similar to thousands of other warehouses in the country. The incident prompted MOE, in coordination with the Civil Defense, to review storage permits and inspect storage conditions more consistently. The GOL has yet to decide how to deal with the more persisting issue –the relocation of storage areas/warehouses containing potentially hazardous substances outside densely populated residential areas.

The July 2006 war with Israel resulted in extensive air pollution and adverse impacts on human health. Exploded ammunitions, ignited fuels, forest fires, damaged industrial facilities and buildings caused air quality deterioration in the southern suburb of Beirut, South Lebanon and the Bekaa region (UNDP-ELARD, 2007). Emissions were quantified whenever possible to provide an order of magnitude of pollutants emitted and guide decision-makers as to which impacts to mitigate. The burning of 60,000 m^3 of fuel oil at the Jiyeh Power Plant and 5,000 m^3 of kerosene at the Beirut Rafiq Hariri International Airport generated large plumes of SO_2, NO_2,

Table 4.3. Summary of pollutants from other anthropogenic activities

Activity	Generated air pollutants (incl. pathogens)
Farming-Agriculture	Sprayed pesticides, NH_3, Odors, GHGs (CH_4, CO_2)
Open dumping	GHGs (CH_4), Bacteria, Viruses
Open burning	Products from incomplete combustion: CO, NO_x, SO_x, HC, PM and other hazardous substances including dioxins and furans (POPs)
Burning tires	CO_x, SO_x, NO_x, NMVOCs, PAHs, dioxins, furans, HCl, benzene (C_6H_6), PCBs; Metals: As, Cd, Ni, Zn, Hg, Cr, and V
Quarrying, construction, open-air storage sites	Large dust plumes comprising PM_{10} and $PM_{2.5}$
Fireworks	CO_2, $K2_S$ and N_2 – For every 270 grams of black powder (gunpowder, propellant) used, 132 grams of CO_2 are created. Colors are generated by oxidized metals (e.g., the color red derives from strontium, blue from copper, gold from charcoal and iron).

Source: Compiled by ECODIT

Uncontrolled roadside burning of solid waste is widespread in rural Lebanon

CO, soot, PM, VOC, dioxins, furans, and other compounds from the incomplete combustion of oil and oil products. Accordingly, an air pollution model projected PM concentrations near pools of fire (oil and kerosene) at various distances (see Table 4.4). The model indicated that particle concentrations were at their highest levels near pools of fire.

Following site clearing and removal, disposal of demolition wastes and construction activities, Total Suspended Particles (TSP) were estimated to reach 860µg/m³ under worst-case scenario and 190µg/m³ under typical scenario in the ambient air of Beirut Southern Suburbs, exceeding the Lebanese (120 µg/m³), EPA (75 µg/m³) and WHO (150 µg/m³) 24-hr exposure standards for TSP in ambient air. Impacts from Jiyeh and airport fires on the neighborhoods were considered to be short-term (< than 1-year); those of construction activities in Beirut suburb were considered to be medium-term (1-10 years). *See other impacts of the 2006 war in Chapters 6 and 9 of this report.*

Burning fuel storage tanks at Beirut Rafic Hariri International Airport (July 2006)

Table 4.4 PM concentrations near pools of fire

Particulate Concentrations	Oil Fire (Jiyeh Power Plant)	Kerosene Fire (Beirut Rafiq Hariri International Airport)
Near the Pool of Fire	34mg/m³ (Vertical Elevation 0m)	31mg/m³ (Vertical Elevation 0m)
At 1-4 km downwind	217-295µg/m³ (Vertical Elevation 695m)	30.3µg/m³ (Vertical Elevation 725m)
At 20 km downwind	21µg/m³ (Vertical Elevation 780 m)	1µg/m³ (Vertical Elevation 260m)
At 20 km downwind	29µg/m³ (Vertical Elevation 350 m)	3.2µg/m³ (Vertical Elevation 725m)

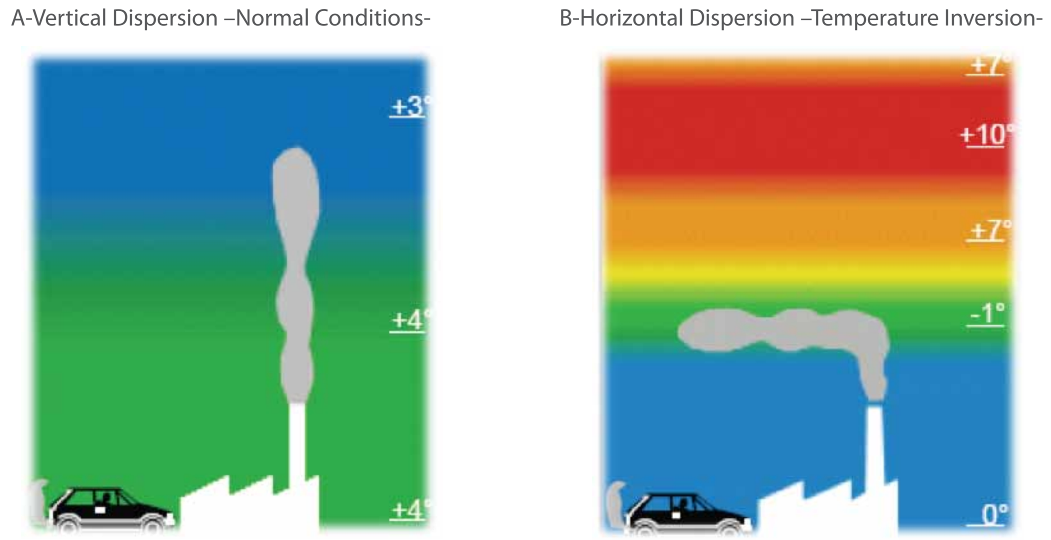
Source: UNDP-ELARD, 2007

4.1.1.2 Natural Sources

In Lebanon, the following natural phenomena impact air quality:

- Forest fires are caused by natural drought, accumulation of dead and highly flammable wood, or by arson. In Lebanon, sources of raging forest fires remain unclear. Between 2008 and 2009, there were 705 recorded fires in the country, devastating around 45 km² of forests which is equivalent to 1.8 percent of the forest cover (MOE, 2010). Generally, forest fires cause significant damages to the wildlife and the forest cover, produce large smoke plumes charged with fine particles rich in carbon and potassium that spread across large tracts of land and have considerable impacts on human health – *see more details on forest fires in chapter 5*.
- Dust storms (*reyah khamseenyah)* affect Lebanon every year. They originate in Africa (spring) and the Arab Peninsula (autumn) and sweep across vast land areas. These hot air masses are loaded with crustal elements increasing levels of PM_{10} in the atmosphere.
- Atmospheric and climatic conditions include temperature, humidity, atmospheric pressure, wind speed, wind direction and the height of the mixing layer (height: 1km). All these conditions have an effect on the concentration of air pollutants in the atmosphere. Under normal conditions, temperature decreases with height *–see Figure 4.5A*. In case of temperature inversion (an increase in temperature with height) with low wind speeds, pollutants are trapped in the mixing layer and move horizontally since their dispersion is blocked vertically *–see Figure 4.5B*.

Figure 4.5: Dispersion of air pollutants in the atmosphere



Internal Security Forces controlling a forest fire using beaters

4.1.2 Indoor Air

Indoor air quality is affected by combustion sources (oil, gas, coal, and wood), tobacco smoking, building materials and furnishings, asbestos-containing insulation, pressed wood products; household cleaning and maintenance products, personal care, or hobbies; central heating and cooling systems and humidification devices; and outdoor sources such as radon, pesticides, and outdoor air pollution. In Lebanon, the main sources of indoor air pollution are smoking and heating malpractices.

4.1.2.1 Excessive Smoking

In Lebanon, smoking cigarettes, cigars and the so called *narguileh* is excessive in both public and private areas. According to a 2005 Global Youth Tobacco Survey which investigated the self-reported attitudes and behaviours related to tobacco among 3,314 Lebanese schoolchildren aged 13–15, 80 percent of youth experience Second Hand Smoking (a.k.a. Passive Smoking) at home. This percentage does not include pre-school children exposed to *narguileh*. The mean age for starting smoking is 14, and smoking prevalence among students (age 13-15) is 15 percent for males and seven percent for females (WHO, 2000). According to the Lebanon's 1998 Tobacco Control Profile, adult smoking prevalence in Lebanon was 46 percent for males and 35 percent for females –considered the highest among all Arab Countries (Kuwait: 29.6% for males and 1.5% for females; Qatar: 37% for males and 0.5% for females) (WHO, 2000).

Cigarette smoke contains an array of gaseous and particulate compounds that may cause long-term health effects including lung cancer.

These include (in approximate order by mass): CO_2, water, CO, PM, Nicotine, NO_x, HCN, NH_3, CH_2O, PAH, VOC, Phenol and dozens of other well known toxic compounds. Some of these components are present in extremely high concentrations. For instance, cigarette smoke contains much higher concentrations of Carbon Monoxide [CO] (0.5-5% v/v) than the auto exhaust from a well maintained vehicle. Such CO concentration would be lethal if inhaled continuously for ~30 minutes (Jaffe and Chavasse, 1999).

4.1.2.2 Heating Malpractices

Lebanese citizens, especially lower income households, often rely on dirty and inefficient solid fuels for home heating including biomass (wood and crop wastes), polymer products (shredded tires) and other liquid fuels such as cooked oil and Diesel oil. The majority of households using solid fuels burn them in open fires or simple stoves that release most of the smoke into the home. The resulting indoor air pollution is a major threat to health, particularly for women and young children, who may spend many hours close to the fire.

Furthermore, the reliance on solid fuels and inefficient stoves has other, irreversible consequences on health (i.e., damages to the central nervous system), the environment, and economic development. Many health-damaging pollutants, including PM, CO, SO_x, NO_x, Aldehydes, Benzene (C_6H_6), and HC are emitted. Inadequate ventilation, high temperature and humidity levels will increase indoor pollutant levels.

Excessive cigarette smoking

4.2 CURRENT SITUATION

Since 2001, Lebanon's capabilities in air quality monitoring have vastly improved. Although the country still lacks a national, government-driven program for air quality monitoring, several universities and institutions have started to coordinate their air pollution related activities. This section therefore first describes Lebanon's current air quality monitoring capabilities, and then draws on a growing volume of air quality data and publications to reveal a partial assessment of Lebanon's air quality situation.

4.2.1. Preliminary Air Quality Monitoring Program inside and outside GBA

Under a partnership agreement with the Municipality of Beirut, Le Conseil Régional d'Ile de France, and Université Saint Joseph (USJ), a

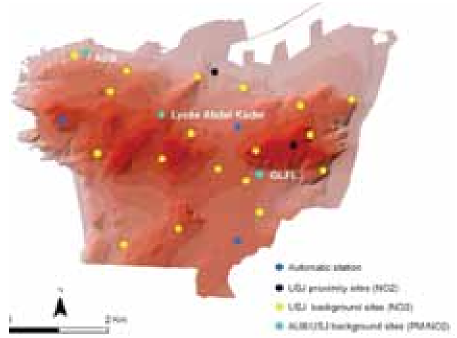
Clear view of Beirut

Preliminary Air Quality Monitoring Program was established in 2003 to provide data on ambient air quality in Beirut. The program installed 23 monitoring stations for sampling and analyzing key air pollutants including (PM_{10}, $PM_{2.5}$, NO_x, SO_x, CO_x, VOC, and O_3), using a variety of fixed and mobile sampling equipment. The program was extended and expanded in 2008 to cover the Greater Beirut Area (GBA), in association with the American University of Beirut (AUB). Specifically, and under the patronage of the Lebanese National Council for Scientific Research (CNRS), faculty members from AUB and USJ joined efforts to establish the Air Quality Research Unit (AQRU). The unit studies air pollutants levels in GBA and their transformations in the atmosphere. Its objectives are to establish a permanent observatory for the continuous monitoring of air quality in Beirut City and initiate an awareness system to appraise the public on air pollution issues and levels (AQRU Brochure, 2009-2010). Accordingly, the upcoming activities of the AQRU will be (1) to develop the Beirut Air Quality Index on air pollution that will be accessed by the public via internet, (2) monitor pollutants outside GBA and (3) monitor emissions from industrial stations (AQRU Conference, 2011). Table 4.5 presents an overview of air quality monitoring stations in Beirut and GBA from 2004 till the present and Figure 4.6 shows their location in Beirut City (NO_2 and PM sampling sites only).

Outside GBA, two institutions, Tripoli Environment and Development Observatory (TEDO) and University of Balamand (UOB), are involved in air quality monitoring. In particular, the observatory started to measure and monitor TSP and PM in 2000 in the region of Al Fayhaa within Tripoli. The University started in 2008 to monitor TSP in the industrial area of Chekaa and Selaata in North Lebanon. Table 4.6 presents an overview on air quality monitoring stations outside GBA. There are no known initiatives in air quality monitoring in the Bekaa Valley and South Lebanon.

For ease of reference, Table 4.7 summarizes key air quality standards in Lebanon, in comparison with EPA and WHO standards and guidelines.
The MOE set National Ambient Air Quality Standards (NAAQS) in 1996. The 2005 WHO standards and 2010 EPA standards are similar to the NAAQS for some pollutants (e.g., CO) and more stringent for other pollutants (e.g., SO_2); the 2005 WHO 24hr-standard for SO_2 is 20 µg/m³ while the NAAQS 24hr-standard for SO_2 is 120 µg/m³. Standards for other ambient

Figure 4.6 NO_2 and PM sampling sites in GBA



Source: AQRU Brochure, 2009-2010

Table 4.5 Summary of air quality monitoring stations in GBA

Period	Responsible Unit	Measured Pollutants	Sampling Equipment	Location of Equipment
2003-2008 (Phase 1)	Le Conseil Régional d'Ile de France, Beirut Municipality and USJ	NO_2 and SO_2	Passive Sampling (collection every 14 days)- Radiello Tubes, Passam Tubes	23 sampling sites within Beirut City
		NO_x, SO_x, O_3, CO, VOC and PM_{10}	Automatic station Online analyzers (automatic readings every 15 min)	Mobile lab in Horsh Beirut (pine forest)
2008-Present (Phase 2, on-going)	USJ-AQRU	NO_2 and SO_2	Passive Sampling (collection every 7 days)-	Extension from 23 to 66 sites distributed over the GBA
	USJ-AQRU	PM_{10} and $PM_{2.5}$	Two additional automatic stations – Impactor	College Protestant Français and USJ Huvlein
	AUB-AQRU	PM_{10} and $PM_{2.5}$	High Volume Samplers – Impactors	AUB, Lycée Abdel Kader and Grand Lycée

Sources: Pers. comm with Rawad Massoud (AUB), Maher Abboud (USJ) and Charbel Afif (USJ)

Table 4.6 Air quality monitoring stations outside GBA

Period	Responsible Unit	Measured Pollutants	Sampling Equipments	Location of Equipments
2000 to present	TEDO	TSP, PM_{10}, $PM_{2.5}$	High Volume Sampler Low Volume Sampler	1) Urban station: down town of Tripoli; 2) Peri-urban station: TEDO building
		Benzene, Toluene, Xylene, HF, NO_2, SO_2, and O_3	Passive Sampling-Radiello Tubes	13 monitoring stations (according to Al Fayhaa community towns)
		vehicle exhaust gas emissions: HC, O_2, CO, CO_2	Exhaust gas analyzer	In the alleys of Tripoli City
2008 to present	UoB	TSP	High Volume Sampler	Chekka and Selaata

Sources: Pers. comm Amal Soufi (TEDO), Hanna El-Nakat (UOB) air pollutants such as $PM_{2.5}$ are still lacking in Lebanon. MOE will need to review and update the current NAAQS based on recent air quality monitoring data, the latest national environmental epidemiology studies as well as international standards (see Section 4.5.1 on Draft Law on the Protection of Air Quality).

Table 4.7 Standards for ambient air pollutants

Parameter	NAAQS Maximum levels (µg/m³)	EPA Standards	WHO
Sulfur dioxide (SO_2)	80 (annual) 120 (24hrs) 350 (1hr)	0.03 ppm (Annual) 0.14 ppm (24hrs) 75 ppb (1hr)	20 µg/m³(24hrs) 500 µg/m³ (10 minutes)
Nitrogen dioxide (NO_2)	100 (Annual) 150 (24hrs) 200 (1hr)	53 ppb (Annual) 100 ppb (1hr)	40 µg/m³(Annual) 200 µg/m³(1hr)
Carbon Monoxide (CO)	30,000 (1hr) 10,000 (8hrs)	35 ppm (40 mg/m³) (1hr) 9 ppm (10 mg/m³) (8hrs)	30 mg/m³ (1hr) 10 mg/m³ (8hrs)
Ground-level Ozone (O_3)	150 (1hr) 100 (8hrs)	0.075 ppm (2008 std) (8hrs)	100 µg/m³ (8hrs)
Total Suspended Particles (TSP)	120 (24hrs)	75 µg/m³ (24hrs)	150 µg/m³ (24hrs)
PM_{10}	80 (24hrs)	150 µg/m³ (24hrs)	20 µg/m³ (Annual) 50 µg/m³ (24hrs)
$PM_{2.5}$	NA	15 µg/m³ (Annual) 35 µg/m³ (24hrs)	10 µg/m³ (Annual) 25 µg/m³ (24hrs)

Source: Compiled by ECODIT based on MOE (Decision 52/1-1996), EPA (2010) and WHO (2005)

4.2.2 Concentrations and Composition of Air Pollutants

In recent years, there have been a growing number of scientific studies published in Lebanon addressing air quality. Scientists and ministries (MOE, MOPH) are showing greater interest and commitment to air quality issues. Atmospheric pollutants are extremely variable in space and time, depending on meteorological and topographical conditions (including the urban morphology) and on the spatial distribution of emission sources. The following paragraphs present and analyze a targeted selection of air quality data, covering gaseous pollutants and particulates, from Beirut and outside Beirut.

4.2.2.1 Greater Beirut Area

Sulfur Dioxide in GBA Saliba *et al.* (2006) and Afif *et al.* (2008) studied mean SO_2 concentrations in Beirut in 2005 and 2006. Measurements showed that mean concentrations of 3.1 ppb and 7.1 ppb were below annual WHO guidelines (17.5 ppb) and MOE's environmental limit values pursuant to Decision 52/1 (1996) (30 ppb) –*see values in Table 4.8.*

Spatially, SO_2 concentrations tend to peak in highly urbanized cities or areas affected by industrial activities, while rural or suburban areas tend to show lower levels. Beside local sources, long-range transport can account for an important source of SO_2 in Beirut (Afif *et al.* 2008).Temporally, SO_2 concentrations increase in winter due to the lower height of the mixing layer and higher SO_2 emissions (home heating, slower rate of SO_2 oxidation, etc.). Although Beirut does not appear to have an SO_2 problem, measurements should be extended to other parts of the country and augmented with short-term measurements (in urban, rural areas and especially around thermal power plants) to monitor spikes and assess short-term health impacts. Worldwide, SO_2 values in Beirut are comparable to values recorded in other cities– *see Figure 4.7.*

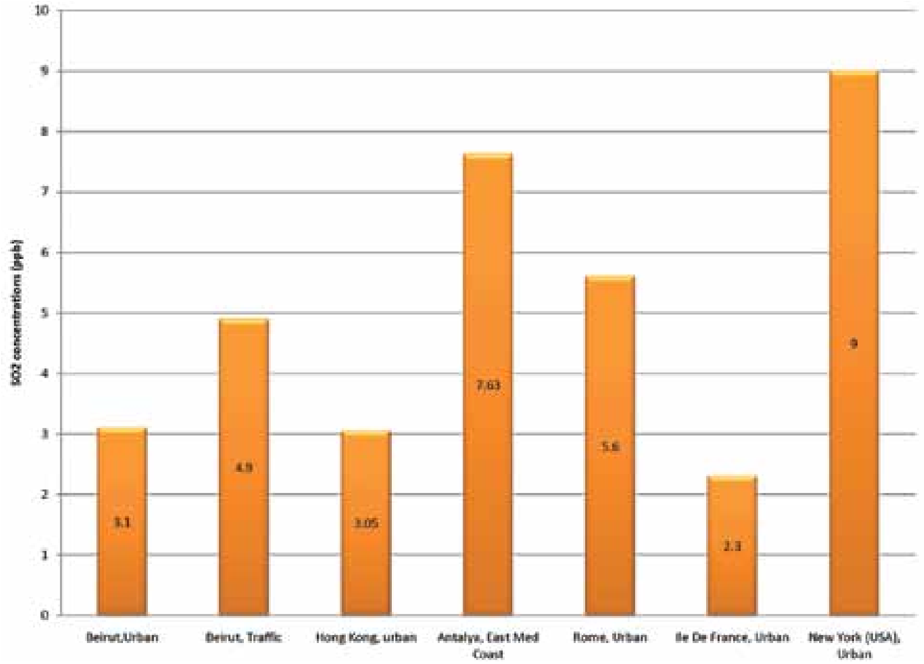
Table 4.8 Mean SO_2 Levels in Beirut

Locations	Sampling Period	SO_2 (ppb)
Beirut, Urban	Dec 2004-Jul 2006 (20 months)	**3.1**
Beirut, Traffic	Summer 2004	4.9
	Winter 2004-2005	9.4
	Mean concentration (2004-2005)	**7.1**
WHO (2005)	Annual guidelines	**17.5**
MOE Decision 52/1 (1996)	Annual guidelines	**30**

Source: Saliba et al. 2006 and Afif et al. 2008

Nitrogen Dioxide in GBA Annual average NO_2 concentration was measured for the first time in 2005 in Beirut City using a city-wide passive sampling network. The main NO_x emission source in Lebanon is traffic (Afif *et al.* 2009). NO_2 concentrations ranged from 17µg/m³ in summer (May 2006) to 178µg/m³ in winter (December 2005), with an annual average concentration of 67µg/m³ (Afif *et al.* 2009), higher than the annual WHO recommended value of 40µg/m³ (WHO, 2005). In 2009 and 2010, AQRU measured annual average NO_2 concentrations in GBA. Reported values for these two consecutive years were 53µg/m³ and 58µg/m³ respectively, also exceeding the WHO standard. It was thus calculated that 93 percent of the population in Beirut are exposed to NO_2 concentrations greater than 40µg/m3 (AQRU Conference, 2011). Chronic exposure to NO_2 can lead serious health effects. To measure short-term concentrations of NO_2 such as hourly averages and concentration peaks, researchers use online analyzers. It should be noted that NO_2 concentrations vary widely during the day, from as low as one µg/m3 to hundreds of µg/m3 depending on climatic conditions and emission sources. Of importance, $SO_{2(g)}$ and $NO_{2(g)}$ are precursors to SO_4^{2-} and NO_3^- in the particle phase.

Figure 4.7 SO_2 levels in different cities around the world



Source: Afif et al. 2008

Smog over Beirut

Carbonyl compounds in GBA In recent years, the toxicity of unregulated pollutant emissions in vehicle exhausts has attracted attention. Formaldehyde (C1), Acetaldehyde (C2), and Propanal/ Acetone (C3) are three carbonyl compounds known to affect human health. They are emitted by primary sources (incomplete combustion of fuels) or by secondary sources through photo-oxidation of VOC (natural or anthropogenic) with OH in the atmosphere, producing HO_2, C1, C2 and C3. Carbonyls and O_3 contribute to the formation of photochemical pollution episodes in summer. Moussa *et al.* (2005) measured lower carbonyl compounds in 2003 and 2004 in two locations in Beirut and found that formaldehyde (C1) and acetaldehyde (C2) were the most common carbonyls –*see carbonyl values in Table 4.9.* Carbonyl levels in the Hamra area were slightly higher than those recorded on AUB Campus. Local anthropogenic emissions mainly vehicle emissions were the predominant source of carbonyl compounds measured in AUB and Hamra. Of importance, carbonyl levels on weekends dropped compared to weekdays.

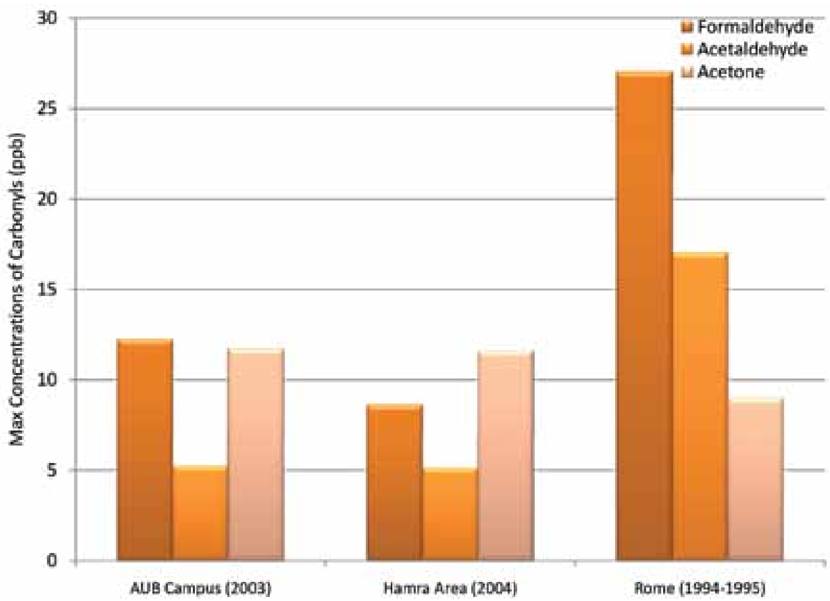
Table 4.9 Concentration of lower carbonyl compounds in Beirut City

Species	*AUB Campus (Jul-Dec 2003) Min-Max*	*Abdel Aziz Street (Aug-Sep 2004) Min-Max*
Formaldehyde (C1) (ppbv)	0.1-12.2	2.4-8.6
Acetaldehyde (C2) (ppbv)	0.02-5.2	0.9-5.1
Propanal (C3) (ppbv)	Max: 0.9	<DL*
Acetone (ppbv)	0.1-11.7	5.8-11.6
Carbon monoxide (CO) (ppmv)	1.1-3	1.1-3

*DL: Detection limit of the measuring device

Source: Moussa et al. 2005

Figure 4.8 Comparison of max carbonyl levels between Beirut and Rome



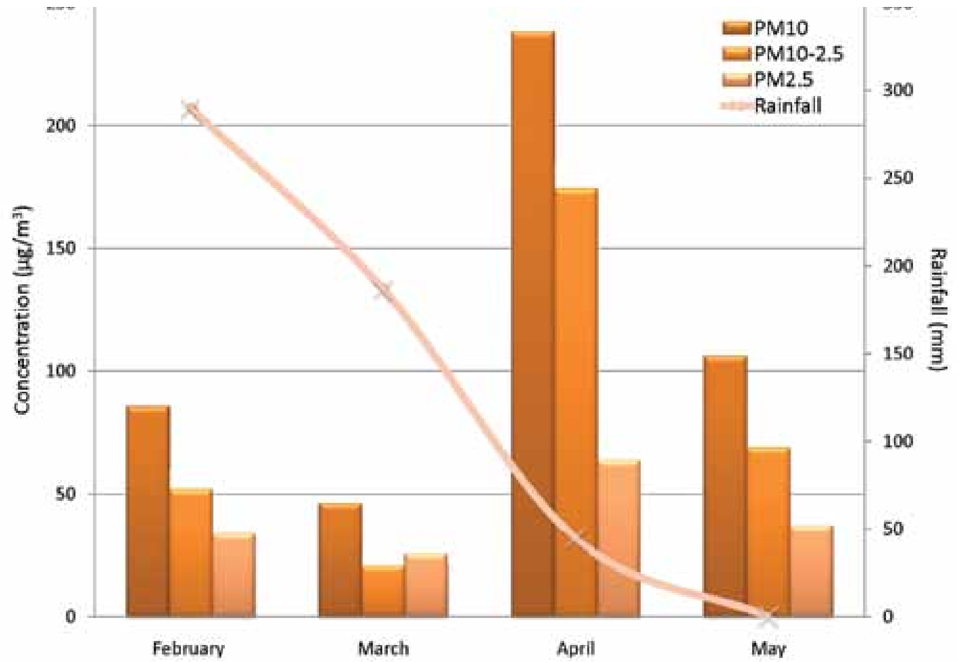
Sources: Possanzini et al. 1996, Moussa et al. 2005

The 2003-2004 urban levels of carbonyl compounds in Lebanon were lower than those recorded in Rome in 1994-1995 –*see comparison of carbonyl levels in Figure 4.8.* In the mid 1990s, European countries (Developed Countries) still used old vehicle technologies, which is therefore a valid comparison period with Lebanon in 2004-2005.

Suspended Particles in GBA (TSP, PM_{10}, $PM_{2.5}$). Population density, the effect of the Mount Lebanon range on the dilution of particulates, recurring dust storms in spring and autumn, as well as emissions from long-range transport, and limited rainfall with long spells of drought have a compounding effect on PM in the atmosphere. Shaka *et al.* (2003) and Saliba *et al.* (2007 -2010) conducted extensive PM sampling and measurement in and around Beirut. *See summary of sampling locations and results in Table 4.9.* In particular, Shaka *et al.* measured PM concentrations (all particle sizes) over a four-month period (February-May 2003). Low PM concentrations during February and March may be attributed to rainfall, whereas the spike in PM concentrations in April may have been caused by annual dust–storms. *See PM concentrations versus rainfall in Beirut City in Figure 4.9.*

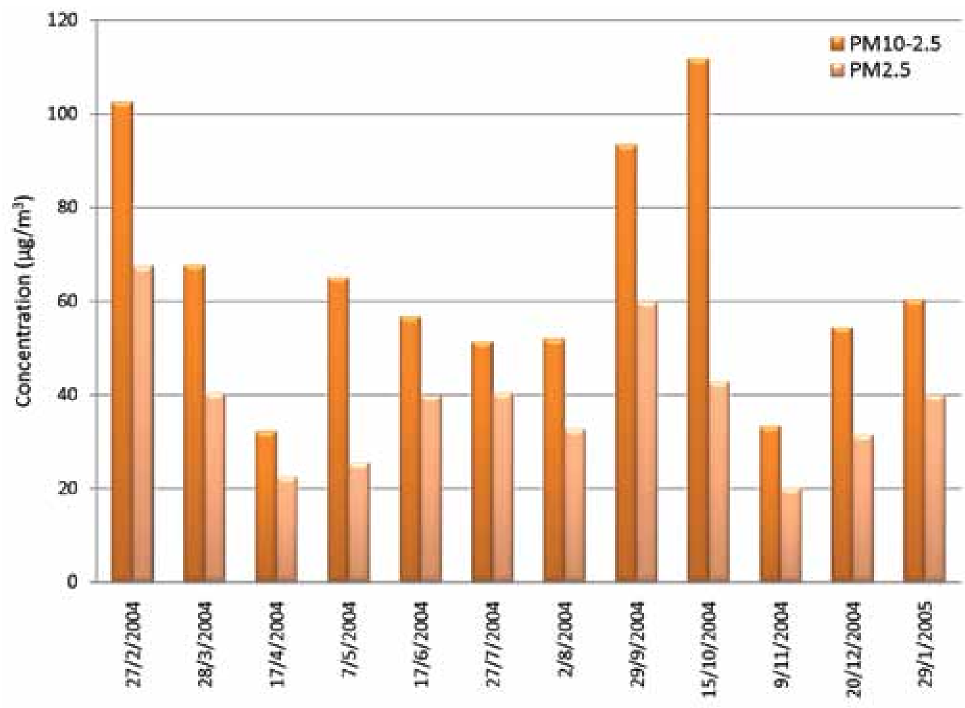
Separately, Saliba *et al.* measured in 2004 PM concentrations in the Borj Hammoud area, one of Beirut's busiest suburbs. The area is characterized by a concentration of residential and commercial activities, day-long vehicle traffic, significant sea-spray exhausts from Beirut harbor operations, as well as some open-air waste burning. The highest concentrations of $PM_{10-2.5}$ were recorded in February, September and October 2004, and were correlated with dust storm episodes coming from Africa and the Arabian Peninsula –*see Figure 4.10*. The average annual concentration of $PM_{10-2.5}$ and $PM_{2.5}$ were 65µg/m^3 and 38.5µg/m^3 respectively. *See PM levels recorded by Shaka et al. (2003) and Saliba et al. (2007-2010) in Table 4.10.*

Figure 4.9 PM concentration between February and May 2003 in Beirut-AUB



Source: Shaka et al. 2003

Figure 4.10 PM concentrations in 2004-2005 in Beirut-Bourj Hammoud

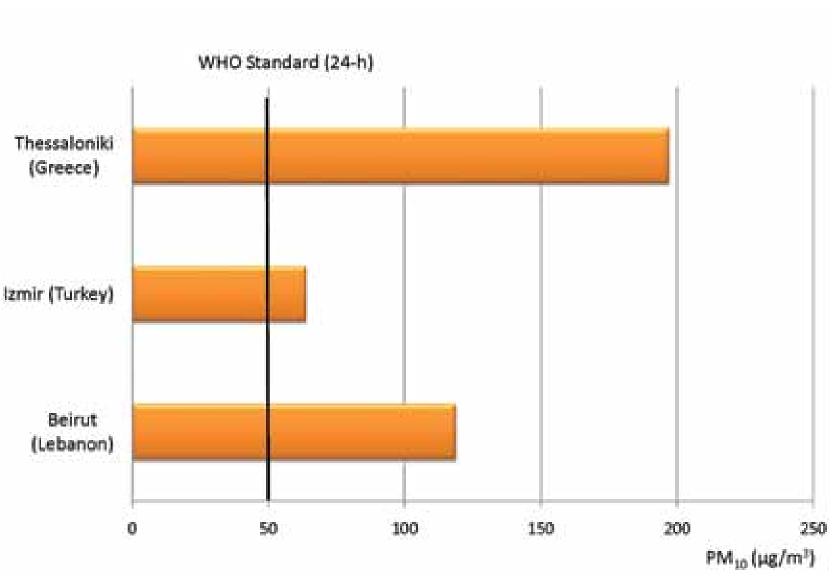


Source : Saliba et al. 2007

Table 4.10 PM levels in Beirut City (listed chronologically by sampling period)

Sampling site	Site description	Sampling period	Mean value during sampling period		Source
			PM_{10}	$PM_{2.5}$	
AUB	Location exposed to different sources of PM (natural & anthropogenic)	2/2003-6/2003 (4 months)	118.9 µg/m³	39.9 µg/m³	Shaka *et al.* 2003
Bliss Street	Urban area and coastal site	3/2003-6/2003 (3 months)	71.34 µg/m³	40.95 µg/m³	Saliba *et al.* 2010
AUB Seagate	Urban area and coastal site	11/2003-3/2004 (4 months)	86.9 µg/m³	-	Saliba *et al.* 2010
Abdel Aziz (Hamra)	Urban area and coastal site	9/2004-12/2004 (3 month)	55.1 µg/m³	-	Saliba *et al.* 2010
Borj Hammoud (Beirut suburb, north)	Urban area, close to Beirut Harbor and a waste facility	1/2004-1/2005 (12 months)	103.78 µg/m³	38.525 µg/m³	Saliba *et al.* 2007
Haret Hreik (Beirut suburb, south)	Urban area affected by post-war reconstruction	12/2006-8/2007 (8 months)	77.1 µg/m³	28.14 µg/m³	Saliba *et al.* 2010
American University	Urban areas	May 2009 -May 2010	54.69 µg/m³	20.18 µg/m³	Saliba & co-researchers, publication in progress
Lycée Abdel Kader			60.77 µg/m³	20.70 µg/m³	
Grand Lycée Franco Libanais			74.69 µg/m³	20.33 µg/m³	
WHO Standards (WHO, 2005)	**Annual average concentrations**		**20 µg/m³**	**10 µg/m³**	

Figure 4.11 PM_{10} Concentrations in Three East Mediterranean Cities



Source: Shaka et al. 2003

PM_{10} variations have different root causes. Near the sea (AUB Seagate in Ain El Mreisseh and Bliss Street in Hamra), high PM_{10} levels were correlated with sea breezes which carry sea salt particles. By contrast, high PM_{10} concentrations in crowded suburbs (Borj Hammoud and Harek Hreik) are not related to wind conditions but to local emissions (dust outbreaks, low precipitation, dust re-suspension, etc.). The main source of $PM_{2.5}$ include combustion processes and photo-chemical reactions combining precursors including $NO_{2(g)}$ and $SO_{2(g)}$ under increased humidity and high solar radiation. In summary, PM_{10} and $PM_{2.5}$ annual levels in all sampling sites in Beirut City exceeded WHO guidelines for PM_{10} (20µg/m³) and $PM_{2.5}$ (10µg/m³). Figure 4.11 compares PM_{10} concentrations in Beirut (Lebanon), Thessaloniki (Greece) and Izmir (Turkey). The most worrisome particles are fine ($PM_{2.5}$) and ultrafine particles (PM_1 and $PM_{0.1}$, yet to be assessed in Beirut City) because they can penetrate lung tissue and cause long-term tissue damage.

Chemical composition of PM in GBA Shaka *et al.* (2003), Kouyoumdjian *et al.* (2006) and Saliba *et al.* (2007) also examined the inorganic composition of aerosol samples in Beirut City (Research into the organic composition of aerosols is on-going *(pers. comm* with Charbel Afif, USJ).

Ionic Compositions and Salts: Ammonium (NH_4^+), Nitrate (NO_3^-) and Sulfate (SO_4^{2-}) ions are the main ionic components of both fine $PM_{2.5}$ and coarse fractions $PM_{10-2.5}$ (Shaka *et al.* 2003). Fine particles which are considered to originate from photochemical reactions hold higher concentrations of the main chemical airborne constituents: Ammonium Sulfates {$(NH_4)_2SO_4$}, ammonium nitrates (NH_4NO_3) and carbonate ions (CO_3^{2-}). Nitrate and Sulfate ions showed higher concentrations in summer due to enhancement of photochemical reactions which facilitates the conversion of NO_2 – SO_2 gases into NO_3^- - SO_4^{2-} respectively and to ammonium sulfates and nitrates. Nitrate is mainly due to local heavy traffic while sulfates are due to local exhaust emissions such as residential heating, Diesel operating buses, etc. and long-range phenomena. Quartz (SiO_2), Kaolinite {$Al_2Si_2O_5(OH)_4$}, typical salts of continental dust coming from Africa, and Calcium carbonate ($CaCO_3$), originating from crustal rocks, were identified to be major species in coarse atmospheric aerosols. Accordingly, Calcium (Ca^{2+}) was dominant in coarse particles along with Chloride (Cl^-) and Sodium (Na^+) resulting from marine aerosols qualified as Eastern Mediterranean Aerosols (Shaka *et al.* 2003, Kouyoumdjian *et al.* 2006).

Elemental Composition: The elemental composition of $PM_{10-2.5}$ and $PM_{2.5}$ was studied in winter, summer, stormy and non-stormy dates, in a populated area of Beirut (Saliba *et al.* 2007)–*see Table 4.11*. Results showed that crustal elements including Ca, Si, K, Ti, Mn and Fe were more abundant in $PM_{10-2.5}$(primary aerosols), increasing in stormy episodes, while enriched elements including S, Cu, Zn and Pb predominated in $PM_{2.5}$ (secondary aerosols). Highly enriched elements like Cu, and Zn, were emitted from worn tires and brakes. S, abundant in both $PM_{10-2.5}$ and $PM_{2.5}$ and originating from local and long range transport, exhibited higher concentrations in the summer season due to high photochemical reactions. It is worth mentioning here that abundance of S in $PM_{10-2.5}$ shows that the aerosol has aged. Chlorine, (Cl), originating from sea salt aerosols and abundant usually in $PM_{10-2.5}$, was found in higher concentrations in $PM_{2.5}$. This can be attributed to waste mass burning (open burning) generating fine particles rich in chlorine during the sampling period.

Table 4.11 Average elemental composition of $PM_{10-2.5}$ & $PM_{2.5}$

	Si (ng/m³)	S (ng/m³)	Cl (ng/m³)	K (ng/m³)	Ca (ng/m³)	Ti (ng/m³)	Mn (ng/m³)	Fe (ng/m³)	Cu (ng/m³)	Zn (ng/m³)	Pb (ng/m³)
$PM_{10-2.5}$	3425.55	814.18	1021.31	369.00	6318.63	154.95	26.64	1898.63	47.27	82.09	78.09
$PM_{2.5}$	38.53	611.00	1755.58	62.78	293.33	17.48	15.75	258.44	14.02	92.30	97.68

Source: Saliba et al. 2007

4.2.2.2 Outside Greater Beirut Area

Outside GBA, air quality data becomes more sketchy and episodic. Most air quality studies outside Beirut have focused on Chekka and Selaata; a region that is infamous for housing large industries including cement plants (Holcim and Cimenterie Nationale) and a phosphate fertilizer industry (Selaata Chemicals Company). The region is also affected by nearby quarries, sea-spray, and long-range transport (secondary aerosols). As described earlier, the Tripoli observatory and the University of Balamand have both implemented air quality monitoring programs in Tripoli and Chekka respectively. Separately, the Lebanese American University (LAU) monitored between September 2002 and February 2004 four criteria air pollutants (PM_{10}, CO, SO_2 and NO_2) in the framework of the USAID-funded project "Air Quality Management and Estimated Health Impact of Pollutants in Urban and Industrial Areas." The program used monitoring stations in five locations in and around the cement industry zone in Chekka and the surrounding Koura villages (Kefraya, Kfarhazir, Fih, and Enfeh). Diffusion and dispersion of pollutants in these areas were also studied according to prevailing and recorded meteorological conditions (Karam & Tabbara, 2004).

Air pollutant levels in Chekka and Koura are presented in Table 4.12 and interpreted below:

- CO: Low levels were recorded in all monitoring locations which is an indication of the absence of inefficient combustion processes.
- NO_2: Relatively low levels were noted in all monitoring locations corresponding to normal transportation and industrial activities. Peak NO_2 levels (from a few hours to a few days) occurred due to irregular

industrial activities and were correlated with a cloud of industrial emissions enveloping the Chekka neighborhood.

- SO_2: Measurements showed significantly high levels during the dry season in the three regions Chekka, Enfeh, and Fih probably due to the smoke plume of the cement factory[3]. However, levels in Chekka were slightly lower than those of Fih and Enfeh.
- PM_{10}: Measurements in the Chekka and Koura region have showed significantly high levels in almost all sampling locations. Chekka showed consistently the highest PM_{10} values, being the closest to all sources of emissions including quarries.

[3] Sulfur is found (6% by weight) in coke and petroleum coke used as fuel in cement kilns.

Large industry in Selaata

Table 4.12 Gaseous pollutants in Chekka and Koura villages

Pollutant	*Concentration range*	*Lebanese Standards MOE Decision 52/1 (1996)*
CO (ppm)	0-2	9.00 (8hr)
NO_2 (ppm)	6.4-10.11	0.053 (annual)
SO_2 (ppm)	0-2*	0.14 (24hrs)
PM_{10} (µg/m^3)	10-450**	80 (24hrs)

* Peaks recorded in Fih and Enfeh; ** Peaks recorded in Chekka

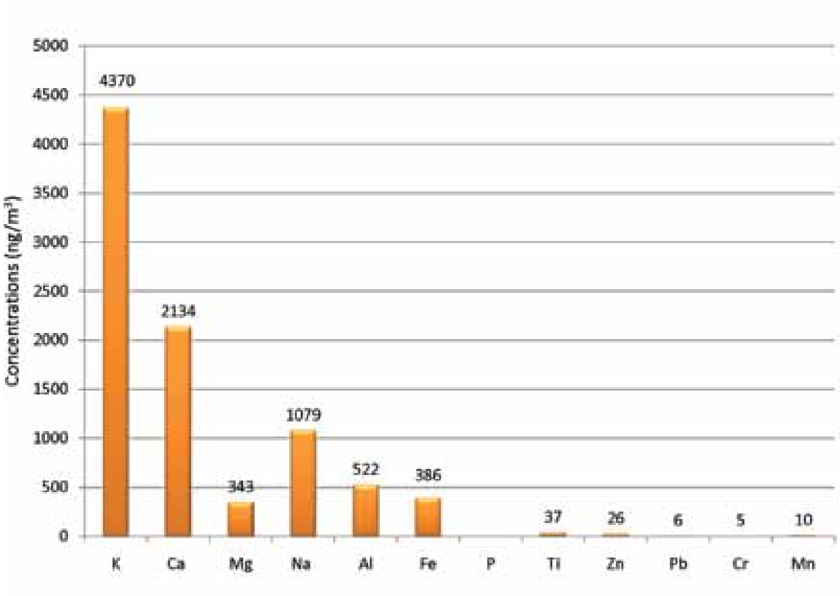
Source: Karam & Tabbara, 2004

Chemical Composition of TSP Kfoury *et al.* (2009) and Yammine *et al.* (2009) investigated the inorganic composition of aerosol samples in Chekka and Selaata. In terms of their ionic composition, NO_3^- had the highest mean concentration linked to gas-particle conversion of NO_2, followed by SO_4^{2-}, Ca^{2+}, NH_4^+ and Cl^- (Kfoury *et al.* 2009, Yammine *et al.* 2010). In terms of their elemental composition, Kfoury *et al.* collected TSP samples in Chekka over a three-month period (August 2008-October 2008). Among all the elements, Potassium (K) was found in highest concentrations, presumably the result of anthropogenic activities. Other crustal elements including Ca, Mg and Fe were detected in lower concentrations *–see elemental composition in Figure 4.12.* Interestingly, average calcium concentration in Chekka (2,134ng/m^3, period Aug-Oct 2008) appear to be lower than values previously reported in Beirut City (6,612ng/m^3; period Feb 2004-Jan 2005), notwithstanding the impact of dust storms in Beirut on Ca concentrations. To determine the influence of industrial activities (cement factories and quarries) on the composition of atmospheric aerosols in Chekka, Kfoury *et al.* (2009) collected samples from two sampling circles. The first circle includes sites near the cement factories (Anfeh, Bdaibhoun, Chekka, Bednayel and Hamat) and the second circle includes sites farther away (Deir alnatour, Fiaa, Kfarhazir, Kelbata and Mseilha). Figure 4.13 illustrates the difference in the elemental and ionic composition of aerosols between the first and second circles.

Calcium concentrations were not affected by emissions from the cement factories (Ca 1st circle ≈ Ca 2nd circle), probably due to low wind activity during the sampling campaign. In general, activities related to the cement industry (not the process itself) including extraction (quarries), crushing and grinding of raw materials as well as cement bagging release particles that are rich in Calcium. Almost similar results were also found for other elements except for Potassium; high Potassium levels were associated to biomass combustion.

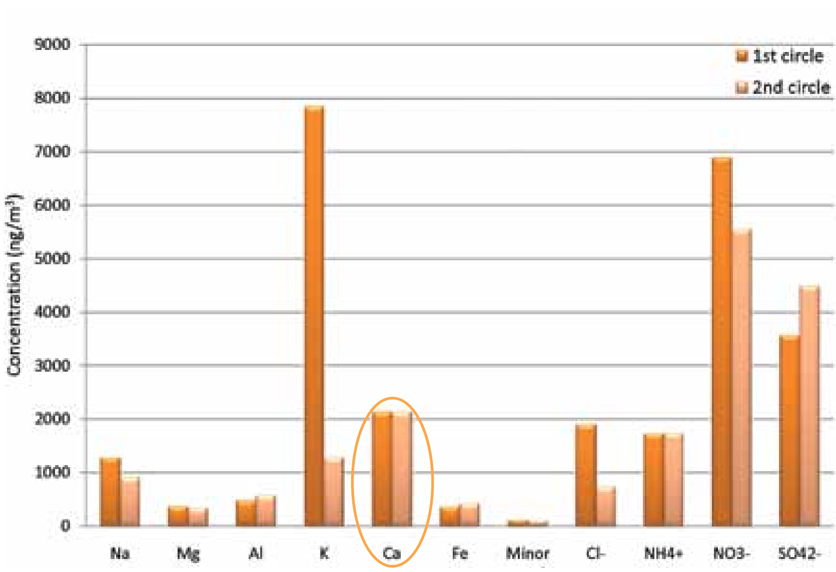
In Selaata, Yammine *et al.* (2009) studied the elemental composition of TSP in seven sampling points near the phosphate fertilizer industry (April-June 2008). Average levels of Na, Mg, Al and K were higher than all sampled sites in Lebanon *–see detailed composition in Figure 4.14*. Phosphorous and Calcium concentrations exceeded 10,500ng/m^3, which is attributed to rocks grinding and other processes.

Figure 4.12 Elemental composition of TSP in Chekka



Source: Kfoury et al. 2009

Figure 4.13 Chemical composition of TSP in Chekka

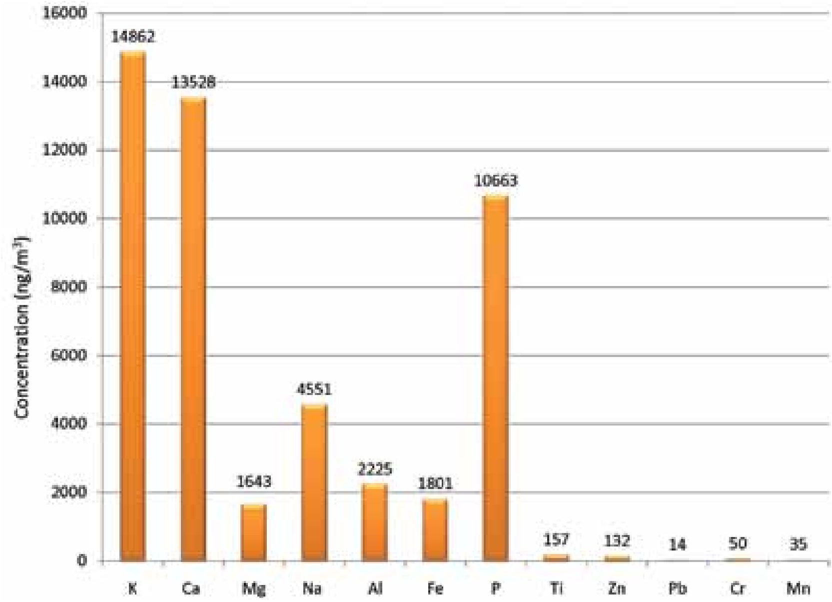


Source: Kfoury et al. 2009

In Tripoli, TEDO has been monitoring air pollutants since 2000. The observatory installed fixed monitoring stations downtown Tripoli (urban) and on the roof of the TEDO building (peri-urban station influenced by sea winds) to monitor TSP, PM_{10} and $PM_{2.5}$. TSP and PM levels downtown Tripoli are aggregated in Table 4.13, covering a six-month period. They also operate 13 passive sampling monitoring stations, distributed across Al Fayhaa's 13 cadastral zones, to monitor benzene, toluene, xylene, HF, NO_2, SO_2, and O_3.

During the sampling period, and out of 105 sampling days, TSP readings exceeded the

Figure 4.14 Elemental composition of TSP in Selaata



Source: Yammine et al. 2010

Box 4.5 Summary of air quality indicators in Lebanon

Pollutants	*GBA*	*Source*	*Outside GBA*	*Source*
		Air quality		
NO_2	58μg/m^3	AQRU Conference 2011	6.4-10.11 ppm	MOE-ECODIT 2002
SO_2	3.1 ppb	Afif et al. 2008	0.45-0.7 ppm	
O_3	-	-	115.5 μg/m^3	TEDO 2009
PM_{10}	63.38μg/m^3	Saliba & co-researchers (in progress)	81.4 μg/m^3	
$PM_{2.5}$	20.4μg/m^3	Saliba & co-researchers (in progress)	29.1 μg/m^3	

Monitoring stations:
GBA 6 automatic stations (PM & gaseous pollutants) and 66 passive sampling stations (NO_2 & SO_2)
Outside GBA 3 Impactors (PM & TSP) and 13 passive sampling stations (NO_2, SO_2 and O_3)

Daily National Standard of 120μg/m^3 25 times (24%). Similarly, PM_{10} values exceeded the Daily National Standard of 80μg/m^3 38 times out of 84 sampling days (45%); compared to the daily PM_{10} WHO standard of 50μg/m^3, the number of days would be much higher. Mean $PM_{2.5}$ in downtown Tripoli (34.6 μg/m^3) was consistently higher than $PM_{2.5}$ values at the seafront station (23.6 μg/m^3), principally due to heavier traffic in downtown Tripoli. Generally, $PM_{2.5}$ values recorded in downtown Tripoli and on the seafront were almost consistently higher than EPA's daily standard for $PM_{2.5}$ (35 μg/m^3) as well as WHO's annual standard for $PM_{2.5}$ (10μg/m^3). In terms of gaseous pollutants, Table 4.14 summarizes mean levels in 2008 (data from four sampling locations missing / not available). NO_2 are surprisingly low and far below the WHO annual standard for ambient NO_2 (40 μg/m^3), as well as mean annual levels reported in Beirut (67μg/m^3); an indication that the monitoring equipment could be dysfunctional (i.e., expired Passam tubes).

The previous sections presented a range of air quality data from multiple sources and for different time periods. Box 4.5 consolidates key findings to populate Lebanon's air quality indicators.

Table 4.13 TSP, PM_{10} and $PM_{2.5}$ levels in Tripoli from Jan-Jun 2008

Month	*Mean Monthly TSP (μg/m^3)*	*Mean Monthly PM_{10} (μg/m^3)*	*Mean Monthly $PM_{2.5}$ (μg/m^3)*	
			Downtown of Tripoli	*TEDO building*
Jan 2008	103	80	45	33
Feb 2008	93	79	49	26
Mar 2008	125	NA	23	27
Apr 2008	106	89	31	19
May 2008	83	76	31	19
Jun 2008	100	83	29	17
Mean	**101**	**81.4**	**34.6**	**23.6**
WHO std (daily)	150	50	25	25
WHO std (annual)	-	20	10	10
EPA std (daily)	75	150	35	35

Source: TSP, PM_{10} & $PM_{2.5}$ levels from (TEDO 2009), WHO standards are (WHO 2005) and EPA standard is (EPA 2010)

Table 4.14 Levels of gaseous pollutants in the urban community of Al Fayhaa

Sampling Station	Benzene (μg/m³)	Toluene (μg/m³)	Xylene (μg/m³)	SO_2 (μg/m³)	NO_2 (μg/m³)	HF (μg/m³)	O_3 (μg/m³)
Al Maarad- Mina Street	1	15	40	0.2	2	0.1	157
Tripoli Port	3	70	83	0.2	3	0.2	139
Abi Samra	2	50	64	0.3	1	0.25	90
Al Maloula	3	68	48	0.5	5	0.2	175
Aazmi and Miatayn Street	-	55	62	0.2	4	0.1	101
Mouharam	5	52	102	1	4.3	0.2	90
Al Kornich	2	60	50	0.7	3	0.1	103
Industrial Zone & Saiid Port	1	51	82	0.2	2	0.2	80
Baddawi Street	3	52	65	0.6	6	0.1	105

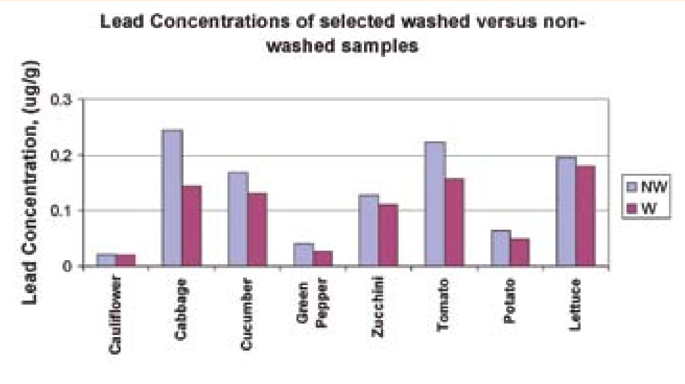
Source: TEDO 2009

Box 4.6 Contamination of agricultural crops

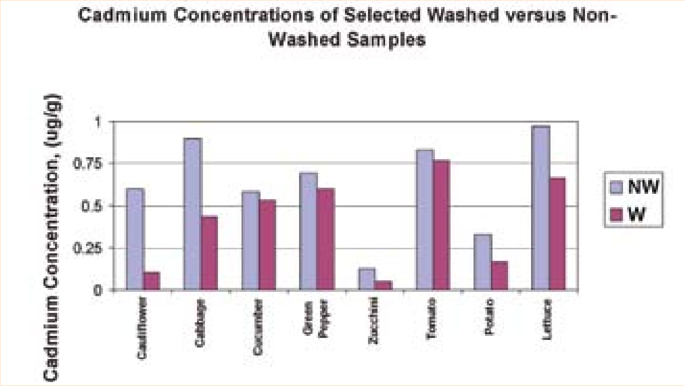
Air pollution can affect agricultural products. In 2009, Al Chaarani et al. investigated the levels of four heavy metals (lead, cadmium, chromium and arsenic) in a large sample of washed and non-washed vegetables (181 samples in total including 66 leafy vegetables, 84 ground vegetables, and 31 below-ground vegetables). The samples were collected from Beirut, Jounieh, Tripoli, and Koura. Heavy metals in ambient air may deposit on the surface of vegetables by adsorption and eliminated by washing whereas heavy metals taken up by the roots from contaminated water or from the soil will enter plant tissue through absorption, are difficult to remove and therefore pose a major health concern. The study showed that, in most cases, concentrations of heavy metals in non-washed vegetables were slightly higher than levels in washed vegetables. Levels of Cr and Ar in non-washed cucumber and lettuce were considerably higher than in washed vegetables *-see test results in figure below.*

Concentrations of four heavy metals in washed and non-washed vegetables

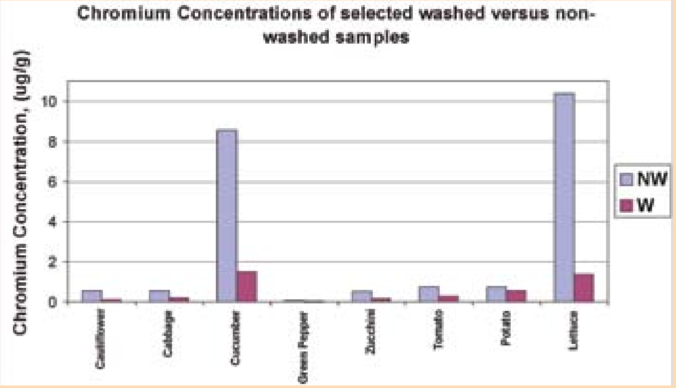
(a) Lead



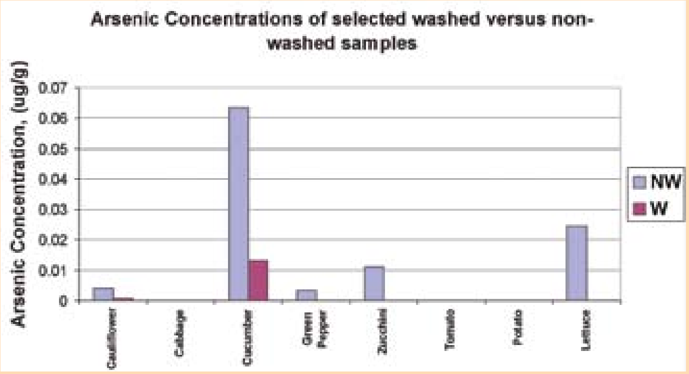
(b) Cadmium



(c) Chromium



(d) Arsenic



Source: Al Chaarani et al. 2009

4.2.3 Odors

Odors are caused by volatilized chemical compounds with low molecular weight (usually NMVOC [aldehydes, acetaldehyde, etc.] and pheromones), nitrogen compounds (amine, ammonia, etc.) and sulfur compounds (Hydrogen Sulfide [H_2S], mercaptans, etc.) that people and animals detect by the sense of olfaction. Intensity of odors depends on their accumulation and dispersion in the atmosphere which is related to climatic conditions (wind speed, wind direction, humidity, ambient temperature, height of the mixing layer, etc.). Olfactometers (electronic nose) measure odor intensity and levels. In Lebanon, although the MOE and municipalities receive regular complaints from citizens related to foul odors (see examples in MOJ/MOE/UNDP, 2010), odor pollution is rarely studied or measured. Major sources of odors in the country stem from poultry farms and slaughterhouses, waste dumps and composting plants as well as open sewers. People who reside in Beirut (or commute daily to and from the capital) often experience a very pungent odor near the areas of Bourj Hammoud and Karantina, which harbor a solid waste sorting and composting facility, a slaughterhouse facility, and the Beirut sea port (unloading and transport of livestock).


View of Bourj Hammoud industrial area

4.3 KEY ACTORS, LAWS AND REGULATIONS

The following sections describe key laws and regulations related to air quality and the environment. Each text cited here is also listed chronologically at the end of this chapter. For a more complete analysis of environmental legislation related to air, please refer to Chapter 9 of SELDAS (EU/UOB/MOE/ELARD, 2005). For a review of environmental jurisprudence cases related to air quality in Lebanon and other countries, please refer to Chapter 9 of SEEL (MOJ/MOE/UNDP, 2010).

4.3.1 Institutional Framework

"Given that air constitutes a basic element of life and a public natural resource, every citizen has the right to enjoy a clean and healthy air so that it does not constitute a hazard to public health and to the quality of life" (MOE, 2005). Safeguarding air quality is a broad and multidimensional endeavor that requires the participation of the public and private sectors *–see Table 4.15.*

4.3.1.1 Ministry of Environment

MOE is responsible for developing Air Quality Standards (AQS), Air Monitoring Programs and Surveillance (AMPS), Pollution Prevention Plans (PPP) in the country for ambient air and national GHG emissions inventories. The ministry has promulgated emission standards for several industries -Decision 8/1-2001 (power plants <300 MW, aluminum industries, etc.) as well as ambient air quality standards -Decision 52/1-1996 (maximum levels and exposure time). The MOE recently issued Circular No. 10/1 (dated 19/3/2011) related to "Monitoring the Operation of Electric Generators". The circular includes technical requirements on how to mitigate air pollutants from power generators (using exhaust systems for trapping air pollutants such as cyclones), control oil and/or fuel leakages (using absorbent materials under generators such as sawdust), and store used oil prior to safe final disposal.

Due to staff shortages and budget constraints, the ministry is only capable of carrying out a limited number of spot checks and/or routine inspections of industry stack and other sources of air pollution, to determine compliance. According to MOE's new organizational structure (Decree no. 2275 dated 15/06/2009), the Service of Environmental Technology includes an Air Quality Department; when adequately staffed and resourced, the department would be better able to carry out routine monitoring and

Table 4.15 Distribution of responsibilities related to air quality

Responsibility \ Party	MOE	MOPH	MOIM	MOEW	MOI	Munici-palities	TEDO–AQRU Others
Ambient Air Quality Standards	X						
Ambient Air Monitoring Programs and Surveillance	X						X
Pollution Prevention Plans	X						
GHG emissions inventories	X						
Inspection of industry & other air pollution sources	X						
Guidelines and regulations for indoor air quality		X					
Vehicle inspection			X				
Air pollutant limits for large power plants (>300MW)				X			
Industry licensing	X	X			X		
Traffic management						X	

Note: The above delineation of responsibilities is not an exhaustive assessment and is subject to change.

analysis of ambient air quality in different areas in Lebanon and update the existing ambient air quality standards.

4.3.1.2 Ministry of Public Health

The Ministry of Public Health (MOPH) is responsible for establishing guidelines and regulations regarding indoor air quality (indoor spaces include workspace, malls, restaurants, etc.). For example, MOPH and the World Health Organization established jointly in 2009 the National Program for Tobacco Control. The program was launched after the GOL signed in December 2005 the WHO Framework Convention on Tobacco Control, to counter the increasing prevalence of smoking in Lebanon, as well as to reduce the burden of tobacco-related diseases, including their impact on human health and economy.

4.3.1.3 Other ministries

In the transport sector, and to reduce vehicle emissions, MOIM contracted in 2004 a national vehicle inspection program to a private Joint Venture (called *mécanique*) on a BOT basis (Build, Operate and Transfer), and for a period of nine years (2004-2013). *Mécanique* built, equipped and is operating five inspection stations on lands owned and provided by the GOL. At the end of the BOT contract period, the firm will in theory hand over the entire operation including infrastructure, buildings and equipment to the GOL (YASA, 2010).

Vehicle inspection includes examination of brakes, lights and emissions from tailpipes. In addition to vehicle safety issues, this inspection aims to reduce emissions from vehicles by adopting the Lebanese pass-or-fail values for CO, CO_2, and HC. A well run inspection program is capable of achieving very significant emission reductions and can be a good starting point for pollution-control.

In the energy sector, the MOEW has prepared tender specifications for transformer oil (they should be PCB-free) and fuel products including limit values for sulfur content in heavy fuel oil (2.5% by weight). To date, there are no emission standards for large power plants (>300MW).

In the industry sector, and according to Law 642/1997 that established the Ministry of Industry (MOI), a permitting committee examines applications received from new and existing industrial establishments. The committee operates under the MOI and brings together representatives from the ministries of Industry, Public Health, Environment, Public Works and Transport including the- Directorate General of Urban Planning (DGUP). The committee can approve new permit applications, as well as renew or cancel existing permits based on environmental, health and safety criteria.

4.3.1.4 Municipalities

Municipalities play a modest role in improving air quality but could do much more, within their mandate, to alleviate air pollution. For example, some municipalities (Hazmieh, Zahleh, etc.) carry out routine inspections of private power generators, making sure they are fitted with appropriate stacks, filters, and noise reduction measures to minimize public nuisance. Other municipalities (Beirut, Tripoli, etc.) are facilitating air quality monitoring programs (but still need to do more to communicate air quality data to citizens). Finally, the municipality and municipal police can also play an important role in traffic management by manning key intersections,

Private power generators are widespread and poorly regulated

installing traffic lights at key locations, enforcing zero-tolerance on double-parking, etc. Collectively, these measures that can ease traffic and help reduce emissions.

4.3.1.5 Other Key Players

Tripoli Environment and Development Observatory (TEDO) was established in 2000 by the Federation of Municipalities of Al-Fayhaa (Tripoli, El-Mina, and Beddawi) and with grant funding from EU's Short and Medium Term Priority Environmental Action Plan (SMAP) Program. The objectives of its air pollution laboratory are to (1) identify air pollutants, (2) prepare inventory of air pollution sources, (3) measure emissions, (4) raise public awareness, and (5) improve urban air quality. Today, long after the initial funding ended, the observatory is formally integrated into the municipal structure of the Federation (COM Decision 18, dated 29/12/2004).

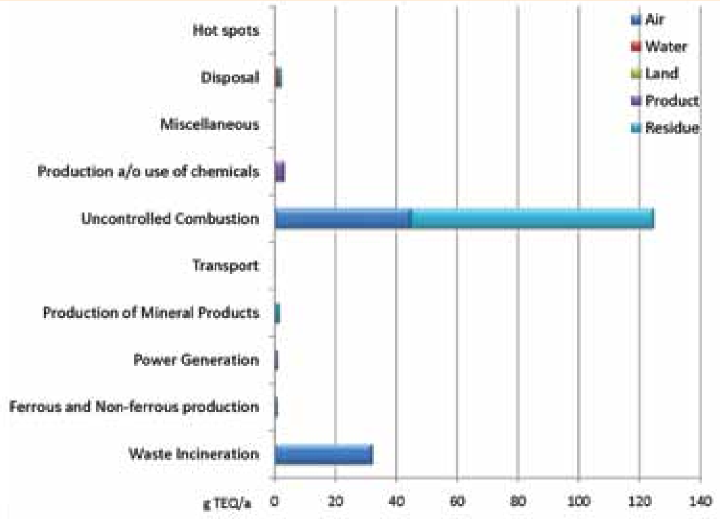
The Lebanese Cleaner Production Center (LCPC) was established by MOE in 2002 with grant funding from the European Commission and the Austrian Government through UNIDO. After an initial hosting period at MOE, the LCPC was relocated to the Industrial Research Institute (IRI) in 2004. The centre is today integrated into the IRI, is part of a global network of National Cleaner Production Centers from 41 countries, and was recently elected as the CPC representative for West Asia. The LCPC was the second center to be established in the Middle East and has been contracted to initiate cleaner production centers in the UAE and KSA. The centre provides assistance to Small- and Medium-Sized Enterprises (SME's) in adopting Cleaner Production measures and sustainable industrial production modes that will reduce consumption of water and energy, decrease pollutants emissions, and effluent loads and waste. In fact, the LCPC chooses industries from each industrial sector, inspects installed equipment, identifies areas of resource inefficiency and proposes the best Cleaner Production option. These services are provided to industrialists free of charge. Subsequent cost implications of implementing the recommendations of the LCPC team are left to the discretion of the industry. For example, a food industry installed a brand new boiler that achieves 85 percent efficiency, up from a previous 40 percent, resulting in much lower emissions. Fuel savings amounted to $25,000 per year. http://www.lebanese-cpc.net/

4.3.2 Multilateral Environmental Agreements

The GOL has acceded to and ratified several multilateral environmental agreements related to (1) phasing out of POPs (see summary in Box 4.7), (2) combating Climate Change (Box 4.8), (3) protecting the ozone layer (see current status in Box 4.9) and (4) controlling tobacco use. Table 4.16 lists key conventions and protocols related to the atmosphere and air, and their implications on Lebanon.

Box 4.7 National Implementation Plans for the Management of Persistent Organic Pollutants

Lebanon was one of 12 countries to conduct a pilot project for handling and managing POPs including (a) dioxins and furans (by-products of combustion activities) (b) pesticides (agriculture), and (c) PCBs (from closed applications such as transformer oil). As part of this regional project, MOE prepared between 2003 and 2006 a *National Implementation Plan for the Management of POPs* with grant funding from GEF and technical assistance from UNEP through UNDP and private consulting firms. To produce the NIP, Lebanon prepared a preliminary inventory of POPs including sources and quantities, and assessed releases of Polychlorinated Dibenzodioxins and Polychlorinated DibenzoFurans (PCDD/PCDF) from various sources and into different media (air, water, land, etc.). This analysis revealed that uncontrolled combustion, so widespread in Lebanon, releases 44.98 gTEQ of PCDD/PCDF annually into the air -*see annual emission levels of PCDD/PCDF per type of activity below.* The NIP identified national challenges in the management of POPs including lack of facilities for the disposal of waste containing or contaminated with POPs; very limited financial and technical resources for remediation of contaminated sites; lack of POPs release monitoring schemes, etc.



Source: National Implementation Plans for the Management of POPs, MOE, 2006

Box 4.8 Climate Change and Lebanon's Second National Communication

Climate Change is one of the major worldwide challenges of our time. It is a growing crisis affecting the global economy, world population health and safety, planet food production, international security, etc. From shifting weather patterns that threaten food production, to rising sea levels that increase the risk of catastrophic flooding, the impacts of climate change are global in scope and unprecedented in scale. Without drastic action today, adapting to these impacts in the future will be more difficult. While developed countries are the largest contributors to climate change, its negative impacts are more severely felt by developing countries including Lebanon; they are more vulnerable because of their high dependence on natural resources and their limited capacity to cope with climate variability and extremes.

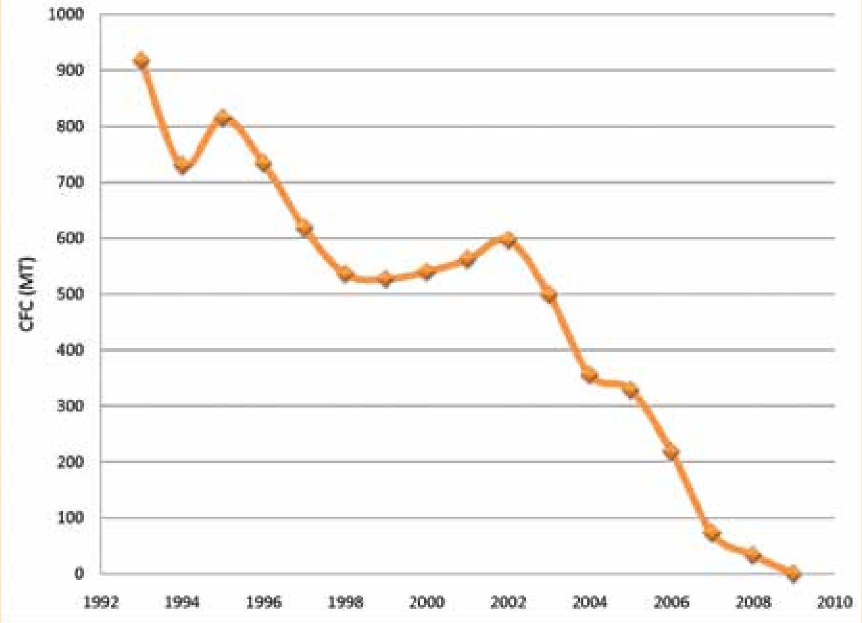
Lebanon's Second National Communication (SNC) to the UNFCCC comes to ascertain that although the country's GHG emissions are insignificant at the global level, Lebanon must prepare for the unavoidable consequences of climate change. The SNC therefore brings forward a set of mitigation and adaptation measures that would allow Lebanon to prepare –*see more details on Lebanon's solution in combating climate change in section 4.5.4*

MOE-UNDP, 2011

Box 4.9 National Ozone Unit: achievements and challenges

In January 1998, MOE and UNDP established the National Ozone Unit (NOU) to meet its obligation under the Montreal Protocol on Substances that Deplete the Ozone Layer. Lebanon has since entered into a $14.3 million agreement with the Multilateral Fund (MLF) for the phase-out of all Ozone Depleting Substances (CFCs, Annex-A, Group-I Substances, Methyl Bromide, Annex E Group-I Substances). The agreement requires Lebanon to completely phase-out CFCs and Halons by 1 January 2010 and Methyl Bromide by 1 January 2015. To achieve the 2010 milestone, the NOU provided technical and financial assistance to about 100 industries (foam, aerosol and refrigeration sectors) in the country, helping them convert their production from ODSs to non-ODSs technology. In practice, this meant that production technology that used CFCs were destroyed, put out of service, and replaced with non-CFC technology. During the period 1998-2010, Lebanon reduced consumption of **CFCs** from 923 tons in 1993 to **zero** consumption in 2010 (see figure). In 2007, on the occasion of the 20th anniversary of the Montreal Protocol, Lebanon has been awarded by the Montreal Protocol "The NOU Best Implementers Award" in appreciation of the government and NOU efforts to make the Protocol's phase-out goals a reality, as well "The Montreal Protocol Exemplary Project Recognition" for the contribution through the Methyl Bromide phase-out public-private partnership.

CFC consumption trend in Lebanon (1992-2010)



Phasing out CFCs did not solve the entire Ozone Depletion problem. While CFC consumption declined, the reliance on alternatives, including Hydrochlorofluorocarbons (HCFCs, such as R-22 and R-141b used in the refrigeration and foam sectors), picked up rapidly. In particular, **HCFC** consumption in Lebanon increased from about 278 MT in 2004 to **826 MT** in 2009 (annual growth of 34% for the past five years). Because HCFCs have a high global warming effect, the Parties to the Montreal Protocol decided at their 19th meeting in September 2007 to freeze the production and consumption of HCFCs in Article-5 countries and accelerate their phase-out (Decision 19/6 of the Meeting of the Parties). In particular, Parties need to freeze production and consumption of HCFCs effective 1 January 2013 to the Baseline Level (average consumption in 2009 and 2010), and then to reduce consumption of HCFCs by 10 percent effective 1 January 2015. The MLF will support the Parties, including Lebanon, to prepare a HCFC Phase-out Management Plan to meet the 2013/2015 control targets. Accordingly, Lebanon prepared and submitted to the MLF a strategy and action plan for compliance with the 2013/2015 control targets in July 2010. With UNDP assistance, MOE is responsible for monitoring the implementation of the HCFCs phase-out plan.

Source: MOE National Ozone Unit, 2011

Table 4.16 Multilateral Environmental Agreements related to the atmosphere and air

Conventions	*Main goals*	*Signature/ Adhesion/ Ratification/ date*	*Implications on Lebanon*
Vienna Convention for the Protection of the Ozone Layer	Framework for the international efforts to protect the ozone layer damaged by ODS including CFCs, HCFCs, halons, methyl bromide	Adhesion by law number 253 (30/03/1993)	See implications under Montreal Protocol
Montreal Protocol on Substances that Deplete the Ozone Layer *and its four amendments*	Protocol to Vienna Convention- Phasing out the production and consumption of substances believed to be responsible for ozone depletion.	Adhesion by law number 253 (31/03/1993)	Phase out the consumption of ODS completely by the end of 2010. The National Ozone Unit (NOU) was established at MOE to assist industries in phasing-ou–ODS
United Nations Framework Convention on Climate Change (UNFCCC)	Framework for the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system	Ratification by law number 359 (11/08/1994)	1) No requirement to decrease national GHG emissions. Lebanon has voluntarily committed to increase Renewable Energy (RE) to 12% by 2020 (Copenhagen 2009). 2) Submit national inventory of GHGs (for baseline years 1994 and 2000, based on the COP decision), assess Lebanon's vulnerability to Climate Change, and propose adaptation and mitigation strategies to reduce GHG emissions (although not an obligation under the UNFCCC) and adapt to the impacts of climate change. .
Kyoto Protocol	Protocol to the UNFCCC Reduction of GHG (CO_2, CH_4, N_2O, SF_6) emissions to levels that would prevent interference with the Climate System.	Raticiation by law number 738 (15/05/2006)	The Clean Development Mechanism (CDM), defined in Article 12 of the Protocol, allows a country (Annex I and Annex B Parties,with an emission-reduction or emission-limitation commitment under the Kyoto Protocol to implement an emission-reduction project in Non-Annex I countries (including Lebanon). Such projects can earn saleable certified emission reduction (CER) credits, each equivalent to one tonne of CO_2, which can be counted towards meeting Kyoto targets.
Stockholm Convention on Persistent Organic Pollutants (POPs)	Framework for the Protection of human health and the environment from POPs, including (a) dioxins and furans (by-products of combustion activities) (b) pesticides (agriculture), and (c) PCBs (closed applications, such as transformer oil)	Signature: 22/5/2001 Accession by law number 432 (08/08/2002)	Eliminate production and import of POPs by 2025; set environmental guidelines and action plan for the use of POPs in the country and release prevention; develop educational and public awareness materials on the effects of POPs; and identify and quantify the main sources of POPs in the country.
WHO Framework Convention on Tobacco Control (WHO FCTC)	Framework for combating the tobacco epidemic and its industry marketing as well as protecting present and future generations from the devastating consequences of tobacco consumption and exposure to tobacco smoke	Ratification by law number 657 (04/02/2005)	A National Program for Tobacco Control (NPTC) was established in 2009 in Lebanon as a result of the GOL signing the FCTC. The NPTC came as a joint program between the MOPH and WHO –See section 4.5.

4.4 SELECTED RESPONSES TO AIR QUALITY ISSUES

Lebanon has made noteworthy strides to reduce air pollution from point sources, but not enough. More is needed from the Government and from individual citizens to limit emissions and abate air pollution impacts. The following sections summarize selected and measurable responses to air quality issues.

4.4.1 Improved Ambient Air Quality Monitoring Programs and Capabilities

Lebanon now has a partial air quality monitoring program. This constitutes the building block for establishing air pollution management strategies in the country. In the last decade, dozens of municipalities and universities started to invest resources in acquiring air quality monitoring instruments and training air quality professionals. These efforts are generating air quality data in Beirut, Chekka, Selaata and Tripoli *–see section 4.2.1 for more details related to inter-agency cooperation*. These monitoring initiatives, although still under-resourced, help define principles for air pollution abatement policies and support the development of a National Air Quality Strategy (MOE/EU/NEAP, 2005u), yet to be developed by MOE (Decree 2275/2009, Article 24).

4.4.2 Partial Implementation of Law 341/2001

One of the primary government responses to Lebanon's air pollution problem was the approval and implementation of Law 341/2001, amended by Law 380 (14/12/2001) and Law 453 (16/8/2002). It has partially curbed air pollution from the transport sector and encouraged the use of less polluting fuels. Specifically, the law banned (1) the import of minivans and buses (<15 passengers + driver) operating on Diesel oil, (2) the import of old and new Diesel engines for private passenger cars and minivans, (3) the use of Diesel in private vehicles, and (4) the use of leaded gasoline in all vehicles. It also made catalytic converters a mandatory requirement in all vehicle categories and reinstated the mandatory vehicle inspection (*mécanique*) for gasoline engines (annual inspection) and Diesel engines (every six months). The total ban on leaded gasoline is an outstanding example of an air pollution reduction measure, with considerable benefits for public health and the environment. However, there has been some debate in recent years over the use of methyl tert-butyl ether (MTBE), an effective substitute of Lead in petroleum products, and its impacts on the environment due to its persistency and mobility.

In the years that followed the promulgation and enforcement of Law 341/2001, private interest groups and legislators recognized a number of deficiencies. This has prompted the GOL to explore avenues for improving and expanding the provisions of Law 341/2001, by reviewing similar laws and experiences in other countries (e.g., United Kingdom, Japan, Korea and China). Years of debate and consultations have yielded a proposed amendment to Law 341/2001 which is expected to be approved by parliament. *See proposed amendments in Table 4.17*. Also, a number of measures have already been adopted by MOF in coordination with MOE including Article 83 of the 2010 proposed budget law (approval pending) which exempts Hybrid cars from customs fees.

Separately, in 2002, the COM enacted Decree 8442 (dated 13/08/2002) which defines standards for gasoline and Diesel oil used in vehicles including their Sulfur content; 0.05% by weight in gasoline 92, 95 and 98 Octane and 0.035% by weight in Diesel oil *–see Chapter 9 for more information on sulfur content in other petroleum products.* While this is a good first step, Lebanon should aim to introduce Ultra Low Sulfur Diesel (ULSD) (>15 ppm). Lower sulfur content will allow the application of newer emission control technologies that will substantially lower emissions from engines.

4.4.3 Emission Control Guidelines

MOE has developed environmental guidelines and limit values for emissions for several industry sectors including Lebanon's cement industry (Decision 8/1 dated 2001). Cement plants pose serious concerns and have been the cause of many complaints received by local municipalities and MOE. Recognizing the need to engage polluters in any air quality monitoring and abatement program, the Ministry has developed a self-monitoring program with each cement plant whereby the industry monitors air emissions on a daily basis and submits monthly reports to MOE for review (Decision 191/1 dated 1997). Subject to resource availability, the ministry conducts random inspection of stack emissions, sometime in response to formal complaints received from nearby residents to community groups *–see for example Batroun Tribunal (Criminal Court) Decision 40/2003 dated 24/2/2003* (MOJ/MOE/UNDP 2010).

4.4.4 Total Phase-Out of CFCs

The Montreal Protocol was established to reverse ozone depletion globally and help parties to the protocol phase-out CFCs and

Table 4.17 Summary of actions and proposed actions in Law 341/2001 and its draft amendment (2010)

Provisions in Law 341/2001	Proposed amendment and additions
Retrieval by GOL of up to 10,000 public license plates (cars including "Taxi" and "Service")	Retrieval by GOL of up to 10,000 public license plates as follows: a) 7500 car plates including "Taxi" and "Service" with an allowance of 9 Million L.B.P for every plate b) 2000 bus plates (15 passengers + driver) with an allowance of 12 Million L.B.P for every plate c) 500 bus plates (>25 passengers + driver) with an allowance of 18 Million L.B.P for every plate
Provide incentives for vehicle owners to renew their public transport fleet (tax cuts and tariff exemption)	Provide incentives (tax cuts, tariff exemption and *mécanique* exemption for first registration) to private and public vehicle owners to switch to hybrid electric, fuel cell/Hydrogen and Natural Gas vehicle
Import ban on minivans operating on Diesel	Import ban on all types of vehicles and engines (civilian and military) including buses (<15 passengers + driver), Pullman, freight cars (weight>3500Kg) and power generators operating on diesel unless they comply with last emission standards: EU Emission Standards (EURO) or equivalent
Set permissible exhaust limit values	Permissible exhaust limit values will be determined by MEW, MoI and MOE
Ban the use of Diesel in minivans and small pick-ups	All Diesel vehicles (locals and foreigners) and engines must comply with EU Emission Standards or equivalent–
NA – new	Ban the operation of Diesel buses (<15 passengers + driver) in urban cities and implement restrictions for their itinerary between urban and rural areas
NA – new	All buses, pick-ups, freight cars and heavy machineries circulating on Lebanese territory must use local fuel to conform with local fuel standards
NA – new	Mandatory inspection of Diesel quality distributed by gas stations
NA – new	Equip MOIM traffic police with special tools to sample and check vehicle fuel quality
NA – new	Standards for fuel quality used in vehicles, industries, will be developed by LIBNOR and based on EU Emission Standards

other ODS. In Lebanon, efforts to reduce ODS consumption achieved stunning success, from 923 tons of CFCs in 1993 down to nil in 2010. The National Ozone Unit at MOE provided technical and financial assistance to about 100 industries helping them convert their production from ODSs to non-ODSs technology *–see Box 4.9 for more information on NOU activities.* On a global scale, chemistry-climate models predict that recovery to pre-1980 Antarctic ozone layer can be expected around 2060-2075 (GEO 4, UNEP, 2007).

4.5 EMERGING ISSUES AND OUTLOOK

In the last decade, the progress that has been made in preventing and controlling air pollution in the country has been achieved through effective multi-stakeholder participation at different scales and mobilization of public-private partnerships.

4.5.1 Draft Law on the Protection of Air Quality

The MOE prepared in 2005 a draft law on the Protection of Air Quality (Clean Air Legislation) within the framework project SELDAS, and after comparing the benefits of developing priority legislation related to water and air pollution. The draft law comprises 34 articles related to ambient air pollution (including fixed and mobile sources), monitoring air pollutants (National Program for Ambient Air Quality Monitoring, National Network for Ambient Air Quality Monitoring, National emission inventory, National report on the Ambient Air Quality), assessment of their levels in the Lebanese atmosphere (Setting Limit Values and Thresholds of Ambient Air Pollutants including CO, NO_x, O_3, Particles, SO_x, NMVOC and Pb, emission limit values of fixed sources, emission limit values of mobile sources, specifications of harmful material in fuel, etc.), prevention, control and surveillance of the ambient air pollution resulting from human activities. This law awaits formal review by the COM and approval by the Lebanese Parliament.

4.5.2 Taxi Fleet Renewal Program

Lebanon should fast-track policies that will renew Lebanon's feeble taxi fleet. A *Taxi Swap to Hybrids and Fuel-Efficient Cars* policy would help rid Lebanon of up to 12,000 old and often dilapidated cars, reduce urban fuel consumption, as well as enhance Lebanon's brand image and green competitiveness. The policy requires a string of government incentives to eligible cars including exemption from customs and excise duties, \$2,500 payment against the old car, and full subsidy of loan interest and guarantee of the car loan. *See detailed findings of a feasibility study to renew the urban taxi fleet in Box 4.10 prepared based on the GOL Ministerial Declaration (dated 8/12/2009).*

Box 4.10 Taxi Fleet Renewal Program

In a 2010 study commissioned by the Presidency of the Council of Ministers, Booz & Company articulated a Taxi Fleet Renewal Program for Lebanon and evaluated its feasibility based on three scenarios all of which constitute a voluntary scheme: (1) swap to hybrids, (2) swap to fuel-efficient cards, and 3) swap to fuel-efficient cars and hybrids. The primary objectives of the program were to contribute to a cleaner environment, enhance Lebanon's brand image, increase the net income of taxi owners, and minimize legislative requirements and financial burden for the government.

To date, there are six fuel efficient hybrid cars on the global market of which only one model (Toyota Prius) is marketed in Lebanon. Globally, Hybrid cars represent less than 4 percent of total gasoline cars in circulation. The study determined that the addressable taxi market are 17,000 legal and urban taxis older than 2005. From this pool, the study estimated that about 5,000 taxi owners would be interested by a swap to hybrids (Scenario 1) but that such a swap would cost the GOL \$70 million including \$16 million in outright payments. Hybrids are expensive (\$37K for a Prius + tax) and taxi owners would need to spread the purchase price, plus cost of repairs and battery replacement (every four years) over an 8-year loan period.

With fuel-efficient cars (Scenario 2), the swap program becomes more feasible. Fuel-efficient cars are cheaper (about \$14K-\$20K + tax) and have a fuel city consumption of 11 liters per 100 km. In particular, the addressable taxi fleet market would increase to 25,000 cars of which an estimated 12,000 cars would be interested in the swap, costing the GOL \$57 million including \$27 million in outright payments. Much higher affordability of fuel efficient cars and lower maintenance requirement would cut the loan period by half, down to 4 years. To enhance green competitiveness and reduce emissions further, encouraging 12,000 potentially interested taxi owners to choose between hybrid or fuel-efficient cars (Scenario 3) would achieve the best results and cost the GOL \$70 million over the coming seven years (\$30 million in outright payments and \$40 million in forgone revenues).

Source: booz&co. 2010

Old and dilapidated taxi in Beirut

4.5.3 Improving Mass Transport

As discussed in Section 4.1, and in the absence of an efficient mass transport system covering the entire territory, Lebanese citizens rely heavily on their private vehicles for daily commuting. Usually, mass transport systems would include a combination of buses, trolleybuses, trams and trains, rapid transit (metro/subways/undergrounds, etc) and/or ferries. In Lebanon, rail transport began in the 1890s and continued for most of the twentieth century until it was interrupted by the civil war and associated impacts including widespread infringement on the public domain.

Today, mass transport is limited to low capacity buses (about 24 passengers; compared with trams and trains) that have no dedicated lanes and therefore compete with private vehicles on very congested roads. Most of them are dilapidated and operate on Diesel oil spewing dark plumes on pedestrians, traffic policemen, and street stores. In the GBA, there are two bus networks; one is public (operated by the MOPWT) and one is private (Lebanese Commuting Company). Ticket fares range from LBP750 to LBP1,000 ($0.5-0.7). Lebanon urgently needs to devise and implement a bus fleet renewal program that would encourage the public and the private sector to acquire new buses that run on cleaner fuels. Dedicated bus lanes should also be explored to reduce travel time and build consumer confidence in the public service. This is a priority measure to reduce air pollution and road congestion in cities. It is worth mentioning here that the Directorate General for Land and Marine Transport at MOPWT submitted to the GOL in 2002 a draft transport policy that aims to promote the economic, financial, environmental and social sustainability of the land transport sector in Lebanon. No action was taken by the GOL and the draft policy was never enacted nor approved. Presently, a new draft Law/Strategy on transport is being discussed.

4.5.4 GOL Commitment to Renewable Energy

Phenomenal growth in energy consumption worldwide engenders rapid increases in GHG emissions, accelerated urban growth and infringement on natural areas thereby compromising carbon sinks. Mounting evidence suggests beyond doubt that global warming is occurring and its impacts will intensify in the coming decades. And air pollution is no longer a local issue but a global concern since polluted air masses move long distances. Air pollutants remain suspended in the environment for long periods of time and are carried by winds

Remains of the defunct national railway in Dahr el Baydar

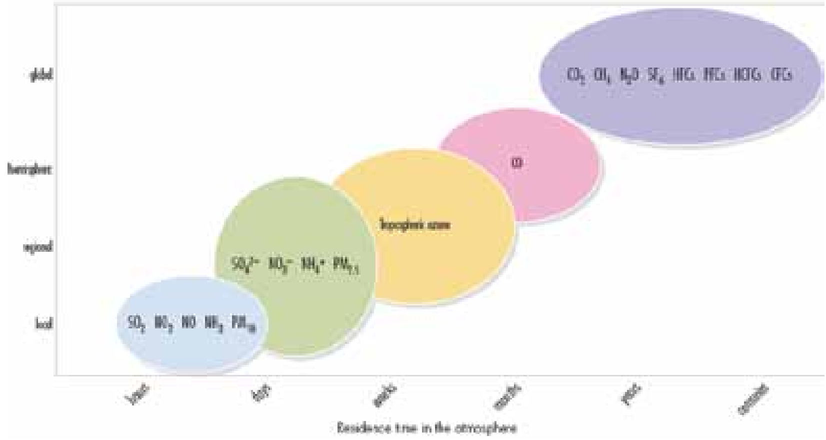

Public transport buses are old and inefficient (here a graveyard for out of service buses in Mar Mikhail, Beirut)

hundreds and thousands of kilometers from their origin –*see lifespan of major air pollutants in the atmosphere in Figure 4.15*.

Lebanon's contribution to global GHG emissions is insignificant. For example, in 2000, CO_2 emissions in the UK reached 553,046Gg compared to Lebanon's 18,507Gg (UNFCCC); the per capita contribution to CO_2 emissions in Lebanon is significantly lower than in the UK (4.6 t of CO_2 per capita per year in Lebanon versus 8.9 t CO_2/capita/year in the UK). Ironically, the smallest contributors to total GHG emissions will be affected by the impacts of global warming the most. In Lebanon, predictions show that global warming will bring significant consequences on water resources (snow melting, drying springs, rainfall intensity and regime, etc.), biodiversity (species loss, agricultural damages, etc.), land resources, public health and major socio-economical systems.

[4]Smoking ban in all hospitals, pharmacies, cinemas, theatres, public transport, sport clubs and schools & universities classrooms.

Figure 4.15 Life-span and spatial scale of major air pollutants in the atmosphere



Source: UNEP-GEO 4, 2007

Beyond its long-term impacts on the environment, global warming is already affecting lifestyles (i.e. nowadays, air conditioners are considered standard home appliances rather than luxury items). The GOL is slowly appreciating the anticipated impacts of global warming on society and so has made a voluntary pledge, and on condition to be supported financially and technically by developed countries, to increase the share of renewable energy in its total energy consumption from 4 to 12 percent by 2020 (A developing country, Lebanon is not required to decrease GHG emissions). This pledge was made at the UNFCCC COP in Copenhagen (Denmark) in 2009. Subsequently, the MOEW prepared a strategy paper (road map) for the electricity sector and included initiatives on how to increase RE harvesting to meet the 12 percent target –*see Chapter 9 for more details on the Policy Paper for the Electricity Sector and RE 2020 target.*

4.5.5 Anti-Smoking Legislation

A National Program for Tobacco Control (NPTC) was established in 2009 to counter the increasing prevalence of smoking in Lebanon, as well as to reduce the burden of tobacco-related diseases including their impact on human health and economy by focusing on raising awareness. However, Lebanon still has one of the weakest tobacco control policies in the Middle East region. The current and most important aim of the NPTC is to advocate for a national law on tobacco control that focuses on advertising bans, smoke-free public places, and warning labels. Advocacy of strong tobacco control policies such as a total smoking ban in indoor places without exemption is supported by other key players including the AUB Tobacco Control Research Group. The anti-smoking law will update and amend ministerial Decree 213/1 (1993)[4] and Decision 394 (1995).

4.5.6 Miscellaneous Initiatives and Greener Lifestyles

Improving air quality is a shared responsibility. The GOL shoulders a lot of responsibility for reducing air pollution from point and non-point sources, but citizens also can make a difference through lifestyle changes. For example, Lebanese citizens and other residents of Lebanon can:

- Participate in reforestation programs (through public or private initiatives) –*see reforestation efforts in Chapter 6.*
- Walk or bike to nearby destinations, whenever possible, while exercising and saving money
- Use mass transportation / public transport whenever possible but avoid transportation that uses air-polluting fuel
- Buy and/or use fuel-efficient vehicles including hybrid cars if possible
- Carpool, the simplest and most common "ride sharing" arrangement –see for example national car pooling initiative www.lebanoncarpooling.com
- Buy local / Lebanese products to reduce transportation costs and air pollutant emissions

Made in Lebanon
صنع في لبنان

- Buy energy-saving devices and appliances

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CITED LEGISLATION RELATED TO AIR QUALITY AND ATMOSPHERE

نوع النص	الرقم	التاريخ	عنوان النص
قرار وزيري الصحة والشؤون الاجتماعية	١/٢١٣	١٩٩٣/٠٣/٠٢	يتعلق بمنع التدخين في الأماكن العامة
قانون	٢٥٣	١٩٩٣/٠٧/٢٢	الإجازة للحكومة الإنضمام إلى معاهدتين متعلقتين بطبقة الاوزون
قانون	٣٥٩	١٩٩٤/٠٨/٠١	إتفاقية الأمم المتحدة بشأن تغير المناخ
مرسوم	٦٦٠٣	١٩٩٥/٠٤/٠٤	تحديد شروط إستعمال سيارات الشحن وسيارات اوتوبيس والمركبات الآلية العاملة على المازوت وكيفية مراقبتها ومستوى المعدل المقبول لكثافة الدخان المتصاعد منها ونوعيته
قرار مجلس النواب	٣٩٤	١٩٩٥/٠١/١٢	التحذير من مضار التدخين
قرار وزير البيئة	١٩١/١	/١٠/١٩٩٧٠٨	تطبيق المذكرة الارشادية لصناعة الاسمنت في لبنان والتلوث البيئي العام الناتج عنها
قانون	١٢٠	١٩٩٩/١٠/٢٥	الإجازة للحكومة الانضمام إلى تعديلات كوبنهاغن المتعلقة ببروتوكول مونتريال حول حماية طبقة الأوزون من المواد المستنفذة لها
قرار وزير البيئة	١/١٥	٢٠٠٠/٠٤/١٣	منع إستيراد وإستعمال مطافيء عاملة بمواد سائلة خاصة بالسيارات والآليات
قرار وزير البيئة	١/٨	٢٠٠١/٠١/٣٠	المواصفات والمعايير المتعلقة بملوثات الهواء والنفايات السائلة المتولدة عن المؤسسات المصنفة ومحطات معالجة المياه المبتذلة
قانون	٣٤١	٢٠٠١/٠٨/٠٦	قانون التخفيف من تلوث الهواء الناتج عن قطاع النقل وتشجيع الإتجاه إلى إستعمال الوقود الأقل تلوث
قرار وزير البيئة	١/٥	٢٠٠١/٠١/١٢	الشروط البيئية لرخص إنشاء و/أو استثمار محطات توزيع المحروقات السائلة
قانون	٣٨٠	٢٠٠١/١٢/١٤	يتعلق بتعديل بعض مواد في القانون رقم ٣٤١(٢٠٠١) قانون التخفيف من تلوث الهواء الناتج عن قطاع النقل وتشجيع الإتجاه إلى إستعمال الوقود الأقل تلوث
قانون	٤٤٤	٢٠٠٢/٠٧/٢٩	حماية البيئة
قانون	٤٣٢	٢٠٠٢/٠٧/٢٩	الإجازة للحكومة الإنضمام إلى إتفاقية ستوكهولم للملوثات العضوية الثابتة
قانون	٤٤٨	٢٠٠٢/٠٧/٢٩	الإجازة للحكومة شراء اليات عاملة على المازوت
مرسوم	٨٤٤٢	٢٠٠٢/٠٨/١٣	يتعلق بمواصفات البنزين ٩٢ و ٩٥ و ٩٨ اوكتان من دون رصاص والديزل اويل (المازوت) لاستخدامها في المركبات الآلية
قانون	٤٥٣	٢٠٠٢/٠٨/١٦	تعديل الفقرة (ب) من المادة الثانية من القانون رقم ٣٤١ المعدل بالقانون رقم ٣٨٠ وإلغاء القانون رقم ٤٤٨
قرار وزير البيئة	١/٩	٢٠٠٤/١٢/٠٢	تحديد المسافات الدنيا التي يجب ان تفصل جميع انواع المزارع المنوي انشاؤها و/او استثمارها في المناطق الغير منظمة عن المناطق الآهلة
قانون	٦٥٧	٢٠٠٥/٠٢/٠٤	الإجازة للحكومة الإنضمام إلى إتفاقية منظمة الصحة العالمية الإطارية بشأن مكافحة التبغ
قانون	٧٣٨	٢٠٠٦/٠٥/١٥	الإجازة للحكومة الإنضمام إلى برتوكول كيوتو الملحق بإتفاقية الامم المتحدة الإطارية بشأن تغير المناخ
قانون	٧٥٨	٢٠٠٦/١١/١١	الإجازة للحكومة الانضمام إلى تعديلات بيجين المتعلقة ببروتوكول مونتريال بشأن المواد المستنفذة لطبقة الأوزون
مرسوم	٢٦٠٤	٢٠٠٩/٠٩/١٧	التحكم في المواد المستنفذة لطبقة الأوزون

5 Biodiversity and Forests

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Photo Credit: Christian Akhrass

ABBREVIATIONS & ACRONYMS

ABS	Access and Benefit Sharing
AECID	Spanish Agency for International Cooperation & Development
AEWA	African Eurasian Water Bird Agreement
AFDC	Association for Forest Development and Conservation
APAC	Appointed Protected Areas Committee
CBD	Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CWR	Crop Wild Relatives
DRRNR	Directorate of Rural Development and Natural Resources
FNR-CBD	Fourth National Report prepared by MOE and submitted to the CBD
GEF	Global Environment Programme
GMO	Genetically Modified Organisms
HCH	Higher Council for Hunting
ISF	Internal Security Forces
IUCN	World Conservation Union
MAP	Medicinal and Aromatic Plants
MOA	Ministry of Agriculture
MOE	Ministry of Environment
NSFFM	National Strategy for Forest Fire Management
OWL	Other Wooded Land
PA	Protected Area
SEPASAL	Survey of Economic Plants for Arid and Semi-Arid Lands
SISPAM	Stable Institutional Structure for Protected Areas Management
SRLWR	Safeguarding and Restoring Lebanon's Woodland Resources Project
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development
USFS	United States Forest Service

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Lebanon's geographic location, its mountains and extreme diversity in climatic conditions have generated a unique biodiversity (see Box 5.1) in a very limited land area –a true biological hotspot. Since millennia, Lebanon's ecosystems have experienced significant transformations including historic deforestation, vast replanting and reforestation programs, bench terracing for agricultural production, protected area designation and, more recently, climate change. Although biodiversity and forests provide invaluable ecosystem services and support countless jobs, either directly or indirectly, human activities are rapidly degrading this resource base. The cost of environmental degradation linked to land and wildlife resources is estimated at $100 million per year, or 0.6 percent of Lebanon's GDP (WB 2004).

Box 5.1 What is Biological Diversity?

Biological diversity, or "biodiversity," refers to the variety of life on earth. As defined by the United Nations Convention on Biological Diversity, it includes diversity of ecosystems, species and genes, and the ecological processes that support them. Lebanon's ecosystem diversity results from the country's dramatic topographic and altitudinal diversity, combined with its location at the far eastern end of the Mediterranean Sea.

This chapter starts with an ecological overview of the country, and then describes the main drivers of change affecting biodiversity and forests as well as the current state and trends of biodiversity including terrestrial, freshwater, marine, and agro-biodiversity. It then provides an analysis of Lebanon's policy setting and institutional arrangements affecting biodiversity, describes selected responses to biodiversity issues, and concludes with a policy outlook to guide decision makers and inform the general public on future opportunities for biodiversity conservation and management.

5.1 AN ECOLOGICAL OVERVIEW OF LEBANON

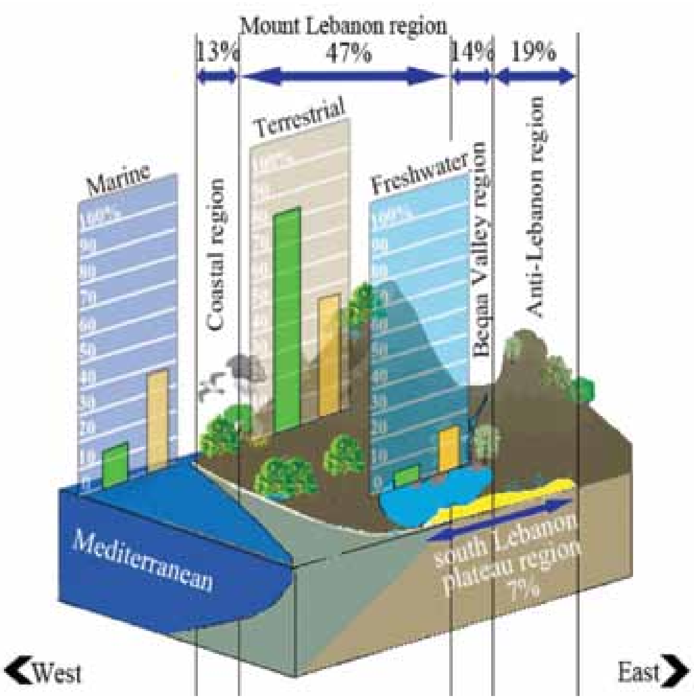
5.1.1 Lebanon's Unique Biodiversity

Lebanon is a bio-diverse country which also has a high level of socio-cultural diversity and a rapidly growing transition economy. There are 9,119 known species in Lebanon, almost equally distributed between fauna (4,486 species) and flora (4,633 species) (MOA/UNEP/GEF, 1996). The distribution of the floral and faunal species across habitats (marine, terrestrial and freshwater) and Lebanon's geo-morphological regions (coastal zone, Mount Lebanon range, Bekaa Valley, Anti-Lebanon range and the south Lebanon plateau) is illustrated in Figure 5.1.

See description of geo-morphological regions in Lebanon in Chapter 6.

Lebanon's flora (the endemic Black Iris)

Figure 5.1 Distribution of known flora and fauna in marine, terrestrial and freshwater domains, and percent distribution by geo-morphological region (Flora in green and fauna in brown)



Source: Visualization by G. Ramadan Jaradi based on (MOA/UNEP/GEF, 1996)

Lebanon occupies 0.007 percent of the world's land surface area and is a home to 1.11percent of the world's plant species (Tohmé & Tohmé, 2007) and 2.63 percent of the reptile, bird and mammal species. Its sea harbours about 1790 species, representing almost 2.7 percent of the world's marine species. Table 5.1 presents the number of described species in Lebanon by taxonomic group, and as a percent of globally described species.

Table 5.1 Species richness within Lebanon in relation to the world

Taxon	*Number of described species in Lebanon*	*Percentage of the earth's species*	*Source*
Mammals	59	1.38	MOA/UNEP/GEF, 1996; Bara &Tohmé, *pers. comm.*
Birds	395	4.06	Ramadan-Jaradi *et al.* 2008
Amphibians	6	0.15	Hraoui et al, 2001
Reptiles	54	0.8	Hraoui et al, 2002
Freshwater	610	7.06	MOA/UNEP/GEF, 1996; Dia, *pers. comm*.
Marine fish	367	1.20	MOA/UNEP/GEF, 1996; Bariche *et al.* 2004
Invertebrate	3835	0.27	MOA/UNEP/GEF, 1996
Terrestrial Plants	3790	1.60	MOA/UNEP/GEF, 1996 & Tohmé &Tohmé, 2007

As shown in Table 5.1 Lebanon is home to about 3,790 terrestrial plant species, of which 8.5 percent are broad endemic (endemic to Lebanon, Syria and Palestine) and 3.5 percent are endemic to Lebanon (MOA/UNEP/GEF, 1996). This percentage is high compared to other Mediterranean countries with similar histories of human activity (Médail and Quézel, 1997). Relative to its size, Lebanon boasts one of the highest densities of floral diversity in the Mediterranean basin, which in turn is one of the most biologically diverse regions in the world (Médail and Quézel, 1997). Similarly, Lebanon's vegetation has an exceptionally high species-area ratio of 0.25 species per km^2, compared to 0.0081 per km^2 for South Africa, 0.0044 for Brazil, 0.0021 for Egypt, 0.022 for Jordan, 0.015 for Spain, 0.017 for Syria and 0.011 for Turkey. The faunal diversity of Lebanon is also high relative to the country's surface area when compared to neighbouring countries (0.028 species/ km^2 for Lebanon; 0.019 for Syria; and 0.017 for Libya) (MOE/UNDP, FNR-CBD, 2009).

Lebanon is influenced by the Mediterranean Sea. Four principal factors have interacted in this region to produce an exceptionally rich and unique biodiversity: biogeography, geology, ecology and historic human settlements in the Mediterranean area (Blondel and Aronson 1999). More than any other region in the world, the Mediterranean region best exemplifies the environmental change in response to interactions between people and the environment. Lebanon is part of Mediterranean Basin, a recognized centre of plant diversity that is considered a global hotspot (see Figure 5.2). According to Conservation International, this hotspot ranks third among the world's hotspots in both plant diversity and endemism, surpassed only by the ultra-diverse Tropical Andes and Sundaland (MOE/UNDP, FNR-CBD, 2009).

Figure 5.2 Lebanon in the Mediterranean Hotspot

Source: Myers et al. 2000

5.1.2 Major Ecosystems

Lebanon encompasses the important components of the Mediterranean vegetation (*Arbutus, Ceratonia, Pistacia, Pinus, Quercus* and *Laurus*) which are surviving remnants from the ancient forests that dominated the Basin two Million years ago and which represent the past and present climax of the country. Additionally, cold shrubs (*Artemisia, Astralagus*, and members of Ephedraceae) and trees (*Acer, Betula, Cercis, Fagus, and Ulmus*) invaded the Mediterranean, including Lebanon, during the Pleistocene from Europe and Asia and some are still present on the Lebanese territory. Notable keystone and flag species in the country is the famous Lebanon cedar (*Cedrus libani*) that has been exploited since millennia.

One of the remarkable attributes in Lebanon is the gradual shift from Mediterranean to continental Mediterranean and sub-desert conditions from west to east, and the gradual altitudinal change from the batha (degraded garrigue) of the Thermo Mediterranean to the tragacanth of the Sub-alpine and Alpine zones through garrigues (degraded maquis) and maquis of oak and forests of pine, cedar and fir. The southernmost extent of fir trees in the northern hemisphere is the northern parts of the Mount Lebanon range.

5.1.3 Forests

Based on the FAO Forest Resources Assessment (2010), forests cover about 137,000ha (13 percent of the territory) and Other Wooded Land (OWL) covers 106,000ha (about 10 percent) of the territory, yielding a total of about 23 percent. Table 5.2 illustrates the ownership of these forested lands. About 57 percent of the forest cover is broadleaved species (primarily oaks), with coniferous species (mainly pines) contributing about 31 percent. The remainder is mixed broadleaved and coniferous forests –*see Map 3 for Forest Cover, Protected Areas, and other Natural Landmarks*.

Ownership of forested lands is almost equally distributed between the private and public sectors and religious orders (in Table 5.2, religious communities are included in the private ownership category). The following sections provide a brief overview of forest species and distribution in Lebanon, based on a milestone document published by the Association for Forest Development and Conservation (AFDC) --*State of Lebanon's Forests 2007.*

Table 5.2 Ownership of forested and other wooded lands in Lebanon (2004)

Ownership type	Forest (ha)	OWL (ha)
Private	84,183	86,702
Public	53,799	14,956
-State	38,189	
-Municipal	13,938	
-Communal	1,672	
Unknown	1,394	6,720
Total	139,376	108,378

Source: FAO, 2010

5.1.3.1 Oak Forests

The Calliprine oak *Quercus calliprinos* forests are currently found at the lower altitudes of the western slopes of the Mount Lebanon chain, covering an area of approximately 40,000 ha. Also on the eastern slopes of Mount Lebanon, oak forests discontinuously extend, on low altitudes, between Yammouneh and Hermel and on the slopes of Jabal Barouk/Niha. On the western slopes of the Anti-Lebanon chain, only a few and diminutive oak stands persist, mainly east of Baalbeck, Masnaa and around Rachaya. Similary, in the south, only few degraded overgrazed oak forests still persist (in Jabal Amel).

Mixed forest in Wadi Qudin (Andket, Akkar)

5.1.3.2 Pine Forests

Pine forests are found on the western slopes of the Mount Lebanon chain where they occupy an area of about 17,000 ha. Stone pine *Pinus pinea* forests extend on altitudes ranging between sea level and 1500m, particularly in the Metn, Baabda, and Jezzine areas. Other types of pine forests are located at middle elevation where Calabrian Pine *Pinus brutia* forests occupy a large area in the North, and Aleppo Pine *Pinus halepensis* forests extend over an area of 400-500 ha in the southern part of the country (Cazas of Marjaaoun and Hasbaya).

Pine forest in Arsoun (Higher Metn Region)

5.1.3.3 Cedar, Fir and Juniper Forests

The remaining evergreen cedar forests are distributed in patches on the western slopes of the Mount Lebanon Chain, accounting for an area not more than 2,200ha due to severe degradation over the years. These cedar assortments are located in the northern part of the country in Karm Shbat, Ehden, Qamou'a, Danie, Bsharre, Hadeth-Tannourine and in Mount Lebanon in Jaj, Bmohray, Ain-Zhalta, Barouk, Maasser al-Shouf, and Niha. Mixed forests of fir *Abies* and cedar *Cedrus* (with the latter in higher densities) are found in Qamou'a and in the southern-most limits of Ehden. Sparse Grecian Juniper *Juniperus excelsa* forests can be found also in patches on the eastern slopes of the mountain chain, specifically in the district of Hermel. Since ancient times, deforestation and agro-pastoralism have degraded and reduced the forest canopy, resulting in soil erosion and gradual loss of topsoil. These forests nevertheless continue to represent an irreplaceable seed bank for future reforestation activities.


Juniper forest in Afqa and Aqoura, Jbail


Cedar forest in Jaij, Jbail


Fir forest in Qammouaa, Akkar

5.1.3.4 Evergreen Cypress

Evergreen Cypress *Cupressus* forests are almost extinct in Lebanon; some remaining patches grow in restricted areas in Akkar, Ras Chekka, Ehden, Karm-Sadet and Aito, in combination with other tree types. From a habitat standpoint, the forest cover extent and its continuity probably figure most prominently in its importance to biodiversity. The forest cover map reveals the fragility of these forest systems which are confounded by the rugged elevation differences that define Lebanon.

5.1.3.5 Riparian Vegetation and Wetlands

The riparian vegetation also changes with altitude. In many areas riparian vegetation covers river slopes. It is highly diverse and constitutes a fragile ecosystem that plays a major role in watershed protection and erosion control. Near sea level, the riverbank vegetation cover includes oriental plane tree (*Platanus orientalis*), oleander (*Nerium oleander*), St John's wort (*Hypericum spp*.), laurel (*Laurus nobilis*), small-flowered pancratium (*Pancratium parviflorum*), officinal chaste tree (*Vitexagnus-castus*), and white willow (*Salix alba*). At higher altitudes, the vegetation cover includes alder (*Alnus spp*.) and Lebanese willow (*Salix libani*) (MOA/UNEP/GEF, 1996).

Lebanon's few swamps and wetlands, principally in Aammiq and Anjar, are important habitats for migratory birds. Dominant vegetation in these ecosystems includes Syrian ash (*Fraxinus syriaca*), Lebanese willow (*Salix libani*), southern reed (*Typha australis*), water iris (*Iris pseudocarus*), and many other species (Ramadan Jaradi *et al*., 2008).


Aammiq wetland in the Bekaa Valley , an important Bird Area

5.1.4 Marine and Coastal Areas

Except for a short (about 22km) stretch from Tyre to Ras el Naqoura in South Lebanon, most of Lebanon's coastline is heavily impacted by human activity and infringements. A group of islands off the coast at Tripoli has also been allowed to revert to a natural state. River systems emptying into marine waters have very irregular flows and are almost nonexistent for five to six months of the year. In the spring, sediment loads are heavy and often carry industrial and agricultural pollutants.

Lebanese waters constitute less than one percent of the world's ocean surface, while holding as much as 6 percent of all marine species (Quignard & Tomasini, 2000). This richness is probably due to numerous historical, ecological or paleo-geographical, as well as other factors (Bianchi & Morri, 2000). The marine and coastal flora of Lebanon is considered to be Mediterranean with some subtropical elements. Most marine organisms and ecosystems are typically Mediterranean. The connection established by the Suez Canal in 1869 resulted in the introduction of Indo-Pacific marine organisms (Lessepsians) (Bariche *et al*., 2007), affecting Lebanese waters where today at least 67 species occur (nektons, nectobenthos, benthos fauna and flora) that originated from the Red Sea (FAO, 2008).

Within Lebanese territorial waters (up to 12 nautical miles, representing a marine basin of 4,702 km^2) and the continental shelf (about 1,169 km^2), the average annual capture (excluding aquaculture) of marine fish and mollusks/crustaceans is 3,646 and 200 metric tons respectively (FAO & MOA, 2000). Sea depths are relatively deep even close to shore, allowing a variety of deeper dwelling marine organisms to occur in Lebanese waters.

5.1.5 Other Habitats and Natural Areas of Importance

To protect endemic species and forests, Lebanon has established nine nature reserves by law and reserve by ministerial decision. Internationally, UNESCO-MAB has identified three sites as biosphere reserves and the UNESCO World Heritage lists the Valley of Qannoubine as a cultural landscape including the Arz el Rab cedar forest. Birdlife International has listed fifteen sites as Important Bird Areas and there are four recognized Ramsar sites in the country. The higher region of Akkar-Dinnieh-Hermel in north Lebanon is listed as a candidate national park in the National Land Use Master Plan of Lebanon which was approved by the Council for Ministers in 2009 (see Section 6.3.4 for more details). MOE declared additional sites and landscapes (river streams, sinkholes, forests, etc.) protected by ministerial decision (see full list in Chapter 6), and MOA has declared many forests protected also by ministerial decision (see full list of protected forests in Section 5.4.1).

Cedars of the Lord (Arz El Rab) in Bcharre, Lebanon's largest and oldest cedar specimens

5.2.DRIVING FORCES

Lebanon is a developing country with a vibrant economy in transition. Many economic sectors are growing rapidly, sometimes at the expense of natural habitats. Moreover, the 1975-1990 civil war and subsequent flare-ups and political conflicts have induced chaotic social behaviours and unsustainable harvests of natural resources (illegal hunting, over-fishing, overgrazing, wood cutting, agriculture expansion, urban encroachment, etc.). The following paragraphs explain key threats to Lebanon's biodiversity and forests.

5.2.1 Loss, Conversion, and Degradation of Forests and other Natural Terrestrial Habitats

According to most published papers and interviewed stakeholders in Lebanon, the main driver of change leading to species fragmentation and decline is habitat change (including conversion and degradation) or loss. Visible changes in habitats reflect more fundamental transformations in Lebanese society including uncontrolled urban expansion (urbanization, population growth), destruction and/or permanent alteration of the coastal zone, extension of agricultural areas, overgrazing, quarries, sand removal, destruction of sea bed habitats due to pollutants or trawling, and forest fires (MOE/UNDP, FNR-CBD, 2009). When natural habitat is not completely transformed or destroyed, it is often degraded into sub-optimal states. However, between 1965 and 1997, the extension of agricultural areas increased from 123,000 ha to 295,000 ha. At least nine percent of this increase occurred inside forests (MOE/UNDP, FNR-CBD, 2009).

Forest fire in Deir el Qamar, Shouf

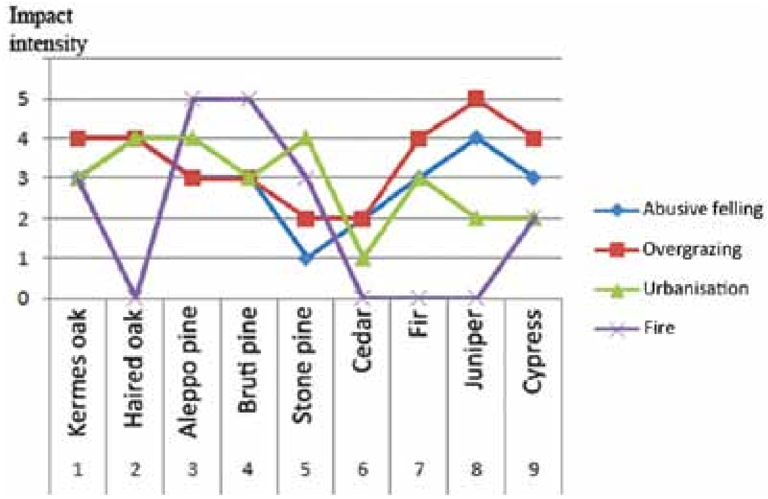
Since the preparation of the Biodiversity Country Study (MOA/UNEP/GEF, 1996), urbanisation appears to be the main driving force to habitat loss or change in all areas of Lebanon except in pine forest communities where recent fires (natural and man-induced) are the main cause of degradation. Juniper and several oak species are preferentially felled for the production of charcoal. Overgrazing is further threatening dwindling juniper forests and compromising or inhibiting regeneration. The stone pine (umbrella pine) is primarily threatened by urban development and forest fires. The severity of threats by forest type is presented in Figure 5.3.

Quarries and stone crushers, agricultural expansion into forested areas, climate change, limited public awareness of conservation issues, and political tensions have a compounding effect on natural resources including biodiversity and forests.

In rangelands, the main driving force is urbanisation but followed by overgrazing. In fact, large swaths of land constitute graze lands for agro-pastoral ruminant production. Some of these lands were degraded from *maquis* to *garrigue* and then to *batha*. If these areas degrade further due to unsustainable grazing activities and intensity, they will no longer support the biodiversity they originally sustained. Graze lands cover much greater areas than areas under conservation management; the sustainable management of graze lands therefore will contribute to improving biodiversity management (MOE/UNDP, FNR-CBD, 2009). In short, Figure 5.4 illustrates the impact of each source of pressure on habitat loss and/or forest degradation.

Forest fires, especially fires recorded in 2007 and 2008, have destroyed in a relatively short time span 4,200 ha of Lebanon's vegetation cover. During a single day in October 2007, the total burned area was equivalent to three times the area reforested during 17 years (AFDC, 2007). The devastating fires and their impact on forest cover raised national concern and fears that Lebanon's forest cover would disappear unless radical steps were taken to address and prevent fires (Mitri, 2009). These fires have caused forest fragmentation and loss of associated ecosystem services. This, in turn, is affecting the livelihoods of local communities. Figure 5.5 shows the extent of reported forest fires in Lebanon; these data were consolidated by the MOE based on the records of the Internal Security Forces (ISF).

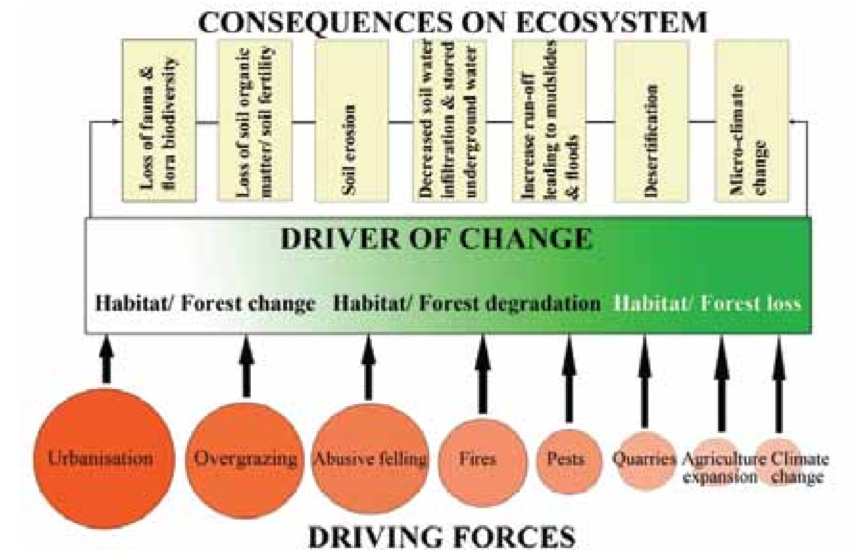
Figure 5.3 Threat intensity based on nine forest species



Source: Adapted from MOA/UNEP/GEF, 1996 by G. Ramadan Jaradi (unpublished)

Tree felling in Sir El Dinnieh

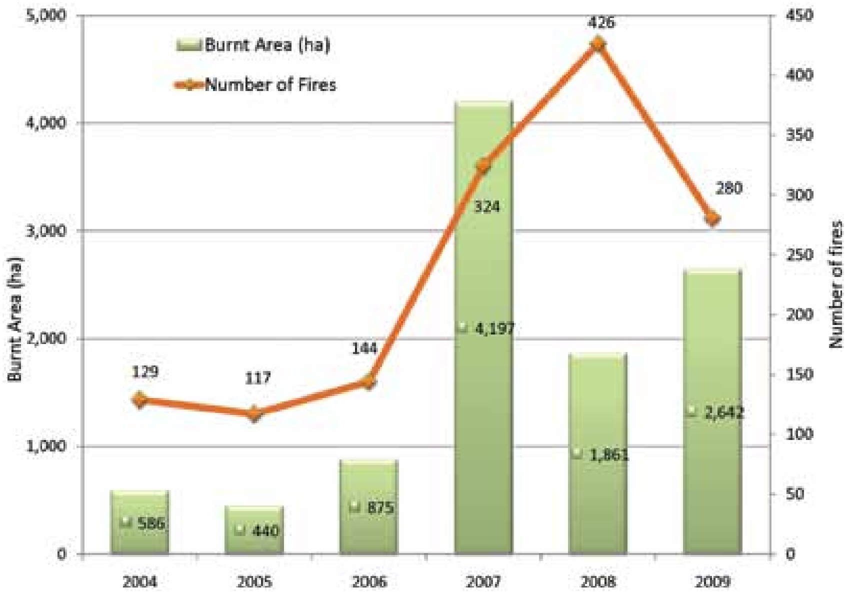
Figure 5.4 The impact of driving forces on ecosystem change in Lebanon



Note: The size of the driving force is proportional to its influence. The influence of climate change on ecosystems is misevaluated due to lack of data.

Source: G. Ramadan Jaradi (unpubl.)

Figure 5.5 Number of fires and burnt areas per year (2004-2009)



Source: MOE based on ISF records

5.2.2 Overharvesting of Species

Overharvesting of natural resources occurs on many levels. Unsustainable hunting practices and hunting malpractices are killing millions of birds every year. Reckless hunting is seriously impacting selected bird populations (Lebanon is situated on one of the world's key migratory bird corridors and has turned into a death trap for avian populations); overfishing of several marine species (using dynamites, small mesh size trawling nets, massive collection of molluscs); and liberal harvesting of trees, medicinal and aromatic plants (the estimated market value of medicinal and aromatic plants produced by forests in Lebanon is $29.6 Million per year) (MOE/UNDP, FNR-CBD, 2009).

5.2.3 Exotic Invasive Species

Non-native *plant* species are introduced, propagated and spread independently throughout the country. Seeds of forest and horticultural species are imported and planted in nurseries, and seedlings are then out-planted around the countryside. The same is true for agricultural species and genetically modified organisms (GMOs), such as food products, which find their way into Lebanon without control or monitoring. Introduced species are often in conflict with native and endemic species, endangering habitats and competing for resources needed for their survival. Invasive species are able to reproduce in large numbers and grow rapidly with no natural controls and quickly take over the habitat of native species. For example, with regards to bird species, the introduced Common Mynah replaced the Hoopoe and other tree-hole nesting species in Beirut and its suburbs, and the Rose-ringed Parakeet destroyed crops in farms near Beirut (G. Ramadan Jaradi, unpubl.). Although invasive species are a real threat to the diversity of biological resources and forest habitats, this issue remains a lower national priority compared to other biodiversity issues (MOE/UNDP, FNR-CBD, 2009).

Exotic *fish* invasive species is another dilemma for conservationists. The connection established by the Suez Canal in 1869 resulted in the introduction of Indo-Pacific marine organisms (Lessepsians) into the eastern Mediterranean. In Lebanon, at least 67 recorded species (nektons, nectobenthos, benthos fauna and flora) are Lessepsians.

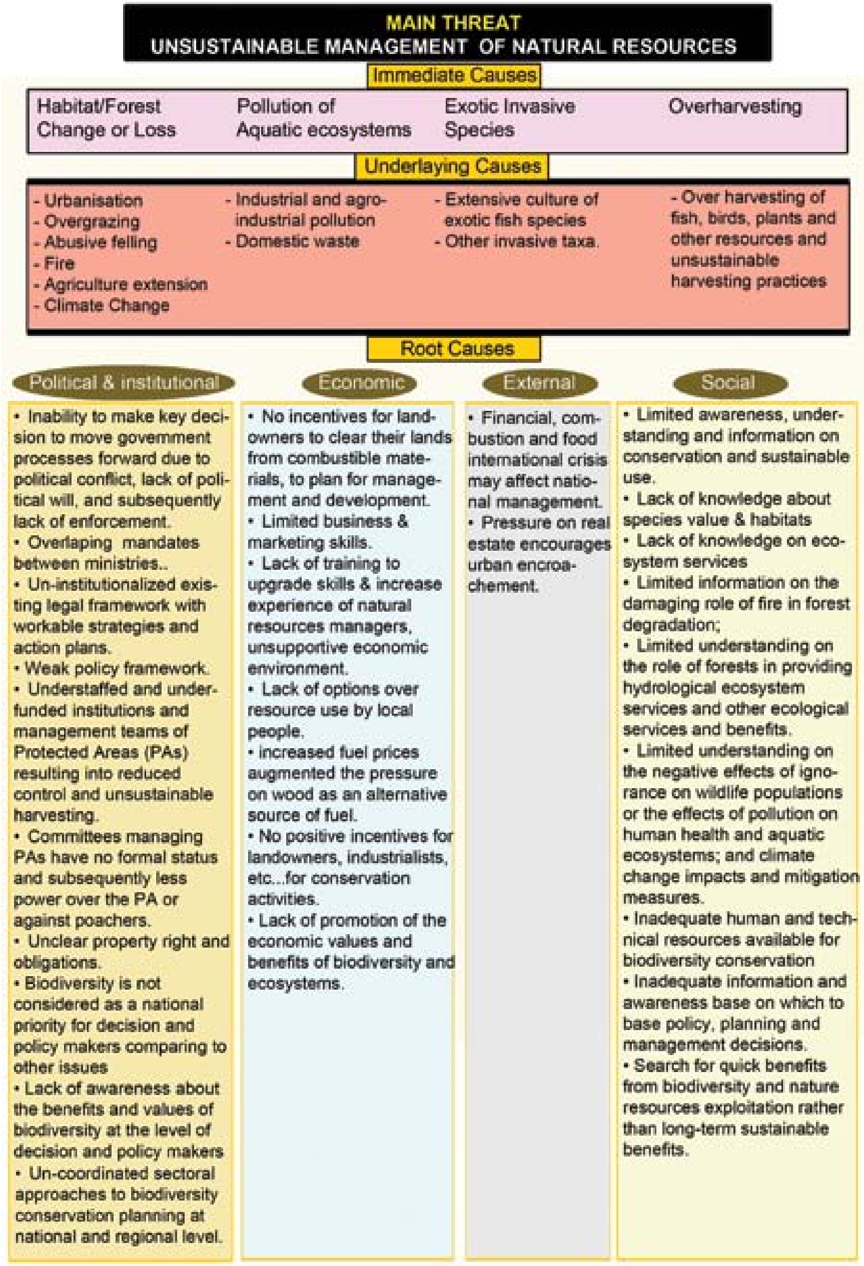
5.2.4 Pollution of Aquatic Ecosystems

Major sources of pollution of surface and groundwater resources include untreated municipal wastewater discharge, industrial effluents, improper solid waste disposal and agricultural runoff. Pesticides and herbicides are often applied unmonitored on fruit trees and vegetable crops. Although of much Lebanon's population is connected to sewer systems, many of those networks are leaking and or discharge into streams and lakes. Potable water networks are frequently polluted by wastewater infiltration. In the Beqaa Valley, the accumulation of pollutants during low flow periods directly impacts the avifauna and mammals that inhabit the few existing wetlands. During the zero rainfall period (April-September), seasonal water courses dry up or are reduced to a trickle, which increases pollutant concentration and threaten aquatic ecosystems. The discharge of these pollutants into the sea threatens the survival of sea grasses, birds, and marine life such as turtles, fish and mammals. *See detailed analysis of water and wastewater infrastructure in Chapter 3.*

5.2.5 Climate Change

In Lebanon, climate change has yet to feature at the forefront of national priorities. The general public is still unaware of the social and environmental repercussions of climate change, and politicians and policy-makers are preoccupied with other, seemingly more pressing, geo-political and economic issues. Lebanon appears to have started to experience the impacts of climate change; mainly in the form of hotter summer spells and reduced and more erratic winter rainfall (see analysis of climate data in Chapter 3). Observations of Lebanese avifauna suggest that few tropical bird

Figure 5.6. Summary of root causes to forest and biodiversity losses



Source: G. Ramadan Jaradi, unpublished

species from hot desert climate have started to colonize the vulnerable zone of the semi-arid Qaa by competing with native avifaunal species (Ramadan-Jaradi *in press*). Other species are wintering at higher altitude (much like Lebanon's ski resorts who are installing new ski-lifts at higher altitudes to capture the receding snowline) and summering at much higher altitude or latitude. In short, direct threats to biodiversity and forest ecosystems have multiple underlying root causes or drivers. These can be broadly categorized as political, institutional, economic, external (or global), and social causes and are affected by the prevailing socio-political context (see Figure 5.6).

Credit: G. Bitar

Floating solid waste in the sea

5.3 BIODIVERSITY STATE AND TRENDS

5.3.1 Terrestrial Biodiversity

5.3.1.1 Flora Species

Flora species inventories date back to the Ministry of Agriculture's UNEP-funded study of 1996. Work since then has been with individual species and or habitats such as the studies that were conducted between 1999 and 2005 in the protected areas of Lebanon. The only exhaustive terrestrial flora study that was conducted at national level was published by Tohmé & Tohmé (2007), describing 2,597 photographed flower plants from Lebanon. It indicates that about 52 percent of Lebanese flowers do not exist in Europe, and 1,185 plants are particularly known in the East Mediterranean region. Of the 2,597 species, 221 are endemic to the region, 34 are rare and 69 are endangered. The authors studied and photographed 94 endemic Lebanese species, of which 12 are varieties.

The Fourth National Report to the CBD (2009) noted that the country has a high percentage (12%) of endemic plant species, surpassed only by Turkey in a list of five neighboring Mediterranean countries. Analyses show that most of the endemic species are located on the high summits of the two mountain ranges, specifically at Mount Makmel, Mount Sannine, Qammouha, Ehden and Mount Hermon. The isolation effects characterizing these summits render the alpine uplands a reservoir for endemic species. Consequently, more than a hundred species specific to Mount Hermon and the Anti-Lebanon Range have been counted (Medail & Quezel, 1997). Of Lebanon's endemic species, 17 are rare, 4 are nearing extinction, and 16 are threatened.

Eleven tree species in Lebanon are on the IUCN Red List, including the *Cedrus libani*, but all are listed at low risk levels. There is greater pressure on shrubs and lesser vegetation, especially those traditionally collected for their medicinal and aromatic uses. A Survey of Economic Plants for Arid and Semi-Arid Lands found 224 species (10.8%) plants of economic importance distributed in Lebanon (SEPASAL, 1999), including 365 medicinal and aromatic plants (MAPs) commonly utilised. Of them at least six are globally significant and threatened by current harvesting practices (UNDP/GEF project: Mainstreaming Biodiversity Management into Medicinal and Aromatic Plants Production Processes in Lebanon, *project on-going*). As for shrubs and lesser plants, they are exhibited in Table 5.3 which also shows the percent of endangered species.

Table 5.3 Summary of endangered shrubs and lesser plants species

Class	No. of species	No. of Endangered Species	Percent of Endangered Species
Fodder plants	69	34	49.3
Medicinal plants	236	16	6.8
Mushrooms	207	4	1.9
Lichens	800	--	--
Mosses & Hepatica	219	--	11
Ferns	31	14	45.2
Endemic plants	92	37	41.3
Total	1654	106	

Source: MOA/UNEP/GEF, 1996

Trends. Observations have found exotic species near the Beirut International Airport, unwittingly carried by travellers caught in clothing or luggage. Some of these species have then spread naturally to other areas of Lebanon (Georges Tohmé *pers. comm.*). Some flowers, thought to have disappeared, have re-emerged, such as the *physalis* now present from northern to southern border, the Lebanese cyclamen (*Cyclamen libanoticum*) and some wild orchids. At least 93 species have disappeared, including 13 endemic species, whilst 13 new species have now joined Lebanon's flora list, including two species that are indicators of salinity and desertification. Common to other areas in the Mediterranean Basin, the Lebanese coastline is highly threatened by unregulated development and its two endemic species (*Matthiola crassifolia* & *Origanum ehrenbergii*) are on the brink of extinction (Talhouk *et al.,* 2005).

5.3.1.2 Forests

It is estimated that 74 percent of Lebanon's surface area was historically covered with forests. Recent studies now show that 13 percent of the country is covered by forests (137,000 ha) and 10 percent is covered by other woodlands (106,000 ha) (FAO, 2010). Annual deforestation is estimated at 0.4 percent while annual reforestation is estimated 0.83 percent. Of the forest areas, 50,250ha are considered dense (more than 65 percent canopy coverage) (LULC, 1998). The highest concentrations of forests are found in North Lebanon (30%) and Mount Lebanon (37%), followed by South Lebanon (9%) and Nabatieh (6%) (MOA, 2003). Oak forests occupy the largest surface areas (52.42%) of the forest cover while Cypress (0.15%) cedar (0.83%) and fir (1.76%) occupy the lowest cover areas. The relic cedar and fir forests harbor several endemic, threatened and economic plant species. Mixed forests represent 17.98 percent whilst the pine forests 14.91 percent and the Juniper 8.74 percent (calculated based on MOA data 2003 and FAO 2005).

Trends. It is difficult to assess forest trends with any high degree of certainty. Compared to previous studies conducted by the Green Plan in collaboration with FAO in 1965, the *total* forest area has remained largely unchanged but high density forest areas have decreased. Between 1990 and 2000, Lebanon gained on average 1,000 hectares of forest per year (equivalent to an annual reforestation rate of 0.83 percent). Despite the reforestation of 583.5 ha by MOE during 2002-2004 and the reforestation of other areas by MOA and NGOs, the reforestation rate decreased between 2000 and 2005 to 0.76 percent per year. In total, between 1990 and 2005, Lebanon's forest cover expanded by 12.4 percent compared to pre-1990 levels[1]. This is equivalent to 1.28 percent of Lebanon's territory. However, more research is needed to validate the data, and to account for the concurrent loss in forest cover due to fires.

5.3.1.3 Mammal Species

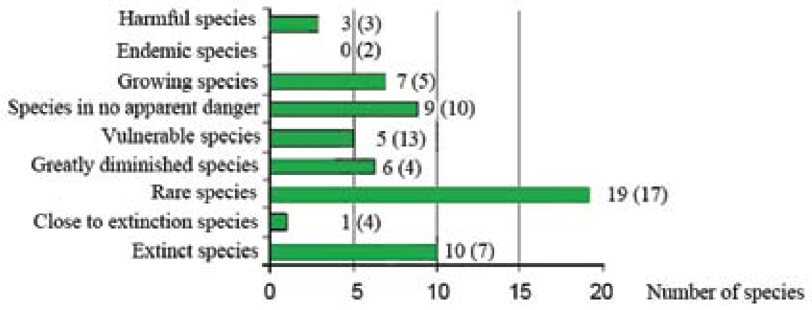
Analyses of BCS (1996) and following published and unpublished papers show that 46 percent of faunal species are terrestrial and that 10 mammal species are already extinct in Lebanon, 36.54 percent of the existing mammals are rare, 1.92 percent are near threatened, 7.7 percent vulnerable, and 1.92 percent close to extinction (see Figure 5.7). Most of the mammals are subspecies limited to East Mediterranean of Middle Eastern areas. Only two mammals are endemic to Lebanon at the level of subspecies: *Nyctalus noctula lebanoticus* and *Myotis myotis macrocephalus.*

Trends. Of the 61 mammal species recorded in Lebanon, ten species were already extinct by the beginning of the 20th century (Syrian brown bear, Asian leopard, Cheetah, Persian lynx, Nubian Ibex, Wild Goat, Deer, Arabian gazelle and the golden hamster in addition to the lion which disappeared in the 16thcentury). The other species which are close to extinction include the wild cat, the mongoose and the squirrel, whereas the rare species include three shrews, eleven bats, the weasel and spiny mouse. There still exists a variety of species which are vulnerable like the three species of bats, the wolf and the otter. Since 1996, two mammal species new to Lebanon (the Forest Dormouse (Bara, 2002) and the Gerbil) were discovered and two more species were added to the previously four declining mammal species of Lebanon.

[1]http://rainforests.mongabay.com/deforestation/2000/Lebanon.htm

Egyptian Fruit Bat Rousettus aegyptiacus

Figure 5.7 Status of mammal species in Lebanon (1996 and 2010)



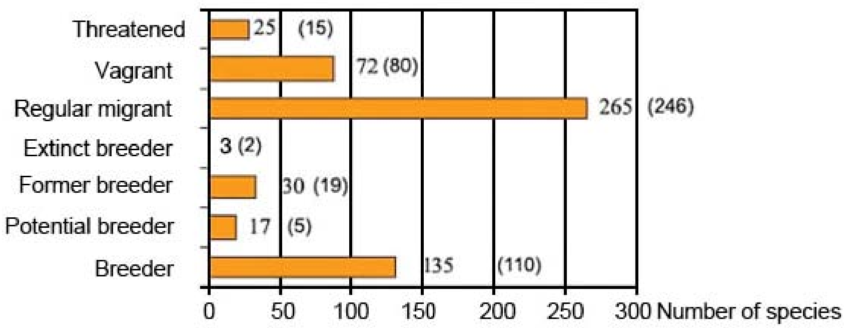
Source: Ramadan-Jaradi in prep.

Note: The number of species between brackets represents the status reported in 1996 (MOA/UNEP/GEF, 1996). Richness, which is defined as the total number of species in a determined area (Lebanon) was 57 species in 1996 and 61 species in 2010 (Ramadan-Jaradi in prep.). The difference between 1996 and 2010 does not reflect an increase in species but improved observation and research. Species may appear in more than one category so the number of species inside and outside the parentheses does not reflect the total number of known species.

5.3.1.4 Bird Species

Out of Lebanon's avifauna (395 species), three species (*Sterna bengalensis, Francolinus francolinus* and *Merops persicus*) have vanished, 6.3 percent are threatened and 32 percent are rare --*see Figure 5.8*. According to the 2007 IUCN Red List, Lebanon's bird species include one Critically Endangered, two Endangered, 8 Vulnerable and 17 Near Threatened species (Ramadan-Jaradi *et al.,* 2008). An updated status of bird species in Lebanon is shown in Figure 5.8.

Figure 5.8 Status of bird species in Lebanon (1999 and 2008)



Source Ramadan-Jaradi et al., 2008

<u>Note</u>: The number of species between parenthesis represents the status reported in 1999 (*Ramadan-Jaradi & Ramadan-Jaradi 1999*). Richness was 337 species in 1996, 372 species in 1999 and 395 species in 2008. The difference between 1996 and 2008 is attributed to improved observation and research. Species may appear in more than one category so the number of species inside and outside the parentheses does not reflect the total number of known species.

Trends. Lebanon's present bird inventory contains 395 species (Ramadan Jaradi *et al.* 2008) compared to 337 in the Biological Diversity of Lebanon Report (MOA/UNEP/GEF, 1996). The 61 new bird species to Lebanon are categorized as follows[2]:

[2]The number of species should be 395 (2008) – 337 (1996) = 58 species. However, 3 of the species reported in 1996 (each of which represented 2 or more subspecies) recently became 6 species. This occurs when a subspecies is ranked a true species based on advanced DNA research.

- Sixteen were present before 1996 but inadvertently omitted from the Biological Diversity of Lebanon report (*e.g.* Sand Partridge *Ammoperdix heyi*, Sooty Shearwater *Puffinus griseus*, Slender-billed Gull *Larus genei*, Gold crest *Regulus regulus*). They include four originated from three parent taxa following upgrades from subspecies to species level (*eg* Steppe Buzzard *Buteo b. Vulpinus,* Caspian Gull *Larus cachinnans,* Ashy-headed Wagtail *Motacilla flava cinereocapilla,* Sykes's Wagtail *Motacilla flava beema*).

Naightjar, Caprimulgus europaeu

- Forty five species are totally new to Lebanon. Of them 19 were first recorded by Ghassan Ramadan-Jaradi (*e.g.* Red-crested Pochard *Netta rufina*, Horned Grebe *Podiceps auritus,* Crested Honey Buzzard *Pernis ptilorhynchus,* Chestnut-shouldered Petronia *Gymnoris xanthocollis*) and 26 by eleven other observers (*e.g.* Barbary Falcon *Falco pelegrinoides,* Pacific Golden Plover *Pluvialis fulva,* Terek Sandpiper *Xenus cinerea,* Bearded Reedling *Panurus biarmicus*). Despite the increased richness of the Lebanese avifauna, the common species of the country have declined by 14 percent in 1999, 18 percent in 2003 and 19.8 percent in 2008 (Ramadan-Jaradi, *in press*).
- Of the above new species to the country, only two breeding species are apparently affected by climate change: Bar-tailed Lark *Ammomanes cinctura* (species of hot desert) and Scrub Warbler *Scotocerca inquieta* (species of desert and semi-desert). Their appearance in Lebanon (*e.g.* Qaa, Hermel, Baalbek) doesn't seem to be subsequent to increased observation efforts or habitat change but most probably the result of global warming.

5.3.1.5 Herptile Species

The herptiles (amphibians and reptiles) encompass seven amphibian and 55 reptilian species (Souad Hraoui, *pers. comm.*). Two amphibian species and 17 reptile species are globally threatened, including four snakes. With the exception of the Lebanon Viper, none of the amphibians or reptiles is considered endemic at the national level.

Trends. The herptile species increased since 1996 from 48 to 62 species. This is apparently due to increased and improved research. This upward trend may continue for some years as there are still areas to be discovered and rediscovered. As is the case of the flora above, the herptiles of the Lebanese coastline are highly threatened by unregulated development and its skink and snake species are in decline. In general, the herptiles of Lebanon are critically decreasing in and around cities, towns and villages. This is not only because of urbanisation and habitat loss but also because of the traditional persecution of these living organisms by local populations. However, the percentage of threatened reptile species is particularly high (18.2percent) and expected to increase in the absence of a defined national strategy to conserve these species.


Credit: TERRE

Eirenis levantinus, reptile species threatened in Lebanon

5.3.2 Freshwater Biodiversity

Lebanon's freshwater fauna and flora include 987 species (Al-Zein, 2001)**,** of which 656 are invertebrate species (61 species of worms, 41 mollusks, 60 crustaceans, and 494 insects; MOA, 1996).The faunal species in freshwater represent 16 percent of the total fauna biodiversity of the country and the floral species represent 6 percent of the flora species only. Five percent of the country's freshwater fauna are threatened, including the Globally Near Threatened Otter *Lutra lutra,* and 1.3 percent are endemic (MOA/UNEP/GEF, 1996). The only endemic freshwater fish to Lebanon *Phoxinellus libani* was considered extinct in the country (MOA/UNEP/GEF, 1996) but it has been observed at least in the Yammouneh Lake, Litani River and Qaraoun Lake (El Zein, 2001). Many have been exterminated from specific river systems due to overfishing.

There are 25 fish species pertaining to different families: Cyprinidae, Cyprinodontidae, Cobitidae, Salmonidae, Anguillidae, Cichlidae, Mugilidae, Puciliidae, Blenniidae, Lutjanidea. Of them, one species is listed as vulnerable, three are endangered and two are critically endangered. In addition to these, other species have been introduced for aquaculture: rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmotrutta fario*; Al Zein, 1997), brook trout (*Salvelinus fontinalis*), common carp (*Cyprinus carpio*), mosquito fish (*Gambusia affinis*), silver carp (*Hypophthalmichthys molitrix*), etc. Whilst some were introduced for sports, other species were introduced to control different pest purposes, for example snails *(Cyprinus carpio),* mosquitoes *(Gambusia affinis)* and weed *(Hypophthalmichthys molitrix)*. Because of low wild fishery yields and an abundance of pristine cold rivers and springs in Lebanon, small trout farms have sprouted throughout the country. Moreover, this aquaculture industry has grown significantly in recent years, especially after returning expatriates have introduced new ideas and new approaches to aquaculture from around the world.

Trends. Freshwater biodiversity is being impacted particularly by disturbances affecting water sources and rivers which weaken freshwater ecosystems and result in the elimination of weak species especially those sensitive to pollution. Drainage, pollution and human interference have drastically changed the fresh water ecosystem and resulted in a high proportion of endangered species whereas overfishing has caused the extermination of some fish species from certain rivers (MOE/UNDP, FNR-CBD, 2009).

Freshwater stream in Kfarhelda (Batroun)

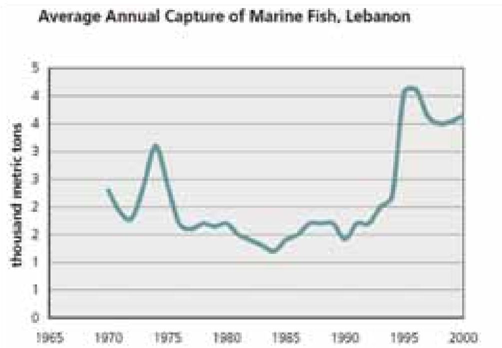
5.3.3 Marine Biodiversity

The status of marine species was assessed within the 1996 Biological Diversity of Lebanon country study and then reviewed through several published and unpublished papers. There are 367 fish species in Lebanon. Phytoplankton encompasses 580 species whilst the zooplankton accounts for the largest share of marine faunal diversity with more than 747 species recorded. Micro-zooplanktons are at the base of the marine food pyramid and are hence essential for maintaining the ecological equilibrium. The microzoobenthos are represented with 12 known species whereas the macrozoobenthos are diversified and encompass 662 species (Bitar, 2001). Other families of marine organisms include seven species of cephalopods (octopuses, cuttlefish and squids), at least three species of reptiles (Loggerhead, Green and Leather-back marine turtles) and five species of mammals (dolphins and porpoises and, less common in local waters, whales and seals). The information on the conservation status is mainly available for selected species (Turtles and cetaceans). The Biodiversity Country Study identified submerged rocky, sandy and grassy habitats as well as sciaphile, photophile, endofauna and epifauna communities, including 68 threatened species.

Mature loggerhead returns to the sea after laying her eggs

Trends. Lebanon's marine biodiversity is part of the Mediterranean biodiversity that is undergoing rapid alteration under the combined pressure of climate change and human impact, but protection measures, either for species or ecosystems, are still scarce. The marine species of Lebanon are moderately impacted by the fishing industry. Average annual capture of marine fish is illustrated in Figure 5.9. Native marine floral and faunal species are competing with the unabated increase in the number and population of invading species originating from the Indo-pacific and Atlantic.

Figure 5.9 Average of annual capture of marine fish in Lebanon



Source: Earth trends 2003

Phytoplankton which includes all microphytic algae, constitutes the basis of the food chain in the sea, and along with micro and macrophytic benthic algae, is seriously declining because of the high degree of coastal pollution.

5.3.4 Genetic and Agro-Biodiversity

More information on the status of genetic and agro-biodiversity in Lebanon is surfacing to understand and manage agro-biodiversity as it should be understood. Although the benefits of agro-biodiversity are increasingly appreciated by agriculturalists and conservationists alike, global market forces continue to adopt more commercial, fast-growing and high-yielding crops, including genetically modified organisms (GMOs), at the expense of the more traditional crop varieties. In response to the potential impacts of GMOs on biodiversity and public health, Lebanon acceded in 2008 to the Protocol of Cartagena (Biosafety Protocol) regulating the transboundary movement, import, export and use of GMOs. Whereas imported and genetically modified crops usually generate higher yields, traditional crops are incontestably hardier: they exhibit higher drought resistance, higher resistance to salt and heat stress, and are less susceptible to pests and diseases. Genetic diversity of traditional and crop wild relatives

(CWR) allows species to adapt to changing climates and other ecological conditions. This natural genetic diversity is critical to the survival of many species in the face of global climate change.

Nine authors (Chalak *et al.,* 2011) contributed recently to elucidate the status of Agro-biodiversity in Lebanon. According to MOA statistics from 2007, the most important crops in Lebanon are:

Crop	Production (tons/year)	Varieties
Olive	117,330	12+
Cereals	116,200	10+
Barley	33,100	
Potato	514,600	5+
Citrus	3,451,000	24+
Grapes	106,000	30+
Apples	125,200	2+
Cherry	30,000	5+
Apricot	32,000	5+
Almond	29,400	2+
Banana	89,700	2+
Legumes		

Source: Chalak et al., 2011

These crops include local / traditional, improved and introduced varieties. LARI and ICARDA have jointly developed several improved varieties of cereals using local landraces. Legacy species and local landraces, especially horticultural crops such as wild almond, pear, plums, pistachio, fig, walnut, pomegranate, carob and apple (*Malus spp*), are commonly found in Lebanon. These species are naturally adapted to local conditions but lack exploitation and mechanization to constitute a reliable export crop. Their culture is generally neglected and located on marginal lands or scattered around orchards. Newly introduced subtropical crops such as kiwi, avocado and custard-apple are progressively increasing on the littoral, often replacing citrus plantations, and are destined for both local and export markets. Finally, Lebanon also harbours many aromatic and medicinal plants, as well as spices and condiments which are harvested from the wild and used as food. These species are gaining recognition in local development projects, and the food and herbal medicine industry.

The country's high level of endemism is a good indicator that other CWR exist which can provide natural products in response to increasing demand as well as the genetic resources needed to develop crops that are more resilient to diseases, pests and climate change. In a bid to better understand and mainstream agro-biodiversity in the agricultural sector, GEF and ICARDA funded a regional project *Conservation and Sustainable Use of Dryland Agro-Biodiversity in the Near East* to kick-start applied research studies and farmer-based training in agro-biodiversity (Box 5.2). Project activities in Lebanon were implemented by UNDP and executed by LARI and focused on the conservation and promotion of important wild relatives and landraces of agricultural species.

Box 5.2 Regional Agro-biodiversity Project (1999-2005) GEF/UNDP/ICARDA

- Raised public awareness on agro-biodiversity,
- Increased national capacity building in areas related to the conservation and sustainable use of agro-biodiversity,
- Promoted alternative land-use practices,
- Developed policy options and draft legislation to support the conservation of agro-biodiversity,
- Promoted alternative sources of income, and
- Improved our understanding of the major causes of agro-biodiversity degradation of target species.

Trends. More research is needed to understand the trends in genetic diversity of domesticated animals, cultivated plants, and fish species of major socioeconomic importance. It is expected however that the following threats, in addition to the long list of other threats facing biodiversity, will over time erode plant genetic resources (Chalak *et al.*, 2011):

1) The replacement of traditional and genetically diversified farming systems with modern and large-scale monoculture farming systems.
2) The tendency of farmers to adopt one or two cultivars which makes the future of crops more vulnerable especially in case of climatic variations or occurrence of new diseases.
3) Market trends that favor the introduction of new and so called *improved* varieties leading to the disappearance of local varieties that have lesser marketability.

5.4 KEY ACTORS, LAWS AND REGULATIONS

The following section describes key laws and regulations related to biodiversity and forests. Each text cited here is also listed chronologically at the end of the chapter. For a more complete analysis of environmental legislation related to biodiversity and forests, please refer to Chapter 12 of SELDAS (EU/UOB/MOE/ELARD, 2005). For a review of environmental jurisprudence cases related to biodiversity and forests in Lebanon and other countries, please refer to Chapter 12 of SEEL (MOJ/MOE/UNDP, 2010).

5.4.1 Forest Laws, Regulations and Action Plans

Lebanon has two forest laws. The first law is the Forest Code of 1949 that provides the basis for the management of forests by the Ministry of Agriculture, and the second law 85 for the protection of forests was promulgated in 1991 and amended by law 558 in 1996. MOA has designated more than a dozen sites as national *himas* and/or protected forests, pursuant to the Law 558/1996 (see full list in Table 5.4). These decisions ban a number of activities inside the forests (including camping, pruning and logging, grazing and hunting) within a specified protection radius, usually 500m. The ban exempts activities related to forest management and research.

Following the devastating fires of 2007, the Prime Minister formed an inter-governmental committee (Decision 119 dated 6/11/2007) that later became a National Executive and Technical Committee chaired by MOE. To expedite the preparation of a National Strategy for Forest Fire Management, COM approved an MOU between MOE and AFDC to develop and implement an action plan for forest fire prevention and landscape restoration (Decision 138 dated 27/10/2007). The *National Strategy for Forest Fire Management* was finally released in 2009 and endorsed by the COM (Decision 52 dated 13/5/2009). The strategy was prepared jointly by the MOE-AFDC, MOIM, MOA, the Lebanese Army, the Directorate General of Civil Defence.

The Lebanese Parliament subsequently approved in March 2010 Law 92 banning all land uses inside burnt forests to prevent future acts of arson. Also in 2010, the Lebanon Recovery Fund launched the project *Forest Fires Management, Prevention and Control and Damaged Forests Assessment and Rehabilitation* (RF-14 OSRO/LEB/703/UNJ Project) to assist the GOL in creating the enabling environment for (1) the prevention of future forests fires; 2) improving fire fighting when they do occur; 3) assessing the ecological and socio-economic damages resulting from fires during the July 2006 war; and (4) rehabilitating burnt forests to restore access to forest resources by rural communities after due clearance of landmines and other unexploded ordinances.

Table 5.4 Detailed list of protected forests and himas in Lebanon

Decision	Date	Location	Predominant Species				
			Cedar	Fir	Juniper	Quercus	Other
127/1	1991	Maaser El Chouf, Barouk, Ain Zhalta and Ain Dara	X				
71/1	1992	Kfarzabid (Zahle)	Mixed forest and fruit trees				
152/1	1992	Hbaline (Jbeil)	Mixed forest and fruit trees				
21/1	1992	Khorbat Selem (Bint Jbail Caza)	Mixed forest and fruit trees				
499/1	14/10/96	Tannourine/Hadath El Jebbeh, Jaij and Arz El Rab	X			X	
587/1	30/12/96	Swayse (Hermel)	X	X	X		
588/1	30/12/96	Qammouaa (Aakkar)	X	X	X		
589/1	30/12/96	Karm Chbat (Aakkar)	X	X	X	X	
591/1	30/12/96	Bazbina (Aakkar)	X	X	X	X	Pine
592/1	30/12/96	Knat (Knat)	X	X	X	X	Pine
10/1	17/1/97	El Sfina (Aakkar)	X			X	
11/1	17/1/97	Mrabbine (Wadi Jhannam, Sir El Doniyeh)	X	X	X		
8/1	17/1/97	Ain El Houkaylat/Karm El Mohr (Sir El Doniyeh)	X	X	X	X	
9/1	17/1/97	Jurd El Njass/Jabal El Arbaiin (Sir El Dennieh)	X		X		
174/1	25/3/97	Chbaa (Hbaline, Jbeil)				X	Pine
3/1	8/12/97	Bkassine (Jezzine)					Pine
399/1	18/9/08	Jabal Moussa (Kesrouan)			X	X	Pine

MOA's Directorate of Rural Development and Natural Resources enforces forest legislation and apprehends offenders. The Directorate has 152 forest guards, operating from 31 forest stations, mostly underpaid and underequipped. Although the Directorate has been receiving some donations in the form of water trucks and utility vehicles, it has not shown sufficient commitment to maintaining such equipment. In a recent move, the MOA reviewed some aspects of the forest legislation and cancelled the ban on the production of charcoal to allow a controlled exploitation and stop illegal felling (FAO 2005). This decision was also motivated by the need to reduce the build-up of highly flammable biomass, and alleviate poverty. It may also prevent acts of arson initiated to circumvent the ban on charcoal extraction. The immediate and long-term implications of the return to small-scale charcoal production should be closely monitored and evaluated by the Directorate.

The protection and conservation of forests and ecosystems engenders consequences for land owners and other users of natural resources. These consequences are particularly hard felt when protection measures limit or prohibit the use of resources. Conservation objectives can, under certain conditions, impair food security and/or income levels. Economic alternatives and compensational measures should be studied and applied to ensure the sustainability and effectiveness of the legislation. Ironically, the lack of compensation is considered one of the root causes forest and biodiversity degradation. Meanwhile, the Directorate is currently examining the feasibility of decentralizing forest management, up to a certain degree. Decentralization will lead to a higher involvement of local community groups, municipalities and grassroots organizations. However, such a measure can only be implemented after building the capacities of targeted stakeholders and raising awareness of targeted communities and populations (AFDC, 2007).

5.4.2 Reforestation

Reforestation is considered one of the main activities that support the proliferation of green areas in Lebanon. According to the 1949 Forest Law, MOA has lead responsibility for setting up a national program for forest management and reforestation (Law of 7/1/1949 and its amendments). Subsequently, a 1951 law on the conservation of soil and the protection of forests from grazing also addressed reforestation. During the late 1960s and early 1970s, Lebanon pioneered large scale reforestation programs across the country known as the "Green Plan"; millions of trees were planted and/or seeded in vast areas of the country. While the Green Plan remains today a semi-autonomous directorate under the MOA, its scope and purpose have shifted from reforestation to land rehabilitation. Moreover, MOA was mandated to designate reforestation areas, formulate relevant programs, provide seeds and seedlings and preserve them, in addition to conducting needed research to guarantee successful forestation (Decree 5246-1994 and its amendments).

Unfortunately, in the last decades, a sizeable number of seedlings used by MOA (and NGOs) in reforestation were imported from neighboring countries, except for Cedar seeds and seedlings for which MOA has banned all imports (Decision 108/1 of 1995). In an attempt to improve plant cover, MOA established several tree nurseries (Decree 5246/1994 and its amendments). In 2001, the GOL allocated LBP25 billion from the national treasury (Framework Law 326 dated 28/6/2001) to implement a National Reforestation Plan (NRP) over a five-year period in a bid to restore the country's green cover to reach 20 percent of the total country area. In a controversial move, Law 326/2001 mandated MOE (not MOA) to design and implement the NRP. *See NRP achievements and difficulties in Section 5.5.*

Tree Nursery in Dibbieh (MOA)

5.4.3 Protected Areas System

MOE is today the lead government agency responsible for protected area management in Lebanon. Article 23 of Law 690/2005 mandates MOE to determine candidate areas for establishing protected areas (PA) and criteria for PA designation, and propose necessary laws and regulation for PA management. *See analysis of draft laws and regulations related to protected areas prepared under the EU-funded SISPAM project in Section 5.5.2*. Lebanon today has 10 legally established nature reserves (Table 5.5) covering 2.2 percent of the territory (up from two nature reserves in 1992 covering just 15 km^2). In addition to these nature reserves, the number of other types of protected areas has also increased including three biosphere reserves (measuring 414 Km^2, almost 4% of the territory), 13 protected forests, 16 protected natural sites/landscapes, four Ramsar sites, five World Heritage Sites and 15 IBAs. Some of the sites and nature reserves have acquired one or more international designations. With the exception of formal nature reserves and biosphere reserves, all other protected areas urgently need mechanisms for proper management and monitoring –*see full list of nature reserves in Table 5.5 and locations in* ***Map 3***.

The management and operation of protected areas including nature reserves is today a shared responsibility between MOE, the Appointed Protected Areas Committee (APAC), and the management teams in the field. The creation of APACs has brought together key players and actors under one body, including local NGOs, municipalities, conservationists and scientists. MOE has been providing significant guidance to APACs and management teams including training (management plans, resource mobilization, biodiversity monitoring, visitor management and carrying capacity), and EIA reviews related to small-scale tourism activities. Unfortunately, the APAC is not an organization that is duly registered and recognized by the GOL and therefore it has no legal identity. This means that APACs cannot hire staff and sign contracts and agreements (other than with MOE). Management teams therefore cannot enrol with the National Fund for Social Security to receive social benefits (health insurance, family allowance and end-of-service indemnity), *unless* they are hired by a local NGO or any other legal entity including universities and research institutions. This is the case in Al-Shouf Cedars, Horsh Ehden, Palm Islands, and Tyre Coast which all face similar difficulties and have setup interim arrangements to resolve the legal hold-up.

Shouf Biosphere Reserve in the spring, one of three biospheres in Lebanon

Table 5.5 Detailed List of Nature Reserves in Lebanon

Nature Reserve	Legal Instrument	Date	Approximate Area (ha)	Elevation Zone (meters)	International Designations
Horsh Ehden	Law 121	9/3/1992	1,100	1,200-1,900	IBA
Palm Islands	Law 121	9/3/1992	500	Sea Level	RS, SPA, IBA
Karm Chbat	Decision 14/1	6/10/1995	520	1,400-1,900	
Al-Shouf Cedars	Law 532	24/7/1996	16,000	900-2,000	BR, IBA
Tyre Coast	Law 708	5/11/1998	400	Sea Level	RS
Bentael	Law 11	20/2/1999	200	250-800	IBA
Yammouni	Law 10	20/2/1999	1,600	1,400-2,000	
Tannourine Cedar Forest	Law 9	20/2/1999	150	1,300-1,800	IBA
Wadi Al Houjair	Law 121	23/7/2010	1,300	250-400	
Mashaa Chnaniir	Law 122	29/7/2010	200	500-530	

Note: areas are ECODIT estimates using GIS. The area of Palm Islands Nature Reserve is a marine basin.
Abbreviations: **BR** Biosphere Reserve, **IBA** Important Bird Area, **SPA** Specially Protected Area, **RS** Ramsar Site

PA management is expensive! Studies from around the world confirm that revenues from visitors and other forms of ecotourism alone cannot sustain operational costs. PA management is therefore a national responsibility that requires government-approved annual funding. MOE has been disbursing funds to support the management of nature reserves through APACs. Between 2001 and 2008, MOE disbursed LBP2.58 billion ($1.72 million) to six nature reserves. (Note: allocations in 2004, 2006 and 2007 were cancelled; allocations in 2009 and 2010 are still pending). The limited size and intermittency of government allocations have strained the work of management teams and challenged the ability of APACs to honour annual budgets and implement work plans. This situation is expected to change when the draft Framework Law for Nature Reserves is approved and comes into effect.

5.4.4 Protection and Conservation of Marine Resources

Fishing regulations in Lebanon date back to 1929 (Decision 2775/29). The MOA has been coordinating efforts with FAO since 2004 to draft a new law based on extensive field data collection. (This draft law is still under discussion with fishermen and syndicates). The fishing sector is managed and controlled by MOA which has banned dynamite fishing and trawling nets, banned fishing of marine turtle, cetaceans and monk seals (Decision 125/1 issued in 1999), banned the use of small mesh sizes (Decision 408/1 issued in 2007), and regulated the scuba-diving industry including permitting procedures and safety measures (Decision 93/1 issued in 2008). The ministry has also banned the use of spear fishing by scuba divers as well as the sale and trading of any of its derivates. MOA's ability to enforce these bans and restrictions is severely limited due to lack of human resources and equipment to patrol fishing waters and fishing activities.

As signatory to the Convention of Barcelona and other agreements for the Protection of the Mediterranean Sea against Pollution, Lebanon is required to reduce land-based sources of pollution into the Mediterranean Sea and treat wastewater before being discharged to the sea from cities and towns with populations

Credit: G. Jaradi

Leatherback rescue in Palm Island Nature Reserve, Tripoli exceeding 100,000. While this has not been achieved yet, CDR (lead planning and donor coordination agency) has at least invested $350 million in the wastewater treatment sector during the period 1992-2008.

5.4.5 Protection and Conservation of Freshwater Resources

There is no national initiative that aims to establish a water quality control system specifically targeting biodiversity conservation. On the other hand, there are strict regulations related to well drilling. Poor law enforcement however has led to a proliferation of private artesian wells with no consideration for aquifer capacity. Moreover, Environment Law 444/2002 embraces the polluter-pays-principle, as well Environmental Impact Assessment and Strategic the Environmental Assessment process, to help curb pollution including freshwater pollution.

Inland, Lebanon's proposed wastewater treatment plants offer interesting opportunities for water reuse. Relevant ministries have yet to establish formal water reuse standards. In theory therefore, treated wastewater produced by any of the recently completed wastewater treatments plants in the Bekaa Valley (Baalbeck, Aitanit and Ferzol) cannot be reused by farmers directly. In practice however, it is widely reported that many farmers mix raw sewage with irrigation water in times of drought or simply to improve soil fertility. On the solid waste front, MOE has prepared two decisions in 2004 on 1) the use and disposal of sewage sludge, and 2) the utilization of compost in agriculture, horticulture and landscaping. Those ordinances have not been formally approved.

5.4.6 Protection and Conservation of Flora and Fauna

Lebanon signed the Convention on Biological Diversity (CBD) in 1992, ratified it in 1994 (Law No. 360/94) and has taken noteworthy steps to promote flora and fauna conservation. MOE developed in 1998 in partnership with GEF/UNDP a National Biodiversity Strategy and Action Plan (NBSAP), and prepared a draft addendum to the strategy and action plan in 2005. MOA has issued a number of decisions/circulars prohibiting or restricting wild harvests (Decision 125/1 of 1999 regulating fishing of Wales, Monk seals, and their derivatives) and the commercial trading of a selection of plant species: cedars (Decision 108/1, dated 12/9/1995 regulating the introduction of cedar seeds and seedlings), and aromatic and medicinal plants (Decision 340/1 of 1996, regulating export of oregano and salvia), etc. Although Lebanon has yet to ratify the CITES Convention, MOA is already requiring CITES permit for the import and export of species that are included in Appendix 1 and Appendix 2 of the Convention.

Hunting

The Government imposed (but did not enforce) a total ban on hunting since 1995. Not only was enforcement ludicrous, but the government did very little to limit or restrict the import, production and sale of hunting gear and ammunition, as well as game calls and other forms of luring devices. Hunting in Lebanon is widespread and often indiscriminate. There are reportedly more than 300,000 hunters in the country and an even greater number of shooters (hunters without license).

Lebanon's first hunting law dates back to 1952. In 2004, Parliament ratified a new hunting law (Law 580 dated 25/4/2004) which resembles the law of 1952 but recognizes the heritage value of wild fauna and advocates measures to ensure sustainability, partly to comply with the EU "Birds Directive." For example, the new law prohibits hunting and trapping of internationally threatened bird species and all species during spring migration and nesting seasons. The law also prohibits the hunting of all resident and migratory birds and terrestrial mammals, except species designated as *game*. It prohibits the collection of eggs and nestlings from nests. Most importantly, Law 580/2004 established the Higher Council for Hunting (see Box 5.3) and outlined the conditions necessary for obtaining a hunting permit (mandatory insurance, hunting exam, etc.).

Although the current hunting law offers new opportunities to protect fauna and wildlife, it also presents some deficiencies. In particular, Articles 6 and 20 contradict Decree 137/1959 related to firearms and ammunition. The hunting law stipulates that firearms from Category 4 and 5 of Decree 137/1959 can be used for hunting. According to Decree 137/1959, only Category 5 weapons are classified for hunting (Category 4 weapons, while non-military, are not).

Credit: B. Merheb

Honey Buzzard killed, Pernis apivorus

Hunting is widespread all over the territory despite a hunting moratorium in effect since 1995

Box 5.3 The Higher Council for Hunting

The Higher Council for Hunting (HCH) convened for the first time in 2009. It has drafted several application decrees and decisions, including:

(1) Conditions and procedures for licensing private shooting clubs who offer hunting exams (approved by MOE Decision 129/1 dated 17/8/2010).
(2) Procedures for fining hunters who break the law (approved by the HCH on 1/9/2009).
(3) Mandatory insurance for hunters (draft approved by the HCH on 24/10/2008 but COM decree pending).
(4) List of game birds (including birds harmful to agricultural crops) and other game (mammals) including bag counts.

The COM appointed in 2010 new members to the Higher Council for Hunting to serve a three-year period (Decree 5370/2010).

5.4.7 Multilateral Environmental Agreements related to Biodiversity Ratified by Lebanon

Lebanon has signed and ratified most of the international conventions related to environmental protection and conservation, mainly:

- Convention on Biological Diversity
- Barcelona Convention for the Protection of the Mediterranean Sea
- UNESCO World Heritage Convention
- Protocol concerning Mediterranean Specially Protected Areas
- United Nations Framework Convention on Climate Change
- United Nations Convention to Combat Desertification
- RAMSAR Convention on Wetlands of International Importance
- African Eurasian Water Bird Agreement
- Agreement on the Conservation of Cetaceans of the Black sea, Mediterranean Sea and Contiguous Atlantic Area "ACCOBAMS"
- International Treaty for Plant Genetic Resources
- Protocol of Cartagena / Bio safety

The *Nagoya Protocol on Access and Benefit Sharing* was adopted in October 2010 by the Conference of Parties to the CBD (COP10) and was opened for signature on 2 February 2011. Lebanon has started to initiate procedures to sign the Protocol. Of the remaining conventions and treaties that Lebanon did not sign yet are the *Convention on International Trade in Endangered Species*, CITES (W/DC, 1973) and the *Convention on the Conservation of Migratory Species of Wild Animals* (Bonn, 1979). It appears that nothing prevents Lebanon from signing these conventions but accession is time-consuming and requires resources. MOE and MOA should work jointly to mobilize such resources (prepare application files for accession, follow-up with the convention secretariat and respond to questions, provide additional clarifications, promulgate legislation, etc.).

5.5 SELECTED RESPONSES TO BIODIVERSITY AND FOREST ISSUES

5.5.1 Restoring Forests and Fire Prevention

Forest cover has recently undergone significant losses and dieback primarily as a result of habitat change or conversion of forests into croplands, chaotic clearing of the forests for unplanned urban expansion, diseases and insect pests, forest fires, illegal and excessive fuel wood collection and charcoal production, and reckless quarrying devastating mountain ranges. The resilience of some forest ecosystems is being compromised. In response to these problems, Lebanon has initiated and is implementing a number of programs to restore forests and/or prevent fires. Selected programs and initiatives are described below.

Programs and initiatives related to reforestation

- MOE developed in 2001 a **National Reforestation Plan (NRP)** that uses indigenous forest species and private sector contractors. The original plan (2002-2006) contracted private firms to produce and transplant native seedlings in pre-selected reforestation sites throughout Lebanon, and provide aftercare for two years with seedling replacement in case of mortality. Phase I of the plan (2002-2004) targeted 305ha across 23 sites (see site locations in Section 4.2.1). Phase II (2004-2006) targeted an additional 278ha across 18 sites but activities were interrupted by the war in July 2006 and contracts were subsequently terminated. Workers could not reach many sites and other sites sustained direct shelling and burning; other sites were not affected by the war and produced good results.

- After a two-year hiatus (2006-2008), MOE resumed work on the NRP in 2009 with supplemental funding from GEF and implemented by UNDP to the tune of $2.26 million. The project **Safeguarding and Restoring Lebanon's Woodland Resources** complements on-going investments under the National Reforestation Program and will build capacity for sustainable land management. In particular, the project seeks to remove the institutional, economic, and technical barriers to sustainable land management in a bid to up-scale forestry models and approaches over the coming five years. In practice, MOE is testing a new model for reforestation by subcontracting activities directly to municipalities in accordance with preset standards. In 2010, MOE signed 41 agreements worth LBP 1.9 billion ($1.3 Million) and covering 185 ha. The project is also testing new planting techniques using hand seeders and "solid water" to fix seeds and irrigate shoots cost-effectively.]

- Building on the momentum of the NRP and the GEF/UNDP project cited above, the International Program of the US Forest Service (USFS) launched in 2010 a five-year and $12 Million **Lebanon Reforestation Initiative**. The goals of the initiative are to strengthen Lebanon's forest seedling producing nurseries and oversee the implementation of large-scale reforestation activities in the country, in line with the NRP. In particular, the initiative will enhance the capabilities of eight nurseries (existing and new) evenly distributed in the country to ensure proximity to reforestation sites and hardening.

- Other than MOA and MOE, several leading organizations have implemented scattered reforestation activities in many parts of the country including the AFDC, Friends of the Cedars of Bsharre Committee, Jouzour Loubnan, and the Lebanese Yacht Club (aerial seeding with Lebanese Army helicopters) --*see reforestation activities in Chapter 6*.

- MOA developed in 2003 a **National Action Plan to combat desertification** through a participatory process that brought together active stakeholders representing public and private sectors, civil society, and academia. The formulation of the National Action Plan was supported by the German Technical Cooperation (GiZ) and UNDP's Drylands Development Centre. MOA recently signed a $6 million loan agreement with IFAD to implement selected activities.


Credit: N. Hani

Forest pruning in Maasser el-Shouf, an activity to reduce forest fire hazard

Programs and initiatives related to fire prevention and fire-fighting

- The National Center for Remote Sensing developed in 2005 a **Fire Risk Map** to predict forest fire-prone areas in Lebanon (scale 1:100000). Prepared in partnership with the Lebanese Civil Defense, AFDC and Greenline Association, the map was designed to serve as a planning tool for predicting forest fires during heat spells and thereby optimize resource allocation for fire prevention and response. It is unclear to what extent the map has been used to monitor forest fires.

- Following the devastating fires of 2007 and 2008, several ministries (Environment, Interior and Municipalities, Agriculture), the Lebanese Army, the Directorate General of Civil Defence, and the AFDC came together to produce Lebanon's **National Strategy for Forest Fire Management**. Funded by the EU and AECID, the strategy was endorsed through COM Decision 52 (dated 13/5/2009). It rests on five pillars: (1) research, information and analysis, (2) risk modification, (3) readiness and pre-suppression, (4) response and (5) recovery, post-fire management and rehabilitation. Equally important, the Lebanese Parliament approved in March 2010 Law 92/2010 which prohibits the exploitation of burnt forest areas in an attempt to deter arsonists. (It is widely acknowledged that many fires are started by arsons who want to change the land use).

Forest fire fighting by Lebanese Army helicopter (Huey)

The Lebanese Army acquired in the summer of 2009 **three Sikorsky N61 fire-fighting helicopters** as part of a national "Forever Green" fund-raising campaign led by the Minister of Interior, raising $15 Million. These helicopters bolster the country's modest aerial fire-fighting fleet which consists of half a dozen Lebanese Army helicopters known as "Huey" (or Bell UH-1 Iroquois) equipped with carry buckets. The Sikorsky can carry 4,000 litres of water while the Huey carries only about 600 litres. It is unclear how effective these helicopters have been so far in reducing and containing fires (see analysis of response time in Box 5.4). Their effectiveness in containing forest fires should be assessed before making new investments in fire equipment.

- The Lebanon Recovery Fund funded the project **Integrated Forest Fire Management in Lebanon** (2008-2011, $2.6 Million). Implemented by the FAO in coordination with MOE, MOA, AFDC and LARI, the project helped create an enabling environment for the GOL to (1) prevent future forests fires, (2) enhance the effectiveness of fire fighting, (3) assess the ecological and socio-economic damage resulting from the July 2006 war and the October 2007 fires, and (4) rehabilitate damaged forests. In particular, the project supplied the Directorate General of Civil Defence with four new trucks as well as basic tools and equipment for early intervention (the Civil Defense owns a modest fleet of fire-fighting water vehicles and trucks with a maximum water capacity of 7,600 litres); trained nearly 200 volunteers from the Civil Defense, Air Force, and Lebanese Army; and drafted a law on forest fires (under review by concerned ministries and agencies).

Box 5.4 Forest Fire Intervention

A statistical analysis of forest fire records for 2008 (done by MOE based on the reports of ISF) showed a positive correlation between burnt area and fire duration. Accordingly, it was calculated that if fires can be controlled within 54 minutes from their start, then the affected area can be reduced by two thirds. Beyond 54 minutes, fires tend to spread 2.29 times faster.

Source: MOE leaflet

- MOE and AFDC signed a Memorandum of Understanding in 2007 related to forest fires. This MOU facilitated the implementation of many activities and the provision and distribution of fire trucks to the Civil Defense as well as basic fire fighting tools and equipment to the Lebanese Army, MOA, municipalities, and local community groups under the EU-funded project **Towards a National Strategy for Forest Fires in Lebanon**. The Project also setup a temporary operations room in the Directorate General of Civil Defense to coordinate fire-fighting efforts in 2008. Under the Lebanon Recovery Fund project, AFDC developed detailed fire prevention and fire-fighting plans for selected sensitive areas; the NGO also implemented targeted prevention measures in sensitive forest areas such as cleaning, pruning and establishing fire breaks, fire ponds and water outlets. As part of the LRF and EU projects, AFDC organized training programs on (1) forest fires techniques for members of the Civil Defense, Forest Guards and the Lebanese Army; (2) forest fire investigation for members of the Internal Security Forces; and (3) forest laws and forest fire management and prevention for municipal police officers.

5.5.2 Improving Conservation Management in Protected Areas

With grant funding from FFEM/UNDP, MOE implemented the project *Conservation of Wetlands and Coastal Zones in the Mediterranean* (also known as MedWet Coast Project) –a Mediterranean initiative under the Ramsar Convention (2002-2006). The project addressed biodiversity conservation issues in Tyre Coast Nature Reserve and Ammiq wetland in the Bekaa Valley. For example, the project assessed the carrying capacity of Zone E1 of the Tyre Coast Nature Reserve to guide the municipality of Tyre on how to manage the public beach while ensuring the protection of the endangered Mediterranean marine turtles. The assessment led the municipality to reduce the number of kiosks from 100 to 50 (they receive thousands of tourists and beachgoers in summer) and push these kiosks back 60m from the wave level during high tide. These measures are expected to increase the occurrence of marine turtle nesting and hatching.

With grant funding from the EU, MOE implemented the project *Stable Institutional Structure for Protected Areas Management* (SISPAM, 2004-2006) to capitalize on the vast cumulative experience in PA management and make recommendations for enhancing the PA system in Lebanon. Under SISPAM, the Ministry and ECODIT prepared a *National Action Plan for Protected Areas* and developed a new PA category system**.** Inspired by the IUCN classification system for protected areas, the new system would comprise four categories with unique management objectives:

1. National Park
2. Natural Monument
3. Habitat/Species Management Area
4. Protected Landscapes/Seascapes

Based on this proposed category system, MOE has developed a draft decree on **PA category system** which awaits formal endorsement by the Council of Ministers. If endorsed, the current protected areas would need to be reclassified according to one of the four categories listed above. SISPAM produced other outputs as well including a (1) draft law program to finance activities outlined in the National Action Plan for Protected Areas, (2) national strategy for sustainable PA financing, (3) database of alternative sources of funding for PA management including application conditions and procedures, and (4) capacity building strategy for key players in PA management (MOE, APACs and management teams). Equally important, MOE has drafted a Framework Law for Nature Reserves in Lebanon –*see targeted analysis in Section 5.6.3.*

With GEF funding, MOE and IUCN are implementing the project *Supporting Management of Important Marine Habitats and Species in Lebanon* to support the development of a network of Marine Protected Areas (MPAs) and an associated monitoring program to evaluate the management effectiveness (2009-2011). The project will provide management options for the marine environment, including marine protected areas, and supporting assessments to assist in the identification of policy and management reforms. So far, the project has assessed the feasibility of declaring three marine protected areas (Awali estuary, Ras El Chekaa cliff, and the Beirut Airport wave breaker), and started to carry out detailed biodiversity assessment and inventories in those sites and produce related GIS maps.

5.5.3 Protecting and Conserving Marine and Freshwater Resources

CDR launched a National Emergency Reconstruction Program (NERP) in the early 1990s to design and build wastewater networks and treatment plants all over the country (coastal and inland areas). The program was initially funded through a World Bank loan and later received additional funding (though grants and loan agreements) from other bilateral donors. Although NERP implementation is still in progress and has experienced extensive delays (i.e., financing, interruption due to war and other emergencies), noteworthy accomplishments include the completion of five wastewater treatment plants (Tripoli, Chekka, Batroun, Jbail, and Nabi Younes) and several pre-treatment plants.

When complete, the master plan for wastewater treatment in the coastal zone will significantly reduce environmental pollution into the Mediterranean Sea by treating wastewater from an estimated 2.5 million people. The plan however does not explicitly encourage water reuse as most of the treatment facilities are located in urban and peri-urban areas where farmland is either scarce or too far to justify the cost of water conveyance. The impact of war on marine pollution is best exemplified by the war in July 2006 which caused a devastating oil spill affecting much of Lebanon coastline including the Palm Island Nature Reserve in north Lebanon (see response in Box 5.5).

For inland freshwater protection from pollution, the construction of collector lines and treatment plants was undertaken in main cities (Zahleh, Baalbeck, Nabatieh, and others); and also in villages/towns close to water sources and springs (Labweh, Qaraoun Lake, Anjar, Hermel, Mechmech, Bcharre, Bakhoun, Chabaa, Jbaa, Hasbaya, Chakra, Hrajel and Qartaba). In Baalbek, the wastewater treatment facilities are completed but many farmers refused to connect their premises to the network; probably because, as many reports suggest, many farmers tend to mix raw sewage with irrigation water in times of drought or simply to improve soil fertility. Several treatment plants are not receiving the minimum required inflow because farmers divert the wastewater upstream.

Box 5.5 Palm Island Nature Reserve affected by the 2006 July war

The Palm Islands Nature Reserve (PINR) was severely affected by the war in July 2006. The oil spill oiled its beaches and rock ledges impacting migrating birds, marine turtles and other fauna and flora species – *see more details on the oil spill in Chapter 9*. Indirect impacts included the temporary loss of tourism activities and the livelihoods of local fishermen. Paradoxically, the war had a positive effect insofar as revealing a dire need (1) to gather marine data (lack of marine data prevented the ability of experts to assess the extent of environmental damage caused by the oil spill) (2) strengthen management of the site, and (3) develop sustainable tourism to increase revenues and support for conservation efforts. Accordingly, the Swiss Development Agency (SDA) initiated clean-up operations after the war by removing oil adsorbed on rocks. Operations continued with the Spanish Agency for International Cooperation and Development (AECID) who used high-pressure water jets for washing oil residues. AECID subsequently helped design a state-of-the-art biological monitoring programme to help local scientists track the status of marine ecosystems and water quality in the PINR. AECID also prepared guidelines for the management of the PINR and for coordinating and harmonizing the biodiversity management activities. In parallel, the World Conservation Union assessed and monitored marine biodiversity (especially fishes) in the reserve in cooperation with AUB and MOE. It can be argued that the war had an expedient effect on environmental research and development for the PINR.

Sources: MOE/UNDP/ELARD, 2007 & AECID, 2009

5.5.4 Protecting and Conserving Flora and Fauna

So far, the protection of threatened and endemic species is primarily occurring in protected areas. See Box 5.6 on how Lebanon detected and responded to a forest disease in Tannourine. A few other species (threatened, endangered and/or endemic) are also protected by MOA decisions including: the import ban on cedar trees and seeds, the regulation of harvesting of *Oregano* and *Salvia*, the harvest and export ban on *Ferrula hermonensis* and the ban on marine turtle fishing, cetaceans and monk seals, as well as the selling, use or trade of any derivates from the mentioned species (indication that Lebanon is ready for accession to the CITES Convention).

Box 5. 6 Saving the Cedar Forest of Tannourine

Lebanon experienced a dramatic example of forest infestation that almost decimated the cedars of Tannourine, in north Lebanon, had it not been for the concerted efforts and response of local residents, scientists and government agencies. Disease symptoms including die-back and browning were first reported in 1992 and increased rapidly until 1996. In 1998, a French forest ecologist (Guy Demolin) from French INRA (national research center) visited Lebanon to assess the problem with AUB scientists (Messrs. Nasri Kawar and Nabil Nemer). By 1999, and following a workshop organized in Tannourine attended by MOA, MOE, AUB, Lebanese University, and the NCSR, it was decided to suppress the pest with an insect growth regulator (IGR) known as diflubenzuron. With the technical support of a French contractor and the Lebanese Army, the MOA carried out four aerial spraying events using helicopters equipped with ultra low volume sprayers (1999, 2000, 2001 and 2004). The IGR is very effective against insect larvae and also acts as an ovicide, killing insect eggs, without harm to bees. Subsequent monitoring of underground prepupal populations of the insect showed that the IGR had reduced population by 90 percent (from 692 prepupa/m^2 in 1999 to 70 prepupa/m^2 in 2004). In 2002, the insect was identified and named *Cephalcia tannourinensis* and specimens were sent to natural history museums in Europe.

Aerial spraying to combat forest infestation in Tannourine

The case of the Tannourine cedar forest is a remarkable example of interagency and interdisciplinary collaboration which brought together more than a dozen agencies including *ministries* (MOE and MOA), *local stakeholders* (Municipality of Tannourine, Tannourine Cedars Forest Nature Reserve committee, and the Friends of the Tannourine Cedars Forum), *universities* (AUB and the Lebanese University), other *institutions* (NCSR in Lebanon, French INRA and FAO) and *international development agencies* (GEF, UNEP, AFD and FFEM). The project has helped built mutual trust and respect between local and government stakeholders and also required a great deal of innovation and mediation. Building on this success, Lebanon hosted and MOE executed a $1.2 million regional project (Integrated Management of Cedar Forests in Lebanon in Cooperation with other Mediterranean Countries) to promote the exchange of information and lessons learned with other entomologists from Syria, Cyprus, Turkey, Algeria and Morocco (2004-2008). The project was funded by GEF, implemented by UNEP and managed by AUB. The cause of the outbreak in Tannourine was attributed to climate change, which is affecting several ecological parameters including soil moisture content. The absence of snow in 2009 and 2010 appear to be causing an increase in prepupal population. A rigorous monitoring program is on-going.

Source: Based on pers. comm. with Mr. Nabil Nemer, Entomologist, USJ

Outside protected areas, Lebanon is currently participating in a regional project funded by GEF and implemented by UNDP: Mainstreaming Conservation of Migratory Soaring Birds into Key Productive Sectors along the Rift Valley/Red Sea flyway (June 2008 – December 2012). This flyway is the second most important flyway for migratory soaring birds (raptors, storks, pelicans and some ibis) in the world --over 1.5 million birds (37 species including 5 globally threatened species) use this corridor between their breeding grounds in Europe and West Asia and wintering areas in Africa each year. The overall goal of this project is to ensure that globally threatened and significant populations of soaring birds that migrate along this unique flyway are effectively maintained. To achieve this, the project is mainstreaming conservation management objectives and actions into the hunting, energy, agriculture, waste management and tourism sectors along the Rift Valley/Red Sea flyway, including Lebanon making this a safer route for soaring birds.

5.5.5 Wider Responses

A number of other and wider responses also have positive implications for Lebanon's biodiversity and forests. For example:

- The ratification of Environment Law 444/2002, and the completion and endorsement of the National Land Use Master Plan (prepared in 2004 and enacted by the COM in 2009).
- The preparation of the draft law regulating access to and benefit sharing of biological and genetic resources in Lebanon; the draft biosafety decree that was developed based on the National Biosafety Framework.
- The publication of a manual "Integrating Biodiversity into SEA and EIA – A Tool for Decision Makers and Practitioners". The manual was prepared by the Society for the Protection of Nature in Lebanon (SPNL) for the Ministry of Environment and as part of the "Strategic Environmental Assessment and Land Use Planning" project with grant funding from the European LIFE-Third Countries Programme. The manual identifies potential entry points for mainstreaming biodiversity in the EIA and SEA processes (MOE-SPNL, 2006).
- The integration of environmental concepts and biodiversity conservation and sustainability into (1) the gathering, processing and marketing of globally significant Medicinal and Aromatic Plants (MAPs) in Lebanon; (2) the new hunting law; (3) different levels of education and schools curriculum; (4) other legal and policy instruments such as the Agricultural Atlas (2004) and the recently enacted law on oil exploration. Biodiversity considerations have been indirectly linked to Climate Change impacts, combating desertification, Ramsar Sites and World Heritage Sites.
- Agricultural development in certain sectors (such as increases in economic plant products, organic farming, poultry, and aquaculture products) has helped reduce pressures on natural exploitation, and thus protect biodiversity and aquatic communities. The preparation of the Strategy for Agricultural Development in Lebanon by MOA in 2004.

5.6 EMERGING ISSUES AND OUTLOOK

5.6.1 Conserving and Protecting Species

It is necessary to improve and update the knowledge about species biodiversity and threat level. For example, a **National Red List** would help keep decision makers and managers informed about natural resources to act appropriately to conserve and maintain species. All recent species studies are either in the form of checklists limited to protected areas or specific studies conducted in some sites by single researchers. Lebanon has yet to develop its first **Species Action Plan**.

Little legislation exists regarding the conservation of target species outside nature reserves and these legislations target only few wild species. In addition to enforcing existing legislation, there is a need to update the legislation within the framework of a new **Species Policy.** Such a policy would need to consider other target species as well as species interactions (the extent and importance of such interactions was not well understood when the legislation was passed). Furthermore, there is a need to develop sustainability criteria and standards for the use of natural resources, and to pay more attention to invasive species through identification, monitoring, and management.

More efforts are needed for diversity assessment, seed distribution, valorization of ethno-botanical heritage and associated use of important wild plants. Another point that deserves more attention is the study of the ethno-pharmacological properties of local medicinal plants such as *Capparis* species (Chalak *et al*., 2011). Additionally, the characterization and evaluation of plant genetic resources is mostly limited to morphological descriptors and agronomical traits. It has been applied so far to landraces and improved varieties of fruit trees, field crops and some vegetables. Molecular characterization has only been applied to a limited number of crops using European funds. Financial and technical support is needed to expand plant genetic resources characterization and evaluation by using advanced techniques and by strengthening skills and adopting adequate equipments.

Only few breeding activities have been carried out in Lebanon. They are limited to wheat, barley, chickpea and lentil. Regarding fruit species, breeding activities are restricted to some clonal selection activities that have been recently conducted for stone fruits and grapevines. There is an urgent need to establish a national strategy for the breeding and improvement of the Lebanese plant genetic resources for target crops (Chalak *et al.,* 2011).

5.6.2 Formulating a National Forest Policy and Strategy

The National Reforestation Plan and National Strategy for Forest Fires should be integrated into a broader and much needed *National Forest Policy* and/or *National Forest Strategy*. This is particularly needed for sensitive forests (e.g., cedars, junipers) which could be affected by climate change in a topographical corridor determined by bioclimatic zones, and for communal forests near villages and towns. The strategy would need to address the scattered efforts at reforestation and land restoration, and strengthen their technical aspects. It would also provide management tools and incentives to prevent forest fragmentation, ensure habitat conservation and conserve environmental services. In the absence of strategies and action plans that encourage citizens and decision-makers to become better stewards of their landscape, today's piecemeal efforts to conserve the nation's forests and their biodiversity will not achieve sustainable results.

Equally important, the decade long contention between the ministries of Environment and Agriculture over their respective forest and protected area mandates must be resolved. Their overlapping responsibilities must be streamlined. Each ministry alone cannot protect and develop forest resources. Their combined resources and approaches will help ensure a conservation ethic and reforestation program that is compatible with rural development needs.

5.6.3 Challenges and Opportunities for Sustaining Lebanon's Protected Areas

With the exception of nature reserves, most of which have well established management plans, all other protected areas need management and monitoring. The number of protected areas and their coverage can be misleading indicators of conservation (especially for marine areas), as their establishment is not necessarily followed by effective management and enforcement of regulations (Mora *et al.* 2006, Rodrigues *et al.* 2004). Stated differently, measuring the number and extent of protected areas only provides a uni-dimensional indicator of Lebanon's (political) commitment to biodiversity conservation. There is a growing need therefore to also develop indicators on the effectiveness of conservation activities, including PA management. Such indicators will generate data that may be included in the World Database of Protected Areas, and help countries assess progress towards meeting global biodiversity targets.

The GOL needs to show greater commitment on several PA fronts. It should approve the draft Framework Law for Nature Reserves without further delay. This law (1) defines the management objectives of nature reserves, (2) regulates the establishment of nature reserves on private lands, (3) outlines the management structure of nature reserves and formally recognizes APACs, (4) addresses financing mechanisms, (5) allows APACs to charge admission fees and impose fines in case of violations, and (6) uses zoning to encourage sustainable use of natural resources inside the nature reserve. Building on this draft Framework Law, the COM must endorse without delay the draft PA Category System which defines PA categories and scientific criteria and guidelines for PA designation. MOE has also prepared a draft decree on the roles and responsibilities of PA management staff. Finally, the GOL should also formally declare Lebanon's first national park (the Akkar-Hermel-Dinnieh intersection), already identified in the National Land Use Master Plan which was enacted by the Council of Ministers in 2009.

5.6.4 Upscaling Ecotourism and Other Forms of Low Impact Recreation

Nature and culture tourism are important activities and sources of income to villages and towns near protected areas and all along the Lebanon Mountain Trail (Box 5.7). Because this sector is growing and gaining recognition among municipalities and tour operators, it is important to develop environmental and business guidelines for responsible tourism. Local residents, farmers and shepherds should participate in the provision of ecotourism services (guides, rangers, natural foods and cottage products, guesthouse accommodation, festivals, etc.). Fair and responsible tourism provide many opportunities for balancing income generating activities with natural resource management and bidiversity conservation. To the extent possible, profits from ecotourism should be shared equally between tour operators, service providers, and local authorities who are responsible for ensuring the continuity of public commons.


Credit: LMT Association

Hiking on the Lebanon Mountain Trail (Dinnieh)

Box 5.7 Protecting the Lebanon Mountain Trail

With grant funding from USAID (2006-2007), ECODIT established the Lebanon Mountain Trail (LMT) in an effort to protect the natural, cultural and architectural heritage of rural Lebanon. This first long-distance hiking trail spans 440 km from Qbaiyat in north Lebanon to Marjaayoun in the south, meandering through and near 75 towns and villages, grouped into 26 sections. The trail also transects three nature reserves (Horsh Ehden, Tannourine Cedars, and Al Shouf Cedars), one World Heritage Site (Qadisha Valley), one Biosphere Reserve and several Important Bird Areas. The LMT showcases the natural beauty and cultural wealth of Lebanon's mountains offering unlimited opportunities for sustainable economic development in rural areas through environmentally- and socially-responsible tourism. Visitors (an estimated 30,000 in 2010) can walk the LMT in one stretch (about 30 days) or in sections of multiple days, hiring guides and staying in local guesthouses and other forms of rural lodging thereby bringing much-needed income to rural families. Sustaining the LMT requires formal recognition by the GOL and trailside municipalities (50 in total) as well as legal protection from unwanted development and infringements on the public domain, communal forests, and rights-of-way. To date, at least two municipalities have formally featured the LMT into their regional master plans (Aitanit and Tannourine) and a dozen more, currently not on the trail (Andqet, Ehmej, Bkassine, Deir Mimes, etc.), have submitted formal requests to extend the LMT into their towns through side trails. The LMT Association was established to protect and promote the LMT through three overarching goals: school education, trail corridor protection, and economic activities in trailside villages. For more information, visit www.lebanontrail.org.


Credit: LMT Association

Blazes on the Lebanon Mountain Trail

Source: LMT Association

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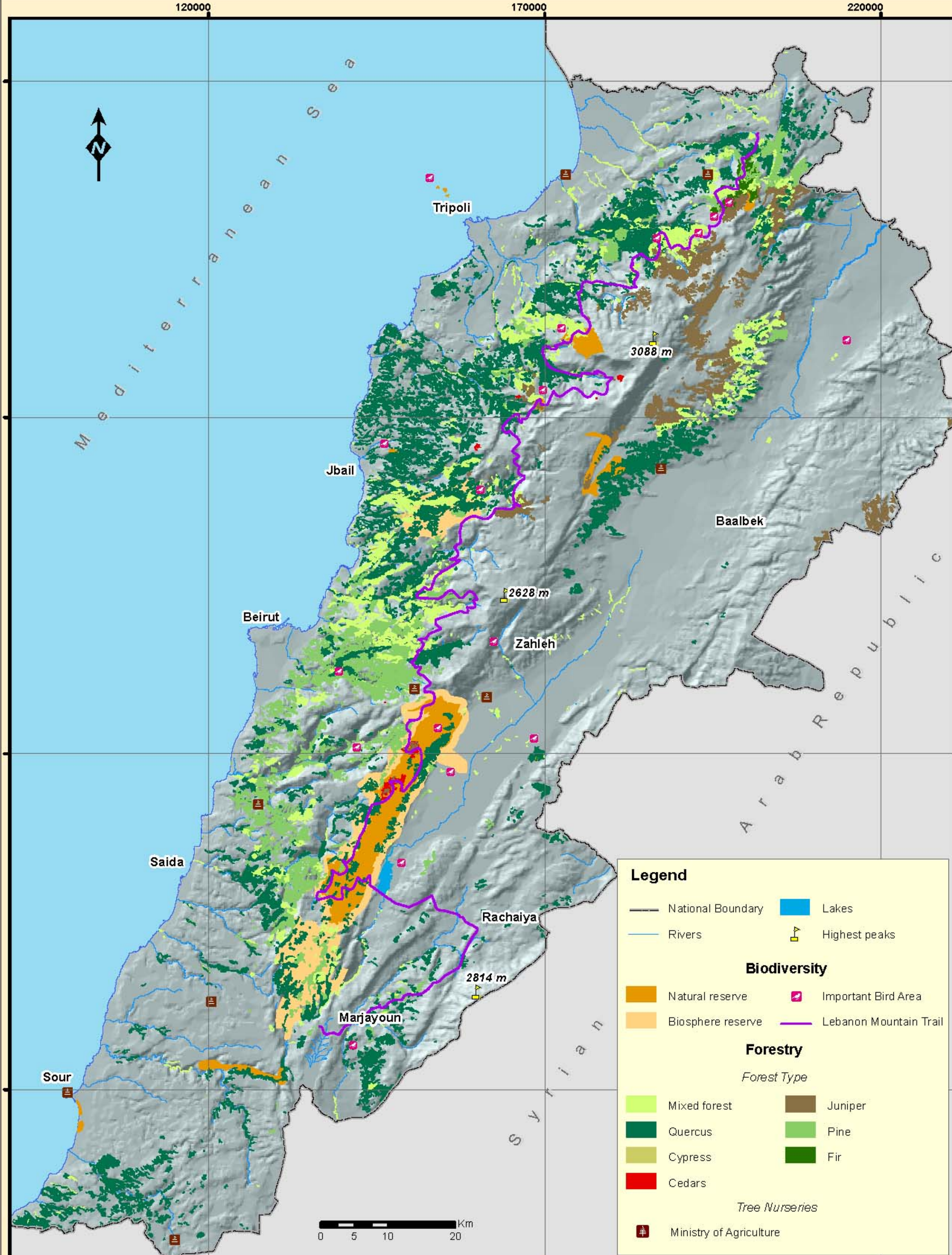
CITED LEGISLATION RELATED TO BIODIVERSITY AND FORESTS

نوع النص	الرقم	التاريخ	عنوان النص
قانون صادر بقرار	٢٧٧٥	١٩٢٩/٠٩/٢٨	مراقبة الصيد البحري الساحلي
قانون		١٩٤٩/٠١/٠٧	قانون الغابات معدل بموجب القانون رقم ٦٧/٣ تاريخ ١/١٦ /١٩٦٧ والمرسوم الاشتراعي رقم١٤١تاريخ ١٩٧٧/١٢/٣١ والمرسوم الاشتراعي رقم٤٣ تاريخ ١٩٨٣/٦/١٧ والقانون رقم ٨٥ تاريخ ٧ /٩ /١٩٩١ والقانون رقم ١٩٥ تاريخ ٥/٢٤ /٢٠٠٠
قانون		١٩٥١/١١/٠٩	حفظ التربة وتحريجها وحمايتها من المرعى
قانون		١٩٥٢/٠٦/١٨	نظام الصيد البرّي
مرسوم	١٣٧	١٩٥٩/٠٦/١٢	الاسلحة والذخائر
قانون	٨٥	١٩٩١/٠٩/٠٧	المحافظة على الثروة الحرجية والأحراج
قرار وزير الزراعة	١/١٢٧	١٩٩١/١٠/٢٣	إنشاء حمى وطني «محمية» من معاصر الشوف حتى ضهر البيدر على سلسلة جبال لبنان الغربية حيث الأراضي هي ملك للدولة وضمن مشاعات بلديات معاصر الشوف والباروك وعين زحلتا وعين داره
قرار وزير الزراعة	١/٧١	١٩٩٢/٠٥/١٣	إنشاء حمى وطني «محمية» في قرية كفرزبد قضاء زحلة - على عقارات ملك الدولة
قانون	١٢١	١٩٩٢/٠٣/٠٩	انشاء محميتين طبيعيتين في بعض الجزر أمام شاطئ طرابلس
قرار وزير الزراعة	١/١٥٢	١٩٩٢/١٠/١٥	إنشاء حمى وطني «محمية» في قرية حبالين على عقارات ملك الدولة
قرار وزير الزراعة	١/٢١	١٩٩٢/٠٢/١٢	إنشاء حمى وطني «محمية» في خربة سلم الشحل والزبداني ووادي الحجير قضاء بنت جبيل حيث الأراضي هي ملك للدولة وضمن مشاعات بلديات القرى المحيطة
قانون	٢١٦	١٩٩٣/٠٤/٠٢	إحداث وزارة البيئة
قانون	٣٦٠	١٩٩٤/٠٨/٠١	الإجازة للحكومة ابرام إتفاقية الامم المتحدة للتنوع البيولوجي الموقعة في ريو دي جانيرو في ١٩٩٢/٠٦/٠٥
مرسوم	٥٢٤٦	١٩٩٤/٠٦/٢٠	تنظيم وزارة الزراعة وتحديد ملاكها وشروط التعيين في بعض وظائف هذا الملاك وسلسلة رتب ورواتب الموظفين الفنيين فيه
قرار وزيري البيئة والزراعة	١/١١٠	١٩٩٥/٠٥/١٨	تنظيم الصيد البرّي
قرار	١/١٠٨	١٩٩٥/٠٩/١٢	-
قرار وزير الزراعة	١/٣٤٠	١٩٩٦/٠٨/٠١	يتعلق بالسماح بتصدير المريمية والزعتر المحوج
قانون	٥٣٢	١٩٩٦/٠٧/٢٤	انشاء محمية طبيعية ارز الشوف
قانون	٥٥٨	١٩٩٦/٠٧/٢٤	حماية الغابات
قرار وزير الزراعة	١/٤٩٩	١٩٩٦/١٠/١٤	اعتبار غابات الارز غابات محمية
قرار وزير الزراعة	١/٥٨٧	١٩٩٦/١٢/٣٠	اعلان غابة محمية في منطقة السويسة - الهرمل
قرار وزير الزراعة	١/٥٨٨	١٩٩٦/١٢/٣٠	اعلان غابة محمية في منطقة القموعة - عكار
قرار وزير الزراعة	١/٥٨٩	١٩٩٦/١٢/٣٠	اعلان غابة محمية في منطقة كرم شباط - عكار
قرار وزير الزراعة	١/٥٩١	١٩٩٦/١٢/٣٠	اعلان غابات محمية في منطقة بزبينا - عكار
قرار وزير الزراعة	١/٥٩٢	١٩٩٦/١٢/٣٠	اعلان غابة محمية في منطقة قنات
قرار وزير الزراعة	١/١٧٤	١٩٩٧/٠٣/٢٥	اعلان غابة محمية في مشاع حبالين
قرار وزير الزراعة	١/٣	١٩٩٧/٠١/٠٨	اعلان غابة محمية في بكاسين جزّين
قرار وزير الزراعة	١/٨	١٩٩٧/١٢/١٧	اعلان غابة محمية في منطقة عين الحقيلات (كرم المهر) وقرنة الكيف مشاع منطقة الشالوط - الضنية

نوع النص	الرقم	التاريخ	عنوان النص
قرار وزير الزراعة	١/٩	١٩٩٧/١٢/١٧	اعلان غابة محمية في منطقة جرد النجاص - جبل الاربعين - الضنية
قرار وزير الزراعة	١/١٠	١٩٩٧/١٢/١٧	اعلان غابة محمية في منطقة قرية السفينة - عكار
مرسوم	١/١١	١٩٩٧/١٢/١٧	اعلان غابة محمية في منطقة مربين - وادي جهنم
قرار وزير البيئة	١/١٢٩	١٩٩٨/٠٩/٠١	تصنيف الموقع المعروف بمجرى وادي الدامور من المواقع الطبيعية
قرار وزير البيئة	١/١٣٠	١٩٩٨/٠٩/٠١	تصنيف الموقع المعروف بمجرى نهر بيروت من المواقع الطبيعية
قرار وزير البيئة	١/١٣١	١٩٩٨/٠٩/٠١	تصنيف الموقع المعروف بمجرى نهر الاولي من المواقع الطبيعية
قرار وزير البيئة	١/١٣٢	١٩٩٨/٠٩/٠١	تصنيف مواقع واقعة في منطقة الشوف من المواقع الطبيعية
قرار وزير البيئة	١/٩٧	١٩٩٨/٠٧/٠٢	تصنيف الموقع المعروف بمجرى نهر الكلب من المواقع الطبيعية
قرار وزير البيئة	١/٢٢	١٩٩٨/٠٢/٢٤	تصنيف الموقع المعروف بوادي مجرى نهر الجوز الواقع في منطقة البترون من المواقع الطبيعية الخاضعة للحماية
قانون	٧٠٨	١٩٩٨/١١/٠٥	يرمي الى انشاء محمية شاطىء صور الطبيعية في جفتلك رأس العين - منطقة صور العقارية
قرار وزير البيئة	١/١٨٧	١٩٩٨/١١/١٧	تصنيف الموقع المعروف بجبل المكمل القرنة السوداء من المواقع الطبيعية
قرار وزير البيئة	١/١٨٨	١٩٩٨/١١/١٩	تصنيف الموقع المعروف بمجرى نهر عرقه من المواقع الطبيعية
قرار وزير البيئة	١/١٨٩	١٩٩٨/١١/١٩	تصنيف الموقع المعروف بمجرى نهر العاصي من المواقع الطبيعية
قانون	٩	١٩٩٩/٠٢/٢٠	انشاء محمية غابة ارز تنورين الطبيعية
قانون	١٠	١٩٩٩/٠٢/٢٠	انشاء محمية طبيعية في اليمونة
قانون	١١	١٩٩٩/٠٢/٢٠	انشاء محمية طبيعية في بنتاعل
قرار وزير والزراعة	١/١٢٥	١٩٩٩/٠٩/٢٣	منع صيد الحيتان وفقمة البحر والسلاحف البحرية
قانون	٣٢٦	٢٠٠١/٠٦/٢٨	الموازنة العامة والموازنات الملحقة للعام ٢٠٠١
قانون	٤٤٤	٢٠٠٢/٠٧/٢٩	حماية البيئة
قرار وزير البيئة	١/١٩	٢٠٠٢/٠٣/١١	اعتبار منطقة القموعة - قضاء عكار من المواقع الطبيعية
قرار وزير البيئة	١/٢١	٢٠٠٢/٠٣/١١	اعتبار منطقة وادي القراقير - قضاء زغرتا من المواقع الطبيعية
قرار وزير البيئة	١/٢٢	٢٠٠٢/٠٣/١١	اعتبار حرج دلهون - قضاء الشوف من المواقع الطبيعية
قانون	٥٨٠	٢٠٠٤/٠٢/٢٥	نظام الصيد البري في لبنان
قانون	٦٩٠	٢٠٠٥/٠٨/٢٦	تحديد مهام وزارة البيئة وتنظيمها
قرار وزير والزراعة	١/٤٠٨	٢٠٠٧/١١/٠٢	يتعلق بتحديد أنواع الصيد البحري
قرار وزير الزراعة	١/٩٣	٢٠٠٨/٠٣/١٤	تنظيم الغوص تحت الماء
قرار وزير والزراعة	١/٣٩٩	٢٠٠٨/٠٩/١٨	انشاء غابة محمية في جبل موسى
قانون	١٢١	٢٠١٠/٠٧/٢٩	إنشاء محمية في وادي الحجير الطبيعية في الجنوب
قانون	١٢٢	٢٠١٠/٠٧/٢٩	إنشاء محمية مشاع شننعيرالطبيعية في قضاء كسروان الفتوح
قانون	٩٢	٢٠١٠/٠٣/١١	المحافظة على المساحات الخضراء المحترقة وعدم تغيير وجهة استعمالها



State & Trends of the Lebanese Environment Chapter 5 - Biodiversity and Forests	Map 3 - Forest Cover, Protected Areas and other Natural Landmarks

DISCLAIMER: This map was prepared by ECODIT based on AFDC, MOA, MOE and National Land Use Master Plan (2004). Every effort has been made to ensure the accuracy of the information displayed on this map. The international boundaries are approximate. MOE/UNDP/ECODIT do not assume any responsibility for any decision that may arise from the use of the map.

6 Land Resources

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ABBREVIATIONS & ACRONYMS

CAS	Central Administration for Statistics
CDR	Council for Development and Reconstruction
CERMOC	Centre d'Etudes et Recherches sur le Moyen-Orient Contemporain
COM	Council of Ministers
DGA	Directorate General of Antiquities (MOC)
DGUP	Directorate General of Urban Planning (MOPWT)
EIA	Environmental Impact Assessment
GDP	Gross Domestic Product
GIS	Geographic Information System
GOL	Government of Lebanon
HCUP	Higher Council of Urban Planning
IDAL	Investment Development Authority of Lebanon
IUCN	International Union for Conservation of Nature
LA	Lebanese Army
LP	Lebanese Parliament
MOA	Ministry of Agriculture
MOC	Ministry of Culture
MOE	Ministry of Environment
MOEW	Ministry of Energy and Water
MOIM	Ministry of Interior and Municipalities
MOPWT	Ministry of Public Works and Transport
MOT	Ministry of Tourism
NCQ	National Council of Quarries
NCSR	National Council for Scientific Research
NGO	Non-Governmental Organization
NLUMP	National Land Use Master Plan
NRP	National Reforestation Plan
OWL	Other Wooded Land
PA	Protected Area
SEA	Strategic Environmental Assessment
SEEL	Supporting the Judiciary System in the Enforcement of Environmental Legislation
SELDAS	Strengthening/State of the Environmental Legislation Development and Application System in Lebanon
SOER	State of the Environment Report
UNRWA	United Nations Relief and Works Agency

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The natural and built environment is strongly affected by land management plans. In Lebanon, the lack of urban planning and/or inadequate urban regulations is facilitating urban sprawl at the expense of natural landscapes and urban living conditions. Construction is consuming agricultural lands, roads and expressways are infringing on scenic mountain landscapes, and real estate speculation is changing the social fabric of some communities and villages. This chapter describes the driving forces affecting land resources in Lebanon (see definition in Box 6.1), the current situation, as well as policy issues and opportunities for improving land resources in the future.

6.1 DRIVING FORCES

Current land management practices in Lebanon are not sustainable as they continue to erode the country's natural resource base (soil, water, green cover, and landscapes). Whereas traditional practices such as terracing, controlled grazing and forest management helped protect the lands, modern practices (many of which emerged during the civil war) have significantly altered the natural and social make-up of our lands including our perception of natural resources. Population growth, the continued loss of arable land and biodiversity, concerns about food security and the rising costs of infrastructure due to population growth and urban sprawl are major factors impacting land resources, our natural environment, as well as social behaviors.

6.1.1 Population Growth

The population density in Lebanon is high (about 400 persons/km^2 including Palestinian refugees). An estimated 80 percent live in urban areas and more than half reside in Beirut and its suburb, also known as the Greater Beirut Area (WB Database, 2010). The highest population density is recorded in the coastal zone and the lower mountain areas (up to 500m). Population density is much lower at higher elevations and in the Bekaa Valley. Mass displacement during the civil war (and/or in search of better socio-economic opportunities) have resulted in a noticeable population decline in dozens of villages and the exponential growth of peri-urban areas around major cities but also between secondary cities and towns. See for example Figure 6.1 for a current view of the urban extension linking Zahle to Chtoura, as well Beirut to Bauchrieh, Sin El Fil, Fanar, Zalka and Antelias. These towns were previously distinctly separate but unplanned urban expansion has merged the cities into large agglomerations.

Urban expansion along the northern entrance of Beirut

Box 6.1 What are land resources?

A delineable area of the earth's terrestrial surface, encompassing all attributes of the biosphere immediately above or below this surface, including those of the near-surface, climate, the soil and terrain forms, the surface hydrology (including shallow lakes, rivers, marshes and swamps), the near-surface sedimentary layers and associated groundwater and geo-hydrological reserve, the plant and animal populations, the human settlement pattern and physical results of past and present human activity (terracing, water storage or drainage structures, roads, buildings, etc.).

Source: FAO, 1997

Figure 6.1 Urban densification and linkage

(a) Urban linkage-Chtoura to Zahle

(b) Urban densification north of Beirut city

Source: Google Earth Imagery (2009)

As explained in the 2001 SOER and other previous reports, Lebanon has not conducted a national census since 1932. All population estimates are based on surveys and extrapolations. According to the Central Administration of Statistics (CAS), Lebanon's resident population in 2008 was 3.7 million, excluding an estimated 416,600 Palestinian refugees (CAS, 2008 and UNRWA, 2008), bringing the total population including refugees to 4.2 million. Using an annual growth rate of 0.7 percent, total population is expected to reach 5.2 million inhabitants by 2030 (WB Database, 2010 & CDR-NLUMP, 2004).

6.1.2 Unplanned Urban Expansion

Population growth is increasing demand for housing; wealth and changing lifestyles are increasing demand for secondary housing including mountain retreats and beach chalets. Cities are consequently growing both vertically and horizontally. For example, developers are erecting buildings in vacant plots (often used as paid parking areas) or in lieu of old buildings which are torn down (sometime illegally) and replaced with new housing units. Meanwhile, cities are also expanding horizontally either in the form of ribbon construction (houses and buildings dotting both sides of a connecting road or highway) or concentrically (peri-urban construction around main cities) or leap-frog development (new residences some distance from an existing urban area). Horizontal growth is happening at the expense of agriculture fields (e.g., Al Bassatine in Tripoli – see Figure 6.2), forested areas (e.g., Metn areas including Beit Merry, Broumana, Baabdat and Bharsaf), and other natural areas of unique environmental significance (e.g., Faytroun in Kessrouan, Fnaideq in Akkar). Unplanned urban growth is hampering traffic and exacerbating road conditions on major road arteries and intersections.

View of the Mudeirej Bridge destroyed in July 2006, Lebanon's tallest and longest bridge

Figure 6.2 Rate of urban expansion in Al Bassatine (Tripoli 2003 and 2009)

(a) 2003

(b) 2009

Source: Google Earth Imagery (2003 and 2009)

Real estate speculation and remittances

The Lebanese real estate market has by-and-large weathered the global financial crisis unscathed in 2007. Many analysts would argue that Lebanon benefited during the crisis from sizeable cash transfers to Lebanese banks and reinvestments mostly in the construction sector, in and around Beirut. Bankers, promoters, investors, and real estate firms have all reported record sales and profits in recent years. The sector also witnessed a boom in the number of new brokers and real estate agencies. More significantly, the extent of growth in the construction sector can be monitored by reviewing the number of awarded construction permits during a specified time period and the equivalent floor area. For example, in Mount Lebanon alone, the total surface area of construction permits almost doubled between

2007 and 2008, from 4.3 million to 8.4 million m^2. Nationwide, the surface area leaped from 7.9 million to 14.2 million m^2 (*Figure 6.3*).

Key factors contributing to this construction boom include:

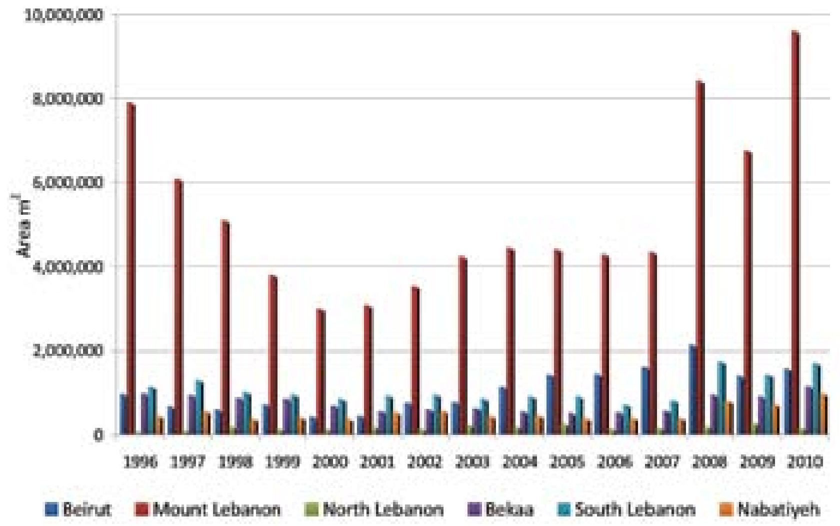
1. The July 2006 war destroyed more than 1,200 buildings, 90 factories, 92 bridges, and about 445,000 m^2 of roads (UNEP/ELARD, 2007). The construction sector rebuilt and replaced damaged buildings and infrastructure, increasing demand for construction aggregates.
2. The Doha Accord of May 2008 brought political stability to the country and renewed investments from neighboring countries.
3. Foreign currency deposits and liquidity encouraged the Central Bank (and commercial banks) to offer attractive housing loans at competitive interest rates.
4. The Government of Lebanon's continued laissez-faire approach to real estate transactions by non-Lebanese (Law 296 dated 3/4/2001). Lured by Lebanon's property tax haven, foreign investors (mostly Arabs) are buying a lot of property, mostly in mountain areas, with little state control and/or oversight.
5. Lebanon's population is young (mean age is 29.4 years compared to 39.7 in France and 44.3 in Germany). A young population increases demand for housing units.

See detailed analysis of construction boom and property demand in Chapter 7.

6.1.3 Rampant Road Construction

In 2004, Lebanon's road network totaled 11,600 km including international, primary and secondary roads (CDR-NLUMP, 2004). The road density[1] in Lebanon is high (111 km per 100 km^2) compared to neighboring Arab countries including Syria (21 km per 100 km^2), and Jordan (8.75 km per 100 km^2)[2]. In fact, the road density is almost at parity with Cyprus (132 km per 100 km^2) which is a member of the European Union and has a much higher GDP per capita. The construction of new roads and highways in mountain areas and over Lebanon's mountain ridges exerts pressure on dwindling land resources and cause irreversible damage to landscapes. Roads impact land resources in many ways by effecting landforms, vegetation cover, ecosystems and habitats. Construction activities cause short-term impacts including noise pollution and emissions from earth moving vehicles affecting surface water, top soil, and air quality. Ugly billboards on side roads and highways present lasting eyesores. Finally, new roads consume virgin land and open new ones for construction.

Figure 6.3 Total floor area of construction permits



Source: OEA, 2011

[1]Road density is the ratio of the length of the country's total road network to the country's land area --equal to km of road per 100km^2 of land area

[2]Road statistics from www.indexmundi.com for year 2007

Beit Misk road construction on Metn expressway

This list of intrusive and ill planned or poorly executed roads is very long. Examples include the 14 km Metn expressway from Nahr El Mot to Baabdat, the Bteghrine-Zaarour-Sannine road, and the 40 km highway linking Sir Al Dinnieh to Hermel. The Metn expressway is a particularly striking example of a high-impact road; not only it scared the landscape and caused significant loss to forests, it also provided access to a new residential complex of 655,000 m^2 (commercially known as *Beit Misk*) that requires additional access roads *-see impact of access roads in Bhersaf in Figure 6.4.*

Figure 6.4 New access roads in mountain areas (here in Bhersaf)

(a) 2003

(b) 2009

Source: Google Earth Imagery (2003 and 2009)

6.2 CURRENT SITUATION

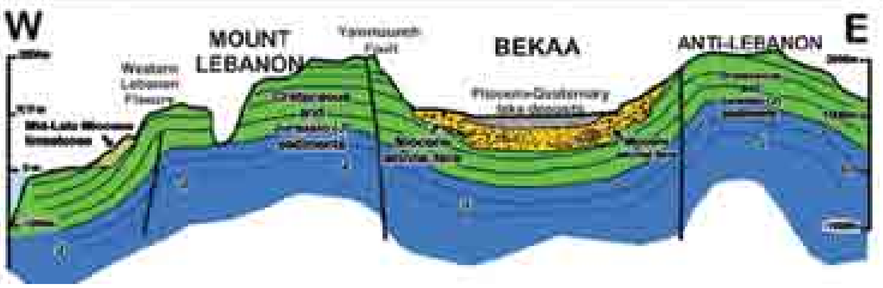
6.2.1 Geo-Morphological Regions

Lebanon's geo-morphology has influenced the history and evolution of towns and villages. The country is predominantly mountainous characterized by a rugged terrain, high-mountain peaks, and two mountain ranges that trend north-south, separated by a fertile valley. *See schematic cross-section in Figure 6.5.*

There are 5 distinct geo-morphological regions:

- The Coastal Zone, including the shoreline and continental shelf, the coastal plain, and the foothills of Mount Lebanon rises to 250 meters; it represents 13 percent of the territory.
- The Mount Lebanon Range (or chain), including middle-and high-elevation zones, rises from Akkar in the north and extends south to the hills of Jabal Amel. The highest peak is Qornet el-Sawda (3,087 meters). It represents 47 percent of the territory.
- The Bekaa Valley, a fertile land corridor separating the Mount Lebanon and Anti-Lebanon ranges, is drained to the north by the Aassi River and to the South by the Litani River. It represents 14 percent of the territory.
- The Anti-Lebanon Range, which extends across the Lebanese-Syrian borders along the eastern part of the country and includes, at its Southern terminus, Jabal el Cheikh (Mt. Hermon, 2,814 meters), which distributes rainfall and snowmelt into at least three main watersheds across Lebanon, Syria and Palestine; it represents 19 percent of the territory.
- South Lebanon, an elevated plateau that extends a short distance inland from the western shores of South Lebanon to the Mount Hermon foothills in the East. Seasonal streams flowing from east to west into the Mediterranean Sea intersect this region; it represents 7 percent of the territory.

Figure 6.5 Schematic East-West Cross Section of Lebanon



Source: adapted from Walley, C.D., The Geology of Lebanon, DDC-AUB

6.2.2 Land Cover and Land Use

Land cover refers to the observed bio-physical cover on the earth's surface, while *land use* is characterized by the arrangements, activities and inputs that people undertake in a certain land cover type to produce change or maintain it. Definition of land use in this way establishes a direct link between land cover and the actions of people in their environment. The first land cover attributes were generated in 1962 when the Lebanese Army and the French Institut Géographique National produced the first topographic maps of Lebanon in French and Arabic (scale of 1:20,000). They provide extensive (and reasonably accurate) information on Lebanon's spatial attributes including forest cover, urban extension, roads, water streams and other natural features including foot trails and rights-of-way. The Lebanese Army's Directorate of Geographic Affairs is currently updating these maps and started selling the revised maps in 2009 (French only).

Separately, the MOE produced in 2002 in cooperation with the National Center for Remote Sensing (NCRS) a revised *Land Use / Land Cover Map of Lebanon*. The team used pan-sharpened 5m resolution satellite images from 1998 (Landsat and IRS-1C Satellites). The map disaggregated land use and land cover into seven main categories and 23 subcategories (further divided into 57 subcategories). According to this very extensive mapping exercise, Lebanon's built-up area in 1998 covered six percent of the territory (about 650km^2) *-see type and percent land cover in Figure 6.6 and spatial distribution in **Map 4**.*

Box 6.2 Difference between forest and OWL

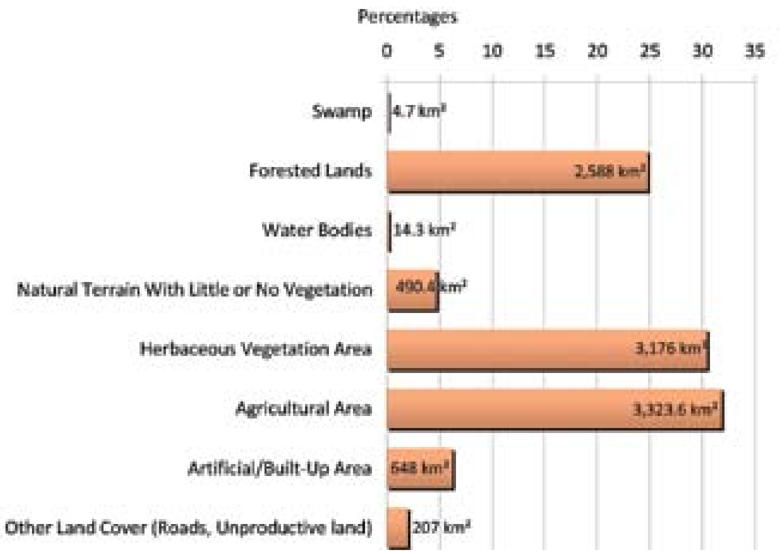
In an effort to minimize confusion in forest data, the FAO has defined forests and other wooded lands as follows:

Forest: A land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use.

Other Wooded Land (OWL): Land not classified as *Forest*, spanning more than 0.5 hectares; with trees higher than 5 meters and a canopy closure of 5–10 percent, or trees able to reach these thresholds in situ; or with a combined cover of shrubs, bushes and trees above 10 percent. It does not include land that is predominantly under agricultural or urban land use.

Source: FAO, 2010

Figure 6.6 Type and percentage of Land Cover



Source: MOE/NCSR, 2002

The National Center for Remote Sensing (part of NCSR) is currently updating the Land Use / Land Cover Map of Lebanon and intends to complete its work in 2011. This report therefore derives its conclusions based on the map produced in 2002.

Forest Resources

Despite inconsistencies in forest terminology (see Box 6.2) and forest data, there is a general consensus that forests cover about 137,000ha (13% of the territory) and Other Wooded Land (OWL) covers 106,000ha (about 10%). Combined, forests and OWL cover 23 percent of the country (FAO, 2010). Table 6.1 shows the extent of forests and OWL for years 2000, 2005 and 2010. Assuming the data is accurate, there has been remarkably little change in forest and OWL cover in the last decade despite intensive reforestation efforts, widespread and recurring forest fires (see forest fire statistics in Chapter5) and extensive logging and reconstruction all over the country. Forest fires occur mainly between July and October, during heat spells, and are partly due to changing land uses. ***Map3*** in Chapter 5 shows the distribution of forest cover in Lebanon, as well as tree nurseries and nature reserves. Chapter 5 also provides a detailed description of forests types.

Table 6.1 Evolution of Forest and Other Wooded Land

Category	*Total Area (1,000 ha)*			
	FAO		AFDC	FAO
	2000	2005	2007	2010
Forest	131	136	139	137
Other Wooded Land	117	106	108	106

Source: FAO (2010) & AFDC, State of Lebanon's Forests (2007)

6.2.3 Urban Planning and Zoning Extent

The Lebanese urban planning system does not adequately address sustainability, livability, environmental, spatial and equity issues. Urban plans in Lebanon focus exclusively on the physical planning of the region under study and do not approach urban planning from a strategic perspective. Services that affect the quality of the urban environment such as accessibility, public transport, renewable energy, sustainable water supply, as well as green and recreational areas are not adequately addressed by urban planners. Currently, urban planning is largely a desktop study that is based on readily available demographic, geographic and socio-economic data. These data are analyzed to produce a zoning system. Data validation and public participation are usually lacking in the urban planning process. The current system is not immune to political interference and is often geared towards maximizing land use coefficients. Naturally, there are positive exceptions. For example, the land use plan of Saghbine (West Bekaa) designated a plot in the vicinity of the Qaroun Lake to establish a Wind Farm (HCUP Decision No. 19 dated 21/5/2010). This initiative can and should be replicated in other urban plans based on the findings of the recently published Lebanon Wind Atlas (see more on Wind Atlas in Chapter 9 Energy Crisis). Another alternative to conventional land use planning is the application of the Strategic Environmental Assessment (SEA) process --*see example in Box 6.3.*

Box 6.3 Strategic Environmental Assessment & Land Use Planning – Tannourine Pilot Project (2006)

The SEA evaluates the environmental and socio-economic impacts of policies, plans and programs. It usually covers large geographical areas and is conducted at a regional level. A pilot land use planning project under the guidance of the MOE/UNDP was funded by the EU for the region of Tannourine. The planning activity engulfed the nearby site of Baatara Sinkhole in Chatine (protected by MOE Decision 8/2004). The pilot project applied the SEA process to a regional development plan that is based on sound land use planning. The pilot produced encouraging results and was a learning experience for all including the municipality of Tannourine, the regional department of urban planning, and the Ministry of Environment. The project should be replicated in other parts of the country as part of a national effort to go from *physical* master planning to *strategic* planning.

Source: DAR/ELARD/Yazigi Atelier, 2006

In 2000, urban master plans covered 10.3 percent of the Lebanese territory (CERMOC 2000 in SOER 2001). Subsequent analysis showed however that this extent only covered urban master plans that had been both approved by the Higher Council of Urban Planning (HCUP) and decreed by the Council of Ministers (COM), and issued during the period 1960-2000. A study conducted in 2004 identified additional urban master plans that were approved by the HCUP but not yet decreed by the COM (Verdeil et al., 2007). They cover 614.3 km^2 (see ***Map 5***). Therefore, the total zoning extent in Lebanon until 2004 covered about 16.2 percent of the territory (or 1,693 km^2). The number and extent of urban master plans approved and decreed *after* 2004 has not been compiled.

While zoning regulations aim to regulate and organize construction, some regulations can have an opposite impact by accelerating urbanization, resulting in chaotic urban agglomerations. For instance, during the late 1960s and early 1970s, the Directorate General of Urban Planning (DGUP) amended urban planning regulations in several winter and summer destination sites including Broumana, Beit Merry, Bikfaya, Rayfoun and Aajaltoun. *See analysis of the impact of urban master plans, or the lack thereof, on urbanization in Chapter 7.*

6.2.4 Coastal Zone

The coastal zone stretches over 240 km in length from north to south, with an average width of less than 500m. Lands located along this zone are in extremely high demand due to their tourism potential and proximity to the sea and a booming real estate sector. This pressure has led to the implementation of large-scale reclamation projects (public and private), the construction of dozens of marinas (for leisure boats and fisheries), and rampant urbanization stretching along vast coastal areas. Violations of the public maritime domain are significant.

Abuses of the public maritime domain

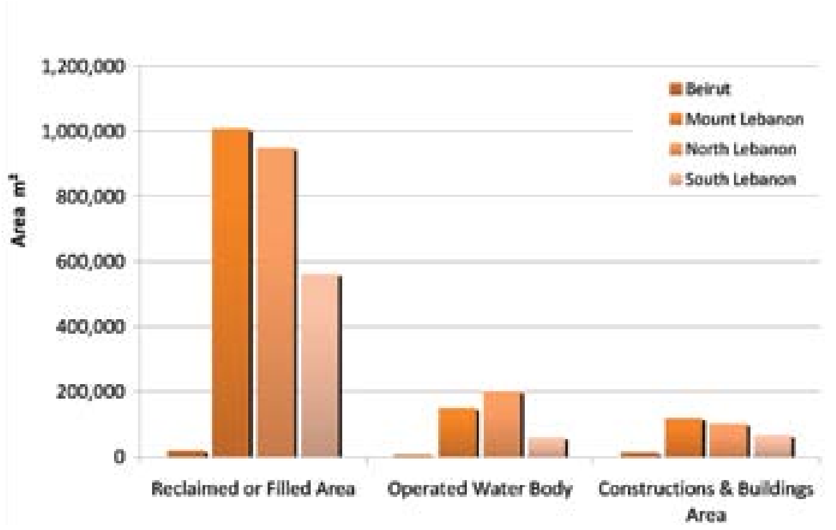
During the civil war period (1975-1990), there were many abuses to and infringements on the public maritime domain. Hundreds of residential and commercial establishments mushroomed on the seafront without legal permits. According to Ministry of Public Works and Transport (MOPWT) records, the total area of *licensed* developments in the public marine domain before 1975 (onset of Lebanese civil war) was about 876,000 m^2. These developments are operated by 94 private establishments and/or individuals. During the period 1990-2001 (after the end of the civil war), successive governments gave licenses covering an additional 732,620m^2 of the public domain (436,601 m^2 on land and 296,019 m^2 at sea). These licenses include port expansion works, recreational pools and gardens, sports stadium, and road works.

Meanwhile, during the period 1975-2001, an estimated 1,269 unlicensed developments mushroomed along the coastline covering about 3.2 Million m^2 of the public maritime domain (see geographic distribution in Figure 6.7). Responsibility for these violations is shared among municipalities (about 22%), fishing ports (about 11.5%), and government agencies (66.5%).

Although government violations of the public maritime domain are not taxed (even if they were licensed), the GOL has yet to come up with a plan for settling (or removing) seafront violations and infringements, pursuant to Decree 2522/92 (which defines levies for using the public maritime domain) and Decree 7919/1996 (which transfers a draft law on the settlement of the violations to parliament for review and approval). A sizeable number of the abuses on the public maritime domain are large-scale development projects, as explained next.

Multiple land uses on the coastal zone (here Beirut manara)

Figure 6.7 Type and Distribution of Illegal Marine Properties



Source: Based on Information International, 2003 (statistics from MOPWT)

Large-scale developments in the coastal zone

The coastal zone is targeted by promoters and real estate developers. The GOL, usually represented by the MOWPT, receives frequent permit applications to lease the public maritime domain for large-scale developments including marinas, tourism resorts, and other commercial facilities. These applications are normally examined by the HCUP, as well as by the MOE as part of the mandatory Environmental Impact Assessment process and MOE's mandate (Article 2.20 of Law 690/2005 on setting the environmental conditions to protect beaches, streams, rivers, springs, lakes, wetlands and valleys to safeguard the environment and natural resources). It should be noted that the EIA process is since 2002 fully integrated in the permitting procedure; project proponents must complete and submit the EIA study as part of their application file to the MOPWT. Unfortunately, several project proponents are still able to bypass the MOPWT and MOE, and secure a permit directly from the COM. While many coastal projects are approved for construction, some projects are either downsized or cancelled due to public pressure. The following examples show how the EIA and SEA process can control large-scale development projects, and how the municipality can challenge the decision of the COM.

1) ***Kfar Abida Coast*:** In 2007, a real estate developer presented a large-scale seafront development project to the MOPWT for permit approval. The COM enacted Decree 955 (dated 23/11/2007) authorizing the construction of the resort that would consume 37,000m^2 of sea space, in Kfar Abida (Jbail). Construction would include

land reclamation works, two marinas with L-shaped breakwaters, and the conversion of the rocky coastline into a sandy beach. MOE requested the developer to submit a full EIA study. The study concluded that the project would generate adverse impacts on the environment and MOE therefore requested significant changes to the project design. In particular, the EIA recommended that the developer cancels one of the marinas and the sandy beach, reduces the length of the first breakwater pier and replace some of the housing with floating bungalows. Successive rounds of design modifications to mitigate project impacts on marine ecosystems reduced the reclaimed sea area to 4,000m^2. The developer eventually scrapped the project and the Kfar Abida beach was saved from yet another infringement on the public maritime domain.

2) ***Jounieh Bay****:* In 2005, a developer approached the DGUP with a project to reclaim the entire seafront in Jounieh Bay (about 4 km long). The developer was deferred to the HCUP who requested the assistance of MOE to review the draft SEA of the proposed project. MOE's review of the SEA study revealed that the project would cause significant environmental damage to marine ecosystems and inland natural resources. The reclamation project was eventually scrapped but discussions could resume again in the future.

3) ***Jbail sandy beach:*** In 1999, the COM passed Decree 1920 (dated 16/12/1999) authorizing a large-scale seafront development in Jbail that would consume 32,000m^2. The area in question is located in Kartaboun (near Eddé Sands today) and falls within the jurisdiction of the Municipality of Jbail. To protect the public beach from encroachment and to maintain the aesthetic value around the archeological vestiges of Jbail, the Municipality of Jbail appealed Decree 1920/1999. The Council of the State examined and approved the appeal against the developer and Decree 1920/1999 was cancelled by Decree 16798/2006. Although the resort was scrapped, the beaches in question were later targeted by beach developers (Eddé Sands, Voile Bleu, etc.) who rent the beach from the Municipality, have set up high-end beach facilities, and charge pricey admission charges. Although the continuity of the natural beach was maintained, *public* access to the beach has significantly declined.

6.2.5 Lebanon's Geology

Lebanon's geology is predominantly Jurassic, Cretaceous and Tertiary karstic limestone with some Cretaceous and Quaternary sandstone and conglomerate. More than two-thirds of the territory consists of carbonated rock formations

Illegal infringements and makeshift structures dot the Lebanese coastal zone and reduce public access to it (here in Chekka)

Proximity of building construction to old quarry site in Nahr El Mot (Metn)

Table 6.2 Lebanon's earthquake history between 2001 and 2010

Date	Local Magnitude*	Epicenter	Date	Local Magnitude*	Epicenter
29-Apr-01	4.1	Qaa El Rim (Zahle)	19-May-08	4	Jaouhariye (Sour-Nabatieh)
7-Jun-03	3.5	Majdel El Koura (Koura)	21-May-08	3.6	Jaouhariye (Sour-Nabatieh)
17-Dec-05	3.5	Chabtin (Jbeil)	23-May-08	4.2	Jaouhariye (Sour-Nabatieh)
24-Mar-06	3.5	in the Sea fronting Batroun	23-May-08	3.7	Jaouhariye (Sour-Nabatieh)
28-Mar-06	3.6	in the sea fronting Amchit	12-Jun-08	4	Zaoutar (Sour-Nabatieh)
9-Apr-06	3.5	in the sea fronting Amchit	12-Jun-08	4.1	Zaoutar (Sour-Nabatieh)
11-Apr-06	3.7	in the sea fronting Amchit	12-Jun-08	4	Zaoutar (Sour-Nabatieh)
6-May-06	3.5	Bechmezzin (Koura)	12-Jun-08	4.1	Jaouhariye (Sour-Nabatieh)
19-May-06	3.5	in the Sea fronting Batroun	12-Jun-08	4.1	Zaoutar (Sour-Nabatieh)
11-Feb-08	4.2	Qaaqaait El Jesr (Sour-Nabatieh)	13-Jun-08	4	Zaoutar (Sour-Nabatieh)
14-Feb-08	3.7	Qaaqaait El Jesr (Sour-Nabatieh)	13-Jun-08	3.5	Zaoutar (Sour-Nabatieh)
14-Feb-08	3.6	Kfar Sir (Sour-Nabatieh)	22-Jul-08	3.7	Jaouhariye (Sour-Nabatieh)
15-Feb-08	5	Kfar Sir (Sour-Nabatieh)	4-Nov-08	3.8	Qaaqaait El Jesr (Sour-Nabatieh)
15-Feb-08	4	Marnaba (Sour-Nabatieh)	17-Apr-09	4.3	Maifadoun (Sour-Nabatieh)
15-Feb-08	3.7	Marnaba (Sour-Nabatieh)	17-Apr-09	3.5	Ghandourieh (Sour-Nabatieh)
20-Feb-08	3.5	Marnaba (Sour-Nabatieh)	6-May-09	4.1	Yahchouch (Jbeil)
28-Feb-08	3.5	Qaaqaait El Jesr (Sour-Nabatieh)	10-Jul-09	4	Tayr Semhat (Sour-Nabatieh)
1-Mar-08	3.5	Qaaqaait El Jesr (Sour-Nabatieh)	12-Jul-09	3.5	Qaaqaait El Jesr (Sour-Nabatieh)
30-Mar-08	3.5	Tayr Semhat (Sour-Nabatieh)	28-May-10	3.6	Louaiziye (Sour-Nabatieh)
11-May-08	3.7	Qaaqaait El Jesr (Sour-Nabatieh)			

*Only earthquakes equal to or higher than 3.5 Magnitude on Richter's scale are listed

Source: NCSR-National Centre for Geophysical Research, November 2010

which make up most of the mountain ranges, rendering them vulnerable to groundwater pollution and natural risks such as landslides and earthquakes. The country is located in an active tectonic area characterized by three major faults (Yammouneh, Roum and Serghaya) and bisected by minor faults (see Figure 6.5 above).

Such faults are a source of concern in relation to built-up areas *–see **Map 6** for spatial distribution of major fault and urban agglomerations*. Table 6.2 below presents Lebanon's earthquake history covering a full decade (2001-2010). During this period, Lebanon experienced 39 earthquakes with a magnitude equal to or above 3.5 (often felt) on Richter's Scale, of which 29 occurred in the region of Sour-Nabatieh and five were recorded in the sea. The most active year was 2008 with 24 recorded earthquakes in Sour and Nabatieh including one earthquake of magnitude 5.

Although the Lebanese building code (Law No. 646/2004 followed respectively by Application Decree No. 15874/2005 and amended by Application Decree No. 617/2007) includes seismic design standards, enforcement is sporadic especially outside major cities and during periods of security concerns. Inspection of building foundations and building floors during the 1975-1990 civil war, and immediately after subsequent wars with Israel, was probably very limited to absent. In case of seismic event, there are no publically known evacuation and emergency response measures. Many high-risk areas have yet to be decreed as no-construction zones.

6.2.6 Soils of Lebanon

In 2006, the NCSR published *The Soil Map of Lebanon* - a booklet divided into 27 sheets containing detailed information on soils of Lebanon, their location and morphology (scale 1:50000). The most widely represented soils are the calcareous Terra-Rossa and Rendzinas. These soils are located in agricultural plains of Bekaa, Aakkar, Koura, Sour, Saida, Rachaya and Hasbaya. Other soil types include sandstone, basalts and similar older volcanic materials. Generally, soils in Lebanon are young and characterized by fragility, poor consistency and shallowness (especially on sloping terrains). Soil fertility is affected by natural and anthropogenic factors that may result in soil degradation as well as soil erosion --*see Table 6.3 for an overview of pressures affecting soil quality.*

Table 6.3 Leading causes of soil degradation in Lebanon and their impact

Source	Cause	Potential Impact
Natural	Climate change	• Water-borne erosion from torrential precipitation • Drought and soil crusting (mainly silty soils)
	Topography	• Accelerated soil erosion and landslides
Anthropogenic	Urban expansion	• Excavation and removal of top soil, replaced by concrete • Desertification of vulnerable lands • Deforestation due to fires, overgrazing and quarrying
	Soil pollution	Chemical degradation of the soil, modification of the biochemical balance of soils, reduced purification and filtering capacity of soils
	Overuse of fertilizers	
	Agricultural malpractices	

Source: Prepared by ECODIT for 2010 the SOER

Soil Salinization

Several studies have observed the occurrence of secondary soil salinization, particularly in the semiarid areas of the northern Bekaa valley and the Anti-Lebanon mountain range as well as in coastal greenhouses (Darwish T., 2001). Salinization is caused by an overuse of fertilizers and poor irrigation management practices. For example, the lack of crop rotation schemes (replaced by monoculture systems) has contributed to soil salinity build-up in El Qaa (Bekaa). Other studies in the Bekaa also show significant nutrient build-up and salinity under greenhouse conditions. In the coastal zone, salt water intrusion in coastal aquifers may lead to extensive soil salinization – *see Chapter 3 Water Resources* for more information on salt water intrusion in coastal wells and aquifers. Good water and nutrient management will significantly improve plant nitrogen uptake, and therefore help prevent nutrient build-up and salinity hazards (Darwish T., 2001).

Extensive excavation for construction leading to loss of top soil and erosion

Soil Erosion

Erosion rates in Lebanese mountain areas can reach 50–70 tons/ha/year (FAO 1986). In 2006, Bou Kheir developed a model for mapping soil erosion risk covering a 955 km^2 study area (9% of the territory). This area was representative of the environmental diversity of the country in relation to geology, soil, hydrography, land cover and climate. It extends from west to east covering three major landform zones (coast, the Mount Lebanon range, and the Bekaa Valley). Using Geographic Information System (GIS), the mapping system was produced on a scale of 1:100000. The author classified soils based on their potential for water retention, infiltration and erodibility. Water-borne soil erosion can cause significant land degradation. The most vulnerable soils are shallow soils with low organic matter content. The study indicated that 49 percent of the study area has *high to very high* runoff potential and 24 percent has *very low to low* runoff potential. The erodibility potential was estimated to be (1) low for "terra rossa" on Upper Jurassic and Cenomanian bedrocks of the Lebanon Mountains, (2) medium in the Bekaa Valley, and (3) high on sandy soils. The study also produced several erosion risk maps (Bou Kheir *et al*., 2006).

Soil (and groundwater) Contamination

Soils and groundwater are contaminated by the excessive use of crop pesticides and fertilizers, crop irrigation using polluted water, and dumping of non-treated waste onto soils (Darwish *et al.,* 2008). Farmers tend to spray too much and too close to the harvest date, with little knowledge of and compliance with minimum withdrawal periods. Such practices cause considerable levels of contamination in the food chain. In 2008, Darwish analyzed the soil-groundwater vulnerability to contamination by heavy metals in the central Bekaa plain. The study is based on the risks of heavy metal transfer (from top soil to groundwater) and the degree of protection offered by the soil cover and soil-metal interaction. Farmers often resort to irrigation with contaminated water to offset water shortages during dry summer spells and periods of peak crop water demand. Such practices increase pollution hazards on soil and groundwater quality. The research confirmed that the major sources of heavy metal contamination derive from agro-chemicals and industries. It also explained nitrogen behavior in agricultural soils. In particular, Nitrates follow the wetting front and therefore, as anions, they are not retained by the negatively charged soil mineral complex. Nitrates therefore move easily downward with percolating water to contaminate shallow aquifers, and appear to leach faster with sprinkler irrigation as compared to drip irrigation (higher flow rates). Finally, the research also showed a direct correlation between soil type and soil depth with the rate of heavy metal transfer into groundwater, as determined by heavy metal content in irrigation water from wells in the central Bekaa (Darwish *et al.*, 2008).

Surface karst in Jaij (Jbail)

6.2.7 Karst Features

Much of our knowledge about Lebanon's karst features comes from specialized caving clubs in Lebanon including: Association Libanaise d'Etudes Spéléologiques (ALES) and Spéléo Club du Liban (SCL). Karst is a terrain with distinctive landforms and hydrology created from the dissolution of soluble rocks, principally limestone (USGS, 2010). Karst features are characterized by springs, caves, sinkholes, and a unique hydrogeology system that results in aquifers which are highly productive but extremely vulnerable to water contamination. There are three major categories of karst in Lebanon, each of which has a different landform and unique elements: (1) *surface karst* including

Surface Karst in Jabal Moussa (Kesrouan)

Box 6.4 Kfardebian Natural Bridge

Kfardebian natural bridge is a majestic and unique karstic feature located in Kesrouan. The bridge was designated a Natural Site by Decree 434/1942, with a 300m protection radius. The integrity and heritage value of the natural bridge are affected by activities that may occur within and beyond the protection zone. In particular, a private land owner has been trying since 1994 to build a residential house on his land located 200m from the bridge (Lot No. 5445, 5446 and 5447). MOE responded by issuing Decision 15/1 (dated 5/10/1995) which (1) bans all forms of construction works on and near the bridge, (2) calls for prosecuting any party that damages the bridge or its protected radius, and (3) requests DGUP not to issue any construction permit that would impact the bridge.

In 1996, the owner asked the Council of the State to designate a team of experts to evaluate the environmental impacts of the project. The resulting study claimed that the project would not impact the bridge and so the owner appealed MOE's decision. The Council of the State accepted the appeal by Decision No. 469 (dated 24/3/2004), overriding MOE's Decision 15/1, but also requested additional studies. MOE accepted the decision of the Council but did not approve the project's EIA study presented by the owner. Grounds for rejection were based on geological and hydro-geological conditions. The owner appealed MOE's rejection of the EIA study in 2008 but, this time, the Council of the State rejected the appeal. During this period, conservationists and civil society groups organized multiple sit-ins at the site to express their grave disapproval of any works on or near the natural bridge. So far, the Kfardebian Natural Bridge has been saved!

cockpit karst, sinkholes entries, natural bridges, pinnacle and broad tower karst, karren and lapiaz, scallops, ripples pans, flutes and rills, and dolines; (2) *subsurface karst* are caves that developed horizontally and vertically; and (3) *underwater karst* which are submerged caves under the sea.

Extent of Lebanon's Karst Heritage

Karst in Lebanon is widespread and evolved over millennia and during different geological periods. More than 65 percent of Lebanon's surface area is covered with karstic rocks (Edgell, 1997). Some have spectacular scenery and some are less significant in terms of beauty and biodiversity, however all are important in terms of groundwater resource --*see shortlist of important Karst sites in Lebanon in* ***Annex 1***. Karst is very vulnerable to pollution, contamination and damage. It is easily destroyed by physical activities such as construction (see example of construction pressure on Karst in Box 6.4) and quarrying activities and can be readily polluted by chemical and biological contaminants.

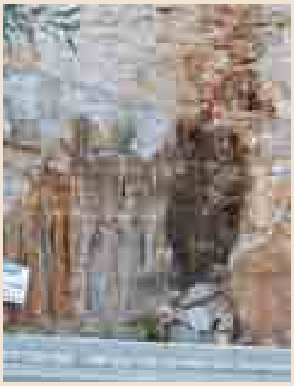
The widest exposed karst is the Sannine-Maameltein Formation of the Cenomanien epoch from the Cretaceous period. It covers approximately 43 percent of the Lebanese territory, extending from the coast to the highest peak in the north and present along the coast in the south and covering most of the western mountain range (see ***Map 7***). They are less spectacular than their Jurassic counterpart in surface features but as impressive in underground karst elements. These two formations form the backbone of the groundwater resource in Lebanon. They are recognized for their water basin, caves and springs, such as Ain el Zarka, Jeita spring, and Aanjar spring.

On the contrary, the Kesrouan Formation, of the Jurassic Period, is the most impressive in terms of surface and underground karst. It is widely seen in central Mount Lebanon between the rivers of Nahr Beirut and Nahr el Jaouz. Less spectacular, but still important in terms of hydrogeology, are the ones in Jabal el Cheikh, Niha and Barouk ranges (see ***Map 7***). They cover around 12 percent of the surface area of Lebanon. Other karstified formations are the Eocene and the Miocene aged rocks which cover eight percent and 1.25 percent, respectively. The Eocene is present mainly in the south and southern Bekaa and the Miocene in Beirut and Tripoli areas. The Bekaa Valley is covered with extensive non-karstic Quaternary aged deposits beneath which lie karstic formations belonging to the Eocene, Miocene and Cretaceous periods. Moreover, karst areas beneath the sea are less exposed but also important; examples include Chekka, Batroun, and Jounieh in Mount Lebanon and Naqoura in the south.

Sources of Pressure on Lebanon's Karst Heritage

Many anthropogenic activities threaten Lebanon's unique karst heritage. The most common sources of pressure include quarrying (mainly blasting), construction, substandard sewage infrastructure, waste dumping, the reckless disposal of construction waste in ravines and along riverbeds, and unplanned road construction. Vandalism is not uncommon and can cause significant and irreversible damage to karst formations (including stalactites and stalagmites). Table 6.4 shows a few recorded examples of damaged karts due to anthropogenic activities.

Table 6.4 Sources of pressure on karst formations (Examples from Lebanon)

Sources of Pressure on Karst Formation	*Photos*
The karst in Faytroun, Mayrouba, Aachkout and Hrajel (Kesrouan) is threatened by road and building construction. Note only have surface features been degraded but the region is part of the Jeita catchment area (the main water supply to Beirut). Contamination of the Jeita water source is caused by haphazard construction and uncontrolled disposal of solid and liquid waste on karst. *Photo: Buildings implanted on surface karst in Faytroun*	
The quarries (sand and aggregates) were recently reopened. One of those quarries is situated less than 500m from Lebanon's most important sinkhole (Fouar Dara) and 1 km from Lebanon second deepest sinkhole (Qattine Azar), which constitutes a major water source for most of the Metn area and also Beirut. The quarries are destroying the precious limestone rocks, releasing suspended particles into underground water, and increasing water turbidity at resurgence points near the coast. *Photo: View of Tarchich quarry*	
The Metn Expressway, connecting Nahr el Mot to Baabdat, was built mostly on Jurassic karstic limestone rocks. Although surface karst in the area is not spectacular, the highway has destroyed at least three major sinkholes, including Mar Chaaya sinkhole and Jouret el Ballout sinkhole (each about 30m deep). The middle and upper part of the highway is in the catchment area of Fouar Antelias karstic spring. The construction has reduced the amount of water infiltrating into the Jurassic aquifer feeding this spring mainly because the highway is built along the Nahr el Mot fault. The construction and poor management of unwanted debris have increased the amount of suspended particles in the aquifer (recently observed from the high turbidity in the Fouar Antelias spring recently). *Photo: Remnants of collapsed sinkhole on Metn Expressway*	
Vandalism is a behavior (graffiti) or ruthless destruction or spoiling of anything beautiful or venerable. Many caves show signs of vandalism including graffiti and bullet holes. The general public usually is unaware and unappreciative of the time scale needed needs to grow speleothems. Many homes and home-gardens in Lebanon display pieces of stalagmites and stalactites because they are perceived as ornaments. *Photo: Graffiti in Zahlan cave (Sir El Dinnieh)*	

6.2.8 Quarrying

Lebanon's quarry sector is very poorly organized --*see Box 6.5 on quarry malpractices*. Although it is difficult to survey with precision all quarries, a recent study counted 1,278 quarries covering 5,267 ha scattered all over the country (Darwish *et al*., 2010). Separately, and in response to mounting public opposition and critique of the government's handling of the sector, the Ministry of Interior and Municipalities (MOIM) launched a nationwide survey to assess the number of quarries and their status (data still unpublished and not in electronic format). These quarries scar the Lebanese landscape, and the vast majority remain unlicensed (see distribution of major quarries in ***Map 7***). Only one quarry was designed using terracing technique (Qaraoun state quarry) and only one was rehabilitated after closure (Sibline). This dismal performance record for the quarry sector is seemingly unaffected by a battery of measures and incentives to rehabilitate quarries including: MOE decision to rehabilitate quarries (Decision 48/1 dated 17/06/2009), the $4 million earmark in the MOE budget for rehabilitating public quarries (year 2011), and MOE's public right to deposit and use the money from bank guarantees.

Box 6.5 Quarry violations and malpractices

In 2010, MOE and UNDP contracted HAS to review and inspect 150 quarry applications and operations. The aim of this study was to analyze the malpractices and irregularities of quarries during pre-permitting and post-permitting using GPS readings, maps overlay and Quick Bird satellite imagery. The study showed four types of violations: (1) excavation extends outside the designated license area; (2) operators don't respect the stages of the quarry license (e.g., they consume afive years –the duration of the license), (3) cliffs and quarry faces exceed allowable heights, and (4) no site rehabilitation after closure.

Source: Pers. comm. Nakhle Hachem, HAS

Rock quarries in Antelias (Metn)

Box 6.6 Lebanon's demand for construction aggregates

During the period 1994-2000 (at the peak of post-war reconstruction), the demand for construction aggregates ranged between 10 Mm^3 and 15 Mm^3 per year. About one third of this volume was used for sea reclamation works such as Marina Dbayeh, Beirut Central District and the Beirut International Airport runway. Subsequent demand for construction aggregates dropped and can be summarized as follows:

- 2-4 Mt per year for houses, 0.5 Mt per year for other types of construction and 2 Mt per year for roads
- On average, 200-300 tons of aggregates (sand and gravel) is required to build an apartment
- Roads need 5,000 tons of aggregates per 1 km and highways need 20,000 tons/km
- To extract 3 Mm^3 of usable materials, a quarry must produce 4 Mm^3, equivalent to about 60-80 ha.

Source: CDR-NLUMP, 2004

The chaotic state of the quarry sector has many root causes including rising demand for construction aggregates, political wrangling, delays in promulgating the long-awaited quarry master plan, and large scale infrastructure projects including sea reclamation. It can also be argued that for a small country the size of Lebanon, the occurrence of five cement plants (Ciment de Sibline, Cimenterie National, Holcim (Liban), Cimenterie du Moyen-Orient, and Société Libanaise des Ciments Blancs) has a perverse effect on the construction sector and on GOL infrastructure plans (see demand estimates in Box 6.6).

Quarrying impacts land resources, ecology, and natural landscapes irreversibly. They remove topsoil, destroy natural vegetation, alter ecosystems, cause air pollution, and reduce the aesthetic value of the surrounding landscape. A 2004 study published by the World Bank and the Mediterranean Environmental Technical

Assistance Program (METAP) on the cost of environmental degradation in Lebanon showed that quarries reduce the value of surrounding land annually by 16-71 percent and the value of apartments by 16-45 percent. This is equivalent to 0.1 percent of Lebanon's national Gross Domestic Product (GDP) or, in monetary terms, $14-16 million per year (WB, 2004). In 2009, the cost of environmental degradation from quarries was estimated at $34.5 million based on a GDP of $34.5 billion (WB, 2010).


Sand quarries in Rihane, south Lebanon

6.2.9 Land Mines

Lebanon has an estimated 137 km^2 of mine contaminated land (1.3% of the territory). The *caza* of Nabatieh is the most affected area, harboring a quarter of Lebanon's mine infested land; nearly half of recent and reported mine accidents occurred there. Selected areas in the *Mohafaza* of Mount Lebanon are also heavily affected by landmines from the civil war period, followed by the Bekaa Valley (about 15% of contaminated lands). The presence of mines, whether confirmed or presumed mine fields, affect livelihoods and alter land resources. Known minefields are usually cordoned off or sign-posted to alert local populations and discourage activities including shepherding, agriculture, and recreation. Unfortunately, many minefields are not adequately sign-posted and local residents sometimes trespass or decide to resume agricultural activity, including shepherding, to improve their income. Landmine victims are usually picnickers, walkers, and shepherds, but also unsuspecting children who play and tamper with mines, unexploded ordnances, and/or unsuspecting objects (UNCC, 2004).

Land mine warning signs on Jabal Hermon

During the July 2006 war, unexploded cluster bombs contaminated an estimated 35 km^2. Israel dropped an estimated four million cluster bombs over South Lebanon, of which at least 25 percent (one million) don't detonate upon impact. Following this war, landmines, cluster bombs and unexploded ordnances resulted in the death and injury of 313 persons (UNDP, 2008).

6.3 KEY ACTORS, LAWS AND REGULATIONS

The following section describes key laws and regulations related to land and the environment. Each text cited here is also listed chronologically at the end of the chapter. For a more complete analysis of environmental legislation related to land resources, please refer to Chapters 1, 2 and 11 of SELDAS (EU/UOB/MOE/ELARD, 2005). For a review of environmental jurisprudence cases related to land resources in Lebanon and other countries, please refer to Chapters 1, 2 and 11 of SEEL (MOJ/MOE/UNDP, 2010).

6.3.1 Institutions Related to Land Management

Land management is directly related to ownership (see different categories of land tenure and ownership in Box 6.7). The ministries and institutions involved in land management are presented in Table 6.5.

Table 6.5 Distribution of responsibilities related to land management

Responsibility \ Party	MOPWT (DGUP)	MOE	MOA	MOC (DGA)	MOEW	MOIM	CDR	Religious Orders
National land use master planning	X						X	
Protected areas management		X	X					
Forest Management		X	X					
Urban planning regulations	X							
Public maritime domain (coastal zone)	X							
Protection of cultural heritage				X				X
Protection of rivers and waterways	X	X			X			
Management of religious estates								X
Quarry sector		X			X	X		

Note: The above delineation of responsibilities is not exhaustive and subject to change.

Box 6.7 Land tenure type in Lebanon

Land tenure in Lebanon is complex. It consists of at least five principle categories:

1. *mulk*: private ownership
2. *amiria*: State owned and managed by MOF (Directorate General of Cadastral Affairs, DGCA)
3. *matrouka/machaa*: State owned and managed by municipalities.
4. *matrouka mahmiya:* can be owned by the State or by municipalities. Considered public and managed by MOF (DGCA).
5. *Khāliya moubaha*: also stated owned and similar to *amiria* lands but they have not been identified nor delineated.

Source: MOF Decision 3339 and its amendments (Dated 12/11/1930)

Ministry of Public Works and Transport / Directorate General of Urban Planning

The Directorate General of Urban Planning (DGUP) falls under the authority of the MOPWT. Its mandate is to develop urban regulations and coordinate urban planning activities. The directorate prepares and reviews urban master plans all over Lebanon except in Beirut and Tripoli, and three federations of municipalities (Jbail, Kesrouan and Metn) who have an urban planning / engineering unit. It is also involved in the building permit application process. Urban master plans are either prepared by the DGUP or by a private urban planning office.

The DGUP plays a key role in the building permitting process (see Figure 7.5 in Chapter 7) and in the formulation and/or review of proposed urban master plans. Completed master plans are submitted to the concerned municipality, which has one month to provide comments and critique. If accepted, the plan is then sent to the COM for endorsement. The DGUP is also involved in the protection of archaeological and cultural heritage. All urban plans have to be approved by the DGUP before implementation –*see functions of the Higher Council of Urban Planning in Chapter 7.*

Ministry of Environment

Law 690/2005 defines the mandate of the MOE and its organization. In particular, Article 2 describes the responsibilities of the ministry across all environmental sectors. See targeted selection of responsibilities related to land use and land resources below:

Article 2.16	Determine the environmental conditions for zoning classification in different regions through regional and detailed master plans in collaboration with MOPWT
Article 2.17	Determine the environmental conditions necessary for establishing and managing gardens, parks, public swimming pools and cemeteries
Article 2.20	Determine the environmental conditions to protect beaches, streams, rivers, springs, lakes, wetlands and valleys to safeguard the environment and natural resources
Article 2.21	Determine the environmental conditions related to land use, if such use causes any harm to the environment or natural resources
Article 2.23	Determine candidate areas and sites for Protected Area (PA) designation as well as develop criteria and guidelines for PA management. The ministry is the lead government agency responsible for nature reserves. *See proposed new category system in Section 6.4.1*
Article 2.27	Require and enforce the EIA and/or IEE process on all projects

Ministry of Agriculture

The management of forested areas in Lebanon is the responsibility of the Department of Forest and Natural Resources under the Directorate of Rural Development and Natural Resources at Ministry of Agriculture (MOA). Lebanon has two overlapping forest laws: (1) the Forest Code of 1949 and (2) the Law on Forest Protection, Law 85 of 1991 amended by parliament in 1996. While the law of 1949 regulates forest activities including pruning, coppicing, thinning and charcoal production, the laws of 1991 and 1996 imposed severe restrictions on forest activities and a total ban on harvesting resinous trees including pines (Calibrian, Aleppo and Stone Pines), Lebanese cedar, juniper, cypress and fir. The law of 1949 recognizes three types of forests based on land ownership (private, municipal and state) and therefore continues to provide the basis for the management of forests by the MOA. Unfortunately, the Ministry is understaffed and unable to effectively monitor and manage recreational and economic activities or risks within forests.

Ministry of Culture / Directorate General of Antiquities

The Directorate General of Antiquities (DGA) falls under the authority of the Ministry of Culture (MOC). It is responsible for implementing the provisions stipulated in regulations related to antiquities (Decision No.166/L.R. dated 7/11/1933 and its amendments), and other legal and regulatory provisions related to archeological remains, antiques, traditional and historical monuments. DGA comprises three units: (1) Directorate of Archaeological Monuments and Built Heritage; (2) Directorate of Archaeological Excavations and (3) Directorate of Movable Archaeological Property.

Ministry of Energy and Water

The Ministry of Energy and Water (MOEW) is responsible for the water sector under Law 221 dated 26 May 2000. According to Article 2 of this law, the Ministry has the following responsibilities in relation to land resources and water protection: (1) provide advice in the licensing of mines and quarries when such mines and quarries impact on water resources; and (2) protect water resources from pollution and waste by issuing laws and regulations and their application and enforcement. *See additional details on MOEW responsibilities in Chapter 3.*

Ministry of Interior and Municipalities

Municipalities, Federation of Municipalities, Governors, and Kaemakam fall under the responsibility of the MOIM. These four bodies play a modest role in the issuance of permits related to construction and quarries as well as other procedures related to land management and urban planning. The mandate of Municipalities is stipulated under Legislative Decree 118/1977 (and its amendments) and under Decree 4082/2000 on the organization of the MOIM. Legislative-Decree 116/1959 (and its amendments) delineates Lebanon's Mohafazas and Caza and defines the responsibilities of the *Mohafez* (Governor) and the *Kaemakam*.

Council of Development and Reconstruction

Reporting to the Council of Ministers (COM), the CDR is a public institution established in 1977 (Legislative-Decree No.5 dated 31/1/1977). Article 3 of that decree mandates CDR to establish "the general framework for urban planning" in Lebanon and submit it to the COM for approval. In 2002, the COM requested CDR to prepare a National Land Use Master Plan for Lebanon. Following an international tender, CDR contracted the consortium DAR-IAURIF to prepare the required studies and articulate the master plan in concert with CDR and the DGUP. The final analysis was published in 2004 including a Final Report, maps, and a Geo-Database (a spatial database that includes shapefiles of different themes such as water, administration, land cover, etc. that can be manipulated using ArcGIS).

The Master Plan describes holistically the physical realities impacting land use, future challenges, alternative configurations for land use and development, land use principles, as well as sectoral action plans (transport, tourism, energy, water, environment, education, etc.). In particular, the plan proposes a unified set of land use categories covering the entire territory, and delineated several protection zones of ecological and patrimonial importance. Five years later, and after protracted debates and under pressure from the European Union, the COM approved the Master Plan (Decree 2366 dated 20/06/2009) *–see overview of the Master Plan in Sections 6.5.1.*

Public Properties

Public properties are lands used for public interests; they cannot be sold and do not acquire ownership over time. In Lebanon, Legislative-Decision 144 dated 10/06/1925 classifies public properties and stipulates their management and penalty in case of violation. They include the public maritime domain, salty ponds and lakes, land protrusions into the sea including promontories, waterways, underground rivers and springs, waterfalls suitable for hydropower, navigation and irrigation channels, dams, military structures, telegraph and telephone lines, roads, streets, passageways, railways, ports and marine terminals and bays.

Several ministries share responsibility for the management of public lands (and related infrastructure). For example, the MOPWT is responsible for the maintenance of primary roads and the railway right-of-way, as well as the public maritime domain including its ports and marine terminals. The Ministry of Energy and Water (MOEW) is responsible for waterways, underground rivers, springs, rivers and riverbanks.

Makeshift structures dot the Lebanese coastal zone and damage natural rock edges

Religious Orders

Religious orders, *Awqaf*, are important land owners. Every religious communion in Lebanon has a unit in charge of the management of their estate. The total area owned by the Christian, Muslim and Druze orders represents an estimated 35 percent of Lebanon's territory (unpublished data). Accurate data on the composition and the location of each estate are not available and would constitute the basis for a detailed land survey, in coordination with the Directorate General of Cadastral Affairs at the Ministry of Finance.

The church owns large swaths of land in valleys and mountains in several governorates and usually observes a very strict land policy dictated by the Vatican Church[3] and supervised locally by the Archbishopric. While the Church cannot sell the land it owns, it can rent it to support economic development and other public interest projects. This loophole has led to many flagrant abuses of the religious estate in the form of commercial centers and residential blocs, serviced by new roads that dissect pristine forest landscapes.

[3]This restriction applies only to the Maronite and Catholic Church, but not the Orthodox Church.

A controversial example of urban encroachment on church land is the hill surrounding the Jounieh Bay (Harissa), which has been scared by a large zigzag road and dotted with residential buildings blocks. The Sunni estate are managed by the Department of Sunni Estates presided by the Mufti of the region. They are concentrated in major cities such as Beirut, Tripoli, and Saida. The Shiite estate is administered by the Supreme Islamic Shiite Council and they are primarily concentrated in Tyre, Beirut's southern suburb, and the regions of Baalbek and Hermel. The Druze estate is managed by the Sectarian Council of Druze and is primarily located in the Shouf region.

6.3.2 Conservation Legislation

Lebanon has been designating protected areas since 1942 when the GOL established eight protected sites pursuant to Decree 434 (dated 28/03/42) *–see definition of protected area in Box 6.8.* These early protected sites were very diverse ranging from urban parks (Horsh Beirut), to springs (Nabaa el Laban), natural sites (Yammouneh Lake and Kfardebian Natural Bridge), forests (Bologna pine forest, Mrouj oak forest, and the cedars of Bsharre) and historic monuments (temple of Baalbeck, Deir el Kalaa). Since 1942, several ministries have been proclaiming protected areas including the ministries of Tourism, Agriculture, Culture and most recently Environment.

Box 6.8 What is a Protected Area?

A clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.

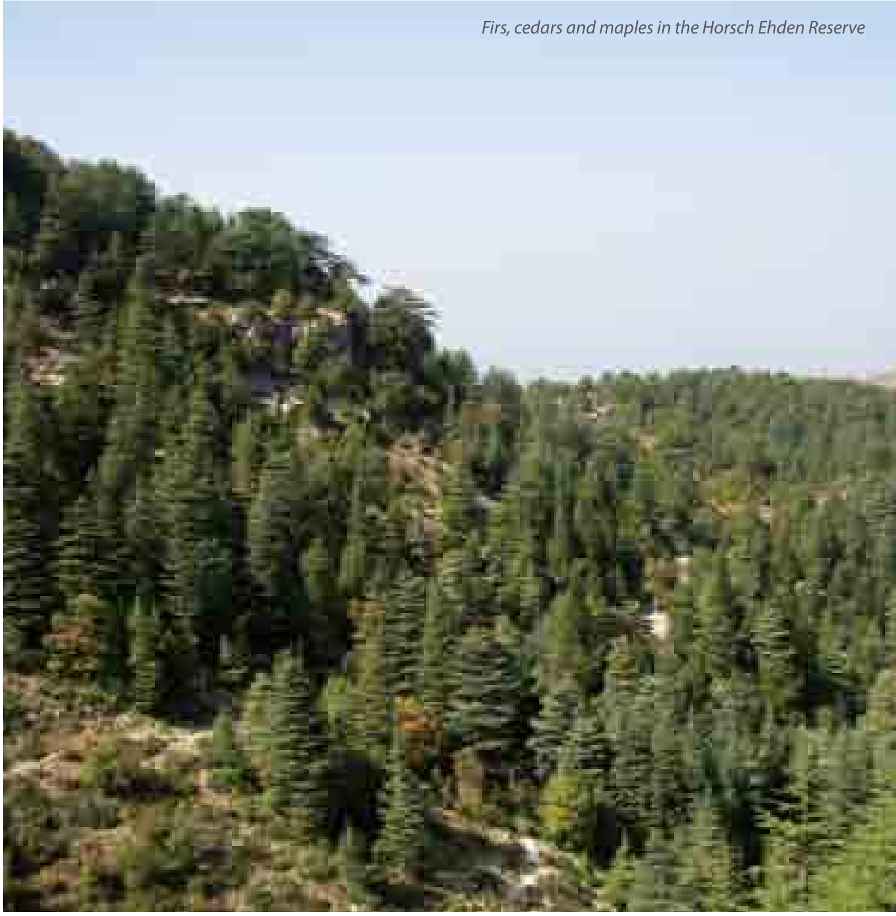
Source: IUCN, 2010

Lebanon today offers several nature reserves, protected forests, and protected sites many of which have also acquired international designations including Ramsar Sites, Special Protected Areas of Mediterranean Importance, Important Bird Areas, and World Heritage Sites. While *protected area* is the broad term encompassing all forms of conservation areas and perimeters, a review of Lebanon's conservation legislation reveals that there are at least six different categories of conservation: (1) nature reserves, (2) natural sites, (3) hima and forests, (4) touristic sites, (5) monuments and (6) sites of natural and/or ecological importance in need of protection including wetlands, caves, sinkholes, natural bridges and peaks. Managing these areas is a complex responsibility shared among several public institutions and agencies –*see complete list of nature reserves in Chapter 5*.

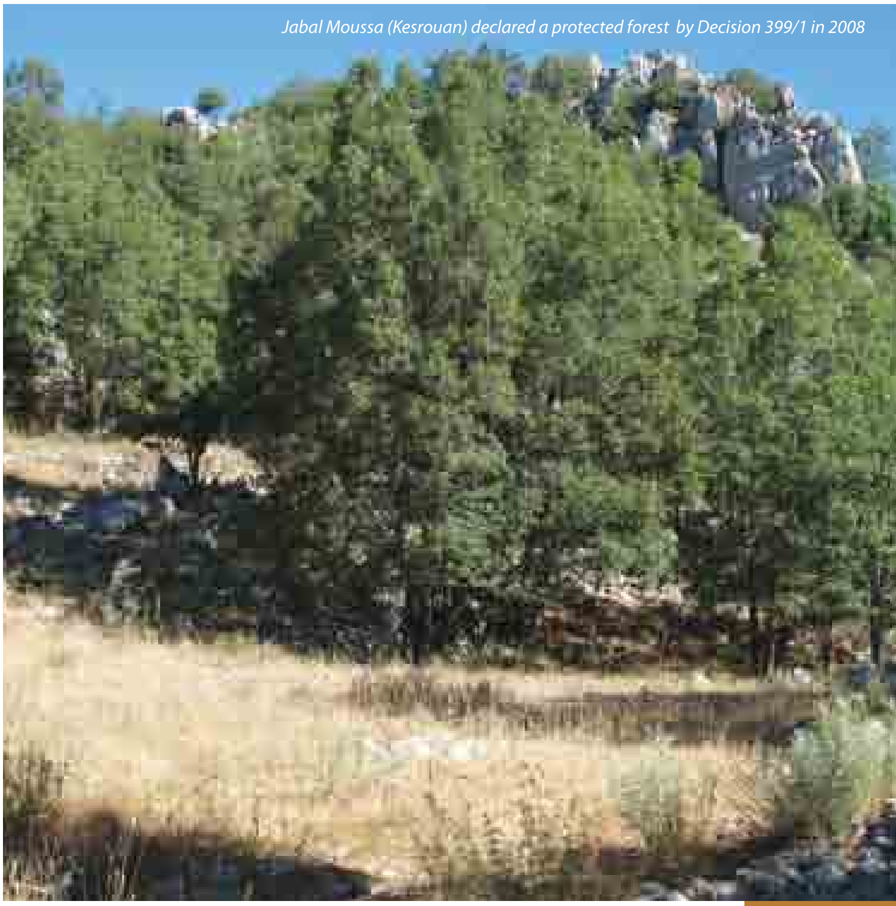
Nature reserves promote ecotourism in Lebanon and play an important role in local development. They represent nuclei for scientific research and conservation. Between 2000 and 2007, the number of visitors to Lebanon's nature reserves was highest in 2004 (56,000 visitors) and lowest in 2007 (14,500) due to the war's residual effect. The highest number of visitors was recorded in the Al-Shouf Cedars and Palm Islands nature reserves, as per the breakdown in Figure 6.8. New data from these two reserves show an upward trend in visitor number; from 21,308 visitors in the Al-Shouf Cedars in 2008 to 57,963 visitors in 2010; and from 17,100 visitors in Palm Islands in 2007 to 23,250 visitors in 2010.

Protected Forests

The Forest Code (Law 85 of 12/9/1991), amended by Parliament in 1996 (Law 558 of 24/7/1996) stipulates that all cedar, fir, cypress, oak, juniper and other forests in Lebanon are protected by ministerial decision. Based on the amended 1996's forest code, MOA declared 13 protected forests between 1996 and 1997. In 2008, the ministry also declared the forest of Jabal Moussa protected (Decision 399/1 dated 18/9/2008). There was a visible hiatus in the designation of protected forests by MOA during the period 1997-2008, partly due to the fact that the anticipated Department of Forest Protection did not come to fruition at MOA. Separately during this period, MOE started to play a more pronounced role in (1) the establishment and management of nature reserves some of which harbor significant forests and, (2) reforestation. *See complete list of protected forests in Chapter 5.*



Firs, cedars and maples in the Horsch Ehden Reserve

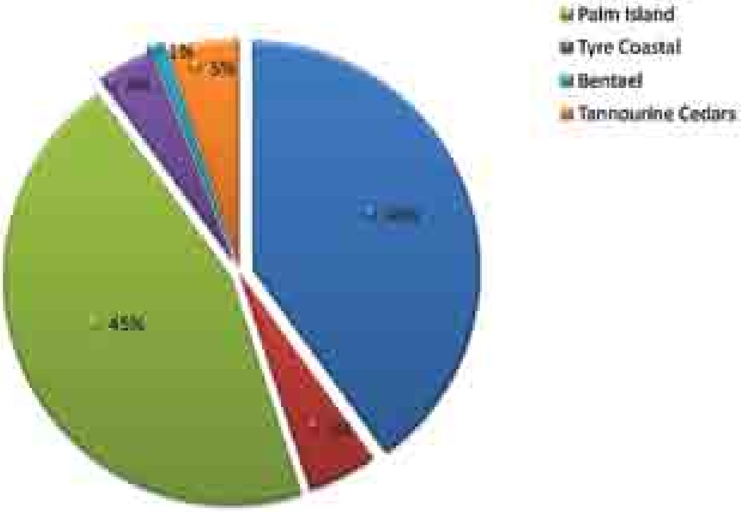


Jabal Moussa (Kesrouan) declared a protected forest by Decision 399/1 in 2008


View of the valley of Qannoubine, part of the Kadisha World Heritage Site


Hiking in Ezer (Oak) forest in Fnaideq, a popular form of ecotourism activity

Figure 6.8 Number of visitors to Lebanon's Nature Reserves (2005 data)



Source: MOE Leaflet on Ecotourism in Nature Reserves, 2008

Protected Sites

Important sites in Lebanon are protected by decisions from the ministries of Environment, Agriculture, Tourism and Culture (in the case of World Heritage Sites which are classified by UNESCO). They include landscapes, rivers streams, valleys, forests, caves, sinkholes, archeological monuments and touristic sites. *See full list of protected sites in Lebanon in* ***Annex 2***. Decisions emitted by MOE to protect special sites stipulate that MOE and DGUP will jointly develop permitting standards for the construction and operation of facilities within a 500-meter protection radius (buffer zone). Other conservation legislation derives from international conventions including the 1971 Ramsar Convention.

6.3.3 Quarry Legislation Affecting Land Resources

Lebanon has seen a string of regulations related to the quarry sector. The following list describes the most important decrees affecting quarrying from 1996 to 2009.

- *Decree No. 5616/1996* was enacted to regulate the quarry sector in Lebanon but enforcement has been noticeably cavalier and/or absent. Separately, MOIM would issue quarry permits, sometimes after consultation with MOE.
- *Decree No. 8803/2002* canceled Decree 5616/1996. It organizes the activity of quarries and crushers, licensing procedures, as well as the operation, management and rehabilitation of quarries. The decree established the National Council of Quarries (NCQ) which brings together representatives from nine public agencies and is presided by MOE. It requires operators to obtain a declaration (statement) from the MOEW (General Directorate of Exploitation). The decree presented the long-awaited National Master Plan for Quarries indentifying four regions: (1) Aarsal, (2) Tfail and Ain El Jaouz in Baalbek, (3) Yanta and Aita El Fokhar in Rachaiya and (4) Qousaya and Deir El Ghazal in Zahle. All these regions are located in the Anti-Lebanon Mountain Range and cover about 163 km^2. The decree requires quarry contractors to rehabilitate the site at owner expense by terracing and replanting the site after closure; brings local municipalities into the licensing process; and imposes fines on non-complying operators. It also requires owners to present a bank guarantee to ensure the rehabilitation of the quarry.
- *Decree No. 16456/2006* amends Decree 8803/2002. It brought further improvements and restrictions to the quarry sector. For example, the decree manages blasting operation, bans quarrying inside protected areas, and requires the owners to hire a supervising engineer to oversee geotechnical, civil and hydro-geological works. As of 31 December 2010, MOE had 135 bank guarantees on

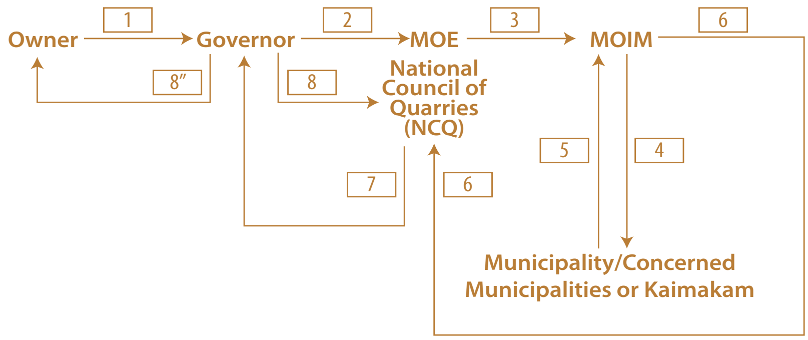
file worth LBP4.6 billion (or $3.07 million). Despite widespread noncompliance by the vast majority of operators, MOE has yet to exercise its public right to deposit bank guarantees and use the money to finance site rehabilitation.

- *Decree No. 1735/2009* also amends Decree 8803/2002. It explicitly requires the declaration (statement) that operators must obtain from the MOEW (General Directorate of Exploitation) to address the potential impacts of the proposed quarry on surface and groundwater and on transmission lines. The decree also expanded the list of designated quarry areas to include 12 new areas: (1) Qaa Baalbek, Qaa Baayoun, (2) Ras Baalbek, (3) Ain Bourday, Brital, (4) Taraiya, Chmestar, (5) Ftouh Kesrouan, (6) Fnaydeq, (7) Michmich (Akkar), (8) Kfour El Aarabi, (9) Rihane, Aaramta, (10) Aachiyeh, Mazraat El Ouzaaiye, (11) Tiri, Ain Ebl, and (12) Majdelzoun. Combined, these sites cover an additional 74 km^2, bringing the total designated quarry area to 237 km^2.
- Environmental conditions based on Decree No. 8803/2002 and its amendments. MOE issued many operational and license decisions related to the quarry sector including four decisions in 2009 and three in 2010 as described below:

Decision 16/1 (1/04/2009)	Defines the license conditions and documents required for crushers for gravel production only (no quarry)
Decision 17/1 (1/04/2009)	Defines the license conditions and documents required for rock quarries for crushers and rubble
Decision 18/1 (dated 1/04/2009)	Defines the license conditions and documents required for rock quarries for producing mosaics
Decision 20/1 (1/04/2009)	Defines the license conditions and documents required for sand quarries or naturally fragmented gravel
Decision 48/1 (17/06/2009)	Defines procedures for quarries rehabilitation
Decision 136/1 (23/08/2010)	Defines procedures for operating small-sized quarries
Decision 137/1 (23/08/2010)	Defines the Daily Activity Report template for quarrying
Decision 138/1 (23/08/2010)	Provides a template for the "commitment" (to be provided by the quarry operator)

The quarry owner / operator can obtain a quarry license (after submitting the required documents) that extends up to five years. Figure 6.9 presents an illustrative flowchart of the current licensing procedure. The NCQ meets periodically to review, approve and/or reject license applications. The Council issued 52 licenses in 2009 and 69 licenses in 2010.

Figure 6.9 Licensing procedure for quarries



Source: MOE Decree 8803/2002 and its amendments

Legend:

Steps 3, 4 and **5** apply if there is a municipality (of federation of municipalities); if the municipality does not exist, then the authority to deny document approval to an operator is relegated to the Kaemakam. **Step 8** is the acknowledgment by the Governor of the approval from the National Council for Quarries. **Step 8"** is the issuance of the license by the Governor after approval by the National Council for Quarries.

6.4 SELECTED RESPONSES TO LAND ISSUES

In an effort to increase awareness of the country's natural and cultural heritage, and in response to mounting urban pressure, there has been a noticeable increase in conservation activities and programs, engaging several governmental and non-governmental actors including Non-Governmental Organizations (NGO). The following sections describe selected responses related to protected areas management, land use planning, and reforestation.

6.4.1 Attempts to Reorganize Lebanon's Protected Area System

Although Lebanon has an impressive catalogue of protected areas and other protected sites, there is currently no overall vision for protected areas in the country. As part of the EU-funded SISPAM program (2004), ECODIT and MOE proposed the following national category system for PA designation (adapted from the IUCN classification system) and secured widespread acceptance for this new system among conservationists and PA staff:

1. *Category A - Habitat/Species Management Area (IUCN Category IV)*: area of land and/or sea managed to maintain and/or restore the habitat conditions necessary for the persistence of significant species (e.g., rare, endemic, threatened or vulnerable), groups of species, or biotic communities; as well as to preserve vulnerable and/or rare ecosystems or habitats.
2. *Category B - National Park (IUCN Category II)*: natural area of land and/or sea designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations, (b) exclude exploitation or occupation inimical to the purposes of designation of the area and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.
3. *Category C - Natural Monument (IUCN Category III)*: area containing specific natural or natural/cultural feature(s) of outstanding or unique value because of their inherent rarity, representativeness or aesthetic qualities or cultural significance.
4. *Category D - Protected Landscapes/Seascapes (IUCN Category V)*: area of land, with coast or sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity.

To implement this category system, the Lebanese Parliament must first approve the draft Framework Law for Nature Reserves, and then COM (upon the recommendation of MOE and MOA) would need to reclassify individual sites according to the four categories --*see tentative reclassification of a dozen nature reserves and protected sites in Table 6.6.*


Barouk cedar forest inside the Al-Shouf Cedars Nature Reserve

Table 6.6 Proposed reclassification of protected areas (illustrative list)

Site	Current Status	Proposed Category			
		A	B	C	D
Horsh Ehden	Nature Reserve	X			
Palm Island	Nature Reserve	X			
Karm Chbat	Nature Reserve	X			
Shouf Cedars	Nature Reserve		X		
Tyre Coastal	Nature Reserve				X
Bentael	Nature Reserve	X			
Yammouni	Nature Reserve	X			
Tannourine Cedars	Nature Reserve	X			
Baloo Baatara	Protected Site			X	
Faqra Natural Bridge	Protected Site			X	
Pigeon Rocks	Protected Site			X	
Jeita Grotto	Protected Site			X	
Cedars of Bsharre	Protected Forest			X	

Legend: A: Habitat/Species Management Area, B: National Park, C: Natural Monument, D: Protected Landscapes/Seascapes

Box 6.9 Deforestation, reforestation and afforestation

Deforestation refers to change of land cover with depletion of tree crown cover to less than 10 percent. Changes within the forest class (e.g. from closed to open forest), which adversely affect the stand or site and, in particular, lower the production capacity, are termed forest degradation.
Reforestation is the artificial establishment of forest on lands which carried forest before.
Afforestation is the artificial establishment of forest on lands which previously did not carry forest within living memory.

Source: FAO, 2010

6.4.2 Reforestation Efforts

Forests provide many ecosystem services including air quality improvement, carbon sinks, protection against soil erosion, timber, wildlife habitat, and recreation. Forests protect watersheds and ecosystems and help combat desertification.

MOA and MOE are spearheading several programs to upscale reforestation efforts in the country (see forest terminology in Box 6.9). The Department of Forests and Natural Resources at MOA is in charge of reforestation program in small scale. In 2008, it produced about 200,000 seedlings in nine plant nurseries across the country (see ***Map 3*** in Chapter 5). The MOA distributes the seedlings for free and therefore has little control over them after handover; they are usually planted along roadsides and on communal lands. Although MOA has banned the import of cedar seeds and seedlings (Decision 108/1 of 1995), enforcement is questionable as reforestation programs frequently rely on imported seedlings.

At MOE, reforestation is carried out under the National Reforestation Plan (NRP) managed by the Service of Natural Resources. The Lebanese Parliament approved in 2001 Framework Law 326 (dated 28/6/2001 and subsequently updated by a Law-Decree 40 dated 22/2/2007) allocating LBP25 billion to MOE over a five-year period to implement large-scale reforestation activities in carefully selected areas. Subsequently, the MOE formulated the NRP and started implementing the plan (Phase I between 2002 and 2004, and Phase II between 2004 and 2006) by contracting private nurseries to collect the seeds, produce and transplant the seedlings on municipal/government land and irrigate and maintain the seedlings over a two-year period. *See achievements of the NRP and more analysis of current and future reforestation programs in Lebanon in Chapter 5.*

6.4.3 Green Plan

A public administration under the authority of the MOA, the Green Plan was established in 1963 (Decree No. 13335) to "improve Lebanese mountains" through land reclamation, irrigation and reforestation. Starting 1965, the Green Plan helped farmers enhance the productivity of their farmland by terracing their lands and building or expanding agricultural dirt roads. Later, during the late 1960s and early 1970s, the administration pioneered large-scale reforestation programs across the country, with a great deal of success and national pride. Millions of trees were planted and/or seeded in vast areas of the country.

The Green Plan is today a semi-autonomous directorate and its mandate has entirely shifted to land rehabilitation. It provides grants to farmers (up to LBP15 Million) to repair and/or build stone terraces and retaining walls, build hill lakes and install irrigation networks. In the period 2001-2009, the Green Plan provided technical and financial assistance to 14,451 farmers; reclaimed 5,390ha of bare lands; built 906,452m^3 of earth-lined hill lakes and 285,865 m^3 of concrete reservoirs; built or rehabilitated 187 km of agricultural dirt roads (Green Plan, 2009). Green Plan activities are not always subject to environmental scrutiny or examination and therefore may cause local environmental degradation. For example, it has been widely reported that farmers have asphalted agricultural dirt roads using resources received from the Green Plan, contrary to regulations. Illegally asphalted dirt roads may invite unwanted urban development.

Agricultural terraces is part of Lebanon's unique mountain heritage (Jezzine)

Hill Lake in Zaarour (Metn)

6.4.4 Other Responses by Non-Governmental Organizations

NGOs are playing an active role in lobbying against unwanted development and raising awareness of important conservation issues. Selected NGOs have been working actively to protect forests, landscapes, land resources and historic monuments *-see targeted selection of NGOs who are implementing projects affecting land use and land resources in Lebanon in* ***Annex 3.***

6.5 EMERGING ISSUES AND POLICY OUTLOOK

The current trend in construction (roads, housing, and commercial developments) as well as in sea reclamation projects (marinas, fishing harbors, sports facilities, and wastewater treatments plants) is alarming and not sustainable. Lebanon is too small to sustain this construction drive in the medium to long-term, without causing irreversible damage to its natural resources and landscapes. Urban development projects are not only increasing in number, but they are also increasing in size. The GOL should enact and enforce regulations to curb construction and speculative investment, and to improve the management of public resources including the public maritime domain and municipal mashaa. The following paragraphs highlight priority investments and actions for improving the management of land resources in Lebanon.

6.5.1 Implementing the National Land Use Master Plan

The Master Plan presents a holistic vision for national urban planning and critical recommendations for enhancing and harmonizing land uses in Lebanon while protecting the natural and cultural resource base. Key recommendations related to the environment include: (1) preparing legal instruments for establishing regional parks and the national park (in North Lebanon); (2) updating inventories of natural sites in need of protection (e.g., grottos, cliffs, fossil deposits, natural bridges, valuable geological formations, wetlands, etc.); (3) updating land use and land cover maps every five years; (4) implementing cedar and other forest corridors between 1,500m and 1,900m; and (5) revising and reforming urban planning regulations, including urban planning operations, and identifying priority sites for local urban planning.

The COM endorsed the National Land Use Master Plan (NLUMP) in June 2009 (Decree No. 2366 dated 20/6/2009). The Master Plan is a reference document for several administrations including the DGUP (which has to refer back to the Master Plan when preparing, reviewing or approving new urban master plans) and line ministries (Agriculture, Environment, Public Works and

Transport, Water and Energy, Industry, Economy and Trade and Culture/Directorate General of Antiquities). They should refer to the Master Plan when making decisions related to urban development, the provision of public services, and environmental heritage conservation.

The decree recognizes nine planning zones (denoted U, R, A, **N**, **P**, **S**, F, G and W) including three zones related to natural and cultural heritage conservation: **Zone N** are areas of national natural assets such as high mountain plateaus, cedar corridors, mountain horticulture, connection areas of forests, valleys and other natural sites; **Zone P** are great landscapes; and **Zone S** are archeological, historical, patrimonial and other natural sites. The nine zones include servitudes for land management: (1) exploitation factors for construction, (2) construction height, (3) construction setbacks, (4) provisions for urban expansion around exiting urban areas, (5) land parceling for construction activity, (6) large scale projects, (7) quarries, and (8) industries.

The NLUMP is a marvelous planning tool that helps the GOL make lasting impressions on the form and orientations of Lebanon's future land use. The NLUMP decree and related zoning should be widely circulated among urban planning agencies, municipalities, the Order of Engineers and Architects in Beirut and Tripoli, and private sector urban planning offices. For reference, this SOER has reproduced in English the zoning classification in ***Annex 4*.** The GOL must work proactively and commit sustained resources to ensure phased implementation of the NLUMP over the coming years.

6.5.2 Mainstreaming Geographic Information System in Land Use Planning

In Lebanon, some of the information related to cadastral boundaries, ownership, roads, water ways and sewage networks are still stored on paper. It is crucial that the Lebanese public administration computerizes and digitizes all spatial information to facilitate the consolidation of such data at the national level and the exchange of relevant data groups between line ministries and other public agencies. The Geographic Information System is today the reference software for the compilation and analysis of spatial data. Simply put, GIS is a system that captures, stores, analyzes, manages and presents geographic data. GIS applications merge cartography, statistical analysis and database technology. GIS was extensively used during the preparation of the National Land Use Master Plan (see structure of geodatabase in Chapter 2) and should be mainstreamed in the Lebanese administration system including urban planning departments, water and energy utilities, environmental monitoring, transport, and agriculture to name a few.

6.5.3 Curbing Real Estate Speculation

Demand for property grew exponentially in the last decade and Lebanon witnessed record investments in its real estate sector from nationals, expatriates and foreigners. Around fifty percent of total Arab Foreign Direct Investment in Lebanon targeted large property developments (ESCWA-UN, 2008). Projects such as the Four Seasons Hotel in Beirut, City Center in Hazmieh, Habtoor Grand Hotel, Le Mall and Metropolitan Palace Hotel in Sin El Fil, City Mall in Dora, Habtoor Land in Jamhour in addition to many other developments testify to the nature of Arab investment in Lebanon which increased 20 percent in 2009, reaching $4.3 billion from $3.6 billion in 2008 (Daily Star, 2010).

New and cluttered buildings in the Beirut suburbs

Foreign ownership in Lebanon is regulated by Decree 11614 dated 4 January 1969 and its subsequent amendments notably Law 296/2001. This Law eases the legal limits on foreign ownership of real estate properties in Lebanon, and stand as another important factor behind the Arab capital inflow towards this sector –*see analysis of foreign ownership law in Lebanon in Chapter 7*. Statistics on the size and distribution of property and land ownership by foreigners in Lebanon is sketchy. For example, land holdings by Gulf Cooperation Council (GCC) investors in Lebanon totaled 2 million m^2 in 2005, up from 0.5 million m^2 in 2002 (BLOM Invest Bank, 2010). Most of the investments come from Saudi Arabia, Kuwait, Qatar and the UAE, and are oriented towards residential, commercial, and touristic projects. Gulf citizens invest mostly in Beirut and the Southern Metn region but recently expanded into northern Metn and Kesrouan.

Despite the fact that foreign investments create jobs potential and an added economic value to Lebanon, the expansion in this sector has also negative consequences on Lebanon. First because the Lebanese economy will be highly vulnerable and dependent on international developments, in particular to the movement in oil and gas prices as they heavily affect the wealth state of Gulf citizens and thus, their investment decisions. Secondly, Lebanese citizens will feel deprived from their own space as foreign are purchasing their lands to create a project or to buy a property. Therefore, a legislative action must be taken to limit the excessive desire of foreign on the real estate sector and preserve Lebanon's land legacy such as the approval on the proposed law on foreign ownership in Lebanon presented to the Lebanese Parliament on 2/1/2009.

6.5.4 Controlling Large Scale Development Projects

The nature of local Lebanese economy deeply affects and attracts real estate investment to Lebanon. The tax system is one of the lowest fiscal charges worldwide, with maximum tax rates of 15 percent for companies and 20 percent for individuals. Lebanon adopts a liberal financial environment with a free foreign exchange market, full currency convertibility policies, banking secrecy law and no restriction on the movement of capital, which makes the country ideal for conducting business. Furthermore, the country holds a well-developed, transparent and non-discriminatory legal framework that protects private property and provides Lebanese and Non-Lebanese with equal business rights (BLOM Invest Bank, 2010).

In addition, the GOL launched in 1994 the Investment Development Authority of Lebanon (IDAL), a public institution enjoying independent legal personality with financial and managerial independence, under the direct administrative authority of the Prime Minister. IDAL was established by virtue of decree No. 5778 dated 11 October 1994 to spearhead Lebanon's investment promotion efforts. On 16 August 2001, the role of IDAL was reinforced by the enactment of the Investment Development Law No. 360. It regulates the investment promotion of domestic and foreign entities and strives to stimulate Lebanon's economic and social development and enhance its competitiveness. Large projects that go through IDAL enjoy tax exemptions for a period of 10 years, with a maximum 50 percent reduction in permit fees for construction works.

These factors lure developers and holding companies who wish to invest in Lebanon, on a big scale. Illusive projects such as *Sannine Zenith* in Ouyoun el Siman, and *Cedar Island* in coast of Damour, would impact the environment and land resources in many ways and irreversibly. They require significant infrastructure works and construction materials that Lebanon doesn't have. It is important to review these projects more critically and seek public opinion as part of the mandatory EIA and/or Strategic Environmental Assessment process prior to permit approval.

6.5.5 Preparing a Mountain Law

The mountains of Lebanon constitute a national treasure and a repository for heritage, landscapes, biodiversity, water, and renewable energy namely sun and wind. Unfortunately, the current myriad of laws and regulations related to urban planning, water, forests and protected areas do not recognize the intrinsic value of mountains as a system and tend to approach development piecemeal. The conservation, protection and sustainable management of mountain ecosystems require public participation in decision-making, coordination, and long-term and strategic planning. In France, for instance, mountains are protected by Law No. 85-30 dated 9/1/1985 called "Loi Montagne". This law delimits mountain zones, provides guidelines for construction, recognizes specific institutions dedicated to the management of mountain areas, approaches sustainable economic development of rural areas, and regulates tourism projects in mountains. In countries such as Nepal, Peru, Italy, and Cyprus, several mountains are classified as national parks[4].

In Lebanon, only Makmel Mountain in North Lebanon is classified as a Natural Site based on MOE Decision No. 187/1 (dated 17/11/1998). Unless the site is proclaimed a National Park consistent with the recommendations of the National Land Use Master Plan, the mountain will come under increasing pressure from urbanization including logging, hunting, and quarrying. Other mountains and plateaus such as Sannine, Kneisseh, Hermon (Cheikh), Barouk, Aaqoura, Tannourine and Aakkar are not protected by any regulation and are therefore vulnerable to large-scale urban developments that will inevitably change their natural features including karst, springs, caves, sinkholes and dolines[5]. These mountains constitute Lebanon's water reservoir which feeds its rivers and groundwater.

A supporting tool to review and control development in mountain areas is the EPIK method for assessing karst systems vulnerability (see application in Box 6.10). The EPIK method is based on specific geological, geo-morphological and hydro-geological factors. *EPIK* stands for **E**pikarst (the surface and subsurface karstic features); **P**rotective cover (the distribution of the soil thickness); **I**nfiltration condition (the relation between the slope and the different land use pattern in the watershed); and **K**arst network (the degree to which the karst network is developed). This method produces vulnerability maps that can support land use management and assist in the permitting process as it shows areas of potential groundwater contamination and identifies protection perimeters.

Box 6.10 Application of EPIK method in Lebanon

The EPIK method was used to evaluate the potential impacts on underground water from a proposed development on Kneisseh Mountain. The EPIK method produced maps to show areas vulnerable to contamination. EPIK findings helped the project.

The protection of high-altitude areas by a national mountain law is a national priority. Prospective large scale developments will sooner or later pollute groundwater resources and reduce aquifer recharge. The ministries of Agriculture, Environment, Tourism, Energy and Water, and Public Works and Transport (DGUP) must work collaboratively to prepare a framework law for mountains that would articulate a long-term vision for harmonizing development and conservation in high-altitude areas, say above 1,500 m.

[4]Protected areas declared or owned by the government, set aside for human recreation and enjoyment, wildlife, and environmental protection and restricted from most development

[5]A closed depression in karst areas draining underground system from snow melting

Scenic view of dolines in Jabal Sannin (with Mount Hermon in the background)

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CITED LEGISLATION RELATED TO LAND RESOURCES

نوع النص	الرقم	التاريخ	عنوان النص
قرار وزارة المالية	٣٣٣٩	١٢/١١/١٩٣٠	أنظمة الملكية العقارية
قانون		١٩٣٩/٠٧/٠٨	حماية المناظر والمواقع الطبيعية في لبنان
مرسوم	٤٣٤	١٩٤٢/٠٣/٢٨	تصنيف واخضاع المواقع والمباني الطبيعية في الجمهورية اللبنانية لنصوص قانون ١٩٣٩/٠٧/٠٨
مرسوم	١٣٣٣٥	١٩٦٣/٠٧/١٠	احداث مشروع استصلاح الاراضي "المشروع الاخضر"
مرسوم	١١٦١٤	١٩٦٩/٠١/٠٤	اكتساب غير اللبنانيين الحقوق العينية العقارية في لبنان
مرسوم اشتراعي	٥	١٩٧٧/٠١/٣١	انشاء مجلس الانماء والاعمار
مرسوم اشتراعي	١٤٨	١٩٨٣/٠٩/١٦	قانون البناء (ملغى)
قانون	٨٥	١٩٩١/٠٩/٠٧	المحافظة على الثروة الحرجية والأحراج
قانون	١٢١	١٩٩٢/٠٣/٠٩	انشاء محميتين طبيعيتين في بعض الجزر أمام شاطئ طرابلس
مرسوم	٥٦١٦	١٩٩٤/٠٩/٠٦	تنظيم المقالع والكسارات (ملغى)
مرسوم	٥٧٧٨	١٩٩٤/١٠/١١	إنشاء مؤسسة عامة تدعى « المؤسسة العامة لتشجيع الإستثمارات» (ملغى)
قرار وزير البيئة	١/١٤	١٩٩٥/١٠/١٦	انشاء محمية طبيعية «كرم شباط»
قانون	٥٥٨	١٩٩٦/٠٧/٢٤	حماية الغابات
قانون	٥٣٢	١٩٩٦/٠٧/٢٤	انشاء محمية طبيعية ارز الشوف
قانون	٧٠٨	١٩٩٨/١١/٠٥	يرمي الى انشاء محمية شاطىء صور الطبيعية في جفتلك رأس العين - منطقة صور العقارية
قرار وزير البيئة	١/١٨٧	١٩٩٨/١١/١٧	تصنيف الموقع المعروف بجبل المكمل القرنة السوداء من المواقع الطبيعية
قانون	١١	١٩٩٩/٠٢/٢٠	انشاء محمية طبيعية في بنتاعل
قانون	١٠	١٩٩٩/٢/٢٠	انشاء محمية طبيعية في اليمونة
قانون	٩	١٩٩٩/٠٢/٢٠	انشاء محمية غابة ارز تنورين الطبيعية
قانون	٢٩٦	٢٠٠١/٠٤/٠٣	تعديل بعض مواد القانون المنفذ بالمرسوم الرقم ١١٦١٤ تاريخ ١٩٦٩/١/٤
قانون	٣٦٠	٢٠٠١/٠٨/٠٦	تشجيع الاستثمارات في لبنان
مرسوم	٨٨٠٣	٢٠٠٢/١٠/٠٤	تنظيم المقالع والكسارات
قرار وزير الداخلية والبلديات	٨	٢٠٠٤/٠١/١٣	انشاء بلدية في بلدة رشاف قضاء بنت جبيل محافظة النبطية
قانون	٦٤٦	٢٠٠٤/١٢/١١	تعديل المرسوم الاشتراعي رقم ١٤٨ تاريخ ١٩٨٣/٩/١٦ قانون البناء
مرسوم	١٥٨٧٤	٢٠٠٥/١٢/٠٥	المرسوم التطبيقي لقانون البناء
قانون	٦٩٠	٢٠٠٥/٠٨/٢٦	تحديد مهام وزارة البيئة وتنظيمها
مرسوم	١٦٤٥٦	٢٠٠٦/٠٢/٢٧	تعديل المرسوم رقم ٨٨٠٣
مرسوم نافذ حكماً	٦١٧	٢٠٠٧/٠٨/٠٨	تعديل المرسوم رقم ١٥٨٧٤ المرسوم التطبيقي لقانون البناء
قرار وزير الزراعة	١/٣٩٩	٢٠٠٨/٠٩/١٨	انشاء غابة محمية في جبل موسى
قرار وزير البيئة	١/١٦	٢٠٠٩/٠٤/٠١	تحديد المستندات والشروط العائدة للترخيص لاستثمار كسارات بحص) منفردة (دون مقلع)
قرار وزير البيئة	١/١٧	٢٠٠٩/٠٤/٠١	تحديد المستندات والشروط العائدة للترخيص لاستثمار مقالع الصخور للكسارات والردميات
قرار وزير البيئة	١/١٨	٢٠٠٩/٠٤/٠١	تحديد المستندات والشروط العائدة للترخيص لاستثمار مقالع الصخور لصناعة الموزاييك

نوع النص	الرقم	التاريخ	عنوان النص
قرار وزير البيئة	١/١٩	٢٠٠٩/٠٤/٠١	تحديد المستندات والشروط العائدة للترخيص لاستثمار محافر الرمل أو البحص المفتت طبيعيا
مرسوم	١٧٣٥	٢٠٠٩/٠٤/١٤	تعديل المرسوم رقم ٨٨٠٣/م ٢٠٠٤ وتعديلاته لا سيما المرسوم رقم ٢٠٠٦/١٦٤٥٦
قرار وزير البيئة	٤٨/١	١٧/٠٦/٢٠٠٩	آلية الترخيص لتأهيل مواقع المقالع
مرسوم	٢٣٦٦	٢٠٠٩/٠٦/٢٠	الخطة الشاملة لترتيب الأراضي اللبنانية
قرار المجلس الاعلى للتنظيم المدني	١٩	٢٠١٠/٠٥/٢١	المخطط التوجيهي لمنطقة صغبين
قرار وزير البيئة	١/١٣٦	٢٣/٠٨/٢٠١٠	آلية لتحديد الكسارات الصغيرة الحجم وعملها
قرار وزير البيئة	١/١٣٧	٢٣/٠٨/٢٠١٠	تحديد نموذج عن السجل اليومي الخاص بعمليات الإستثمار
قرار وزير البيئة	١/١٣٨	٢٣/٠٨/٢٠١٠	تحديد نموذج تعهّد

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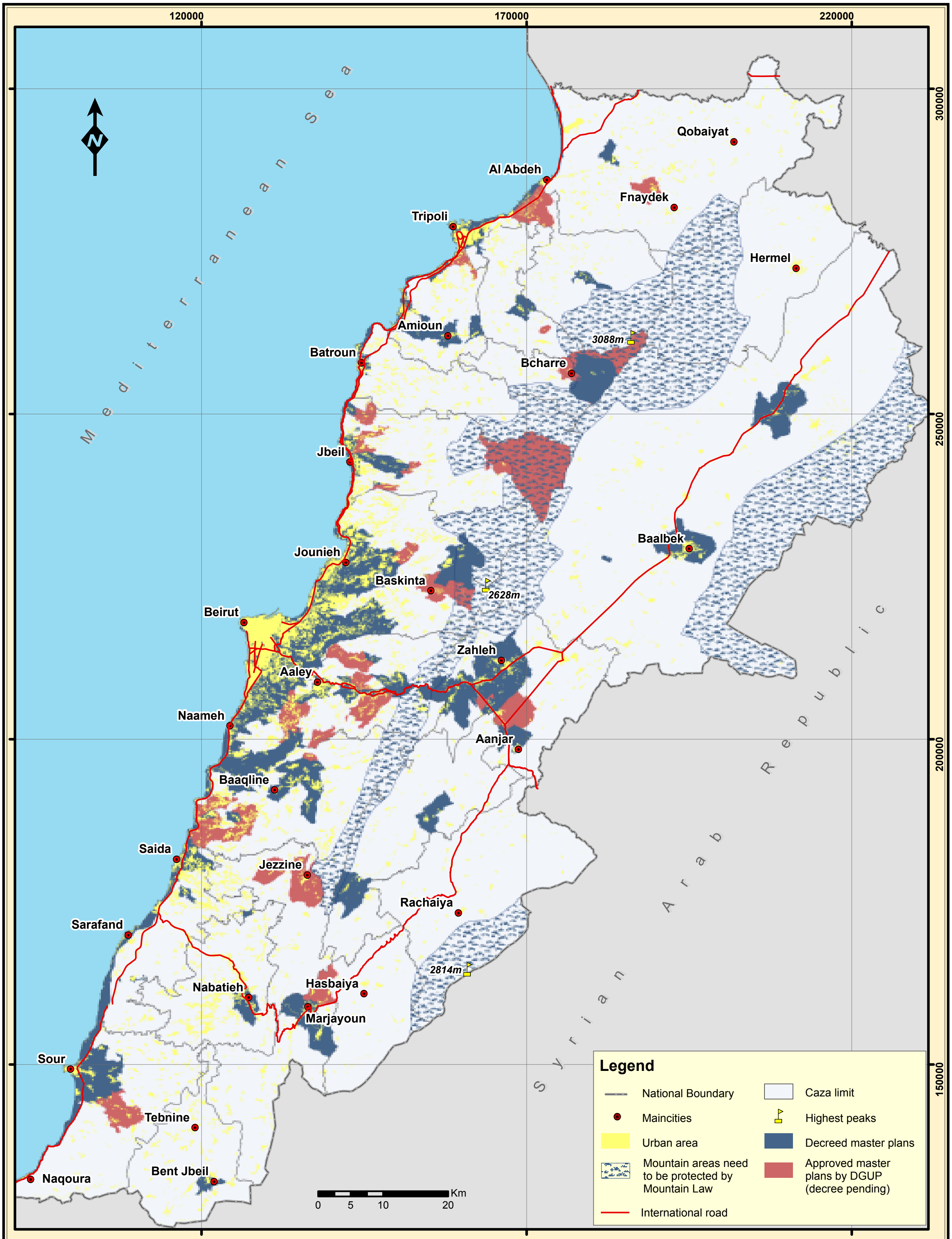
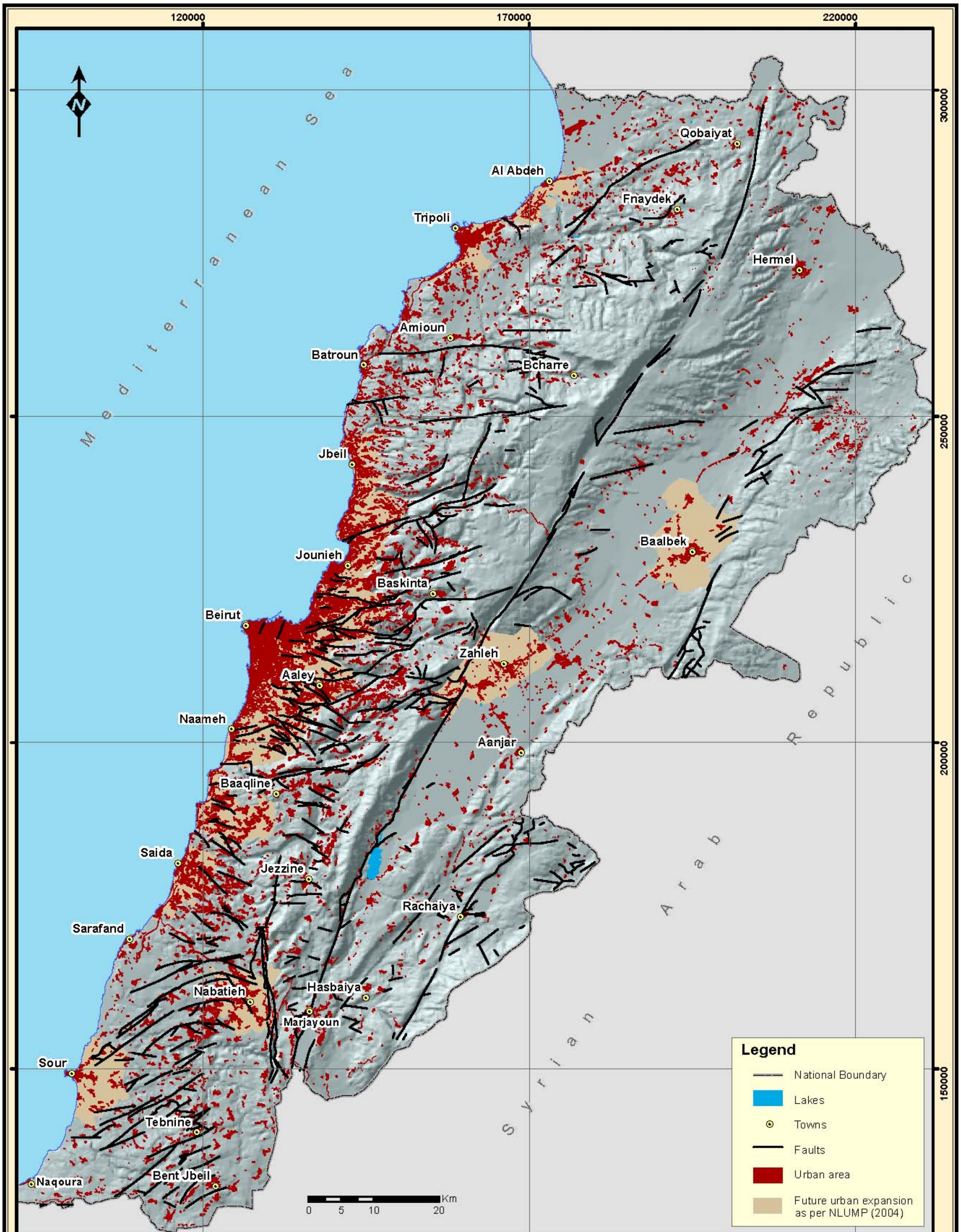
Map 4 - Lebanon's Simplified Land Cover Map (2002)

DISCLAIMER: This map was prepared by ECODIT based on MOE-NCSR (2002) and National Land Use Master Plan (2004). Every effort has been made to ensure the accuracy of the information displayed on this map. The international boundaries are approximate. MOE/UNDP/ECODIT do not assume any responsibility for any decision that may arise from the use of the map.



State & Trends of the Lebanese Environment Chapter 6 - Land Resources	**Map 5 - Extent of Zoning and Urban Master Plans in Lebanon (2004)**

DISCLAIMER: This map was prepared by ECODIT based on National Land Use Master Plan (2004). Every effort has been made to ensure the accuracy of the information displayed on this map. The international boundaries are approximate. MOE/UNDP/ECODIT do not assume any responsibility for any decision that may arise from the use of the map.



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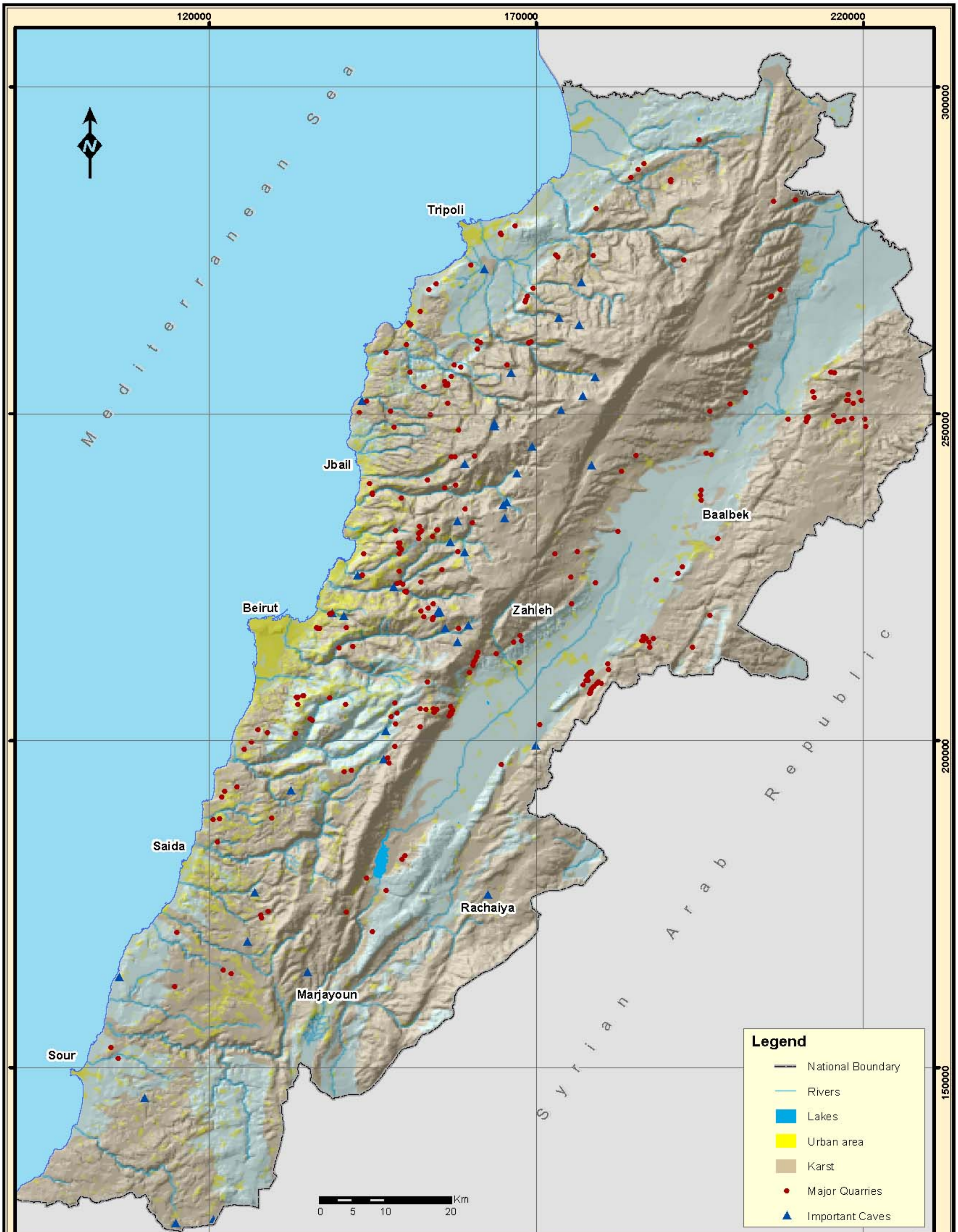
Map 6 - Location of Major and Minor Faults and Urban Agglomerations

DISCLAIMER: This map was prepared by ECODIT based on National Land Use Master Plan (2004). Every effort has been made to ensure the accuracy of the information displayed on this map. The international boundaries are approximate. MOE/UNDP/ECODIT do not assume any responsibility for any decision that may arise from the use of the map.



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Map 7 - Lebanon's Karst Heritage and Vulnerability

DISCLAIMER: This map was prepared by ECODIT based on National Land Use Master Plan (2004). Every effort has been made to ensure the accuracy of the information displayed on this map. The international boundaries are approximate. MOE/UNDP/ECODIT do not assume any responsibility for any decision that may arise from the use of the map.

ANNEX 1 IMPORTANT KARSTIC SITES IN LEBANON

Site	Age & Formation	Type & importance to GW	Protection Status	Condition	Require spatial expansion	Remarks
Baatara (Tannourine)	Jurassic rocks / Kesrouan	Sinking Stream/ High	Protected under MOE Decision 8/1 dated 2004	Good	Yes	Need to extend the protection perimeter to also include Balaa pothole and Jouret el Abeb
Qammouaa (Akkar)	Cretaceous Rocks / Cenomanian	Polje/High	MoA Decision 165 dated 1991 to protect the forests in the Mountain. Touristic Sites declared by MoT Decision no. 198/1993	Moderate	Yes	Need to cover the entire doline area and surrounding mountains
Afqa	Cretaceous Rocks / Cenomanian	Cave-Spring / High	Need protection as of MoE	Bad	Yes	Need to be part of the area that of the high mountain protection zone
Tarchich	Jurassic rocks / Kesrouan	Sinking stream-underground river / High	Need protection as of MoE	Bad	Yes	Need to extend it to become part of Beirut river along with Qattine Azar sinkhole
High Mount Lebanon area: Jabal Kneisseh, Jabal Sannine, Ouyoun el Siman, Jabal Kesrouan, Aaqoura-Tannourine Plateau, Jabal El Makmel	Cretaceous rocks / Cenomanian	Doline field, sinkholes and caves / High	Needs protection as of MoE	Moderate	Yes	Small portions protected but its importance natural beauty, Biodiversity and source of groundwater requires protection
Kfardibian Natural bridge	Cretaceous rocks / Mdairej	Natural Bridge / No	Natural Site by Decree 434/1942	Moderate	Yes	Need to expropriate lands and compensate owner
Jaj Mountain (Between Jajj-Tannournine-Qartaba and Ehmej villages)	Jurassic rocks / Kesrouan	Doline field / High	Hima and Forests by MoA Decision 499 of 1996	Moderate	Yes	Natural beauty and biodiversity and importance for groundwater require extension to cover the rest of the Mountain.
Barouk Mountain	Jurassic rocks / Kesrouan	Doline / High	Natural reserve by Law no. 532 of 1996. Hima and Forests by MoA Decision 127 of 1991	Moderate	No	Natural beauty and biodiversity and importance for groundwater. Under threat from quarrying.
Shatawie Cave	Jurassic rocks / Bikfaya	Cave and spring / high	Needs protection as of MoE	Bad	Yes	Natural beauty and importance for groundwater require extension to cover the rest of the area
Jeita cave	Jurassic rocks / Kesrouan	Cave and spring / high	Show cave	Moderate	Yes	Natural beauty and importance for groundwater require extension to cover the rest of the area

ANNEX 2 OTHER PROTECTED SITES IN LEBANON

Decision	Date	Description	Location
Decree 434	1942	Cedars of the Lord Deir El Kalaa Bolonia Forests Mrouj Oaks Beirut Pine Forest Baalbek Heritage Constructions Yammouneh Lake Natural Bridge Site on Al Laban Spring	Bcharre Metn Metn Metn Beirut Baalbek Bekaa Kesrouan
Ministry of Environment			
15/1	1995	Prevent any action or making any changes in the vicinity of Faqra Natural Bridge in the district of Kesrouan	Kesrouan
151	1997	Kadisha Valley	Bcharre
34	1997	Ibrahim River to sea outfall	Jbail
200	1997	Coastal Front Rocks of Wata Silm	Tabarja
22	1998	Al Jawz River to sea outfall	Batroun
29	1998	Al Damour River to sea outfall	Shouf
97	1998	Al Kalb River to sea outfall	Kesrouan
130	1998	Beirut River to sea outfall	Beirut and ML
131	1998	Al Awali River to sea outfall	Saida
132	1998	Forests between Ain El Hour- Daraya- Debiyé- Bérjin; Sheikh Osman Forest; Deir al Mokhalis surrounding; Ain w Zein Hospital surrounding; Dalboun forest; Al Mal valley; Kafra wells; Ainbal valley sites	Shouf
187	1998	Al Makmel Mountain	North Lebanon
188	1998	Arka River to sea outfall	Aakkar
189	1998	Al Assi River to sea outfall	Hermel
19	2002	Al Kammoua Area	Aakkar
21	2002	Al Qaraqeer Valley	Zgharta
22	2002	Dalhoun Forest	Shouf
8	2004	Baatara Sinkhole	Tannourine
Ministry of Tourism			
198	1993	Arqa Village - Historical monuments	Aakkar
198	1993	Kammoua Village - Natural landscape	Aakkar
634	1999	Beni Saab Farm - Natural landscape	Bcharre
262	2004	Al Shawaghir Village - Historical monuments and natural landscape	Hermel
263	2004	AlHibariya Village - Historical monuments and natural landscape	Hasbaya
264	2004	Zanoubiya Village - Historical monuments and natural landscape	Baalbeck-Hermel
265	2004	Shaqra & Dobiya Villages - Historical monuments & natural landscape	Bint Jbeil
266	2004	Jbaa Village - Historical monuments and natural landscape	Shouf
267	2004	Arnoun Village - Historical monuments and natural landscape	Nabatieh
268	2004	Mezyara Village - Historical monuments and natural landscape	Ehden
269	2004	Shameh Village - Historical monuments and natural landscape	Sour
270	2004	Hardeen Village - Historical monuments and natural landscape	Batroun
271	2004	Kosba Village - Historical monuments and natural landscape	Koura
325	2004	Qaa El Rim Village - Historical monuments and natural landscape	Zahleh
UNESCO World Heritage			
SC-84/ CONF.004/03	1984	Anjar	Bekaa
SC-84/ CONF.004/03	1984	Baalbek	Baalbek
SC-84/ CONF.004/03	1984	Byblos	Jbail
SC-84/ CONF.004/03	1984	Tyre	Sour
WHC98/CONF.203/ 10Rev.	1998	Wadi Qadisha (the Holy Valley) and the Cedars Forest of Bsharre (a.k.a. Ghabet Arz el-Rab)	Bcharre
UNESCO Biosphere Reserve			
-	2005	Shouf Biosphere Reserve	Shouf
-	2009	Jabal Moussa Biosphere Reserve	Kesrouan
	2009	Jabal el Rihane	Jezzine

ANNEX 3 SELECTION OF NGO'S WITH ACTIVITIES RELATED TO LAND RESOURCES

(Listed by establishment year)

NGO Name	Field of Activity	Achievements
Association pour la Protection des Sites et Anciennes Demeures au Liban, APSAD (established in 1960)	Promote the protection and restoration of ancient buildings that carry historical and/or unique architectural value. Lobbies for promulgating laws and regulations protecting the architectural heritage	Active since 1962 in the restoration and rehabilitation of traditional Lebanese houses (historical façades), old souks, khans, and old streets (Jbeil, Jounieh, Bikfaya, Zouk Mikhael, Deir El Kamar, etc.). Lobbied for protecting a historical building in Sodeco (Beirut) and converting it into a museum *Beit Beirut*.
Friends of the Cedars of Bsharre Committee (established in 1986)	Charged by the MOT to oversee and manage the ancient cedar grove of Bcharre (Arz el Rab, a World Heritage Site). Implement increasingly larger and bolder reforestation activities in the area of Bcharre.	The organization manages its own plant nursery (located in Bcharre) and transplants approximately 10,000-12,000 seedlings per year, mostly cedars, to restore the cedar mantle overlooking the Qadisha Valley.
Association for Forest Development and Conservation, AFDC (established in 1995)	Community-based forest management and conservation including fire prevention. Build awareness and raise capacities in support of national efforts to improve environmental management.	COM approved a MOU between MOE and AFDC to develop and implement an action plan for forest fire prevention and landscape restoration (Decision 138 dated 27/10/2007). Working in collaboration with the World Conservation Union (IUCN), AFDC released in May 2009 the long-awaited "Lebanon's National Strategy for Forest Fire Management: Building Partnerships".
Mada (established in 2000)	Reinforce the relationship between local communities and their natural environment for the satisfaction of their subsistence needs especially in Aakkar, Donnieh and Hermel	In 2006, Mada defined a pilot zone (about 270 km^2) stretching from Brissa to Qbaiyat, and signed cooperation protocols with the municipalities of Qbaiyat, Hrar, Michmich and Fnaideq to formulate a regional action plan to promote and enhance the natural resources of the area. The organization also conducted studies on flora and avifauna and will soon extend those studies to fauna as well. The proposed national park is today embedded in the NLUMP (Decree 2366 dated 20/06/2009) along with six other regional parks.
Lebanon Mountain Trail Association, LMTA (established in 2007)	Develop, maintain and promote the Lebanon Mountain Trail, a 440km path that crosses 75 towns and villages; protect the natural, cultural and architectural heritage and landmarks near the trail; enhance economic opportunities by promoting responsible tourism	Prepared and updates a complete set of communication material including brochures and maps; attracts more than 30,000 visitors on the trail every year; organizes an annual thru-walk spanning 30 days; co-sponsored the production of a coffee-table book *A Million Steps;* organizes training for local guides; lobbies MOT for recognition of local guesthouses and MOE for protection of trail corridor.
Jouzour Loubnan (established in 2008)	Participate in the restoration of Lebanese woodland and promote sustainable forestation in arid regions	Implemented dozens of reforestation campaigns including in Ehmej and Chabrouh (Oct-Nov 2009) and in Kfardebian (Oct–Nov 2010) with local community participation .

ANNEX 4 ZONING ACCORDING TO NATIONAL LAND USE MASTER PLAN

Based on Decree No. 2366 dated 20 June 2009

Table A – part of Decree 2366 dated 20/6/2009

	U Urban	R Rural	A Agricultural	N1 Natural/Peaks	N2 Natural/Cedars	N3 Natural/Corridor
General exploitation factor	Medium to high	Medium	Medium inside the residential areas Low outside the residential areas	Very low except for general technical facilities and military facilities	Very low except for ski resorts	Medium inside the residential areas Low outside the residential areas Very low in forests and on slopes of 30%
Buildings Height	Medium to high	Medium inside the residential areas Low outside the residential areas	Low to medium inside the residential areas Very low outside the residential areas	Very low	Low in the residential areas Very low outside the residential areas According to a carrying capacity plan for ski resorts	Medium inside the residential areas Low outside the residential areas
Buildings Setbacks	According to local guidelines	10 meters from rivers border	10 meters from rivers border	No specific additional conditions	20 meters from forests border according to village Master Plan recommendations	10 meters from rivers border during winter
Urban expansion and its location in respect to the current urbanized areas	No specific additional conditions	Preferably near the urbanized village, unsuitable far from it	Preferably near the urbanized village, unsuitable far from it	No specific additional conditions	Preferably near the urbanized village, unsuitable far from it	Preferably near the urbanized village, unsuitable far from it
Land sorting for construction	Possible	Possible near the urbanized village	Preferably near the urbanized village	Not possible except for general technical facilities and military facilities	Preferably near the urbanized village, unsuitable far from it	Preferably near the urbanized village, unsuitable far from it except for touristic resort after the submission of EIA and landscape study
Large Scale Projects	Possible	Possible	Preferably near the urbanized village	Not Possible	Possible for ski resorts after the submission of EIA and landscape study	Possible for touristic resort after the submission of EIA and landscape study
Quarrying	Not possible	Forbidden in the forests Possible on a distance above 500m from rivers border	Possible after the submission of EIA and re-vegetation study for the cover of the quarry site	Not possible	Not possible	Forbidden in the forests Possible on a distance above 500m from urbanized areas and from shore border
Industries and industrial facilities	Possible for industries of 1st, 2nd, 3rd class after the submission of EIA and landscape study	Possible	Possible for industries of 3rd, 4th, 5th class, must abide by environmental guidelines	Not possible	Possible for mineral waters facilities, for vital cooperative facilities such as petrol stations after the submission of EIA and landscape study	Possible for industries of 3rd, 4th, 5th class, must abide by environmental guidelines

Table B – Part of Decree 2366 dated 20/6/2009

	P View area of natural sites	S1 500 Radius around classified sites	S2 500 Radius around special natural sites
General exploitation factor	Very low, except inside the residential areas	• Nil outside the residential areas • Very low for zones classified A, N, R • Designated as per terms of zone U	• Nil outside the residential areas • Very low for zones classified A, N, R • Designated as per terms of zone U
Buildings Height	• Low to medium in the residential areas • Very low outside the residential areas	Low for zones classified A, N, R and in a distance selected as per terms of zone U	Very low for zones classified A, N, R and in a distance selected as per terms of zone U
Buildings Setbacks	According to local guidelines	50 meters from site's border except for zone U	50 meters from site's border except for zone U
Urban expansion and its location in respect to the current urbanized areas	Preferably near the urbanized village	No specific additional conditions	No specific additional conditions
Land sorting for construction	Possible following the submission of Project's landscape study and its impact on the general view	Possible following the submission of Project's EIA study and its impact on the site	Possible following the submission of Project's EIA study and its impact on the site
Large Scale Projects	Possible following the submission of Project's landscape study and its impact on the general view	Possible following the submission of Project's EIA study and its impact on the site	Possible following the submission of Project's EIA study and its impact on the site
Quarrying	Not possible	Not possible	Not possible
Industries and industrial facilities	Possible following the submission of Project's landscape study and its impact on the general view	Not possible on 50 m radius from the site	Not possible on 50 m radius from the site

Table C – Part of Decree 2366 dated 20/6/2009

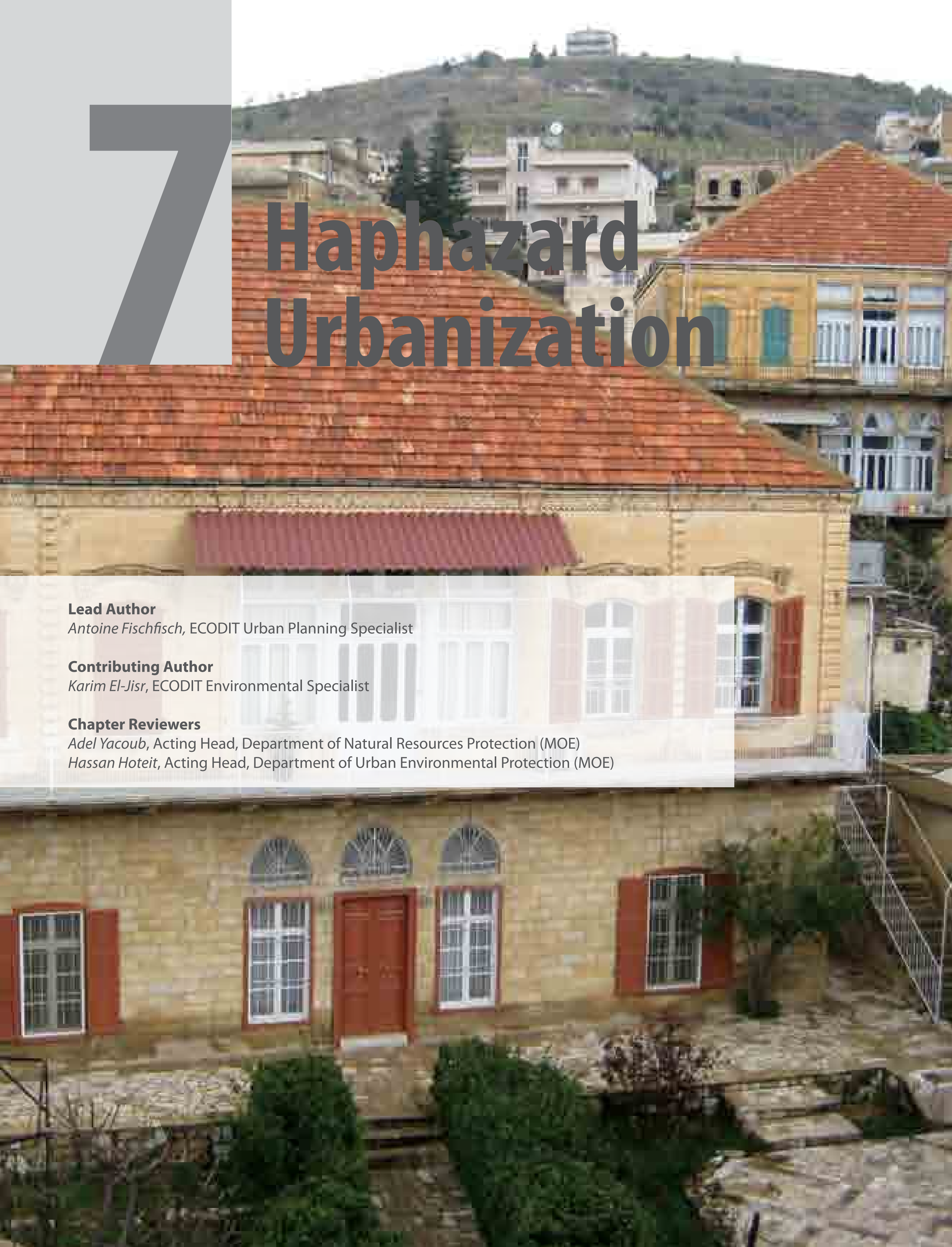
	F* Prone to flooding	G** Prone to landslides and rock fall-down	W Prone to underground water pollution
General exploitation factor	Very low to take into account existing conditions	• Very low • nil or close to nil on slopes above 10% (natural land before settlement) taking into account existing conditions	In case of no existing wastewater network, medium in zones U and R, low in zones A and N3, very low in N2 zone, non-existent in N1 zone
Buildings Height	Low taking into account existing conditions	• Construction forbidden in zone N1 • Low taking into account existing conditions	No specific additional conditions
Buildings Setbacks	80% of the plot area remain natural (gardens without tiling) taking into account existing conditions	80% of the plot area remain natural taking into account existing conditions	No specific additional conditions
Urban expansion and its location in respect to the current urbanized areas	Imposed along residential areas taking into account existing conditions	No specific additional conditions	No specific additional conditions
Land sorting for construction	Possible with a study that proves there are no threats and no double threats in the neighborhood	Possible along residential areas with a study that proves there are no risks, no threats and non-double threat in the neighborhood	Possible if existing wastewater network. If not, a wastewater network and a wastewater treatment plant must be totally implemented before any execution of road networks and construction activities
Large Scale Projects	Possible if a study proves the safety of the Building occupants	Possible with a study that proves there are no threats and no double threats in the neighborhood during and after investment	Possible if existing wastewater network. If not, a wastewater network and a wastewater treatment plant must be totally implemented before any execution of road networks and construction activities
Quarrying	Possible with a study that proves there are no threats and no double threats in the neighborhood during and after investment	Possible with a study that proves there are no threats and no double threats in the neighborhood during and after investment	Possible with a study that proves the absence of any possibility of destabilizing the rock formation in the ground that would change groundwater streams or impact springs
Industries and industrial facilities	Possible for industries that do not generate solid or liquid waste that contain poisonous or toxic components that will possibly leak into the underground in case of floods	Possible with a study that proves there are no threats and no double threats in the neighborhood during and after investment	If no wastewater network prevention of industries that could contaminate groundwater
Public facilities	Possible if a study proves the safety of the Building occupants	Possible if a study proves the safety of the Building occupants	Possible if total implementation of procedures to treat wastewater

Section III: Environmental Priorities

Chapter 7 **Haphazard Urbanization**

Chapter 8 **Solid Waste**

Chapter 9 **Energy Crisis**



7 Haphazard Urbanization

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ABBREVIATIONS & ACRONYMS

COM	Council of Ministers
DGUP	Directorate General of Urban Planning
GBA	Greater Beirut Area
GOL	Government of Lebanon
HCUP	Higher Council of Urban Planning
MOE	Ministry of Environment
MOF	Ministry of Finance
NCSR	National Council for Scientific Research
NLUMP	National Land Use Master Plan
OEA	Order of Engineers and Architects
SOER	State of the Environment Report

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Haphazard and rampant urbanization in Lebanon is attributed to many historical, political and socio-cultural factors. *See alternative definitions in Box 7.1.* Rural migration and the evolution of a society towards industry and the provision of services have rendered cities and towns the principle source of jobs and income. The cultural and political appeal of cities (e.g., Beirut, Tripoli) encourages more people to relocate to cities despite the rising cost of living and housing. Rising real estate costs intensifies construction and the use of land.

Urbanization occurs naturally from individual and corporate efforts to reduce time and expense in commuting and transportation while seeking better jobs, education, housing, and transportation. People move into cities to seek economic opportunities. In rural areas, it is difficult to improve one's standard of living beyond basic sustenance. Farming is dependent on unpredictable environmental conditions, and in times of drought, flood or pestilence, survival becomes problematic. Cities, in contrast, are known to be places where money, services and wealth are centralized. Businesses, which generate jobs and capital, are usually located in urban areas. Ironically, the perception that cities offer unlimited jobs and wealth has created poverty belts around all major Lebanese cities including Beirut, Tripoli, Saida and Nabatieh.

Box 7.1 What is urbanization?

Urbanization is the physical growth of urban areas as a result of global change. Urbanization is also defined by the United Nations as movement of people from rural to urban areas with population growth equating to urban migration. The United Nations projected that half of the world's population would live in urban areas at the end of 2008.

Source: Wikipedia, the Free Encyclopedia

Urbanization is the movement of population from rural to urban areas. It results in increasing proportion of a population that resides in urban rather than rural places. It is derived from the Latin 'Urbs' a term used by the Romans to a city. Urbanization is closely linked to modernization and industrialization.

7.1 DRIVING FORCES

7.1.1 The Lebanese Context

The sanctity of the private property is rooted in the Lebanese Constitution. According to Article 15 of the 1923 constitution, "private land is under the protection of the law, no land can be taken away from his owner, except in cases that serve the public interest and as established by law, and only after the owner has been duly and fairly compensated"[1]. This article has in practice sanctified the private ownership in Lebanon. Landowners often brandish this article to justify their actions, even if at the expense of the environment including natural resources and landscape. So far, expropriation of private lands has been linked to the provision of public goods and services including roads, electricity and water. There has been no reported case of expropriation of private land to support conservation efforts or the protection of ecosystem services. Inadequate appreciation of current urban planning laws and regulations, and the allure of profit and wealth from the construction industry, exacerbate construction and urban sprawl in natural areas that are poorly serviced or poorly suited for construction activity.

[1] الملكية في حمى القانون فلا يجوز ان ينزع عن احد ملكه إلا لأسباب المنفعة العامة في الاحوال المنصوص عليها وبعد تعويضه منه تعويضا في القانون عادلا (Lebanese Constitution, Article 15, 1943)

Another dimension to urbanization in Lebanon is limited land area and high population density. The country is very small (ranks 166 among 235 countries) and predominantly mountainous (about 75%). Steep valleys trending east-west are generally unsuitable for construction and require very expensive and meandering roads to connect towns and villages across the valley. A third dimension to urbanization in Lebanon

Rampant construction degrade landscapes and natural resources is income level and lifestyle. Many people are able to afford secondary housing, by renting or buying a summer house (apartment or villa) or a chalet (mountain and beachfront resorts). In 2004, there were at least 68,620 secondary houses in Lebanon, which is equivalent to five percent of the total housing stock (CAS, 2004). Secondary housing is not inexpensive, increases demand on construction material, and accelerates urbanization. There are no restrictions on secondary housing and such housing stands empty during many months each year.

7.1.2 Inadequate Master Planning

Urban master planning in Lebanon is rudimentary. Urban master plans are primarily concentrated along the coastal zone and large agglomerations (Verdeil *et al.*, 2007). An estimated 84 percent of the country has no master plans yet. Unplanned areas, called *manateq ghayr mousannafa* are administered and managed by blanket regulations that rely on two factors: lot coverage and floor-area-ratio. Until 2004, these coefficients were 40 and 80 percent respectively. In other words, a landowner could build on 40 percent of his land parcel and build two floors to achieve a floor-area-ratio of 80 percent. Since 2004, these coefficients were revised down as shown in Table 7.1.

Table 7.1 Land use coefficients in unplanned areas – 2004 (*manateq ghayr mousannafeh*)

Zone	Built Up Area	Floor-Area-Ratio
Summer areas*	25%	50%
Residential	25%	50%
Non-residential, agricultural and valleys	Construction not permitted**	

* Selected areas above 800 meters

** Except if expressly approved by the DGUP

At the administrative level, there are significant deficiencies in the information base. In particular:

- About 50 percent of the country has not been surveyed yet. Areas that have not been demarcated rely on very approximate maps most of which were drawn many decades ago based on aerial photos and with a high margin of error. It should be noted however that at least 80 percent of the territory has been delineated and freed of other obligations; a legal procedure that precedes formal survey and demarcation of properties (COMAP, 2007).
- Since about 10 years, the Directorate General of Land Registration and Cadastre at the Ministry of Finance (MOF) has been surveying the entire territory, particularly, in mountain areas. Progress has been slow partly due to bureaucratic procedures and partly due to the substandard performance of some topographers.
- Although the Central Administration of Statistics (CAS) has made significant progress in compiling primary data, statistical information about many services and living conditions are either incomplete or updated too infrequently. Such data groups include *inter-alia* water networks and resources, wastewater networks, electricity, profile of land owners (residents, non residents, non-Lebanese, etc.), detailed land use maps, soil type, as well as other data groups related to anthropology and sociology.
- A significant number of regional master plans were prepared by non-specialists; by architects and/or civil engineers who have no prior experience or competencies in urban planning. Their work is further complicated and constrained by the lack of basic socio-economic data and substandard follow-up and supervision by public administrators.
- The majority of technical employees working at the Directorate General of Urban Planning (DGUP) -including regional departments- are architects and civil engineers with little expertise in urban planning (according to Decree 10490/1997, the DGUP personnel comprise 26 engineers, 16 technicians and 28 admin staff). This monochromatic composition is not conducive to sound urban planning which requires other expertise including sociologists, anthropologists, land management specialists, and environmental specialists.

All these deficiencies have a compounding effect on the final product. Master plans are frequently inadequate and fuzzy, dealing with zoning only from the perspective of permissible built-up area and total allowable height with little regards to other vital factors. Master plans are rarely conceived holistically and often fail to include the necessary environmental infrastructure. The case of Solidere in Beirut's city center is an interesting example of town planning that is based on urban morphology and has successfully restored the architectural and homogeneity of each islet. However,

Coastal zone of Sahel Aalma, Harissa in Jounieh

Solidere has achieved little insofar as developing environmental services and amenities. Despite great efforts to build state-of-the art infrastructure, including street furniture and landscaping, the area still lacks public gardens, dedicated bicycle lanes, parking area, and a wastewater treatment facility.

In many cases, urban master plans were approved with grave errors or implications on the environment. For example, the coastal zone of Sahel Aalma in Jounieh banned all forms of terracing (or benching) on construction lots. This restriction had a perverse effect on urban morphology as engineers and architects had to lower the building level to avoid terracing. This led to excessive excavation of the lot and loss of top soil and trees (the original objective of the restriction was to maintain the building skyline below the pine canopy). Excessive excavation also impaired groundwater recharge and the natural flow of groundwater. Other master plans are simply not sustainable because they introduced and allowed building coefficients that exceed the service capacity of access roads and urban infrastructure (e.g., Sarba- Sahel 'Alma in Jounieh, El Qobbeh in Tripoli, Ain el Roummaneh in Beirut).

7.1.3 Vibrant Real Estate Sector

Lebanon has witnessed an unprecedented increase in real estate prices (lands and buildings) in recent years. Contributing factors include the (1) reconstruction efforts after the July 2006 war and (2) the global financial crisis and credit crunch. The financial crisis affected several countries in the gulf region and encouraged many investors to channel some of their capital in the Lebanese real estate sector which has demonstrated resilience and growth. A sizeable number of foreigners and expatriate Lebanese who work abroad started buying property in Lebanon on a significant scale, driving prices upward as demand exceeded supply. The continued increase in real estate prices has been so significant that many Lebanese working in Lebanon can no longer afford to buy a home without commercial financing –*see more details in Chapter 6.*

The extent of lands bought by non-Lebanese is alarming. Lebanese legislation related to foreign ownership of land and property in Lebanon is very supple. A critical review of the legislation (in particular Decree 11614 dated 4/1/1969 and Decree-Law 296 dated 3/4/2001) shows that restrictions are ludicrous and do not serve the supreme interest of Lebanon (see relevant provisions of the legislation in Box 7.2). Key deficiencies are summarized below:

Box 7.2 Property ownership by non-Lebanese

Non-Lebanese can own property in Lebanon. They can buy and own up to 3,000 m^2 without any restrictions. If they wish to buy more than 3,000m^2, they require prior approval by the Council of Ministers. Overall, the cumulative area owned by non-Lebanese cannot exceed three percent of the territory, three percent in each caza, and 10 percent in Beirut.

Source: Decree 296 dated 3 April 2001

1) No overarching notion that properties are «Lebanese lands for the Lebanese people»
2) Land purchases by non-Lebanese are not subject to reciprocity *«mou'amala bil mithil»*. There is no agreement signed between the Government of Lebanon and other countries to that effect.
3) No restriction on non-Lebanese to buy lands near the international borders. This deficiency is particularly grave considering the persistent lack of demarcation of Lebanon's international frontiers with Syria and Occupied Palestine.
4) There is no upper limit on the total surface area that non-Lebanese can buy and own after obtaining prior approval from the COM. Provided the three percent rule is respected (and 10 percent in Beirut), and the COM approves the transaction, then a buyer can own millions of m^2 concentrated in one location or distributed in several locations across the country. In fact, there is no clear procedure in place, or criteria, for approvals by the COM of applications to buy land and property that exceed 3,000m^2.
5) Keeping track and count of the cumulative ownership of non-Lebanese is very difficult, almost impossible in some cases, as more than 50 percent of the territory has not been surveyed yet (*aradi ghair mamsou7ha).*
6) Taxes paid by non-Lebanese buyers are almost identical to taxes paid by Lebanese buyers. In both cases, there is no tax on capital gain which encourages non-Lebanese to buy and resell lands with profit, depriving the public treasury from colossal revenues.
7) Non-Lebanese buyers have up to five years to implement their projects on the lands they bought. According to Decree-Law 296/2001, if works are not completed within this period, then the lands will return to the state. In practice, this has never happened to date (non-Lebanese can own lands for decades without commencing any works and with no scrutiny whatsoever).

In short, Lebanon is home to one of the world's most vibrant real-estate markets. The real estate sector, which accounts for some six billion dollars in Lebanon's economy, has traditionally been a catalyst of growth. Thirteen to fifteen percent of state revenues come from real estate transactions. This sector is supported by a very developed real estate property law, which guarantees rights to private property that is registered with the Government (UNDP website). The custodian of property rights is the Directorate General of Land Registration & Cadastre at the Ministry of Finance.

7.2 CURRENT SITUATION

7.2.1 Extent of Urbanization

Master plans need to be approved by the DGUP and decreed by the COM within a maximum period of three years. If the approved master plan is not decreed by the COM within three years, then the master plan is considered void and is replaced by the urban planning regulation in vigor before the master plan was approved by the DGUP. In 2000, decreed master plans covered 1,091 km^2 (10.4% of the territory), while un-decreed master plans covered an additional 614 km^2 (5.8%) – these master plans await their corresponding decree. Therefore, until 2004, the total area covered by master plans (approved/decreed and approved/non-decreed) is about 1,705 km^2 (16.2%). The remaining area (83.8%) is unplanned (*ghayr mousannaf*) and only partially surveyed (*ghayr mamsouh*).

Like the rest of the world, Lebanon is urbanizing – *see relevant statistics in Box 7.3.* The National Land Use Master Plan presented detailed land cover and land use maps for Lebanon. Although the results of the master plan were published in 2004, land cover data was based on 1998 satellite images provided by MOE and the NCSR (IRS and LandSat images). According to this plan, urban areas in the beginning of the 1960s covered approximately 260 km^2 and by 1998 this coverage had increased to 649 km^2 (see evolution of urban areas between 1963 and 1998 in Figure 7.1). The urban areas were further subdivided into four broad categories (see percentage distribution in Figure 7.2):

1) Urban zones: This category includes continuous and discontinuous urban areas, tourist complexes and archeological sites.
2) Infrastructure and activity zones: This category includes road networks, seaports, airports, and industrial and commercial zones.
3) Non-built artificial zones: This category includes quarries, dumpsites, landfills, sea reclaimed land, construction sites, urban vacant plots.
4) Artificial green zones: This category includes sport centers, public parks.

The Master Plan further estimated that urbanization would every year consume an additional 10km² of natural areas. A more accurate method for estimating urban growth over time is based on a total floor area approved through construction permits (see permit data in Chapter 6).

Box 7.3 Urbanization in Lebanon

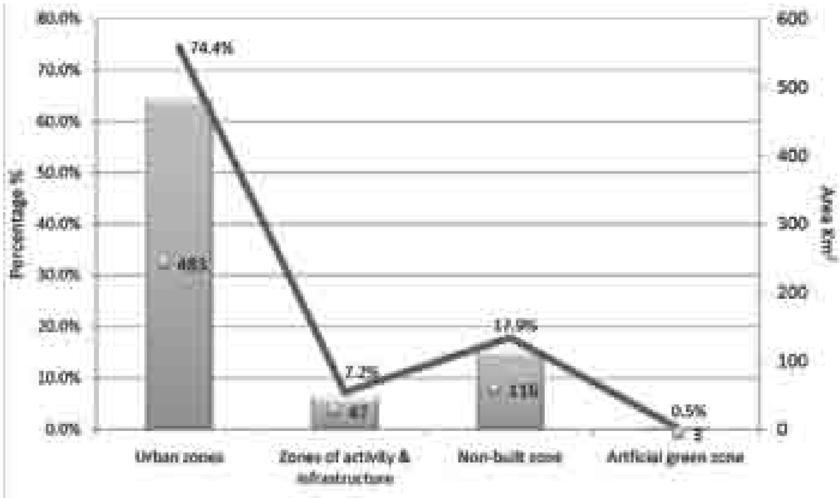
Population density: 400 persons/km² (including Palestinian refugees)

Source: WB, 2010

Urbanization rate: 88% (2005)
Urban population growth rate: 2.2% (2005)

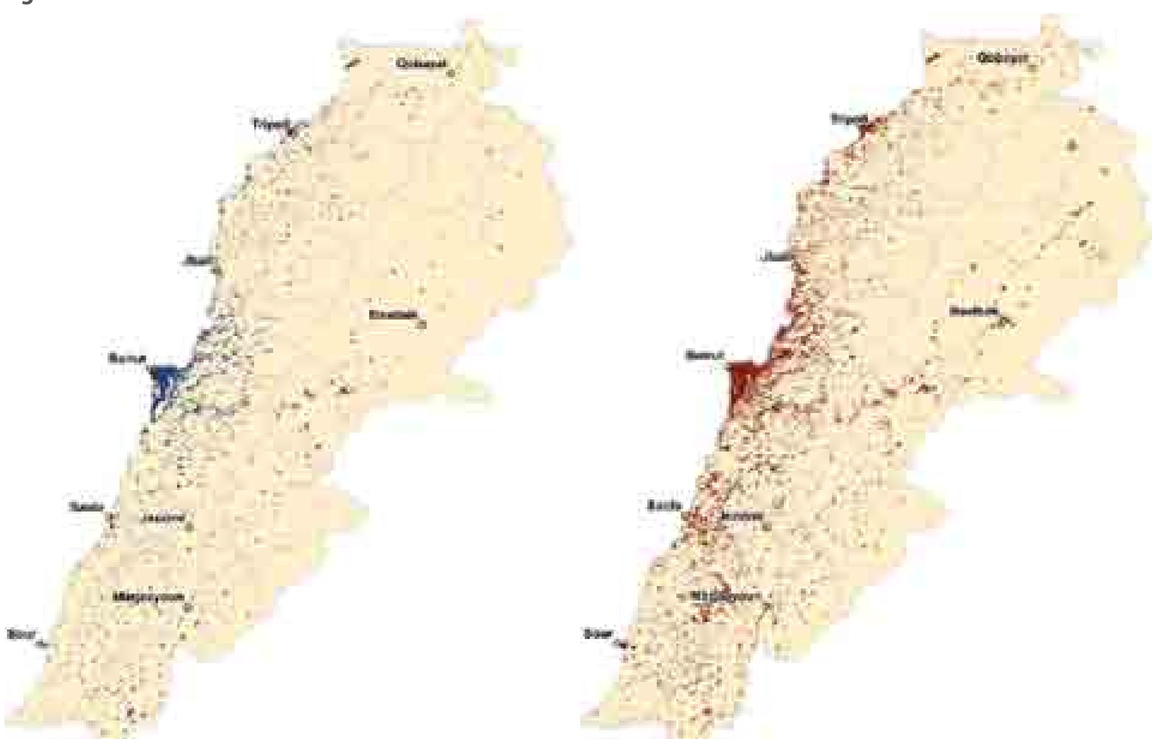
Source: At A Glance - Lebanon Statistics, UNICEF 2007

Figure 7.2 Total urban area in Lebanon by category (1998)



Source: CDR-NLUMP (2004)

Figure 7.1 Urbanization in Lebanon between 1963 and 1998



(a) Urban areas in 1963

(b) Urban areas in 1998

Source: CDR-NLUMP, 2004


General view of Greater Beirut Area

This method is based on several assumptions including the percent of permits actually implemented, and the number of floors actually built (a high-rise building consumes more floor space than a low-rise building). According to this method, the annual growth rate is closer to $5km^2$. Notwithstanding the impact of the war in July 2006 and the recent global financial crisis on the construction sector in Lebanon, it can be estimated that total urban area between 1998 and 2010 increased to about $709-769km^2$ (equivalent to 7-8% of the territory) depending on which growth scenario is used. The National Center for Remote Sensing (part of the NCSR) is currently updating the land use and land cover data for Lebanon and will release new data in 2011.

Urban expansion

Urban expansion in Lebanon can be categorized into circular, linear and leap-frog. *Circular* (or concentric) expansion is very visible around major cities and towns including Beirut, Baalbeck, Zahleh, and Marjayoun. *Linear* expansion (or ribbon construction) occurs when towns and villages expand along major roads, creating long rows of residential housing units and commercial centers on both sides of a road. Noteworthy examples include the coastal highway (from Beirut to Jounieh and from Beirut to Sarafand) and selected inland regions (from Tripoli to Halba in north Lebanon and from Zahrani to Nabatieh in south Lebanon). *Leap-frog* development occurs when developers build new residences some distance from an existing urban area, bypassing vacant parcels located closer to the city, examples include Mechref Village (Mechref), Pine Hills (Chbanieh), Pine Park (Roumieh) and Beit Misk (Bhersaf). The land in between is suddenly accessible to more people and thus attractive to commercial developers and to urbanization. *See urban expansions in **Map 8**.*

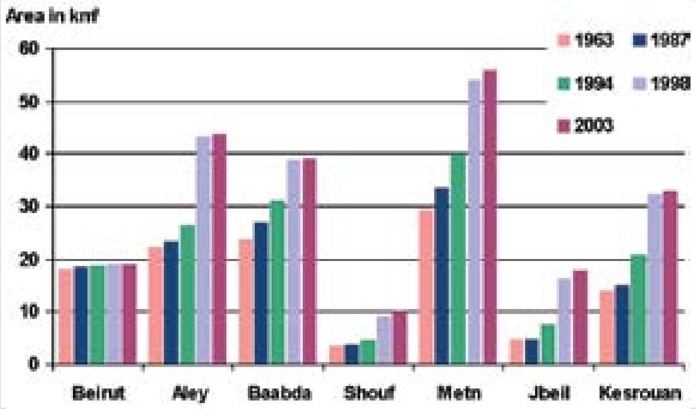
Greater Beirut Area

Lebanon's major urban pole is the capital Beirut which has grown into a 1.8 million-people agglomeration better known as the Greater Beirut Area (GBA). The city has over the last

Box 7.4 Evolution of urban areas in Beirut and selected *cazas* in Mount Lebanon

Year	Total Urban Area (km^2)	Annual Growth (km^2/year)
1963	116	
1987	126	0.74
1994	149	3.40
1998	213	15.69
2003	219	1.27

Source: Faour et. al, 2005



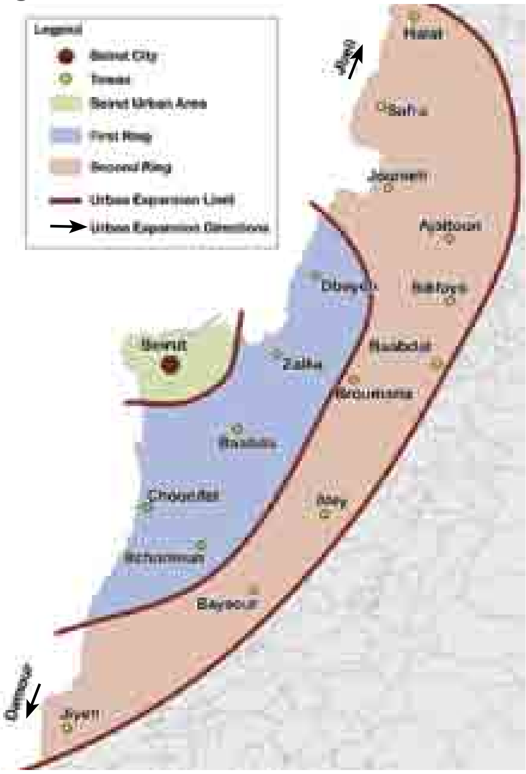
three decades expanded in three distinct directions: (1) northward in the direction of Jbeil, (2) southward in the direction of Damour, and (3) eastward into Aley, Broumana, Bikfaya and Bchamoun. In practice, all the cities and towns that are located within a 20km-radius from Beirut are today largely connected to Beirut city by construction. GBA stretches over 60km from north to south between Halat and Jiyeh (nearly 30% of the Lebanese coastline) and covers 468 km^2 (Faour et al., 2005). Illustratively, GBA can be divided into two rings: (1) the first ring stretches from Dbaye to Khaldeh (below 400m of altitude), and (2) the second ring stretches further north and south of Beirut from Jounieh, to Ajaltoun, Bikfaya, Broumana, Aley, Baysour, Jieh and Damour. *See urban extent in Figure 7.3*

Faour also studied the rate of urban growth in Beirut and selected *cazas* in Mount Lebanon during the period 1963-2003 (Faour et. *al* 2005). His analysis shows that Beirut did not grow much during this period, primarily because the city is already built-up and there are very few vacant lands, whereas the *cazas* of Aley, Baabda, Shouf, Metn, Jbeil and Kesrouan have shown tremendous growth rates since four decades. For example, in Aley, urban areas doubled in coverage from 22 km^2 in 1963 to 44 km^2 in 2003, and in Kesrouan, the urban coverage more than doubled from 14 km^2 in 1963 to 33 km^2 in 2003. *See key findings in Box 7.4.*

Informal settlements

According to UNRWA, there are 12 formal camps in the country (Ain El Helwe, Beddawi, Burj Barajneh, Burj Shemali, Dbayeh, El Buss, Mar Elias, Mieh w Mieh, Nahr el Bared, Rashidieh, Shatila, and Wavel) and about 15 informal settlements. They tend to cluster around major coastal cities and consume areas that should be protected for their environmental and/or

Figure 7.3 Urban extent of Greater Beirut Area



Source: prepared by ECODIT for 2010 SOER

archaeological heritage. Such is the case in Tripoli, Beirut, Saida and Tyre. Notwithstanding the human dimension, these camps have encroached on natural areas that have no zoning regulation whatsoever. In the absence of zoning regulations, the continued legal contention surrounding their status has deprived the camps of some of the basic infrastructure and services including water connection and sewer systems.

New mountain resorts

In the past decade, there has been an unprecedented rush to build mountain resorts, primarily in the hills overlooking Beirut, but also in other regions of Mount Lebanon. These resorts assume different forms and shapes, offer different levels of comfort and recreation, and attract both Lebanese and non-Lebanese buyers. Whereas Lebanese buyers are more likely to live in these resorts all year (permanent housing), non-Lebanese buyers use their property more sporadically and in many cases only during the peak summer months (July and August). In some cases, Lebanese buyers seek chalets, apartments, and villas in well-organized mountain resorts as a form of secondary housing to be used during selected winter and summer months, or to escape from Beirut which has experienced repeated street protests and other security incidents since the publication of the 2001 SOER -*see selected mountain resorts in Table 7.2*

The environmental implications of mountain resorts have yet to be thoroughly assessed by urban planning departments as well as by the relevant host municipality. This SOER argues that mountain resorts engender potentially significant and irreversible impacts not only on the natural environment but also on the rural fabric of mountain villages and towns. *See analysis of impacts in **Section 7.2.5.***

Households

At the building level, urbanization can be measured in terms of the number of new construction permits, the number of new buildings and residential units. Table 7.3 below shows the growth in the number of buildings and residential units between 1996 and 2004, by *Mohafaza*. The overall increase in the number of buildings was 4.03 percent and 5.51 percent for residential units. The highest increases were recorded in the *Mohafaza* of Nabatiyeh –a staggering 10.75 percent for buildings and 17.80 percent for units (negative percentages are the result of data errors during the census and should not be interpreted as a decline in the building and housing stock).

New high-rise towers

High-rise towers are mushrooming in Beirut. Soaring demand for property has driven the price of land upward, motivating developers to buy property and build vertically. In the process, many old buildings were torn down (sometimes illegally) to be replaced by high-rise buildings. Often, adjacent plots are annexed to make way for a larger and taller building. These buildings increase the ratio of rentable and/or sellable floor space per unit area of land.

High-rise buildings are eroding Beirut's heritage, affecting its social and urban fabric, and changing the city skyline. Powerful developers, backed by lending institutions, are leading the drive to reshape Beirut. The city is fast losing its traditional old houses, with their red-tiled roofs, arched windows, and beautiful balconies and inviting gardens. Many buildings with French colonial and Ottoman architectural features are being demolished to make way for high-rise apartment complexes. The number of vacant lots used as parking lots is rapidly declining, to be replaced by cranes and jackhammers –*see selected high-rise towers in **Table 7.4.***

7.2.2 Institutional Framework

Ministry of Public Works and Transport/Regional Departments of Urban Planning

Regional Departments of urban planning were established in every *caza* to review construction permits and ensure compliance with urban planning regulations issued by the DGUP and/or HCUP. The regional department usually has one director and several civil engineers or architects who assume responsibility for a specific area within the *caza*. The regional departments act as a technical advisor to local municipalities on urban planning and construction issues.

For almost a decade, and following the reactivation of municipal elections in Lebanon in 1998, several Federations of Municipalities (e.g., Metn, Jbeil and Batroun, Koura) established their own (municipal) Department of Urban Planning with the same mandate as DGUP's regional departments with one difference; the urban planning jurisdiction of the federations is limited to the jurisdiction of its member municipalities. It is important to note that many villages and towns in Lebanon have no municipal council and therefore resort to the *Kaemakam* for administrative issues and the regional department of urban planning for urban planning issues. Only two municipalities in Lebanon have their own departments of urban planning, namely Beirut and Tripoli.

Ministry of Public Works and Transport/Higher Council of Urban Planning (HCUP)

The HCUP was established in 1962 (Legislative-Decree 69 dated 24/09/1962) and its functions extend over the entire territory. The Council is chaired by the Director General of Urban Planning. Based on the Urban Planning Law (Legislative-Decree 69/1983 and its amendments), the Council consists of 12 members: the Director General of Urban Planning, Justice, Interior and Municipalities

Table 7.2 Selection of mountain resorts in Lebanon (under construction and/or recently completed)

Project name	Location	Total area (m^2)	Description
Ahlam Mountain Resort	Kfardebian	1,750,000	500 villa plots, spa, clubhouse, boutique hotel, golf and ski schools
Ain Barakeh	Chtaura (Bekaa)	40,000	Divided into 20 plots to build villas and family homes
Alabadiyah Hills	Al Abadiyeh, Bhamdoun	75,000	12 private villas, 33 townhouses and 220 luxury apartments, plus spa, etc.
Beit Misk	Bhersaf	655,000	15,000 residential units
Bhersaf Tourist Village	Bhersaf	23,000	17 residential villas
Clouds Faqra	Faqra	15,000	11 villas
Lamartine Residences	Shbanieh, Hammana	NA	6 residential buildings
Les Suites de Faqra	Faqra	18,000	110 suites
Les Villettes de Kfardebian	Kfardebian	10,000	Five 650 m^2 villas and twenty 290 m^2 villas
Tilal Bhersaf	Bhersaf	NA	14 residential buildings
Tilal Faqra	Faqra	NA	NA

Source: Compiled by ECODIT for 2010 SOER based on commercial ads.

Table 7.3 Evolution of buildings and residential units in 1996 and 2004

Mohafaza	*Buildings*		*Evolution*	*Residential Units*		*Evolution*
	1996	2004		1996	2004	
Beirut	18,810	18,336	-2.52%	159,438	156,890	-1.60%
Mount Lebanon	111,504	115,488	3.57%	460,440	498,252	8.21%
North Lebanon	107,268	110,953	3.44%	257,514	263,497	2.32%
Bekaa	97,727	105,380	7.83%	178,879	183,041	2.33%
South Lebanon	69,873	67,557	-3.31%	152,367	161,786	6.18%
Nabatiyeh	56,705	62,801	10.75%	96,835	114,068	17.80%
Total	**461,887**	**480,515**	**4.03%**	**1,307,469**	**1,379,538**	**5.51%**

Source: Census of Buildings, Dwellings and Establishments (CAS, 2004)

Table 7.4 Selection of high-rise towers in Beirut (under construction and/or recently completed)

Project name	Location in Beirut	Approx. Height (m)	Floors	Previous site
Sama Beirut	Sodeco District	187	50	Car parking, old house and petrol Station
Sky Gate	Achrafieh	170	40	Abandoned land, green shrubs
The Landmark	Riad el Solh District	168	42	Historic vestiges, Car Parking
Platinum Tower	Mina El Hosn District	153	34	Vacant land
Marina Tower	Mina El Hosn District	150	27	Vacant land
Mirror Tower	Mina El Hosn District	142	37	Green Space
Les Domes de Sursock	Achrafieh	140	28	Car parking and old house
La Citadelle de Beyrouth	Ain El Mreisseh	140	34 (2 blocks)	Car parking and construction
Bay Tower	Mina El Hosn District	125	30	Vacant land
Four Seasons Hotel	Mina El Hosn District	120	26	Vacant land
Beirut Tower	Mina El Hosn District	112	30	Vacant land
Venus Towers (3 towers)	Mina El Hosn District	105 – 95 - 84	30 - 27 - 24	Vacant land and car parking
Beirut Terraces	Mina El Hosn District	100	25	Vacant land and car parking
Atomium 5242	Achrafieh	100	27	Car parking
Ashrafieh Tower	Achrafieh	100	25	Car parking and old house
Harbor Tower	Medawar	80	25	Old houses, green space
Plus Towers	Bechara El Khoury Av.	49	14	Vacant land, historic vestiges

Source: Compiled by ECODIT for 2010 SOER based on commercial ads.

(Local Councils and Administration), Public Works and Transport (Roads and Buildings), Housing, and Environment, in addition to the Director of Programs at CDR, the President of the OEA in Beirut and Tripoli, and three experts (sociology, urban planning and environment, and architecture).

This composition is arguably tilted in favor of construction advocates. The role of the Higher Council is to: (1) review and approve urban master plans as well as large-sized projects --projects greater than 3,000m² in Beirut, and greater than 10,000m² outside Beirut, measured in terms of total land area prior to construction; (2) draft decrees related to the establishment of real estate companies, land expropriation and land parceling; (3) review decisions related to licenses for construction and parceling; and (4) review proposed amendments to urban planning and construction legislation.

Ministry of Interior and Municipalities/ Municipalities

Lebanon has 994 municipalities. Issuance of construction permits is the sole responsibility of the President of the Municipality – this is an extraordinary power if exercised duly and fairly. The construction permit in turn rests on the approval of the relevant institution such as DGUP's regional departments of urban planning, the Federation of Municipalities, and/ or the HCUP. *The permitting process is explained in detail in* ***Section 7.2.4***.

Order of Engineers and Architects (OEA)

Lebanon has two OEAs, in Beirut and Tripoli respectively. They were established in the mid 1950s primarily to formalize the profession of engineers and architects in Lebanon and to eliminate self-proclaimed engineers and architects from this profession. Engineers and architects do not choose their Order but register based on their origin (engineers in north Lebanon register in Tripoli whereas all other engineers register in Beirut). The total number of registered engineers in 2010 was about 33,000 in Beirut and 7,300 in Tripoli. Members have different areas of specialty (architects, civil, electrical, mechanical, telecommunication, and agricultural). Only architects and civil engineers may sign construction permits and execution plans; they should be freelance architects and engineers who are neither civil servants or employed by private (engineering) firms. Each freelance architect and civil engineer is allowed to sign up to 16,000m² of floor plans per year. This quota system is partially extended to civil servants under exceptional cases, but not to private sector employees. The other members of the OEA (mechanical, electrical, etc.) can participate in the preparation of execution plans but cannot sign those plans without the approval of the lead architect or civil engineer.

7.2.3 Historical Review of the Private Ownership

Property ownership in Lebanon goes back to the 16th century, during the Ottoman Empire, and evolved subsequently under the influence of Ottoman regulations (called *tanzimat*), the French mandate (1920-1943), and the Lebanese Republic. The most important transformations are explained below as they contribute to the current state of urbanization in the country.

Ottoman Regulations (tanzimat)

The Ottoman Empire instituted a deed system known as *dafter khaqany* (or registry book) during the mid 1800s. The system simply formalized the process of registering real estate transactions daily. The Ottoman Empire also established registry offices in every administrative region known as *sandjak* and each office was administered by a director and several secretaries. With every real estate transaction, the seller was required to present several key documents including a certificate *ilm wa khabar* issued by the local *mokhtar* or *imam* describing the property. The registry office would then review the documents, and the cadastral office would determine the corresponding fees to execute the transaction and verify if there are any outstanding taxes. The transaction required the approval of the director of the cadastral office who would register the transaction in the presence of the seller and buyer or their designee, and witnesses. The buyer would then receive the new deed title called *tapou sanadi*. The information contained in the deed title would be identical to the information stored in the registry book.

These regulations or *tanzimat* had a profound impact on the real estate sector in Lebanon (and beyond). Before this period, the private property was not guaranteed or protected by law. Owners were often intimidated into selling their lands and buyers would bribe administrations to formalize the transaction without proper documentation.

In 1864, the Ottoman Empire approved a law that would ban and nullify all real estate transactions that did not go through the registry office or the cadastral tribunals also known as *Mahaqem* *el Chaiyya.* Individuals who implemented transactions outside these two legal avenues would be sent to prison. Moreover, policemen were stationed in all registry offices to intervene in case of any fraudulent transaction or transaction based on intimidation and force. Collectively, these *tanzimat* helped protect the private property, increased property values, and opened the door for new and large-scale constructions outside city walls.

French Mandate (1920-1943)
Under the French Mandate, a new cadastral system was instituted to further protect the private ownership by offering additional guarantees that would facilitate and promote economic activities. The mandate recognized the value of the property in terms of agricultural production, real estate, and as an avenue for mobilizing finances (Aveline, 1997). The system, still in force today, started to demarcate every land parcel in Beirut, Tripoli and other regions. The aim was to resolve any dispute due to overlapping properties between adjacent owners (never achieved under the Ottoman Empire)[2] and to reaffirm individual titles to property unequivocally and based on a detailed census.

The deed also known as *Iqar* was formalized as the cornerstone of the property and all rights to it. A deed is a formal legal document that is signed, witnessed, and delivered to effect a conveyance or transfer of property or to create a legal obligation or contract. In terms of real estate, a deed governs all the activities inside a well delineated property. Trees and buildings are considered integral to the deed. Deeds may have one or several owners who exercise their rights to the property called *Tessarouf.* Deeds can be modified by grouping several adjacent parcels into one large parcel (Aveline, 1997).

Lebanese Republic (1943-Present)
Property legislation in Lebanon did not change much since the French Mandate (Decree 3339/LR dated November 1930) (Boustany, 1983). The system in place worked seamlessly during the period 1950-1975, a period of great economic growth and stability. Even during the Civil War period (1975-1990), the administrative procedures continued to work normally and were not contested or defied by the militias of that time. In fact, cadastral registries were neither burnt nor stolen. This phenomenon was most likely the result of informal agreements between war lords and politicians at the time because they too were land owners or speculators. There were very few cases of cadastral fraud and these were usually sporadic and trivial.[3]

The system therefore had a stabilizing effect on the real estate and construction sectors, despite the troubled war period. One noteworthy and pivotal transformation at the end of the French Mandate was the termination of taxes on vacant lands (i.e., not built up). By contrast, all other lands with standing buildings, including offices, shops, factories, banks, and residential units (provided that the owner owns more than one unit) were and continue to be subject to annual property taxation also known as *Daribat al Amlak al Mabniyya.*[4]

7.2.4 Urban Planning Law
Lebanon's urban planning law dates back to 1983 (Legislative Decree 69 dated 9/9/1983). Comprehensive and visionary, the law is divided into seven parts: (1) organization and structure of the Higher Council of Urban Planning, (2) urban master plans and planning regulations for villages and cities, (3) implementation of regulations and urban master plans in villages and towns, (4) construction permits, (5) regulations for quarries and crushers, (6) land parceling, and (7) various provisions and applications. Drafted and approved during a period of great civil unrest and insecurity in the country, the law astonishingly mentions the terms environment and nature 16 times.

The following excerpts from Legislative-Decree 69/1983 highlight the most important environmental provisions:

[3]Cadastral archive of Beirut

[4]*Ibidem.*

[2]Cadastral archive of Beirut

Article 7	*Urban planning for sustainable development:* urban planning should take into account the relationship between communities and surrounding areas, and it should balance built-up areas with the protection of environmental sites, agricultural activities and forest areas.
Article 8	*Urban master plans* must define the criteria for land use including the possibility of banning construction within the studied area (declaring no-construction zone).
Article 9	*Placing unplanned zones under study:* based on the proposal of the Minister of Public Works and Transport, and after consultation with the HCUP and the concerned municipality, an area may be placed "under study" for a period of up to two years. During this period, no permits may be issued (construction, parceling, etc.).
Article 17	*Restriction on exploitation coefficients:* Any restriction on building coefficients (including setbacks, number of floors, building height and color) that is deemed necessary to protect public health and safety, or the natural environment, is not compensated.
Article 19	*Land swap to protect heritage or landscape:* duly authorized agencies may expropriate private land (to serve the public interest) by compensating its owner with a nearby land of equal value. In effect, the authority is implementing a land swap.
Article 20	*Land reparceling to protect or enhance urban planning.* In cases where the prevailing distribution and delineation of lands impedes meaningful urban planning, the relevant authority may reparcel the entire area to facilitate urban planning.
Article 23	*Land bartering to protect forests*: In cases where forests or green spaces are located near residential areas, the Government or the municipality can barter the forested land with the owner by offering another piece of land.
Article 24	*Public-private partnership to access forest and natural sites on private lands.* Municipalities or federation of municipalities may enter into a contract agreement with private owners to provide public and recreational access to private forests and other natural areas. Municipalities would in return charge an admission fee to pay for rangers and upkeep.

The importance and foresight of the Urban Planning Law of 1983 cannot be stressed enough. Unfortunately, there is very little evidence that urban planning departments are using it and that civil society is cognizant of this Decree-Law.

7.2.5 Construction Laws and Permits

The First Construction Laws

Lebanon's early construction laws stem from Beirut during the late 1800s. The Municipality of Beirut developed building regulations that were subsequently adopted by other municipalities in response to the densification of certain areas and neighborhoods. These early municipalities saw the need to control and manage urban landforms, and prevent and/or resolve legal disputes between adjacent land parcels (i.e., boundaries, setbacks, height). It was A. Abdel Nour, an engineer at the Municipality of Beirut, who was tasked with writing and consolidating construction laws and expropriation decisions into a compendium *Qanoun al Abniah Wa Qarar al Istimlak* dated 1896.

According to those first legal instruments, property owners had to present a construction permit to the municipality before all works. The permit had to include a hand-written application describing the proposed works, as well as design drawings that primarily focused on the building dimensions (length, width and height). In case of non-conformity with the approved building dimensions, builders called *Moallem* and owners were held accountable. Non-compliant works were immediately terminated and the municipality would impose hefty fines and require the parties responsible to demolish the illegal construction (Abed el Nour, 1896).

In practice, these early construction laws required that buildings align existing roads and they recognized five road categories based on road width. (The road width is calculated from the edge of a building to the edge of the opposite building). This restriction was a decisive factor in the development and evolution of linear and more harmonious urban landforms (Abed el Nour, 1896). Today, it is Construction Law 646 dated December 2004 (also known as Building Code) that is the centerpiece of all construction activities in Lebanon. In some regions, construction activities are further impacted and modulated based on urban master plans that follow linear and/or radial zoning patterns. The overarching premise of a master plan is the delineation of an urban space into homogenous zones with different building coefficients. The underlying logic behind the early urban master plans was to afford the center of towns and cities the highest building coefficients –areas renowned for their urban and architectural heritage.

Construction Law 646/2004

Construction Law 646 of 2004 introduced a number of changes to the sector. Some of the changes appear to benefit the construction sector while others are important for landscape protection and environmental sustainability in general. See short analysis of new construction law in Table 7.5.

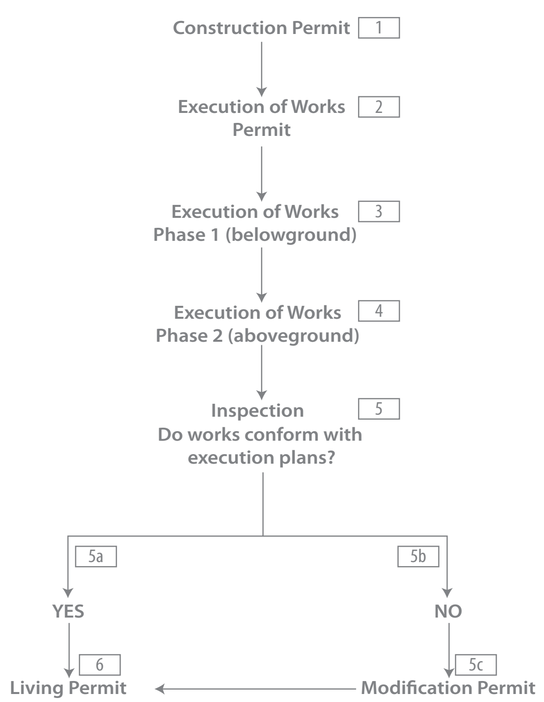
Table 7.5 Environmental implications of Construction Law 646/2004 (selection)

Changes Introduced	***Environmental Implications***
The validity period of a construction permit was increased from 4 to 6 years, with the possibility of a further 2-year extension without taxes.	Construction sites extend longer; in cities, this affects neighbors and pedestrians (dust, noise, prolonged obstruction of sidewalks); in villages, unfinished buildings impact the landscape. Fortunately, *Article 3* of the law regulates fines for buildings that are not completed within the permit period (8 years max). These fines came into force in December 2005 but have yet to be exercised.
Staircases (and elevator shafts) are excluded from the calculation of building coefficients provided they consume less than 20m² per floor	In practice, this means that buildings exceed the legal building coefficient by 20m² (lot coverage) which reduces water infiltration further. Small parcels are now more attractive to construction.
Every additional underground car park, above and beyond what is prescribed in the construction law, will be exempt from taxes.	This incentive encourages builders to maximize underground floor space. Unfortunately, in practice, underground construction is prohibitively expensive and underground parking is competing with other floor use such as warehousing (often illegally).
Article 13 requires that construction and demolition activities comply with environmental regulations pursuant to Environment Law 444/2002.	The article identifies conditions for not granting construction permits (safety, public health, landscape, architectural). It also allows urban planning authorities to require developers to provide additional infrastructure including WWTPs and gardens.

The Permit Process

Construction in Lebanon goes through a complicated permitting process. This report presents a simplified overview of the multiple permits needed, in an effort to understand the weaknesses in the system and implications on the environment. The overall process can be divided into six major stages illustrated in Figure 7.4:

Figure 7.4 Simplified Overview of the Permitting Process for Residential Buildings



Source: prepared by ECODIT for 2010 SOER

Annotated Legend:

Stage 1: The owner must designate a civil engineer or architect duly registered in the OEA in Beirut or Tripoli to apply for the construction permit. Once issued, the owner can proceed with the Execution of Work permit. *In theory,* permits should comply with the Construction Law, Building Coefficient and Urban Master Plan (if applicable). *In practice*, errors and deliberate deviations from the regulations may pass unnoticed or occur due to patron-client relationship.
Stage 2: The Execution of Work permit allows the owner to start construction works, which is divided into two phases, called Phase 1 and Phase 2.
Stage 3: Phase 1 of construction works include all underground works up to 1m above the ground level (mostly excavation, shoring, and other concrete works). *In theory*, Phase 1 must be completed and inspected by a civil engineer or architect from the regional department of urban planning *prior* to Phase 2 commencement. Inspection should verify elevation points, terracing, backfilling, etc. *In practice,* inspection is rudimentary if at all and nonconformity is easily settled through patron-client relationship.
Stage 4: Phase 2 of construction includes above ground levels and is contingent on the approval of Phase 1 works. *In practice,* owners often collude with members of concerned municipalities to bypass the mandatory inspection, proceed with aboveground works without prior approval, and then shift the burden of inspection (and settlement) to the end of all construction works. Owners can then obtain a delayed permit for Phase 1 from the DGUP's regional office. It should be noted however that in certain cases such a violation of the permitting process is not unreasonable considering the excessive period needed to obtain an approval of Phase 1 works even for buildings that are fully compliant.
Stage 5: After completion of all works, the building must be inspected by OEA and the local municipality and/or DGUP regional office to verify compliance with the as-built engineering plans and drawings, including the replacement of damaged and/or uprooted trees and the configuration of the septic tanks in non-sewered communities. If the building does not conform to the plans, then the Owner must apply for and obtain another permit prior to obtaining a Residential Permit. The aim of the Modification Permit is to modify the engineering drawings, in full respect of the Building Code, and obtain approval of the new drawings. *In practice*, modifications are not always in full compliance with the Building Code (or the approved Building Coefficient) but approvals are nonetheless issued using bribery and other forms of enticements.
Stage 6: After the building is inspected and determined to be compliant and suitable for living, the Municipality issues the Residential Permit.

To date, most construction permits that are submitted to the DGUP's regional departments or to the Federation of Municipalities (that have an urban planning department) are rudimentary and focus primarily on the building dimensions and overall form. The technical review and follow-up related to the execution of work permits remain the sole responsibility of the OEA in Beirut and Tripoli. Unfortunately, in practice, the activities of the OEA remains limited to administrative procedures. The supervision of key technical construction parameters, such as the specifications of cladding material, the execution and performance of plumbing works and the building structure is generally left to the discretion of OEA employees whose determination is not based on rigorous inspection. In addition, license approval at the municipal level usually focuses exclusively on whether building specifications comply with the law; they rarely consider other urban criteria such as urban morphology, urban landscape, setbacks, building appearance, urban skyline, and green spaces.

The construction permit and the execution of works permit involve many steps and alternatives based on the location of the proposed building and the presence or not of a local municipality. Figure 7.5 is a flowchart illustrating the process in a step-by-step approach, with a detailed legend.

Step-by-Step Legend:
1: Owner appoints an architect or a civil engineer
2: Architect or civil engineer applies for a construction permit at the Order of Engineers & Architects (OEA) in Beirut or Tripoli (depending on where the Architect or Civil Engineer is registered).
3a: In the case of Beirut, the application is sent to the Municipality of Beirut
3b: In the case of Tripoli, the construction permit is sent to the Municipality of Tripoli
3c: Outside Beirut and Tripoli, the application is presented at the Urban Planning Regional Office or the Municipal Federation if the federation has its own urban planning unit
4a: The Beirut Governor (in coordination with

the President of Beirut Municipality) issues the construction permit

4b: The President of Tripoli Municipality issues the construction permit

4c1: If there is no municipality, the Kaemakam issues the construction permit

4c2: If there is a municipality, the President of the municipality issues the construction permit

5: Owner (or his designee) collects the construction permit

6: Owner asks architect/civil engineer to prepare the execution plans for the permit of execution of works

7: Architect/civil engineer prepares the construction plans (civil and electromechanical)

8: Architect/civil engineer presents the construction plans to OEA in Beirut or Tripoli (depending on registry)

9: OEA either approves or rejects the plans. If rejected, the applicant must revise and resubmit the plans

10: The architect/civil engineer should present the approved plans to the relevant municipality or kaemakam (if there is no municipality)

11: After reporting to the concerned municipality or kaemakam, the relevant OEA issues the permit for the execution of works

7.2.6 Implications of Haphazard Urbanization on the Environment and Urban Heritage

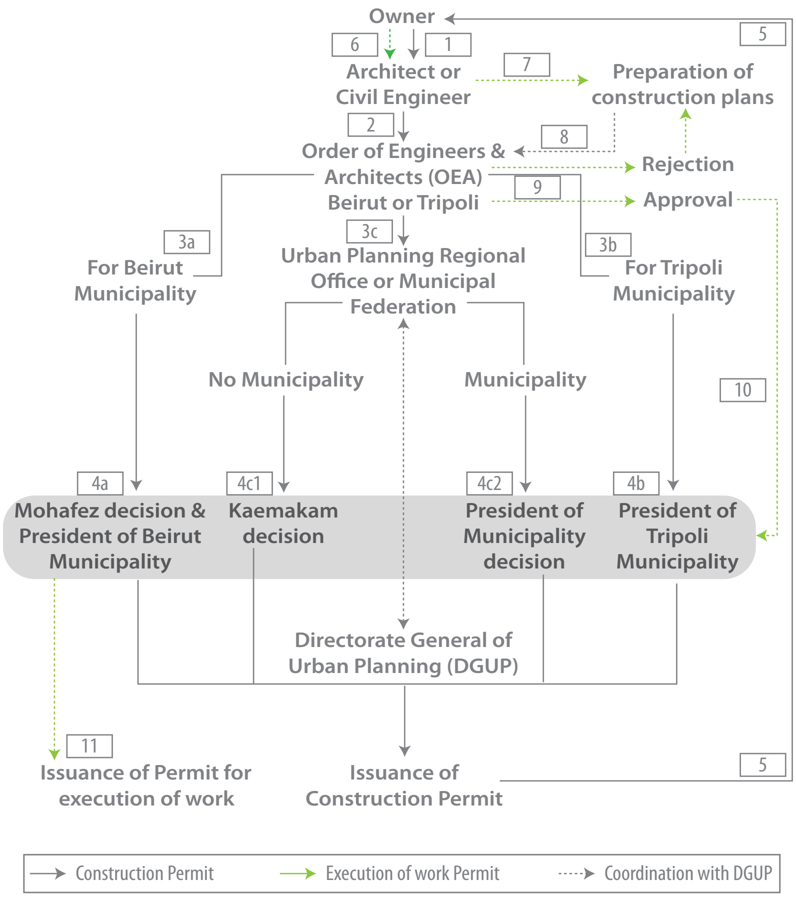
Poor zoning and construction regulations have rendered almost all territories open to construction (coastal, agricultural, natural, historic city centers, etc.), provided the land is serviced by an access road. A liberal market has invited investors and real estate promoters to build in all corners of the country with lasting impacts on the urban and rural landscape, and with severe implications on energy consumption. The following paragraphs explain key impacts on the environment, as well as the implications of haphazard urbanization on the urban heritage.

7.2.6.1 Environmental Aspect

Excavation

Excavation and earth works are environmentally intrusive. Short-term impacts include noise and dust from earth moving equipment (noise levels measured in decibels can be unreasonable to neighboring houses). The long-term and irreversible impact is the permanent loss of top soil and the impermeability of the land to rainfall causing runoff. In fact, the building coefficients described in **Table 7.1** imply a restriction of the

Figure 7.5 Detailed overview of the construction permitting process



Source: prepared by ECODIT for 2010 SOER

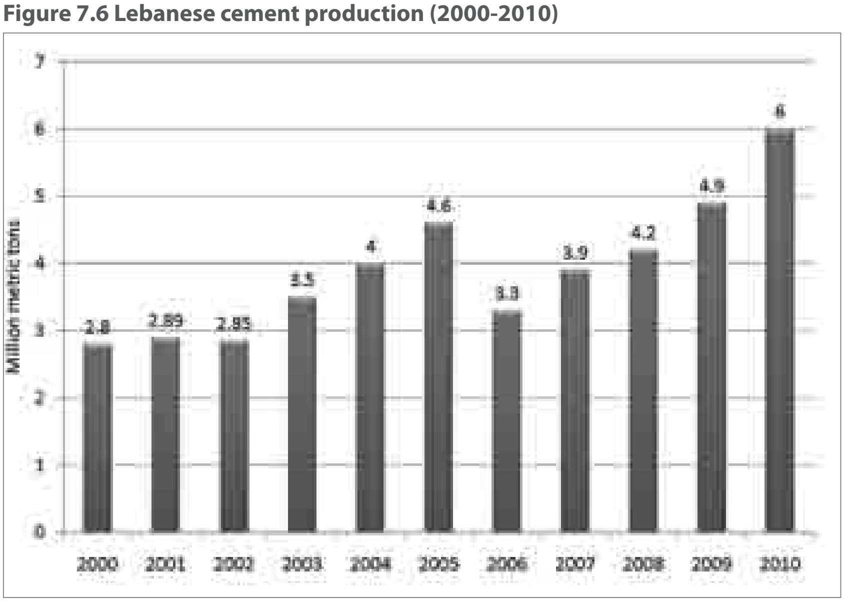
Excavation and earthworks

construction volume. This restriction however is limited to construction aboveground. In practice, owners can and will in most cases excavate the entire parcel, creating a large cavity, and use the underground space for other services including parking, fitness centers, warehouses, etc. During Phase 2 of construction, aboveground floors retract to respect the prescribed lot coverage (25% in unplanned areas, and up to 100% in planned areas depending on zoning regulations). Excavation of the entire parcel therefore destroys all standing trees, removes top soil, and may alter the shallow groundwater regime.

Construction material

Construction consumes a lot of material including cement, steel, aluminum, wood, gypsum, glass, ducting, etc. Most of this material is imported except concrete. Lebanon's five cement industries (Ciment de Sibline, Cimenterie National, Holcim (Liban), Cimenterie du Moyen-Orient, and Société Libanaise des Ciments Blancs) have been expanding production to meet local demand. At least three plants also produce cement and clinker for export to Syria and Iraq. According to the US Geological Survey, Lebanon produced in 2010 about 6 million tons of cement, up from about 2.8 million tons in 2000 (see Figure 7.6). These numbers are consistent with the data reported in the 2001 SOER (3.2 million tons in 1995 plus about 2,500 tons imported).

Figure 7.6 Lebanese cement production (2000-2010)



Source: Data for years 2000-2009 from USGS 2009 Minerals Yearbook; and data for 2010 from International Cement Conference, Beirut 2011

Lebanon's cement industry uses raw material (limestone) from natural quarry stone, usually located near the plants. The quarries consume lands, cause irreversible damage to landscape, and release fine particles into water and air. The transport of cement and concrete to construction sites affect road conditions and road safety, and contribute to total greenhouse emissions.

Loss of green cover and habitat fragmentation

Construction all over Lebanon, but mainly in and around forested areas, occurs at the expense of the green cover. The pine forests that used to cover the hills overlooking Beirut are shrinking rapidly to make way for buildings and resorts. Paradoxically, most of these developments are marketed and advertized as being located in a green oasis or surrounded by forests. While many building projects attempt to restore some of the lost greenery at the end of construction, landscaping usually relies on imported or introduced species that are not well suited for Lebanon. Also, much of this landscaping is confined to flower beds and other enclosures with no hydraulic continuity to groundwater. At the level of ecosystems, mountain resorts break up habitats into ever smaller units thereby impacting wildlife. Noise and artificial lights after nightfall may also disturb wildlife.

Impact on urban morphology

Current urban planning and building regulations have dramatically failed insofar as producing a coherent urban morphology. The emphasis on building coefficients and floor-area-ratios has resulted in the construction of cluttered buildings that are incongruent and non-aligned. In fact, in Beirut, there is a total laissez-faire in relation to how architects and/or civil engineers decide to position the buildings inside the parcel. Owners may decide to build any distance away from the main road and from the edge of the sidewalk, to optimize the building coefficients. Setbacks are not regulated. Adjacent buildings in Beirut are therefore disorderly and assume different heights. The building skyline in Beirut is notoriously irregular and tangled. A compounding effect to the urban morphology and skyline are the illegal annexes and implants built during the Civil War (and beyond), most of which constitute enduring eyesores.

Ribbon construction

As explained in Section 7.2.1, construction is not always concentric. Linear construction in rural areas, also known as ribbon construction, is unsightly and obstructs the view. For example, ribbon construction along many roads stretches in the Bekaa Valley as well as in Akkar has cloaked the natural scenery on both sides of the road. Ribbon construction also voids communities of a city center and a central market where people congregate, and presents formidable challenges for pedestrians on both sides of the road. With time, built-up roads need to be retrofitted with speed bumps and/or traffic lights, as well as road medians and girders for separating opposite traffic lanes, and overpasses for pedestrians –all these measures eventually reduce traffic flow. It should be noted that linear construction is sometimes partially due to the absence of basic infrastructure in villages. Owners therefore choose to build along roads because roads can improve access to water, wastewater and electricity.

Loss of agricultural land and top soil

For decades, Lebanon's agricultural sector has been declining, both in terms of percent contribution to GDP as well as total arable land. The continued shift towards a service-based economy (banking, tourism, health, etc.) and the sustained demand in the construction sector is putting a lot of strain on agricultural lands. The comparative advantage of the Lebanese agricultural sector is losing ground due to regional competition and WTO requirements for the free flow of goods. Agricultural lands are also breaking up into ever smaller plots (through inheritance) which render agricultural production even more difficult and cost ineffective. The absence of a national policy to protect agricultural lands from unwanted development and incentivize farmers to modernize their production systems is leading to the rampant encroachment of buildings on fertile lands. Urban sprawl is most severe in the Bekaa valley and the Akkar plain (see example in Figure 7.6). The scale of construction on agricultural land will further compromise Lebanon's food security.

Groundwater pollution

Haphazard construction in rural areas not equipped with adequate wastewater and drainage networks is contributing to groundwater pollution. In non-sewered communities, most septic tanks are built amateurishly and by irresponsible engineers and contractors, with little municipal control and oversight, if any. In fact, many septic tanks are bottomless or built to leak or overflow so that owners don't have to pay for suction pumps to come and empty the tanks.

Reckless road construction and habitat degradation in Metn

The skyline over Beirut and its suburbs is distinctly uneven and lack harmony

Figure 7.6 Pressure from urbanization on agricultural lands

(c) Akkar Plain in 2005

(d) Akkar Plain in 2010

Source: Google Earth imagery (2005, 2010)

Reckless disposal of construction and excavation waste in ravine, Wadi Jhannam (Baskinta)

Heat island effect

The urban heat island has become a growing concern and is increasing over the years. The urban heat island is formed when industrial and urban areas are developed and heat becomes more abundant. In rural areas, a large part of the incoming solar energy is consumed by evaporating water from vegetation and soil. In cities, where the extent of vegetation and exposed soil is negligible, most of the sun's energy is absorbed by urban structures, concrete and asphalt. These surfaces trap the sun during warm daylight hours and release much of that heat during evening hours. Meanwhile, less evaporative cooling in cities allows surface temperatures to rise even higher compared to rural areas. Additional city heat is given off by vehicles and factories, as well as by industrial and domestic heating and cooling units. These factors increase city temperatures by 1 to 6°C compared to surrounding landscapes. Impacts also include reduced soil moisture and intensification of carbon dioxide emissions.

Substandard infrastructure in mountains

Mountain resorts consume significant environmental resources during construction and operation. Planned resorts usually require the technical review of and approval by the Higher Council of Urban Planning (if greater than 10,000m²). Unfortunately, the review process generally fails to ensure the provision of basic infrastructure that is environmentally sustainable. Mountain resorts are typically implanted in natural areas that have never been built before and therefore lack basic infrastructure including access roads, water supply networks, sewage collection and treatment systems, and electricity. Large scale resorts need a lot of water and generate a lot of wastewater as well as solid waste. On the social side, some mountain resorts tend to offer complete amenities to its tenants, including sports facilities and mini-markets, effectively eliminating reliance on the services offered in Lebanese villages and towns. Depending on their location, mountain resorts may even have separate access roads that may or may not be equipped with adequate drainage systems and usually scar the landscape well beyond the limits of the resort.

Living conditions in poorly serviced cities and suburbs

Haphazard or poorly planned construction, especially around cities, has produced urban communities with **substandard infrastructure** and living conditions. Selected suburbs around Beirut (e.g., Hay el Sellom, Nab'3a) and Tripoli (e.g., Bab al Tabbaneh, Jabal Mohsen) have regressed into slums, or shantytowns, with very modest services and amenities, if any. These areas evolved gradually, over many years, and as result of rural-urban migration. The earliest settlements were individuals seeking work in the ports of Beirut and Tripoli and/or the railway. With time, these early settlements became denser with new and taller construction, rendering public spaces minimal and usually unhygienic. Furthermore, the majority of buildings in these impoverished suburbs and marginalized slums lack proper septic tanks or sewer connections. Buildings commonly discharge raw sewage on vacant plots, in nearby streams or abandoned water wells.

Many Lebanese cities (Beirut, Tripoli, Saida and Sour) are **densely populated**. Buildings are collated to one another, preventing natural ventilation and obstructing sun rays. Unhygienic conditions, including odors, may occur especially during summer. Open-top curbside waste containers further impact the street landscape, attract rodents and insects, and emit foul odors. Densely populated neighborhoods generate more waste than waste collection services have capacity to remove while preventing odors.

The impermeability of city surfaces to rainfall creates episodes of **localized flooding**. City dwellers in Beirut, Tripoli, as well as Zahle experience every year floods in low-lying areas, under bridges and in tunnels, and wherever stormwater networks cannot drain standing water fast enough. While it is true that stormwater network blockage is the result of inadequate or irregular maintenance, rainfall intensity combined with dwindling open spaces in cities will incontestably further increase flood incidents during winter no matter how effective the storm water networks are.

Street parking in Lebanon's major cities is very difficult, sometime impossible. Roads are narrow and congested and most buildings dating from the period pre-1980 were not equipped with underground car parks. In many cases, underground floors if present are designated shelters (a former requirement), most of which have been converted to makeshift car parks or warehouses.

Most importantly, Lebanese cities **lack public spaces** such as gardens, playgrounds, sanitary public beaches, designated sport areas, etc. Beirut is scandalously poor in terms of green areas (Sanayeh Park, Hassan Khaled Park and Sioufi Park) and the largest green spaces (Beirut pine forest and Beirut Hippodrome) are inaccessible to the public most of the time. The lack of urban green spaces in Beirut and other cities impairs living conditions and reduces opportunities for social interaction.

7.2.6.2 Urban and Historical Heritage

Cities modernize and sometimes develop at the expense of heritage. New architectural styles and new housing forms have sprung up in recent decades to replace traditional shapes and structures. Although conflict damaged a great number of historic buildings in the capital, the pace of demolition accelerated during post-war reconstruction efforts and the recent spike in property prices had a catastrophic impact on Beirut's dwindling heritage stock despite some legislation to protect historic buildings (see overview in **Box 7.5**). The heart of Beirut became a large shareholding company (Solidere) that was responsible for all town planning and reconstruction efforts. Although their work was largely criticized, either for having demolished conservable historic buildings or for removing valuable archaeological sites, the final result was a fine balance between economic gains, aesthetic concerns and historic considerations. The systematic transformation of Lebanon's architectural heritage is apparent in all major cities including Beirut, Tripoli, and Saida. Across the country, many important landmarks including the pink house in Manara, the historic coffee house in Gemayze (*Ahwet Al Ezaz*), the Beirut Dome, the 19th century historic opera house in Tripoli (*Masrah Al Inja*) and many more face eminent demolition. Other retro buildings of important cultural value have already disappeared (e.g., Raouche Carlton Hotel built in the 1960s).


Landmark heritage building in Beirut, overshadowed by high-rise tower

Box 7.5 Is the government doing enough to protect architectural heritage?

Protection legislation dates back to 1933, for buildings erected before 1700. In 1999, the COM enacted Decree 32 (dated 3/3/1999) which was based on the work of Khatib & Alami, recognizing five categories of historical buildings denoted A, B, C, D and E. Category A refers to buildings in very good condition and Category E are buildings that need a lot of work. The directive initially protected buildings under Category A, B and C. This was later amended by Decree 57 (dated 10/3/2010) to extend the protection to buildings of Categories D and E. In 2007, parliamentarians drafted a law to reinforce the 1999 directive but the General Assembly has yet to approve it. The Minister of Culture issued Decision 119 (dated 24/11/2010) to form a follow-up committee with architects and members of the Directorate General of Antiquities. In theory, demolishing buildings under Category A, B or C requires the approval of the Minister of Culture. In practice, developers have been able to declassify some buildings through lobbying or by presenting (false) evidence that the buildings are structurally unsafe, or simply by demolishing the building during odd hours. Conservationists have argued that protecting historic buildings scattered around the city is less effective and less meaningful than protecting groups of adjacent buildings that form an architectural ensemble.

7.3 POLICY OUTLOOK AND THE WAY FORWARD

Urbanization is weighing heavily on Lebanon's natural resources as well as mountain and coastal landscapes. If the current rate of construction continues unabated, without legal and policy restrictions, Lebanon will undergo drastic and irreversible transformations in the coming decades. The following sections present a shortlist of policy recommendations that would help change the current course of urbanization to more sustainable urbanization and construction. These recommendations are divided into five sections:

1. Administrative reform
2. Urban planning reform
3. Reform of the construction permitting process
4. Restrictions on ownership by non-Lebanese
5. Public education on more sustainable construction standards

7.3.1 Administrative Reform

Public administration reform should be comprehensive and must include process changes related to organizational structures, decentralization, personnel management, public finance, results-based management, regulatory reforms etc. It can also refer to targeted reforms such as the revision of the civil service statute.

1) Afford greater administrative and financial independence to municipalities and municipal federations to improve and streamline procedures. Buttress the municipal work force with subject matter specialists who understand and can improve heritage conservation efforts including urban morphology and landscapes.
2) Recruit civil servants in key positions based on professional competencies and merit. Work actively to stop appointments that are politically motivated. Recruit more qualified personnel in urban planning departments and review and diversify the personnel prescribed in Decree 10490/1997 (DGUP).
3) Resume discussion to institutionalize the *Baksheesh*, so widespread in Lebanon and the Middle East. Although *Baksheesh* is a term used to describe tipping, charitable giving, and certain forms of political corruption and bribery in the Middle East and South Asia, it does not correlate with the European system of tipping, as it also includes demonstrations of gratitude, respect or veneration. Because the *Baksheesh* is entrenched in the construction permitting process (and in other sectors as well), it has reached staggering proportions. Formalizing the *Baksheesh*, some professionals would argue, will cap the amount spent on tipping for each type of transaction, improve transparency and reduce shame.

7.3.2 Urban Planning Reform

Urban planning reform is needed to contain haphazard urbanization and to produce homogenous urban neighborhoods. The reform process would need to address the following priorities:

1) Shield urban planning activities from political interference. By the same token, the GOL should stop and prohibit all legal settlement of illegal constructions. It should also implement firm measures to demolish and remove illegal constructions and revalorize the urban landscape.
2) Resume and complete the work initiated under the National Land Use Master Plan (SDATL) by developing detailed regional plans. Existing master plans would need to be amended to comply with the National Land Use Master Plan. New master plans would need to be prepared based on the National Land Use Master Plan.
3) Manage and control the natural expansion

of villages and towns by restricting urban sprawl, maintaining urban continuity, and reducing energy consumption.

4) Rethink urban master plans to:
   - Shift from *physical* planning to *strategic* planning. Strategic planning is inclusive of sustainable development goals and targets and would also entail EIA and/or SEA studies. The SEA process was successfully used to develop the urban master plan for the region of Tannourine in north Lebanon (mentioned in Chapter 6 Land Resources). The SEA process and the EPIK method for karst vulnerability assessment are indispensable tools in urban planning and for the protection of water recharge zones.
   - Protect natural landscapes and scenic outlooks, and maximize the use of sunlight.
   - Reduce the extent of excavation by limiting belowground works to the effective lot coverage aboveground. Reuse the excavated topsoil in gardens. Protect the remaining surface area (beyond the lot coverage) to enhance natural infiltration of rainfall.
   - Increase green spaces in cities by choosing heat and pollution-resistant ornamental trees and shrubs. Avoid introducing exotic species because they usually require excessive and expensive aftercare.
5) Improve protection measures of urban heritage buildings by increasing the budget allocated to the Directorate General of Antiquities and streamlining administrative procedures.
6) Improve, standardize and monitor the work of topographers. Use geodesic reference points for all cadastral and topographic studies, supported by GIS applications.

7.3.3 Reform of the Construction Permitting Process

Reform of the construction permit process will help reduce fraud and construction malpractices. Proposed measures include:

1) Redesign the permit process by streamlining procedures and applications.
2) Establish and staff a service inside all regional urban planning offices (or municipal federations) charged with the technical supervision of construction sites and without intervention from Internal Security Forces (ISF). ISF patrols may only interfere after express approval from the relevant urban planning office.
3) Review and enforce the role of OEA engineers in the inspection of construction sites to ensure compliance with approved engineering drawings and plans.
4) Promote environmentally-friendly and other forms of sustainable construction including Green Buildings if and when possible. Several universities (AUB, USEK, etc.) are actively promoting green design as part of their curriculum and the recently established *Lebanon Green Building Council* (an NGO) is promoting green buildings at the policy level.

7.3.4 Restrictions on Ownership by Non-Lebanese

In February 2009, 10 members of parliament presented a draft law (No. 94/2009) that would amend Law 296 dated 3 April 2001. Proposed amendments include:

- Introduce a clear method for calculating the total land area acquired by non-Lebanese at the *caza* level (10% in Beirut and 3% in all other *cazas*).
- Amend the restriction on total land areas owned by non-Lebanese at the *caza* level by removing from the stated percentages all municipal lands *mashaa*, as well as lands owned by the state *aradi jamhourieh*, protected areas and forests, as well as all other areas that have a lot coverage of five percent or less. The 3 and 10 percent restriction should be based solely on lands approved for construction (not total land area).

Other proposed restrictions:

- Increase land registration taxes for non-Lebanese (currently at par with Lebanese buyers)
- Reduce land registration taxes for Lebanese who buy property from non-Lebanese
- Introduce capital gain tax to dissuade speculators (Lebanese and non-Lebanese)
- Accelerate and complete the cadastral demarcation all over the Lebanese territory. This will help calculate the percentage earmarked for non-Lebanese buyers.
- Return to the state all lands owned by non-Lebanese who have not started (or completed) construction within the prescribed five-year period.

7.3.5 Public Education and Mass Media

Reforms without public education will not go far. It is important to educate the public, including landowners, builders, contractors, and investors on the need to revamp the Lebanese construction sector to protect national heritage and landscapes. This is not easy, especially when the return on the investment or the transaction is high. The GOL should collaborate with all major media outlets (TV, radio and newspapers) to insert messages related to construction, urbanization, and heritage conservation. TV inserts, debates, and spots should also remind the people of the benefits of compliance and law enforcement, and the repercussions of fraud and malpractices. Banks can and should play a key role in this effort as they are the principle lenders and beneficiaries of the construction sector.

Historical building in Gemayze

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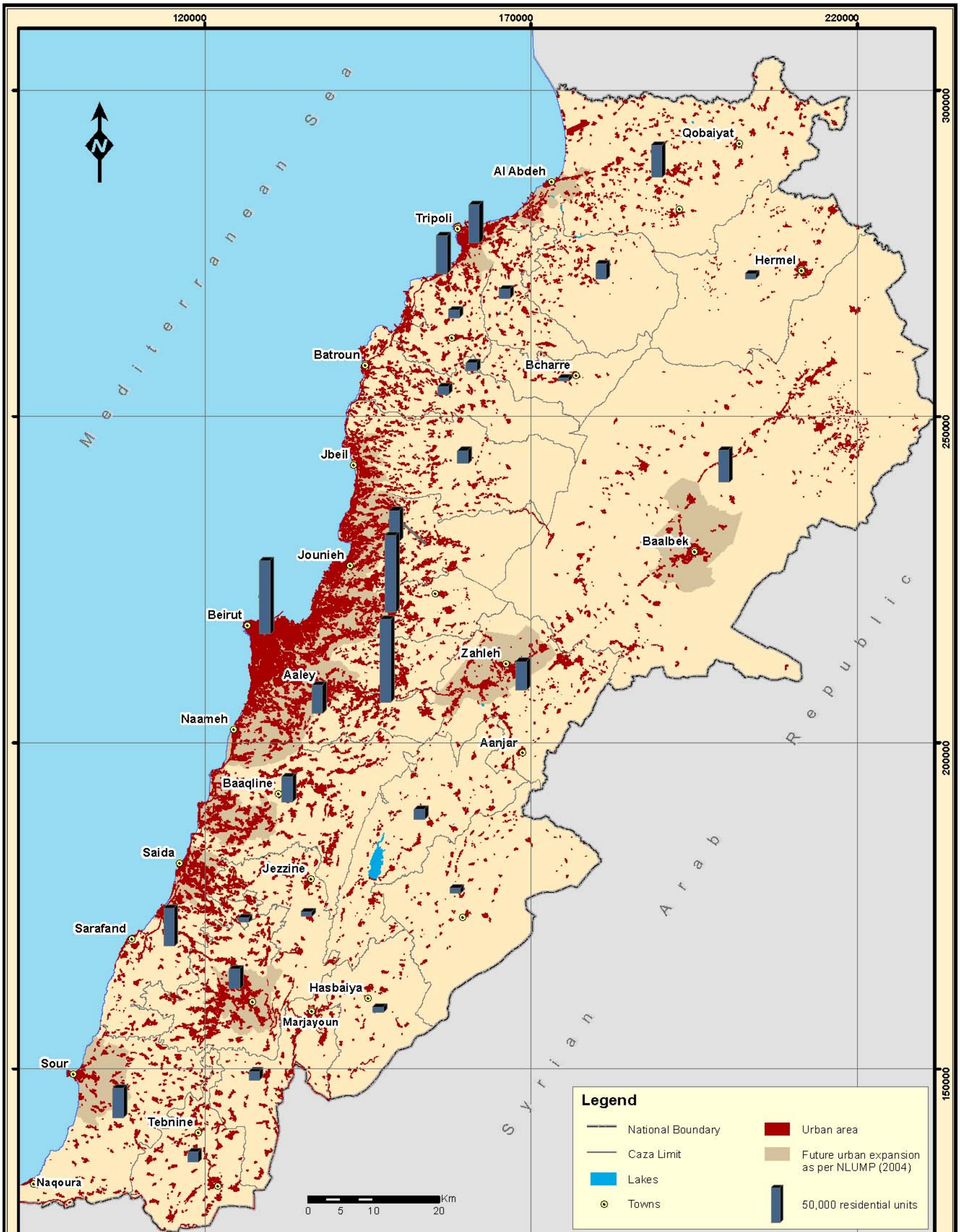
CITED LEGISLATION RELATED TO HAPHAZARD URBANIZATION

نوع النص	الرقم	التاريخ	عنوان النص
قرار وزارة المالية	٣٣٣٩	١٩٣٠/١١/١٢	قانون الملكية العقارية
مرسوم	١١٦١٤	١٩٦٩/٠١/٠٤	اكتساب غير اللبنانيين الحقوق العينية العقارية في لبنان
مرسوم اشتراعي	٦٩	١٩٨٣/٠٩/٠٩	قانون التنظيم المدني
قانون	٢١٦	١٩٩٣/٠٤/٠٢	إحداث وزارة البيئة
مرسوم	١٠٤٩٠	١٩٩٧/٦/٢١	إعادة تنظيم وتحديد ملاك المديرية العامة للتنظيم المدني
قانون	٢٩٦	٢٠٠١/٠٤/٠٣	تعديل بعض مواد القانون المنفذ بالمرسوم الرقم ١١٦١٤ تاريخ ٤/١/ ١٩٦٩إكتساب غير اللبنانيين الحقوق العينية العقارية في لبنان
قانون	٦٤٦	٢٠٠٤/١٢/١١	تعديل المرسوم الاشتراعي رقم ١٤٨ - تاريخ ١٩٨٣/٩/١٦ قانون البناء



State & Trends of the Lebanese Environment
Chapter 7 - Haphazard Urbanization

Map 8 - Lebanon's Urban Expansion and Major Cities

This map was prepared by ECODIT based on National Land Use Master Plan (2004). Every effort has been made to ensure the accuracy of the information displayed on this map. The international boundaries are approximate. MOE/UNDP/ECODIT do not assume any responsibility for any decision that may arise from the use of the map.

8 Solid Waste

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Photo Credit: CDR-LACECO

ABBREVIATIONS & ACRONYMS

AEC	arcenciel (NGO)
CDR	Council for Development and Reconstruction
COM	Council of Ministers
C&D	Construction and Demolition
EIA	Environmental Impact Assessment
EU	European Union
GBA	Greater Beirut Area
GOL	Government of Lebanon
HCW	Health Care Waste
HCWM	Health Care Waste Management
IMF	Independent Municipal Fund
ISWM	Integrated Solid Waste Management
OMSAR	Office of the Minister of State for Administrative Reform
OMW	Olive Mill Wastewater
MOA	Ministry of Agriculture
MOF	Ministry of Finance
MOE	Ministry of Environment
MOIM	Ministry of Interior and Municipalities
MOPWT	Ministry of Public Works and Transport
MSW	Municipal Solid Waste
UNDP	United Nations Development Programme
SEA	Strategic Environmental Assessment
SEEL	Supporting the Judiciary System in the Enforcement of Environmental Legislation
SELDAS	Strengthening/State of Environmental Legislation Development and Application System in Lebanon
SWM	Solid Waste Management
SWTP	Solid Waste Treatment Plant
WTE	Waste to Energy

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Population growth, urbanization and dwindling land areas are exacerbating solid waste management (SWM) issues in Lebanon to the brink of a national crisis. Nationwide, an estimated 51 percent of all municipal solid waste (MSW) is landfilled, 32 percent is dumped, and the remaining 17 percent is recovered through sorting and composting (SWEEP-NET 2010). While government- and donor-funded studies and master plans related to municipal SWM have started to show modest results, very little has been achieved insofar as managing industrial waste, including hazardous waste, as well as other types of waste such as construction and demolition waste. Political indecision has so far prevented the implementation of a comprehensive plan for SWM in Lebanon.

This chapter describes the drivers of change impacting SWM, the institutions and other key players affecting the sector, current practices including collection, treatment and disposal, and concludes with an analysis of policy options for improved SWM in Lebanon.

8.1 DRIVING FORCES

Waste generation is related to human activities, lifestyles, and environmental awareness. Rapid urbanization, growing consumption, and limited environmental awareness are having a compounding effect on waste generation. Inadequate solid waste legislation and enforcement, and the lack of political consensus on critical SWM issues, have led successive governments to adopt and prolong emergency measures. Consequently, environmental management solutions in Lebanon are not always the best ecologically but often the most politically-acceptable.

8.1.1 Population

With a resident population of 4.2 million (inclusive of an estimated 416,600 Palestinian refugees), and an average waste generation rate of 0.95 kg/capita/day (1.1 kg/d in urban areas, 0.7 kg/d in rural areas), Lebanon generates about 1.57 Million tons of waste per year (SWEEP-NET 2010, CAS 2008, and UNRWA 2008a) –*see Box 8.1 and Figure 8.1 for generation quantities*. Waste generation is expected to increase by 1.65 percent annually to reach 2.3 Million tons by 2030, notwithstanding potential waste recovery from sorting and composting facilities (WB/METAP, 2004). Waste disposal is particularly difficult in Lebanon because of its rugged terrain and limited surface area.

Insecurity affects waste collection services (here, during July 2006)

Box 8.1 MSW generation rate

MSW generation rates vary based on region and data source. For example: the 2001 SOER used 0.92 Kg/c/d for Lebanon (1.1Kg in Beirut and 0.85Kg for rural areas). In their 2004 Country Report, METAP used 0.5 to 0.7 KG/c/d for rural areas and 0.75 to 1.1 KG for urban areas. OMSAR used 0.5-0.6 Kg/c/d for rural areas and MOE uses 1.1Kg/c/d for urban areas and 0.7 for rural areas, with a national average of 0.96Kg/c/d. Generally, in Lebanon, urban centers produce 1.1 kg/c/d (Beirut and most of Mount Lebanon) while rural areas produce 0.7kg/c/d (North, South, Nabatiyeh and Bekaa). These rates include waste generated by tourists, restaurants and hotels.

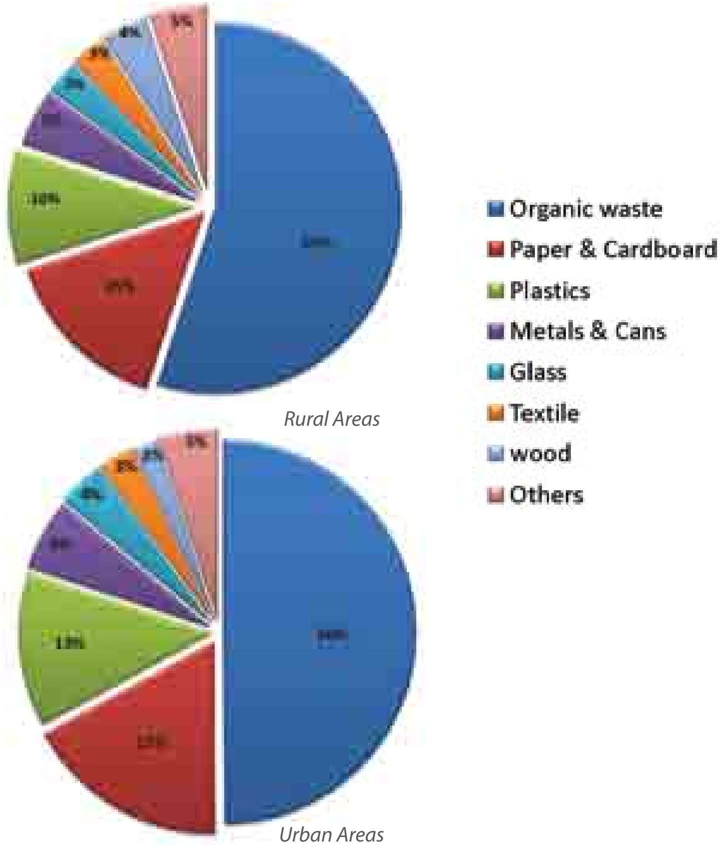
Source: Adapted from SWEEP-NET, 2010

Figure 8.1 MSW Generation by Mohafaza

Source: SWEEP-NET, 2010

Waste composition varies with a person's lifestyle and economic status. The organic fraction of solid waste in Lebanon is very high, primarily because of exuberant hospitality and the makeup of Lebanese cuisine. The composition of solid waste also changes according to area (cities and commercial centers produce much more paper and plastics than rural areas) and season (during summer, the consumption of fresh produce such as fruits and vegetables goes up markedly, which affects the organic and moisture content of the waste stream). *See tentative solid waste composition in Figure 8.2.*

Figure 8.2 Solid waste composition in Lebanon



Source: SWEEP NET, 2010

Seafront open dumps pollute and spoil public beaches (here in Saida)

8.1.2 Awareness & Lifestyle

Environmental education and awareness help reduce waste generation through source separation and reuse. In the absence of serious and sustained environmental education programs in schools, universities and mass media channels, people tend to consume unabatedly, reuse less, and throw more. Social trends and marketing gimmicks resulted in excessive packaging and use of non-degradable materials that end up in dumpsters and landfills. Aggressive promotions entice consumers to buy more and fix or reuse old appliances less. Prevalent Not-In-My-Backyard (NIMBY) sentiments by the general public have so far delayed or scrapped master plans involving landfills and Solid Waste Treatment (SWT) facilities near towns and villages.

8.1.3 Political Indecision

SWM solutions require long-term vision and political commitment and consensus. So far, in the absence of both, the Government of Lebanon (GOL) has been relying on emergency response measures. The foremost example is the Emergency Plan for SWM in Beirut and Mount Lebanon (except for the caza of Jbeil), in effect since 1997. The plan contracted Sukkar Engineering Group (today Averda Group)[1] to collect, treat, and landfill solid waste from an area serving about 2 million people. The plan was partially implemented despite controversies linked to (1) system costs, and (2) the effectiveness of sorting and composting plants. The Council of Ministers (COM) extended the management contracts for Sukleen (collection only) and Sukomi (treatment and disposal), several times since 1997 –the last contract extension, to span four years, was enacted by the COM in April 2010 and will extend through 2013.

Outside GBA, municipalities and federations are responsible for the collection, treatment and disposal of municipal waste and assume all related costs. Austerity measures by the GOL have prevented many municipalities to plan for and invest in proper solid waste systems. They typically receive their budgetary allowances from the Independent Municipal Fund (IMF) several years behind schedule and therefore tend to resort to quick solutions and fixes, including open dumping. Several international development organizations (European Union, Italian Cooperation, Spanish Agency, USAID, etc.) have stepped in by providing direct technical and financial support to individual municipalities and groups of municipalities. Such support is needed and welcomed but, at some level, delays or distracts government efforts to draw up a national plan for SWM and divert resources to ensure plan implementation.

8.1.4 Inadequate Legislation

Lebanon has legislation related to SWM but these are oftentimes outdated or incomplete. Several legal instruments do not address solid waste directly but approach solid waste concomitantly with other public issues including the protection of public health, natural sites, the Mediterranean Sea, etc. Other instruments were enacted spontaneously and with little regard for implementation. For example, Decree No. 9093 (dated 15 November 2002; amendment to Decree No. 1917/1979) stipulates that municipalities will receive financial rewards for hosting SWM facilities, including landfills, within their jurisdiction –this decree, sound at the surface, could never be implemented for a variety of reasons discussed later in this chapter.

8.2 CURRENT SITUATION

8.2.1 Key Players and Actors

The GOL, as part of its Ministerial Declaration (dated 8 December 2009), committed itself to protect the environment by finding alternatives to open dumping, and solutions for SWM (Article 16). On the energy front, the declaration also pledged to implement energy conservation measures such as adopting waste-to-energy technologies for urban areas and major cities. Pursuant to the declaration, MOE incorporated SWM as one of 10 priority themes into its Work Program for 2010-2012, working in partnership with relevant ministries (MOIM, MOF, MOPWT, MOPH, MOA, and OMSAR) and CDR. The Work Program also promotes Integrated Solid Waste Management (ISWM) covering municipal, industrial and hazardous waste, and calls for managing uncontrolled dumpsites and defining guidelines for the treatment of special waste such as e-waste (Theme No. 6). Below is a quick overview of key players and actors in the solid waste sector (for both non-hazardous and hazardous waste). See cost of environmental degradation from illegal dumping and waste burning in Box 8.2.

Box 8.2 Cost of environmental degradation from illegal dumping and waste burning

A study conducted by the World Bank in 2004 on the state of environmental degradation in Lebanon, quantified the cost of degradation caused by pollution from illegal dumping and waste burning to be around $10 Million per year, and rising.

Source: Cost of Environmental Degradation: The Case of Lebanon and Tunisia, World Bank, June 2004.

Ministry of Environment

According to MOE's new organizational structure (Decree No. 2275, dated 15 June 2009), solid waste issues fall under the Service of Urban Environment (Department of Urban Environmental Pollution Control). Notwithstanding resources availability, the Department should (1) review all studies and tender documents related to solid waste and wastewater treatment plants, (2) participate in committees for the reception of works linked to SWT facilities and landfills, (3) prepare and formulate Master plan for the management of MSW and (4) define environmental limit values for the disposal of non-hazardous solid waste (and liquid waste) in water bodies and on soil. MOE has prepared environmental guidelines for the construction and operation of sorting and composting plants, and sanitary landfills, as well as compost guidelines (unpublished)[2]. Most importantly, MOE prepared in 2005 a draft law on ISWM –*see analysis in Section 8.3.1*. In 2006, MOE coordinated with CDR the preparation of a national municipal SWM plan and was also

[1] Holding company of SUKLEEN (collection services) and SUKOMI (treatment & disposal services)

[2] Ordinance on the Quality Assurance and Utilization of Compost in Agriculture, Horticulture and Landscaping. MOE, 2004.

involved in the preparation of the 2010 Waste-To-Energy (WTE) Plan.

Ministry of Interior and Municipalities
According to Decree-Law No. 8735 (dated 23 August 1974) on the maintenance of public cleanliness, municipalities are responsible for the collection and disposal of household wastes, and the location of waste disposal sites should be approved by the health council of the Mohafaza. The Municipal Law of 1977 (legislative decree No. 118, Article 49) authorizes municipal councils to build solid waste disposal facilities. Municipalities report to the local governor and the MOIM, which manages the allocation and distribution of funds from the IMF, under the control of the MOF. Outside the GBA, municipalities use IMF resources to pay for SWM services including street sweeping, waste collection, and disposal. MOIM Decree No. 9093 (dated 15 November 2002) provides financial incentives to municipalities for hosting SWM facilities or landfills. In particular, municipalities who agree to host a sanitary landfill or a SWM facility would according to the decree receive five-folds their annual allocation from the IMF and 10-folds this allocation in case the facility serves 10 municipalities or more. To date, the decree has never been implemented. Several municipalities (Tripoli, Zahle, etc.) have developed their own MSWM services and are providing this service quite successfully and cost-effectively --*see Section 8.2.4*

Ministry of Public Health
The ministry aims to improve population health by ensuring equal access to reliable health services. Based on Decree 8377 dated 13/12/1961 and Law 546 dated 20/10/2003, the Ministry is responsible for licensing health institutions including hospitals and clinics. MOPH is therefore indirectly responsible for health care waste. The ministry, through regional Health Councils, is indirectly involved in the permitting of small-scale waste treatment facilities. Additionally, the Syndicate of Private Hospitals plays a major role in the evaluation, classification and accreditation of hospitals.

Council for Development and Reconstruction
The CDR lends support to the COM and manages infrastructure projects financed through international loan agreements. Whereas Law 501 (dated 6 June 1996) charged CDR with the implementation of the WB-funded Solid Waste Environmental Management Program (SWEMP), the program was terminated and the loan was withdrawn after extensive delays and strong public opposition to proposed landfill sites. CDR continues to be in charge of the implementation of the Emergency Plan for SWM in GBA and has also developed proposals for improving SWM services in other cities such as Tripoli and Zahle. In 2003, the COM requested CDR to devise a national municipal SWM plan (Decision No. 16 dated 14/08/2003) but the plan was aborted after strong public opposition -- *see details in Section 8.3*

Office of the Minister of State for Administrative Reform
The Office of the Minister of State for Administrative Reform (OMSAR) is a governmental organization that seeks to develop the institutional and technical capacities of ministries, other government and public agencies, and municipalities. Under the EU-funded program *Assistance to the Rehabilitation of the Lebanese Administration* (ARLA), OMSAR launched a municipal SWM program to improve the provision of solid waste services in rural areas. A new unit was created within OMSAR to manage the implementation of the €14.2 million EU-funded program (to build and equip the facilities) and related investments worth $15 million from the national treasury (to operate and maintain the facilities).

8.2.2 Treaties and Conventions Related to Solid Waste

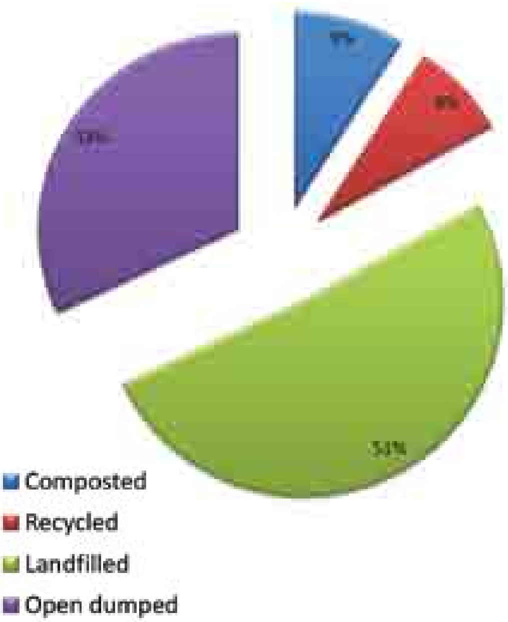
Lebanon has signed several conventions related to waste disposal (hazardous and non-hazardous) and pollution including the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (1973), the Barcelona Convention for Protection against Pollution in the Mediterranean Sea (1976) and the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-based Sources in Athens (1980). In 1994, Lebanon ratified the Basel Convention regulating the trans-boundary movement of hazardous wastes and their disposal, and requiring Lebanon to provide disposal facilities for the sound management of hazardous wastes. In 2001, Lebanon signed the Stockholm Convention on reducing and eliminating the release of persistent organic pollutants (POPs), which can be produced from thermal processes involving organic matter and chlorine (hazardous waste). The Convention also requires the GOL to improve waste management, cease open burning of solid waste, minimize the generation of municipal and medical waste through source recovery, reuse, recycling, waste separation, and promoting products that generate less waste.

8.2.3 Policy Setting

The following section describes key regulations and policy issues related to solid waste. Each legal text cited here is also listed chronologically at the end of the chapter. For a more complete analysis of environmental legislation related to solid waste, please refer to Chapter 13 of SELDAS (EU/UOB/MOE/ELARD, 2005). For a review of environmental jurisprudence cases related to solid waste in Lebanon and other countries, please refer to Chapter 13 of SEEL (MOJ/MOE/UNDP, 2010).

Over the last 15 years, Lebanon experienced a string of SWM plans, of which three plans deserve mention and analysis in this report: (1) Emergency Plan for SWM dated 1997, (2) Master Plan for SWM dated 2006, and (3) Waste-to-Energy Plan dated 2010. Despite notable progress in SWM, at least 80 percent of Lebanon's solid waste still ends up in landfills and open dumps- *see Figure 8.3* (SWEEP-NET, 2010).

Figure 8.3 Fate of MSW in Lebanon



Source: SWEEP-Net, 2010

Emergency Plan for SWM (1997-Present)

The Emergency Plan for SWM (COM Decision No. 58, dated 2/1/1997), still in force today, provides a framework for SWM in Beirut and most of Mount Lebanon (Kesrouan, Metn, Baabda, Aley, and Shouf) excluding the caza of Jbeil. Pursuant to the plan, the GOL shut down the Bourj Hammoud and Normandy dumpsites and established a waste management system comprised of the following main components:

- Sorting and baling in two facilities: Quarantina (1100 T/d) and Amrousieh (600T/d),
- Composting of organic material at the Coral facility (300T/d),
- Temporary storage of bulky and recyclable materials at the warehouse facility located near the Bourj Hammoud dump,
- Disposal of sorted MSW at the Naameh Landfill Site,
- Disposal of inert and bulky items at the Bsalim Landfill.

The contracts with Averda Group included quantity-based deliverables (i.e., compost produced and recyclables salvaged). This has created the need to negotiate adjustments to Contractor invoices, since the total amount of waste treated annually exceeded the assumptions laid forth in the Plan. In particular, the Plan assumed that the Contractor would collect 1,700 tons per day, recover 160 tons per day of recyclable material (or 9.41 percent) and compost 300 tons per day of organic waste (or 17.6 percent). Instead of aiming for percent recovery targets, the contract was geared towards the tonnage of compost and recyclables.

Master Plan for SWM (2006)

Following an explicit request from the COM (Decision 1/4952 dated 18 August 2005), MOE and CDR prepared jointly a 10-year municipal SWM plan to cover the rest of Lebanon. The plan (2006-2016) recognizes four service areas --(1) North & Akkar, (2) Beirut & Mount Lebanon, (3) Bekaa & Baalbak-Hermel, and (4) South & Nabatiyeh – and proposes an integrated approach to SWM involving collection and sorting, recycling, composting, and landfilling. It foresees that each service area will be equipped with sanitary landfills (6-7 landfills in total) and that every *Caza* will have its own waste treatment facility for sorting and composting (about 12-14 plants in total). Although the plan was approved by the COM in June 2006, the subsequent war in July 2006 drained government resources and sapped political will to implement it. Lack of public funding and consensus on the location of proposed facilities further eroded all prospects for implementation. Table 8.1 summarizes key elements of the plan.

Table 8.1 Municipal Solid Waste Management Master Plan (2006)

Service Area	MSW Generation (t/d)	Sanitary Landfills		Composting Plants		Sorting Plants	
		No	Proposed Location	No	Proposed Location	No	Proposed Location
Group 1: North Lebanon & Akkar	712	1	Srar	1	Srar	1	Srar
Group 2: Bekaa & Baalbeck-Hermel	425	2	Zahle & Teybeh	2	Zahle & Teybeh	2	Zahle & Teybeh
Group 3: South Lebanon & Nabatiye	626	2	Mazraat Bsfour & Shakraa Barashit	2	Mazraat Bsfour & Shakraa Barashit	2	Mazraat Bsfour & Shakraa Barashit
Group 4: Beirut & Mount Lebanon	2,300	1 or 2	Jiyeh (Dahr el Mghara) or Khreybeh	1 or 2	Jiyeh (Dahr el Mghara) or Khreybeh	1 or 2	Jiyeh (Dahr el Mghara) or Khreybeh
Lebanon	**4,063**	**6-7**	-	**6-7**	-	**6-7**	-

Waste-to-Energy Plan (2010)

The 2006 master plan achieved very little in the period 2006-2010. The GOL did not build any of the proposed treatment plants and landfills but several small-scale facilities that complement the master plan were implemented with grant funding from partner agencies (EU-OMSAR, EU-IMG, etc.). Recognizing this impasse, and acting pursuant to the Ministerial Declaration, the COM issued Decision 55 (dated 1/9/2010) to amend and complement the 2006 master plan. The 10-point Decision advocates Waste-To-Energy (WTE) technologies in large cities, and renews the government's commitment to the 2006 master plan in the rest of country while also exploring the feasibility of WTE systems. *See summary of 10-point plan in Box 8.3.*

Box 8.3 Summary of Waste-To-Energy Plan 2010

The COM endorses the recommendations of the inter-ministerial committee for SWM, summarized below:

1. Adopt waste-to-energy technologies in large cities
2. Adopt the 2006 master plan in the rest of the country
3. Engage the private sector in the provision of SWM services
4. Mandate MOE and CDR to reconcile and merge the two plans (2006 and 2010)
5. Mandate MOEW to draft regulations for waste-to-energy generation by the private sector
6. Incentivize municipalities that will host waste treatment facilities
7. Mandate CDR, in coordination with MOE, to contract an international consulting firm to select the most appropriate and proven technologies (through due diligence), prepare related tender documents and supervise operations
8. Mandate MOE to hire an international consulting firm to monitor system performance
9. Mandate MOE to hire a local consulting firm to promote awareness of waste-to-energy
10. Vest authority in the Prime Minister to oversee implementation and secure finances

Source: COM Decision 55 (dated 1/9/2010)

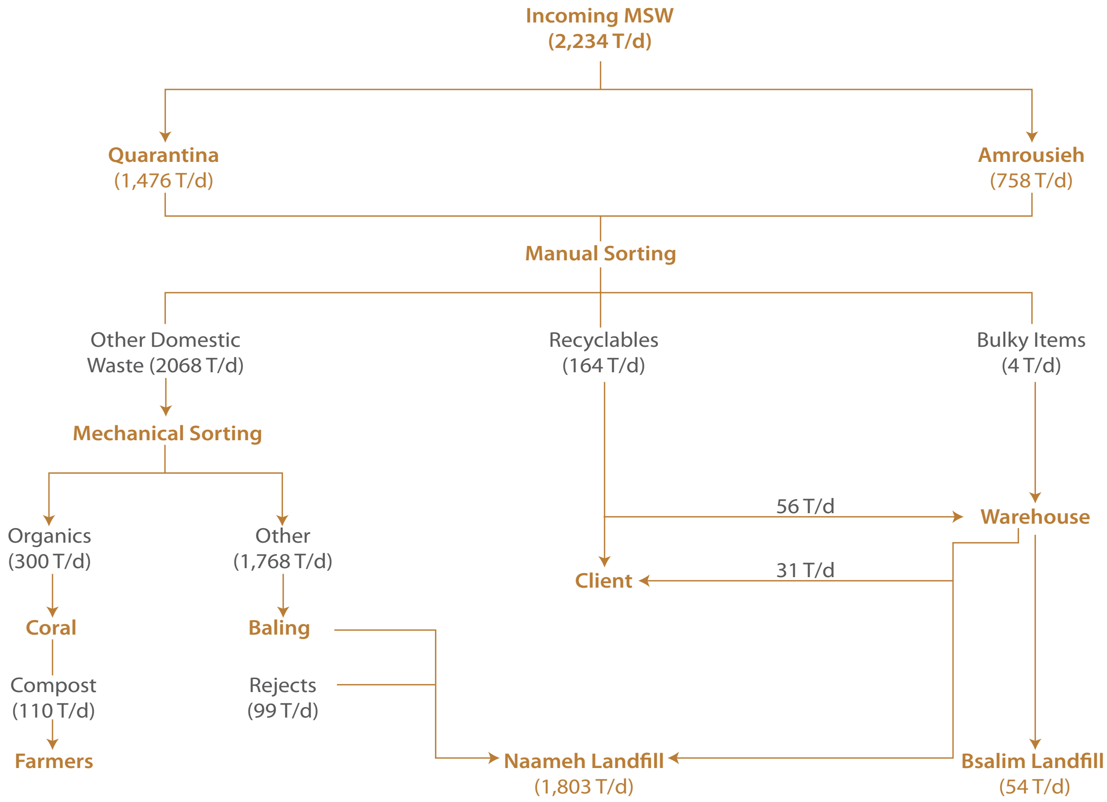
Although recycling and composting remain the first priority for managing solid waste based on the SWM hierarchy principles, the new priority in some developed countries (especially in European countries), after recycling, is the recovery of energy and metals by controlled combustion such as WTE processes. Like all technologies, WTE technologies present solid waste management costs and benefits. On the benefit site, the newest generation of WTE allows to (1) use waste as a supposedly clean renewable energy fuel to generate electricity (with at least 30% efficiency), (2) optimize land use by reducing reliance on landfills, and (3) reduce the carbon footprint (0.366 kg of CO_2/Kwh of electricity generated) as compared to power plants (0.594 kg of CO_2/Kwh) or landfill cells (1.037 kg of CO_2/Kwh). WTE also present cross-sector synergies as it would help forego a number of planned investments for treatment of sludge, hazardous waste, etc. On the cost side, the process requires pricey smoke depollution systems to capture and destroy gas pollutants including dioxins (the most dangerous and complicated compound to abate) (World Bank, 2010).

8.2.4 Municipal Solid Waste Management

Overall Management in Beirut and Mount Lebanon

In Beirut and Mount Lebanon (excluding the Caza of Jbail), SWM is still based on the 1997 Emergency Plan. Waste collection from curbside containers and other designated disposal areas is provided by Sukleen and transported to two sorting plants in Aamrousieh and Quarantina respectively. The (original) Emergency Plan assumed that Sukleen would collect 1,700 tons per day (equivalent to 620,000 t/y); and recover 160 tons per day of recyclables (9.41 percent of incoming waste). As the geographic coverage of Sukleen expanded, the design capacity of 1,700 tons per day was quickly exceeded to reach about 2,300 tons per day in 2010 and waste recovery rates dropped to around 6-7 percent (SWEEP-NET, 2010). Recyclables include cardboard (about 40-45 percent), plastics (27-29 percent), and other items (tins, wood, tires, glass, and aluminum).

Figure 8.4 Emergency Plan for SWM in Beirut and Mount Lebanon (in effect since 1997)



Source: CDR-LACECO, 2010 (data based on 2008 figures)

Commingled municipal waste in Beirut and Mount Lebanon includes green waste and cardboard

About 300 tons of organic waste (about 13 percent of incoming waste) is processed in the Coral compost plant producing 110 tons of finished compost. The remaining waste fraction (about 1,800 t/d or 82 percent of waste stream) is baled, wrapped and hauled for final disposal at the Naameh Landfill. Bulky items are sent to the Bsalim Landfill site (see flow chart of MSWM system in Figure 8.4 for year 2008). As reported in the 2001 SOER, and notwithstanding compost quality, the GOL faulted in the implementation of the Emergency Plan by not providing an additional composting plant. The current compost plant (Coral) is small and cannot handle more than 300 tons per day (equivalent to 109,500 t/y), about 17.6 percent of the waste stream envisioned in the CDR-SUKOMI contract.

Overall Management outside Beirut and Mount Lebanon

Outside Beirut and Mount Lebanon (excluding the Caza of Jbail), municipalities continue to assume lead responsibility for carrying out SWM operations (sweeping, collection and disposal), pursuant to Municipal Law No. 118 (dated 30 June 1977). Municipalities either use their own waste collection vehicles and workers or outsource the service to private contractors. Towns with no municipal councils typically piggyback on the collection and disposal system of neighboring municipalities based on mutual agreement, or illicitly. Recycling and composting outside Beirut and Mount Lebanon is estimated at 5 and 13 percent of the waste stream, respectively (SWEEP-NET, 2010).

A number of municipalities have received assistance (technical and financial) from international development organizations to improve SWM services by building small and medium-sized solid waste sorting and composting facilities. For example:

1. With grant funding from the EU, OMSAR is managing the implementation of a €14.2 Million SWM program. The program has to date financed 18 SWM activities targeting 177 municipalities representing about 1.15 Million people. The cost of each activity varied between €100,000 and €1.4 million. The type of assistance provided was determined through Expressions of Interest submitted by individual municipalities or groups of municipalities. Some municipalities received waste containers; others received waste collection vehicles, and/or sorting and composting facilities. The program also financed one sterilization center for medical waste in Abbassiyeh (south Lebanon). In 2010, the program committed the GOL to operate and maintain the newly completed facilities using public treasury funds (Decree 3860 dated 19/4/2010). The Decree has in principle secured O&M funding for three years and for three facilities (Ain Baal in Sour, Ansar in Nabatieh, and Khiyam in Marjayoun) and could be amended in the future to include additional facilities when they come online. *See overview of investment under EU-OMSAR in Box 8.4.*
2. The Italian Development Cooperation also financed many activities in the solid waste sector. In particular, the Cooperation worked with the Coordinating Committee for Voluntary Service (COSV) to improve SWM systems in four municipalities in South Lebanon (Kfar Sir, Khirbet Selm, Aytaroun, and Bint Jbail) through ROSS and ROSS II emergency program fund. Assistance ranged from facility rehabilitation/ reconstruction, to training in operation and management. More recently, the Cooperation (Italian Government) signed a €2.5 Million agreement with MOE to improve SMW services in Baalbeck. The agreement covers dumpsite closure and rehabilitation, as well as the construction of a new sanitary landfill for the caza of Baalbek, and OMSAR will complement this initiative by financing the construction of a sorting and composting facility.
3. The United States Agency for International Development (USAID) financed the construction of a number of small-scale plants, mostly in South Lebanon. These plants achieved little success for many reasons including technical (contractors did not use proven technologies), operational (limited resources to ensure preventive maintenance, power shortages, etc.), and security (physical damages during July 2006 war).

Municipal Solid Waste is mostly commingled (no source separation). Material recovery is therefore carried out at the end of the waste collection scheme at a centralized Material Recovery Facility and/or composting plant. This reduces the quality of recyclables (due to cross contamination from other waste particles as well as leachate), and leads to low recovery rates (less than 10 percent at the national level). Actual material recovery may be higher than reported rates, thanks to an organized network of scavengers who remove waste from dumpsters and dumpsites before collection by municipal services and mechanized waste contractors. *See detailed overview of current and proposed SWM facilities in Lebanon in* ***Annex 1*** *and* ***Map 9*** *--excluding the WTE facilities proposed under the 2010 plan.*

Solid Waste Disposal: Sanitary Landfills
Lebanon has two sanitary landfills (Naameh and Zahle) and one landfill for inert materials (Bsalim). Combined, the three landfills receive solid waste from about half of Lebanon's population (2 million people). A short description of Lebanon's landfills follows.

Naameh Sanitary Landfill is located in the Shouf *caza* in an old quarry site, across a seasonal watercourse, about 15km south of Beirut and 4km from the coastline. The landfill would according to its original design cover 120,000 m^2 and receive 2 million tons of waste in two cells denoted Cell 1 and Cell 2. In April 2001, the two cells reached capacity and CDR requested SUKOMI to build Cell 3 covering an area of 62,000 m^2 [3]. This cell was further divided into Cells 3A, 3B, and 3C, which reached their full capacity in 2005 and were expanded in 2006 by an additional 25,000 m^2 [4]. In 2008 and concurrently with the extension of SUKOMI's contract period through 2011[5] SUKOMI built two new cells denoted 3D1 and 3D2, which would extend the landfill service period until July 2010 (CDR-LACECO, 2010). The landfill was expanded again in April 2010, in anticipation of a new SWM strategy for Lebanon.

Expanding the landfill required expensive land expropriations and (quite expectedly) faced stiff public opposition and protests by local residents. Since it came into operation in 1998, the Naameh Landfill has been receiving much more waste than originally planned. Whereas the Emergency Plan had estimated that it would receive 1,240 t/d (73% of incoming waste), and no more than 690 t/d (40% of incoming waste) after the planned expansion of the composting facility, the Naameh Landfill received on average 1,955 t/d in 2000; 2,208 t/d in 2004, 2,234 t/d in 2008 and 2,300 t/d in 2010. It is very unlikely that Lebanon will be able to accommodate a second Naameh Landfill on its territory. The cost of waste collection, treatment and disposal at the Naameh Landfill is approximately $150 per tonne of waste *–see Box 8.5 for the cost of municipal waste management in Lebanon.*

Bsalim Landfill for inert materials is located in a former quarry on the northern side of Nahr El Mot valley in the Metn caza. The quarry was selected by the CDR for the disposal of inert fill and bulky items as part of the restoration of the quarry and as part of the global management strategy for the GBA. The quarry site consists of semi-vertical cliffs extending almost 150m and covers an area of about 45,000 m^2. The operation activity started in April 1998 and they were interrupted severely in: (1) 31 May 1999 under Court direction, (2) 20 January 2000 due to storm that washed out the access road, (3) on the night of 5 March 2000 due to a serious rock fall on the site and (4) 3 October 2000 under Court direction. The interruptions were


The Bourj Hammoud dumpsite (closed since 1997) is an eyesore for Beirut seafront

Box 8.4 EU-OMSAR investment in solid waste facilities and services

The EU-OMSAR program supplied equipment, built waste management facilities and implemented a targeted awareness campaign on waste sorting at source. In particular, the program supplied:

(1) 13,663 container of different sizes (1,100 liters, 1,000 liters, 660 liters, 240 liters, 50 liters)
(2) 52 solid waste collection vehicles (Compactor trucks, pickups, skid steer loaders, etc)
(3) Specialized solid waste management equipment (Compost turning machines, baling presses, shredders, bagging equipment, generators, etc)

The program also built the following facilities:

(4) 5 sorting and composting facilities (capacities 150 t/d, 61 t/d, 26 t/d, 15 t/d and 10 t/d), 1 sorting facility (77 t/d) and a medical waste sterilization center (300 kg/day) –completed
(5) 3 sorting and composting facilities (120 t/d, 10 t/d and 15 t/d), 1 sorting facility (150 t/d) --ongoing
(6) 2 Sorting and composting facilities (120 t/d and 60 t/d) --planned in 2011

See details in Annex 1 - Overview of Proposed and Actual SWM Systems in Lebanon

Source: OMSAR 2011

[3]CDR Decision no.183/2001/A, dated 13 February 2001

[4]COM Decision no. 1 dated 28 June 2006

[5]CDR Decision no. 491/2008/A dated 19 June 2008

Sorting line at the Zahle solid waste treatment plant (Bekaa Valley)

temporary and operations resumed shortly thereafter. The landfill is devised into three cells with a total volume capacity of one million m^3 and expected to accommodate about 730,000 tons of waste. Materials that are accepted at this landfill include: subsoil, topsoil, rock, stone, clay, sand, tree branches, tiles and slates, brick and concrete, timber and wood, silica, glass and pottery, cement, shredded wood and shredded tires (CDR-LACECO, 2010).

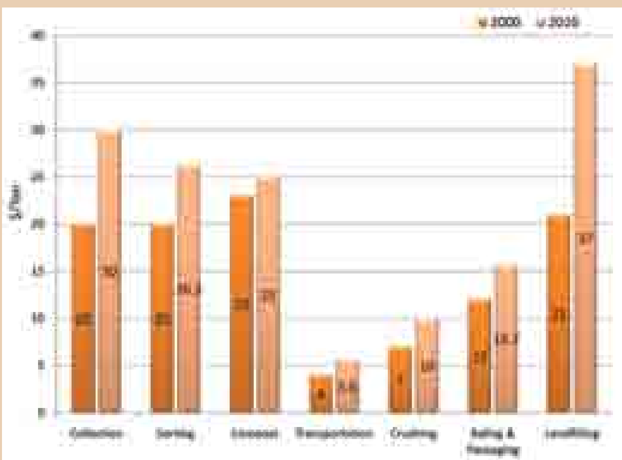
Zahle Sanitary Landfill is located in the Bekaa Valley in the *caza* of Zahle. It was designed and built in 1998 under the World Bank-funded "Solid Waste Environmental Management Project" to receive 150 tons per day, serving 15 out of 29 municipalities in the Caza of Zahle. This is equivalent to eight percent of the waste generated outside Beirut and Mount Lebanon. In 2001, CDR contracted SERDIM/SCS to operate the Zahle Landfill and rehabilitate the 30-year old dumpsite by transferring its contents to one cell. Landfill operation and maintenance costs are financed by the public treasury and the Federation of Municipalities in Zahle. In 2006, USAID Lebanon signed a $2.4 Million agreement with the Municipality of Zahle to expand the existing sorting plant and build a composting plant adjacent to the landfill. The sorting plant was completed in 2007 and started operating in 2008 by recovering 300 tons of waste daily. The compost plant (90t/d) has yet to go online. The landfill today comprises five cells (average height 24 meters) and receives about 43,000 tons per year (118 t/d). The cost of waste treatment and disposal at the Zahle SWM facility is $40/t.

Solid Waste Disposal: Open Dumping

Outside Beirut and most of Mount Lebanon, waste dumping and burning is prevalent. About 410,000 tons of MSW are dumped in the environment every year including household waste, bulky items, as well as medical, industrial, and slaughterhouse waste (MSC-IPP 2005). Based on the findings of a field report prepared by the MSC-IPP project in 2005, MOE has identified 27 priority dumpsites that require immediate attention (see list in Box 8.6). Then in 2010, as part the MOE-UNDP contract for the Preparation of a Master plan for the Closure and Rehabilitation of Uncontrolled Dumps, the Consultant (ELARD) counted about 670 open dumps (including 504 municipal and 166 construction and demolition waste) throughout the country. Dumpsite closure and rehabilitation will require colossal resources, coordination and

Box 8.5 Cost of Municipal Waste Management in Lebanon

Evolution of cost for collection services & waste treatment by Sukleen & Sukomi



Source: Le Commerce Du Levant, No 5610, November 2010 (based on World Bank 2004 & Reporter Interview CDR 2010) and Cost Recovery for Solid Waste Management in Lebanon, MOE-METAP/ELARD, 2005

Waste collection prices Unit rate ($/t)	
Saida	24
Tripoli	22
Zahle	18
Beirut	26.6
Beirut (bulky items)	17.6
Mount Lebanon	34.6

Landfilling prices Unit rate ($/t)	
Tripoli	29
Zahle Landfil	22
Naameh	38-54
Bsalim	31

Source: COM decision 3 dated 20/10/10

Box 8.6 Priority Dumpsites in Lebanon

Ashash, Deir el-Ghazel el-Jerd, El-Fekha, En-Nabi Chit, Fnaideq/Qammouaa, Ghazieh, Hamat/Batroun, Hbaline, Hermel, Jdaide/ Bebnine, Jebaa, Jebjannine, Kayyal, Kfar Habou, Kfartebnit, Kousba, Miziara, Mzar-Sannine, Qab Elias, Ras el-Ain, Saadnayel, Saida, Sarafand, Srar, Srifa, Taalbaya, Terbol el-Jerd (see distribution in Map 9).

Source MOE SWM Plan, March 2010

commitment from all parties concerned. The cost of environmental degradation from waste dumping and burning is estimated to be $10 million per year, and rising. ***Annex 1*** summarizes waste disposal practices by Mohafaza and Caza. This section examines more closely the status of two problematic seafront dumpsites.

Tripoli Controlled Dump. Located on the Tripoli seafront, the dumpsite serves the city of Tripoli as well as the neighboring towns of Al-Mina, Beddawi and Qalamoun with an estimated population of 400,000. CDR contracted in 1999 BATCO, a local waste contractor, to improve waste disposal practices and manage the dumpsite by retrofitting it with gas extraction wells and flaring units. In 2003, CDR commissioned Dar al Handasah (Nazih Taleb) to prepare a study to expand the dumpsite and extend its service life[6]. The approved study recommended building a waste sorting and composting plant (requiring the expropriation of 13,000m^2) and building a gabion wall around the dump (9-10m high) to contain the waste and prevent breakage into the sea (see Figure 8.5).[7] CDR executed the sea wall in 2006 and the EU-funded SWM program tendered the construction of a 150-ton sorting plant in 2009.

The dumpsite currently covers 63,000m^2 and receives 350-400 tons per day of mixed waste including household waste, animal / slaughterhouse waste, agriculture waste, and some construction and demolition waste. Operation and Maintenance costs are covered by the Federation of Municipalities of Al Fayhaa. Although it is not a proper sanitary landfill, multiple investments and improvements have significantly reduced the environmental load of the dump by flaring about 1,000m^3 of methane gas per day, collecting leachate in a drainage ditch that extends around the dump perimeter and re-circulating it in the waste pile to accelerate decomposition, and by applying a daily cover to reduce odors and deter rodents. An on-site primary treatment unit will in the future pre-treat the leachate before discharge into a nearby wastewater treatment plant.

Saida Dump is located on the seafront, only 200 meters from nearby residences and commercial units. Managed by the Municipality of Saida, the dumpsite receives about 150 tons of solid waste per day from 15 municipalities (or 250,000 people). Originally established in 1982 to receive rubble and demolition waste from destroyed buildings, the dumpsite has received all kinds of waste since, an estimated 775,000m^3 so far (60 percent rubble and 40 percent municipal waste). The waste mountain stretches 32 meters high, covers 29,182m^2 and is an enduring eyesore to local residents and tourists. The environmental repercussions are severe; occupational hazards related to incoming health care waste, recurring waste slides into the Mediterranean Sea, and stench have invited countless complaints from local fishermen and residents.

Figure 8.5 Location of Tripoli controlled seafront dump

Source: Google Earth Imagery 2009

The dumpsite has drawn a lot of media attention as well as calls for action from government officials, philanthropic organizations and the private sector. In particular, the Prince Walid Bin Talal Humanitarian Foundation in 2004 pledged $ 5M to help clean up the dump. In 2010, IBC (a private waste contractor) completed the construction of a Mechanical and Biological Treatment Plant located about 200m south of the dumpsite. Designed to handle organic waste, the plant will go online when a service agreement is reached between the Municipality of Saida and the waste contractor (who has reportedly requested a hefty tipping fee). Meanwhile, the COM has decided to rehabilitate the dumpsite by (a) building a seawall around the dumpsite and for which the KSA has already pledged $20M, and (b) treating the waste on-site using public treasury funds and remaining funding from the Foundation. Earlier plans to relocate the dumpsite to an inactive quarry have been scrapped. The lingering problem after dumpsite closure and rehabilitation and the formal inauguration of the biological treatment plant is what to do with the inorganic waste fraction that cannot be recycled.

[6] COM decision no. 28, dated 17 June 2003

[7] COM decision no. 13, dated 15 August 2005

Saida seafront dumpsite in South Lebanon

Seeoverviewofwastedisposalpracticesin Lebanon including landfills and dumpsites in Table 8.2.

Table 8.2 Overview of municipal waste disposal practices in Lebanon

Mohafaza (population)	*Caza*	*Waste Disposal*
North Lebanon (488,147)	Batroun	Open Dumping (Edde, Hamat, etc.)
	Bcharre	Open Dumping (Srar/Akkar, other)
	El-Koura	Open Dumping (Hamat, other)
	Minieh-Dannieh	Open Dumping
	Tripoli	Tripoli controlled dump (Tripoli, El-Mina, Bohsas, Beddawi, and Qalamoun) and open dumping elsewhere
	Zgharta	Open Dumping (Srar/Akkar, Mejdlaya, other)
Akkar (280,562)	Akkar	Open Dumping (Srar, other)
Beirut (389,661)	Beirut	Naameh and Bsalim landfills
Mount Lebanon (1,501,282)	Aley	Naameh and Bsalim landfills + limited open dumping (5 towns)
	Baabda	Naameh and Bsalim landfills + limited open dumping (1 town)
	Chouf	Naameh and Bsalim landfills
	Kesrouan	Naameh and Bsalim landfills + limited open dumping (12 towns)
	Metn	Naameh and Bsalim landfills+ limited open dumping (6 towns)
	Jbeil	Open dumping (Hbaline, other)
Bekaa (221,920)	Rachaiya	Open dumping
	West Bekaa	Open dumping
	Zahle	Zahle Landfill (15 towns) + open dumping (about 14 towns)
Baalbak-Hermel (277,518)	Baalbak	Open dumping (Kayyal, other)
	Hermel	Open dumping
South Lebanon (401,075)	Jezzine	Open dumping (Kfar Tebnit, Ras el Ain, other)
	Saida	Open dumping (Saida, Zahrani, Sarafand, other)
	Sour	Open dumping (Ras el Ain, Srifa, other)
Nabatiyeh (221,920)	Bint Jbayl	Open dumping
	Hasbaiya	Open dumping
	Marjeyoun	Open dumping
	Nabatiyeh	Open dumping (Ras el Ain, other)

Source: Adapted from MSC-IPP Report, 2005

8.2.5 Industrial Waste

Generally speaking, industrial waste is all waste produced by industrial establishments classified according to Decree 5243/2001. Lebanon's estimated 22,000 industrial establishments (see statistics in Chapter 4) generate a very diverse solid waste stream, and contribute about six percent to the total solid waste stream in Lebanon (WB-METAP 2004). A sizeable fraction of the industrial waste stream is non-hazardous (packaging, Styrofoam, wood pallets, food residues, etc.). The remainder fraction however is potentially hazardous, as defined by the Basel Convention. The composition of Lebanon's industrial waste is poorly documented and efforts to manage industrial waste are insignificant and sketchy (industrial wastewater is addressed in Chapter 3 on Water Resources). In 2002, and within the framework of a METAP Project funded by the Italian Government, the MOE prepared three draft decrees on industrial waste management: (1) licensing and permitting for industrial facilities to dispose off industrial and hazardous waste, (2) classification and management of industrial and hazardous waste and (3) healthcare waste classification. The first two drafts are not approved yet. Only the third one is approved and enacted by Decree 13389/2004. In its 2010-2012 work program, MOE included preparing "guidelines for the treatment of specific types of waste, for example, oil waste, used batteries and electronic equipment, organic pollutants and expired goods" as a priority action.

8.2.5.1 Non-Hazardous waste

Slaughterhouse Waste

Lebanon produces about 40,000 tons of slaughterhouse waste per year (METAP/Tebodin, 1998), most of which is generated in up to 10 centralized slaughterhouses located in Beirut (Karantina), Bourj Hammoud, Tripoli, Baalbak, Saida, Sour, Jezzine and Nabatiyeh (see overview in Table 8.4). None of the slaughterhouses currently provide adequate treatment of their waste (blood, internal organs, and bones). They were either primitively designed or built as temporary facilities to be replaced by proper slaughterhouses subject to funding and the acquisition of more suitable lands.

These slaughterhouses are usually run by the municipal service or by an external operator under contract to the municipality or the governor. They are rarely equipped with cold storage facilities to ensure food safety and lack basic climate control and ventilation systems for odor control. So far, the only attempt to manage slaughter waste in Lebanon is in Beirut, where the municipality contracted Cedar Environmental, a Lebanese waste contractor, to treat the waste onsite under very difficult work conditions using a double-cycle composting plant. With a nominal capacity of 30 tonnes per week (excluding blood), the plant produces an organic substrate. Achieving compliance with corresponding EU standards for the sterilization of slaughter waste would require that the waste be exposed to temperatures of at least 133°C for more than 20 minutes. A study commissioned by the Environment Fund for Lebanon (GiZ) has determined that the cost of building a modern waste treatment facility for the Beirut slaughterhouse is about $7 million (Pondus, 2009).

Table 8.3 Overview of major slaughterhouses in Lebanon

Slaughterhouse	*Waste Quantities*	*Treatment*
Beirut (Karantina)	Max. Weekly Qt. 30 t/w Max Daily Qt. 10 t/d Normal Daily Qt. 3 to 4 t/d	Double cycle composting plant which handles all organs including stomach/ intestines and bones. Liquid parts are not treated because of the slaughterhouse configuration.
Nabatieh (Kfar Joz – Wadi El Kfour)	Not Available	Not Available
Bourj Hammoud (Industrial Area)	No data on waste Qt. but on animals: 400 sheep/month and 200 cows/month	Drainage system discharges liquid waste (including blood) into the public sewer system. The Municipality of Bourj Hammoud contracted operations to a private company (OBESAR). Records of waste quantities not available.
Saida	Not Available	Not Available
Jezzine	6 t/w	Waste are sent to Saida open dump
Baalbek	Not Available	Not Available
Tripoli (Near Tripoli port)	Avg. Qty 5.1 t/m (2007)	No treatment – Solid waste (bones & contents) are sent to Tripoli Landfill – No treatment of liquid waste
Sour (Sour Entry near El Bass Roundabout)	No data on waste qty. but on animals: 20-30 sheep/day and 5-10 cows/day	Built in 2005, the slaughterhouse came online in 2010. Waste is sent to open dumps without prior treatment. Blood is filtered on site then discharged into the sewer system.
Zahle (Haouch El Oumara)	Not Available	An old slaughterhouse is out of operation. A new facility was built but is not online. Slaughtering continues in small-scale private slaughterhouses.

Source: Compiled by ECODIT for 2010 SOER

Lebanon's poultry industry is quite developed, producing slaughter waste and poultry litter. To date, only one poultry house is equipped with its own rendering plant to process waste (TANMIA); a second slaughter house is building a waste facility which is expected to go online in 2012 (HAWA Chicken). Smaller poultry houses and farms are not treating their waste stream but recycle some of the litter onsite.

Olive Oil Waste

There are 492 olive mills in Lebanon (MOE, 2006). The production of olive oil generates two types of waste: Olive Mill Wastewater (OMW) and pomace (a solid residue also known as olive cake). Although OMW is usually disposed off in streams and sewers, affecting water quality during the harvest season, both OMW and pomace are addressed in this chapter as one type of non-hazardous industrial waste. The improper management of OMW has adverse environmental impacts due to its high organic and phenolic content affecting soil and water resources. To manage this waste stream, Lebanon hosted the regional project *Integrated Waste Management for the Olive Oil Pressing Industries in Lebanon, Syria and Jordan* (2005 and 2008). Funded by the EU, and implemented under the Short and Medium Term Priority Environmental Action Program II (SMAP II), the MOE hosted the project to introduce and mainstream an integrated system for olive oil waste management in all three collaborating countries (http://olivepress.moe.gov.lb).

Selected achievements include:

1) Conducted an exhaustive survey of olive mills (492) and their complementary industries (about 36 including soap, coal, packaging and composting) to promote the exchange of by-products through an online database.
2) Estimated the cost of environmental degradation from the olive oil production sector. In 2006, this cost amounted to $13.3 million include lost fishing revenues, water treatment costs and damages to natural amenities and landscape.
3) Upgraded 10 olive oil facilities that use different pressing techniques to serve as pilots (e.g., Aoun olive oil press in Majd Al Maaouch (Chouf), Boulos Estabilisments for industry and trading in Jadayel (Jbail), Olive trade in Bayno (Akkar), Jean Nmeir olive oil press in Zahle). The project financed cleaner production method and treatment units.
4) Defined environmental limit values for waste from the olive oil industry, as well as environmental guidelines for using treated OMW in irrigation. These limit values and guidelines were published through MOE decisions 100/1/2010, 101/1/2010 and 102/1/2010. The total cost of compliance with the prescribed environmental requirements was estimated at $60,000-$275,000 per olive mill depending on facility size and technology.

8.2.5.2 Hazardous wastes

The Basel Convention (ratified by the GOL in 1994) defines and describes hazardous waste as follows: Annex I (categories of wastes to be controlled), Annex II (categories of wastes requiring special consideration), Annex III (list of hazardous characteristics), Annex VIII (list A) and Annex IX (list B). Generally, hazardous wastes are materials that pose a substantial present or potential hazard to human health or living organisms (Tchobanoglous *et al.*, 1993). Such materials are considered hazardous because they have one or more of the following properties: explosive, flammable, reactive, oxidizing, irritant, harmful, toxic, carcinogenic, corrosive, infectious, teratogenic, mutagenic, and ecotoxic. Hazardous waste cannot and should not be disposed of with the municipal waste stream. They require special handling, management and treatment.

Healthcare waste management

Healthcare Waste

Healthcare Waste (HCW) is waste generated from healthcare facilities such as hospitals, laboratories, and clinics. Decree 13389/2004 classifies healthcare wastes into four categories: (1) non-hazardous waste, (2) hazardous waste include infectious and non-infectious, (3) special waste include pharmaceuticals, chemical waste, cytotoxic and pathological, and (4) radioactive waste.

It is difficult to estimate the quantities of infectious hazardous HCW generated from all sources including laboratories and clinics. Focusing on hospitals only can produce meaningful estimates. Assuming 60 percent occupancy and an average generation rate of 1.0-1.5 Kg per bed per day[8] Lebanon's 174 public and private hospitals (about 13,668 hospital beds) produce daily about 8.2-12.3 tons of health care risk waste (about 3,000-4,500 tons per year). This estimate is lower than previous projections, which indicated that Lebanon would by 2010 produce 69 tons of HCW per day (25,200 tons per year) divided into risk waste (14t/d) and non-risk waste (55t/d) (ERM, 1999).

In the last decade (2001-2010), Lebanon has made noteworthy strides towards improving the management of infectious hazardous HCW. The first breakthrough was the enactment of Decree 8006 (dated 11/6/2002) on HCW categories and disposal methods; amended by Decree No. 13389 (dated 18/9/2004). The decree classified healthcare waste into different types, indicated the proper management and disposal of each type, and prompted several hospitals and organizations to start managing their HCW in an environmentally-appropriate manner. In particular, arcenciel (a local NGO, AEC) and EnvSys (a private waste contractor) started in 2003 to collect and treat infectious hazardous waste from hospitals and clinics. With grant funding and good management skills, AEC was able to expand its service area rapidly and reduce the unit rate for waste treatment to \$0.6/kg. EnvSys closed business shortly after.

Currently, about two percent of private medical laboratories, 33 percent of private hospitals and 20 percent of public hospitals treat their HCW in *on-site* and *offsite* units (inside and outside hospital premises respectively). These units don't have formal permits yet but operate under temporary approvals from the MOE, renewed annually. Once the corresponding Environmental Impact Assessment (EIA) studies have been approved, the facility will receive an environmental permit from the MOE and an administrative permit from the *Mohafez*. Overall, in 2010 AEC was treating 55-60 percent of the total HCW stream (about 90% of the waste stream in Beirut), collected from 81 public and private hospitals. See national overview in Table 8.4. Some establishments including AUB/AUH and MERSACO (pharmaceutical importer) are exporting hazardous waste under Basel Convention.

[8]Lower rate (1 kg/c/d) is based on MOE and upper rate (1.5 kg/c/d) is based on arcenciel

Table 8.4 Overview of HCWM treatment units in Lebanon

Location	*Source of Funding*	*Operator*	*Treatment Type*	*HCW Treated Daily (kg/d)*	*No. of Hospitals served**	*No. Of beds served (actual)*	*Other Notes*
Clemenceau Medical Center in Beirut	Self	CMC & USM (private)	Microwave/ On-site	315	1/-	94	Operational
Haykal Hospital in Koura (North Lb)	Self	Haykal hospital	Microwave & Autoclave/ On-site	82	1/-	160	Operational
Hotel Dieu de France in Beirut	Self	Arcenciel	Autoclave/ On-site	385	1/3	343	Currently receives HCW from Hotel Dieu only
Zgharta (adjacent to Saydet Zgharta hospital)	AECID (Spanish)	Arcenciel	Autoclave/ Off-site	783	22/-	1,889	Operational. License pending EIA approval
Jisr el-Wati (within the premises of AEC center)	EU (LIFE)	Arcenciel	Autoclave/ Off-site	3,235	37/48	3,371	Operational. License pending EIA approval
Zahle (near Zahle landfill area)	Self	Arcenciel	Autoclave/ Off-site	332	12/-	929	Operational. License pending EIA approval
Saida (adjacent to existing WWTP in Saida seafront)	AECID	Arcenciel	Autoclave/ Off-site	1800	9/-	733	Operational. License pending EIA approval
Abbassieh HCW treatment center (South Lebanon)	EU-OMSAR	Mirage (Private)	Autoclave/ Off-site	450	3/-	325	Operational

Note: Number of hospitals served show actual number and number of hospitals according to permit

Source: Data provided by MOE and AEC (2010)

Infectious hazardous waste from facilities not reported in Table 8.4 is most likely comingled with the MSW stream. Impacts on water, soil, air and public health are potentially significant. Uncontrolled and unlicensed incineration of HCW continues in many hospitals releasing persistent organic pollutants (POPs) and other pollutants. Mercury is still used in some medical devices, such as thermometers, although efforts are underway to promote the use of mercury-free devices.

Key players and actors in HCW management include MOE (they develop environmental guidelines and review EIA studies, issue environmental approvals and permits, monitor and inspect facilities, etc.) and MOPH (they oversee public hospitals, manage the accreditation program, and examine health impacts related to HCW activities). In 2002, MOE published an "Environmental Auditing Manual for Hospitals" in Lebanon to encourage and facilitate compliance with government legislation (namely Decrees 8006/2002 and 13389/2004). In 2009, MOE launched the GEF-funded and UNDP-implemented project *Demonstrating and Promoting Best Techniques and Practices for Reducing Healthcare Waste to Avoid Release of Dioxins and Mercury* (2009-2012). The project will establish model facilities and programs to demonstrate best practices in HCWM, deploy and evaluate non-incineration HCW treatment technologies, introduce mercury-free devices in model facilities, develop and disseminate training material, and provide policy support to the GOL in relation to HCWM.

Poly-Chlorinated Biphenols (PCBs)
A Persistent Organic Pollutant, PCBs are a class of man-made compounds that were manufactured and used extensively before 1985 in both closed and open applications. Closed applications include electrical equipment such as transformers and capacitors, whereas open applications are much more diverse and include paints, printing inks, pesticides, hydraulic fluids, lubricants, synthetic rubber, floor tiles, brake linings, adhesives, and corking sealants, to name a few. PCBs are chemically stable and non-flammable. A suspected carcinogen, PCBs have also been demonstrated to cause serious non-cancer health effects on people and animals including effects on the immune, reproductive, nervous and endocrine systems.

Lebanon ratified the 2002 Stockholm Convention on the phase out of POPs including PCBs by 2025. In 2004, MOE conducted a preliminary inventory of POPs including PCBs in the electricity sector (closed applications only) and prepared in 2006 a National Implementation Plan for the phase-out of POPs (MOE-UNDP, 2006). The PCB inventory was updated and expanded in 2010 in support of an upcoming GEF Full Sized Project for PCB management and disposal. According to the updated inventory, Lebanon has 185 tons of PCB-containing power transformers and capacitors in the production and transmission sectors (of which 141 tons are out-of-service), plus an estimated 2,500 PCB-contaminated transformers in the distribution sector. The largest quantities of PCB oil are located in the Jieh power plant. PCB hotpots (evidence or high risk of leakage) are the Zouk power plant and the Bauchrieh warehouse and repairshop (WB-COWI, 2011). *See summary of inventories on dioxins and furans in Table 4.3 in Chapter 4 Air Quality.*


PCB-contaminated transformers in Bauchrieh (Metn)

Waste Oil and Sludge
Waste oil from the transport (lubrication oil) and food sectors (cooking oil) are problematic and hazardous. Inappropriate burning and disposal represent a serious pollution risk to water, soil and air. Waste oil is often used for indoor heating which represents a serious threat to public health. See private sector initiatives in the treatment of used lubrication and cooking oil in Box 8.7. Sludge accumulation in fuel storage tanks poses another disposal problem for fuel importers and the Ministry of Energy and

Water's Petroleum Directorate and Electricité du Liban. See more about sludge disposal in *Chapters 9 Energy Crisis.*

Box 8.7 Used oil treatment

In 2007, TOTAL Lebanon in partnership with Ecolib launched a nationwide project to recover and process used oils from petrol stations. The used oil is collected regularly, to be treated and valued as an alternative fuel for industries. These oils are burned at temperatures exceeding 1400 º C. The recovery and processing of waste oils is now effective in all TOTAL stations and gradually offered to customers of general trade.

Source: www.outremer.total.com

Established in 2006, *Biodiesel Lebanon* started operating in summer 2007. Located in Nahr El Mot, the company has its own collection system and collects used cooking oil from restaurants, hotels and catering companies; about 200 tons per month from Beirut and Mount Lebanon. The cooking oil is transformed into biodiesel and glycerin.

Source: Pers. comm. Fady Faddoul, Managing Director of Biodiesel Lebanon SAL, January 2011.

Demolition waste in Zalka (Metn)

8.2.6 Other Waste

In addition to municipal and industrial waste, Lebanon produces other waste streams such as electronic waste, construction and demolition waste, and special waste.

Electronic Waste

Lebanon, like the rest of the world, is experiencing a quantum leap in electronic waste, also known as *e-waste*. E-waste includes computers and peripherals, batteries, printers, faxes, scanners, cameras, mobile phones and accessories, and network components. Generally, and in the absence of a national strategy, most e-waste enters the MSW stream and ends up in dumpsites or landfills. Such disposal is problematic because e-waste contains heavy metals, (Polyvinyl Chloride (PVC) and Polychlorinated Biphenyls (PCB) that will seep into the ground or cross-contaminate organic waste, thereby affecting compost quality (in case of a composting plant) and/or pollute soil and water (in case of dumping). The disposal of e-waste also represents lost resources as computers and mobile phones can be recycled to make new products --*see for example Ecycle-me Project by Beeatoona and Nokia Take Back program with AFDC in Box 8.8.* See Table 8.5 for e-waste sources and heavy metal content.

Box 8.8 *e*-waste reduction initiatives

In 2008, the Lebanese NGO Beeatoona launched an "E-waste and Battery Recycling for a Better Environment" project in Lebanese schools, with the aim of raising awareness among students, teachers, and their families on environmental and health risks associated with hazardous disposal of electronic waste and household batteries. In Phase 1 (ended in March 2009), the project collected batteries from 75 schools in Lebanon (about 20,000 students). In Phase 2 (launched in July 2009), Beeatoona expanded the project to "Ecycle-me", encouraging computer retail shops, companies, banks, and students, to sort and collect their e-waste through school programs and public-private partnerships. The project has to date mobilized more than 60 computer stores to serve as collection points, more than 200 schools, and several NGOs and private institutions. After collection, the waste is dismantled and stored in a warehouse in Dora for subsequent shipment to waste disposal/recycling facilities abroad. Warehousing is proving difficult because export procedures are complicated and time-consuming as they must comply with the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. In January 2011, Beeatoona prepared a draft decree that would establish guidelines to monitor and collect e-waste from ministries. This draft decree awaits MOE review. See list of collection points at http://www.ecycle-me.org/component/Projects/Collection.asp

Source: Beeatoona 2010

In June 2010, Nokia launched its "Take Back Program" in partnership with the Association for Forest Development and Conservation (AFDC), which aims to raise environmental awareness and provide practical solutions for recycling mobile phones and accessories in Lebanon. The program requires users to drop off their old devices to Nokia Care Centers or AFDC centers. After collecting sufficient numbers, Nokia will ship the phones to Europe where up to 80 percent of the device will be recycled to help make new products such as kitchen kettles, park benches, dental fillings or even musical instruments. The primary audience for Nokia/AFDC includes universities and private companies.

Source: AFDC 2010 and www.iloubnan.info

Table 8.5 Sources of e-waste and heavy metal content

Heavy Metal	Electronic equipment
Arsenic	Microwaves, electronic circuit board, switches, relays
Cadmium	Batteries, mobile phone
Chromium	Hardener in plastics, a dye in pigments and coating for metal parts
Copper	Copper wire, printed circuit board tracks
Lead	Solder, computer or TV monitor, batteries
Nickel	Rechargeable batteries
Silver	Mobile phone
Beryllium	Motherboards, connectors
Mercury	Batteries, flat screens, switches
PVC	Screens, keyboards, mouse, laptops, flash memory

Source: Beeatoona leaflet on e-cycle, November 2010

Illegal discharge of construction and demolition waste in valley in Baskinta (Metn)

Construction and Demolition Waste

Construction waste include stones, bricks, plaster, lumber, plumbing, heating and electrical parts. Demolition waste includes waste from demolished (or damaged) buildings, uprooted roads and streets, sidewalks, bridges and other structures. Construction and Demolition waste (C&D waste) are inert materials and should be disposed off separately from the municipal waste stream as they are unsuitable for disposal in landfills or incinerators.

Lebanon has a grave disposal problem of C&D waste. Decree 8735/1974 bans the disposal of bulky and C&D waste on street sides, in public areas, water streams, on the public maritime domain or in residential areas. It also recommends the disposal of C&D waste in construction sites or in depressions. In practice however, there is very little control on the fate of C&D waste in the country. Earth moving trucks commonly tip their bucket on roadsides and down ravines, producing trails of rubbles and lasting eyesores. Illegal dumping usually happens at night, but also in broad daylight. In Beirut and Mount Lebanon, the Bsalim landfill receives some C&D waste. The rehabilitated Normandy dumpsite received C&D up and until 2009.

Lebanon has experienced several security events that have generated astonishing volumes of C&D waste, well beyond the normal rates of generation. The war in July 2006 caused extensive destruction to infrastructure, residential buildings, and commercial establishments. Physical damages were primarily concentrated in three areas (Beirut southern suburbs, districts of the South, and Baalbek-Hermel region) where significant quantities of C&D waste resulted from military operations (see waste estimates in Table 8.6).

Box 8.9 Treatment and cost of C&D waste from July 2006 war

UNDP developed several options and scenarios for the treatment and disposal of C&D. The UNDP report assessed two main treatment scenarios: (1) treatment in a fixed recycling facility, and (2) on-site treatment with mobile equipment. Each of the treatment alternatives was also assessed for different disposal options. In general, four alternative disposal options for demolition waste were considered: (1) landfilling in an inert waste landfill (Bsalim), (2) backfilling for quarry rehabilitation, (3) donating to landfills to be used as daily cover, and (4) donating to SOLIDERE for sea reclamation. According to the various scenarios, the estimated cost for the treatment and disposal of C&D waste ranged from $US4 to $33 million (Avg = $17 million) for 1 million m3 of rubble in the Beirut Southern Suburbs and between $US8 and $65.5 million (Avg = $35 million) for 1.8 million m3 of rubble in the South and Baalbek El Hermel regions.

Source: UNDP-ELARD, 2007

Table 8.6 Quantities of Construction and Demolition Waste of July 2006 War

Region	Quantity (Million m³)	
	UNDP 2007	*Presidency of the Council of Ministers 2007*
Southern Suburbs of Beirut	1.02 – 1.87	1.43
Districts of the South	0.95 – 1.75	3.32
Baalbek-Hermel	0.54 – 0.99	1
Total	2.03 – 3.72	5.75

Source: UNDP-ELARD, 2007 and Presidency of the Council of Ministers (PCM), 2007

In Beirut's Southern Suburbs, the demolition waste was hauled to four makeshift sites, two in low-lying areas near the sea, one on the Choueifat road, and one along the Airport Road in Bourj Al Barajneh. **In the South**, some municipalities reused the waste to fill depressions in the roads or to use at other building sites. In severely hit towns (Khiam, Bint Jbail), authorities piled the waste on empty lands. Some of the waste in Aytaroun and Maroun el Ras was diverted to an abandoned dried-up pond on Aytaroun. **In Baalbek-Hermel**, the waste was dumped in an abandoned quarry and several other locations in the suburbs of Baalbek (UNDP-ELARD, 2007). See Box 8.9 for estimated cost of C&D waste treatment after the war.

The fighting in the Nahr-El-Bared Camp in North Lebanon (May 2007) produced an estimated 0.6 million cubic meters of demolition waste. Based on an agreement with the United Nations Relief and Works Agency (UNRWA), UNDP implemented a rubble removal project where debris from 5,000 housing units were cleared and transported to a nearby site, sorted, crushed, and screened prior to recovery for reconstruction activities (UNRWA, 2008b).

Bulky Waste

Bulky items are large worn-out or broken household, commercial, and industrial items such as furniture, white goods, lamps, bookcases, filing cabinets, and other similar items (Tchobanoglous *et al.*, 1993). In Beirut and Mount Lebanon, bulky items are hauled to Bsalim landfill (Nahr el Mott) pursuant to the Emergency Plan, where they are used to backfill a former quarry. With a floor area of 45,000m² and a design capacity of about one million m³, the site receives broken furniture, other wood, large objects and shredded tires. Many waste fractions are banned including household waste, HCW, electrical equipment, vehicle parts, and chemical products and residues. *See more about Bsalim Landfill in **Section 8.2.4**.* There is no formal plan for managing and storing bulky waste in other parts of the country.

Expired Goods and Medicine

There are no reliable estimates of expired goods and medicine in the country. Local authorities (customs, municipalities, regional health councils, etc.) often discover stocks of expired goods and medicine and face major difficulties in finding disposal solutions for them. The MOE has prepared environmental guidelines for destroying expired goods but there are no specialized facilities that can treat the waste. In the absence of such facilities, it can be assumed that expired drugs end up in landfills and/or open dumpsites around the country. The MOE is reviewing an EIA study for co-processing expired drugs including cytotoxic waste in cement kilns (Holcim).

Imported Waste

Decision 71/1 dated 19 May 1997 regulates the import of wastes to Lebanon. The decision presents two separate waste lists: allowed waste and banned waste. The MOE receives frequent applications and invoices for waste shipment imports to Lebanon. Waste importers must be classified industrial establishments and must produce a number of documents. According to MOE records, Lebanon imported 29,445 tons of waste in 2009 and about double this amount in 2010 (statistics provided by MOE). Imported wastes include shredded cardboard, sawdust, feathers and plastic and metals leftovers. The countries of origin include Jordan, Iraq, Turkey, Cyprus, Greece, Holland, Italy, France, Canada, and South Africa.

Used Tires

Used tires can be shredded into chips and used as a lightweight fill material for road sub-grades and for other civil and environmental engineering purposes. In Lebanon, there are currently no facilities for recovering used tires. Within Sukleen's service area, used tires are collected as part of the bulky waste stream and stored at the warehouse. A small portion is then resold to tire recycling customers while the remaining portion is shredded and sent to Bsalim landfill to be used as inert material. Outside Sukleen's service area, used tires are either (1) stockpiled in various locations (mainly near vehicles repair shops), (2) dumped haphazardly, (3) used as solid fuels for home heating, and/or (4) burned (see air pollution impacts in *Chapter 4 Air Quality*). During the rehabilitation of the Normandy landfill in Beirut, the waste contractor shredded the used tires and used the byproduct as an inert fill material on site. Beirut residents have experienced fire accidents involving piles of tires.

Stockpiling and disposal of used tires in Bourj Hammoud

8.3 POLICY OUTLOOK AND THE WAY FORWARD

Sections 1 and 2 described the solid waste sector and analyzed the problems facing SWM in the country. This section presents an overview of policy options and needed actions to enhance SWM services in the country by enacting critical waste legislation, mainstreaming public awareness, minimizing waste generation, improving the performance of solid waste facilities, and improving solid waste disposal practices.

8.3.1 Enacting Waste Legislation

Over the past decade, Lebanon has developed important legislation (Law 444/2002, Decree 8006/2002 and Decree 13389/2004) and acceded to several new conventions (2001 Stockholm Convention). Additional legislation is needed to complete the SWM system, including:

Law on Integrated Solid Waste Management

MOE prepared in 2005 a draft law on Integrated Solid Waste Management (ISWM), as part of the EU-funded project *Regional Solid Waste Management Project (RSWMP) in Maghreb and Mashreq Countries*. The project was implemented through METAP and managed by the World Bank. The draft law was presented to COM in October 2005 and awaits approval and approval by parliament. The draft text places a premium on waste "prevention and reduction" in addition to "material reuse, recovery and power generation" and embraces private sector participation in the delivery of SWM services. Other pertinent provisions include:

- General principles related to ISWM (including waste treatment and disposal)
- Allocation of SWM responsibilities and overall institutional setting
- Information management, including data storage and record keeping
- Management of non-hazardous waste, including collection, storage, sorting, treatment, reuse, composting, power generation, and final disposal
- Management of hazardous waste, including updating classification of hazardous waste, management of medical waste, and prohibition of trans-boundary waste movement
- Financing, cost recovery, and incentives, including potential sources of financing, and cost recovery via tax exemptions and others
- Penalties and sanctions, and application of the "polluter pays principle".

Waste-to-Energy Legislation

If the government is earnestly committed to implementing Decision 55/2010 which advocates waste-to-energy technologies in urban areas and major cities, it needs to make significant headway on waste-to-energy legislation. In particular, facility operators (municipalities and/or waste contractors) would need authorization to produce and sell energy to EDL or private electricity concessions by feeding directly into their grid. On-site energy storage is still expensive and not a viable solution.

In addition, appropriate WTE technologies should be identified and assessed as part of a SEA study (see point 7 in Box 8.3). The SEA process should engage relevant and impartial experts in all stages of the WTE plan including literature review, SEA scoping, public consultation and workshops, as well as the assessment of technical and policy options. The SEA should present a complete cost estimation of the WTE plan including a comparison of costs between landfilling and WTE technologies.

Compost and Sludge Reuse Standards

There has been a lot of hype surrounding compost quality (especially compost produced from comingled MSW). There is an urgent need to finalize and endorse national guidelines for compost quality to ensure future markets for the finished compost. Such guidelines typically recognize three types of compost categories (based on waste source and compost use) and will inform end users on how to apply compost while respecting minimum safety and handling standards.

8.3.2 Mainstreaming Public Awareness Programs

Implementing and sustaining an integrated approach to SWM requires community engagement. Raising public awareness on solid waste issues would greatly improve the performance of any SWM system, in urban centers as well as in rural villages and towns. ISWM should adopt proven technologies that are customized to the local situation and waste composition. Systems should be flexible to meet anticipated growth in waste generation and changes in waste composition (less organic/putrescible, more inorganic/recyclable material). Therefore, a critical component of any waste management program is public awareness and participation. People produce waste everyday and waste generation rates are rising. Communities must better understand waste management issues and the imminent waste crisis if we continue on the same path. Without such understanding, the success of even the best conceived waste management plan becomes questionable. Solid waste awareness campaigns should be legislated by the government and mainstreamed in both public and private schools through the Ministry of Education and Higher Education. The GOL should require media houses (radio and TV stations) to promote the campaigns free of charge. Awareness programs must be sustained over the long-run to create a gradual paradigm shift in how people perceive waste issues and handle waste at schools, in their homes, offices and other work places. *See OMSAR awareness campaign in Box 8.10*

Box 8.10 OMSAR solid waste awareness

In 2010-2011, OMSAR launched a solid waste awareness campaign urging consumers to rethink their purchasing practices by buying products with little or no packaging and buying more fresh fruits and vegetables rather than packaged/processed foods. The Campaign also seeks to reduce waste volumes and change attitudes and behavior by encouraging source separation. It targets nine cluster areas where OMSAR is implementing SWM projects with EU funding. The campaign slogan is "Think Before You Throw" (*Fakker qabel mat'kib)*. For more information, visit www.omsar.gov.lb and sas.omsar.gov.lb

8.3.3 Waste Minimization

Source minimization or reduction is the first echelon in any ISWM hierarchy (See figure 8.6). It is the most effective and sustainable way to reduce waste quantities, as well as associated costs and environmental impacts. Waste reduction starts with the design, manufacture and packaging of products. It can also take place at the household level, or inside commercial and industrial facilities, through selective buying patterns and the reuse of products and materials.

Several organizations are advocating a so called "zero waste strategy" --a philosophy that encourages the redesign of resource life cycles so that all products are reused and the amount of waste sent to landfills is reduced. For instance, beverage containers (including glass bottles, PET bottles, and cans) are filled and distributed to the consumer. Conventional waste systems would see the bottle disposed in a landfill or incinerator. Under a zero waste method, the container can be saddled at the time of sale with a deposit, which is returned to the bearer upon redemption. The bottle (glass and PET) can be washed, refilled, and resold, while aluminum cans are smelted to produce new cans. This strategy helps waste reduction and incorporates manufactures, sellers and buyers in the waste reduction process.

Another waste minimization strategy is the introduction of a waste tax on selected products and goods. It is a tax applied to fees for the collection, transfer, storage, and disposal of products that will ultimately transform to waste. Waste taxes will generate revenues locally that can be reinvested into waste management technologies and services, and they will also act on the consumption behavior of the community. In Lebanon, the ministries of Environment and Finance, in coordination with the Parliamentarian Committee for Environment, are exploring the feasibility of introducing a green tax for safe collection and disposal of special waste including used engine oil, tires and batteries[9]. The tax would lure private sector interest in service delivery, by offsetting a portion of the collection and disposal costs. Private waste contractors may also demand conditional exclusivity to protect initial investment costs.

Other small-scale but noteworthy initiatives in Lebanon include the recent introduction of biodegradable bags and eco-friendly bags. Several leading commercial outlets and malls

[9]Pers. comm. Edgard Chehab, Assistant Country Director, UNDP Environment & Energy Section, December 2010

have started to provide such bags to their customers (some of them free of charge). Up-scaling this initiative could be achieved by introducing a green tax (or mandatory fee) on regular, non-degradable plastic bags, so commonly used and abused in Lebanon. Customers could then choose between regular plastic bags or a green shopping bag that can be reused many times.

Used paper and cardboard in bales destined for recycling in Lebanon

8.3.4 Improved Waste Treatment

Waste treatment is the second echelon in an ISWM hierarchy (See figure 8.6). It involves recycling and transformation. The first will reuse materials and reduce the demand on resources and the amount of waste requiring final disposal (see innovative initiative to collect plastic caps to help handicapped people in Box 8.11). The second will recover materials and convert them to products such as compost, biomass fuel pellets, shredded tires, etc. Other conversion Lebanon has come a long way in building solid waste treatment plants but these plants require additional resources, testing, and O&M training to be fully operational and reliable. Although the COM has approved master plans to build a number of facilities outside Beirut and Mount Lebanon, political will and finances are still lacking to follow the plan through. Supplementary facilities equipped with trained labors are needed to increase the amount of recyclables and organic waste. Waste recovery targets in Beirut and Mount Lebanon must improve by building a third sorting plant and by expanding the existing composting capacity and/or build a new compost facility, pursuant to the 1997 Emergency Plan.

Box 8.11 Bouchons-Roulants Project

In 2008, the Lebanese NGO Arc En Ciel (AEC) launched a new socio-environmental project "Bouchons Roulants" to encourage source separation, increase awareness of recycling, while helping physically disadvantaged individuals. AEC is relying on local communities (schools, private sector, and individuals) to collect plastic caps (Label 2-PEHD and Label 5-PP). AEC then resells the collected caps to recycling companies at $200 per ton and revenues are used to finance wheelchairs. The project has so far collected 19 tons of caps and built seven wheelchairs. They need approximately 500,000 caps to build one wheelchair. The target number of wheelchairs is 100.

Source: Pers. comm. with Rita Mouzannar, AEC

On a national level, the GOL should move towards granting limited exclusivity to waste contractors who handle special waste. That, in addition to waste taxation, will encourage the development of new treatment technologies of special waste including tires, electronic waste, biomass waste, healthcare waste, etc. Also, the GOL should seriously reconsider the terms and conditions of large-scale waste contracts. In particular, quantity-based contracts (Averda) has a perverse effect on system costs as it entices the waste contractor to increase waste collection (by expanding coverage, collecting special waste, maintaining open waste containers that store rainwater in winter, etc.). Quantity-based contracts encourage consumerism. Current and future contracts should be based on material recovery targets, whereby contractors must improve sorting and composting systems to meet those targets.

Most importantly, MOE should enforce the EIA cycle on proposed solid waste facilities but also expedite the review process by respecting review periods stipulated in the draft EIA decree. Excesive delays and slippage will deter prospective waste contractors and investors from preparing EIA studies in the first place. EIAs should place a premium on *proven* technologies and best environmental practices.

8.3.5 Improved Waste Disposal

Waste disposal is the lowest rank in the ISWM hierarchy (see Figure 8.6). Waste that cannot be recycled or recovered and has no further use will be landfilled or incinerated. Landfilling is the controlled disposal of solid waste in carefully engineered cells and it is by far the most commonly used disposal method worldwide. Waste-to-energy is a process of creating energy in the form of electricity or heat from the incineration of waste. Most waste-to-energy processes produce electricity directly through combustion, or produce a combustible fuel commodity, such as methane, methanol, ethanol or synthetic fuels.

Lebanon has so far attempted landfilling in three locations (Naameh, Bsalim and Zahle). Landfilling has been difficult and controversial. In Naameh, the site has expanded well beyond its initial design capacity and invited stiff public opposition; in Zahle, the site is relatively secluded but has consumed prime agricultural lands, a precious natural resource in the Bekaa. The reliance on landfills generates a false sense of optimism and saps other initiatives and calls to find alternative treatment systems. Lebanon is too small to accommodate other large-scale landfills and must therefore do much more upstream, i.e., waste minimization and improved treatment and recovery of recyclables. If the GOL formally approves waste-to-energy technologies, it would have to review waste contracts and waste collection infrastructure. As a signatory to the Stockholm Convention, waste-to-energy technologies would need to comply with the most stringent emissions standards to prevent the formation and release of poly-chlorinated biphenyls (PCBs). Control parameters including incineration temperature and residence time should be controlled to reduce releases[10].

[10]Part V. General guidance on best available techniques and best environmental practices. Section B (Best Available Techniques), b (General Release Reduction Measures).

Figure 8.6 Integrated waste management hierarchy

Source: Prepared by ECODIT for 2010 SOER

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CITED LEGISLATION RELATED TO SOLID WASTE

نوع النص	الرقم	التاريخ	عنوان النص
مرسوم اشتراعي	٣٤٠	١٩٤٣/٠٣/٠١	قانون العقوبات
مرسوم	٨٣٧٧	١٩٦١/١٢/٣٠	تنظيم وزارة الصحة العامة
قرار	١/٤٢٥	١٩٧١/٠٩/٠٨	فرض استعمال أكياس بلاستيك لجمع النفايات
مرسوم	٨٧٣٥	١٩٧٤/٠٨/٢٣	المحافظة على النظافة العامة
مرسوم اشتراعي	١١٨	١٩٧٧/٠٦/٣٠	قانون البلديات
مرسوم	١٩١٧	١٩٧٩/٠٤/٠٦	تحديد أصول وقواعد توزيع أموال الصندوق البلدي المستقل المعدل بموجب: المرسوم رقم ١٧٨٣ تاريخ ١٩٩١/١٠/١٠ والمرسوم رقم ٧٤٢٥ تاريخ ١٩٩٥/١٠/٢٤ والمرسوم رقم ٣٠٣٨ تاريخ ٢٠٠٠/٥/١٩ والمرسوم رقم ٩٠٩٣ تاريخ ٢٠٠٢/١١/١٥ والمرسوم رقم ١١١٧ تاريخ ٢٠٠٨/٣/١٨
قانون	٨٨/٦٤	١٩٨٨/٠٨/١٢	المحافظة على البيئة ضد التلوث من النفايات الضارة والمواد الخطرة
قانون	٢١٦	١٩٩٣/٠٤/٠٢	إحداث وزارة البيئة
قانون	٣٨٧	١٩٩٤/١١/٠٤	الإجازة للحكومة ابرام معاهدة بازل بشأن التحكم في جركة النفايات الخطرة عبر الحدود والتخلص منها
قانون	٥٠١	١٩٩٦/٠٦/٠٦	الجازة للحكومة ابرام اتفاقية بين الجمهورية اللبنانية والبنك الدولي للانشاء والتعمير واتفاقية المشروع المتممة لها الموقعتين بتاريخ ١٩٩٥/٠٦/٠٩ (تمويل مشروع ادارة النفايات الصلبة البيئية)
قرار	١/٧١	١٩٩٧/٠٥/١٩	تنظيم استيراد النفايات
قرار مجلس الوزراء	٥٨	١٩٩٧/٠٩/٢٩	
مرسوم	٦٠٧٧	٢٠٠١/٠٨/١٦	ابرام مذكرة تفاهم وتعاون في مجال البيئة بين الجمهورية العربية السورية والجمهورية اللبنانية
قرار	١/٤	٢٠٠١/٠١/١٢	الشروط البيئية لرخص إنشاء و/أو استثمار مسالخ
قانون	٤٣٢	٢٠٠٢/٠٧/٢٩	الإجازة للحكومة الإنضمام إلى إتفاقية ستوكهولم للملوثات العضوية الثابتة
قانون	٤٤٤	٢٠٠٢/٠٧/٢٩	حماية البيئة
مرسوم	٨٠٠٦	٢٠٠٢/٠٦/١١	تحديد انواع نفايات المؤسسات الصحية وكيفية تصريفها
قرار مجلس الوزراء	١٦	٢٠٠٣/٠٨/١٤	
مرسوم	١٣٣٨٩	٢٠٠٤/٠٩/١٨	تعديل المرسوم رقم ٨٠٠٦تاريخ ٢٠٠٢/٦/١١ تحديد انواع نفايات المؤسسات الصحية وكيفية تصريفها
قرار مجلس الوزراء	١	٢٠٠٦/٠٦/٢٨	الخطة المقترحة لادارة النفايات المنزلية الصلبة وتوسعة مطمر الناعمة
مرسوم	٢٢٧٥	٢٠٠٩/٠٦/١٥	تنظيم الوحدات التابعة لوزارة البيئة وتحديد مهامها وملاكها وشروط التعيين الخاصة في بعض وظائفها
مرسوم	٣٨٦٠	١٩/٠٤/٢٠١٠	نقل إعتماد من إحتياط الموازنة العامة إلى موازنة رئاسة مجلس الوزراء – مكتب وزير الدولة لشؤون التنمية الإدارية لعام ٢٠١٠
قرار مجلس الوزراء	٥٥	٢٠١٠/٠٩/٠١	اقتراح خطة تتعلق بادارة النفايات الصلبة في المناطق اللبنانية كافة

State & Trends of the Lebanese Environment
Chapter 8 - Solid Waste

Map 9 - Solid Waste Facilities and Disposal Sites in Lebanon

This map was prepared by ECODIT based on MSC-IPP (2005), MOE-CDR Plan 2006 and OMSAR-EU Project. Every effort has been made to ensure the accuracy of the information displayed on this map. The international boundaries are approximate. MOE/UNDP/ECODIT do not assume any responsibility for any decision that may arise from the use of the map.

ANNEX 1 OVERVIEW OF PROPOSED AND ACTUAL SWM SYSTEMS IN LEBANON (EXCLUDING WTE PLANTS)

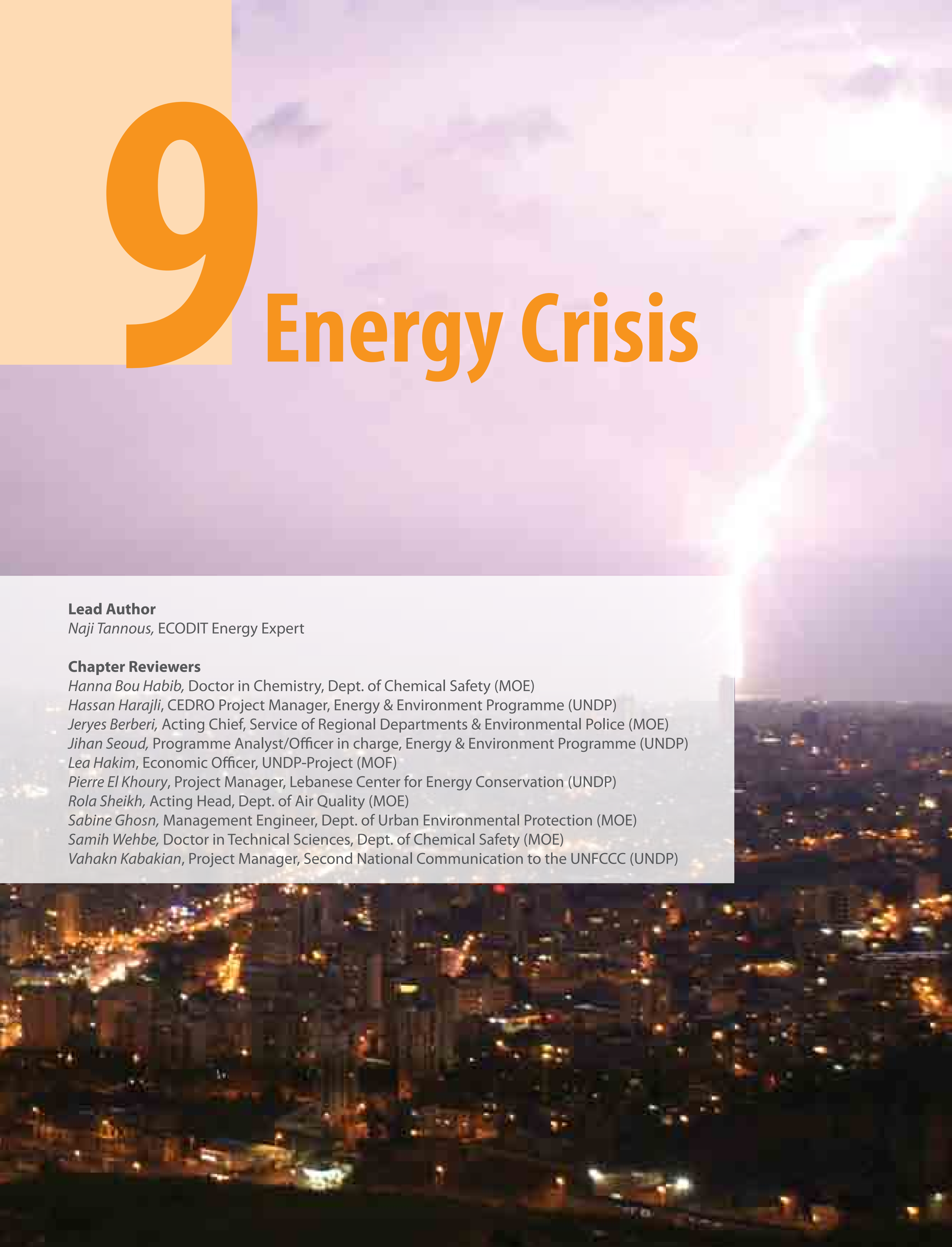
Mohafaza (population)	Caza	Waste Treatment Facilities					Waste Disposal	
		Location	Type	Tonnage	Managed by	Status	Landfill	Open Dumpsite
North Lebanon (768,709)	Batroun	Selaata	S-C	57 t/d	CDR-MOE	Not built	-	Edde, Hamat, other
	Bcharre	Berhalyoun	S-C	28 t/d	CDR-MOE	Not built	-	NA
	Koura	Kfar Hazir	S-C	62 t/d	CDR-MOE	Not built	-	Hamat, other
	Minieh-Dannieh	Minieh	S-C	61 t/d 37 t/d	OMSAR-EU	Under construction	-	Kfar Habou, Raouda, other
		Beddawi	S-C	400 t/d	CDR-MOE	Not built	-	
		Raouda	S-C	150 t/d	CDR-MOE	Not built	-	
	Tripoli	Al Fayhaa	S	150 t/d	OMSAR-EU	Under construction	Tripoli controlled dumpsite	Tripoli Dumpsite (closed)
	Zgharta	Mejdlaya	L– LB	70 t/d	CDR-MOE	Not built	-	Mejdlaya, Mizyara, other
	Akkar	Srar	S-C-L–LB	322 t/d	CDR-MOE	Not built	-	Srar, Jdeidit El Kayteh, Fnaydeq, Qammouaa, other
		Michmich	S-C	10 t/d 6 t/d	OMSAR-EU	Under construction	-	
Beirut (389,661)	Beirut	Aamrousieh	S	758 t/d	Averda	Operational	NSL, BL for inert mat.	Normandy (rehabilitated by SOLIDERE)
		Qarantina	S	1,476 t/d	Averda	Operational		
		Coral (Qarantina)	C	300 t/d	Averda	Operational		
Mount Lebanon (1,501,282)	Aley	Choueifat	S-C	NA	CDR-MOE	Not built	NSL, BL for inert mat.	Limited open dumping
		Aley	SW Services	-	OMSAR-EU	Delivered	NSL, BL for inert mat.	
	Baabda	-	-	-	-	-	NSL, BL for inert mat.	Limited open dumping
	Chouf	Dahr El Mghara	S-C-L–LB	296 t/d	CDR-MOE	Not built	NSL, BL for inert mat.	Limited open dumping
		Swayjani Community	S	26 t/d 15 t/d	OMSAR-EU	Completed		Rehabilitation and closure of Slayeb open dump
		Aali Chouf Community	SW Services	-	OMSAR-EU	Delivered		Limited open dumping
	Kesrouan	Zouk Mosbeh	S-C	NA	CDR-MOE	Not built	NSL, BL for inert mat.	Limited open dumping
	Metn	Bsalim	LB	NA	CDR-MOE	Not built	NSL, BL for inert mat.	Limited open dumping, Bourj Hammoud Dumpsite (closed without rehabilitation)
	Jbeil	Mounsef	L	NA	CDR-MOE	Not built	-	Hbaline, other
		Hbaline	S-C	102 t/d	CDR-MOE	Not built	-	
		Hbaline	S	77 t/d	OMSAR-EU	Completed	-	

Legend:

S Sorting; **C** Composting; **L** Landfill; **LB** Landfill Bulky; **BL** Bsalim Landfill, **NSL** Naameh Sanitary Landfill, **Pont. Mission** Pontifical Mission;

Source: Compiled by ECODIT based on data provided by MOE, CDR and OMSAR

Mohafaza (population)	Caza	Waste Treatment Facilities					Waste Disposal	
		Location	Type	Tonnage	Managed by	Status	Landfill	Open Dumpsite
Bekaa (499,438)	Rachaiya	Rachaiya	S-C	NA	CDR-MOE	Not built	-	Joub Jannin, other
	West Bekaa	Dakweh	S-C	83 t/d	CDR-MOE	Not built	-	Joub Jannin, other
		El Marj	SW Services	-	OMSAR-EU	Delivered	-	
	Zahle	Haouch El Oumara	S-C-L–LB	221 t/d	CDR-MOE	Operational	Zahle Landfill serves 15 towns	Qousaya, Terbol, Taalabay, Saadnayel, Qabb Elias, other
	Baalbak	Baalbeck	L	290 t/d	Italian	Pending EIA approval	-	Kayyal, Ras Baalbak, Nabi Chit, other
		Baalbeck	S-C	60 t/d 45 t/d	OMSAR-EU	Pending EIA approval	-	
	Hermel	Hermel	S-C	46 t/d	CDR-MOE	Not built	-	Hermel, other
South Lebanon (401,075)	Jezzine	Jezzine	SW Services	-	OMSAR-EU	Delivered	-	Saida, Jbaa, other
	Saida	-	-	-	-	-	-	Saida, Qennerit, Qrayet, Sarafand other
	Sour	Aabbassieh	S-C	257 t/d	CDR-MOE	Not built	-	Ras el Ain, Neftakhiyeh, Jouaiya other
		Sour	S-C	150 t/d 100 t/d	OMSAR-EU	Construction Completed	-	
		Aabbassieh	Medical Waste Treatment	300 kg/d	OMSAR-EU	Operational	-	
Nabatiyeh (221,920)	Bint Jbayl	Chacra-Baraachit	S-C-L–LB	150 t/d	CDR-MOE	Not built	-	Chacra, Aitaroun, other
		Kherbet Selm	S-C	NA	Pont. Mission -Italian	Operational	-	
		Kherbet Selm	SW Services	-	OMSAR-EU	Delivered	-	
		Aitaroun	S-C	10 t/d	Pont. Mission-Italian	Operational	-	
		Chacra	S-C	5 t/d	Pont. Mission	Operational	-	
		Bint Jbeil	S-C	10 t/d	Pont. Mission	Operational	-	
	Hasbaiya	Hasbaiya	S-C-L–LB	39 t/d	CDR-MOE	Not built	-	NA
	Marjeyoun	Khiyam	S-C	15 t/d 10 t/d	OMSAR-EU	Operational	-	Chacra, Aitaroun, Kfar Tebnit, other
		Qabrikha	C	NA	OMSAR-EU	Under construction	-	
		Taybeh	S-C	10 t/d	YMCA	Operational	-	
		Qlaiaa	S-C	5 t/d	Pont. Mission	Operational	-	
	Nabatiyeh	Ansar	S-C-L–LB	160 t/d	CDR-MOE	Not built	-	Jbaa, Kfar Tibnit, Mazraat Bsaffour, Mazraat Qalaat El Mais, other
		Ansar	S-C	10 t/d 7 t/d	OMSAR-EU	Operational	-	
		Nabatiyeh El Tahta	S-C	120 t/d 90 t/d	OMSAR-EU	Under construction	-	
		Kfar Sir	S	7.5 t/d	YMCA	Operational	-	



9 Energy Crisis

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ABBREVIATIONS & ACRONYMS

ADEME	Agence de l'Environnement et de la Maitrise de l'Energie
AE	Alternative Energy
ALMEE	Association Libanaise pour la Maitrise de l'Energie et pour l'Environnement
BDL	Banque Du Liban
CCGT	Combined Cycle Gas Turbines
CDM	Clean Development Mechanism
CEDRO	Country Energy Efficiency & Renewable Energy Demonstration Project for the Recovery of Lebanon
CFL	Compact Fluorescent Lamp
CH_4	Methane
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide equivalent
CPD	Consumer Protection Directorate (at MOET)
DSWH	Domestic Solar Water Heater
DWT	Dead Weight Tonnage
EDL	Electricité Du Liban
EGAS	Egyptian Natural Gas Holding Company
EGPC	Egyptian Petroleum Corporation
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GoL	Government of Lebanon
GWhr	Giga Watt hours
HEFF	High Emission Factor Fuel
HFO	Heavy Fuel Oil
HV	High Voltage
HVAC	Heating Ventilation & Air Conditioning
IEA	International Energy Agency
IFC	International Finance Corporation
IMO	International Maritime Organization
IPCC	Intergovernmental Panel on Climate Change
KTOE	Kilo TOE
KWhr	Kilo Watt hours
LBC	Lebanon Building Code
LCEC	Lebanon Center for Energy Conservation
LED	Light Emitting Diode
LFO	Light Fuel Oil (Diesel)
LGBC	Lebanon Green Building Council
LNG	Liquid Natural Gas
LPG	Liquid Petroleum Gas
LSES	Lebanese Solar Energy Society
LT	Low Tension
MEPS	Minimum Energy Performance Standards
MOE	Ministry of Environment
MOET	Ministry of Economy and Trade
MOEW	Ministry of Energy and Water
MOF	Ministry of Financ
MOPWT	Ministry of Public Works and Transport
N_2O	Nitrous Oxide
NG	Natural gas (Methane)
NMVOC	Non Methane Volatile Organic Compounds
NO_x	Nitrogen Oxides
OEAB	Order of Engineers and Architects of Beirut
PEI	Primary Energy Intensity
PPES	Policy Paper for the Electricity Sector
PPP	Purchasing Power Parity
PV	PhotoVoltaics
RE	Renewable Energy
SEEL	Supporting the Judiciary System in the Enforcement of Environmental Legislation
SELDAS	Strengthening/State of the Environmental Legislation Development and Application System in Lebanon
SO_2	Sulfur Dioxide
SUVs	Sport Utility Vehicles
tC	Tonne of Carbon, (Tonne = 1,000 kg)
Tj	Terra Joules
TOE	Tonne of Oil Equivalent (11,630 KWhr)
TPES	Total Primary Energy Supply
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
VOC	Volatile Organic Compounds
VOLL	Value Of Lost Load

Kilo = 10^3, Mega = 10^6, Giga = 10^9, Terra = 10^{12}

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Energy related environmental concerns have reached global dimension. Radio-active waste from nuclear power plants, the effect of Greenhouse gases (GHG) on climate change, the loss of biodiversity due to pollution and encroachment on natural habitats in search of hydrocarbons, etc. are impacting the environment in ways that we cannot fully comprehend. One of the greatest challenges in the 21st century is how to decouple development from energy usage and find clean energy sources to mitigate the environmental implications of current lifestyles and growth patterns.

This report provides a hard factual look at where Lebanon stands and in which direction it is planning to go in relation to energy utilization. While environmental considerations are used as the main reading grid, institutional, economic and social dimensions are also considered as well as policy issues that could usher in an era of sustainable development.

9.1 DRIVING FORCES

The main drivers of the energy sector in most countries including Lebanon are: Climate, Gross Domestic Product (GDP), and Energy Availability / Acceptability (WEC 2003). Each of these drivers is further impacted by demography, economy, technology and governance. Drivers and impact factors are intricately related as explained in the following overview.

9.1.1 Climate

Although Lebanon's Mediterranean climate is mild, especially in the coastal zone where more than 60 percent of its population lives (CDR-NLUMP 2004), it is experiencing a noticeable change in weather patterns. Extended periods of drought, Northern and Eastern winds blowing at an increasing frequency, prolonged periods of peak temperatures in summer and fewer but torrential rainfall in winter, as well as an increase in snowline elevation from around 1200m to 1400m, constitute weather changes with dramatic consequences that will affect all sectors of the economy including tourism, agriculture, transport, and industry (including energy industries). Projections show that the East Mediterranean basin could experience a temperature increase averaging 5ºC during the 21st century (IPCC 2007).

9.1.2 Gross Domestic Product

Gross Domestic Product (GDP), considered the main performance indicator of any country's economy, is a fundamental driver of energy demand; the corollary to that statement is that energy is one of the most fundamental resource on which our modern economy is based. The average worldwide elasticity of primary energy with respect to economic output is near unity (i.e., 1) (WEC 2003). That is, for each increase in one percentage point in the economic activity, an equivalent increase will occur in the primary energy consumption. A primary energy elasticity of 1.2 to 1.3 is to be expected for a country like Lebanon, with an upper middle-income service-based economy, enjoying strong real growth rates exceeding six percent since 2007.

Energy elasticity strongly depends upon the penetration rate of energy efficiency in the economic activity of the country. This is specially so in the electricity sector which plays a pivotal role in any economy and is a major consumer of primary energy. Normally, the elasticity of electricity consumption with respect to GDP should be similar to that for primary energy (WEC 2003). Dysfunctions in Lebanon's energy sector are having dire economic and environmental consequences on the country (El-Fadel R.H. *et al.* 2009 & WB 2008).

9.1.3 Demography and Lifestyles

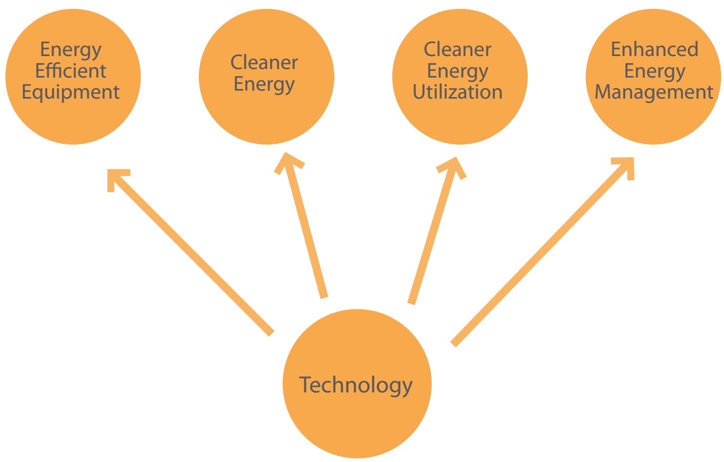
In Lebanon, the effect of demography on Total Primary Energy Supply (TPES) is primarily due to qualitative factors (e.g., increased income, standards of living and comfort requirements) and to a lesser extent to quantitative demographic factors (e.g., fertility is about ~1%) (CDR-NLUMP 2004). Higher incomes that characterize a relatively fast developing economy like Lebanon with a projected real GDP increase of at least five to six percent over the next five years have a self-reinforcing feedback or, more precisely, a double impact

Air conditioning units in buildings considered, nowadays, home appliances rather than luxury items effect on energy consumption. More disposable income means more money to spend on comfort amenities leading to higher comfort expectations which again translate into more energy usage, a seemingly never ending cycle. Nowadays air conditioners are considered home appliances rather than luxury items.

9.1.4 Technology

Technology, when properly used and managed, is *the* most effective means to decouple national development from energy consumption and related environmental pollution; thereby it helps curb energy-related social and environmental impacts. On the demand side, technology impacts energy use in several ways (see interactions in Figure 9.1).

Figure 9.1 Major impacts of technology on energy usage



Energy efficient equipment like Light Emitting Diode (LED) and Compact Fluorescent Lamps (CFL), low consumption refrigerators and air conditioning units just to name a few, go a long way toward reducing the country's energy intensity. Photo-Voltaic (PV), Biomass, Wind Turbines (WT) and Domestic Solar Water Heaters (DSWH) are other aspects of technology that could be the source of cleaner and renewable energy if properly thought out and used (Chaaban *et al.* 1998).

On a larger scale, replacing power generation plants using steam turbines running on Heavy Fuel Oil (HFO) similar to those installed at Zouk and Jieh with technologically advanced Combined Cycle Gas Turbines (CCGT) running on Natural Gas (NG), like those installed at Beddawi and Zahrani plants, will sensibly improve energy efficiency (WB 2008) and at the same time use a cleaner fuel (NG instead of HFO or Gasoil) thus drastically reducing harmful

Replacing standard incandescent lamps with CFL can save about 70% of energy used for lighting.

emissions (Chaaban *et al.* 2003). It should be noted that the Beddawi and Zahrani power plants are currently operating on Gasoil thus not achieving their full technological potential; Beddawi power plant started receiving natural gas in November 2009 but flow was suspended a year later, in November 2010 (MOEW 2011).

Technology could also mitigate the effect of using "dirty fuels" therefore contributing to cleaner energy utilization. Electrostatic precipitators, high performance burners and Flue Gas Desulphurization equipment can effectively reduce emissions at HFO power plants in Lebanon (e7, 2008 & Chaaban *et al.* 2003).

Finally, energy information and management systems, already implemented in many facilities including hospitals, universities, high-end commercial and residential buildings, could help optimize energy usage.

9.1.5 Energy Availability and Acceptability

<u>Energy Availability</u>

Lebanon is an energy poor country importing around 97 percent of its energy needs. An overview of the primary energy supply and usage chain for Lebanon in 2008 is presented in Table 9.1. The primary energy mix relies heavily on liquid hydrocarbons.


Private sector fuel storage tanks in Bourj Hammoud


New fuel storage tanks in Jiyeh power plant built after the war in July 2006

Table 9.1 Sources of primary energy supply for Lebanon (2008)

PE	Importer	Source	Transport	Consumer	Usage	% Share[1]
HFO	MOEW	SONATRACH	Sea Tankers	EDL	Electricity	22.2
HFO	Industry	IM	Sea Tankers	Industry	Ind. Product.	1.7
Gasoil	MOEW	KPC/SONATRACH	Sea Tankers	EDL	Electricity	27.4
Gasoil	MOEW	IM	Sea Tankers	Local Market	Heating	8.0
Diesel	Private Comp.	IM	Sea Tankers	Local market	Trucks/buses	1.5
Gasoline	Private Comp.	IM	Sea Tankers	Local Market	Vehicles	27.2
Kerosene Jet A1	Private Comp.	IM	Sea Tankers	IB	Aviation	3.5
OPD	Private Comp.	IM	Sea Shipping	Local Market	Domestic	0.4
Coal	Industry	IM	Sea shipping	Industry	Industrial Production	1.6
LPG	Private Comp.	IM	Sea shipping	Local Market	Heating, Cooking	2.0
NG[2]	MOEW	Egypt	Land pipeline	EDL	Electricity	0
IE	MOEW	Syria/Egypt	HVTL	Local Market	Electricity	1.2
HE	-	Local	-	Local Market	Electricity	0.6
Biomass	-	Local	-	Local Market	Heating	2.1
AE	-	Local	-	Local Market	Heating/Electricity	0.6

Source: CAS 2009/MOEW 2011

Notes: (1) Approximate share in total primary energy mix for 2008, (2) Supply suspected since November 2010

Abbreviations: **AE** Alternative Energy, **OPD** Other Petroleum Distillates, **IE** Imported Electricity, **HE** Hydro-electricity, **HVTL** High Voltage Transmission Lines, **KPC** Kuwait Petroleum Company, **SONATRACH** Algerian Oil Conglomerate, **IM** International Market, **EDL** Electricité du Liban, **IB** International Bunker

It should be noted that until 1988, the Government retained monopoly over the petroleum sector (import and storage). The Government has since licensed 11 private companies to import, store and distribute petroleum products. Hydrocarbons specifications including Gasoil, HFO, and LFO are issued by the Petroleum Directorate at MOEW (MOEW Decision 56/1997) which oversees the quality of all petroleum products entering the country (MOEW 2011). LIBNOR (Norme Libanaise), the Lebanese standards institution under the aegis of the Ministry of Industry, amended in 2001 the specifications for Residual Fuel Oil (including Heavy Fuel Oil; NL-501:2001). Finally, in 2002, the COM enacted Decree 8442 (dated 13/08/2002) which defines standards for gasoline (92, 95 and 98 Octane) and Diesel oil used in vehicles.

Energy availability is a function of the access to affordable energy; it determines the primary energy mix of a country which impacts the environment depending on how clean the source of energy is. Energy availability, and the lack thereof, also impacts the environment during times of hardship. For example, in 2008 many people in rural Lebanon relied on wood from nearby forests or from their orchards to heat their homes in response to rising Gasoil prices.

Energy availability could also be a major constraint to economic development which brings to the forefront the issue of energy security and its corollary energy resilience and diversification. The shortages experienced in 2006 following the sea blockade caused severe disruptions in the supply of gasoline for vehicles and fuel oil to power electricity plants, a textbook example of energy security dysfunction. However many converted their cars to run on LPG bottles (not without risk to drivers and passengers), a typical case of energy resilience which is enhanced through diversification of primary energy sources and types. Nowadays, energy security is one of the most potent drivers impacting renewable energy schemes whereby countries aim to achieve a higher level of primary energy self-sufficiency.

Lebanon is suffering from a serious case of energy availability. It is incontestable that chronic energy shortages are affecting economic performance in Lebanon. The daily and prolonged electricity blackouts in the country are the result of shortages in generation capacity. EDL's mounting deficit is also further straining public sector debt which is eroding the GOL's ability to overhaul the sector. These are the dire consequences of a precarious energy supply and poorly managed energy dependency.

Energy Acceptability

The unappealing sight of black plumes exiting the Zouk and Jiyeh power plants smokestacks and the effect of their emissions on neighboring areas is a typical case of energy acceptability in the Lebanese context. Human health, climate change, environmental pollution and sustainable development issues have rendered energy acceptability a centerpiece of any country's energy policy. Energy acceptability links energy use to its social and environmental impacts. In the former case it is measured in terms of extent and type of human illnesses induced while in the latter it is measured in terms of GHG emissions, environmental degradation, air pollution as well as ecological and carbon footprints.

Growing concerns over carbon footprint and new international agreements addressing GHG emissions are already influencing the way countries deal with energy acceptability. In the near future, access of an economy to some form of cheap primary energy could not automatically guarantee prosperity and competitiveness in the international arena. Energy acceptability from a life cycle impact assessment perspective implies that energy should be user clean in terms of storage, transportation, handling and end use (GHG release and other emissions). Low energy acceptability implies that it is detrimental to the environment, and human health. Such emissions could include SO_2, N_2O, NO_X, CH_4, NMVOC, aerosols, carbon soot and other solid particulates (Karaki S. *et al.* 2001) on top of the inevitable CO_2.


Jiyeh black smoke plume heading inland

So far, Lebanon has been relying heavily on High Emission Factor Fuels (HEFF) or "dirty" fuels such as light (mainly Gasoil & Diesel) and heavy fuel oil in its primary energy mix. Low sulfur content fuels are desirable for electricity production (<1%) (Chaaban *et al.* 2004) while ultra low sulfur content Diesels are now the norm in most developed countries (<0.0015%) (Godson 2009). Table 9.2 shows that Lebanon has still much to do to align itself with relatively clean fuel standards, a balancing act between technology, energy availability (pricewise) and energy acceptability (sulfur concentration).

Energy acceptability is not only associated with harmful hydrocarbon fuels, even renewable sources have their drawbacks. Using wood for heating and cooking in conventional stoves may have serious health implications in rural areas where houses often lack proper ventilation (WB 2004) *–see more details on indoor air quality in Chapter 4.*

9.1.6 War and other Security Issues

The electricity infrastructure in Lebanon has suffered from repeating wars and conflicts. Damages were either caused by the Israeli Air Force (1996, 1999, and 2006) or by internal conflicts (Nahr el Bared refugee camp in May 2008). In particular, the Jamhour and Bsalim substations were bombed several times, and restored at great expense to the GOL, and fighting in Nahr el Bared camp damaged the electrical installations at the nearby Beddawi Power Plant causing significant downtime. The most severe environmental disaster related to Lebanon's energy sector occurred during the July 2006 war when enemy aircrafts bombed fuel storage reservoirs at the Rafic Hariri International Airport as well as two storage tanks at Jieh Power Plant. While the airport tanks caused significant air pollution, the spill from the power plant storage tanks was identified as *the worst oil spill that the Eastern Mediterranean has ever witnessed*[1] (see Box 9.1) and was also featured in the 501 series *Most Devastating Disasters* (Octopus Publishing Group 2010). The following paragraphs describes the environmental, economic and political implications of the Jieh spill.

Jiyeh Power Plant Oil Spill

On July 13 and 15, the Israeli Air Force bombed two storage tanks containing 10,000 m^3 and 15,000 m^3 of HFO at the Jiyeh power plant, located 30km south of Beirut. The resulting fire and spill had devastating impacts on the Mediterranean Sea (MOE/UNDP/ELARD 2007). Although the attack initially destroyed two

Table 9.2 Allowable sulfur content (by weight) in hydrocarbons on the Lebanese market

HFO1[1] %	Gasoil[2] %	Diesel[3] %	Gasoline 92 Octane[3] %	Gasoline 95 Octane[3] %	Gasoline 98 Octane[3] %	White Kerosene[2] %	LPG[2] mg/m^3
2.5	0.5	0.035	0.05	0.05	0.05	0.3	345

Sources: 1: LIBNOR NL-501: 2001 – 2: Decision 56/1997 – 3: Decree 8442/2002

Notes: Percentages are by weight except where shown otherwise. The cement industry is allowed to import pit coal with 6% sulfur concentration but most of the sulfur is absorbed in the process. LPG: At Standard Atmospheric Pressure and Temperature.

Box 9.1 UN Resolutions Related to Oil Spill

The UN General Assembly expressed its deep concern over the adverse implications of the Jiyeh oil spill caused by the Israeli Air Force in five consecutive resolutions:

1. Resolution 61/194 (dated 20/12/2006),
2. Resolution 62/188 (19/12/2007),
3. Resolution 63/211 (19/12/2008)
4. Resolution 64/195 (21/12/2009)
5. Resolution 65/147 (20/12/2010)

*See summary of UN Resolutions in Annex **1** of this chapter.* The General Assembly, in all five resolutions, considered that the oil slick had heavily polluted the shores of Lebanon and consequently had serious implications for human health, biodiversity, fisheries and tourism; having serious effects on livelihoods and the economy of Lebanon. The Assembly called upon the Government of Israel (GOI) to assume responsibility for prompt and adequate compensation to the Government of Lebanon (GOL) for the costs of repairing the environmental damage caused by the destruction, including the restoration of the marine environment. To date, the GOI has completely ignored the UN Resolutions related to the spill and the GOL has yet to receive any financial compensation for soil spill damages from the GOI. Therefore, in its last resolution, the UN General Assembly requested the Secretary-General to give further consideration to the option of examining the potential role of the United Nations Compensation Commission in securing the relevant compensation from the GOI and welcomed the Lebanon Recovery Fund (in MOET) to host the Eastern Mediterranean Oil Spill Restoration Trust Fund.

Bombing of Jiyeh fuel storage tanks (July 2006)

[1]Statement of the Republic of Lebanon to the UN on 24 September 2007

tanks, the blockade prevented the deployment of firefighting equipment which caused the fire to spread to other tanks as well.

Oil spill cleanup (Summer 2006)

Storage of collected oil waste

An estimated 60,000 m^3 of fuel oil may have burned and 15,000 m^3 may have spilled to the sea (MOE/UNDP/ELARD 2007). The spill affected more than 150km of the Lebanese coastline, and also impacted parts of the Syrian coastline. Subsequent studies have documented some of the impacts on public health, environmentally sensitive ecosystems, beach tourism and coastal resorts and marinas, as well as the livelihoods of fishermen (damages to fish stocks and fishing equipment and gear).

International and National Responses to the Oil Spill

In response to this environmental disaster, MOE mobilized an inter-agency response team and started coordinating a two-phased cleanup plan using materials and resources provided by several bilateral partners and international organizations. During Phase 1, the priorities were to (1) recover free-floating oil from the sea and confined area, (2) clean areas with potential direct human contact or risk to public health, and (3) rehabilitate areas where oil slicks hampered economic activities including sites that are environmentally or culturally important. Phase 1 was completed in February 2007, in partnership with various Member States and organizations including the Government of Italy, the Fund for International Development of the Organization of the Petroleum Exporting Countries, UNDP, the Swiss Agency for Development and Cooperation, the Canadian International Development Agency (CIDA) and the United States Agency for International Development (USAID), as well as local non-governmental organizations (UNDP 2009).

Phase 2 focused on the removal of fuel from rocks, ledges, other cliffs and infrastructure. Clean-up work followed, sponsored by the Government of Japan through UNDP, the Government of Norway through the Higher Relief Commission in Lebanon, USAID and the Government of Spain through the Spanish Agency for International Cooperation and Development. Phase 2 cleanup works were completed by December 2009. In November-December 2008, a comprehensive oil spill shoreline survey was conducted under UNDP's technical supervision. The survey, which extended from Tyre in the South to Lebanon's northern border, recommended minor clean-up activities at selected sites. These recommendations were implemented by MOE with funding from the Government of Norway (UNDP 2009).

Treatment and Disposal of Oil Waste

Waste from cleanup activities was collected and stored in containers and relocated to temporary storage sites designated by the MOE including: the Zouk Power Plant (liquid waste), the Jiyeh Power Plant (solid waste), and Zahrani and Tripoli refineries. Two subsequent studies indentified treatment and disposal options for oil waste but highlighted the absence of adequate waste management infrastructure and hazardous waste management facilities in the country. Despite insufficient capabilities, UNDP was able to coordinate two pilots for the treatment of waste oil; one method used "Recoverit Material" to treat 320 m^3 of oiled waste including debris, equipment, sand and pebbles stored at the Zahrani Refinery, producing a clean material which was returned to the beach and residues were transported to the Zouk power plant, and the second method used quicklime to stabilize 2,300m^3 of oiled sand stored in Beirut which was then used as a top soil substrate by Solidere in Normandy rehabilitated dumpsite. These two methods could be used for the treatment of the remaining waste (about 2,500m^3) stored at the Tripoli and Zahrani refineries and the Jiyeh and Zouk power plants but funding is currently unavailable (UNDP 2009).

9.2 CURRENT SITUATION

An overview of the energy sector in Lebanon is presented from an environmental perspective covering economical, social, technical and legislative aspects with a view to assess sector performance and its implications on the environment.

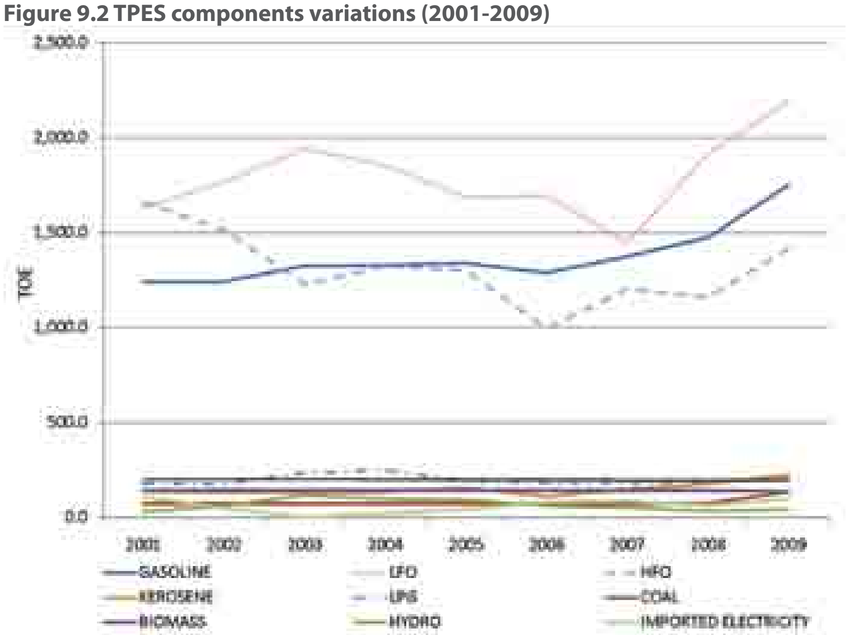
9.2.1 Primary Energy Supply

Between 2001 and 2009, Total Primary Energy Supply (TPES) for Lebanon was relatively constant, hovering around 5,400 kilo Tonne Oil Equivalent (KTOE). The composition of Lebanon's energy mix during this period also did not undergo fundamental changes (see evolution in Figure 9.2).

In 2006 and 2007, TPES dropped 10 percent to 4,850 KTOE due to the July 2006 war but then recovered again in 2008 to its 2004 level (5,270 KTOE). In 2009, TPES experienced an 18 percent increase compared to the previous year. According to MOEW data, High Emission Factor Fuels (HEFF) such as LFO (Diesel/Gasoil) and HFO represent around 62 percent of TPES. Diesel, used in transport and private generators, constitute around 30 percent of LFO supply while Gasoil, used for heating and EDL power stations, make up the rest.

Gasoline experienced a slight dip in 2006 (due to supply shortages) but then started to increase steadily thereafter. The trend is in tune with the increase in car usage in Lebanon. HFO is mostly consumed by the electricity sector (up to 85% of total HFO imports) and its supply is affected by the increased reliance on LFO to run the Beddawi and Zahrani power plants (Gasoil), as well as on private generators (Diesel). Starting in 2008, the supply of both LFO and HFO increased which is unusual and alarming. The share of the electricity sector in total LFO consumption leaped from 35 to 74 percent during the period 2001-2009, a two-fold increase.

Figure 9.2 TPES components variations (2001-2009)



Sources: Data for 2001-2009 is adapted from CAS/MOEW;

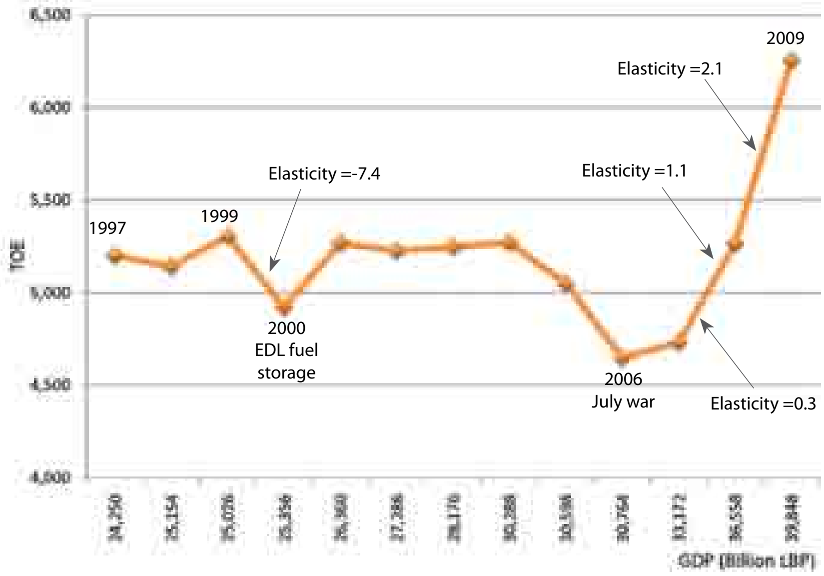
9.2.2 Economic Activity and Energy Utilization

There is a direct and strong relationship between the economy and energy consumption profile of a country (Ramashandra *et al.* 2006). Figure 9.3 shows the relation of TPES to real GDP in Lebanon for 1997- 2009.

The relation between TPES and real GDP during the period 1997-2006 varied considerably because of two main factors: country instability and public finances. Figure 9.3 shows two important dips:

1. In 2000, TPES dipped by -10 percent despite a slight increase in GDP (1.3%) resulting in an elasticity of -7.4. This is not due to a sudden improvement in the Primary Energy Intensity (PEI) of the economy but rather to a government ban on light fuel oil purchase to feed EDL plants because of the huge budget deficit that year.

Figure 9.3 Elasticity of TPES with respect to GDP for Lebanon (1997-2009)



Source of TPES statistics: IEA & MOEW, GDP statistics from CAS

2. In 2005, the TPES dipped by about 4 percent following a period of instability and grave security concerns that engulfed the country and compounded by the war of July 2006.

Overall, the period between 1997 and 2006 is informative because it shows that despite a slightly increasing GDP (from about LBP24,000 billion to LBP30,000 billion), TPES was decreasing or at worst remained constant even though there was no deliberate policy to improve energy utilization in Lebanon. Therefore energy inefficiencies were automatically removed when electricity was getting more scarce due to increased EDL cut outs especially in 2000 (elasticity = - 7.4) and in 2007 which saw an exceptional performance with an elasticity of 0.3 despite a booming economy (GDP +8%).

However things started to change during the last two years when Lebanon enjoyed unusual stability and an exceptional economic boom driven by a bustling real estate sector. While TPES in 2008 seemed reasonable with an elasticity of 1.1 and a real GDP increase of +10 percent, quite normal for a service-based and developing economy, 2009 which also brought economic bounty to the country (real GDP +9%) saw a jump in TPES elasticity to 2.1 (110% the world average).

Assuming a five percent real economic growth rate sustained over the coming five years (2011-2015), as announced by Banque Du Liban (BDL), and an energy elasticity of 1.4 (very optimistic scenario), TPES will reach 8,700 KTOE by 2015. This would represent a 40 percent increase compared to 2009.

9.2.3 Environmental Impacts of TPES

The primary energy supply involves the physical supply of energy under its different forms to the national boundaries of Lebanon, eventual storage, and the production of electricity within those boundaries. This chain has an impact on the environment that is not fully investigated. To date, neither scientific research nor statistical studies have been undertaken to assess the real impact of the energy sector on the environment in the country. The MOE/UNDP work within the context of the Second National Communication (published in March 2011) is considered a significant step to quantify the carbon footprint of various economic activities. This SOER assesses the potential environmental impacts linked to each stage of the energy supply chain and usage in Lebanon –see detailed overview in Figure 9.4. This overview is not complete but can provide the basis for a framework study on the environmental performance of Lebanon's energy sector.

Lebanon relies on six principal sources of primary energy: (1) imported hydrocarbon fuels in liquid and (2) gaseous form, (3) imported electricity, (4) locally produced hydroelectricity, (5) biomass and (6) alternative energy (see top row of the energy supply chain in Figure 9.4). Liquid hydrocarbons, biomass and alternative energy can be stored while the other sources are immediately consumed after entering

Deir Ammar power plant in North Lebanon

Box 9.2 Spillage in Dora Area

On 23 March 2011, a spill occurred in Dora, north of Beirut, while a tanker carrying around 21,000 tons of Kerosene was unloading its cargo through a secondary underwater pipeline to one of the fuel storage tanker located on the coast (Daily Star, 25/3/2011). The spill occurred due to a technical failure in the pipeline and spread over parts of the Lebanese coast to reach Kesrouan area. Generally, oil spills can severely damage marine life and cleanup operations are expensive and extremely difficult.

Fuel storage tankers in Dora are owned by the private companies that are licensed to import, store and distribute hydrocarbons on the Lebanese market (MOEW 2011). According to Environment Law 444/2002, which embraces the polluter-pays-principle, oil importing companies should assume full responsibility in case of a spill. Separately, the COM, in its Decision No. 53 (dated 06/10/2010), accepted the cooperation agreement signed between the MOIM, the Civil Defense and oil importing companies on how to control and contain (future) oil spills.

In practice and immediately after the Dora spill, the MOE in coordination with the Civil Defense implemented a major cleanup effort, recovering more than 20,000 liters of Kerosene from the sea. Both the public and private sectors still lack emergency response plans in Lebanon and the GOL has yet to formalize mechanisms to hold polluters accountable and responsible for cleanup efforts, as well as ecological restoration (see Section 4 / Article 59 of Law 444/2002).

the country or after production. In 2008, 95 percent of Lebanon's primary energy consisted of imported hydrocarbon fuels, 0.6% of Hydro-electricity, 1.2% of imported electricity, 2.1% of biomass and 1% of alternative energy (see details in Table 9.1).

The following paragraphs describe the potential environmental impacts associated with each type of the primary energy supply. For potential environmental impacts associated with other stages of the supply chain, refer to Figure 9.4.

Imported Hydrocarbon Fuels (IHF)

Supply of hydrocarbon fuels is solely by sea tankers as the NG pipeline is currently idle (MOEW 2011). IHF transportation could impact the environment through Gaseous Fugitive Emissions (GFE) (venting, evaporation), cargo spillage and ballast unloading while IHF storage may result in GFE, spillage and sludge accumulation (MOE 2011 & MOEW 2011). There is no data or statistics in Lebanon that could be used to quantify the pollution and determine the resulting environmental load. Some estimates are given here below based on available information.

In 2008, some 5 million tonnes (t) of refined liquid petroleum fuels were shipped to Lebanon by tankers (CAS 2009). In terms of air pollution, total GHG emissions resulting from fuel combustion to power these tankers were roughly estimated at 315 $GgCO_2e$ or 315,000 tCO_2e based on an average CO_2e emission factor of 21 gCO_2e/DWT/km (IMS 2005). For the sake of comparison, the total CO_2e emissions for Lebanon in 2006 amount to 18,171 $GgCO_2e$ (MOE/GEF/UNDP 2011). Total SO_2 emissions were estimated at 3.15 $GgSO_2$ assuming a specific energy consumption of 0.1 MJ/DWT/km (BTE 1994) and HFO at 3.5% sulfur content. It was further assumed that average loaded tanker trip is 3,000 Km as most tankers operate within the Mediterranean basin and tanker size does not exceed 15,000 DWT considering the shallow waters of the unloading ports in Lebanon.

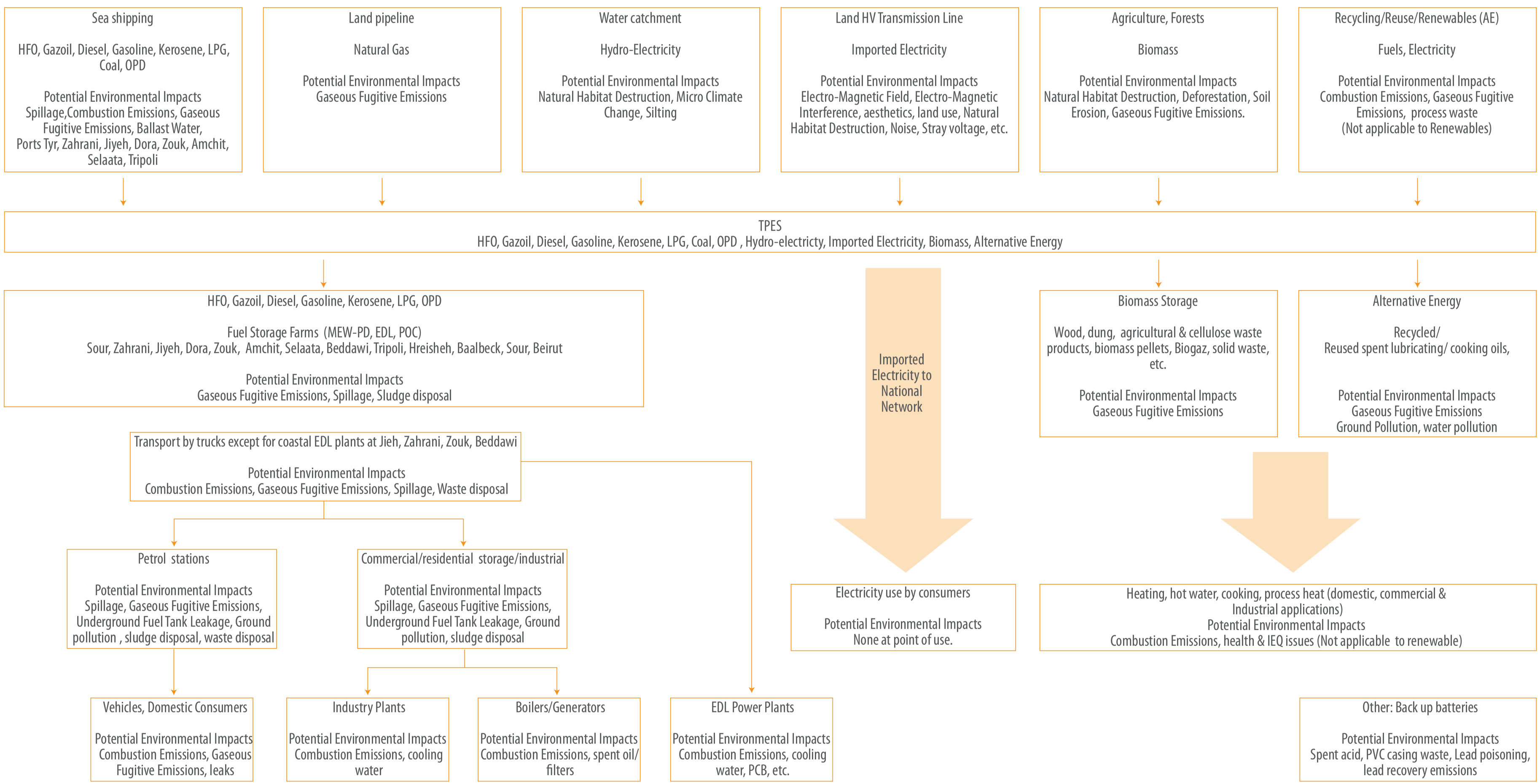
Atmospheric emissions due to shipping are not only limited to exhaust from tanker engines. They include also GFE from tanker compartments venting systems and loading/unloading operations. It is extremely difficult to estimate these emissions so long as shipping operations are not subject to strict regulations and monitoring.

Similarly, *cargo spillage* is a great unknown, it is not easily quantifiable. According to some studies, between 100,000 and 150,000 t of crude oil is spilled yearly in the Mediterranean due to shipping activities (Greenpeace 2011). Spillage can also occur on land if the feed lines between the ship and the storage reservoirs are leaking or due to malpractices or accidents (see recent spillage incident in Box 9.2).

Ballast water contains hydrocarbons as well as sewage from tanker ships which are usually unloaded at sea. As signatory to the Barcelona Convention and other agreements for the Protection of the Mediterranean Sea against Pollution, Lebanon is required to reduce and control sources of pollution including the discharge of sewage reservoirs from ships into the Mediterranean Sea. It is difficult to enforce such regulations in the absence of monitoring capabilities and reception facilities that are equipped to receive and handle ballast water and other waste types.

An estimated 1,600 tanker trips are made yearly to supply Lebanon with primary energy assuming an average tanker capacity of 3,000 DWT. If 50 percent of the ships unload their solid and liquid waste in Lebanese territorial

Figure 9.4 The energy supply chain in Lebanon and its impacts on the environment



Source: Prepared by ECODIT for the 2010 SOER) waters, at the rate of two tons of waste per ship, then these waters receive at least 1,600 tonnes of waste every year. This is a very conservative estimate considering the fact that many tankers must wait days off the Lebanese coast until financial formalities are completed (MOEW 2011).

An estimated 320 tanker trips are made yearly to supply Lebanon with primary energy assuming an average tanker capacity of 15,000 DWT. If 50 percent of the ships unload their solid and liquid waste in Lebanese territorial waters, at the rate of 10 tonnes of waste per ship, then these waters receive at least 1,600 tonnes of waste every year. This is a very conservative estimate considering the fact that many tankers must wait days off the Lebanese coast until financial formalities are completed (MOEW 2011).

Storage of Imported Hydrocarbon Fuels

Storage of hydrocarbons in fuel farms also has environmental consequences mainly in the form of GFE, spillage, and sludge accumulation in storage tanks. Primary energy hydrocarbon fuels storage in Lebanon is divided among three main players: MOEW-Petroleum Directorate (PD), EDL and the private oil companies. The actual storage capacity of the Petroleum Directorate is about 370,000 t while those of EDL and the private companies are not known. The fuel farms owned by private companies should be monitored as it is currently not clear which government agency has jurisdiction to oversee their operations. It has been reported that HFO storage at the premises of one private company was done in an open pit (MOEW 2011).

Both GFE and spillage cannot be estimated due to lack of data. These are functions of type of fuel, storage tank condition and venting system, fuel handling equipment as well as procedures for loading and unloading of bulk tanks as well as tanker trucks for market distribution. Research has shown that the emission rate of product per unit cover area of fuel storage tanks is about 1.2×10^{-3} kg/d.m^2, 4.1×10^{-3} kg/d.m^2 and 10.1×10^{-3} kg/d.m^2, respectively for automotive Diesel, kerosene and gasoline (Chakradhar B 2007). Emissions from HFO are considered negligible. The emission rates of products from gas storage tanks are estimated between 4.3 and 42×10^{-4} Gg per year and per million m^3 withdrawn (IPCC 2000).

Regulations in the US allow no more than 10mg/liter of GFE in loading/unloading of gasoline at fuel terminals (40 CFR 63 subpart R) which implies the use of vapour recovery units. Such equipment is probably not available at the premises of the private companies in Lebanon which are the only ones to handle gasoline, Diesel and LPG.

Sludge accumulation in storage tanks is a function of the type and quality of hydrocarbons being supplied. For example, HFO generates much more sludge than gasoline. MOEW-PD has presently some 20,000 tonnes of sludge stored in seven tanks at the Zahrani and Deir Ammar refineries. EDL currently has one 500m^3 tank full of sludge at Zouk power plant (MOE 2011 & MOEW 2011). Recently, the Petroleum Directorate contracted a firm to study sludge disposal methods (MOEW 2011). As for the private companies, sludge is burnt and residues are disposed off in municipal dumpsites (Chammas 2011).

In terms of fuel quality, the Petroleum Directorate is working with six private laboratories to check the quality of hydrocarbons entering the country. Three samples are taken from the top, medium and bottom of the tanker ship before unloading operations; specifications must comply with MOEW Decision 56/1997 and LIBNOR NL-501:2001. The Petroleum Directorate has no jurisdiction over fuel quality stored by private sector fuel farms. The Consumer Protection Directorate at the Ministry of Economy and Trade (MOET) has attempted to monitor fuel quality at these farms but results of fuel samples analysis from different laboratories have been disparate and therefore inconclusive. This is impeding the implementation of a strict quality control program (Fleifel 2011).

Natural Gas Land Pipeline

A 32-km high pressure NG pipeline (called GASYLE 1) was completed in 2005 linking the Syrian gas network to the Beddawi-Deir Ammar power plant in north Lebanon. Its design capacity is 6 million m^3/d with a minimum contracted capacity of 1.5 million m^3/d (EMEF 2008). However, only half that quantity was effectively supplied between November 2009 and November 2010. The pipeline stands currently idle. A fiscal metering station (FMS) is located at the Syrian Lebanese border.

Methane fugitive emissions (not quantified) from GASYLE 1 NG pipeline depends on the condition of the line and ancillary control/monitoring equipment. Methane is seventy times more potent than CO_2 as a GHG based on 20-year time span and 21 folds over the 100-

year span. Consequently it is always worthwhile looking closer at the GFE of natural gas installations even if they are modest in size and recently built. It is unclear if an EIA study was conducted for the GASYLE 1 project.

Imported Electricity

Importing electricity to Lebanon involves the 400 KV Overhead High Voltage Transmission Lines (OHVTL); such installations are associated with a long list of potential environmental, health and social issues like Electromagnetic fields effects, degradation of natural habitats, noise and stray voltage (PSCW 2010). The potential environmental / social impact is strongly dependent on the areas over which the overhead lines are crossing. There is no readily available survey document of the OHVTL linking the Lebanese to the Syrian network (Anjar and North border).

Hydro-Electric Power

Hydro-Electricity in Lebanon does not involve dams with their potential drawbacks; it is generated by tapping water at the source in pressure manifolds directly connected to the turbines at lower elevations. It is doubtful if any environmental impact analysis has been undertaken considering that these pipelines were built more than 40 years ago. Some of them run exposed while others are routed in deep tunnels drilled in the mountains. At this stage, it may be worthwhile studying if the maintenance activities undertaken on these lines may have any negative environmental impacts.

Qadisha hydro-power plant

Biomass from Agriculture, Forestry and Waste

In 1999 it was estimated that Lebanon consumed some 140,000 tonnes of wood fuel and 1,560 Tonnes of charcoal mostly for the residential sector (MOE/GEF/UNDP 2002). Based on present hydrocarbon fuels prices, there is no reason to believe that these figures have dropped, on the contrary they may have increased. Considering that around four Tonnes of wood fuel make-up one Tonne of charcoal (FAO, 2010) the total wood fuel consumed amounts to 146,200 t or 52 KTOE (IPCC 1996). An additional 90 TOE of biomass was used as fuel for heating and cooking mostly from agriculture products and animal dung.

The exploitation of broad leaved trees is presently allowed in Lebanon but not coniferous trees (FAO, 2010). The official estimates of wood fuel exploitation based on the licenses issued by the Ministry of Agriculture (MOA) amount to roughly 11,000 tonnes assuming a 60 percent markup for illegal exploitation (FAO, 2010). This number falls way short of the estimated 146,200t mentioned above and definitely cannot be made up by discarded fruit trees which may imply that illegal exploitation is far higher than what is assumed and may reach several times the volume allowed by fuel wood harvest licensing issued by the MOA.

Apart from the environmental damage due to uncontrolled tree cutting and/or trimming especially in what concerns coniferous trees, biomass burning in conventional or makeshift stoves in confined spaces, especially if not properly dried, is a serious health hazard to public health. Potential environmental impacts from Waste-To-Energy technologies, which may be used in the future as part of the GOL's energy conservation measures (Ministerial Declaration dated 8/12/2009 and COM Decision 55 dated 1/9/2010), are not addressed in this chapter as there are no current large-scale applications in Lebanon *–see analysis of Waste-To-Energy in Chapter 8*.

Alternative Energy

Alternative energy includes recycled combustible material and renewables like PV, Domestic Solar Water Heaters and wind turbines. Considering that the environmental impact of the latter category is negligible, at least at the point of use, the focus will be on recycled combustible material like spent lubrication and cooking oils.

Recycling Used Cooking Oil (UCO) and Used Lubrication Oils (ULO) as fuels contributes very little to the primary energy supply of Lebanon, less than 0.15% of TPES (SOER estimate). However, the environmental and social impacts of UCO and ULO recycling are significant relative to their energy contribution *if* the recycling process is uncontrolled.

There are informal and non-regulated systems for the collection of used lubricant and cooking oils. Presently, the market for ULO and UCO is very brisk, characterized as cut-throat competition. For example, ULO is bought at around $200/Tonne (Faddoul 2011) while UCO price varies between $500-1,000/Tonne depending on grade (Aoun 2011). In 1997, the estimated amount of ULO sold or given for free by petrol stations was estimated at around 7,200 Tonnes or 47.5 percent of total ULO for that year (MOE 1998). Considering the present price of ULO and growth in car usage, it is safe to assume that the quantities of recycled oil have doubled. ULO is rich in mineral and contains heavy metals (MOE 1998), if un-properly treated it may contain residues which render its combustion even more toxic (MOE 1998 & Faddoul 2011). Burning ULO in low temperature burners like those used in domestic and commercial applications results in extremely harmful emissions. ULO should be confined to high temperature applications like in cement kilns (SOR 2006).

In Lebanon, ULO is illegally blended with Gasoil by unscrupulous fuel distributors (Faddoul 2011) or by users to fire burners for heating or even in bakeries (MOE 1998). Some people use it directly in their stoves with terrible resulting smells and probably damaging health consequences (Aoun 2011). MOE decision 8/1 dated 30/01/2001 sets environmental limit values for emissions resulting from the combustion of used oils in burners of 0.5 MW capacities or bigger. However in practice, ULO is used in all sizes of burners because control over the handling of ULO in Lebanon is practically non-existent (Faddoul 2011). MOE does follow up on contravening parties when a complaint is filed.

Used Cooking Oil uses are more varied; it is directly mixed with Gasoil and Diesel oil, added to filtered ULO to improve its quality for re-use or processed into bio Diesel (Faddoul 2011). Some 80 percent of UCO resulting from restaurants and food outlets operations is collected while none is collected from industry where it is completely used in the process or from private residences where it is sent to the drain (Faddoul 2011).

9.2.4 Electricity Sector

The present state of the electricity sector in Lebanon is not sustainable. The following paragraphs provide a simplified overview of the sector, including formal and non-formal electricity generation. The formal sector is led by Electricité du Liban (EDL) and the informal sector represents thousands of private producers who cover the electricity generation deficit, most of them illegally.

Formal Sector

EDL is an autonomous state-owned entity under the jurisdiction of the MOEW. With the exception of four private concessions (Zahle, Jbeil, Alay and Bhamdoun representing about 82,000 subscribers) and private/semi-private hydroelectric power plants (Nahr Ibrahim and Kadisha), EDL has quasi total monopoly over electricity production, transmission and distribution in the country (Abi-Said 2005). In 2002, parliament approved Law 462 with the aim to end EDL's quasi monopoly over the electricity sector by bringing in the private sector as a partner.

EDL operates seven thermal power plants (*see list in Table 9.3*) and six hydro-electric power plants. Nearly half the generation capacity of EDL (Zouk & Jieh steam plants) is nearing retirement while operation of the other half (gas turbines) is suboptimal because the plants run on Gasoil instead of natural gas. In 2005, the natural gas pipeline linking the Beddawi power plant to the Syrian gas network was completed but the remaining gas turbine plants in Lebanon (Baalbek, Sour and Zahrani) are still not connected to the Beddawi pipeline.

The pipeline was not used for few years due to domestic demand for natural gas in Syria. In May 2009, Lebanon signed an agreement with the Egyptian state-run gas firms EGPC and EGAS to receive up to 600 million m^3/y of Natural Gas over the next 15 years through the Arab Gas Pipeline/Syrian network. This is enough gas to power the Beddawi plant and gas started to flow in September 2009 (the flow was steadied by November 2009). Natural Gas was supplied at a rate of 850,000 m^3/d, enough to cover 50 percent of the daily requirement of Beddawi plant (about 1,700,000 m^3/d). Beddawi has two primary gas turbines running on NG and a third steam turbine operating on the recovered heat of the combined cycle. By November 2010, Natural Gas supply stopped completely with no formal explanation by EGPC/EGAS. During this period, Cairo was experiencing power blackouts (as reported in the local press) and the GOL had not yet footed its fuel bill (partly due to delays in receiving corresponding invoices from the Egyptian gas firms). In January 2011, the Al-Arish Natural Gas booster station in Egypt was blown up, affecting gas supplies to Syria, Jordan and Lebanon. Resuming gas supply from Egypt will not happen until the station is repaired --another example how vital and important energy security is.

Technical losses in EDL network are optimistically estimated at 15 percent while non technical losses (theft) and uncollected bills may reach 30 percent (WB, 2008). The surge in LFO (Diesel/Gasoil) consumption since 2007 is due to the increased reliance on the gas turbines plants operated on gasoil to supply electricity. This is an economic aberration considering the price of gasoil. Normally, the cost of gasoil on the market is 40 percent higher than HFO and 260 percent higher than NG on a calorific value basis. Taking into account capital expenditures, NG will still be 200 percent cheaper than Gasoil taking into consideration EDL plants load factors (WB 2008).


Headquarters of Electricity Du Liban in Mar Mikhael, Beirut

Table 9.3 EDL generating and import capacity

Power Stations	Nominal MW	Available 2004	Available 2008	Current Fuel Type	Retirement year	Equipment Type
Zouk	607	520	365	HFO	2015	ST
Jieh	346	295	187		2010	ST
Hrayche	75	60	-	HFO	2010	ST
Sour	70	70	70	LFO (Optimal efficiency with NG)	2021	OCGT
Baalbeck	70	70	70		2021	OCGT
Beddawi	435	435	435		2025-2030	CCGT
Zahrani	435	435	435		2025-2030	CCGT
Total conventional	2023	1885	1562	-		-
Hydro	282	80	< 80	-	1981	WT
Egypt/Syria import	200	200	200	-	-	-
TOTAL	**2505**	**2150**	**< 1840**	**-**	**-**	**-**

Source: Adapted from Abi Said 2005 and WB 2008

Abbreviations: **ST** Steam Turbine, **WT** Water Turbine, **OCGT** Open Cycle Gas Turbine, **CCGT** Combined Cycle Gas Turbine

In 2009, EDL was able to meet only 71 percent of average load estimated at 2,100 MW (peak load ~ 2600 MW) and supply about 70 percent of electrical energy consumption for that year estimated at 15,000 GWHr. The balance was covered by electricity purchase from Egypt and Syria (7%) and private generation (23%) (MOEW, 2010).

Despite a slight increase in 2009, the hydro electric generation capacity of Lebanon has been declining since 2003 due to ageing equipment and lower water availability (some of that equipment dates back to 1909 but is still operating). In 2009, hydroelectric power represented only 3.5 percent of domestic electricity production with a generation capacity less than 80 MW (MOEW 2010).

Governance issues, debt and serious production deficits prevent EDL from phasing out old installations and expanding capacity. The electricity sector has been suffering from structural and operational deficiencies since three decades due to lack of investments (only $1.6 billion during the period 1992-2009), inadequate tariffs, theft, war-related physical damages, ineffective regulatory framework, and the historic absence of a broad-based political commitment to resolve the energy crisis. This situation may change in the near future thanks to the recent government endorsement of the Policy Paper for the Electricity Sector in June 2010 (see explanation in Section 9.2.6).

GOL spending on EDL constitutes the third largest expenditure after debt interest payment and personnel cost. Government financial support to the EDL is by no means a recent development, as transfers date back to the civil war --although back then, the frequency and structure of transfers was not systematic. Transfers to EDL have increased from LBP283 billion in 2001 to reach LBP2,259 billion in 2009, an eight-fold increase! In 2009, transfers to EDL constituted 20 percent of primary expenditures or around $375/person on a capita basis (MOF 2010). That year, EDL covered only 8.3 percent of the fuel bill, compared to 18.7 percent in 2006. In 2008, a year during which government expenditure on EDL reached a record LBP2,430 billion, EDL coverage was only 4.7 percent (MOF 2010). The cumulative treasury subsidy to EDL since 1992 including interest amounts to $13,766 million or approximately 27 percent of Lebanon's nominal public debt (Soueid 2011). It is estimated that economic losses may exceed $9,500 million in 2015 alone if the dysfunctions of the electricity sector are not seriously, effectively and immediately addressed (MOEW, 2010). In December 2010, Lebanon paid EGAS $28 million (MoF, 2011), nearly one third of the bill, for Natural Gas supplied between September 2009 and November 2010, date of cutoff (MOEW 2011). During that period, the GOL saved around $130 million (see Box 9.3) by switching from Gasoil to NG to feed 50 percent of Beddawi fuel consumption representing some 12.5 percent of EDL's 2,450 KTOE requirements in 2009 (MOEW 2011). This example shows that a well planned energy policy can bring financial rewards to the country.

Box 9.3 Saving $130 million in a nutshell

Although gas supply started in September 2009, it is assumed that effective operation spanned 390 days between September 2009 and November 2010. The total amount of gas consumed was 335,750,000 m^3 equivalent to 299,777 TOE. Based on Natural Gas and Gazoil prices of $266 and $700 per TOE respectively, the savings amount to $130 million.

Source: SOER estimate

Tariffication

EDL tariffs have remained unchanged since August 1994 when the price of oil was $21/barrel (Table 9.4), not to mention the effect of cumulative inflation. Despite the freeze, electricity cost in Lebanon is not low because electricity bills are surcharged with indirect taxes resulting in unfair billing for small domestic consumers (see example in Box 9.4).

Box 9.4 How much does a low income household pay?

A limited income household that consumes no more than 200 kWhr a month will pay $5.6 of direct charges and $9 of indirect charges, therefore the cost of the consumed kWhr is multiplied by 2.5. The lowest slot tariff therefore jumps from 2.3 cents to 6 cents.

For domestic consumers in the highest slot (>501kWhr), the indirect charges are typically 35 percent of the bill amount. Therefore, the tariff in that slot increases from a nominal of ¢8 to an actual of ¢11 after adding surcharges. For large industrial consumers, the indirect charges are typically 13 percent of the direct charges. Overall, the average tariff in 2006, based on billed energy, was LBP141/kWhr (¢9.4/kWh) (WB, 2008). Compared to electricity prices in the region, the 2006 average tariff in Lebanon falls in the upper bracket (*see Table 9.5*). In terms of energy consumption, the electricity sector consumed 2,436 TOE (about 45% of TPES) in 2008.

Table 9.4 EDL monthly tariffication (effective since 1 August 1994)

	Tariff slot	Tariff (LBP/kWhr)	Tariff ($/kWhr)
LT	Domestic		
	< 100 kWhr	35	0.023
	101-300 kWhr*	55	0.036
	301-400 kWhr	80	0.053
	401-500 kWhr	120	0.08
	> 501 kWhr	200	0.13
	Street Lighting, Public Buildings, Free medical care centres, Hospitals, Places of Worship, Cinemas, Charity centres, etc.	140	0.093
	Small industry, craftsmen, agriculture, water treatment, pumping stations	115	0.076
MT	Craftsmen , agriculture , water treatment and pumping stations	130	0.086
	Industry**:** Night slot: 80 LL, Day slot: 112, Peak slot; 320 LL		
	Other subscribers	140	0.093
HT	Category**:** All subscribers	115	0.076

Source: Compiled by ECODIT for 2010 SOER

*For monthly collections, for bi-monthly collections, tariff structure changes. **LT** Low Tension, **MT** Medium Tension, **HT** High Tension

Table 9.5 Average electricity tariffs in some Arab Countries (US¢/kWhr)

Morocco	UE	**Lebanon**	Jordan	Dubai	Tunisia	Abu-Dhabi	Algeria	Qatar
11	9.6	**9.4**	7.2	5.4	4.6	4	3.5	3

Source: Adapted from WB 2008

Note: The above comparison of electricity tariffs should be treated with caution as it includes oil-producing countries.

Informal Sector

In 2007, some 61 percent of all residences in Lebanon were equipped with or connected to private generators (CAS, 2008). In 2010, the cost for private generation paid by Lebanese citizens was estimated to $1.4 billion compared to $700 million for EDL (MOEW 2010). This prompted MOEW to prepare a study according to which the average price for 5A (per hour of blackout) should be LBP350. The study was distributed to all municipalities and private owner generators but compliance remains limited. Additionally, the MOE issued Circular No 10/1 (dated 19/3/2011 and published in the Official Gazette on 21/04/2011) related to "Monitoring the Operation of Electric Generators". The circular includes technical requirements on how to mitigate air pollutants from power generators (using exhaust systems for trapping air pollutants such as cyclones), control oil and/or fuel leakages (using absorbent materials under generators such as sawdust), and store used oil prior to safe final disposal. More importantly, there is no control over the quality of the power delivered to households, resulting in a sizeable harvest of burnt appliances and equipment.

Many of these generators operate at low efficiencies, not exceeding 20 percent (WB 2008) however this is compensated by very low technical losses considering the short transmission distances involved (El-Fadel R.H. et al 2009). They are therefore a significant source of pollution and economic wastage. By comparison, the average generation efficiency of EDL from cradle to consumer gate is around 29 percent (Tannous 2011) --any private generator with lower generation efficiency would be wasteful and environmental unfriendly especially when located in densely populated urban areas. This is especially the case of the independent power providers, many have no incentive whatsoever to improve their equipment considering their quasi monopolistic mode of operation in their respective areas; inefficiencies are passed on to the consumer, unchecked by any legislation.

Environmental impact of the electricity sector

A 2009 environmental life-cycle assessment study assessed the current environmental performance of the Lebanese electricity system based on nine impact factors: Abiotic depletion, Acidification, Global warming, Ozone layer depletion, Human toxicity, Fresh water aquatic eco-toxicity, Marine aquatic eco-toxicity, Terrestrial eco-toxicity & Photo chemical oxidation (El-Fadel R.H. et al 2009). The study showed that Lebanon exhibits higher environmental impacts in eight of the nine factors as compared to European emissions. The only impact factor that was lower in Lebanon is aquatic fresh water eco-toxicity. The study also showed that the present configuration of the Lebanese electricity sector (namely operation using dirty fuels backed up by private generation) is the worst possible scenario while a scenario by which only EDL generates electricity but using dirty fuels is the second worst, as measured by the number of impact factors adversely affected. The best possible scenario is centralized electricity generation using clean fuels (such as NG).

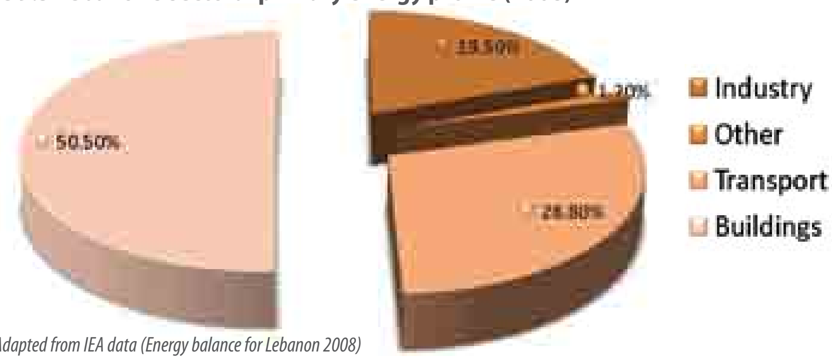
9.2.5 Energy Consuming Sectors

The largest primary energy consumers in Lebanon are buildings, transportation, and industry in decreasing order of importance (see Figure 9.5). The following sections describe in some details the energy profile of each sector and its environmental impact.

9.2.5.1 Buildings

Contrary to popular belief, buildings are the highest consumers of resources in the world! In Lebanon, the building sector absorbs about 50 percent of TPES, 36 percent of final energy and 70 percent of electricity consumption (IEA, 2008). Buildings account for nearly 40 percent of national CO_2 emissions. They include all kinds of construction including residential, commercial and industrial (excluding industrial processes). In 2004, there were approximately 0.5 million buildings in Lebanon representing an estimated 1.4 million dwelling units, of which 87 percent were residential and 13 percent commercial and/or industrial (CAS 2006). More than 90 percent of all buildings are located below 500m altitude. The yearly rate of new constructions (replacement and addition to existing housing stock) is about 2 percent (CDR-NLUMP, 2004). Buildings in Lebanon are poorly insulated, if at all. Heating ventilation and air conditioning (HVAC) as well as household equipment are generally inefficient. However, and thanks to market dynamics (e.g., price decline of CFL lamps and improvements in HVAC efficiency and technology), performance is improving although at slow pace. In 2007, some 56 percent of residences used hydrocarbon fuels for heating (LFO & LPG), 18 percent resorted

Figure 9.5 Lebanon's sectoral primary energy profile (2008)



Source: Adapted from IEA data (Energy balance for Lebanon 2008) to biomass (wood & charcoal) while 22 percent used electric heating (CAS 2008). In 2004, about 17 percent of dwelling units were equipped with air conditioning (CAS 2006). This percent is expected to have increased markedly since due to lower prices of AC units and higher income levels which influence comfort requirements and lifestyles.

According to Table 9.6, building envelope, HVAC equipment, lighting fixtures, water heaters and office equipment should be prime targets for energy efficiency. Although space heating takes the lion share of energy consumption in buildings, water heating is the area where the highest savings could be achieved in residential homes if domestic solar water heaters were installed (MOE/GEF/UNDP 2007). *See potential savings in Box 9.5.*

Box 9.5 Energy consumption of electric resistance heaters

On average, electric resistance heaters consume 350 percent more energy than efficient boilers, and therefore contribute to significantly higher emissions. Heat pumps consume on average half as much electricity than electric resistance heaters; however their performance is limited by altitude and outside temperature.

From an urban perspective, high rise buildings are raising the urban canopy height, thereby exacerbating the so called "Heat Island Effect" (HIE) which is the micro climate in a city due to the density of its infrastructure (roads, parking area) and superstructure (buildings). In other words, cities are generating heat which increases demand for indoor cooling. The lack of green spaces in urban areas intensifies the heat island effect. Recent studies in major European, Asian and North American cities have shown that temperatures in crowded streets surrounded by tall buildings could be as high as 10ºC above open countryside ambient temperatures (Santamouris et al, 2004). The impact of HIE is such that peak electrical loads that used to occur in winter are now shifting to summer time (Santamouris *et al* 2004).

Many buildings are presently equipped with generators operating on a daily basis in addition to boilers. Frequent refueling is required with its consequent fugitive emissions, potential spillage and sludge removal. Of course, quantifying such environmental impact is very tedious; however this should not prevent proper regulations to be enacted and enforced.

Table 9.6 Residential and commercial final energy consumption (%)

	SH	AC	Light	WH	Vent.	OE	Refrig	Cook	TV	Other	TOTAL
Residential	**34**	11.5	8.2	**28**	0.5	-	7	2.3	2.5	6	100
Commercial	**36**	18	**20**	1.5	1.5	13.5	1	1	1.5	6	100

Source: Tannous 2011, SH: Space Heating, AC: Air Conditioning, WH: Water Heating, Vent: Ventilation, OE: Office Equipment

9.2.5.2 Transportation

The transportation sector in Lebanon is not sustainable from the perspectives of productivity and environment. Practically speaking, of every 20 liters filled in the petrol tank, only 4 liters are used to move the car in the best of cases, the rest is lost as heat and smoke! Transportation consumes about 29 percent of TPES and 42 percent of final energy in Lebanon; in 2006, it contributed about 25% to national CO_2 emissions (3,817 $GgCO_2$), directly behind the electricity sector (6,322 $GgCO_2$). One significant contributing factor is the high vehicle dependence among Lebanese residents.

In Lebanon, every percentage point of economic growth engenders one and a half percentage points in car ownership growth and hence car journeys (MOE/EU/NEAP, 2005u). Daily passenger trips are expected to rise from an estimated 1.5 million in 2005 to 5 million in 2015 (MOE/GEF/UNDP 2011). Stop-go driving regimes, typical of traffic jams, induce higher CO levels in tail pipe emissions and increase fuel consumption by 20-30 percent on a mileage basis. In fact, the transport sector accounts for 94 percent of CO and 96 percent of VOC emissions. In 1997, congestion costs in Lebanon were estimated at around \$2.0 billion/year. With growing traffic conditions, costs may reach 10 percent of GDP (MOE/EU/NEAP, 2005u). Private cars in Lebanon account for nearly 86 percent of total vehicles estimated at 1.2 million in 2004 (MOE/EU/NEAP, 2005u). Most of these vehicles are poorly maintained despite that yearly vehicle inspection is now mandatory. This is detrimental to both emissions and fuel consumption efficiency. Meanwhile, the modern car segment has in recent years markedly shifted to gas-guzzling Sport Utility Vehicles (SUVs) despite relatively high gasoline prices. However the population of new smaller cars is also fast increasing but still, 90 percent of all vehicles are 5 years and older while some 60 percent are older than 13 years. The average emission factor for the existing light vehicle fleet in Lebanon is estimated at around 250 gCO_2/km[2], assuming an average 15,000 km/year/car, the average yearly emissions per car amount to 3.7 Tons CO_2/year.

[2]Based on an average consumption of 10 km/liter (very optimistic), gasoline emission factor as per IPCC, 1996

Moreover, low grade gasoline available on the local market does not help to reduce emissions. EU studies have shown that reducing sulfur content from 50ppm to 10ppm in gasoline reduces fuel consumption by 5 percent (Godson 2009). Table 9.7 shows irregularities related to tampering with fuel quality. The prevalence of irregularities by tampering is probably much higher but the majority of cases are not reported or caught. What is interesting however is the dramatic increase in tampering related to Diesel in 2008 when Diesel prices reached astronomical heights ($1,100/Tonne), surpassing gasoline!

Table 9.7 Reported irregularities related to tampering with fuel quality

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Gasoline	50	25	9	1	34	41	-	2	1	9
Diesel	0				1	2	-		**23**	1

Source: MOET-CPD, 2011

Tanker ships may unload gasoline and Diesel fuels that comply with specifications under Decree 8442 (dated 13/08/2002). However what happens between the unloading phase and the delivery of fuel to unsuspecting clients is anybody's guess. Officially, there are 94 secondary distributors licensed to store and distribute fuels in Lebanon, 1,117 legally registered tanker trucks and some 2,130 petrol stations (MOET-CPD 2011). The number of illegally operating actors in that sector is not known. As mentioned previously, ULO could be blended to Diesel and sold to clients, other harmful substances may be added to the mix, even water. Tempering with fuel quality greatly affects vehicle performance and both the quantity and quality of vehicle emissions. Consequently it has sizeable environmental and health impacts.

Gas stations in Lebanon dot the landscape and line most roads and highways –are they all licensed?

Mass transport in Lebanon includes about 40,000 public transport vehicles (shared-taxis, taxis, buses and minivans). Although a sizeable portion is old and dilapidated, some taxi companies are shaping up to meet high-end clientele. To date, Lebanon has no efficient, reliable, clean and cost-effective mass transport system; some 77 percent of all Lebanese have never used a public transport system (Darwish F. 2010). The ban on Diesel fuel and leaded gasoline for light vehicles in 2004 was incontestably a benefit to the environment. However, to date there are no published assessments that have evaluated the impact of such legislation on air quality *–see Chapter 4 Air Quality* for more details on the transport sector and related laws and regulations.

Trucks, buses and construction machinery in Lebanon fare no better than the light vehicles; many are old, are not well maintained, and run on low quality Diesel oil. Lorries with thick black plumes of smoke from their exhaust pipes is a common sight in Lebanon. Rail, air and maritime public transport within Lebanon's national boundaries are practically non-existent. Gasoline stations are part of the transportation system, these could be a major source of environmental pollution if their operations are not properly regulated and monitored. In this chapter, petrol stations are tackled only from energy or fuel related perspective, other environmentally harmful activities like car wash and oil change are not considered – *see Chapter 8 Solid Waste* for more information on used oil.

There are four sources of GFE at petrol stations in Lebanon: (1) the rudimentary venting system of the underground fuel tanks, (2) the absence of vapor return system between the underground tank and the unloading truck (negative pressure created in the underground tank used to pull in the vapors containing VOCs), (3) the absence of vapor recovery system at the refueling car tank and, (4) evaporation of gasoline spills.

A typical gasoline station can release sizeable amounts of fuel as FGE per year (USDE, 2010). Each unloading tanker truck could result in the loss of 20 liters of gasoline if a vapor recovery system for the unloading operation is not installed (MOE, 1998). To date, there are no regulations in Lebanon to address the issue of GFE for refueling operations in Lebanon. Such regulations are far reaching as they involve the whole supply chain from the private oil companies to the petrol stations. Underground fuel tanks leakage (UFTL) is another source of pollution affecting aquifers, soils and nearby structures. In urban areas, UFTL can result in harmful vapors migrating into basements or occupied spaces. UFTL may be very difficult to detect if occurring in small quantities and may go on for several years. Again there is a lack of effective regulations regarding UFTL in Lebanon.

9.2.5.3 Industry

The GDP share of the industrial sector in Lebanon in 2007 was around 9% (CAS 2008) but consumed around 19 percent of TPES and final energy respectively as well as 30 percent of overall electricity production. According to energy audits commissioned by the Lebanese Center for Energy Conservation (LCEC) of 17 industrial plants between 2007 and 2009, 61 percent of their energy expenses were related to self generation while electricity bills make up 77 percent of their energy expenditure (WB, 2009). The high rate of private electricity generation partially explains the inefficiencies in the industrial sector considering that small generation plants are not very efficient, many being old and/or not optimally operated not to mention the low fuel quality. The LCEC energy audits have shown that industries can achieve savings between 9 and 33 percent, with the aluminum sector offering the least opportunity and the cement industry the highest. On an equipment basis, electric motors show the best potential for energy saving (20-25%) while energy recovery the least (2-3%). Surveys in the Lebanese industrial sector suggest a high potential for energy savings, which could be more significant than the world average values (WB 2009).

9.2.6 Laws and Regulations

The following section describes key regulations and policy issues related to the energy sector. Each legal text cited here is also listed chronologically in Annex 2 at the end of the chapter. For a more complete analysis of environmental legislation related to energy and environment, please refer to Chapter 4 of SELDAS (EU/UOB/MOE/ELARD, 2005). For a review of environmental jurisprudence cases related to energy and environment in Lebanon and other countries, please refer to Chapter 4 of SEEL (MOJ/MOE/UNDP, 2010). To date, Lebanese laws and regulations related to energy, Energy Efficiency (EE) and Renewable Energy (RE) are almost non-existent. Lebanon has no formal national energy strategy. The following laws and regulations deserve attention:

- *Building Law 646/2004 and implementation decree 15874/2005;* better known as Lebanon Building Code (LBC). With the exception of Annex E of article 14 which provides incentives for double walls and double glazing, the LBC contains no stipulations related to energy efficiency in buildings. Moreover, under the framework of the cleaner production program, the World Bank is working on a project to upgrade the environmental performance of the building code. Such initiative will improve the energy efficiency of the building sectors and will have a beneficial impact on the energy bill of the country.
- *Thermal standards for buildings; NL 68:1999:* Those are voluntary standards introduced by LIBNOR back in 1999 but never saw any application, they are presently considered as derelict and ineffective. Two consecutive initiatives to replace those standards, sponsored by the Order of Engineers and Architects of Beirut (OEAB) and the Ministry of Public Works and Transport (MOPWT), resulted in two documents namely Thermal Standards for Buildings in Lebanon (TSBL) 2005 and TSBL 2010. The first was supported and financed by UNDP-GEF while the second by the Agence de l'Environnement et de la Maitrise de l'Energie (ADEME). None of them was approved by LIBNOR as a national voluntary standard. Currently, efforts are undertaken under the aegis of the OEAB to come out with an updated version to be approved by LIBNOR. It was estimated that applying TSBL in Lebanon starting 2010 and over a 20 year period would result in saving some 1.67 million TOE, avoiding some 6.8 million Tonnes CO_2 and most of all achieving around $500 million in savings (UNDP-GEF, 2005). When the study was done in 2004, the financial estimates were based on a maximum energy price of $30/barrel over the 20 year period in constant 2002 dollars. Considering actual energy prices, the financial savings are many folds the number stated above.
- *Environmental Law 444/2002* prepared by MOE and approved by parliament in 2002, Law 444 provides a general framework for environmental management activities in Lebanon. It has yet to come into effect pending the preparation and enactment of the implementation decrees (by 2010, not one decree had been issued). Article 20 in particular addresses energy efficiency measures.

- *Electricity sector Law 462/2002* reorganizes the electricity sector and the possibility of privatizing the electricity production and distribution segments (Chapter 1, Article 4). The Law establishes a higher supervisory body called the Energy Regulatory Agency to manage the unbundling (Chapter 2). Similar to Environment Law 444/2002, Law 462/2002 awaits application decrees and has yet to see the light.
- *Policy Paper for the Electricity Sector (PPES) was* unanimously approved by COM in June 2010 (COM decision No.1 dated 21/06/2010). It presents a new strategy for the electricity sector, discussed further in Section 9.3. Implementing the policy paper will require a great deal of goodwill and political consensus from all parties. The policy paper aims to rehabilitate the electricity sector and effectively overhaul Law 462/2002 (MOEW 2010).
- *MOE Decision 52/1-1996 and Decision 8/1-2001;* both decisions relate to gaseous emissions, pollution concentration and effluent discharge. Decision 8/1 partially amended and/or replaced the provisions in Decision 52/1-1996 *– see analysis of Decisions 52/1-1996 and 8/1-2001 in Chapter 4.*
- *Law 132/2010-Offshore Petroleum Resources law* relates to oil and gas activities, from granting rights to prospection to production, to de-commissioning of oil and gas facilities. Law 132 may be the beginning of a long road to solve even partially the thorny issue of energy availability in Lebanon without wreaking havoc upon the environment. According to Law 132/2010 (Article 7 Clause 2), all licensing for exploratory drilling is subject to EIA. Additionally, well development and production licensing requires in depth environmental studies (Article 32). The law provides the necessary framework for safety and environmental protection legislation during the production as well as at de-commissioning stages of a well (Articles 54 to 60). For example, Article 36 stipulates the conditions under which venting and product burning at an exploration site could take place.
- *Law 359/1994;* Lebanon ratified in 1994 the UNFCCC which entered into force in 1995. As a developing country, Lebanon is required to submit to the UNFCCC a national communication with a GHG inventory of Lebanon's emissions by activity sector. The First Communication was issued in 1999 and the Second Communication was issued in March 2011. In November 2006, Lebanon ratified the Kyoto protocol which helps parties become eligible for CDM projects. To date, Lebanon has not benefited from any CDM project.
- *Draft Transport Policy;* the Directorate General for Land and Marine Transport (DGLMT) at the Ministry of Public Work and Transport (MOPWT) submitted to the GOL in 2002 a draft transport policy that aims to ensure the economic, financial, environmental and social sustainability of the land transport sector in Lebanon. The actions proposed were directed to curb the use of private cars, reduce their emissions, increase their safety performance, encourage public transport use and embellish the transportation network. No action was taken by the GOL and the draft was never enacted as law. Presently, a new draft law is being discussed.
- *Draft Energy Conservation law;* LCEC is currently in the final stages of readying this law to be approved by parliament. It will serve as a much needed framework to put Lebanon on the tracks of good energy governance both in the private and public sectors. The focal point of the Law is the establishment of a managing body (LCEC) to oversee its proper application from a technical viewpoint. Hopefully once enacted, this law will pave the way for a national energy strategy that will be highly beneficial for both the environment and the financial health of the country.

9.2.7 Key Actors (and Energy Initiatives)

Irrespective of the poor legislative performance, Lebanon is making noteworthy strides (albeit small in scale) in promoting and institutionalizing energy efficiency and renewable energy programs. Below is an overview of the different actors on the energy scene in Lebanon with a brief description of their undertakings to date (see Table 9.8). The actions described below help effectively remove all kinds of barriers whether regulatory, economical, social, market related or any other impediment delaying the penetration of good practices and processes that favor energy efficiency and clean renewable energy.

Table 9.8 Key players and responsibilities in the energy sector

Function	*MOEW*	*MOE*	*MOF*	*MOPWT*	*EDL*	*BDL*	*Other*
Strategy for the electricity sector	X						X
Construction of new power plants	X						
Construction of transmission infrastructure	X						
Promotion of EE and RE programs	X		X				X
O&M of power plants & substations					X		
Financing	X		X			X	
Regulations and guidelines	X	X	X				
Sustainable strategy for transport sector				X			

Notes: the above delineation of responsibilities is indicative and subject to change.
"Other" includes LCEC, CEDRO, LCPC, LGBC, etc.

9.2.7.1 Government Institutions

The *Ministry of Environment* endorsed some of the proposed clauses and modifications to the LBC presented by the Lebanon Green Building Council (LGBC) and related to EE and RE, with the aim to issue a new version of the code including these modifications. MOE is responsible for meeting Lebanon's reporting obligations under the UNFCCC, particularly the National Communication on Climate Change (which includes emission data for the energy sector) prepared under its aegis. The Second National Communication, inventorying emissions for base year 2000, was released in March 2011.

The *Ministry of Energy and Water* is the most active public body attempting to promote Energy Efficiency and Renewable Energy programs in Lebanon. To date, the most noteworthy achievement is the sponsoring of the Lebanese Center for Energy Conservation Program (Presently LCEC), further discussed below. A more recent initiative is the Policy Paper for the Electricity Sector mentioned in Section 9.2.6. Currently, MOEW is embarking on several programs related to EE and RE (discussed in Section 9.3).

The *Ministry of Finance* co-signed a Sustainable Energy Strategy (SES) project with UNDP in 2008 in collaboration with MOEW and MOE. As part of this project, MOF is exploring fiscal incentives that can be adopted to encourage energy efficiency, renewable energy and better environmental practices. A number of measures have already been adopted by MOF including Article 83 in the 2010 proposed budget law stipulating full exemption from customs fees for Hybrid cars.

There have been substantial increases in allocations to energy efficiency in the 2011 budget proposal such as the governmental initiative for energy demand management[3] and the Lebanese Center for Energy Conservation. Additionally the MOF provides subsidized loans in four sectors (Agriculture, Hospitality, Information-Technology, and Industry) and for environmental and energy-related investments. Such loan programs are managed by the BDL.

Electricité Du Liban is the focal point of the Mediterranean Solar Plan. Launched in 2009, the program is sponsored by Egypt and France to introduce EE & RE projects in Eastern Mediterranean countries. Following a national stakeholder meeting organized by MOEW, Lebanon submitted 28 project proposals in 2010 (sponsoring countries have yet to release their selection results). EDL is also participating in the domestic DSHW program (discussed in Section 9.3).

Banque Du Liban is closely cooperating with MOEW on the National Energy Efficiency and Renewable Energy Account (NEEREA) (discussed in Section 9.3). In particular, it has endorsed several loan structures that encourage cleaner production and renewable energy.

9.2.7.2 Programs and Institutions

Lebanese Center for Energy Conservation (LCEC)

Established in 2002, the Global Environment Facility funded the Lebanese Center for Energy Conservation Program (LCECP) which is currently hosted at the Ministry of Energy and Water and managed by UNDP. Recently registered under the name of Lebanese Center for Energy Conservation (Attestation No. 172 dated 27/1/2011), the organization addresses end-use energy conservation and renewable energy at the national level by supporting the Government of Lebanon in developing and implementing national strategies that promote energy efficiency and renewable energy at the consumer level. LCEC is a financially and

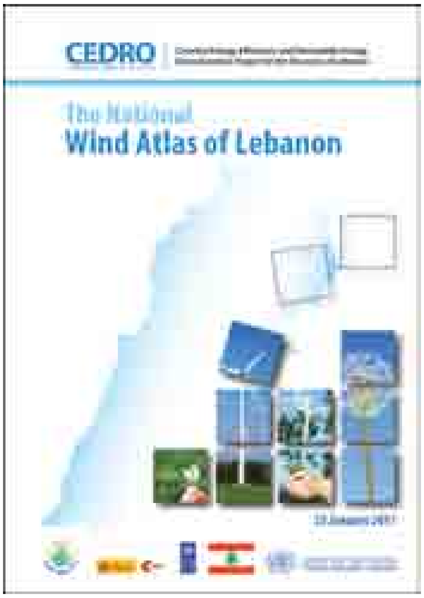
[3] المبادرة الحكومية لترشيد الاستهلاك

administratively independent and operates under the direct supervision of the Minister of Energy and Water. http://www.lcecp.org.lb/

The LCEC has achieved the following:

- Conducted energy audits for 117 sites covering all sectors (2007-2009) including commercial facilities, hotels, hospitals, industrial facilities, schools and university campuses.
- Installed 500 DSWH in the liberated areas of south Lebanon (2005-2006), donated by the Chinese Government. LCEC provided technical and financial support for installing these units and trained more than 40 stakeholders with Chinese experts. A follow-on program is underway to replace the systems that were damaged by war in 2006.
- Conduct extensive energy saving public awareness campaigns (since 2007). Slogans have included "some turn-offs do save", "don't burn your money to heat water, solar energy is free", "Flex your muscle", "One click is enough" and "save the energy and keep the light".
- Piloted the installation of CFL in Niha (Bekaa) in cooperation with Electricité de Zahlé. Eighteen months after installation, a survey showed 80 percent consumer satisfaction among participating households and 8.5 percent in energy savings. Building on the CFL pilot project, MOEW-LCEC launched a project to replace free-of-charge 3 million, 100W incandescent lamps with 23W CFL lamps. This project will target 1 million homes and cost $4.3 million (GOL).
- Launched the Energy Efficiency house doctor project with MEDCO (hydrocarbon importer). The project (on-going) performs free energy audits in the homes of MEDCO clients and advises homeowners on possible EE and RE measures to reduce the energy bill. Related to this, the LCEC is preparing Minimum Efficiency Performance Standards for Appliances. The initiative will set efficiency labels for CFL, DSWH, electric water heaters, unitary air conditioners and refrigerators.
- Managed the DSWH project "One DSWH for every house" aiming at installing no less than 1 million m^2 of collectors by 2020. LCEC is handling awareness campaigns, certification of DSWH suppliers, setting up of a testing facility at IRI as well as capacity building campaign.
- Prepared of the energy conservation law to be submitted to parliament in 2011.

Country Energy Efficiency & Renewable Energy Demonstration Project for the Recovery of Lebanon (CEDRO) is an MOEW/MOF/MOET/LRF/CDR/UNDP partnership created in 2007 with a five-year mandate and a budget of $9.73 million funded by the Lebanon Recovery Fund by means of a donation from Spain. Its aim is to promote energy efficiency and renewable energy in Lebanon through awareness, capacity building, market incentives for EE and RE installations, as well as country-wide research and development activities. CEDRO has to date installed dozens of large Domestic Solar Water Heater (DSWH) systems in public schools, government hospitals, government buildings, Lebanese Army barracks, and ISF's Roumieh Prison. DSHW systems vary in size between 2,000 and 12,000 liters. In total, CEDRO has tendered some 95,000 m^2 of DSHW systems and 80 KWp capacity of PV. CEDRO also initiated and financed several national milestone research documents related to RE including (1) the national bio-energy strategy that shed the light on available bioenergy resources in the country, and (2) a national Wind Atlas, released in January 2011, that establishes an understanding of the dominant wind regimes (onshore & offshore) in the country, essential to determine best areas to build wind farms in the future. www.cedro-undp.org



Lebanese Cleaner Production Centre (LCPC)
LCPC has been established in 2002 by MOE with grant funding from the European Commission and the Austrian Government through UNIDO. After an initial hosting period at MOE, the LCPC was relocated to the Industrial Research Institute (IRI) in 2004. The centre provides assistance to Small- and Medium-Sized Enterprises (SME's) in adopting Cleaner Production (CP) measures

and sustainable industrial production modes that will reduce consumption of water, energy, etc., decrease pollutants emissions, effluent loads and waste –*see more details on the LCPC in Chapter 4 (Air Quality)*.

Order of Engineers and Architects in Beirut
The OEA co-organizes, sponsors and funds frequent seminars and events related to EE and RE including the "Energy Week" and the "Sustainability Week". OEAB actively contributed to the drafting of two thermal standards, it also commissioned the Lebanese Green Building Council (LGBC) to review the LBC to include EE & RE provisions. The World bank and the MOE are also involved in this project

Non-Governmental Organizations
Several NGOs are involved in the energy sector in Lebanon including the *Association Libanaise pour la Maitrise de l'Energie* (ALMEE), the *Lebanese Solar Energy Society* (LSES), the *Lebanon Green Building Council* (LGBC), etc. The LGBC is a non-profit organization, founded in 2008 by a group of Lebanese architects, engineers and academics to promote sustainability in the built environment in Lebanon. The ambition of LGBC is to contribute and develop new construction standards in the country in collaboration with governmental organizations, municipalities, the OEAB, LIBNOR, universities and other buddies. Today, LGBC has 55 members and links with different national and regional green building councils. LGBC has applied for membership of the World Green Building Council (WGBC). The council, through its partnership with the International Finance Corporation, has developed the ARZ green building rating system, adapted for Lebanon.
http://www.almee.org
http://www.lebanon-gbc.org

9.3 POLICY OUTLOOK AND THE WAY FORWARD

Decoupling Lebanon's socio-economic development from the environmental impact of energy utilization could be achieved practically through three main axes namely:

- Switch to cleaner sources of energy including renewable.
- Implement energy efficiency in all major sectors of the economy, mainly electricity production, tertiary sector, transportation, industry & agriculture.
- Adopt more frugal lifestyles.

Many plans are already in the offing in Lebanon to shape up its energy sector; they will be the subject of this section, most fall in line with the first two recommendations mentioned above. The third recommendation is a rather sensitive issue that will not be discussed in this report.

9.3.1 Changing the Energy Mix

Moving away from dirty fuels by seeking a cleaner energy mix will curb pollutant emissions in Lebanon (see Box 9.6). Dirty fuels like HFO impact Lebanon on two counts. They engender local atmospheric pollution, which may cause illnesses especially among children living in the vicinity of fuel burning plants. Second, dirty fuels inflate the carbon intensity of the economy, as well as contribute to global GHG emissions.

Box 9.6 The European experience

Many European countries are switching their energy mix to natural gas to meet their 20 percent GHG emission reduction target by 2020 (calculated against the 1990 baseline). This switch is displacing coal on a large scale.

Table 9.9 Share of energy sector in Lebanon CO_2eq emissions (Ggr) 2000 – 2006

	2000	2001	2002	2003	2004	2005	2006
TNE	18,507	19,311	19,632	19,811	20,300	19,143	18,171
ESE	13,786	14,967	14,892	14,836	14,955	14,254	13,098
%	74.5%	77.5%	75.9%	74.9%	73.7%	74.5%	72.1%

TNE: Total national emissions, **ESE**: Energy sector emissions (both expressed as CO_2eq)
Source: MOE/GEF/UNDP 2010u

Because Lebanon's energy sector is responsible for 75 percent of the emissions of the three most important GHGs (CO_2, N_2O and CH_4 expressed as CO_2eq), it is only fitting to address this sector first. Changing the energy mix will reduce the carbon footprint of the Lebanese economy as well as the atmospheric pollution resulting from the burning of dirty fuels like HFO and LFO (Chaaban *et al.* 2003).

Among the recommended reform measures that resulted from Paris III, was the proposal to switch the Beddawi plant to piped NG and Zahrani plant to LNG. Even though LNG is more expensive than piped NG by around 30% (US¢9/kwhr compared to US¢7/kwhr) it is still way cheaper than gasoil (US¢14/kwhr) (WB, 2008). The bottom line is that replacing gasoil by NG whether in gas or liquid form makes economic and environmental sense on three counts:

(1)The CO_2 emission factor for NG (17.2 tC/Tj) is respectively about 18 & 15 percent lower than that of HFO (21.1 tC/Tj) and LFO (20.2 tC/Tj). (IPCC 1996)

(2)More importantly, local pollution from NG burning is minimal. In particular, its sulfur content is negligible and NG combustion in a properly operating plant will not emit aerosols, carbon soot, solid particles, vanadium oxides and other harmful products. By contrast, almost 99 percent of Lebanon's national SO_2 emissions estimated at 97,000 tons in 2004 come from the energy sector and more specifically from the burning of HFO and LFO. (MOE; 2000-2006). During the operation of gaz turbine II on NG in Beddawi, the operators noticed a much smoother and less noisy operation than when the gas turbine was running on gasoil.

(3)Operating the CCGT plants in Lebanon on NG instead of gasoil will save huge amounts of money. It was already mentioned in section 9.2.4 above (electricity sector) that GOL made a saving of around $130 million by just running 50% of Beddawi plant on piped NG for the period between November 2009 and November 2010. Actually, the expected savings of running 100% of the plant on NG amount to some $330 million yearly (WB 2008). Using LNG to run Zahrani will save $200 million/year at the worst of estimates (WB 2008) enough to recover the LNG terminal cost in two years. The case of Zahrani and Beddawi is a good example how short sighted governance driven by self interest and without any consideration for energy availability issues can lead to disastrous financial implications. Lebanon is squandering yearly no less than $550 million as a result of burning very expensive gasoil in its plants instead of much cheaper NG.

However one should note that changing the hydrocarbon mix keeps Lebanon fully dependant on outside sources to meet its energy demand unless local hydrocarbon production is achieved through oil/gas exploration thus partially or fully solving the energy availability /security issue.

9.3.2 Reshaping the Electricity Sector

The Policy Paper for the Electricity Sector (PPES) mentioned previously presents a detailed plan to revamp the electricity sector in Lebanon. It addresses both supply and demand-side management issues. Such a policy must incorporate environmental and socio-economic considerations prior to implementation. This can be achieved by conducting a Strategic Environmental Assessment of the PPES, which is an indispensable step in policy setting and formulation. The Policy Paper is articulated along three strategic areas and formulates actions over three time horizons (short 2010-2012, medium 2012-2014, and long term 2015 and beyond):

(1)Infrastructure: Electricity generation, transmission and distribution.

(2)Supply and demand: choice of fuel and outsourcing, RE, EE, and tariffs.

58 substations are spread all over Lebanon.- Ksara substation

(3)Legislation: norms and standards, corporatization of EDL, and legal status.

On the **generation side**, the goal is to achieve 4,000 MW of generating capacity by 2014 through new thermal power plants (2,200 MW), rehabilitation of Zouk and Jieh (100 MW) and upgrade of Beddawi, Zahrani, Baalbeck & Tyr (145 MW). The policy paper also aims to increase hydropower by 40 MW, harvest 60-100 MW of wind power and 15-25 MW through waste-to-energy plants. Consequently, at least 2600 MW of added capacity will be implemented in partnership with the private sector (Independent Power Producers).

On the **transmission side**, within the coming two years the 220 KV Mansourieh loop which has been pending for some years will be closed, the 400 KV Ksara substation infrastructure will be completed and the Lebanese Electricity National Control Centre implemented (this will remove major bottlenecks that were the source of technical losses and improve the reliability and stability of the system). Moreover, additional substations and transmission lines are planned all over the Lebanese territory.

On the **distribution side,** the policy paper envisions that the sector will mostly rely on the private sector which will introduce the necessary improvements within the coming three years like automatic metering and billing, remote connection and disconnection, feed-in tariffs, prepaid cards, smart grid strategies, etc.

In short, the PPES aims to switch the energy mix from polluting fuels to LNG, increase electricity generation efficiency and promote renewable and alternative energy sources. To implement the switch, Lebanon would need to build an off-shore LNG terminal at Selaata or Zahrani and connect all the power stations in the country with a land (or subsea if necessary) pipeline extending from Beddawi to Sour. The pipeline will follow the railway track to limit expropriation costs, and would eventually also feed industrial, commercial, and residential facilities (City Gas). It could in the future also support a Natural Gas Vehicle initiative (2010-2012) –see *Chapter 4 Air Quality* for more details on the switch to hybrid electric, fuel cell/Hydrogen and Natural Gas vehicles in section 4.4.2. The energy switch would not only make the energy mix in Lebanon more acceptable (cleaner) but also more economical.


Old distribution transformers located in EDL repair shop and graveyard (Bauchrieh)

9.3.3 Renewable Energy and Energy Efficiency

At the Copenhagen climate conference, Lebanon officially pledged to meet 12 percent of its energy consumption from renewable energy sources, by 2020. However it was not made clear whether the stated percentage covers primary energy, final energy or only electrical energy. The PPES is also ambiguous when it states that the policy aims to achieve 12 percent RE contribution to *"electrical and thermal supply"* (PPES Section 5).

Even if only electrical energy supply is targeted, 12% coverage by RE is an extremely ambitious goal especially for a country that has still to make important outlays to rehabilitate a deficient electricity sector. Assuming an average yearly growth rate of 3 percent in electricity demand (WB 2008), RE would need to supply by 2020 some 2,400 GWhr per annum, the equivalent of 206 kTOE.

RE will be a tremendous advantage as it contributes to solving two of the thorniest issues facing the energy sector in Lebanon namely energy security and energy acceptability. The spectrum of available technologies envisaged is quite wide including Wind Turbines (WT), Photo-Voltaics (PV), Domestic Solar Water Heaters (DSWH), waste to energy and geothermal heat pumps.

Already many initiatives are being implemented to favor the penetration of these technologies in the Lebanese market. They fall under the umbrella of the National Energy Efficiency Action Plan (NEEAP) which is currently debated for adoption by GOL. Funding will be mainly covered by the National Energy Efficiency and Renewable Energy Account (NEEREA) a joint cooperation between BDL, UNDP, the EU, MOEW-LCEC, Lebanese banks and private investors. The Account has been allocated €24 million in EU grants and is expected to leverage $100 million from the local market to be invested in energy efficiency, renewable energy, and green building projects. The following key provisions and projections are included in the NEAAP:

- Some 100 MW of wind turbines farms are planned by 2014 at a total cost of $115 – $190 million. The Wind Atlas of Lebanon, completed and launched under the supervision of CEDRO, will make available much needed data that will boost WT installation in Lebanon. According to the wind atlas, the potential installed onshore wind power capacity has been calculated as 6.1 GW based on the wind speed at 80m above ground level, a number of high level assumptions and constraint data supplied (refer to the national wind atlas for more information on wind maps onshore & offshore).
- The DSWH campaign "One DSWH for every house" has already been launched. It is planned that 190,000 m^2 of DSWH will be installed by 2014. Annual sales of 50,000m^2 are expected by that year with subsequent growth to reach 1,050,000m^2 by 2020, five folds the current installed capacity of 210,000m^2. It is targeted to practically retrofit all buildings in Lebanon with DSWH, a huge challenge considering that no less than 80% of Lebanon population lives in cities where building roofs are cluttered with all sorts of equipment or turned into gardens. MOEW will subsidize this program to the tune of $200 per grant for the first 7,500 applications. The units will be financed at 0 percent interest rate over a 5 year period (BDL Circular 236, November 2010), payments shall be made through the electricity bill.

Renewable energy (rooftop solar water heaters)

- On the PV front, NEEAP calls for some 100-200 MW of PV farms by 2013. As described earlier, CEDRO already completed 40 KWp of PV projects and plans to install another 40 KWp in 2011.
- Some 100 MW of hydro and micro-hydro projects are contemplated by 2015 at an approximate cost of $500 million, with significant private sector investment.
- Decentralized WT and PV installations at the consumer premises. Contemplated installed power varies between 50-100 MW at a total cost of $250 - $500 million through long term loans to citizens.
- Geothermal and waste to energy projects (See Section 8.3) are expected to generate 15-25 MW at a total cost ranging from $30-$50 million. CEDRO is already experimenting with one small scale geothermal project in Beji village. Here it may be worthwhile noting that waste to energy projects, adopted in decision 55/2010 by the council of ministers, need careful consideration taking into account the environmental implications of burning waste even if at very high temperatures.
- Legislation is currently being considered to introduce Feed in Tariffs (FIT) mechanisms in the Tariff system of EDL. Feed in tariffs imply that consumers will be able to generate power and inject it in the grid at a benefit. FIT will go a long way towards removing economic barriers to use PV and wind turbines. FIT systems are currently being actively assessed by CEDRO which is lobbying together with LCEC for its implementation.
- Net metering is another mechanism that will allow consumers to inject generated power at their premises into the grid. However unlike FIT, the consumer will be charged the net balance of electric energy supplied and consumed. Again CEDRO and LCEC are the main actors lobbying for the introduction of net metering in the tariff system of EDL. However, the present legislative framework related to the

electricity sector should be revised to allow small private entities to generate electricity and sell it to the utility.

Of course, the NEEAP will not materialize and its proposed projects will not succeed without a sustained commitment from decision makers and improved environmental governance.

9.3.4 Clean Development Mechanism

The Clean Development Mechanism (CDM), defined in Article 12 of Kyoto Protocol (a protocol to the UNFCCC) allows a country (Annex I and Annex B Parties), with an emission-reduction or emission-limitation commitment under the Kyoto Protocol, to implement an emission-reduction project in Non-Annex I countries including Lebanon. Such projects can earn saleable certified emission reduction (CER) credits, each credit equivalent to one tonne of CO_2, which can be counted towards meeting Kyoto targets. Recently, the MOE issued Decision 176/1 (dated 28/10/2010) to "Review proposed projects submitted under the CDM of the Kyoto Protocol" which outlines the required steps to apply for CDM projects and obtain MOE approval prior to sending the documents to the CDM Executive Board (in Germany). Despite some emission reduction potential (renewable energy, energy efficiency, fuel switching, etc.), Lebanon has not been very active on the CDM scene. In fact, the country missed a considerable opportunity by not applying for CDM credits in connection with the switch from gasoil to Natural Gas at the Beddawi power plant. In 2008, one proposal was submitted related to a Landfill Gas project (53,000 tCO2e/year) but without success. Currently, the MOE is reviewing several CDM projects including the distribution of three million Compact Fluorescent Lamp project by the MOEW and LCEC, the installation of SWHs in urban and semi-urban areas by a Lebanese private company and several other projects by Lebanese private industries that have showed interest in the CDM market.

9.3.5 Towards Greener Buildings

The National Energy Efficiency Action Plan also addresses the building sector. The framework document to make things happen will be the Draft Energy Conservation Law which is currently in review for submission to parliament for approval in 2011. The draft law aims to provide MOEW a framework for mainstreaming EE & RE activities in Lebanon, and will institutionalize the LCEC as the lead energy entity in the country for the management of EE & RE activities. The draft law proposes:

1. Conducting obligatory and periodic energy audits
2. Evaluating and assessing of energy intensive projects
3. Hiring the services of energy auditors or energy services firms
4. Energy Labeling of products, machines, equipment and electrical appliances
5. Energy saving in both the private and public sector
6. Agreements between LCEC and institutions who want to invest in energy conservation
7. Tax exemptions for EE & RE equipment

If implemented, the Energy Conservation Law will create a dynamic market for energy audit firms, improve the energy efficiency of the Lebanese economy, spread technological know-how, and introduce best practices in energy efficiency. Green buildings are yet to gain foothold in Lebanon. The concept is still neither widely widespread nor properly understood. Green buildings consume fewer resources and provide healthier living and working environments.

Currently and in addition to ARZ, the national green building rating system, several internationally recognized green building rating systems are also being introduced in Lebanon chief among them are the US based Leadership in Energy and Environmental Design (LEED) as well as the British based Building Research Establishment Environmental Assessment Method (BREEAM). The widespread implementation of green building practices will go a long way towards sensibly reducing the environmental footprint of the Lebanese economy considering that the building sector is one of its major components and the biggest resources and energy consumer.

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CITED LEGISLATION RELATED TO ENERGY CRISIS

نوع النص	الرقم	التاريخ	عنوان النص
مرسوم اشتراعي	١٤٨	١٩٨٣/٠٩/١٦	قانون البناء
قانون	٢١٦	١٩٩٣/٠٤/٠٢	إحداث وزارة البيئة
قانون	٣٥٩	١٩٩٤/٠٨/٠١	إتفاقية الأمم المتحدة بشأن تغير المناخ
قرار وزير البيئة	١/٥٢	١٩٩٦/٠٧/٢٩	تحديد المواصفات والنسب الخاصة للحد من تلوث الهواء والمياه والتربة
قرار وزير النفط	٥٦	١٩٩٧/٠٧/٢٥	تحديد مواصفات المشتقات النفطية
قرار وزير البيئة	١/٨	٢٠٠١/٠١/٣٠	المواصفات والمعايير المتعلقة بملوثات الهواء والنفايات السائلة المتولدة عن المؤسسات المصنفة ومحطات معالجة المياه المبتذلة
قرار وزير البيئة	١/٥	٢٠٠١/٠١/١٢	الشروط البيئية لرخص إنشاء و/أو استثمار محطات توزيع المحروقات السائلة
قانون	٤٦٢	٢٠٠٢/٠٩/٠٢	تنظيم قطاع الكهرباء
قانون	٤٤٤	٢٠٠٢/٠٧/٢٩	حماية البيئة
مرسوم	٨٤٤٢	٢٠٠٢/٠٨/١٣	يتعلق بمواصفات البنزين ٩٢ و ٩٥ و ٩٨ اوكتان من دون رصاص والديزل اويل (المازوت) لاستخدامها في المركبات الآلية
قانون	٦٤٦	٢٠٠٤/١٢/١١	تعديل المرسوم الاشتراعي رقم ١٤٨ تاريخ ١٩٨٣/٩/١٦ (قانون البناء)
مرسوم	١٥٨٧٤	٢٠٠٥/١٢/٠٥	المرسوم التطبيقي لقانون البناء
قانون	١٣٢	٢٠١٠/٠٩/٠٢	الموارد البترولية في المياه البحرية
قرار وزير البيئة	١/١٧٦	٢٠١٠/١٠/٢٨	الية مراجعة المشاريع المقدمة ضمن الية التنمية النظيفة التابعة لبروتوكول كيوتو

ANNEX 1 OIL SLICK UN RESOLUTIONS (2006-2010)

UN General Assembly Resolutions					
Resolution Clause	61/194 of 20 December 2006 Sixty first session	62/188 of 19 December 2007 Sixty second session	63/211 of 19 December 2008 Sixty third session	64/195 of 21 December 2009 Sixty fourth session	65/147 of 20 December 2010 Sixty fifth session
1	Expressed deep concern over the adverse implications of the destruction by the Israeli Air Force of the Jiyeh oil storage tanks	Took note of the report of the Secretary General on the implementation of General Assembly resolution 61/194 on the oil slick on Lebanese Shores	Took note of the report of the Secretary General on the implementation of General Assembly resolution 62/188 on the oil slick on Lebanese Shores	Took note of the report of the Secretary General on the implementation of General Assembly resolution 93/211 on the oil slick on Lebanese Shores	Took note of the report of the Secretary General on the implementation of General Assembly resolution 64/195 on the oil slick on Lebanese Shores
2	Considered the oil slick had heavily polluted the shores of Lebanon	Expressed deep concern over the adverse implications of the destruction by the Israeli Air Force of the Jiyeh oil storage tanks	Expressed deep concern over the adverse implications of the destruction by the Israeli Air Force of the Jiyeh oil storage tanks	Expressed deep concern over the adverse implications of the destruction by the Israeli Air Force of the Jiyeh oil storage tanks	Expressed deep concern over the adverse implications of the destruction by the Israeli Air Force of the Jiyeh oil storage tanks
3	Requested from the Government of Israel (GOI) to assume responsibility for prompt and adequate compensation to the Government of Lebanon (GOL) for the costs of repairing the environmental damage	Considered the oil slick had heavily polluted the shores of Lebanon	Considered the oil slick had heavily polluted the shores of Lebanon	Considered the oil slick had heavily polluted the shores of Lebanon	Considered the oil slick had heavily polluted the shores of Lebanon and partially polluted Syrian shores
4	Encouraged Member States, regional and international organizations, financial institutions, NGO and the private sector to provide financial and technical assistance to the GOL in support of its efforts to clean up the polluted shores and sea of Lebanon	Requested from Government of Israel (GOI) to assume responsibility for prompt and adequate compensation to the Government of Lebanon (GOL) for the costs of repairing the environmental damage	Requested from Government of Israel (GOI) to assume responsibility for prompt and adequate compensation to the Government of Lebanon (GOL) for the costs of repairing the environmental damage	Requested from Government of Israel (GOI) to assume responsibility for prompt and adequate compensation to the Government of Lebanon (GOL) for the costs of repairing the environmental damage	Requested from Government of Israel (GOI) to assume responsibility for prompt and adequate compensation to the Government of Lebanon (GOL) for the costs of repairing the environmental damage

UN General Assembly Resolutions					
Resolution Clause	61/194 of 20 December 2006 Sixty first session	62/188 of 19 December 2007 Sixty second session	63/211 of 19 December 2008 Sixty third session	64/195 of 21 December 2009 Sixty fourth session	65/147 of 20 December 2010 Sixty fifth session
5	Requested from the Secretary General to submit to the General Assembly at its sixty second session a report on the implementation of the present resolution under the item entitled "Sustainable development"	Appreciated efforts of GOL, Member States, regional and international organizations, financial institutions, NGO and the private sector in the initiation of clean-up and rehabilitation operations on the polluted shores and encourage above-mentioned entities to continue their financial and technical support to the GOL towards completion of clean-up and rehabilitation operations with the aim of preserving the ecosystem of Lebanon and that of the Eastern Mediterranean Basin	Appreciated efforts of GOL, Member States, regional and international organizations, financial institutions, NGO and the private sector in the initiation of clean-up and rehabilitation operations on the polluted shores and encourage above-mentioned entities to continue their financial and technical support to the GOL towards completion of clean-up and rehabilitation operations with the aim of preserving the ecosystem of Lebanon and that of the Eastern Mediterranean Basin	Appreciated efforts of GOL, Member States, regional and international organizations, financial institutions, NGO and the private sector in the initiation of clean-up and rehabilitation operations on the polluted shores and encourage above-mentioned entities to continue their financial and technical support to the GOL towards completion of clean-up and rehabilitation operations with the aim of preserving the ecosystem of Lebanon and that of the Eastern Mediterranean Basin	Requests the Secretary-General to give further consideration to the option of examining the potential role of the United Nations Compensation Commission in securing the relevant compensation from the Government of Israel
6		Called for the mobilization of international technical and financial assistance through donor support for the creation of an Eastern oil spill restoration fund, based on voluntary contribution, to support the integrated environmentally sound management from the clean-up to safe disposal of oily waste	Decided to establish an Eastern Mediterranean Oil Spill Restoration Trust Fund (EMOSRTF) , based on voluntary contributions, to provide assistance and support to the States directly affected in their integrated environmentally sound management from the clean-up to safe disposal of oily waste resulting from the destruction of oil storage tanks at Jiyeh power plant and requested from the Secretary General to implement this decision before the end of the sixty third session of the General Assembly	Reaffirmed its decision to establish an EMOSRTF to provide assistance and support to the States directly affected in their integrated environmentally sound management from the clean-up to safe disposal of oily waste resulting from the destruction of oil storage tanks at Jiyeh power plant and requested from the Secretary General to continue working towards the hosting and operationalization of the Trust Fund and finalize the implementation of this decision before the end of the sixty fourth session of the General Assembly	Reiterates its appreciation for the efforts of the GOL and those of Member States, regional and international organizations and institutions, non-NGOs and the private sector in the initiation of clean-up and rehabilitation operations on the polluted shores, and encourages Member States and the above-mentioned entities to continue their financial and technical support to the GOL towards achieving the completion of clean-up and rehabilitation operations

UN General Assembly Resolutions					
Resolution Clause	61/194 of 20 December 2006 Sixty first session	62/188 of 19 December 2007 Sixty second session	63/211 of 19 December 2008 Sixty third session	64/195 of 21 December 2009 Sixty fourth session	65/147 of 20 December 2010 Sixty fifth session
7		Requested from Secretary General to submit to the General Assembly at its sixty third session a report on the implementation of the present resolution under the item entitled "Sustainable development"	Invited States, intergovernmental organizations, NGO and the private sector to make voluntary financial contributions to the Trust Fund and requested from Secretary General to mobilize international technical and financial assistance to ensure that the Trust Fund has sufficient and adequate resources	Invited States, intergovernmental organizations, NGO and the private sector to make voluntary financial contributions to the Trust Fund and requested from Secretary General to mobilize international technical and financial assistance to ensure that the Trust Fund has sufficient and adequate resources	Welcomes the agreement of the Lebanon Recovery Fund to host the EMOSRTF, based on voluntary contributions, to provide assistance and support to the States directly adversely affected in their integrated environmentally sound management, from clean-up to safe disposal of oily waste, of this environmental disaster
8			Requested from Secretary General to submit to the General Assembly at its sixty fourth session a report on the implementation of the present resolution under the item entitled "Sustainable development"	Requested from Secretary General to submit to the General Assembly at its sixty fifth session a report on the implementation of the present resolution under the item entitled "Sustainable development"	Invites States, intergovernmental organizations, NGOs and the private sector to make voluntary financial contributions to the EMOSRTF, and in this regard requests the Secretary-General to mobilize international technical and financial assistance, to ensure that the Trust Fund has sufficient and adequate resources, since Lebanon is still engaged in the treatment of wastes and the monitoring of recovery;
9					Recognizes the multidimensionality of the adverse impact of the oil slick, and requests the Secretary-General to submit to the General Assembly at its sixty sixth session a report on the implementation of the present resolution under the item entitled "Sustainable development".

Section IV: The Outlook - Towards 2020

10 The Future Today

Authors
ECODIT SOER Team

ABBREVIATIONS & ACRONYMS

AUB	American University of Beirut
COM	Council of Ministers
DGCA	Directorate General of Cadastral Affairs
EDL	Electricité Du Liban
EIA	Environmental Impact Assessment
EPA	Environment Protection Agency
GBA	Greater Beirut Area
GDP	Gross Domestic Product
GEF	Global Environment Facility
GEO	Global Environment Outlook
GOL	Government of Lebanon
HCUP	Higher Council of Urban Planning
IRI	Industrial Research Institute
LARI	Lebanese Agricultural Research Institute
LCEC	Lebanese Center for Energy Conservation
LCPC	Lebanese Cleaner Production Center
MOA	Ministry of Agriculture
MOE	Ministry of Environment
MOEW	Ministry of Energy and Water
MOF	Ministry of Finance
MOI	Ministry of Industry
MOIM	Ministry of Interior and Municipalities
MOPH	Ministry of Public Health
MOPWT	Ministry of Public Works and Transport
NCSR	National Center for Scientific Research
NEAP	National Environmental Action Plan
NGO	Non-Governmental Organization
PA	Protected Areas
SEA	Strategic Environmental Assessment
TEDO	Tripoli Environment and Development Observatory
UNDP	United Nations Development Program
UOB	University of Balamand
USEK	Université Saint Esprit Kaslik
USJ	Université Saint Joseph
WWTP	Wastewater Treatment Plant

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This chapter builds on previous chapters by exploring how current social, economic and environmental trends may unfold along divergent development paths in the future, and what this might mean for the environment, development and human well-being. It presents two scenarios to the year 2020, using narrative storylines and qualitative data to explore different policy approaches and societal choices. While the chapter is inspired by the Global Environment Outlook process, it departs from the process in several ways. In particular, the 2010 SOER uses only two scenarios (GEO 4 uses four); it focuses on specific policies and societal choices already discussed in the report (GEO 4 uses a suite of advanced global and regional models including International Futures, IMAGE, IMPACT, WaterGAP, LandSHIFT, Ecopath with Ecocism, etc.); and it examines future environmental change in Lebanon only (GEO 4 offers regional and global analysis).

10.1 ABOUT THE SCENARIOS

The GEO process has crafted four scenarios to predict the future state of the environment: *Market First*, *Policy First*, *Security First*, and *Sustainability First*. The 2010 SOER has selected and adapted two of these scenarios:

Market First. This would be equivalent to Business As Usual whereby market forces continue to dominate government policies and societal choices. With active government support, the private sector continues to pursue maximum economic growth as the best path to improve the environment and human well-being. There is little focus on the broader human-environment system. Technological fixes to environmental challenges are emphasized at the expense of other policy interventions and some tried-and-tested solutions.

Sustainability First. Government, civil society and the private sector work collaboratively to improve the environment and human well-being, with a strong emphasis on equity. Equal weight is given to environmental and socio-economic policies, and accountability and transparency are stressed across all actors. The Government works proactively to implement the recommendations and agreements of the Rio Earth Summit and all related multilateral environmental agreements affecting the environment (BSP, UNFCCC, UNCCD, Stockholm, etc.). Emphasis is placed on developing effective public-private sector partnerships not only in the context of projects but also in governance, ensuring that stakeholders across the spectrum of the environment-development discourse provide strategic input to policy making and implementation. There is an acknowledgement that these processes take time, and that their impacts are likely to be more long-term than short-term. Civil sector reform is the order of the day.

Both scenarios assume that Lebanon will (1) enjoy a period of political stability and relative government coherence, and (2) not experience any significant military confrontation or flare-ups. Additionally, the *Sustainability First* scenario assumes that Lebanon will (3) implement measures to mainstream the environment in selected economic sectors, and (4) move towards improved environmental governance and the rule of law. Table 10.1 presents general assumptions for each scenario based on a set of drivers and sub-drivers. Table 10.2 at the end of the chapter summarizes detailed assumptions for each chapter in the 2010 SOER.

The *Policy First* scenario introduces some measures aimed at promoting sustainable development, but the tensions between environment and economic policies are biased towards social and economic considerations. The *Security First* scenario focuses on the interests of a minority: rich, national and regional. It emphasizes sustainable development only in the context of maximizing access to and use of the environment by the powerful.


Credit: Christian Akhrass

Table 10.1 Overview of Drivers, Uncertainties, and Assumptions by Scenario

Driver and Sub-Driver	Markets First	Sustainability First
Governance		
Dominant actor and power balance	Private sector with strong government support; more power goes to the private sector	Balanced. Government, private sector, and civil society share power and influence decision making
Governance approach	Top-down (with emphasis on hierarchical structures)	Balanced. Bottom-up and top-down approaches
Level of public participation	Low public participation	High public participation
Priority	Maximum economic growth, with presumption that social and environmental concerns will realign with market forces	Social and environmental welfare with economic sufficiency
Mainstreaming of social & environmental policies	Low	High
Economic Growth		
GDP growth	Highest	Medium
Diversification	High towards services	High towards services
Privatization	Highest, no control	Medium with control
Demographic Growth		
Population growth rate	Moderate to high	Low to moderate
Immigration (expatriates and labor force)	Open, uncontrolled (market driven)	Partly controlled, with strong national substitution programs
Urbanization	High due to population growth rate, unplanned	Well planned, in sync with the NLUMP, stabilized in proportion to resources
Human Development		
Level of investment in education and health	Medium	Highest
Capacity building and training programs	Medium, left to market demands	Highest, well planned by leading government efforts
Environmental awareness	Medium, and ad-hoc subject to funding	Highest and integrated in mass media
Science & Technology		
Level and type of investment	High, but market driven by the private sector, for its own needs and problems, emphasis on profit	High, government and private sector, to solve mainly societal needs and problems (e.g., desalination technology)
General level of technological progress and Science infiltration into society	Low	Highest
Culture and Heritage		
Global culture homogenization	Highest	Wise! Diverse and accepting
Individualism vs. community focus	Individual	Community
Indigenous culture and Heritage retention	Eroded with conflicts (religious retreat)	Retained with least conflict
Regional Integration and Cooperation		
Type, level, and rate	Market driven (trade focus), medium to slow rate	Policy driven. Highest towards or approaching integration, fast rate
General Status	Worse	Best

10.2 MARKET FIRST – SCENARIO NARRATIVE

Environmental governance does not improve markedly. Key environmental laws and decrees (environmental prosecutor, environmental police, environmental impact assessment, environmental fund, etc.) are either approved/enacted but not implemented, or have yet to be approved/enacted. The Parliamentarian Committee for Environment convenes irregularly, to respond to emerging issues and priorities (waste management contracts, spills, pollution, fires, etc.) but their work is often blurred by other national issues gripping the country (privatization, oil exploration, security, etc.). The ability of the Ministry of Environment and other line ministries and intergovernmental agencies to enforce environmental regulations is weak. Stop-and-go work planning by the MOE is affected by ministerial cabinet reshuffles and the National Environmental Action Plan does not crystallize. Patron-client relationships prevail in many sectors including construction, energy and industry. Leading public research organizations (IRI, LARI, NCSR, TEDO, LCEC, etc.) as well private environmental institutions located on university campuses (AUB, UOB, USJ, USEK, etc.) continue their work as usual, subject to funding availability and research priorities, with little interagency cooperation. Synergies among research organizations are only partially explored and pursued. Research and development is not always in sync with national environmental priorities. Access to environmental funding continues to depend on the goodwill of international development organizations and multilateral trust funds while the Government of Lebanon is unable or unwilling to divert and /or spend more resources on the environment.

Water resources will continue to dwindle over the next decade. Recent impacts of climate change on weather patterns including decreasing precipitation, receding snowline and shorter snow period, will reduce groundwater recharge and net exploitable resources. Annual water demand will increase from about 1,473 Mm^3/year to about 2,055 Mm^3/year (projection by the World Bank). While government efforts to build and complete water systems including dams and networks will achieve noteworthy results, the concomitant lack of progress in protecting water sources from large scale mountain developments, industrial effluent, wastewater discharge and waste disposal offsets the impact of such public expenditure in the water sector. The groundwater table will drop further in the Bekaa Valley and other major agricultural regions. Seawater intrusion in coastal areas will also increase rendering it unsafe for irrigation. The Awali-Beirut water conveyance project will alleviate water stress in the Greater Beirut Area and reduce water rationing. Significant progress in the implementation of the national wastewater treatment plants (at least 5 new coastal WWTPs will come online by 2020) bodes well for the marine environment but at least two plants provide only pre-treatment and regional Water Establishments are unable to operate the new facilities. Outsourcing to the private sector is the preferred option but financing is lacking. The completion of at least four WWTPs in the Litani River basin reduces the environmental load entering the river system. The National Water Sector Strategy begins to show results but political commitment to forge ahead is lacking. Capital investment envisioned during the period 2011-2015 is only partially completed. The institutional reform defined under Law 221/2000 makes some headway but is not yet complete.

Air quality in Lebanon deteriorates slightly over the coming decade, due to increasing emissions from the transport, industry, and energy sectors. Annual vehicle registration increases by 5 percent annually (from 106,959 in 2008 to almost 200,000 in 2020). In the private car category, small fuel-efficient cars assume a bigger market share but gas-guzzling 4x4s are still prevalent and trendy. Emissions from energy industries increase but electricity production is gradually becoming more efficient thanks to a partial shift in the country's energy mix (from dirty fuels to cleaner fuels such as Nitrogen Gas and Liquid Nitrogen Gas). Sulfur emissions also decline because of stringer sulfur content standards, and improved inspection measures. Emissions from industries experience little change, if any, because pollution abatement initiatives by relevant ministries and the World Bank are offset by higher production and industrial output. The draft Law on the Protection of Air Quality (prepared in 2005) is not approved. Private electricity generation (20% in 2010) begins to drop thanks to higher energy production by EDL but power outages and rationing is still widespread. The ban on indoor smoking in public areas and government buildings is partially enforced. Lebanon's air quality monitoring capabilities improve but continue to rely on ad-hoc sources of funding to generate and share air quality data in a timely fashion. The Government approves and kick-starts the long-awaited taxi fleet renewal program but so far only 2,000 taxi owners have switched to hybrid or fuel-efficient cars. Mass transport is limited to low-capacity buses which are in dire need of renewal.

Lebanon's biodiversity and forests come under increasing pressure from anthropogenic sources and due to climate change. The country begins to experience species extinction. Among Lebanon's 94 endemic species, at least half are now considered rare and/or threatened. The forest cover (about 23% in 2004) does not change greatly but the share of Other Wooded Land increases at the expense of natural forests. Urban sprawl and haphazard urbanization all over the territory consumes and/or degrades natural forests and accelerates the fragmentation of important biological habitats. New coastal resorts and marinas degrade marine ecosystems further and Lebanon's fisheries (mostly artisanal) begin to experience noticeable decline in fish catch, prompting some fishmongers to invest in larger boats and more sophisticated fishing gear and equipment, with the approval of the MOPWT and the Lebanese Army. The Government does not acquire new aerial and ground fire-fighting equipment and the country continues to experience more intense forest fires during late summer and fall (at least 300 fires consume 4,000ha in 2020). The absence of law enforcement (Law 92/2010) and accountability continues to encourage acts of arson especially near urban areas. The Higher Council for Hunting makes earnest attempts to regulate and control the hunting sector. The hunting exam and insurance becomes mandatory for all hunters but hunting practices and malpractices continue unabated. A myriad of reforestation efforts (MOE's National Reforestation Plan, USFS's Lebanon Reforestation Initiative, GEF-UNDP's Safeguarding and Restoring Lebanon's Woodland Resources, NGOs, etc.) convert about 500ha into forests each year but the supply, distribution and selection of forest seedlings is not optimal. The draft Framework Law on Nature Reserves is still not approved. Lebanon declares several new protected areas bringing the total area under *legal* protection to 300Km^2 (up from 220Km2 in 2010) but the basis for declaring the areas protected is not clear and does not respond to ecological priorities. Improved ecosystem monitoring provides compelling evidence that climate change is stressing mountain ecosystems (e.g., recurrent spikes in the population of selected forest insects, increased incidence of dieback symptoms of key forest species at lower altitudes).

Land resources continue to face mounting pressure from anthropogenic sources. Population growth (from 4.2 million in 2010 including Palestinian refugees to about 4.6 million in 2020 assuming a 1% annual growth rate) will increase demand for housing. Much of this urban expansion occurs at the expense of agricultural land in the coastal zone and inland areas. Approved construction permits add approximately 10 million m^2 of floor space to the building stock every year, consuming 5km^2 of land area every year, 50km^2 by 2020. New housing development in mountain areas engenders new road construction in pristine habitats, degrading landscapes and mountain ecosystems. The current pace of change in land cover and land use continues. In particular, the total built-up area increases from 648km^2 in 1998 to almost 800km^2 in 2020. The Higher Council of Urban Planning approves new master plans covering five percent of the territory, bringing the total extent of zoning to about 21 percent. But the makeup of the HCUP and the methodology and procedures for preparing urban master plan remains unchanged. The National Land Use Master Plan is not mainstreamed into regional master plans.

The MOE continues to receive EIA studies for coastal development projects but is unable to introduce design changes to all projects equally to minimize environmental damages. The MOPWT approves the conditional use of the public maritime domain for at least a dozen new establishments and resorts. The Government is still undecided on the issue of settling illegal maritime properties. Lebanon's karst heritage comes under increasing pressure from quarrying and the construction sector, and several surface and underground karst formations are irreversibly damaged. The Lebanese Army clears 60 percent of the total area affected by unexploded cluster bombs in south Lebanon during the July 2006 war (about 20km^2 out of 35km^2). The Higher Council for Quarries makes earnest attempts to implement Decree 8803/2002 and its amendments but enforcement remains erratic. The MOE rehabilitates at least five quarries using the money deposited from bank guarantees, to serve as pilots, but the total value of bank guarantees remains derisory compared to the market value of aggregates. Little progress is achieved in declaring and managing Lebanon's first national park in the upper Dinnieh-Hermel region.

Urbanization intensifies over the next decade. Rural-urban migration accelerates in the absence of real growth opportunities outside major cities. Regional disturbances (financial crisis in Gulf countries) and conflicts (Ivory Coast and other African countries) encourage many expat Lebanese to return to their home country pushing property demand even higher, but at least seven percent of the housing stock is secondary housing (up from 5% in 2004). The rate of urbanization hits 90 percent by 2020 (up from 88% in 2010). Urbanization is primarily concentrated around urban poles (Tripoli, Saida, Baalbeck, Nabatiyeh, Zahle, etc.) but haphazard urbanization outside these areas continues unabated. At least 100 new high-rise towers mushroom in Beirut, changing the skyline, and erasing many cultural landmark buildings. The DGCA at the MOF makes significant progress in demarcating non-surveyed mountain lands but at least 35 percent of the territory has not been demarcated yet. Formal refugee camps and other informal settlements do not experience any change. The pace of construction of mountain resorts increases and most of these resorts escape the EIA and SEA process. Key environmental provisions in the urban planning (Legislative-Decree 69/1983) and construction laws (Law 646/2004) are not heeded nor implemented. There are no reported cases of construction permits revoked or denied based on environmental considerations and other natural hazards. Foreigners continue to buy and sell property in Lebanon, with relative ease, depriving the state of hundreds of millions of dollars in capital gain tax. Haphazard urbanization continues to impact groundwater recharge (from relentless excavation) and air quality (mostly from cement industry), infringes on fertile agricultural land, clutters roads, and fragments natural habitats. The demand for construction aggregates overrides efforts to control and regulate quarrying. Living conditions in major cities deteriorate due to population density, localized flooding during winter, congestion, noise, heat island effect, and the lack of green and public spaces.

Solid waste management in Lebanon experiences some improvements in the next decade. In rural areas, capital investment by the EU-OMSAR and other development organizations yields positive results. Several solid waste treatment facilities (including composting and Waste-To-Energy) go online thereby reducing the prevalence of open dumping. Parallel efforts begin to rehabilitate and close selected inland open dumps. In Beirut and Mount Lebanon (excluding the Caza of Jbail), the Government maintains status quo by extending its contracts with AVERDA for the collection, treatment, transport and disposal of solid waste from approximately 2 million people. Effectively, the Emergency Plan of 1997 is still the order of the day but the Naameh landfill is now closed and replaced with a new landfill site. The tonnage price increases by at least 15 percent to reach $172 per tonne of solid waste. Construction contractors and truck drivers continue to dump excavation material and construction waste on roadsides and in ravines, undeterred, and in total impunity. Arcenciel increases its area coverage by collecting and treating 70 percent of the country's health care risk waste (up from 55% in 2010). The Saida seafront dumpsite is permanently closed and the new biological waste treatment facility goes online but faces technical difficulties. The inorganic fraction is disposed off in a controlled site inland. The Bourj Hammoud dumpsite north of Beirut remains idle. Lebanon is able to ship 200 tons of PCB oil and PCB-contaminated equipment abroad for destruction in partial fulfillment of its obligations under the Stockholm Convention. The first model slaughterhouse facility, equipped with its own treatment plant, is built outside Beirut and goes online. Remaining slaughterhouses continue business as usual. The draft law on Integrated Solid Waste Management is not finalized and waste minimization incentives are absent.

Lebanon's energy crisis show signs of recovery. GDP growth is sustained (it plateaus around 5% in 2020) and continues to drive Lebanon's energy consumption. With an energy elasticity of 1.4, Total Primary Energy Supply will hit 10,000 KTOE in 2020 (up from 5,400 KTOE in 2009). The energy mix changes moderately, in favor of cleaner and less expensive fuels. The environmental performance of Lebanon's electricity sector does not improve noticeably. Storage facilities for imported hydrocarbon fuels do not undergo a detailed environmental audit, sludge is burnt or disposed in the municipal solid waste stream, the number of unlicensed gas stations continues to rise and the majority of storage tanks escape inspection. Unlicensed gas stations continue business as usual. Private electricity concessions and investors in renewable energy pressure the government to amend energy production legislation but EDL continues to maintain monopoly over the sector, as well as cost the Government billions of dollars annually in fuel subsidy. Demand for energy by the construction, transportation, and industry sectors continues to rise. The Government launches several international tenders for oil exploration based on Law 132/2010 and awards one oil extraction and production contract. Despite environmental provisions in the law, risk prevention and emergency response procedures related to oil spills are not tried and tested. The Lebanese Center for Energy Conservation grows but is not fully integrated into the organizational structure of the MOEW. The Lebanon Green Building Council is unable to introduce noteworthy changes to the Lebanese Building Code (Law 646/2004). The 2010 Policy Paper for the Electricity Sector is only partially implemented.

10.3 SUSTAINABILITY FIRST – SCENARIO NARRATIVE

Environmental governance begins to improve as part of a national reform effort to increase participation, transparency and accountability in several sectors. Key environmental laws and decrees (environmental prosecutor, environmental police, environmental impact assessment, environmental fund, etc.) are approved and enacted and partially implemented. In particular, the judiciary system is now fitted with environmental prosecutors who can examine jurisprudence cases with a profound understanding of environmental issues and options. The EIA and SEA decrees are enacted and recognized by line ministries as a necessary step in the permitting process and as a preventive tool in natural resource management. The quality of EIA studies improves slightly but only to the extent of concomitant advances in the generation and dissemination of environmental data on water, air and biodiversity. The Parliamentarian Committee for Environment convenes at least twice every month to examine emerging issues and priorities proactively, and reaches out to civil society groups and the private sector to identify and prepare legislative instruments.

The Ministry of Environment gains recognition and authority. Its staff size grows from 60 to 100 (equivalent to 55% of the staff size prescribed in Decree 2275/2009) and its budget from $5 million in 2010 to $10 million in 2020. Its ability to monitor environmental change and respond to emerging issues in the country is enhanced through the Service of Regional Departments and Environmental Police. The ministry completes the National Environmental Action Plan which becomes the basis for its work planning activities. Leading public research organizations and private environmental institutions explore synergies and collaborate in response to emerging environmental needs in water, air quality, ecology, and energy. The National Environmental Fund and the Arab Fund for the Environment are well established and mobilize at least $30 million of funding in 2020 to environmental research and projects in the country. Spending is partly immune from patron-client relationships. Universities in Lebanon graduate at least 50 environmental graduates every year of which at least 60 percent are able to find green jobs in Lebanon within 6 months of graduation.

Water resources will continue to dwindle over the next decade but improved management of the resource alleviates water stress partially. Although the impacts of climate change on net exploitable resources cannot be mitigated locally, public awareness and technological advances will curb water demand to reach 1,500 Mm3/year (projections MOEW). The government will complete at least three new dams in Lebanon and upgrade several water conveyance systems and networks. The impacts of such public expenditure will yield higher results on water availability and water quality thanks to a tougher government stance in relation to controlling large scale mountain developments, industrial effluent, wastewater discharge and waste disposal. The MOEW cracks down on unlicensed wells in the agricultural and industry sectors as well as households and provides incentives for water conservation and metering. The number of unlicensed wells drops from 22,500 to 15,000 by 2020. The drop in the groundwater table in major agricultural plains including the Bekaa Valley increases at a decreasing rate. The Awali-Beirut water conveyance project is completed and prolongs the continuity of water supply in the Greater Beirut Area.

Equally important, the Regional Water Establishments acquire the necessary tools and skills to detect network leakages and start a nationwide public information campaign to inform end users of water scarcity issues and opportunities for water conservation. Significant progress is achieved in the implementation of the national plan for wastewater treatment (at least 8 new coastal WWTPs will come online by 2020) and regional Water Establishments acquire the skills and resources to either operate the new facilities and/or outsource operation and maintenance to the private sector while maintaining effective oversight. The Ghadir WWTP is upgraded from pre-treatment to biofiltration (secondary treatment). Improved tariffication and cost-recovery help finance service contracts. The completion of at least four WWTPs in the Litani River basin, including partial treatment of industrial effluent by selected industries, reduces the environmental load entering the river system. Successive governments are committed to implementing the 2010 National Water Sector Strategy and approve key capital investment projects during the period 2011-2015. The institutional reform defined under Law 221/2000 makes significant headway.

Air quality in Lebanon does not deteriorate over the coming decade. Emission reductions by some industries are offset by a growing energy demand from other sectors. Annual vehicle registration increases by three percent annually (from 106,959 in 2008 to about 152,000 in 2020). In the private car category, the Government imposes a CO_2 tax on gas-guzzling 4x4s; small fuel-efficient and hybrid cars assume a much bigger market share thanks to the approved amendment of Law 341/2001 providing incentives (tax cuts, tariff exemption and mécanique exemption for first registration) to private and public vehicle owners to switch to hybrid electric, fuel cell/Hydrogen and Natural Gas vehicles. Although emissions from energy industries increase, the environmental performance of the Lebanese electricity sector improves thanks to a significant shift in the country's energy mix (from dirty fuels to cleaner fuels such as Natural Gas and Liquid Natural Gas). Sulfur emissions also decline because of stringer sulfur content standards, and improved inspection measures. Emissions from selected industries stabilize or drop slightly thanks to effective pollution abatement initiatives by relevant ministries and the World Bank. Private electricity generation (20% in 2010) drops by half thanks to higher energy production by EDL and power outages and rationing is almost cut by half. The Jieh and Zouk power plants are renovated.

The ban on indoor smoking in public areas and government buildings is enforced and is supported by social media campaigns on Facebook and other venues. The draft law on the protection of air quality is approved whereby MOE sets new (1) Limit Values and Thresholds of Ambient Air Pollutants, (2) emission limit values for fixed sources, and (3) emission limit values for mobile sources. The Council of Ministers institutionalizes Lebanon's first national air quality monitoring program in collaboration with leading universities working in collaboration with MOE. The program generates continuous air quality data in major cities and publishes the data in real-time. MOE monitors air pollution episodes especially when adverse meteorological conditions prevail, advises large polluters to temporarily curtail operations, and communicates with MOPH cautionary measures to the general public through mass media channels. The Government-approved taxi fleet renewal program achieves encouraging results and at least 5,000 taxi owners have switched to hybrid or fuel-efficient cars. The government further extends customs exemption to all hybrid vehicles entering the country. MOPWT and relevant municipalities (Al Fayhaa, Beirut, Zahle, etc.) introduce low-emission buses as part of a public-private partnership program for improved mass transport.

Lebanon's biodiversity and forests come under increasing pressure due to climate change but conservation measures are scaled up. Among Lebanon's 94 endemic species, only 25 percent are considered rare and/or threatened. The forest cover increases slightly (from 13% in 2004 to 15% in 2020) despite renewed and more intense forest fires in summer and fall. The Government acquires at least three more fire-fighting helicopters and equips the Civil Defense and the Ministry of Agriculture with additional fire trucks. Improved jurisprudence, with the support of environmental prosecutors, has a deterring effect on arsons. Urban sprawl continues but is limited to major cities, while haphazard urbanization slows down as a result of sounder urban planning and a more critical permitting process. New coastal resorts are approved without marinas and concrete piers and therefore do not adversely impact the marine environment. Subject to security conditions, the Government and Lebanese Army approve fishing to within 12 nautical miles from the coast, prompting fishermen and fishmongers to invest in larger boats.

The Higher Council for Hunting institutionalizes the mandatory hunting exam and insurance. Anti-hunting sentiments grow while bird watching activities gain popularity among tourism providers. Synergies between the country's major reforestation efforts (MOE-USFS, MOA-FAO and NGOs) convert about 2,000ha into forests each year and the supply, distribution and selection of forest seedlings appears to be sustainable. The draft Framework Law on Nature Reserves is approved which means that APACs have become legal employers and can charge admission fees. Lebanon reclassifies its 10 nature reserves according to the new Protected Area classification system and demarcates at least 200km^2 of reserves. New requests for PA designation are examined against preset classification criteria. Monitoring capabilities generate new evidence of climate change, but also produce new data on wildlife status and habitats.

Land resources continue to face pressure from anthropogenic sources but selected pressures are controlled. Population growth (from 4.2 million in 2010 including Palestinian refugees to about 4.5 million in 2020 assuming a 0.75% annual growth rate) will increase demand for housing but developers provide smaller housing that is more attractive to lower and middle income families. Sounder urban planning makes it more difficult to build on agricultural land. The rate of approval of construction permits levels at around 8 million m^2 per year which is equivalent to about 4 km^2 of new construction each year, and 32 km^2 by 2020. The total built-up area increases from 648 km^2 in 1998 to about 720 km^2 in 2020. The Higher Council of Urban Planning approves new master plans covering 10 percent of the territory, bringing the total extent of zoning to about 26 percent. The SEA process is integrated in at least half of these urban master plans and all the plans are aligned with the recommendations of the National Land Use Master Plan, which is now fully integrated at the level of the regional departments of urban planning. The DGUP undergoes a major restructuring and hires several urban planners (or civil engineers and architects with considerable urban planning experience).

The MOPWT approves the conditional use of the public maritime domain of no more than three new developments and coastal resorts and only after a strict and thorough review of the corresponding EIA by the MOE. The Lebanese parliament debates a new law on the settlement of illegal infringements on the public maritime domain based on Decree 7919/1996. The Government (incl. MOEW, MOIM, MOPWT and MOE) take due note of Lebanon's most impressive and vulnerable karst formations mentioned in the 2010 SOER and take precautionary measures to avoid damages by road construction and quarrying. The Jeita Grotto is one of the seven wonders of nature. The Lebanese Army clears 80 percent of the total area affected by unexploded cluster bombs in south Lebanon during the July 2006 war (about 28 km^2 out of 35 km^2). The Higher Council for Quarries works collaboratively to implement Decree 8803/2002 and its amendments, and the first cases of illegal or non-compliant quarries are taken to court and result in hefty fines. The MOE rehabilitates at least five quarries using the money deposited from bank guarantees, to serve as pilots, and the total value of bank guarantees increases significantly and proportionally to the market value of aggregates (at least \$15 million in bank guarantees up from \$2.75 million in 2010). Lebanon's first national park is declared in the upper Dinnieh-Hermel region and local initiatives are backed by the Council of Ministers, the Governor and all local municipalities.

Haphazard Urbanization progresses at a slower pace. Rural-urban migration continues but at a decreasing rate thanks to Government initiatives related to decentralization and job creation in secondary cities and in rural areas. Internet services and bandwidth improve markedly allowing many small and medium-sized businesses to operation outside cities. The Government is unable to stop the flow of returning Lebanese expats due to regional security and financial disturbances but new housing projects are concentrated around cities. The rate of secondary housing does not change compared to its level in 2010. The rate of urbanization drops to about 80 percent by 2020. Urbanization is primarily concentrated around urban poles (Tripoli, Saida, Baalbeck, Nabatiyeh, Zahle, etc.) and the occurrence of haphazard urbanization subsides. The rate of new high-rise towers in Beirut replacing landmark buildings subsides but the city skyline has already changed. The DGCA at the MOF makes significant progress in demarcating non-surveyed mountain lands but at least 30 percent of the territory has not been demarcated yet. The ongoing national debate on extending basic civil rights to refugees intensifies and results in improved living conditions for refugees in at least five camps, with international support. The EIA and SEA processes are mainstreamed in the construction sector, notably large-scale developments in the coastal zone and mountain areas, with the backing of relevant ministries (MOPWT, MOF, etc.). Selected environmental provisions in the urban planning (Legislative-Decree 69/1983) and construction laws (Law 646/2004) are heeded by regional urban planning departments and the Order of Engineers and Architects, resulting in a growing number of cases in which construction permits are revoked or denied based on environmental considerations and other natural hazards. The Government amends Law 296/2001 related to property ownership by non-Lebanese by introducing restrictions on the purchase of lands near the international borders and by capping the total area that a non-Lebanese can buy after obtaining COM approval. There is a raging debate over the introduction of a tax on capital gain. At least a dozen urban master plans are amended to limit excavation works, protect fertile agricultural land, and conserve natural habitats. All major cities inaugurate at least one new urban park and public playground.

Solid waste management in Lebanon experiences noteworthy and lasting progress in the next decade. In rural areas, capital investment by the EU-OMSAR and other development organizations yields positive results and the Government honors its commitment under Decree 3860/2010 to support and finance the operation and maintenance of the new facilities. The MOE and relevant municipalities rehabilitate and close at least 10 inland open dumps. The Government does not renew/extend the AVERDA contracts beyond 2013 and decides instead to open the market for competition, pursuant to the 2006 National Plan for Solid Waste Management and the 2010 Waste-To-Energy Plan. The cost of the new systems is variable but remains lower than the total cost of the AVERDA system. The Naameh Landfill is permanently closed and a long-term environmental monitoring system is put in place. New waste legislation recognizes limited exclusivity and opens new business opportunities for managing special waste including e-waste and tires.

Each caza designates an area (usually an abandoned quarry) for the disposal of construction and demolition waste and reported cases of haphazard dumping are prosecuted. Arcenciel and a second contractor collect and treat 90 percent of the country's health care risk waste (up from 55% in 2010) and all the facilities have received environmental permits based on the EIA process. The Saida seafront dumpsite is permanently closed and the new biological waste treatment facility goes online. The inorganic fraction is sorted in an adjacent plant; inert material is disposed off in a controlled site landfill. The Municipality of Bourj Hammoud resumes the debate on how to restore the seafront dumpsite. Lebanon is able to ship 200 tons of PCB oil and PCB-contaminated equipment abroad for destruction in partial fulfillment of its obligations under the Stockholm Convention. At least two model slaughterhouse facilities, equipped with their own treatment plant, are built outside Beirut and go online. Remaining slaughterhouses continue business as usual. The draft law on Integrated Solid Waste Management is finalized and waste minimization incentives are mainstreamed.

The Government of Lebanon addresses the country's energy crisis head on. GDP growth continues to rise but at a decreasing rate (it plateaus around 3% in 2020). With an energy elasticity of 1.2, Total Primary Energy Supply will hit 7,500 KTOE in 2020 (up from 5,400 KTOE in 2009). The energy mix changes markedly, in favor of cleaner and less expensive fuels. The environmental performance of Lebanon's electricity sector improves on several fronts. For example, the Government requires oil importing companies to implement a sludge treatment facility and undergo biannual environmental facility audits. The Government also cracks down on illegal gas stations and does not license new stations. Under pressure by international lending organizations, the private sector and conservationists, the Parliament ends EDL's monopoly over the electricity production sector and the Council of Ministers regulates renewable energy and energy efficiency systems. Renewable Energy reaches 10 percent of total energy production in 2010. Demand for energy by the construction, transport, and industry sectors begin to level off thanks to a myriad of initiatives and tax incentives. The international tender related to oil exploration and production in Lebanese territorial waters coincides with the preparation of risk prevention and emergency response procedures related to oil spills, which is tried and tested with all relevant agencies and organizations in the country under MOE's supervision. The Lebanese Center for Energy Conservation grows and is fully integrated into the organizational structure of the MOEW. The Lebanon Green Building Council lobbies the Government, as well as the DGUP and the OEAs to introduce energy conservation measures to the Lebanese Building Code (Law 646/2004). Successive governments are committed to implementing relevant provisions of the 2010 Policy Paper for the Electricity Sector.

Table 10.2 Detailed assumptions related to each scenario (current and 2020)

Chapter	*Subject*	*Current Value (2010)*
Environmental Governance	MOE staff	60
	MOE budget	$4.88 million
	National Environmental Fund and the Arab Fund for the Environment	$0
Water Resources	Net Exploitable Resources	2,700 Mm^3/year
	Annual water demand	1,473 Mm^3/year
	Dams	2 (Qaraoun and Chabrouh)
	Unlicensed wells	22,500
	Coastal WWTPs in operation	2 (Ghadir and Saida, PT)
	Inland WWTPs in operation (Litani River Basin)	2 (Baalbeck and Aitanit)
Air Quality	*Transport sector:* annual vehicle registration Private cars	106,959 in 2008
	Energy Industries Sulfur emissions	68% of National SO_2 emissions in 2005
	Industries Emissions from industries	13% of National CO_2 emissions in 2005
	Taxi fleet renewal program (taxi owners switch to hybrid or fuel-efficient cars)	0
	Private electricity generation	20% of total electricity production in 2010
Biodiversity and Forests	94 species endemic to Lebanon	17 rare, 4 nearing extinction, and 16 threatened
	Forest cover (% of territory)	13% (2004)
	Forest fires	705 fires (recorded between 2008-2009) consume 4,500ha
	Reforestation	305ha (2002-2004) 279ha (2004-2006)
	Protected Areas	220 Km^2
Land Resources	Population growth	4.2 million in 2010 incl. refugees
	Total floor area of construction permits	15.1 million m^2
	Total built-up area	648 km^2 (1998)
	Extent of Master plans	16%
	Total area affected by unexploded cluster bombs in south Lebanon	35 km^2
Haphazard Urbanization	Secondary housing	5% (2004)
	Rate of urbanization	88% in 2010
	No of new high-rise towers in Beirut	Around 50
	Number of construction permits rejected based on environment	0
Solid Waste	Number of small scale Solid Waste Treatment Facilities in operation (outside GBA)	11
	Major open dumps	27 (700 total)
	Tonnage price of municipal SWM in GBA	$150/t
	Collection and treatment of Health Care risk waste	55% in 2010 (1 NGO)
	PCB oil and PCB-contaminated equipment	In use
Energy Crisis	GDP growth	7% $34.5 billion
	Primary Energy Supply	5,400 KTOE in 2009
	Number of gas stations	2,130
	Renewable energy	0.6%

	Market First (2020)	Sustainability First (2020)
	80	100
	$6 million	$10 million
	$0	$30 million
	↓ with no protection measures of available water resources	↓with public awareness and technological advances
	2,055 Mm^3/year	1,500 Mm^3/year
	2 new dams	3 new dams (290 million m^3)
	No change	15,000
	5	8
	4 (no treatment of industrial effluent)	4 (+ partial treatment of industrial effluent)
	200,000	152,000
	SO_2 emissions ↓ (Shift to cleaner fuels)	SO_2 emissions ↓ (Shift to cleaner fuels)
	CO_2 emissions ↓ (Pollution abatement initiatives)	CO_2 emissions ↓ (Pollution abatement initiatives)
	2,000	5,000
	15% (higher energy production by EDL)	10% (higher energy production by EDL)
	47 now considered rare and/or threatened	24 now considered rare and/or threatened
	10%	15%
	300 fires consume 4,000 ha	Number of forest fires ↓ (new fire-fighting equipment)
	500ha/yr converted into forests	2,000ha/yr converted into forests
	300 km^2 but basis for declaring the areas protected still unclear	250 km^2 (incl. reclassification of Lebanon's 10 nature reserves)
	4.6 million (1% annual growth rate)	4.5 million (0.75% annual growth rate)
	10 million m^2/yr	8 million m^2/yr
	800 km^2	720 km^2
	21%	26%
	60% cleared (20 km^2 out of 35 km^2)	80% cleared (28 km^2 out of 35 km^2)
	7%	5%
	90%	80%
	At least 100	<100 but city skyline already changed
	None	Several
	15	26 (Decree 3860/2010 enforced)
	Rehabilitation and closure of 3 inland open dumps	Rehabilitation and closure of at least 10 inland open dumps plus Saida
	$172/t (↑15%)	Market competition
	70% (1 NGO)	90% (at least 2 organizations)
	200 tons of PCB oil and PCB-contaminated equipment shipped abroad for destruction	
	5%	3%
	10,000 KTOE (Energy Elasticity of 1.4)	7,500 KTOE (Energy Elasticity of 1.2)
	Number still rising	Crack down on illegal gas stations; no new licenses
	5%	8-10%