Republic of Lebanon
Cost Assessment of Environmental Degradation

World Bank/METAP

Draft Report

February 2003

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Acknowledgements

This report was prepared by a team consisting of Maria Sarraf (Task Team Leader, World Bank), Bjorn Larsen (Environmental Economist, Consultant), and Marwan Owaygen (Natural Resources Economist, Consultant). M. Sarraf provided overall supervision of the report. B. Larsen was responsible for the analysis and estimates on the costs of degradation. M. Owaygen undertook essential research on coastal degradation, quarries, and inland tourism and recreation.

The authors would like to thank Sherif Arif (Regional Environmental Coordinator, World Bank) for his support, as well as Anne Carlin for editing the report. The team also gratefully acknowledges the financial support provided by the Swiss Agency for Development and Cooperation through a grant to the Mediterranean Environmental Technical Assistance Program (METAP).

Abstract

This report is the first step in a process toward using environmental damage cost assessments for priority setting and as an instrument for integrating environmental issues into economic and social development. The report provides estimates of damage and remediation cost for several areas of the environment. The estimates should be considered as orders of magnitude and a range is provided to indicate the level of uncertainty. As areas of priority are identified, further analysis will be required for more accurate estimates.

The annual damage cost of environmental degradation in Lebanon in 2000 is estimated at 2.3 - 3.6 percent of GDP with a mean estimate of 2.9 percent of GDP, or close to US$485 million per year. The cost of air pollution is assessed at 0.5-1.2 percent of GDP (urban outdoor and rural indoor), followed by inadequate potable water quality, sanitation and hygiene at 0.6-0.8 percent. Cost of coastal zone degradation is estimated at close to 0.6-0.75 percent of GDP, and degradation of land resources and wildlife (soil erosion and environmental degradation) at 0.5-0.7 percent of GDP. Damage cost associated with solid waste management is assessed at 0.05 percent of GDP. Of total damage cost about 55 percent is from damage to health and quality of life, and 45 percent from natural resource degradation. It should be noted, however, that no cost estimate is provided for degradation associated with industrial, hazardous and hospital waste, municipal solid waste disposal, losses of most forest cover, and rangeland degradation and desertification as sufficient data were unavailable. Similarly, cost assessment of degradation associated with inadequately treated or untreated industrial and municipal wastewater is limited to coastal recreational and tourism losses due to data constraints.

Cost is also presented for a limited number of remedial actions in each of the environmental areas analyzed for which damage cost is estimated. More detailed analysis is required in order to compare benefits of remediation to reduction in damage cost at the margin.

Acronyms

CAS	Central Administration of Statistics, Lebanon
CBS	Central Bureau of Statistics, Lebanon
DALY	Disability Adjusted Life Year
DC	Damage Cost
GDP	Gross Domestic Product
Koe	Kilo of oil equivalent
LBP	Lebanese Pound
LEDO	Lebanese Environment and Development Observatory
METAP	Mediterranean Environmental Technical Assistance Program
MoE	Ministry of Environment, Lebanon
PM10	Particulate Matter
RC	Remediation Cost
SOER	State Of the Environment Report, Lebanon
UNDP	United Nations Development Program
USAID	United States Agency for International Development
US$	US dollar
WHO	World Health Organization
WTP	Willingness-to-Pay

Executive Summary

INTRODUCTION

Lebanon's accomplishments in environmental management and protection in the last decade include: include: (i) establishing an environment ministry in 1993; (ii) giving protected status to seven areas (about 2 percent of total surface area), ten forests and several river basins and high mountains; (iii) improving solid waste collection and disposal in several parts of the country; (iv) establishing standards for industrial stack emissions and wastewater discharge; (v) preparing its first environment strategic framework with METAP assistance in 1996; (vi) undertaking a series of actions to decrease air pollution such as banning the use of light diesel vehicle ; and (vii) very recently the enacting the Environment Code in 2002. However, challenges from several decades of past and continuing degradation remain.

This report is the first step in a process supported by the Mediterranean Environmental Technical Assistance Program (METAP) toward using environmental damage cost assessments as an instrument for integrating environmental issues in economic and social development. The specific objectives of this report are three-fold:

i. provide an estimate of the cost of environmental degradation in Lebanon using the most recent data available;
ii. provide an analytical framework that can be applied periodically by professionals in Lebanon to assess the cost of environmental degradation over time; and
iii. provide a basis for a training program for ministries, agencies, institutes and other interested parties to incorporate assessments of environmental degradation costs into policymaking and environmental management.

A training manual that builds on the analytical framework, environmental categories, and results and conclusions of this report is being developed. This manual will be used in a training program that will concentrate on in-depth analysis of environmental damage assessments, and benefits and costs of environmental action in priority areas.

The report also provides cost estimates of select remedial actions that may be necessary to protect and restore the environment. It also presents a discussion comparing damage and remediation costs, and the potential benefits of remedial actions for some environmental issues.

The estimates of environmental damage and remediation costs should be considered as orders of magnitude. As priority areas are identified, further analysis will be required for more accurate estimates. Nevertheless, the estimates presented in this study indicate the severity and magnitude of environmental degradation and provide a rationale for continued environmental management and priority setting for environmental action.

COST OF ENVIRONMENTAL DEGRADATION

In 2000, the cost of environmental degradation in Lebanon was estimated at 2.3-3.6 percent of GDP per year, with a mean estimate of close to US$485 million per year, or 2.9 percent of GDP. In addition the cost to the global environment is estimated at about 0.5 percent of GDP per year.

Estimated costs of damage have been organized by environmental category, and are presented as such in Table A and Figure A (not including the global environment). Figure B presents the same mean estimates by economic category, indicating that the cost to health and quality of life (including avertive expenditures) is about 1.6 percent of GDP, followed by 1.3 percent for natural resources.

Table A. Annual cost of environmental degradation--mean estimate

	US $ millions per year	Percent of GDP
Air	145	0. 87%
Water	120	0. 71%
Land and wildlife	100	0. 60%
Coastal zones and cultural heritage	110	0. 68%
Waste	10	0. 05%
Sub-Total	**485**	**2.9%**
Global environment	90	0. 5%
Total	**575**	**3. 4%**

Figure A. Annual cost of environmental degradation by environmental category (mean estimate as a percentage of GDP)

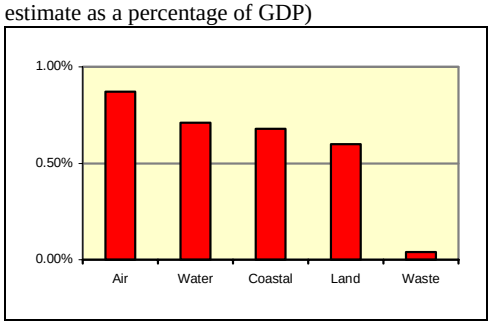
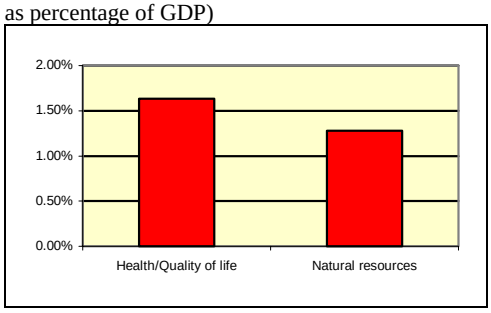


Figure B. Annual cost of environmental degradation by economic category (mean estimate as percentage of GDP)



The most significant negative impacts on health are caused by urban air pollution (particulates and Pb) in Greater Beirut and Greater Tripoli at an estimated cost of 0.45-0.90 percent of GDP per year, with a mean of about 0.7 percent. Negative impacts on health from indoor air pollution in rural areas from biomass fuel use is estimated at 0.1-0.3 percent of GDP. The cost of diarrheal illness and mortality is estimated at 0.1-0.3 percent of GDP, with a mean of 0.2 percent caused by a lack of access to potable water and sanitation, and inadequate domestic, personal and food hygiene. Most of those impacted are children. The lack of safe potable water, or perception thereof, has an additional cost in terms of avertive expenditure on bottled water, estimated at 0.5 percent of GDP per year. The last category is waste management with potential impacts on health from uncollected and unsafe disposal of municipal and industrial waste, hazardous waste and health sector waste.

The cost of natural resource degradation is predominantly from losses in recreational, tourism, ecological and non-use values associated with coastal zone degradation (0.6-0.75 percent of GDP per year), and agricultural soil/terrace degradation (0.4 - 0.5 percent of GDP). The assessed cost of degradation of the inland natural environment is estimated at 0.1-0.2 percent of GDP and mainly limited to areas in Mount Lebanon (see Chapter 3 and Annexes).

COST OF REMEDIATION

The cost of remediation has been estimated for a limited number of actions for each environmental category and presented in Chapter 4. While the focus of this chapter is the cost of remediation, and mainly of investments and programs, a discussion of policy context is warranted. Reducing degradation and protecting the environment should be viewed in the context of economic and sector policies and development, and in the broader framework of environmental management.

Much can be gained from preventing degradation through analyzing the environmental impacts of policies and development plans. Eliminating price, tax and economic regulatory distortions can also benefit the environment if such distortions favor inefficient use of “dirty” resources or “dirty” industries.

Reducing degradation and protecting the environment also require strict enforcement of environmental legislation, public/private partnerships, environmental awareness raising, and local participation. Sound environmental management also requires that the roles of the public and the private sectors be clarified. It

should be said that the remedial actions discussed in this report should not necessarily be undertaken by the public sector. The private sector should bear the cost of remedying the pollution and degradation it causes, and the private sector can provide a significant contribution to the delivery of environmental services.

COMPARISON OF DAMAGE AND REMEDIATION COSTS

A comparison of benefits (reductions in damage) and costs (remedial actions) can be useful to point to environmental issues for which benefits of remediation are likely to exceed the cost of remedial actions.

Chapter 5 points to some areas for which a comparison of costs and benefits are made. However, in making such comparisons, a note of caution is warranted:

i. Environmental damage is unlikely to be completely eliminated no matter how stringent and comprehensive the remedial action.
ii. The remedial action discussed in Chapter 4 is in most cases insufficient to adequately address the damage.
iii. Quantification of environmental damage and its monetary valuation can never be completely accurate (Chapter 2), and the costs of remedial action are most often only estimates.
iv. The principle of marginal analysis needs to be applied to obtain remedial action that is likely to provide the greatest benefits per unit of cost.

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CONCLUSION

This study indicates that the cost of environmental degradation in Lebanon is in the range of 2.3-3.6 percent of GDP, with a mean estimate of 2.9 percent. This is substantial and on the order of 1.5 times higher than in high-income countries. The main reasons for this are: (i) a significant disease burden and avertive expenditures associated with the lack of safe water and sanitation facilities and inadequate hygiene; (ii) substantial negative impacts on health from air pollution; (iii) environmental degradation and productivity losses associated with soil degradation; and (iv) significant coastal zone degradation.

This report also indicates that Lebanon would benefit significantly from remedial action to protect and restore the environment, although estimates of the cost to do so are tentative. Further analysis of the costs and benefits of select environmental issues that are considered priority areas by the Government of Lebanon would facilitate priority setting and improved environmental management, as well as promote inter-sectoral support for action. Future cost analysis should include more in-depth assessment of the impacts of environmental quality on tourism and recreation, and on soil and water resources management

1. Introduction

A. BACKGROUND

1.01 Like other countries in the region and around the world, Lebanon has long faced environmental degradation and threats that impinge on the health of the population and economic development.

1.02 Lebanon, an upper middle-income country according to World Bank classifications, has a per capita GDP of about US$4,000. Ninety percent of its population live in urban areas. The country has a population density of about 430 people per square kilometer. More than one-fourth of the population live in Greater Beirut and more than half live in the coastal areas. Forested area, as a percentage of total land area, is around 3.5 percent, compared to 1.5 percent in the Middle East and North Africa region and close to 30 percent worldwide. Freshwater resources amount to about 1,100 cubic meters per capita per year which is similar to Egypt, 7-8 times more than Jordan, and less than half that of Syria. Agricultural land constitutes close to 32 percent of the total land area, comparable in the region though somewhat less than the rest of the world (World Bank, WDI 2001). Agricultural land per capita, however, is only about 0.074 hectares (0.74 dunums), one of the lowest in the world.

1.03 The 2001 Lebanon State of the Environment Report (SOER), published by the MoE and LEDO and prepared in collaboration with ECODIT Liban, provides a comprehensive assessment of Lebanon's environment, recent accomplishments and remaining challenges. It also identifies specific actions for environmental protection and the restoration of environmental quality.

1.04 Accomplishments in environmental protection in the past decade include: (i) establishing an environment ministry in 1993; (ii) giving protected status to seven areas (about 2 percent of total surface area), ten forests and several river basins and high mountains; (iii) improving solid waste collection and disposal in several parts of the country; (iv) establishing standards for industrial stack emissions and wastewater discharge; (v) preparing its first environment strategic framework with METAP assistance in 1996; (vi) undertaking a series of actions to decrease air pollution such as banning the use of light diesel vehicle ; and (vii) very recently the enacting the Environment Code in 2002. With respect to other environmental challenges, the SOER stresses the need to reduce air pollution from vehicle emissions, strive for balanced development and urbanization, protect beaches and assure public access, and continue to improve industrial pollution control and waste management.

B. COST OF ENVIRONMENTAL DEGRADATION

1.05 In 1995, the World Bank published the "Middle East and North Africa Environmental Strategy." The strategy provided an order of magnitude for the regional cost of environmental degradation as a percentage of regional GDP. The main areas for which the strategy provided estimates for the cost of degradation were the detrimental impacts on health from the lack of safe water and sanitation facilities and urban air pollution, and the cost of natural resource degradation (soil erosion and salinisation as well as rangeland and forest degradation).

1.06 The strategy was based on 1990 data and was a first attempt to quantify the impacts of environmental degradation on health and economic activity. In addition, the strategy identified areas of resource inefficiencies (such as energy and water) that had high economic costs and contributed to environmental degradation.

1.07 During the 1990's, several country-specific studies were also undertaken in the region. They provided estimates of the cost of environmental degradation for specific

environmental issues and subsets of issues. These include studies commissioned by METAP, UNDP, USAID, the World Bank and others in Algeria, Egypt, Iran, Lebanon, Morocco, and Syria.

1.08 More recently the World Bank has prepared its Corporate Environment Strategy and updated the Middle East and North Africa regional strategy[1]. The updated regional strategy committed to demonstrate the economic importance of a clean environment by assessing the damage costs of environmental degradation. This sort of assessment also represents an analytical tools to assess environmental sustainability, as called for in the Millennium Development Goal #7.

1.09 Estimating the cost of environmental degradation is not a new topic in Lebanon. Several studies have been undertaken that provide quantitative estimates of the cost of air pollution (e.g. El-Fadel and Massoud, 2000; Hashisho and El-Fadel, 2001(b); and METAP/HIID, 2000) and the value of nature conservation and protection (e.g. Owaygen, 1999; and Zurayk and Moubayed, 1994). The SOER also provides quantitative estimates for the cost of degradation in select areas. These studies represent important contributions to the understanding of the cost of environmental degradation and the value of protection and improving environmental quality.

C. RATIONALE AND OBJECTIVES

1.10 No previous study has attempted to provide a perspective on the overall cost of environmental degradation in Lebanon, although several studies, as discussed above, provide valuable contributions in select areas. Local capacity is to a significant extent available in Lebanon to undertake an overall quantification. A further increase in such capacity could provide a better understanding of the magnitude of the cost to society of environmental degradation in various sectors. This in turn could help improve the continuing process of environmental priority setting to achieve reductions in the overall cost of environmental degradation with less public and private sector resources.

1.11 This report is the first step in a process supported by METAP to use environmental damage cost assessments as an instrument in environmental management. The specific objectives of the report are three-fold:

i. provide an estimate of the cost of environmental degradation in Lebanon using the most recent data available.
ii. provide an analytical framework that can be applied periodically by professionals in Lebanon to assess the cost of environmental degradation over time.
iii. provide a basis for a training program for ministries, agencies, institutes and other interested parties to incorporate assessments of the cost of environmental degradation into policymaking and environmental management.

1.12 A training manual is currently being developed that builds on the analytical framework, environmental categories, and results and conclusions of this report. This manual will be used in a training program that will concentrate on in-depth analysis of environmental damage assessments and the costs and benefits of environmental action in priority areas.

D. THE PREPARATION PROCESS

1.13 The study commenced in January 2002 with discussions at the Ministry of Environment, other ministries, institutes and universities, and with Lebanese experts. Initial data were collected and a local expert was included on the study team.

1.14 During the preparation of the study, a review of relevant literature and documents was carried out. Data from various Governmental documents, statistical analysis, economic and sector work by the World Bank, and reports from various international agencies were utilized. For environmental issues for which sufficient data and analysis were not available, the team's local expert carried out primary research and data collection. In

[1] *Making Sustainable Commitments*, An Environment Strategy for the World Bank, 2001

addition, analysis from other countries was utilized to supplement the estimates for the cost of environmental degradation included in this report.

1.15 Chapter 2 provides an overview of the methodologies applied in this report. Chapter 3 presents estimates of the degradation costs. Remedial actions with select cost estimates are discussed in Chapter 4. A comparison and discussion of the costs and benefits are provided in Chapter 5. Annexes I and II present degradation and remediation costs, as well as further details of degradation cost estimates. Annex III provides research by the local expert on forests and woodland degradation, quarries, and inland tourism and recreation.

2. Methodological Framework

A. DEFINITION

2.01 This report provides first order estimates on the cost of environmental degradation in Lebanon, as well as the cost of remediation of environmental degradation for select actions.

2.02 An attempt has been made to capture what may be expected to be the most significant costs of degradation. However, data limitations have been a constraint, which implies that estimates in some environmental areas are not included. Hence, the total estimate of environmental degradation, as presented in this study, is likely to underestimate the true costs of degradation.

2.03 As the main objective of the report is to quantify degradation, assessment of remediation is limited and in most cases insufficient to provide a comparison of the costs and benefits of remediation.

2.04 The cost of environmental degradation can be understood as a measure of the lost welfare of a nation due to environmental degradation. Such a loss in welfare from environmental degradation includes (but is not necessarily limited to):

i. loss of healthy life and well-being of the population (e.g.: premature death, pain and suffering from illness, absence of a clean environment, discomfort).
ii. economic losses (e.g.: reduced soil productivity and reduced value of other natural resources, lower international tourism).
iii. loss of environmental opportunities (e.g.: reduced recreational value for lakes, rivers, beaches, forests).

2.05 In this report the cost of environmental degradation is expressed as a percentage of GDP in order to provide a sense of magnitude. It is also useful to compare the cost of degradation to GDP to assess the relative magnitude over time.

2.06 If the cost of degradation as a percentage of GDP grows over time, it suggests that the welfare loss from environmental degradation is growing faster than GDP, i.e. that economic and human activity is having increasingly negative (environmental) consequences on the nation relative to their economic affluence. If the contrary is the case, it suggests that environmental consequences are being reduced relative to the nation's economic affluence.

B. METHODOLOGICAL PROCESSES

2.07 The process of estimating the cost of environmental degradation involves placing a monetary value on the consequences of such degradation. This often implies a three-step process:

i. quantification of environmental degradation (e.g. monitoring of ambient air quality, river/lake/sea water quality, soil pollution).
ii. quantification of the consequences of degradation (e.g. negative impacts on health from air pollution, changes in soil productivity, changes in forest density/growth, reduced natural resource based recreational activities, reduced tourism demand).
iii. a monetary valuation of the consequences (e.g. estimating the cost of ill health, soil productivity losses, reduced recreational values).

2.08 Environmental science, natural resource science, health science and

epidemiology, economics and frequently other sciences are often applied to quantify environmental degradation/conditions and its consequences. For valuation of the consequences, and sometimes to quantify the consequences of degradation, environmental economics and natural resource economics are applied.

2.09 This report has utilized available information on the quantification of environmental degradation in Lebanon and the consequences of degradation. In limited cases for which no information on the consequences of degradation was available, primary research was conducted during the course of the study and expert opinions were utilized as to the likely consequences and their magnitudes.

C. CATEGORIES OF ANALYSIS

2.10 To estimate the cost of environmental degradation for various aspects of the environment, the analysis and estimates have been organized into these categories:

i. water
ii. air
iii. land and wildlife
iv. waste
v. coastal zones and cultural heritage
vi. the global environment.

2.11 For each of these categories there are separate analysis and cost estimates for:

i. health/quality of life
ii. natural resources.

D. CONSEQUENCES OF DEGRADATION

2.12 Several methodologies and approaches have been applied to provide a quantitative estimate of the consequences of environmental degradation. Brief explanations are provided in the annexes at the end of the report for each area in which cost of degradation has been estimated. However, an elaboration of some issues is warranted here.

2.13 Impacts on health from environmental degradation are expressed as Disability Adjusted Life Years (DALYs). This is a methodology that has been developed and applied by WHO and the World Bank in collaboration with international experts to provide a common measure of disease burden for various illnesses and premature mortality. Illnesses are weighted by severity so that a relatively mild illness or disability represents a small fraction of a DALY, while a severe illness represents a larger fraction of a DALY. A year lost to premature mortality represents one DALY, and future years lost are discounted at a fixed rate.

2.14 For waterborne illnesses - associated with inadequate water and sanitation services and hygiene - the loss of DALYs presented in this report are predominantly due to child mortality caused by diarrheal illnesses. Each child death represents about 35 DALYs.

2.15 For air pollution, impacts on health are primarily estimated based on ambient air quality data in Beirut and international studies on the negative impacts on health from air pollution. In this report, each premature death due to air pollution represents 10 DALYs.

E. MONETARY VALUATION

2.16 To arrive at a monetary valuation of the consequences of environmental degradation (i.e. the cost of environmental degradation), various methodologies of environmental and natural resource economics have been applied.

2.17 The notes in the annexes at the end of the report provide brief explanations of the estimated cost of degradation. A range has been used for most of the estimates to reflect uncertainties. An elaboration of some of the issues follows here.

2.18 The cost of negative impacts on health, i.e. the cost of a DALY lost have been valued using two approaches. GDP per capita has been used as a benchmark - in some cases as the lower bound of the range estimate and in others as the upper bound. The rationale for this valuation technique is that the economic value of a year lost to illness or early death is the productive value of that year, which is approximated by GDP per capita. It should be

noted that this valuation technique has nothing to do with the non-economic value of life in general. An alternative valuation method is willingness-to-pay (WTP) by an individual to reduce the risk of death. Valuations arrived at in studies in United States and Europe that apply WTP are substantially higher than the GDP per capita approach (at least for adults). WTP has in some cases been used in this report as the upper bound for the valuation of a DALY.

2.19 DALYs lost due to child mortality are in this report valued at a different rate than DALYs lost due to adult mortality. International valuation studies of child mortality in developing countries are limited. For consideration, if DALYs are assigned the same value (e.g. GDP per capita) for the death of a child and an adult, the valuation of a child death would be 2-3 times higher than an adult death. This may be an unreasonable valuation based on household welfare considerations and social choice, i.e. higher valuation for productive, income-earning adults. Thus GDP per capita has been used as an upper bound for DALYs lost due to child mortality. As a lower bound, 50 percent of GDP per capita has been applied to reflect that the household population that suffers from higher rates of child mortality has lower income. This valuation range has been applied to child mortality (and morbidity) from inadequate and poor quality water, sanitation and hygiene, and indoor air pollution.

2.20 As an upper bound for the range estimates of the cost of DALYs lost due to adult mortality, WTP to reduce the risk of death has been applied in this report. WTP is from assessments in the United States and Europe that have been adjusted by the GDP per capita differential to Lebanon. As a lower bound, DALYs have been valued at GDP per capita. This range has been applied for adult mortality due to indoor and outdoor air pollution.

2.21 It should be noted that a DALY valued at WTP is about six times higher than a DALY valued at GDP per capita. Thus the lower bound estimate of the cost of a DALY lost due to adult mortality would be a gross understatement of the cost of environmental degradation if WTP provides a better representation of welfare cost.

2.22 For some issues (wastewater pollution and inadequate industrial waste management), the consequences of environmental degradation have only been quantified for the recreational and international tourism value of the coastal zone, and to some extent on potable water. No assessment or quantification is provided for possible losses in fisheries, values of ecosystems, or impacts on agriculture.

2.23 A last point is that all estimates of the cost of environmental degradation and remedial action are annual costs. Whenever necessary, costs have been annualized over its relevant time period and discounted at an annual rate of 10 percent.

F. DAMAGE AND REMEDIATION COSTS

2.24 The following chapters present estimates of the cost of environmental degradation (DC for damage cost) and (RC for remediation cost).

2.25 As previously stated, damage costs express the national welfare loss associated with environmental degradation. Damage costs also provide a perspective on the extent of the potential benefits that would occur with good environmental management.

2.26 The assessment of remediation costs provides an indication of the resources needed to at least partially avoid recurrent environmental degradation. As the remedial action for which costs have been estimated are limited, it remains uncertain to what extent remedial action would restore environmental quality. Thus any comparison of degradation costs and remediation costs (i.e. potential benefits compared to costs of environmental improvements) should be undertaken with great care and undergo a more detailed assessment before utilization as a policy tool.

G. MARGINAL ANALYSIS

2.27 A marginal (incremental) analysis should be applied to assess the benefits (reductions in the cost of environmental degradation) and costs of remedial action. Only in specific and limited cases can it be expected that incremental benefits from an additional remedial action will be the same as for a previous action. In most cases, incremental benefits are declining and it becomes increasingly costly to improve environmental quality. Thus the costs and benefits of each action should be assessed to the extent possible and actions with the highest benefits per unit of cost should be implemented first. This process should be continued up to the point where benefits of an action equal the cost. Implementing action to improve the environment beyond this point would result in a net welfare loss.

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2.28 In practice, however, it may prove very difficult (if not impossible) to assess benefits and costs sufficiently accurate to apply the principle of marginal analysis. In such cases, other principles should be applied that may be based on precautionary concerns, irreversibility of environmental damage, intergenerational concerns, and gender, poverty alleviation and equity objectives. These principles may also be combined with marginal analysis for cases in which benefits and costs can be quantified. The issue of marginal analysis regarding remediation costs and the comparison of damage costs and remediation costs will be addressed later in the report.

3. Cost Assessment of Environmental Degradation

A. INTRODUCTION

3.01 This chapter presents estimates for the cost of environmental degradation (damage cost: DC) based on the methodologies outlined in Chapter 2. Damage cost is presented for each of the following environmental categories:

i. water
ii. air
iii. land and wildlife
iv. waste
v. coastal zones and cultural heritage
vi. the global environment.

3.02 For each of these categories cost estimates are presented for:

i. health/quality of life
ii. natural resources.

3.03 It should be noted that these estimates are orders of magnitude and therefore only an indication of actual costs. The main reasons for not being able to provide precise estimates are that available data are often aggregates that do not reflect important geographic variations across Lebanon, that precise data or estimates on the consequences of environmental degradation are unavailable or incomplete, and the valuation of these consequences are very rough estimates.

3.04 Calculations of each damage cost estimate as percentages of GDP in 2000 and as total U.S. dollar figures can be found in the annexes. Summaries of these estimates are presented here.

B. TOTAL COST OF DEGRADATION

3.05 The cost of environmental degradation in Lebanon in 2000 is estimated at 2.3 - 3.6 percent of GDP, with a mean estimate of US$485 million, or 2.9 percent of GDP. The damage cost to the global environment is estimated at 0.5 percent of GDP. Mean estimates of these costs are presented in Table B and Figure A. (exclusive of the global environment) for each environmental category.

3.06 By economic category, the cost to health and quality of life is about 1.6 percent of GDP and 1.3 percent for natural resources as seen in Figure B.

Table B. Annual cost of environmental degradation -mean estimate

	US$ Million s per year	Percent of GDP
Air	145	0. 87%
Water	120	0. 71%
Land, wildlife	100	0. 60%
Coastal zones, cultural Heritage	110	0. 68%
Waste	10	0. 05%
Sub-Total	**485**	**2. 9%**
Global environment	90	0. 5%
Total	**575**	**3. 4%**

Figure A. Annual cost of environmental degradation by environmental category (mean estimate as a percentage of GDP)

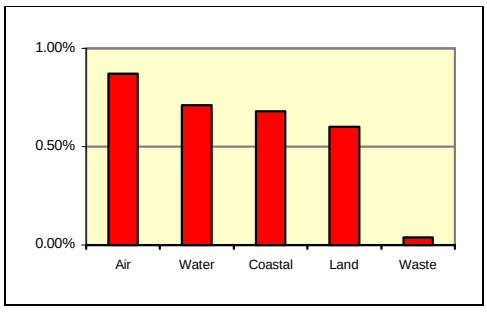
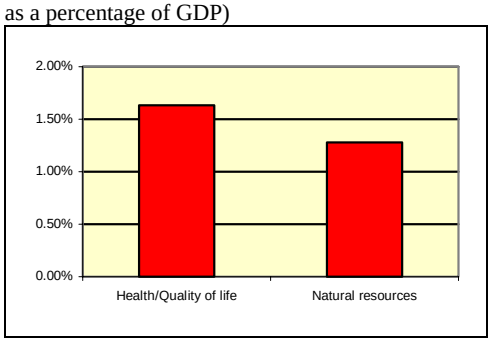


Figure B. Annual cost of environmental degradation by economic category (mean estimate as a percentage of GDP)



C. WATER

3.07 **Health and quality of life.** Sub-standard quality and an inadequate quantity of potable water for drinking and hygiene purposes, inadequate sanitation facilities and sanitary practices, and inadequate personal, food and domestic hygiene have a cost to society. This cost arises primarily on two fronts. First, it is well known that inadequate water, sanitation and hygiene are associated with waterborne illnesses and mortality (Esrey et al, 1991). Second, individuals and communities at risk from waterborne illnesses and mortality may incur costs associated with protective measures (avertive expenditures such as purchases of bottled water). Estimates of both types of cost are presented in this study.

3.08 Based on data from a Ministry of Health report (1996), a CBS/UNICEF report (2001), and estimates in this study, it is estimated that about 260 children die (10 percent of all child deaths) every year in Lebanon from diarrheal diseases associated with inadequate potable water, sanitation and hygiene. This represents an annual loss of more than 9,000 disability adjusted life years (DALYs).[2] The same factors are also responsible for the burden of infectious disease morbidity among children and adults and include intestinal worm infections and non-fatal diarrheal episodes. While no data are available on the prevalence of intestinal worm infections, non-fatal diarrheal episodes among children are estimated at almost 2,000 DALYs per year. Thus more than 11,000 DALYs are lost each year. A DALY valued in a range of 50 - 100 percent of GDP per capita[3] implies a damage cost of US$22-44 million per year, or 0.13-0.27 percent of GDP (see Annexes I and II).

3.09 Lebanon's population consumes a large quantity of bottled water mostly due to the perception that municipal water is of a low quality. Water pollution and possible contamination of municipal water in the distribution system cost society. Data on bottled water consumption is reported in the State of the Environment Report (ECODIT, 2001). According to the report, bottled water consumption is about 115 liters per capita per year. Some consumption is due to taste and lifestyle preferences. This estimate is based on bottled water consumption in Europe and the United States in the 1970s (prior to the large increase in bottled water consumption in the 1980s and 1990s, widely believed to be due to perceptions of inadequate municipal water quality).

3.10 The cost of inadequate municipal water quality (in terms of bottled water consumption) is the difference between actual bottled water consumption and the estimated consumption associated with taste and lifestyle preferences. The cost is estimated at US$82 - 89 million per year, or around 0.5 percent of GDP (see Annexes I and II).

3.11 In addition to bottled water consumption to protect against inadequate (real or perceived) municipal water quality, many households and residential buildings have installed water purification equipment. There are no readily available data on the use of such equipment, but most new buildings in Beirut install purification equipment. Data from one residential building in Beirut indicates that the operation and maintenance cost for UV and carbon filters are US$2,000 for a building with nine households. This translates into US$45 per resident per year (if there are 5 members per household), which is

[2] See Chapter 2 for an explanation of DALY.

[3] See Chapter 2 for a discussion of the valuation of a DALY.

equivalent to the cost of almost 200 liters of bottled water per resident.

3.12 In addition, pollution of rivers and lakes by industry, sewerage, and agriculture is reducing the recreational value and quality of life in Lebanon. No estimate is provided in this report due to lack of data. The cost of pollution in the coastal areas is presented in the coastal zones section.

3.13 **Natural resources.** Pollution of rivers and lakes may also be impairing ecological functions, fishery resources, groundwater quality, etc. No estimate is presented in this report due to a lack of data.

Table C. Water: Annual damage cost – mean estimate.

Water	Percent of GDP
Health/Quality of life	
Health	0.20%
Avertive expenditures (bottled water)	0.51%
Quality of life (recreation)	n.a.
Natural resources (damage to ecosystems from municipal and industrial wastewater)	n.a
Total	**0.71%**

D. AIR

3.14 **Health and quality of life.** There is substantial research evidence from around the world that both indoor air pollution and outdoor/urban air pollution have significant negative impacts on public health and result in premature deaths, bronchitis, respiratory disorders, and even cancer. Indoor air pollution, especially in rural areas, can be even higher than outdoor/urban air pollution due to the indoor use of biomass fuels for cooking and heating. The most significant air pollutant in terms of impacts on health is most commonly found to be particulate matter, especially fine particulates (PM10 or smaller). Estimates of impacts on health from both urban and indoor air pollution are presented below.

3.15 No study that statistically links urban air pollution and health, based on local health and ambient air monitoring data, has been carried out in Lebanon. However, applying findings from international studies to the local air pollution situation in Lebanon can produce an estimate. Based on average concentration levels of PM10 monitored in Greater Beirut and estimates for Greater Tripoli, it is estimated that more than 350 people die prematurely every year due to urban air pollution. Combined with illnesses (morbidity) from air pollution, an estimated 9,000 DALYs are lost each year. This corresponds to US$35-98 million, or about 0.2-0.6 percent of GDP per year, based on valuation of a DALY equal to GDP per capita as the lower bound and WTP as the upper bound. WTP is based on studies from the United States and Europe adjusted by GDP per capita differentials to Lebanon (see Chapter 2, Table D, and Annex I and II). It should be noted that the PM 10 concentration levels applied here are based on monitoring data after the implementation of the diesel vehicle ban. El-Fadel and other (2003) provide data that indicate that PM 10 declined to about 55 ug/m3 in Beirut. Levels of PM 10 prior to the ban were reported at around 100 ug/m3 (ECODIT, 2001 and Team International, 2000).

3.16 It should also be noted that pollutants other than particulates (PM 10) are likely to be impairing health in Lebanon, such as ground level ozone, sulfur dioxide, nitrogen oxides and lead (Pb). No or limited monitoring data are available for most of these pollutants. However, based on available information on lead concentrations in the air of Greater Beirut, the cost of lead pollution is estimated at US$28-40 million per year, or 0.17 - 0.24 percent of GDP, associated mainly with impaired neurological development in children (e.g. reduction in intelligence). See Table D and Annexes I and II for further details.

3.17 Biomass fuel use for cooking and heating causes health-threatening indoor air pollution in developing countries, especially for women and young children who spend disproportionately more time indoors than men and older children. According to the United Nations (see WDI, World Bank, 2001), biomass fuel use in Lebanon is on the order of 3 percent of total energy consumption. Assuming this is concentrated in the rural areas, this figure corresponds to about 360 koe per capita in rural areas. In the absence of

indoor air quality monitoring data, methodology and risk assessments from other countries presented in Smith (2000), in combination with data on biomass use, have been applied to Lebanon. On this basis, it is estimated that health damage from indoor air pollution is 3,200-7,000 DALYs per year, or US$14-51 million per year (almost 0.1 to more than 0.3 percent of GDP). This estimate is only an order of magnitude, and more detailed data on household consumption of biomass fuel and respiratory illnesses are needed to provide better estimates (see Chapter 2 for valuation methodology, and Annexes I and II for details).

3.18 In addition to detectable health effects from air pollution, the affected population is also suffering from general discomfort. Based on a study from Rabat, Morocco, the cost of such discomfort may be estimated at 0.07 percent of GDP per year in Greater Beirut and Tripoli (Annex I).

3.19 In total, the damage cost of urban and rural indoor air pollution on health and the quality of life is estimated at US$89 - 200 million per year with a mean estimate of US$145 million (0.5-1.2 percent of GDP per year with a mean estimate of 0.87 percent (see Table D).

Table D. Air: Annual damage cost – mean estimate

Air	Percent of GDP
Health/Quality of life	
Urban air pollution – particulates	0.40%
Urban air pollution – lead (Pb)	0.20%
Indoor air pollution	0.20%
Quality of life	0.07%
Natural resources (impacts on agricultural productivity)	n.a
Total	**0.87%**

3.20 **Natural resources.** It is well known that some air pollutants, such as sulfur dioxide and sulfur compounds, can harm natural resources (agricultural production, forests and lakes). The cost of such damage has not been estimated for Lebanon, but it may be expected to be substantially less than the damage cost to health.

E. LAND AND WILDLIFE

3.21 **Natural Resources.** A high population density of 420 people per square kilometer (almost as high as in the Netherlands and twice as high as in Germany), decades of uncontrolled and unplanned development and construction, more than 700 quarries, degradation of forests and woodland from fuel wood collection and charcoal production, rangeland degradation, desertification, and abandonment and neglect of terraced agricultural land have placed Lebanon's relatively limited land and wildlife resources under pressure. According to El-Haber (1991), Lebanon lost some 75 percent of forest and woodland cover from 1968 to 1991, with continued losses in the past decade.

3.22 It is very difficult to provide a comprehensive estimate of the cost of degradation for all of these issues. An attempt, however, is made in this study to quantify some of the costs associated with some of the issues.

3.23 Agricultural land per capita in Lebanon is only 0.074 hectares (0.74 dunums), one of the lowest in the world. The country has a long agricultural history, spanning millenniums, as evidenced by mountainous stone-walled terraced land on the order of 100,000 hectares. However, as much as 40,000-60,000 hectares of this land is at various stages of degradation and in need of rehabilitation (Zurayk, 1992; 1994; World Bank, 1996). The Government of Lebanon's Green Plan has done much to rehabilitate terraced land over several decades, but much remains to be done. Zurayk and Moubayed (1994) estimated the productivity cost of terraced land degradation in Kfarselwan in terms of lost revenues. While comprehensive data are limited for degraded terraced land as a whole, the cost of degradation of 40,000-60,000 hectares in need of rehabilitation is estimated here at US$60 - 90 million per year, or 0.36-0.54 percent of GDP, based on approximate return on land for irrigated fruit trees and vegetables (see Table E and Annex I).

3.24 Quarries can cause various environmental impacts, including destruction

of natural vegetation and habitats, air pollution from dust, and a reduction in aesthetic value in and around such localities. There are more than 700 quarries in Lebanon, of which more than half are in Mount Lebanon province. Many of the quarries are abandoned with minimal or no rehabilitation, and many have been established with little consideration for the environment and surrounding human settlements.

3.25 While it would be a significant undertaking to assess the damage cost of all the quarries, the impact of four quarries on surrounding settlements in Mount Lebanon was assessed in this study. Measured as loss in land and apartment values (associated with a reduction in aesthetic value), the damage cost of three of the quarries that continues to affect surrounding settlements is estimated at US$90 million. As an annual damage cost, this corresponds to about US$9-10 million per year (see Annex III). While this assessment indicates a very high damage cost associated with the quarries surveyed, caution is warranted before extrapolating these costs to other quarries in Lebanon due to differentials in property prices and location. As a conservative estimate, the cost of degradation associated with the more than 700 other quarries is calculated as the value of the land that the quarries occupy. This is estimated at US$48 million. As an annual damage cost, this corresponds to US$5-6 million per year (see Table E and Annex I). In total, the annual damage cost of quarries is conservatively estimated at US$14-16 million, or about 0.1 percent of GDP.

3.26 In addition to quarries, uncontrolled construction and forest and rangeland degradation are also causes of land and environmental degradation in Lebanon. An attempt has been made in this study to capture some of the costs of this degradation in limited areas of Mount Lebanon. Based on estimates of the value that domestic and international tourists in Lebanon place on recreational opportunities and bird watching (Owaygen and Salame, 2002 in progress), the cost of degradation in the districts of Aaley, Kesrouan, and Maten in Mount Lebanon is conservatively estimated at US$4-14 million per year (see Table E and Annex I).

Table E. Land and Wildlife: Annual damage cost – mean estimate

Soil	Percent of GDP
Natural resources	
Soil erosion/terrace degradation	0.45%
Mount Lebanon quarries	0.10%
Mount Lebanon nature degradation	0.05%
Total	**0.60%**

F. WASTE

3.27 **Health and Quality of Life.** Uncollected municipal and household waste that may accumulate for shorter or longer periods in urban and rural areas pose a risk to health and impinge on the quality of life. Waste attracts rodents, flies and insects that may be vectors of infectious diseases and cause various allergies. Children in particular are a vulnerable group. In the absence of any studies in Lebanon on health effects, estimated damage cost is WTP for improved waste management, based on studies in other countries. Damage cost is estimated at US$8 million per year, or 0.05 percent of GDP (see Table F and Annex I).

3.28 Untreated industrial, hazardous, and health sector waste also pose a risk to health through water resources and land. No study in Lebanon has quantified the risk and damage. No damage cost estimate is therefore provided in this report.

3.29 **Natural resources.** Improperly disposed or stored waste may contaminate soil and water resources, reducing their value to society. While in some cases it may be significant, no study exists for Lebanon and given the complexity of the issue no estimate is provided in this study.

Table F. Waste: Annual damage cost -mean estimate

Waste	Parts au PIB
Health/Quality of life	
Municipal/household waste collection	0.05%
Municipal/household waste disposal	n.a.
Risks associated with industrial, hazardous and health sector waste	n.a.
Total	**0.05%**

G. COASTAL ZONES AND CULTURAL HERITAGE

3.30 **Natural resources.** The coastal zones and cultural heritage of Lebanon represent unique cultural, ecological, economic and recreational assets. Estimates of the annual cost of coastal zone degradation are presented in this report in terms of domestic recreation and international tourism, and losses in ecological and non-use value. For cultural heritage, no systematic assessment has been undertaken regarding the condition and degradation, if any, of cultural sites.

3.31 Lebanon has a coastline of more than 240 kilometers and more than 50 percent of the population is concentrated along the coast (ECODIT, 1997). Unfortunately, much of the coastal zone, including beach areas, is degraded by pollution (untreated municipal wastewater, seafront solid waste dumps, etc.) and uncontrolled development of resorts and vacation homes all the way to the shoreline. This has severely reduced its recreational and tourism value. The degradation is particularly severe in the areas around Beirut and Jounieh, but also other areas north of Beirut and around Tripoli. The only significant stretch of beaches and coastline that remains relatively unspoiled is in the southernmost part of Lebanon.

3.32 The cost of coastal degradation in terms of domestic recreation is estimated based on the additional cost of recreation associated with increased travel costs (time and vehicle cost) to areas with less or insignificant degradation. In particular, the population in and around Beirut, Jounieh, and Tripoli are traveling north and/or south for beach recreation because the coastal areas closest to them are polluted and uncontrolled development is limiting public access.

3.33 As part of this report, Owaygen (2002) conducted a survey on beach recreation in eight beach areas from Tripoli in the north to Tyre in the south. Based on the results of the survey, it is estimated that the additional costs for recreation associated with coastal degradation around Beirut, Jounieh and Tripoli amounts to US$9-12 million per year, or 0.05-0.07 percent of GDP (see Annex I).

3.34 For international tourism in Lebanon, much of it is concentrated around a relatively limited number of inland cultural and natural sites as well as entertainment and nightlife centers. Beach tourism for international visitors is limited and estimating the magnitude of beach tourism that might have been today if the coastal areas had been preserved and not degraded is difficult.

3.35 International studies that quantify the impact of environmental degradation on international tourist visits are also limited. Huybers and Bennett (2000) find that tourists may be willing to pay US$70 more per day for an unspoiled rather than a spoiled destination. However, the study does not assess nor quantify the loss in number of visitors due to environmental degradation.

3.36 An indication of the losses in international beach tourism due to coastal degradation in Lebanon may be provided by a comparison with tourism in Tunisia. Tunisia receives around 5 million tourists annually, most from Western Europe and to a limited extent from North America. Ninety percent of tourists go for coastal tourism. Adjusting for differences in price between Lebanon and Tunisia, the length of their coastlines, and their natural beaches, it is estimated that Lebanon may be losing US$70 million in international tourism revenues per year due to coastal degradation. This is more than 0.4 percent of GDP, and represents 6-7 percent of Lebanon's international tourism revenues (see Annex I).

3.37 To assess some of the losses in ecological and non-use values of the coast associated with pollution and uncontrolled development, a survey was undertaken as part of this report to estimate the value the Lebanese would place on restoration of Jounieh beach to ensure the survival of sea turtles facing extinction (Owaygen, 2003). The estimate was US$27 - 40 million per year for the population of Lebanon, or about 0.2 percent of GDP (see Annex I). This figure also includes the cost of degradation at Jounieh beach.

Table G. Coastal zones and cultural heritage: Annual damage cost – mean estimate.

Coastal zones, cultural heritage	Percent of GDP
Natural resources	
Domestic recreational losses	0.06%
International tourism losses	0.42%
Losses of ecological and non-use value	0.20%
Fishery losses due to pollution	n.a.
Total	**0.68%**

H. GLOBAL ENVIRONMENT

3.38 **Biodiversity**. Biodiversity losses are even more difficult to value. Estimates therefore differ greatly. In Madagascar, for example, a company developed two drugs from the rosy periwinkle of Madagascar's rainforest. These drugs have annual sales of US$100 million. Other estimates have put the value of an untested species at anywhere from US$44 to US$23.7 million. On a per-hectare basis, however, one estimate suggests that the value to drug companies is only about US$20 per hectare.[4] Because of the difficulty of arriving at a meaningful estimate, no estimate for the cost of biodiversity degradation in Lebanon has been included in this study.

3.39 **Climate change**. The international community has become increasingly concerned that certain gases released into the atmosphere – of which carbon dioxide is the biggest in many countries – are causing an increase in global temperatures that adversely impact local climates and cause polar ice meltdowns. In Lebanon, carbon dioxide emissions were about 16.3 million tons in 2000 (World Bank, 2001). At an international damage cost of US$20 per ton of carbon, this represents 0.5 percent of GDP per year (see Annex I). This figure is highly tentative and impacts of climate change will vary greatly from country to country. In the case of Lebanon, impacts may include coastal zone damage due to sea-level rise and adverse effects on agriculture and vegetation.

[4] *Ibid*.; Balvanera *et al*., 2001.

4. Cost of Remediation

A. INTRODUCTION

4.01 This chapter presents cost estimates for a limited number of remedial actions for much of the environmental category discussed in Chapter 3. The extent to which these remedial actions would restore environmental quality, however, remains uncertain. The following clarifications are warranted regarding the remedial action suggested and cost estimates presented in this chapter: (i) the cost estimates are not necessarily based on the most cost-effective or least-cost remedial actions or technologies; they represent overall cost estimates of actions that are likely to be necessary to reduce environmental degradation; (ii) the remedial action and cost estimates only partially correspond to environmental damage categories and further analysis is needed for a more accurate assessment of optimal remedial action (see Chapter 5 for further discussion) and (iii) the cost estimates of remedial action are annualized - at a 10 percent discount rate over the useful lifetime of the investments.

B. POLICY CONTEXT

4.02 While the focus of this chapter is on the cost of remediation, mainly on investments and programs, a discussion of policy context is warranted. Reducing degradation and protecting the environment should be viewed in the context of economic and sector policies, socioeconomic development and in the broader framework of environmental management.

4.03 Much can be gained from preventing degradation by evaluating the environmental impacts of policies and development plans. Eliminating price, tax and economic regulatory distortions can also benefit the environment if such distortions favor inefficient use of “dirty” resources or “dirty” industries.

4.04 Reducing degradation and protecting the environment also require strict enforcement of environmental legislation, public/private partnerships, environmental awareness raising, and local participation. Sound environmental management also requires that the roles of the public and the private sectors be clarified. The remedial actions discussed in this report should not necessarily be undertaken by the public sector. The private sector should not only bear the cost of remedying the pollution and degradation it causes but also provide a significant contribution to the delivery of environmental services.

C. WATER

4.05 **Health and quality of life.** The damage cost to health (DALYs lost), estimated in Chapter 3, is associated with inadequate clean water, sanitation, and hygiene. In addition, avertive expenditures were estimated (bottled water consumption) that are likely to reflect perceptions of inadequate potable water quality.

4.06 It is difficult to estimate the cost of actions required to mitigate the estimated negative impacts on health and provide potable water of a satisfactory quality. However, if the necessary improvement in potable water quality would cost an additional US$0.2 per cubic meter, the total annual cost would be 0.28 percent of GDP (see Table H and Annex I).

Table H. Water: Cost of remediation

Water	Percent of GDP
Health/Quality of life	
Potable water quality improvements	0.28%
Water network loss reductions	n.a.

D. AIR

4.07 **Health and quality of life.** The remediation cost of indoor air pollution in rural areas is based on the substitution of 50 percent of biomass energy with cleaner commercial energy at a cost of 0.12 percent of GDP (Annex I). Lower cost options might be available, such as improved ventilation and improved stoves and cooking arrangements, to reduce the need to switch to commercial energy.

4.08 Combating urban air pollution requires a comprehensive inventory of emissions and a careful assessment of mitigation options and costs. Only a few options are discussed in this study. Estimates of the overall cost of industrial air pollution control to comply with Lebanese standards are not readily available. Such actions are particularly important for industrial plants in the proximity of population centers. Remedial action to reduce urban air pollution from vehicles include cleaner diesel (0.05 percent sulfur) to reduce PM10 from diesel vehicles and facilitate the effectiveness of emission control technology that is available on newer vehicles. The cost of this option is estimated at about 0.02 percent of GDP per year (see Table I and Annex I). While Lebanon recently banned the use of light diesel vehicles, minibuses and pick-ups, there may still be significant benefits to using low-sulfur diesel for heavy trucks and large buses.

4.09 As the estimates provided in Chapter 3 indicate, lead pollution from leaded gasoline has significant negative impacts on health. The cost of switching to lead-free gasoline (for all remaining leaded gasoline vehicles used in Lebanon) is estimated at 0.17 percent of GDP per year. There is abundant evidence from other countries that older vehicles can be successfully modified to use lead-free gasoline.

4.10 Additional action that is necessary to reduce mobile source pollution include installation of catalytic converters on gasoline vehicles, at least on all new cars, and vehicle inspection and maintenance programs, especially for high-use vehicles. It is also likely that a scrappage program for old and highly polluting vehicles is necessary to improve urban air quality, as well as improved traffic management.

Table I. Air: Cost of remediation

Air	Percent of GDP
Health/Quality of life	
-substitution of biomass to commercial energy	0.12%
-industrial depollution	n.a.
-low sulfur diesel (for vehicles)	0.02%
-low sulfur heavy fuel oil	n.a.
-lead free gasoline	0.17%
-catalytic converters	n.a.
-vehicle inspection/maintenance	n.a.

E. LAND AND WILDLIFE

4.11 **Natural resources.** Zurayk (1992 and 1994) has provided estimates of US$3,000-10,000 per hectare for the cost of agricultural terrace rehabilitation. Applying the mean cost of this range to the number of hectares estimated to be in need of rehabilitation (40,000-60,0000 hectares), the annualized cost of rehabilitation is estimated at some US$35 million per year, with a mean estimate of 0.2 percent of GDP. This is based on annualizing rehabilitation investments over 30 years at a 10 percent discount rate.

4.12 For quarries, the SOER provides an estimate of the cost of mitigation measures and rehabilitation for a medium-sized quarry. However, further assessment would be required to estimate the cost of mitigating the impact on property prices of the quarries surveyed as part of this study. Therefore no estimate is provided here.

Table J. Land and wildlife: Cost of remediation

Soil	Percent of GDP
Natural resources	
-terrace rehabilitation/soil erosion control	0.2%
-quarries (rehabilitation and mitigation)	n.a.

F. WASTE

4.13 **Health and quality of life.** The remediation cost of waste management includes improvements in municipal waste collection and disposal, industrial waste, hazardous waste, and health sector waste. No estimate of these costs is presented in this study.

Table K. Waste: Cost of remediation.

Waste	Percent of GDP
Health/Quality of life	
-municipal waste	n.a.
-industrial waste	n.a.
-hazardous waste	n.a.
-health sector waste	n.a.

G. COASTAL ZONES AND CULTURAL HERITAGE

4.14 **Natural resources.** The protection and preservation of coastal zones and cultural heritage involve multidimensional actions. In this study, only the cost of wastewater treatment has been assessed. Based on estimates that a population of 2.3 million live in Lebanon's coastal zone, the cost of wastewater treatment would amount to about US$34 million per year, or 0.2 percent of GDP, if the cost of treatment is around US$0.4 per cubic meter (see Annex I). However, this does not include the cost of industrial wastewater treatment or other sources of coastal pollution.

H. GLOBAL ENVIRONMENT

4.15 The cost of protecting the global environment, in terms of climate change and biodiversity, has not been estimated. The cost of such action depends largely on the willingness and cooperative agreements of the international community.

5. A Comparison of Damage & Remediation Costs and Conclusion

A. INTRODUCTION

5.01 This chapter provides a discussion and comparison of the benefits of reducing environmental damage and the cost of achieving such reductions (remediation cost).

5.02 In making such comparisons, a note of caution is warranted:

i. environmental damage is unlikely to be completely eliminated no matter how stringent and comprehensive the remedial actions are.
ii. the remedial actions discussed in Chapter 4 are in most cases insufficient to adequately address the damage.
iii. quantification of environmental damage and their monetary valuation can never be completely accurate (Chapter 2) and the cost of remedial action is most often only an estimate;
iv. the principle of marginal analysis needs to be applied in order to arrive at remedial action that is likely to provide the greatest benefits per unit of cost.

5.03 Nevertheless a comparison of benefits (reductions in damage) and costs (remedial action) can be useful to point out the environmental categories in which the benefits of remediation are likely to substantially exceed the cost of remedial action. However, for a more accurate assessment, further analysis of any particular area or category would be necessary.

B. A COMPARISON BY ENVIRONMENTAL CATEGORY

5.04 **Water.** Evidence from international literature indicates that remedial action to address the negative impacts on health from unclean water, sanitation and hygiene are likely to reduce negative impacts on health by 50-60 percent (Esrey et al., 1991) and cost-effective interventions are generally available. However, a more detailed assessment of specific action would be helpful in identifying the most cost-effective measures in Lebanon, given that child mortality and diarrheal mortality is relatively low.

5.05 In the case of avertive expenditures on bottled water associated with the perception of poor municipal water quality, the estimated expenditures (about 0.5 percent of GDP) are equivalent to about US$0.3 per cubic meter of municipal water supply (at 150 liters per capita per day). While the cost of improving municipal water quality may not be insignificant, it would not be surprising if sufficient improvements could be made at substantially less than US$0.3 per cubic meter.

5.06 **Air.** This is the environmental category with the highest estimated damage cost in this report. To address the impacts on health from indoor air pollution in rural areas, the only remediation action for which a cost estimate is provided in this report is replacement of 50 percent of biomass fuel use with commercial energies. If such fuel substitution reduces indoor air pollution by 50 percent, it is not clear from the estimates in Annex I that health benefits will generally outweigh the cost. However, the damage cost estimate is tentative and deserves an in-depth analysis with more detailed household data on biomass use, indoor air quality, and health conditions. Moreover, remedial action such as improved ventilation and stoves should be evaluated.

5.07 An assessment of the benefits and costs of urban air pollution remediation is as complex as for indoor pollution. It involves a careful assessment of pollution loads across

various sectors and activities, and assessment of a whole menu of actions for each sector and activity. While the negative impacts on health of air pollution concentrations are often found to be relatively linear (i.e., the marginal benefits from reductions are relatively constant), cost per unit of pollution reduction varies substantially across potential remedial actions (rising marginal costs).

5.08 The first step in an assessment is a pollution load inventory (emission inventory) followed by an estimate of contributions to air pollution concentrations of loads from different sources. The next step is the cost assessment of a menu of potential emission-reduction actions to derive marginal costs that can be compared to the estimated marginal benefits of emission reductions. In practice, this is far from an exact science. However, a careful assessment is likely to reveal those actions for which benefits most likely outweigh costs.

5.09 In this report, costs have been estimated only for a few air pollution remedial actions (see Chapter 4). For instance, the health benefits of clean diesel (low sulfur) for heavy diesel road vehicles can outweigh the costs if combined with standards for emission control technology for new diesel vehicles. The health benefits per unit of cost would also be higher if the markets for diesel fuel can be effectively separated (which may allow for higher sulfur diesel in geographic areas with limited air pollution or in certain sectors). Lvovsky et al. (2000) provides estimates of the health damage cost from diesel fuels whereas the Morocco Environment Review by the World Bank provides a benefit-cost analysis of clean diesel for Casablanca (see Larsen 1997).

5.10 In terms of lead pollution from leaded gasoline, a comparison of benefits and costs can be made based on estimates in this report. The damage cost of lead pollution from transport in Beirut is estimated at 0.17 - 24 percent of GDP, while the cost of switching to lead-free gasoline is estimated at 0.17 percent for all of Lebanon. These estimates indicate that the health benefits of lead-free gasoline outweigh its higher cost, especially if the increased use of lead-free gasoline is targeted in the larger urban areas. Estimates provided by Hoshisho and El-Fadel (2001b) indicate significantly higher benefits relative to costs.

5.11 **Land and wildlife.** The damage cost of agricultural terrace degradation is estimated at 0.36-0.54 percent of GDP, while the cost of rehabilitation is estimated at around 0.2 percent of GDP. This indicates that the benefits of rehabilitation outweigh the cost of rehabilitation by a significant margin. Differences, however, across geographic areas in Lebanon necessitate that cost-benefit analysis be undertaken for specific areas.

5.12 **Waste.** Sufficient estimates to compare the costs and benefits of improved waste management are not provided in this report due to data limitations.

5.13 **Coastal zone and cultural heritage.** The damage cost and remediation cost analysis for coastal zones and cultural heritage undertaken in this report is insufficient for a comparison of costs and benefits of remediation and protection. It should be noted, however, that coastal zones and cultural heritage in Lebanon are unique assets that provide recreation for local people and income from international tourism. However, the analysis does suggest that the damage cost of coastal zone degradation is significant and it highlights the importance of protecting the remaining coastal areas that are not overdeveloped and degraded.

C. CONCLUSION

5.14 This study indicates that the cost of environmental degradation in Lebanon is in the range of 2.3-3.6 percent of GDP with a mean estimate of 2.9 percent. This is substantial and about 1.5 times higher than in high-income countries. The main reasons for this are: (i) a significant disease burden (mortality and morbidity) and avertive expenditures associated with a lack of safe water and sanitation and inadequate hygiene; (ii) substantial negative impacts on health from severe air pollution; and (iii) the significant cost of land and coastal resources degradation.

5.15 This report also suggests that Lebanon would benefit significantly from remedial action to protect and restore the quality of the environment, although estimates are tentative. Further analysis of costs and benefits of select environmental issues considered priority areas by the Government of Lebanon would facilitate the process of priority setting and improved environmental management as well as promote intersectoral support for action. Future cost analyses of importance should include a more in-depth assessment of the impacts of environmental quality on tourism and recreation (coastal and inland), a cost-benefit analysis of urban air pollution, and the cost of land resources degradation (agriculture, quarries and construction, and deforestation).

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Annex I Damage Costs Estimate & Annex II Remediation Costs Estimate are provided in a separate Excel File

Annex III

Forest and Woodland Degradation Costs in Lebanon

The percentage of forest and woodland cover in Lebanon decreased from 8 percent in 1968 to around 2 percent in 1991 (El-Haber, 1991). In the last decade, a further decrease in this cover took place. Numerous factors are responsible for this degradation. The major ones are:

i. **Massive tree cutting** for fuel wood collection and charcoal production. Often, those with licenses to prune oak forests cut trees. The lack of efficient control by the authorities responsible for natural resource management aggravates this problem.
ii. **Unplanned and uncontrolled housing construction countrywide** over the past twenty years has led to significant, irreversible losses of forest and woodland. These losses are most obvious in Mount-Lebanon province.
iii. **Wood fires in the dry season** (descriptive data from the Ministry of Environment still to be collected).
iv. **Quarries:** at least, 710 quarries are spread across the country. Half are located in Mount-Lebanon province.
v. **Irrational road construction** in rural areas.

The economic cost of forest and woodland degradation in Lebanon encompasses the cost of the loss of their:

i. Existence value
ii. Indirect use value: ecological functions
iii. Direct use value: recreational value, for example.

In this report, the degradation cost of forests and woodland will be limited to the loss of recreational value (through quarries and unplanned construction) in Aaley, Kesrouan and Maten districts in Mount-Lebanon province. The cost should be considered a minimum estimate because it does not cover the recreational value of the remaining 21 districts in the country nor the loss of existence value and indirect use value of the degraded forest and woodland.

Mount-Lebanon province shows the highest density of quarries in the country with an average of 1.87 quarries per 1,000 hectares (Table 1). The districts of Aaley, Kesrouan and Maten have the highest densities (3.03, 2.38 and 2.20 quarries per 1,000 hectares, respectively) compared to other districts in the province. The high potential of these three districts for nature-based tourism, due to their diverse landscapes, special topography and unique rock formations, has been largely destroyed, mainly by massive, unplanned construction and quarries.

The preliminary results of on-going research work (Owaygen and Salamé, 2002) reveal the interest of visitors to Jeita Cave in nature-based tourism in the Ftouh-Kesrouan region (Kesrouan district). This region has potential since its environment is relatively undisturbed compared to the three districts mentioned earlier. Based on the 2002 tourism survey, the recreational value of the Ftouh-Kesrouan region is estimated to be US$3,387,000 annually, assuming the current visitors' pattern to Jeita Cave continues (see below for more details). If it is assumed that other regions in these three districts have the same recreational value as the Ftouh-Kesrouan region, then the cost of environmental degradation (through quarries and construction) to these regions is US$3,387,000 annually.

Table 1: Density of quarries (number per 1,000 hectares) in Lebanon's provinces

Provinces	Districts	Total area (hectares)	Number of Quarries	Density of quarries (per 1,000 hectares)
Bekaa	Baalbek	235,287	36	0.15
	Rashaya	53,710	15	0.28
	Western Bekaa	41,424	29	0.70
	Hermel	56,716	0	0.00
	Zahle	41,960	58	1.38
	Total	**429,097**	**138**	**Average: 0.32**
Mount Lebanon	Aaley	26,730	81	3.03
	Baabda	19,843	20	1.01
	Chouf	47,615	38	0.80
	Jbail	41,185	87	2.11
	Kesrouan	34,447	82	2.38
	Maten	26,829	59	2.20
	Total	**196,649**	**367**	**Average: 1.87**
North Lebanon	Akkar	79,787	28	0.35
	Batroun	27,580	59	2.14
	Besharri	16,068	19	1.18
	Koura	18,103	14	0.77
	Tripoli	2,676	21	7.85
	Zgorta	17,457	13	0.74
	Total	**161,671**	**154**	**Average: 0.95**
South Lebanon	Jizzine	24,521	11	0.45
	Saida	26,856	3	0.11
	Sour	39,797	18	0.45
	Total	**91,174**	**32**	**Average: 0.35**
Nabatieh	Bint Jbeil	27,164	6	0.22
	Hasbaya	21,615	2	0.09
	Marjayoun	25,738	1	0.04
	Nabatieh	30,296	10	0.33
	Total	**104,813**	**19**	**Average: 0.18**

These figures should be considered minimum estimates because:

i. The Ftouh-Kesrouan region represents less than 5 percent of the total area of the three districts. Therefore the recreational value (before degradation) of the other regions is expected to be much higher.
ii. The aggregation is only based on the visitors to Jeita Cave, which represents a very conservative estimate.

If the average willingness for international tourists to pay to visit Jeita Cave and other sites in the Ftouh-Kesrouan region is aggregated with the total number of international tourists to Lebanon in 2001, then the degradation cost of the three districts would be some US$12,322,000 per year, assuming the same trends in international visitors continues.

Quarries Survey in Mount-Lebanon Province

A quarries survey was conducted during November 2002. The survey aimed to assess the impact of quarries on land and housing prices. Five study areas were selected in Mount-Lebanon province. It is important to note that all functioning quarries in Lebanon ceased operation in November 2002 due to a governmental decree issued September 26, 2002.

Study area 1: The Nahr Ibrahim quarry is located at the entry of the Nahr Ibrahim valley. There are two villages in this valley. One is relatively close to the quarry (Bizhol) and the second (Yahchouch) is farther away. The following information is based on an interview with a real estate agent from the village Bizhol:

- Work in the quarry started in 1985-1987 and stopped in 1998.
- The quarry negatively affected Bizhol village because works at the quarry produced dust and "overdose" explosions caused structural cracks in houses.
- There has been a negative impact on land prices.

Currently, the price of land overlooking the quarry seems to be unaffected. However, in the past the quarry reduced the price of land behind it and along the valley by around 32 percent (a decrease from $22 to $15 per square meter). Since the quarry is located at the entrance to the valley, the trucks transporting stones caused traffic jams and made the valley unattractive as a residential area. Valley residents suffered daily traffic jams when commuting to work and traveling outside the valley. The affected land area (marketable for housing) totals some 2,000,000 square meters.

Impact on land prices: The decrease in land prices (at the time when the quarry was functioning) and resulting loss is: 2,000,000 m^2 x ($22-$15) = US$14,000,000.

Study area 2: The quarry of Shnanaayer is located in the hills facing the bay of Jounieh. These hills are the most expensive places in the country for housing given their special overlook on the bay of Jounieh. The following information is based on an interview with the vice president of the municipality of Shnanaayer:

- The Shnanaayer quarry functioned in two periods: between 1972 and 1979 and in 1998. In 1998, the work was very intensive and the main damage occurred during this year. "Overdose" explosions were used to intensify the extraction of stones. As result, the sewage system (sewage pits) in the village was damaged. Reparation costs are estimated at US$180,000. Of this amount, US$80,000 has already been paid by households.

Impact on land prices: The average land price is $175 per square meter. Land overlooking the quarry is priced at an average of $50 per square meter. The total area affected by the quarry is estimated to be 600,000 square meters. The decrease in land prices and resulting loss is:
600,000 m^2 x ($175-$50) = US$75,000,000.

Impact on apartment prices: The average price for apartment space is $500 per square meter. Some 180 apartments (with an average of 200 square meters per apartment) in the region overlook the quarry. Prices dropped from $500 to $275 per square meter on average. The decrease in apartment prices and resulting loss is: 180 apartments x 200 m^2 x ($500-$275) = US$8,100,000.

Study area 3: The quarry of Abou-Mizan is located in a deep valley relatively far from Beirut and its surrounding urban coastal zones. No villages are located near the quarry. However, several villages are located on top of the surrounding mountains and they overlook the quarry. Before the civil war, people from Beirut spend summer holidays here since it was cooler. The following information is based on interviews with the mayors of Chirin and Bteghrine villages:

- Work in the quarry started in 1981 and ended in 2001. The average land price near the quarry is $40 per square meter.
- "Overdose" explosions cracked 200 houses and increased dust in the villages. Reparation costs for 20 years of damage is estimated to be US$100,000 (200 x $500 per house).

Impact on land prices: The average land price is $40 per square meter. 175,000 square meters (in four villages) overlook the quarry. The price of this land dropped from $40 to $32.5 per square meter. The decrease in land prices and resulting loss is: 175,000m^2 x ($40-$32.5) = US$1,312,500.

Study area 4: Antelias quarry is in the hills overlooking Beirut. Due to its proximity to the capital, the region is highly attractive for housing. The following information is based on interviews with a real estate agent (from Raboueh, a village facing the quarry) and a member of the municipality of Kornet Chahwan.

- The average price of apartments is $625 per square meter. Around 50 apartments (with an average of 150 square meters per apartment) in the region overlook the quarry. Prices dropped from $625 to $525 per square meter on average.
- The average price of land is $150 per square meter. Land overlooking the quarry is priced at an average of $100 per square meter. The total area affected by the quarry is estimated to be 100,000 square meters.

Impact on apartment prices: The decrease in apartment prices and resulting loss is:
50 apartments x 150 m^2 ($625-$525) = US$750,000.

Impact on land prices: The decrease in land prices and resulting loss is:
100,000 m^2 x ($150-$100) = US$5,000,000.

Study area 5: Nahr El Mawt quarry is the closest to Beirut. The following information is based on an interview with the head of the municipality of Jdaide:

- The quarry of Nahr El Mawt is one of the oldest quarries in Lebanon. The work in this quarry started in the 1940s.
- The area near the quarry is classified as an industrial zone. The long existence of the quarry (with no formal housing activities nearby) has probably enhanced this classification. Unlike study areas 2 and 3 there is no official demand for housing, however, there are numerous buildings at the edge of the quarry. They belong to low income groups migrating from Bekaa province.
- Since this is an industrial zone, land prices are relatively high (an average of $300 per square meter).
- The existence of the quarry has no negative impact on land prices.

Conclusion: Based on this survey, the cost of environmental degradation resulting from these five quarries, in terms of a decrease in land and apartment prices, amounts to US$90,162,500. This cost covers only the decrease in real estate prices as a result of the deterioration of the aesthetic value of the landscape in 5 selected regions. This price decreases range from 16 percent to 71 percent for land and 16 percent to 45 percent for apartments overlooking quarries. The impact of quarries on real estate prices (land and apartments) seems to be high in regions located close to urban coastal zones between Jounieh and Beirut as well as in mountainous regions, relatively far away from the coastal zone, but well known as summer residential centers.

The quarries surveyed could be considered among the most important in the country (in terms of deterioration of landscape) bordering the high-density urban coastal zone (study areas 2, 4 and 5) and a popular inland location (study area 3). Therefore, the impact of these quarries on real estate prices in other areas with quarries should not be generalized countrywide where the demand for housing and land may be less.

Cost Assessment of Bird Hunting in Lebanon

Geographically, Lebanon lies on the great migration routes of three continents and is bounded to the west by the sea and to the east by arid land. Thus, it constitutes a bridge where most migrating birds tend to concentrate (Khairallah, 1985). This migration takes place twice a year from the north to the south and vice-versa. This section will focus on predatory birds for their aesthetic importance,

especially during migration. At least five million raptors are estimated to fly above Lebanon annually (Serhal and Bruun, 1988). When soaring over the country from the north, the birds span 45 kilometers before spreading over the whole country Such a number of birds, with a tremendous degree of diversity over a relatively small area, gives Lebanon a high touristic potential for bird watching (Owaygen, 1999). This potential could have an international dimension since bird watching is one of the fastest growing wildlife recreational activities.

The preliminary results of on-going research work (Owaygen, 2002) estimated the recreational value of migratory bird watching in the Shouf Cedar Reserve to be US$43,500 annually assuming the current number of visitors continues. This figure should be considered a minimum estimate since the average willingness to pay of tourists interviewed tourists for bird watching was aggregated by the total number of visitors to the reserve in the survey year, 2001. The preliminary results of additional on-going research work (Owaygen and Salamé, 2002) assessed the recreational value of migratory birds in the Ftouh-Kesrouan region to be US$428,800 annually, assuming the current number of visitors to the Jeita Cave remains the same. This figure should be also considered a minimum since the average willingness to pay for bird watching by tourists interviewed was only aggregated by the total number of visitors to the Jeita Cave in the survey year.

If the average willingness to pay of international tourists to Jeita Cave for a bird watching day in the Ftouh-Kesrouan region is aggregated with the total number of international tourists to Lebanon in 2001, then the recreational value of bird watching would be US$1,645,700 per year, assuming the same number of international visits for bird watching continues in the future. Bird hunting is prohibited in Lebanon, however, this has not stopped people from killing hundreds of thousands of birds – raptors, storks, and protected species - each year during the migration season. This illegal and massive hunting, spread over the whole country, reflects negatively on the recreational value of natural sites in general and on the bird watching potential in particular. Depending on the aggregation level, the cost of bird hunting ranges, as mentioned above, from US$43,500 to US$1,645,700 annually. This cost includes only losses in the recreational value of bird watching and does not cover the loss of the existence value of birds, especially endangered species, nor the loss of their ecological value. Therefore, both figures should be considered as minimum estimates, also taking into consideration the conservative approach of the aggregation.

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