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Arab Republic of Egypt
Cost Assessment of Environmental Degradation
Sector Note

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Rural Development, Water and Environment Department
Middle East and North Africa Region

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Currency Equivalents

(Exchange rate effective June 13, 2002)

Currency Unit = Egyptian pound (LE)
US$1.00 = 4.61 LE

Fiscal Year

July 1 – June 30

Acronyms

DALY	Disability Adjusted Life Year
DC	Damage Cost
EEAA	Egyptian Environmental Affairs Agency
LE	Egyptian Pound
GDP	Gross Domestic Product
METAP	Mediterranean Environmental Technical Assistance Program
NEAP	National Environmental Action Plan
PM10	Particulate Matters
RC	Remediation Cost
UNDP	United Nations Development Program
USAID	United States Agency for International Development
US$	US dollar
WHO	World Health Organization
WTP	Willingness-to-Pay

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Country Director:	Mahmood Ayub
Sector Director:	Letitia A. Obeng
Sector Manager:	Salah Darghouth
Task Team Leader:	Maria Sarraf

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Contents

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Abstract

This report is a first step in a process towards the use of environmental damage cost assessments for priority setting and as an instrument for integrating environment 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 would be required for more accurate estimates.

The damage cost of environmental degradation in Egypt in 1999 is estimated at LE 10-19 billion per year, or 3.2-6.4 % of GDP, with a mean estimate of LE 14.5 billion or 4.8% of GDP. In addition, the damage cost to the global environment is estimated at 0.6% of GDP. The cost of air pollution is assessed at LE 3.3 – 9.6 billion or 1.1-3.2% of GDP (urban outdoor and rural indoor), followed by soil degradation at LE 3-4.2 billion or 1.0-1.4% (erosion and salinity). In the area of water, the damage cost is estimated at LE 2.1-3.6 billion or 0.7-1.2% of GDP (mostly from the lack of safe water, sanitation, and hygiene). Cost of coastal zone degradation is estimated at LE 0.6-1.2 billion or 0.2-0.4% of GDP, and inadequate waste management at around LE 0.6 billion or 0.2% of GDP. Of total damage cost about 2/3 is from damages to health and 1/3 from natural resource degradation. It should be noted that no cost estimate is provided for degradation associated with industrial, hazardous and hospital waste, as sufficient data were unavailable. Similarly, cost assessment of degradation associated with inadequately treated wastewater is limited due to data constraints.

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

Executive Summary

INTRODUCTION

The 1990's were a groundbreaking decade for environmental management and protection in Egypt, a decade with environmental programs and activities that encompassed, at least to some extent, all areas of the environment. However, challenges remain. There has until now been no systematic quantification of the health and natural resource cost of these challenges. The number of areas such as the ones found in Egypt, with a continuing environmental degradation has been increasing.

Most recently on May 28, 2002, H.E. President Hosni Mubarak met with members of the cabinet and three governors regarding the strategy for environmental action up to 2017. In addition to emphasis on improvement in key environmental areas (such as air pollution, water quality, and water re-use), it was also stressed that integration of environmental management and economic development should be strengthened.

This report is a first step in a process supported by the Mediterranean Environmental Technical Assistance Program (METAP) towards the use of environmental damage cost assessments as an instrument for integrating environment into economic development. This initiative is supported by the Swiss Agency for Development and Cooperation.

The specific objectives of this report are three-fold:

(a) provide a first order estimate of the cost of environmental degradation in Egypt with the most recent data available (1999);

(b) provide an analytical framework that can be applied periodically by professionals in Egypt to assess the cost of the environmental degradation over time; and

(c) provide a basis for a training program for ministries, agencies, institutes and other interested parties to incorporate assessments of the cost of environmental degradation in policy making and environmental management.

The next step in the process is to develop a training manual 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 benefits and costs, of environmental actions in priority areas.

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

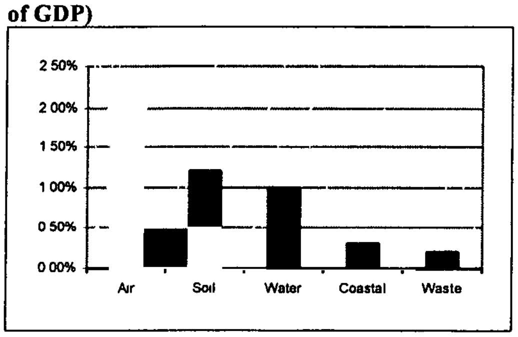
The estimates of environmental damage cost and remediation cost should be considered as orders of magnitude. As areas of priority are identified, further analysis would be required for more accurate estimates. Nevertheless, the estimates presented in this study indicate the severity and magnitude of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

COST OF ENVIRONMENTAL DEGRADATION

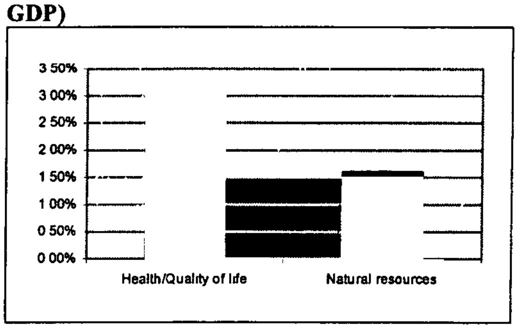
The damage cost of environmental degradation in Egypt in 1999 is estimated at LE 10-19 billion per year, or 3.2-6.4 % of GDP, with a mean estimate of LE 14.5 billion, or 4.8% of GDP. In addition, the damage cost to the global environment is estimated at 0.6 % of GDP.

Estimated damage costs have been organized by environmental categories, and are presented in the Table and the first Figure (not including the global environment). The second Figure presents the same mean estimates by economic categories, indicating that the cost to health and quality of life is about 3.2% of GDP, followed by 1.6% for natural resources.

Annual cost of environmental degradation by environmental categories (mean estimate as % of GDP)



Annual cost of environmental degradation by economic categories (mean estimate as % of GDP)



The most significant impacts on health and quality of life are caused by urban air pollution especially in Cairo (0.7-2.3% of GDP, with a mean of 1.5% of GDP), followed by diarrheal diseases and mortality (0.5-1.1% of GDP, with a mean of 0.8% of GDP) primarily affecting children, caused by lack of access to safe water and sanitation, and inadequate domestic, personal and food hygiene. This is followed by health impacts of indoor air pollution in rural areas from biomass fuel use (0.15-0.5% of GDP). The last category is waste management with potential impacts on health from uncollected municipal waste. Moreover, the health cost of air pollution from burning practices of waste in Cairo is estimated at 0.2-0.5% of GDP (included in urban air pollution). It should be noted that no cost estimate is provided for degradation associated with industrial, hazardous and hospital waste, as sufficient data were unavailable.

The report also suggests that urban air pollution may cause a reduction in

Annual cost of environmental degradation (mean Estimate)

	Million LE per year	Percent of GDP
Air	6,400	2 1%
Soil	3,600	1 2%
Water	2,900	1 0%
Coastal zones and cultural heritage	1,000	0 3%
Waste	600	0 2%
Sub-Total	**14,500**	**4.8%**
Global environment	1,900	0 6%
Total	**16,400**	**5.4%**

international tourist visits. Based on limited evidence from Asia, it is estimated that tourism losses in Cairo are on the order of 0.2-0.3% of GDP.

The cost of natural resource degradation is predominantly from agricultural soil degradation (1.1-1.4% of GDP) caused by salinity and erosion, followed by coastal zone degradation (0.25-0.4% of GDP) associated with losses in coastal zone tourism due to degradation of coral reefs and coastal water pollution.

COST OF REMEDIATION

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 on 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, socio-economic development, and in the broader framework of environmental management.

Much can be gained from prevention of degradation through evaluating 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 proper enforcement of environmental legislation, public/private partnerships, environmental awareness raising, and local participation. Sound environmental management also requires that the role of the public and the private sector 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 damages) and costs (remedial actions) of environmental protection and improvement can be useful in order to point to environmental issues for which benefits of remediation are likely to exceed the cost of remedial actions.

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

(a) Environmental damages are unlikely to be completely eliminated no matter how stringent and comprehensive are the remedial actions;

(b) The remedial actions discussed in Chapter 4 are in most cases insufficient to adequately address the damages;

(c) Quantification of environmental damages and their monetary valuation can never be completely accurate (Chapter 2), and the costs of remedial actions are often rough estimates; and

(d) The principle of marginal analysis needs to be applied in order to obtain remedial actions that are likely to provide the largest benefits per unit of cost.

CONCLUSION

This study indicates that the cost of environmental degradation in Egypt is in the range of 3.2-6.4% of GDP, with a mean estimate of 4.8%. This is substantial and on the order of two times higher than in industrialized countries. The main reasons for this is: (i) a significant disease burden (mortality and morbidity) associated with lack of safe water and sanitation and inadequate hygiene behavior; (ii) substantial health impacts of severe air pollution; and (iii) productivity losses associated with soil degradation that amount to a significant percentage of GDP, given that agricultural share of GDP is many times higher in Egypt than in high-income countries.

This report also indicates that Egypt would benefit significantly from remedial actions to protect and restore environmental quality, although estimates are tentative. Further analysis of benefits and costs of select environmental issues that are considered priority areas by the Government of Egypt would facilitate the process of priority setting and improved environmental management, as well as promote inter-sectoral support for action. As the damage cost of urban air pollution has been relatively well assessed in several studies, future damage cost analysis should include more in-depth assessment of impacts of environmental quality on tourism (and impacts of tourism on the environment), on soil and water resources management, as well as the health impacts of indoor air pollution.

1. Introduction

A. BACKGROUND

1.01 Egypt, as all countries in the region and the world, has long faced environmental degradation and threats that impinge on the health of the population and the economic development process.

1.02 In 1992, Egypt prepared its first National Environmental Action Plan (NEAP 1992) that provided a comprehensive assessment of the environmental situation in the country and identified key areas of priority actions. In 1994, it adopted a comprehensive law for the protection of the environment – Environmental Law No 4. Since then, industrial and urban pollution mitigation, especially, has taken place on a significant scale, although challenges remain.

1.03 A new ministry of environment was created in 1997 as well, and significant progress was made to strengthen local capacity for environmental management. A comprehensive NEAP update and an environmental profile were completed in 2002.

1.04 As a whole, the 1990's and the beginning of this new decade have been a groundbreaking period for environmental management and protection in Egypt with environmental programs and activities that encompassed at least to some extent all areas of the environment. In accordance with a report prepared for EEAA by the Organization Support Program (OSP) in August 2001, international donors and international financial institutions provided an amount of LE 2.4 billion from 1991 to 2001 to improve environmental management

1.05 Most recently on May 28, 2002, H.E. President Hosni Mubarak met with 11 Members of the Cabinet and three Governors regarding the strategy for environmental action to 2017. In addition to emphasis on improvement in key environmental areas, it was also stressed that integration of environmental management and economic development should be strengthened.

B. COST OF ENVIRONMENTAL DEGRADATION

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

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

1.08 During the 1990's, several country specific studies were also undertaken in the region, which provided estimates of the cost of environmental degradation for specific environmental issues or a subset of issues. These include studies commissioned by METAP, UNDP, USAID, the World Bank and others in Algeria, Egypt, Iran, Lebanon, Morocco, and Syria.

C. RATIONALE AND OBJECTIVES

1.09 In Egypt, there has not been until now any quantification of the health and natural resource cost of remaining environmental challenges. Furthermore, the local capacity to undertake such quantifications is limited, as in so many other countries. An increase in such a capacity could provide an added instrument towards a better understanding of the magnitude of the cost to society of environmental degradation in various sectors. This in turn could help improving the continuing process of environmental priority setting, and to achieve reductions in the overall cost of environmental degradation with less public and private sector resources.

1.10 This report is a first step in a process supported by METAP towards the use of environmental damage cost assessments as an instrument in environmental management.

The specific objectives of the report are three-fold:

(a) provide an estimate of the cost of environmental degradation in Egypt with the most recent data available (1999);

(b) provide an analytical framework that can be applied periodically by professionals in Egypt to assess the cost of the environmental degradation over time; and

(c) provide a basis for a training program for ministries, agencies, institutes and other interested parties to incorporate assessments of the cost of environmental degradation in policy making and environmental management.

1.11 A training manual that builds on the analytical framework, environmental categories, and results and conclusions of this report was also developed. This manual will be used in a series of training programs in Egypt and other MNA countries that will concentrate on in-depth analysis of environmental damage assessments, and benefits and costs of environmental actions in priority areas.

D. THE PREPARATION PROCESS

1.12 The study commenced in December 2000 in Egypt with discussions and initial data collection. A senior Egyptian expert was included in the process of the study to contribute to completing the data collection and provide professional expertise. A draft of the study was presented and discussed with participants at a seminar at EEAA in December 2001.

1.13 In the process of study preparation, a review of relevant published literature and documents was carried out, and data from various Government of Egypt documents and statistical data, economic and sector work by the World Bank, and reports and data from various international agencies were utilized.

1.14 Constructive discussions were also held in Cairo for exchanging ideas, opinions, and specific information under the auspices of METAP and the EEAA. Two teams were established – a local team for accompanying the preparation of the study, and an external team for revising the draft of the study. In addition, a connection was established with researchers at Cairo University (Center for Economic and Financial Research and Studies).

2. Methodological Framework

A. DEFINITION

2.01 This report provides first order estimates of the cost of environmental degradation in Egypt, 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.

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

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

(a) 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);

(b) economic losses (e.g.: reduced soil productivity and reduced value of other natural resources, lower international tourism); and

(c) loss of environmental opportunities (e.g.: reduced recreational values of lakes, rivers, beaches, forests for the population).

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 often useful to compare the cost of degradation to GDP in order to assess their relative magnitude over time.

2.06 If the cost of degradation as a percentage of GDP is growing 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 its 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:

(a) quantification of environmental degradation (e.g.: monitoring of ambient air quality, river/lake/sea water quality, soil pollution);

(b) quantification of the consequences of the degradation (e.g.: health impacts of air pollution, changes in soil productivity, changes in forest density/growth, reduced natural resource based recreational activities, reduced tourism demand); and

(c) 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 The report has utilized available information on the quantification of environmental degradation in Egypt, and information that has been available on the consequences of degradation. In limited cases for which no information was available on the consequences of degradation, expert opinions have been utilized as to the likely consequences and their magnitudes.

C. CATEGORIES OF ANALYSIS

2.10 In order to estimate the cost of environmental degradation for the various areas of the environment, the analysis and estimates have been organized by the following categories:

(a) water
(b) air
(c) soil
(d) waste
(e) coastal zones and cultural heritage, and
(f) the global environment

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

(a) health/quality of life, and

(b) natural resources.

D. CONSEQUENCES OF DEGRADATION

2.12 Several methodologies or approaches have been applied to provide a quantitative estimate of the consequences of environmental degradation (for details, see Annex I). However, an elaboration of some issues is warranted here.

2.13 Health impacts of 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, health impacts are primarily estimated based on ambient air quality data in Cairo and international studies of health impacts of 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 health impacts, i.e. the cost of a DALY lost have been valued by two approaches. GDP per capita has been used as benchmark, in some cases as the lower bound of the range estimate and in other cases 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 the 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% of GDP per capita has been applied to reflect the lower income among the household population that suffer from higher rates of child mortality. This valuation range has been applied to child mortality (and morbidity) from inadequate 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 United States and Europe, and has been adjusted by the GDP per capita differential to Egypt. 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, the consequences of environmental degradation have not been quantified. A cost of degradation can therefore not be estimated. This is the case for inadequate industrial waste management, most wastewater pollution and coastal degradation (tourism losses and a rough estimate of fishery losses have been provided to partially reflect the cost of degradation) and cultural heritage preservation.

2.23 Finally, all estimates of costs of environmental degradation and remedial actions 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 COSTS AND REMEDIATION COSTS

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

2.25 As stated previously, 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 the current environmental degradation. As the remedial actions for which costs have been estimated are limited, it remains uncertain to what extent the remedial actions would restore environmental quality. Thus any comparisons of degradation costs and remediation costs (i.e. potential benefits compared to costs of environmental improvements) should be undertaken with great care and needs a more detailed assessment before it can be intelligently utilized 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 actions. Only in specific and limited cases can it be expected that the incremental benefit of an additional remedial action is about the same as for a previous action. In most cases, however, becomes increasingly costly to improve environmental quality. Thus benefits and costs of each action should ideally 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 actions to improve the environment beyond this point would result in a net welfare loss.

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

3. Cost Assessment of Environmental Degradation

A. INTRODUCTION

3.01 This chapter presents the estimates of the cost of environmental degradation (DC for damage cost) based on the methodologies outlined in Chapter 2. Damage cost is presented for each of the following environmental categories:
(a) water
(b) air
(c) soil
(d) waste
(e) coastal zones and the cultural heritage
(f) the global environment.

3.02 For each of these categories cost estimates are presented for:
(a) health/quality of life, and
(b) 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 Egypt, that precise data or estimates on the consequences of environmental degradation are unavailable or incomplete, and that the valuation of these consequences are very rough estimates. Furthermore, estimates of the cost of environmental degradation do not include all environmental areas because of lack of data and difficulties in quantifying impacts. This is particularly, but not limited to incomplete or absent assessment of solid waste (industrial, hospital waste), water resources pollution, and coastal zone degradation.

3.04 Calculations of each of the estimates of environmental damage costs can be found in the Annexes as percentages of GDP in 1999 and as total LE figures. Summaries of these estimates are presented here in terms of annual cost of degradation. Although presented as annual costs, in many areas of the environment damages may be irreversible and impact the opportunities, livelihood, and quality of life of future generations. Moreover, the estimated annual costs are likely to impact the people and natural resources of Egypt to varying extent in terms of geographical regions and impacts on poverty. Assessments of these issues are beyond the scope of this report, and should be considered in sector studies in the future. A brief qualitative discussion of these issues is provided at the end of this chapter.

B. TOTAL COST OF DEGRADATION

3.05 The damage cost of environmental degradation in Egypt in 1999 is estimated at LE 10-19 billion per year, or 3.2-6.4 percent of GDP, with a mean estimate of LE 14.5 billion, or 4.8% of GDP. The damage cost to the global environment is estimated at 0.6 percent of GDP. Mean estimates of these costs are presented in Table 3.1 and Figure A. (exclusive of global environment) for each environmental category.

3.06 By economic category, the cost to health and quality of life is about 3.2% of GDP and 1.6% for natural resources as seen in Figure B.

Table 3.1 Annual cost of environmental degradation -mean estimate

	Million LE per year	Percent of GDP
Air	6,400	2 1%
Soil	3,600	1 2%
Water	2,900	1 0%
Coastal zones, cultural Heritage	1,000	0 3%
Municipal Waste	600	0 2%
Sub-Total	**14,500**	**4.8%**
Global environment	1,900	0 6%
Total	**16,400**	**5.4%**

Figure A. Annual cost of environmental degradation by environmental categories (mean estimate as % of GDP)

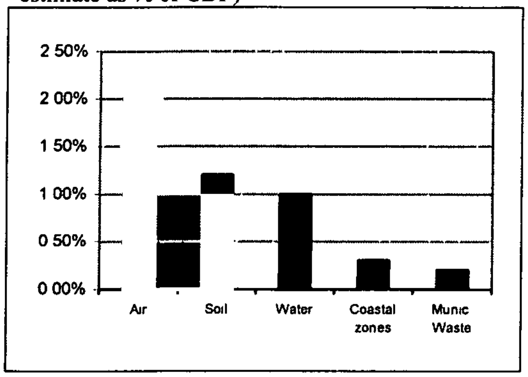
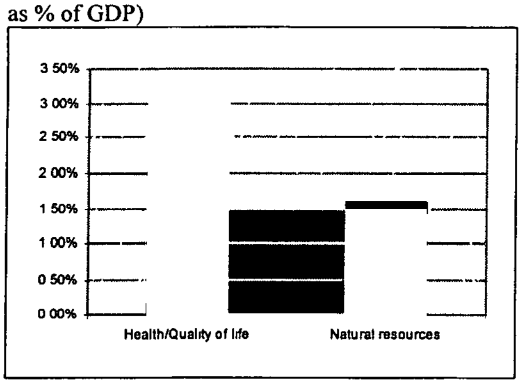


Figure B. Annual cost of environmental degradation by economic categories (mean estimate as % of GDP)



C. WATER

3.07 **Health and quality of life.** It is estimated that more than 17,000 children die (20% of all child deaths) every year in Egypt from diarrheal diseases. The main causes are sub-standard drinking water quality, inadequate quantity and quality of water for personal and domestic hygiene, inadequate sanitation facilities and sanitary practices, and inadequate personal, food and domestic hygiene behavior. This represents an annual loss of about 615,000 disability adjusted life years (DALYs).[1] The same factors are also responsible for a burden of infectious disease morbidity among children and adults, such as intestinal worm infections, schistosomiasis, and non-fatal diarrheal episodes. Non-fatal diarheal episodes among children are estimated at more than 60,000 DALYs per year. Thus, more than 675,000 DALYs are lost each year. A DALY valued at a range of 50-100% of GDP per capita[2], implies a damage cost of 0.5-1.1 % of GDP per year.

3.08 In addition, pollution of coastal waters, river areas and lakes by industry, sewerage, and agriculture is reducing the recreational value and quality of life of the citizens of Egypt. The damage cost to quality of life is estimated at 0.07% of GDP per year. This estimate is based on international evidence of the willingness-to-pay (WTP) of individuals for quality of recreational areas, which implies LE 3.5 per month per urban household in Egypt. Total damage cost to health and quality of life is therefore estimated at about 0.9% of GDP (mean estimate) per year (see Table 3.2. and Annexes I and II).

3.09 **Natural resources.** The assimilative capacity of ecosystems in Egypt is reduced due to billions of cubic meters of untreated/partially treated wastewater discharges. Most water bodies like the Northern lakes and the Nile River have economic and ecological value. Once polluted or contaminated, either the use of such water bodies is restricted or more sophisticated wastewater treatments are required. Only damages in terms of fishery losses have been estimated here (close to 0.1% of GDP), although damages likely extend to the agricultural sector (see Table 3.2. and Annex I). Implications for the coastal areas are included in the coastal zone section.

Table 3.2 Water: Annual damage cost – mean estimate.

Water	Percent of GDP
Health/Quality of life (mortality, morbidity, quality of life)	0 9%
Natural resources (damages to ecosystems from municipal and industrial wastewater)	0.1%
Total	**1.0%**

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

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

D. AIR

3.10 **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 impacts on public health in terms of premature death, bronchitis, respiratory disorders, and even cancer. Indoor air pollution, especially in rural areas, can be even higher than outdoor/urban air pollution do to indoor use of biomass fuels for cooking and heating. The most significant air pollutant in terms of health impacts is most commonly found to be particulate matter, especially fine particulates (PM10 or smaller).

3.11 No study that statistically links urban air pollution and health, based on local health data, has been carried out in Egypt. However, applying the findings from international studies to the local air pollution situation in Egypt can produce an estimate. Based on annual average concentration levels of PM10 monitored in Greater Cairo and a rough estimate for Alexandria (no accurate monitoring data are available), it is estimated that on the order of 20,000 people are dying prematurely every year due to urban air pollution in the two metropolitan areas (mainly because of very high PM10 concentrations in Cairo). Combined with illnesses (morbidity) from air pollution, an estimated 450,000 DALYs are lost each year. This corresponds to 0.7-2.3% of GDP per year, based on valuation of a DALY equal to GDP per capita as a lower bound and WTP as an upper bound (based on WTP studies from the United States and Europe adjusted by GDP per capita differentials to Egypt). Further details are provided in Chapter 2 and Annexes I and II.

3.12 For indoor air pollution in rural Egypt, there is no air quality monitoring data available. However, a household survey from 1993 indicates that 30-40% of rural households rely partially on biomass for cooking and heating (biomass fuel use in Egypt is estimated at 3% of total energy consumption). Based on a methodology and risk assessments from other countries presented in Smith (2000), it is estimated in this report that health damage of indoor air pollution is 85,000 - 180,000 DALYs per year, or 0.15-0.5% of GDP per year (see Chapter 2 for valuation methodology, and Annexes I and II for details).

3.13 In addition to detectable health effects of 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 0.04% of GDP per year in Egypt (Annex I).

3.14 Another source of damage cost of air pollution is impacts on international tourism in Cairo. Based on limited research evidence from other countries, tourism losses in Cairo are estimated at 0.2-0.35% of GDP (Annex I).

3.15 In total the damage cost of air pollution on health and quality of life (including tourism losses) is estimated at 1.1-3.2% of GDP per year with a mean estimate of 2.1% (see Table 3.3).

Table 3.3 Air: Annual damage cost - mean estimate

Air	Percent of GDP
Health/Quality of life (mortality and morbidity from urban and indoor air pollution, quality of life)	2.1%
Natural resources (impacts on agricultural productivity)	n a
Total	**2.1%**

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

E. SOIL

3.17 **Natural Resources.** Soil degradation in the form of erosion/desertification and salinisation is in many areas of Egypt affecting agricultural productivity. It is estimated that about 20% of cultivated land suffers from soil erosion/desertification, or about 1.5 million feddans. An estimated 25-35% of potential crop value is lost. Based on an average crop value per feddan of LE 4.45 thousand per year, the damage cost of erosion/desertification is estimated at 0.6-0.8% of GDP per year (see Annex I).

3.18 In addition to erosion/desertification, it is estimated that about 35% of agricultural land is suffering from salinisation. An estimated 10-15% of potential crop value is lost. At the same average crop value per feddan as above, the damage cost of salinisation is estimated at 0.4-0.6% of GDP per year (see Annex I). In total, the damage cost of soil degradation is estimated at 1.0-1.4% of GDP per year, with a mean estimate of 1.2% (see Table 3.4.). It should be noted that both of these estimates are highly tentative and do not reflect geographical differences.

Table 3.4 Soil: Annual damage cost – mean estimate

Soil	Percent of GDP
Natural resources (soil erosion/ desertification, and salinisation)	1 2%
Total	**1.2%**

F. MUNICIPAL WASTE

3.19 **Health and Quality of Life.** Uncollected municipal/household waste that may accumulate for shorter or longer periods in urban and rural areas poses a risk to health and impinges on the quality of life. Waste attracts rodents, flies and insects that may be vectors of infectious diseases and can cause various allergies. Children may in particular be a vulnerable group. In the absence of any studies in Egypt on health effects, estimated damage cost is WTP for improved waste management, based on studies in other countries. Damage cost is estimated at around 0.2% of GDP per year (see Table 3.5 and Annex I).

3.20 Waste burning is substantial in Cairo and contributes significantly to the urban air pollution. Based on estimated overall contribution of waste burning to air pollution (Lowenthal et al., 2001) and the health impacts presented in the section on Air, the damage cost of waste burning is estimated at 0.2-0.5%[3].

3.21 Untreated industrial, hazardous, and health sector waste also pose a risk to health through water resources and land. No study in Egypt has quantified these risks and damages. No damage cost estimate is therefore provided in this report.

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

Table 3.5 Waste: Annual damage cost -mean estimate

Municipal Waste	Percent of GDP
Health/Quality of life	
Uncollected municipal waste	0.2%
Air pollution from burning of waste in Cairo (0.2-0.5% of GDP, already estimated as part of health impacts of urban air pollution)	n a
Risks associated with industrial, hazardous and health sector waste	n a
Total	**0.2%**

G. COASTAL ZONES AND THE CULTURAL HERITAGE

3.23 **Natural resources.** The coastal zones and the cultural heritage of Egypt represent unique cultural, economic and recreational assets. They attract both domestic and international tourists, thus their quality is important to sustain tourism and provide a basis for tourism growth. Coral reefs around Hurghada at the Red Sea have become degraded. A review of tourism statistics indicate that recent growth in tourism at the Red Sea has shifted towards tourists from origins that are likely to spend less per day than Western European tourists that constitute the largest share of tourism days. Based on a

[3] This figure is not included in Table 3 5 as it is already reflected in the estimated health damages in the Air section.

study by Huybers and Bennett (2000) on WTP for environmental quality, it is estimated in this report that tourism losses due to environmental degradation at the Red Sea are on the order of 0.2-0.3% of GDP (see Annex I).

3.24 Coastal degradation around Alexandria from wastewater pollution is also likely to cause tourism losses. Based on the same methodology as in the preceding paragraph, losses are estimated at around 0.05% of GDP.

3.25 In addition, coastal water pollution and degradation is also likely to affect fisheries. A tentative estimate of 0.03-0.04% of GDP is presented in this report. In total, the damage cost of coastal zone degradation is estimated at almost 0.3-0.4% of GDP per year (see Table 3.6 and Annex I).

3.26 An additional cost of degradation is the cost inflicted on domestic tourism and recreation of reduced quality of coastal zones and cultural heritage. This has not been estimated, but some of it may be reflected in the estimated WTP for recreational quality in the water section.

Table 3.6 Coastal zones and the cultural heritage: Annual damage cost – mean estimate.

Coastal zones, cultural heritage	Percent of GDP
Natural resources Tourism losses due to degradation of coastal zones and cultural heritage	0 3%
Fishery losses due to pollution	0 04%
Total	**0.34%**

H. GLOBAL ENVIRONMENT

3.27 **Biodiversity**. Biodiversity losses are difficult to value. Therefore, estimates differ greatly. For example, two of the drugs, developed by a company from the rosy periwinkle from Madagascar's rain forest, have sales of US$100 million a year. Other estimates have put the value of an untested species at anywhere from US$44 to US$23.7 million a year. On a per-hectare basis, one estimate suggests that the value to drug companies is only about US$20 per hectare[4]. Because of the difficulty of estimation, no assessment of the cost of biodiversity degradation in Egypt has been included in this study.

3.28 **Climate change**. The international community of nations has become increasingly concerned that certain gases released into the atmosphere – of which carbon dioxide is the most important in many countries – are causing an increase in global temperatures with adverse effects on local climates and polar ice meltdowns. In Egypt, carbon dioxide emissions are about 100 million tons per year. At an international damage cost of US$20 per ton of carbon, this represents 0.6% 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 Egypt, impacts may include coastal zone damages due to sea level rise, adverse effects on coral reefs and agriculture, and possibly implications on Nile water availability.

I. FUTURE GENERATIONS AND POVERTY

3.29 Environmental degradation in each of the six environmental categories studied in this report can be expected to have different impacts on future generations as well as on the poor. Table 3.7 presents a very generalized view of these issues. While the cost of environmental degradation that impacts health may be expected to primarily affect the current generation (if pollution is curbed), the impacts on natural resources can often be irreversible, or have much longer effects, and therefore negatively impact future generations.

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

Table 3.7 Impacts on Future Generations and the Poor.

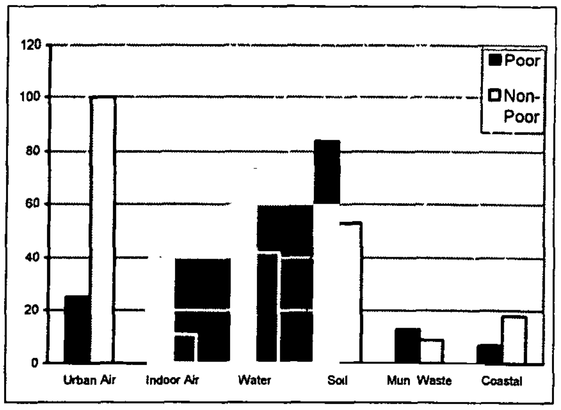
	Future Generations	Poverty
Water		
-Health	L	H
-Ecosystems	H	L to H (?)
Air		
-Health (indoor air)	L	H
-Health (urban air)	L	L
Soil		
-Salinization/erosion/ desertification	H	L to H (?)
Waste		
-Municipal collection	L	H
-Munic waste disposal	L to H (?)	L to H (?)
-Industrial/hospital	H	?
Coastal/cultural		
-Marine environment	H	L (?)
-Ecosystems	H	L (?)
Global environment		
-Climate change	H	H (?)
-Biodiversity	H	L to H (?)

L= expected low impact, H= expected high impact "?" indicates that further assessment is needed to draw any conclusions

3.30 In terms of the impact of environmental degradation on the poor, a detailed assessment would be required to estimate how much of the environmental damage cost is burdening the poor relative to the non-poor. Table 3.7 provides a general indication of environmental issues that are likely to disproportionately affect the poor, given the current environmental situation in Egypt. A question mark indicates that further investigation is needed to ascertain the situation.

3.31 The recently completed report "Poverty Reduction in Egypt-Diagnosis and Strategy" (GOE/World Bank 2002) indicates that about 17 percent of the Egyptian population was poor in year 2000. By region, only 5 percent of the population of Cairo was poor, while poverty rates in several governorates in Upper Egypt exceeded 30 percent. Based on the data in the poverty reduction report and additional data at the governorate level, a very preliminary and tentative estimated index of the per capita cost of environmental degradation is presented in Figure C. As suggested in Figure C, the poor are disproportionately burden by environmental degradation regarding indoor air pollution, water (mortality and morbidity related to water, sanitation and hygiene), soil degradation, and municipal waste collection. In terms of urban air pollution, the non-poor are most affected because so few of the poor live in Cairo and Alexandria. The cost of coastal degradation is also disproportionately affecting the non-poor because most of the poor live in inland areas (more than 65 percent live in Upper Egypt). It should be emphasized that Figure C is only indicative, and further studies are needed in order to provide more accurate estimates. In particular, the estimated cost for the poor and non-poor regarding soil degradation is at this point very uncertain.

Figure C: Index of Per Capita Cost of Environmental Degradation – Poor vs Non-Poor.



4. Cost of Remediation

A. INTRODUCTION

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

B. POLICY CONTEXT

4.02 While the focus of this chapter is on cost of remediation and 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, socio-economic development, and in the broader framework of environmental management.

4.03 Much can be gained from prevention of degradation through evaluating 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 proper enforcement of environmental legislation, public/private partnerships, environmental awareness raising, and local participation. Sound environmental management also requires that the role of the public and the private sector 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 water, sanitation, and hygiene. Estimated remediation cost has three components: (a) the cost of providing improved water source and safer sanitation to the portion of the population without such services. This cost is annualized on the basis of per capita investment cost, discounted at 10% over 25 years; (b) the cost of improving/rehabilitating/upgrading the water supply and sewage system wherever considered necessary to avoid cross-contamination of the water network from leakages in the systems or contamination of water wells. This cost is calculated as 10% of the total construction/investment cost of the water and sewage networks for year 1-10, plus 5% of total networks cost for year 11-20, annualized at a discount rate of 10% and (c) the cost of household and community hygiene education programs at LE 15 per household per year (see Annex I for more details).

4.06 The total annualized cost of these remediation components is estimated at around 0.5% of GDP per year. The largest portion the cost is associated with the rehabilitation/upgrading component. However, this component will save substantial water network losses. Savings are estimated at almost 0.2% of GDP, which substantially reduces the net cost of rehabilitation/upgrading (see Table 4.1 and Annex I).

Table 4.1 Water: Cost of remediation

Water	Percent of GDP
Health/Quality of life	
Water, sanitation investment and hygiene programs	0.48%
Water network savings	-0 18%
Natural resources (municipal and industrial wastewater treatment)	0.44%

4.07 **Natural resources.** As discussed in Chapter 3, partially treated and untreated municipal and industrial wastewater is impacting the ecosystems in Egypt. About 0.9 billion cubic meters of polluted/contaminated municipal wastewater per year and 0.17 billion cubic meters of industrial wastewater per year to the Northern lakes, the Nile Delta and Fayoum are accounted for. The remediation cost is estimated at more than 0.4% of GDP, based on the cost of treatment of municipal and industrial wastewater (Table 4.1 and Annex I). Cost of treating wastewater discharges into the Mediterranean Sea and coastal areas are dealt with in the section Coastal zones and the cultural heritage.

D. AIR

4.08 **Health and quality of life.** Remediation cost of indoor air pollution in rural areas is based on substitution of 50% of biomass energy to cleaner commercial energy at a cost of 0.17% of GDP (Annex I). Lower cost options might be available (such as improved ventilation, stoves and cooking arrangements) that may reduce the need to switch to commercial energy.

4.09 Remedial actions to reduce urban air pollution from mobile sources and industry include cleaner diesel (0.05% sulfur) to reduce PM10 from diesel vehicles and facilitate effectiveness of emission control technology available on newer vehicles in the market; and industrial de-pollution for compliance with environmental legislation. The cost of these options is estimated at about 0.15% of GDP per year (see Table 4.2 and Annex I).

4.10 Additional actions that are likely necessary to reduce mobile source pollution, but have not been assessed in this study, are pollution reductions from gasoline vehicles by installation of catalytic converters, at least on all new cars, and vehicle inspection and maintenance programs in particular for high usage vehicles.

4.11 Burning of waste is estimated to contribute as much as 20% to the total pollution load of PM10 in Cairo (Lowenthal et al., 2001). In this case, improved waste management and control will be important in order to reduce the urban air pollution.

4.12 Energy efficiency improvements, at least for users of mazut and diesel, can also contribute to air quality improvements. Based on energy audits, 5% of energy consumption could be saved at a net saving of around 0.2% of GDP (Annex I).

Table 4.2 Air: Cost of remediation

Air	Percent of GDP
Health/Quality of life	
-substitution of biomass to commercial energy	0 17%
-industrial depollution	0 11%
-low sulfur diesel (for vehicles)	0 03%
-control of waste burning	n a
-catalytic converters	n a
-vehicle inspection/maintenance	n a

E. SOIL

4.13 **Natural resources.** While the damage cost of soil erosion/desertification and salinisation is estimated to be significant, the cost of remedial actions is very difficult to assess because it is likely to vary substantially across geographic areas. For soil salinisation, the cost will also depend on upstream irrigation and drainage etc. However, there are some cost estimates available per hectare of agricultural land and these have been applied to estimate the total remediation cost, despite the difficulties of assessing geographic cost variations, and should therefore be considered very tentative and only an order of magnitude. Cost of remediation is presented in Table 4.3, based on LE 10,000 per hectare for soil erosion/desertification control and LE

15,000 per hectare for salinisation control, annualized over 30 years at 10% discount rate (see Annex I).

Table 4.3 Soil: Cost of remediation

Soil	Percent of GDP
Natural resources	
-soil erosion control	0.5%
-soil salinisation control	1 5%

F. WASTE

4.14 **Health and quality of life.** Remediation cost of waste management includes uncollected municipal waste, and treatment and safe disposal of industrial waste, hazardous waste, and health sector waste. The cost of collection of uncollected municipal waste is based on an estimated 8 million tons per year of uncollected waste (based on rural and urban collection rates) at LE 30 per ton, corresponding to 0.08% of GDP per year (see Annex I). The highest cost of waste management regards untreated industrial waste. Waste treatment is estimated at almost 0.3% of GDP. Cost of hazardous waste and health sector waste treatment is estimated at 0.03% and 0.01% of GDP respectively (see Annex I).

Table 4.4 Waste: Cost of remediation.

Waste	Percentage of GDP
Health/Quality of life	
- uncollected municipal waste	0 08%
- industrial waste	0 30%
- hazardous waste	0 03%
- health sector waste	0 01%
- control of waste burning	n a

G. COASTAL ZONES AND THE CULTURAL HERITAGE

4.15 **Natural resources.** The protection and preservation of coastal zones and the cultural heritage involve multidimensional actions. In this study, only the cost of wastewater treatment has been assessed, not accounting wastewater that is included under natural resources in the water section. The cost of municipal and industrial waste-water treatment – an estimated portion that may not be already treated – is estimated at about 0.2% of GDP per year based on estimated treatment cost per cubic meter of industrial and municipal waste-water (see Annex I). Cost of cultural heritage protection has not been assessed in this study.

H. GLOBAL ENVIRONMENT

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

5. A Comparison between Damage & Remediation Costs and Conclusion

A. INTRODUCTION

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

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

(a) environmental damages are unlikely to be completely eliminated no matter how stringent and comprehensive the remedial actions are;

(b) remedial actions discussed in Chapter 4 are in most cases insufficient to adequately address the damages;

(c) quantification of environmental damages and their monetary valuation can never be completely accurate (Chapter 2), and the costs of remedial actions are most often only estimates; and

(d) principle of marginal analysis needs to be applied in order to arrive at remedial actions that are likely to provide the largest benefits per unit of cost.

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

B. COMPARISON BY ENVIRONMENTAL CATEGORIES

5.04 **Water.** Evidence from the international literature indicates that the remedial actions discussed in Chapter 4 to address health impacts of inadequate water, sanitation and hygiene are likely to reduce the health impacts by 50-60% (Esrey et al., 1991). This suggests that the health benefits of these actions are on the order of 0.3-0.6% of GDP based on estimated damage cost in Chapter 3 (see also Annex I). The overall cost of remedial actions is estimated at 0.3% of GDP. However, from a point of view of marginal analysis (see Chapter 2), health benefits per LE of remediation cost is likely to be highest for a well designed and targeted hygiene improvement program, as well as safe water and sanitation provision to the population groups without such services, indicating that benefits of these actions will well exceed the cost.

5.05 Health benefits per LE of cost of water and sewage rehabilitation/upgrading of existing networks is generally likely to be lower than the two former actions, suggesting that the health benefits of rehabilitation/ upgrading may not outweigh the cost, except in locations with serious problems. However, a more careful analysis of this action may find that other benefits, such as increased reliability and quantity of water delivery, can in many instances justify the cost.

5.06 In the natural resource category (impacts on ecosystems), estimated cost of remediation (municipal and industrial waste-water treatment) by far exceeds estimated benefits (reductions in damage cost). However, several considerations should be made on this issue. For one, the damage cost estimates are very tentative and incomplete. And second, potential negative impacts of water pollution on agriculture are not assessed.

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

5.08 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 health impacts of air pollution concentrations are often found to be relatively linear (i.e., marginal benefits of reductions are relatively constant), cost per unit of pollution reduction vary substantially across potential remedial actions (rising marginal costs).

5.09 The first step of an assessment is a pollution load inventory (emission inventory) followed by an estimate of contributions to air pollution concentrations of loads from different sources. This has been carried out for Cairo. The next step would be the cost assessment of a menu of potential emission reduction actions, to derive marginal costs that could be compared to 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 the costs.

5.10 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 road diesel vehicles can outweigh the cost, in particular 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 use 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 of diesel fuels whereas the Morocco Environment Review by the World Bank provides a benefit-cost analysis of clean diesel for Casablanca. An Energy-Environment Review study for Egypt (draft final report) has confirmed that diesel and heavy fuel oil are responsible for high damage costs in Egypt.

5.11 Waste burning in and around Cairo has been identified as an important source of air pollution (see Lowenthal et al., 2001). If improved waste collection can significantly contribute to solving this problem, health benefits are by far likely to outweigh the incremental cost. Based on Lowenthal et al (2001), it is estimated in this report that the damage cost of waste burning in Cairo could be on the order of 0.2-0.5% of GDP. In addition, estimated household WTP for improved waste collection nationwide is on the order of 0.2% of GDP, while cost of improved collection is estimated at close to 0.1% of GDP.

5.12 The main benefits of select energy efficiency improvements are likely to be economic (see Chapter 4 and Annex I), as well as global from reductions in carbon emissions. The benefits to urban air pollution reductions are likely to be limited in comparison to other available remedial actions.

5.13 **Soil.** If the available data on erosion, salinisation and cost of remediation are reasonably correct, benefits of erosion control outweigh the cost of control measures, while this is not the case for salinisation control. However, the available data reflect averages for Egypt and it is likely to find geographic areas for which benefits of both erosion and salinisation control outweigh control cost. Further analysis is required for a more complete assessment of these complex issues. This is particularly important because agricultural employment is about one-third of total employment in Egypt, and agriculture is an important economic sector, and with important poverty alleviation implications.

5.14 **Waste.** As discussed in the section on Air above, estimated WTP for improved municipal waste collection (which reflects the value that households place on such improvements) exceeds estimated cost by a factor of two. By including the health benefits of reducing waste burning, benefits compared to cost of collection improvements estimated in this report are even higher. However, the estimate of WTP and cost of collection improvements is a national average. Thus the analysis should be undertaken in more specific urban-rural contexts.

5.15 Analysis of benefits of industrial waste management has not been undertaken in this report because of data limitations.

5.16 **Coastal zone and the cultural heritage.** The analysis undertaken in this report on damage costs and remediation cost of coastal zones and cultural heritage is insufficient for a comparison of benefits and costs of remediation and protection. It should be noted, however, that the coastal zones and cultural heritage in Egypt are unique assets that provide a significant source of income from international tourism. These assets are also important for recreation and domestic tourism. However, the analysis does suggest that damage cost of coastal zone degradation is significant, and that coastal zone protection is perhaps especially important for the Red Sea. With continuing to allow growth in the field of tourism, it is important that measures are taken to protect the very resource base that tourism depends on. An analysis of the value of coastal zone protection to domestic recreation and tourism should also be undertaken to improve the understanding of necessary remedial and protective actions.

C. CONCLUSION

5.17 This study indicates that the cost of environmental degradation in Egypt is in the range of 3.2-6.4% of GDP, with a mean estimate of 4.8%. This is substantial and on the order of two times higher than in high-income countries. The main reasons for this is: (i) a significant disease burden (mortality and morbidity) associated with lack of safe water and sanitation and inadequate hygiene behavior; (ii) substantial health impacts of severe air pollution; and (iii) productivity losses associated with soil degradation that amount to a significant percentage of GDP, given that agricultural share of GDP is many times higher in Egypt than in high income countries.

5.18 This report also indicates that Egypt would benefit significantly from remedial actions to protect and restore environmental quality, although estimates are tentative. Further analysis of benefits and costs of select environmental issues that are considered priority areas by the Government of Egypt would facilitate the process of priority setting and improved environmental management, as well as promote intersectoral support for action. Future cost analysis of importance should include a more in-depth assessment of the impacts of environmental quality on tourism, soil and water resources management and indoor air pollution in the context of rural poverty and health as well as in the context of waste burning and urban air pollution.

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Economic Data 1999 *(The World Bank)*	
Population	63,000,000
GDP LE (current)	300,000,000,000
GDP $ (current)	89,000,000,000
GDP/CAPITA $	1,413
LE/USD Exchage Rate Dec 99	3 39

ABREVIATIONS

LE = Egyptian Pound hsld = household inhab = inhabitant ca = per capita
q = quintal t = metric ton ha = hectare n a = non available 1 feddan = 4 201 m²
DALY = Disability Adjusted Life Year
WTP = Willingness-to-pay

Damage Costs

WATER	Method	Quantity		Unit	Price		Unit	Million LE/yr		% of GDP		Notes / Sources
Health/Quality of life		Low	High		Low	High		Low	High	Low	High	
- Inadequate Water, Sanitation, Hygiene	DALYs	675,000		DALYs	2,400	4,800	LE/ DALY	1,620	3,240	0 5%	1 1%	DALYs are lost each year in Egypt due to poor water quality, insufficient water quantity, and inadequate sanitation and hygiene *(see Esrey et al 1991 for a review of worldwide studies)* DALYs are estimated based on a (under 5 year) child mortality rate of 54 per 1000 live births in 1999 (WDI, World Bank 2001) and an estimated diarrheal child mortality equivalent to 20% of child mortality (based on regional data from WHO/World Bank 2001), and diarrheal episodes/illnesses of 1 per month among children 0-14 years of age (expert estimate, EEAA) Valuation (price) per DALY is GDP per capita (high), and 0 5*GDP per capita (low) to reflect income differentials of the bottom 50% of the population Diarrheal child mortality is disproportionately among the latter half of the population (data on income distribution is from WDI, World Bank 1995)
- Quality Losses – Recreational Use	WTP	4,800,000		Urban Households	42		LE/ household/ yr	202	202	0 07%	0 07%	It is assumed that households are willing to pay for improving the quality of water for recreational use This is based on various studies showing a willingness-to-pay for recreational use of water Georgiu et al , Economic Values and the Environment in the Developing World, 1997 Data on number of urban households are from the 1996 Census WTP of LE 3 5 per month per household in Egypt is based on Egyptian expert opinion
								1,822	**3,442**	**0 6%**	**1 1%**	
Natural Resources												
-Impacts on Ecosystems	Fishery losses	10%	15%	Percent losses per year	2,000,000,000		LE per year	200	300	0 07%	0 10%	Partially and untreated municipal and industrial wastewater, and agricultural drainage water is significantly polluting fresh and brackish waterbodies The NEAP 2002 and Environmental Profile 2002 discuss this situation and impacts on fish resources but no quantitative estimate of impacts is presented A fishery reduction of 10-15% is stipulated here to provide a perspective on the potential value of losses due to pollution Value of annual fresh and brackish water fish catch (price) is from the NEAP and Environmental Profile
								200	**300**	**0 07%**	**0 10%**	
	Damage Costs							**2,022**	**3,742**	**0 7%**	**1 2%**	
	Damage Costs (mean estimate)							**2,882**		**1 0%**		

AIR	Method	Quantity		Unit	Price		Unit	Million LE/yr		% of GDP		Notes / Sources
Health/Quality of life		Low	High		Low	High		Low	High	Low	High	
	DALYs children	65,000	120,000	DALYs	2,400	4,800	LE/ DALY	222	444			
- Health - Indoor Pollution										0 14%	0 5%	Indoor air pollution, especially from biomass fuel is known to cause significant health damages A methodology presented in Smith (2000) is applied to Egypt (see Annex IV) A household survey in Egypt in 1993 (see World Energy Council) shows that 30% of rural households use biomass energy for heating and 40% use biomass for cooking For children, valuation (price) per DALY is GDP per capita (high), and 0 5*GDP per capita (low) to reflect income differentials of the bottom 50% of the population, which is the part of the population that uses most of the biomass energy For women, valuation (price) per DALY is GDP per capita (low), and WTP (high) to reduce the risk of death of adults (US/Europe estimates adjusted by GDP per capita differentials to Egypt)
	DALYs adult women	20,000	60,000	DALYs	4,800	28,000	LE/ DALY	192	1,120			
	DALYs mortality	200,000		DALYs	4,800	28,000	LE/ DALY	960	5,600			
- Health-Urban Air Pollution										0 7%	2 3%	DALYs are based on air pollution of PM10 in Greater Cairo and Alexandria using available dose response functions from worldwide studies of the health impacts of air pollution (*see Ostro 1994 for an application to Jakarta*) Annual average PM10 in Greater Cairo is 270 ug/m3 (based on available monitoring data) PM10 monitoring data for Alexandria is not available, and has been assumed to be 100 ug/m3 About 92% of total DALYs are in Greater Cairo because of the higher air pollution and larger population Valuation (price) per DALY is GDP per capita For mortality, WTP to reduce the risk of death of adults is used as a "high" (US/Europe estimates adjusted by GDP per capita differentials to Egypt)
	DALYs morbidity	250,000		DALYs	4,800	4,800	LE/ DALY	1,200	1,200			
- Quality of life - Discomfort from Urban Air Pollution	WTP	960,000		20% Urban Households	120		LE/ household/ yr	115	115	0 04%	0 04%	According to a contingent valuation method applied to urban households in Rabat-Salé, Morocco by Belhaj *(Göteborg University)*, the WTP by households/month for increased comfort from lower ambient air pollution is assessed at $6/month The classification of economies (Egypt, Morocco) by income is the same *WDI, World Bank, 2001* Given that some of this WTP is already included in heath costs, 50% (3 $/household/month) is retained to avoid double counting 20% of urban households were used (data on the number of total households is from the 1996 Census)
- Health/Economic losses-Urban Air Pollution	International Tourism Losses-Cairo	700,000	1,050,000	Tourist day reductions per year	425	475	LE/ day	298	499	0 10%	0 17%	Health threatening urban air pollution such as in Cairo can be expected to reduce international tourism demand Glover and Jessup (1999) estimated that the haze-related air pollution from forest fires in Indonesia in 1997-98 caused a reduction in international tourist arrivals of 30% in Malaysia, 15-22 5% in Indonesia, and 10% in Singapore (adjusted for the financial crises) Based on Cairo's share of total international tourist days in Egypt for 1999 (World Tourism Organization and Egypt Central Agency for General Mobilisation and Statistics), a range of 10-15% reduction in tourist days (quantity) in Cairo has been applied and valued at average tourist expenditure per day for 1997-1999 as an estimate of losses of tourist visits due to air pollution
- Health/Economic losses-Urban Air Pollution	International Tourism Losses-Cairo	7,000,000		Tourist days per year	50	70	LE/ day	350	490	0 12%	0 16%	Huybers and Bennett (2000) finds that tourists are willing to pay a significant premium for environmental quality at overseas tourist destinations On average, tourists (the study assessed British tourists) are willing to pay a premium of around US $70 per day for an "unspoilt" vs "somewhat spoilt", and "somewhat spoilt" vs "very spoilt" destination A conservative US $15-20 per day has been applied to Cairo for annual visitor days (quantity) in 1999 as an estimate of tourism revenue losses due to air pollution (average tourist expenditure in Egypt is around US $125-140 per day, 1997-1999)
- Quality of life-Real Estate Depreciation	Depreciation costs									n a	n a	Estimates of degradation of buildings and structures due to air pollution is not available for Egypt
								3,337	9,468	1 1%	3 2%	
Natural Resources - Productivity Losses	Value lost									n a	n a	Losses associated with degradation of land quality and vegetation are not available
	Damage Costs							**3,337**	**9,468**	**1 1%**	**3 2%**	
	Damage Costs (mean estimate)							**6,402**		**2 1%**		

SOIL	Method	Quantity		Unit	Price		Unit	Million LE/yr		% of GDP		Notes / Sources
Natural Resources Soil Degradation		Low	High		Low	High		Low	High	Low	High	
- Soil Erosion/Desertification	Productivity Lost	1,520 000		feddans	1,111	1,556	LE/ feddan/yr	1,689	2,365	0 6%	0 8%	It is estimated that about 20% of cultivated area (7 6 million feddans) is suffering from soil erosion It is assumed that 25-35% of crop value is being lost due to erosion One feddan is equivalent to 4,201 m2 The value used is the average crop value of LE 4445 per cultivated feddan (calculations by authors are based on agricultural data from NEAP 2002, Environmental Profile of Egypt 2002)
- Salinisation	Productivity Lost	2,870,000		feddans	445	667	LE/ feddan/yr	1,276	1,914	0 4%	0 6%	It is estimated that about 35% of agricultural land (8 2 million feddans) is suffering from salinisation It is assumed that 10-15% of crop value is lost The value used is the average crop value of LE 4445 per cultivated feddan (calculations by authors are based on agricultural data from NEAP 2002, Environmental Profile of Egypt 2002)
	Damage Costs							**2,965**	**4,278**	**1 0%**	**1 4%**	
	Damage Costs (mean estimate)							**3,622**		**1 2%**		

WASTE

WASTE	Method	Quantity Low	Quantity High	Unit	Price Low	Price High	Unit	Million LE/yr Low	Million LE/yr High	% of GDP Low	% of GDP High	Notes / Sources
Health/Quality of life												
Municipal Waste												
-Waste Collection	WTP for improved Waste Collection	10,500,000		households	4 25	5 00	LE/ household/ month	536	630	0 18%	0 21%	Municipal waste collection rate is about 65% in Cairo, 50% in other urban areas, and 20% in rural areas (NEAP 2002) Altaf and Deshazo (1996) estimate households' WTP for improved waste collection in Pakistan, and Blore and Nunan (1996) estimate households' WTP for eliminating the drawbacks of living near a solid waste landfill in Bangkok, Thailand The results of these studies are applied to Egypt by adjusting for GDP per capita differentials (see price), and indicate the social cost of inadequate waste collection
-Waste Disposal and Treatment	Air pollution and Degradation of Natural Resources									see notes	see notes	Uncollected municipal waste is often disposed and burned in cities and towns In Cairo it is estimated that burning of waste contributes as much 20% to PM 10 (fine particulates) air pollution (Lowenthal et al, 2001). If so, burning of waste has a damage cost of 0 2-0 5% of GDP, based on the estimated damage cost of urban air pollution presented in the section on air Municipal waste is also being disposed at unsanitary landfills, illegal dumps and surface waters which may pose risk to water resources (ground and surface water) and public health
Untreated Industrial Waste												
- Industrial Waste								n a	n a	n a	n a	Inappropriate storage and disposal of untreated industrial, hazardous and hospital waste pose risk to human health, water resources and land There is no estimate of the environmental cost of such untreated waste in Egypt, although it should be recognized that it might be significant
- Hazardous Waste								n a	n a	n a	n a	
- Health Care Waste Generation								n a	n a	n a	n a	
								536	630	0 2%	0.2%	
	Damage Costs							536	630	0 18%	0 21%	
	Damage Costs (mean estimate)							583		0 2%		

COASTAL ZONES, CULTURAL HERITAGE

COASTAL ZONES, CULTURAL HERITAGE		Low	High		Price Low	Price High	Unit	Million LE/yr Low	Million LE/yr High	% of GDP Low	% of GDP High	Notes / Sources
Natural Resources												
-Red Sea	International Tourism Losses	8,500,000		Tourist days per year	70	100	LE/ day	595	850	0 2%	0 3%	An important aspect of tourism attraction in the Red Sea (Hurghada) is the coral reefs The NEAP 2002 and Environmental Profile 2002 state that many reefs have become degraded and destroyed (and fish stocks around the reefs have declined or almost vanished). Egypt tourism statistics show that the share of Red Sea tourists with lower daily expenditure than Western European tourists (who used to dominate in the Red Sea) has increased substantially in recent years, indicating a lower average value per tourist day A study by Huybers and Bennett (2000) of British tourists found that tourists are willing to pay a premium of around US $70 per day for "unspoilt" vs "somewhat spoilt" and "somewhat spoilt" vs "very spoilt" destinations A conservative US $20-30 per tourist day has been applied to the Red Sea for total tourist days (quantity) in 1999 as an estimate of tourism revenue losses due to environmental degradation
-Mediterranean Sea	International Tourism Losses	1,800,000		Tourist days per year	70	100	LE/ day	126	180	0 04%	0 06%	Per the NEAP 2002 and the Environmental Profile 2002, coastal waters around Alexandria are polluted, and thus less attractive to tourists that value environmental quality Based on the study by Huybers and Bennett (see above), a conservative US $20-30 per tourist day has been applied to total tourist days (quantity) in 1999 as an estimate of tourism revenue losses due to environmental degradation
-Med/Red Sea	Domestic tourism and recreation							n a	n a	n a	n a	Coastal zone degradation is also reducing the recreational and tourism value of these areas to the Egyptian population No quantitative estimate is available, but this loss could be estimated by for instance contingent valuation of WTP and/or increased travel cost to destinations further away
-Med/Red Sea	Fishery losses	10%	15%	Percent losses per year	850,000,000		LE per year	85	128	0 03%	0 04%	Partially and untreated municipal and industrial wastewater, and agricultural drainage water is significantly polluting coastal waters. The NEAP 2002 and Environmental Profile 2002 discuss this situation and impacts on fish resources, but no quantitative estimate of impacts is presented A fishery reduction of 10-15% is stipulated here to provide a perspective on the potential value of losses due to pollution Value of annual of marine water fish catch (price) for 1998 is from the NEAP and Environmental Profile
	Damage Costs							806	1,158	0 27%	0 39%	
	Damage Costs (mean estimate)							982		0 3%		

GLOBAL ENVIRONMENT

GLOBAL ENVIRONMENT			Unit	Price	Unit	Million LE/yr		% of GDP		Notes / Sources
- Biodiversity	–								–	Some damage to biodiversity are known, as for example a $5 to $122 impact per square meter of lost coral reef in terms of tourism NEAP 2002 Annual damage are however not know (15 million LE were obtained in the court as reparation in 2000).
- CO_2	–	97,900,000	Tons	70	LE/ ton Carbon	1,869		0 6%	0 6%	Damage due to climate change addresses potential adverse effects of climate change like sea level rise, changes in weather patterns, impacts on agriculture CO2 emissions in Egypt are about 100 million tons per year One ton of carbon is equivalent to 12/44 of a ton of CO2 Damage cost used is US $20 per ton of carbon (source Genuine Savings, WDI, World Bank 2001)
DAMAGE COSTS						9,665	19,275	3.2%	6.4%	
DAMAGE COSTS (MEAN ESTIMATE)						14,470		4.8%		
DAMAGE COSTS, AND GLOBAL ENVIRONMENT						11,534	21,144	3.8%	7.0%	
DAMAGE COSTS, AND GLOBAL ENVIRONMENT (MEAN ESTIMATE)						16,339		5.4%		

Economic Data 1999	
Population	63,000,000
GDP LE	300,000,000,000
GDP $	89,000,000,000
GDP/CAPITA $	1,413
LE/USD Exchage Rate Dec 99	3 39

ABREVIATIONS

LE = Egyptian Pound hsld = household inhab = inhabitant ca = per capita
q = quintal t = metric ton ha = hectare n a = non available 1 feddan = 4,201 m2
DALY = Disability Adjusted Life Year
WTP = Willingness-to-pay

Remediation Costs

WATER	Method	Quantity	Unit	Price	Unit	Million LE/yr	% of GDP	Notes / Sources
Health/Quality of life								
- Inadequate Water and Sanitation	Investment Cost		persons	400 to 800	LE per person	425	0 14%	Annualized INVESTMENT cost for water supply for urban and rural population without access to improved water source (4% and 6% respectively) and/or without sanitation (2% and 9% respectively) A 25 year useful life of investment and 10% discount rate has been applied Investment costs per person ($120-240) are based on World Bank data *(see World Bank 1995)*
- Inadequate Water and Sanitation	Rehabilitation/ Upgrading Cost		persons	400 to 800	LE per person	950	0 32%	Annualized REHABILITATION/UPGRADING cost for water and sewage systems for both urban and rural population It is assumed that an equivalent of 10% of the total construction cost of the nationwide systems ($120-240 per person) is needed for rehabilitation/upgrading for the first 10 years, and then 5% of total construction cost for the following 10 years These costs are needed (on top of current maintenance expenditure) to bring the services to adequate quality A 10 year useful life and 10% discount rate has been applied for rehabilitation/upgrading expenditures Estimate for construction costs is based on World Bank data *(see World Bank 1995)*
	Water loss reductions from Rehabilitation/ Upgrading	-1,200,000,000	m3/yr	0 45	LE/m3	-540	-0 18%	Water lost in public networks It is assessed that an excessive 20% of 6 billion m3 of water supplied through networks are lost, in addition to 25-30% that may be considered uneconomic to avoid Pumping and treatment cost per m3 has been used in the calculations here to estimate the value of water savings from rehabilitation and upgrading of water networks *Water Balance for Egypt, NEAP 2002 and Water General Authorities, Cairo*
- Inadequate Hygiene	Program Cost	5,625,000	households	15	LE per household per year	84	0 03%	Programs for hygiene improvement (education, community programs, etc to improve personal, food and domestic hygiene) for 50% of all households for the prevention of infectious diseases related to water and sanitation conditions The cost of $4/household is based on international experience of hygiene progams *(Varley, et al 1998)*
Natural Resources								
- Impacts on Ecosystems	Treatment Cost	900,000,000	m3/yr	0 8	LE/ m3	212	0 24%	Untreated Wastewater It is assumed that two-fifth of 2 25 billion m3 of municipal wastewater discharges to the Northern Lakes, Nile Delta and Fayoum are untreatment and need treatment Water Balance for Egypt, NEAP 2002 Treatment cost of LE 0 8 per m3 has been applied based on consultations with experts in Egypt
		170,000,000	m3/yr	3 5	LE/m3	176	0 20%	Industrial Wastewater Calculations are based on annual industrial wastewater discharge into Nile River, 2 branches, and canals that need treatment Treatment cost of LE 3 5 per m3 has been applied based on consultations with experts in Egypt

AIR	Method	Quantity	Unit	Price	Unit	Million LE/yr	% of GDP	Notes / Sources
Health/Quality of life								
- Indoor Air Pollution	Fuel Substitution Cost	640,000	tons of oil equivalent per year	100	LE/barrel	499	0 17%	Cost of commerial energy (at US $30 per barrel) to substitute/replace 50% of traditional fuel (biomass fuel) consumption This is one of possible actions to reduce unhealthy indoor air pollution primarily in rural areas of Egypt Traditional fuel consumption in Egypt is 3% of total energy consumption (data on energy consumption are from WDI, World Bank 2001) Costs of other measures to remediate indoor air pollution, such as improved ventilation and stoves and cooking equipment have not been estimated in this report.
- Cleaner Diesel	Incremental Cost of Cleaner Diesel	4,000,000	tons per year	25	LE/ton diesel	100	0 03%	Incremental cost of cleaner diesel for light and heavy diesel trucks and buses other than those buses that are in the process of being converted to natural gas This cost is the incremental world price of low sulphur (0 05%) diesel to the level of sulphur that allows particulate control technology on diesel vehicles Lower sulphur will also reduce PM10 from diesel vehicles without control technology The quantity of diesel used in this study is estimated based on number of diesel vehicles and vehicle diesel consumption in Egypt (World Bank data) While several studies have found that the (monetized) health benefits of cleaner diesel outweigh the cost (see for instance Lvovsky et al, 2000), a benefit-cost assessment for Egypt is warranted

-Solid Waste Burning	Improved waste collection and control					n a	n a	Burning of solid waste contributes substantially to PM 10 air pollution in Cairo Improved waste collection, management and control is needed to remedy the situation (see section on Waste)
- Energy Use	Energy efficiency measures	-2,100,000	tons of oil equivalent per year	35	LE/barrel	-573	-0 19%	It is assessed that potential energy savings (with a positive economic return) are at least 5% of total energy consumption based on various energy audits undertaken in Egypt Based on the same audits it is estimated that the net economic value per barrel of energy saved is US $10 ($30 for the economic value of energy, less $20 in efficiency improvement cost)
- Industrial Depollution	Investment Costs	2,000,000,000	Whole Investment (LE)	325,490,790	Annuity (LE/yr)	325	0 11%	Bringing polluting industries into compliance with environment legislation is estimated at 2 billion LE for 2002 A useful life of depollution investments of 10 years and a 10% discount rate have been applied (expert opinion at EEAA)
SOIL	**Method**	**Quantity**	**Unit**	**Price**	**Unit**	**Million LE/yr**	**% of GDP**	**Notes / Sources**
Natural Resources Soil Degradation								
- Soil Erosion/Desertification	Investment Costs	1,520,000	feddans	10,000	LE/feddan	1,612	0 54%	The investment cost was assessed based on LE 10,000 per feddan over 30 years in response soil erosion and/or desertification A 10% discount rate has been applied (cost figures from a study by Prof Gamal Seyam, Cairo University)
- Salinisation	Investment Costs	2,870,000	feddans	15,000	LE/feddan	4,567	1 52%	The investment cost was assessed based on LE 15,000 per feddan over 30 years in response to salinisation A 10% discount rate was applied (cost figure is from a study by Prof Gamal Seyam, Cairo University)
WASTE	**Method**	**Quantity**	**Unit**	**Price**	**Unit**	**Million LE/yr**	**% of GDP**	**Notes / Sources**
Health/Quality of life Municipal waste								
- Uncollected Waste	Waste Collection Cost	8,000,000	t/yr	30	LE/t	240	0 08%	The lower bound of international cost (US$8-16/ton) has been applied given that labor cost is substantially lower in Egypt than in high-income countries Volume of uncollected waste is based on 65% collection rate in Cairo, 50% in other urban areas, and 20% in rural areas Total annual waste generation is about 15 million tons per year (NEAP 2002)
- Uncontrolled Waste Disposal	Control of Waste Burning					n a	n a	Burning of waste contribute substantially to urban air pollution, especially in Cairo (see Damage Costs section) Improved waste collection and changes in waste management practices are important to mitigate this situation Part of this remediation cost is included above in Uncollected Waste
Untreated Industrial Waste								
- Untreated Waste	Treatment Costs	4,500,000	t/yr	200	$/ t	900	0 30%	Treatment costs *NEAP 2002, and international treatment costs*
- Hazardous Waste	Treatment Costs	150,000	t/yr	500	$/ t	75	0 03%	Treatment costs *NEAP 2002, and international treatment costs*
- Health Care Waste Generation	Treatment Costs	16,381	t/yr	500 - 1200	$/ t	20	0 01%	Treatment costs *NEAP 2002, and international treatment costs.*
COASTAL ZONES, CULTURAL HERITAGE				**Price**	**Unit**	**Million LE/yr**	**% of GDP**	**Notes / Sources**
Natural Resources								
- Coastal Zone Protection	Wastewater Treatment	300,000,000	m3/yr	1 9	weighted average LE/ m3	578	0 19%	Annual discharges to the Mediterranean Sea are on the order of 700 million cum of municipal wastewater and 500 million cum of industrial wastewater (Water Balance for Egypt, NEAP 2002) It was assumed that 25% of these discarges need to be treated Treatment cost is LE 0 8 and 3 5 for municipal and industrial wastewater, respectively (Egyptian expert opinion)
- Coastal Zone Protection	Coral reef protection					n a	n a	In additon to their ecological value, coral reefs serve as an important asset for tourism Cost of reef protection is not estimated here
- Cultural Heritage	Investments Costs					n a	n a	Resouce requirement for cultural heritage protection is not available
GLOBAL ENVIRONMENT		**Quantity**	**Unit**	**Price**	**Unit**	**Million LE/yr**	**% of GDP**	**Notes / Sources**
- Biodiversity	Conservation Cost						-	
- CO_2 Reduction Program	CO_2-eq Reduction Costs						-	

DALYs - URBAN AIR POLLUTION (1999)

Key parameters	Egypt	Greater Cairo*	Alexandria
Population (mill)	63	14 9	3 3
Adult population >= 15 yrs (mill)	41	9 7	2 1
Children population <=14 yrs (mill)	22	5 2	1 2
Crude death rate (per 1000)	7	7	7
Annual average PM10 (ug/m3)**		270	100
Exposed population (mill) 80% of tot		11 92	2 64
Exposed adult pop (mill)		7 8	1 7
Exposed children pop (mill)		4 2	0 9

Health categories	Units	Impacts per 1 ug/m3	DALYs per 10000 cases	Cases Greater Cairo	DALYs Greater Cairo	Cases Alexandria	DALYs Alexandria	DALYs Greater Cairo and Alex
Premature mortality	% change in crude mortality rate	0 084	100,000	18,924	189,242	1,552	15,523	204,765
Chronic bronchitis	per 100 000 adults	3 06	12,037	64,092	77,148	5,257	6,328	83,476
Hospital admissions	per 100 000 population	1 2	264	38,621	1,020	3,168	84	1,103
Emergency room visits	per 100 000 population	23 54	3	757,611	227	62,146	19	246
Restricted activity days	per 100 000 adults	5750	3	120,434,571	36,130	9,879,048	2,964	39,094
Lower respiratory illness in children	per 100 000 children	169	3	1,899,367	570	155,802	47	617
Respiratory symptoms	per 100 000 adults	18300	3	383,296,114	114,989	31,441,143	9,432	124,421
	TOTAL DALYS LOST PER YR				419,326		34,397	453,722

*including Giza

**The PM10 figure for Greater Cairo is based on available monitoring data No data are available for Alexandria, and has been assumed to be PM10=100 ug/m3

Data source of Key parameters WDI, World Bank 2001

Source of DALY estimation Dose response coefficients (health impacts per ug/m3) are from international studies

DALYs - WATER, SANITATION AND HYGIENE (1999)

Mortality	**Quantity**	**Units**
Children population (0-4 yrs of age)	8 15	million
Child mortality rate	54	per 1000
Annual child deaths (all causes)	88020	per year
Child diarrheal disease deaths	20 0%	of child mortality rate
Child diarrheal disease mortality rate	10 8	per 1000
Annual child diarrheal disease deaths	17604	
DALYs per child death	35	discounted years of life lost
DALYs from child diarrheal disease deaths	**616140**	per year
Morbidity		
Children population (0-14 yrs of age)	22	million
Diarrheal episodes (per child per month)	1	
Total episodes per year	264	million
Average duration per episode	10	hours
Total duration per year (hrs)	2,640	million hrs
Total duration per year (in years)	301,370	years
DALY per year of diarrheal episode (severity weight)	0 2	
DALYs from child diarrheal disease morbidity	**60,274**	per year
TOTAL DALYs LOST PER YR (mortality and morbidity)	**676,414**	per year

Data source Base data are from WDI, World Bank 2001

Estimation Child diarrheal disease deaths as a percentage of child mortality rate is based on regional averages

Estimation Morbidity estimates are based on children only, because of their substantially higher incidence rates

DALYs - INDOOR AIR POLLUTION EGYPT (1999)

Key parameters	Egypt
Total population (millions) 1999	63
Child mortality rate (per 1000 live births) 1999	54
Rural population share 1999	54 8%
Rural Biomass use (share of rural population) 1993	35 0%
Biomass intensity per household (relative to other developing countries)	0 5
Exposed population share (population equivalents as a % of total population)	9 6%
Commercial energy use per capita (koe) 1999	679
Biomass fuel use (% of total energy) 1999	3 0%
Biomass fuel use per capita (koe) 1999	21

"Low" estimate		NBD deaths	Exposed population PP	Odds ratio OR	PAR	Deaths indoor air	DALYs
Acute respiratory infections	children < 5 yrs old	20900	9 6%	2	0 087508	1829	64012
Chronic obstructive pulmonary dise	adult females (> 15 yrs old)	5200	9 6%	2	0 087508	455	9101
Tuberculosis	adult females (> 15 yrs old)	3100	9 6%	1 5	0 045756	142	2837
Heart disease	adult females (> 15 yrs old)	85300	9 6%	1 1	0 009499	810	8103
	TOTAL DALYS LOST PER YR						84052

"High" estimate		NBD deaths	Exposed population PP	Odds ratio OR	PAR	Deaths indoor air	DALYs
Acute respiratory infections	children < 5 yrs old	20900	9 6%	3	0 160933	3364	117723
Chronic obstructive pulmonary dise	adult females (> 15 yrs old)	5200	9 6%	4	0 223422	1162	23236
Tuberculosis	adult females (> 15 yrs old)	3100	9 6%	3	0 160933	499	9978
Heart disease	adult females (> 15 yrs old)	85300	9 6%	1 4	0 036943	3151	31512
	TOTAL DALYS LOST PER YR						182448

PAR=PP*(OR-1)/(PP*(OR-1)+1)

DATA:

The National Burden of Disease (NBD) for Egypt is estimated based on extrapolation of Burden of Disease data by WHO and World Bank for the Middle Eastern Crescent (MEC) region Child mortality from acute respiratory infections has been adjusted by the child mortality rate differential between MEC and Egypt The disease categories for adult women has only been adjusted by the population share of Egypt in the region The odds ratios (OR) are from Smith (2000) and reflect a review of international studies The exposed population (share of total population) to indoor air pollution from biomass fuel is based on a household survey from 1993 (see World Energy Council), indicating that 30% of the rural population use biomass fuel for heating and 40% for cooking Based on total biomass fuel use (1 3 Mtoe according to World Energy Council and WDI, World Bank) in Egypt and biomass fuel use in other countries the exposed population has been adjusted downwards to reflect a lower intensity of biomass use by rural households in Egypt (relative to many other developing countries) Alternatively, the Odd Ratios could be adjusted downwards to reflect the lower intensity of biomass use

METHODOLOGY:

The methodology presented in Smith (2000) has been applied here The methodology is based on National Burden of Disease (NBD) statistics for illnesses/diseases that are associated with indoor air pollution, and odds ratios (OR) from international studies that reflect the increased risk of illness/disease associated with the indoor use of biomass fuel DALYs are based on discounted years of life lost for each disease Only mortality is included as Smith estimates that DALYs from morbidity is insignificant relative to mortality DALYs are only estimated for children less than five years of age and adult women because these groups are likely to spend disproportionately more time indoors than school children and adult men