Project in Development and the Environment

Environmental Options Assessment for Morocco

March 1995

Submitted to
USAID/Morocco
Submitted by
PRIDE

USAID Contract Number
ANE-0178-Q-00-1047-00
USAID Project Number
398-0365

Sponsored by
USAID/G/ENV/EET
Implemented by
Chemonics International
and its associates

2000 M Street NW Suite 200 Washington DC 20036
Telephone (202) 331-1860 • Fax (202) 331-1871

The objective of the Project in Development and the Environment (PRIDE) is to help the U S Agency for International Development (AID) design and implement programs that foster the agency s environmental and natural resources strategy for sustainable economic growth in the Near East and Eastern Europe

PRIDE provides AID and participating countries with advisory assistance training and information services in four program areas (1) strategic planning (2) environmental policy analysis (3) private sector initiatives and (4) environmental information education communication and institutional strengthening

The project is being implemented by a consortium selected through open competition in 1991 Chemonics International is the prime contractor subcontractors include RCG/Hagler Bailly Inc Science Applications International Corporation Capital Systems Group Inc Environomics Inc Industrial Economics Inc Lincoln University and Resource Management International Inc In addition AID has entered into a cooperative agreement with the World Environment Center to support implementation of PRIDE

Printed on recycled paper

Environmental Options Assessment for Morocco

By

Greg Booth
Joy Hecht
Jack King
Jack Stafurik
Karl Van Orsdol

March 1995

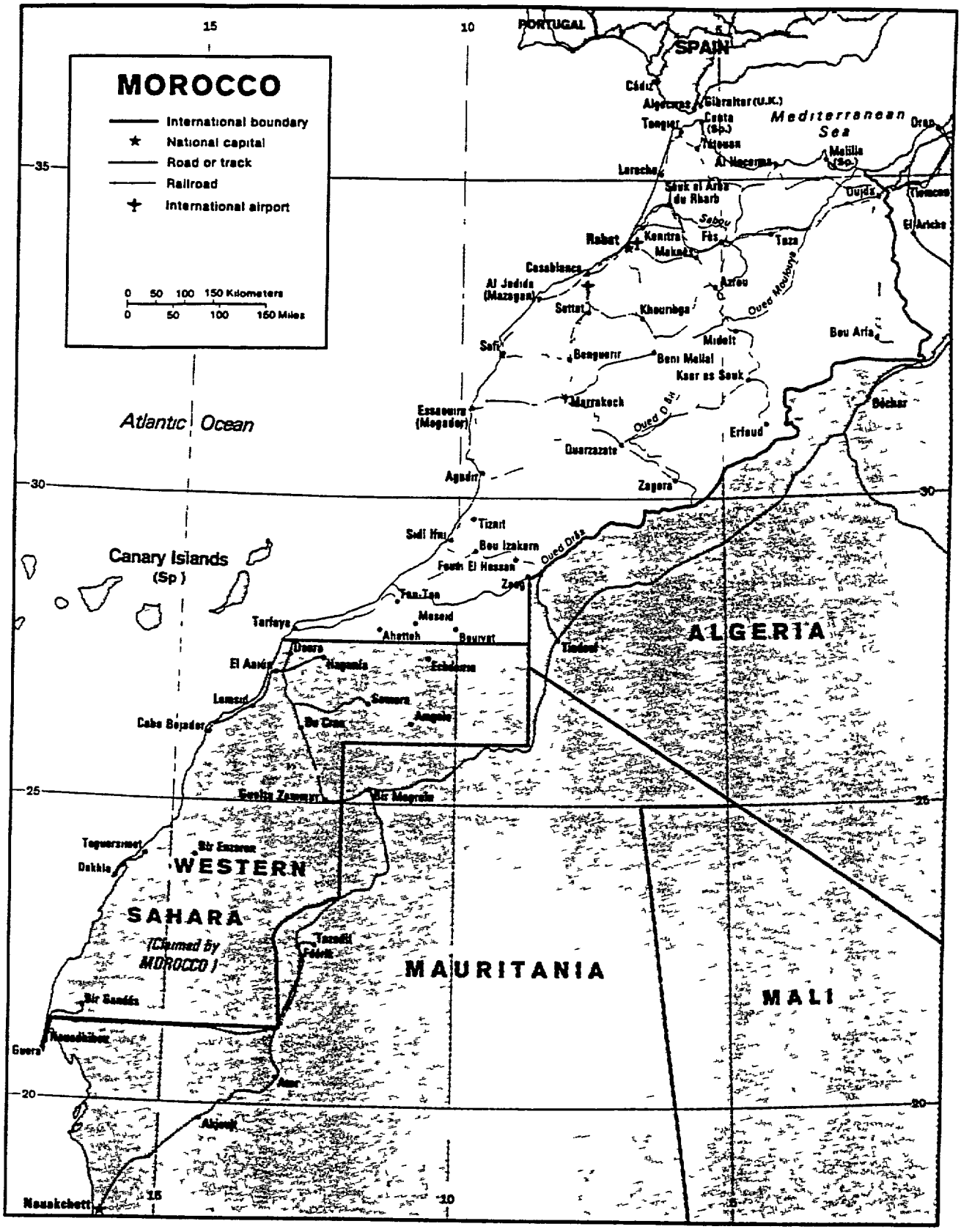

MOROCCO
International boundary
National capital
Road or track
Railroad
International airport
0 50 100 150 Kilometers
0 50 100 150 Miles
PORTUGAL
SPAIN
Cádiz
Algeciras
Gibraltar (U.K.)
Tanger
Ceuta (Sp.)
Tétouan
Al Hoceima
Melilla (Sp.)
Mediterranean Sea
Oran
Larache
Souk el Arba du Rharb
Oujda
Tlemcen
El Ariche
Sebou
Rabat
Kenitra
Meknès
Fès
Taza
Casablanca
Oued Moulouya
Al Jadida (Mazagan)
Azrou
Settat
Khouribga
Bou Arfa
Safi
Beni Mellal
Midelt
Beaguerir
Ksar es Souk
Marrakech
Oued Dra
Essaouira (Mogador)
Béchar
Erfoud
Ouarzazate
Agadir
Zagora
Atlantic Ocean
Tizart
Sidi Ifni
Bou Izakarn
Oued Drâa
Foum El Hassan
Zag
Canary Islands (Sp.)
Tan-Tan
Mseid
Tarfaya
Ahertish
Bouyat
Tindouf
ALGERIA
Dcora
El Aaiún
Hagounia
Echdeiria
Lemsid
Semara
Cabo Bojador
Bu Craa
Amgala
Bir Mogrein
Guerguerat
Tqueursmet
Bir Enzaran
Dakhla
WESTERN SAHARA
(Claimed by MOROCCO)
Tasiilt
Fdérik
MAURITANIA
MALI
Bir Gandús
Nouadhibou
Guera
Atar
Akjoujt
Nouakchott
15
10
5
35
30
25
20

TABLE OF CONTENTS

ACRONYMS

ADER	Agency for the Dedensification of the Medina
ANA	Agence Nationale de l'Assainissement
AQIM	Air Quality Improvement and Monitoring
AS	Annuaire Statistique
ATI	Artisanal Tannery Improvement
BOD	Biological oxygen demand
CEM	Centre de l'Entreprise du Maroc
CNE	Conseil National de l'Environmenent
COD	Chemical oxygen demand
CSE	Conseil Supérieur de l'Eau
DHS	Demographic and Health Survey
DRCTA	Division of Land Rehabilitation and Conservation
EIS	Environmental Impact Studies
EPA	U S Environmental Protection Agency
EU	European Union
FAO	Food and Agriculture Organization
GEM	Gestion de l'Energie au Maroc
GOM	Government of Morocco
GTZ	German Development Agency
EIS	Environmental impact studies
IP3	Industrial Pollution Prevention Project
ISPM	Institut Supérieur de la Pêche Maritime
IUCN	International Union for Conservation of Nature
IAV	Institut Agronomie Veterinaires
MAMVA	Ministere de l'Agriculture et de la Mise en Valeur Agricole
METAP	Mediterranean Environment Technical Assistance Program
MTP	Ministere des Travaux Publics
NGO	Nongovernmental Organization
OCP	L'Office Cherifien des Phosphates
ONEM	Observatoire National de l'Environnement du Maroc
ONEP	Office National de l'Eau Potable
ORMVA	Office Regionale de la Mise en Valeur Agricole
PAH	Polycyclic aromatic hydrocarbons
PP	Project paper
PRIDE	Project in Development and the Environment
SGG	Secretary General of the Government
SIDE	Systeme d'information et de donnees sur l'environnement
SSE	Sous-Secretariat d'Etat pour l'Environnement
TA	Technical assistance
USAID/M	USAID/Morocco
USAID/A	USAID/America
VOC	Volatile organic compounds
WHO	World Health Organization

EXECUTIVE SUMMARY

USAID/Morocco will be developing a major environmental program to help Morocco address its serious environmental problems To help the Mission identify the major problem areas, it requested assistance from the centrally funded Project in Development and Environment (PRIDE) The PRIDE team used an approach under development by USAID that is based on the U S Environmental Protection Agency's comparative risk assessment methodology (although it does not have its depth of detail and analysis) This approach identified the major problem areas and evaluated their relative impacts on health, the economy, and ecosystems Next, the team looked at possible project options, and developed a scoring system to evaluate their relative attractiveness

The team first organized environmental problems around the sectors of economic activity which produced them The sectors examined include industry, mobile sources, households, agriculture, and natural-resource based activities Some of these activities affect the environment through externalities, thus industry, agriculture, and households generate water pollution, and mobile sources and industry generate air pollution Other environmental activities affect their own long-run sustainability through their use of natural resources, this is the case of woodfuel harvesting or "mining" aquifers for irrigation water

Based on quantitative data, interviews with Moroccan experts, and their own judgment, the team members assessed the impacts of each of the problems on health, the economy, and natural ecosystems A set of criteria was developed for evaluating the importance of each impact For health, these were three, the severity of the health impacts, the number of people affected, and reversibility or intergenerational effects For the economy, there were two criteria, total cost and timing of that cost Natural ecosystem effects were evaluated through a more complex set of criteria, the severity of ecosystem damage, whether the ecosystem is common or unique, the extent of human dependence on the ecosystem for non-marketed services, the number of people dependent on the ecosystem, and the timing of impacts

The team scored each problem according to each criterion on a scale of one (minimal impact) to five (serious impact) Within each impact area the scores assigned to the different criteria were averaged, and the resulting impact area scores were averaged to arrive at an overall assessment of the impact of each problem These area scores were averaged to develop a single composite indicator of the importance of each problem area relative to the others

The result of this approach must be used carefully, since it suffers from shortages in accurate data and time for detailed analyses, and subjectivity in judgements and scoring Nevertheless, it provides a useful framework and indications of the relative importance of environmental problems that can be refined as time and resources permit, and that will provide a rational basis for making environmental decisions

Using this approach, the team developed an assessment of Morocco's environmental problems The matrices can be found on pages v-vii

The team also identified a number of possible project activities to respond to these problems Because of the time constraints, it was not possible to wait for the results of the problem review in order to identify areas for project activities, therefore some activities respond to problems which did not emerge as highest priority Each activity was reviewed according to eight criteria the importance of the problems to which it responds (which is the composite score on the problem assessment), its potential impact on those problems, the priority of the problem to the Government of Morocco, the priority of the problem to USAID, U S comparative advantage, trade and investment opportunities, sustainability, relation to other donor activities, and support to NGOs and women's groups The options were evaluated and scored on a 1 (least favorable) to 5 (most favorable) scale, and a weighted composite score developed The composite scores however are only indicative and should be used with care, the team did not feel it had sufficient time to develop and analyze these options to the point that the composite score would be a reliable indicator of the relative attractiveness of the project option

The major project options evaluated included

1 Protected zones for drinking water intake
2 Sanitary landfill management
3 Management support for sewage collection and treatment
4 Integrated watershed management
5 Eco-tourism development in Morocco's interior
6 Artisanal tannery improvement
7 Air quality improvement and monitoring
8 Phosphate processing emissions elimination
9 Industrial pollution prevention
10 Water erosion of soils
11 Dune encroachment control
12 Oum er Rbia River catchment basin management and environmental quality
13 Sebou integrated management plan

PRELIMINARY PROBLEM ASSESSMENT MATRIX
Industrial and Automotive Emissions

Sector	Pollutant/ Activity	Average			Composite
		Human Health	Economic	Biodiversity	
A Emissions into Air					
1 Mobile Sources					
Transport	Sulfur Dioxide	23	20	12	18
	Nitrogen Oxide	23	20	12	18
	Suspended Particles	23	20	12	18
	Lead	30	20	12	20
2 Industrial Fixed Sources					
Cementeries	Dust	10	20	10	13
	Sulfur Dioxide	10	20	10	13
Refineries	Sulfur Dioxide	10	20	10	13
	Nitrogen Oxides	10	20	10	13
Phosphate	Sulfur Dioxide	20	25	12	19
3 Area/Artisanal Sources					
Potteries	Suspended particles	20	*	10	15
	Other pollutants	23	*	10	16
B Water Emissions Rivers					
1 Tanneries	Chrome	33	20	26	26
2 Oil plants (olive)	Suspended particles (margine)	26	35	24	28
3 Textile Industry	Suspended particles	10	25	22	29
4 Sugar factory	Organic matter	13	25	28	22
5 Chemicals		20	25	22	22
Oceans					
1 Phosphate refining	Suspended particles	13	35	34	27
	Heavy metals	26	35	26	29
	Dissolved residue	13	35	22	23
2 Refineries	Oil Water Separation	10	*	24	17

*No estimate made

9'

PRELIMINARY PROBLEM ASSESSMENT MATRIX
Natural Resources Management

Sector	Pollutant/Activity	Average			Composite
		Human Health	Economic	Biodiversity	
A Natural Vegetation Utilization		10	35	44	29
1 Forest utilization (resource use as input)	Fuelwood collection	10	35	46	30
	Construction material	10	35	42	29
	Agricultural expansion	10	35	44	29
	Livestock overgrazing	10	35	46	30
	Resource affected by externalities	10	35	44	29
B Terrestrial Wildlife Utilization		10	10	35	18
1 Wildlife utilization	Sport hunting	10	10	33	18
	Game meat hunting	10	10	36	19
	Ecotourism	10	10	34	18
C Coastal Resources		10	10	33	17
Activities that affect resources (externality generating)	Irrigation	10	10	35	18
	Construction	10	10	46	22
	Tourism	10	10	40	20

PRELIMINARY PROBLEM ASSESSMENT MATRIX
Agriculture and Land Use Issues

Sector	Pollutant/Activity	Average			Composite
		Human Health	Economic	Biodiversity	
Agriculture A Water Eroded and Degraded Land		10	40	42	30
B Irrigated Land		30	30	32	30
C Wind Eroded and Degraded Land		10	10	30	16
	Oasis dune encroachment	10	50	30	30
D Scenic Land		10	10	27	15
E Urban Proximity Land		10	10	18	12

PRELIMINARY RISK ASSESSMENT
Water Suppplies, Domestic, and Accidental Pollution

Sector	Average			Composite
	Human Health	Economic	Biodiversitiy	
A Water Supply Management	23	30	28	27
B Domestic Pollution				
1 Liquid Wastes Overall	32	44	22	38
Fatal diarrhea	40	50	*	45
Non fatal diarrhea	27	45	*	36
Other diseases	30	40	*	35
Drinking water treatment	*	40	*	40
2 Solid Wastes Overall	17	30	22	23
Living on landfill diseases	20	30	*	25
Living near landfill diseases	13	30	*	22
C Accidental Pollution	23	30	16	23

*Not applicable

SUMMARY OF OPTIONS SCORING

OPTION		Problem Importance	Project Impact	GOM Priority	USAID Priority	Comparative Advantage	Trade & Investment Opportunities	Sustainability	Other Donors	NGOs	TOTAL
	Weighting	10	10	50	50	50	50	50	30	30	
WATER											
Protected Zones for Drinking Water Intake		33	40	40	40	10	10	35	30	10	30
Sanitary Landfill Management		23	40	40	50	40	30	40	20	30	35
Management Support for Sewage		33	40	50	40	10	30	30	40	10	33
INDUSTRY											
Artisanal Tannery Improvement		40	40	50	50	30	20	20	40	50	38
Air Quality Monitoring		30	30	20	30	40	50	50	40	10	33
Industrial Pollution Prevention		40	50	40	40	30	40	40	30	10	39
Phosphate Processing Emissions Elimination		30	40	10	30	30	40	30	40	10	30
ECOSYSTEMS											
Integrated Watershed Management		29	40	40	50	10	10	40	30	30	32
Eco-Tourism Development for the Interior		20	30	30	30	10	10	30	30	30	24
AGRICULTURE/LAND USE											
Water Erosion of Soils		32	30	40	30	40	10	40	30	30	31
Dune Encroachment Control		20	30	20	20	10	10	40	20	20	23
Oum er Rbia Management Plan		50	50	50	50	40	10	50	50	40	45
Sebou Integrated Management Plan		50	50	50	50	40	30	40	50	50	46

SECTION I
INTRODUCTION

Protection of the environment is becoming an increasingly important concern to the United States Agency for International Development's (USAID) mission in Morocco Reflecting the increased importance of the environment to the Agency as a whole, the Mission is incorporating improved natural resource management and environmental quality into its strategic objectives As part of this effort, the Mission requested the assistance of the USAID Project in Development and Environment (PRIDE) to take an objective review of the problems posed by Moroccan environmental degradation, in order to establish priorities and develop options for a major new environmental project This report presents the results of that review

A Background

USAID's environmental strategy focuses on two global priority areas, climate change and biodiversity In addition, it supports environmental management practices that further sustainable economic development, thus getting away from "mining" the environment to permit short-run growth at the expense of future generations The agency has identified priority countries which can make the greatest contributions to global climate change, and is in the process of identifying countries whose biodiversity resources warrant special attention Morocco is not among the countries targeted for climate change work, since its industry and power sectors do not contribute significantly to greenhouse emissions and its climate and soil will not provide major carbon sequestration For biodiversity, Morocco's potential and priority will be determined and identified in future agency priority-setting exercises

Therefore the Morocco mission's environmental activities focus on linking sustainable environmental management and economic development Three major projects related to the environment and several smaller efforts are currently underway

- The Gestion de l'Energie au Maroc (GEM) project trains Moroccan engineers to identify and implement profitable pollution prevention and energy conservation practices in industrial plants Since it began in 1989, GEM has carried out audits in scores of plants which have led to marked reduction in energy use and pollutant emissions

- The Tadla project is working on agriculture and irrigation in the Tadla region It is focused on water use efficiency through improvements in system-wide and on-farm management of the resource It also focuses on improving water quality through judicious use of agricultural inputs and sound agricultural practices

- The Urban Infrastructure, Land Development and Financing Program is working on a number of related efforts targeted at improving living conditions for the urban poor Loan guarantees are allowing public agencies to upgrade squatter settlements in 11 cities At the same time, the project is providing technical assistance to those agencies to strengthen their management capability and help them ensure that their work is done in environmentally sound ways

- Through the Project in Development and the Environmental (PRIDE) project, the Mission has launched several other environmental activities supporting private sector initiatives These include an assessment of pollution-prevention opportunities in the Moroccan business sector, support for environmental aspects of privatization, assistance to the Centre de l'Entreprise du Maroc to develop local environmental businesses, and assistance in development of industrial regulations which balance regulatory and incentive-based approaches to pollution control

B Methodology

This study used a two-step process The first step is inspired by the comparative risk assessment methodology developed by the U S Environmental Protection Agency This method helps policy makers identify the environmental problems posing the greatest risk to both humans and natural ecosystems To implement it, the causes or sources of environmental degradation are itemized, and the impacts of each problem on human health, the economy (or human well-being, in some analyses), and natural ecosystems are determined The empirical assessments of impacts of degradation are scored relative to each other according to a standard system agreed on by all participants in the risk assessment exercise This common scoring system allows comparison of the impacts of degradation on health, economy and natural ecosystems By ranking sources of environmental degradation, we can identify the problems of greatest concern for policy makers

As developed by EPA, comparative risk assessment is a systematic and thorough exercise, typically taking one to two years, and involves teams of up to a dozen people in each of the three major impact areas This effort involved five people for less than five weeks each, and therefore did not have the detail of the EPA method, either in the complexity of its analytical work or in the collection of empirical data needed to quantify the impacts of environmental degradation For this reason, we do not refer to this effort as a "risk assessment " Instead, we will refer to it as an environmental "problem review "

The second step of this work involved identifying USAID project options which could respond to the concerns identified through the problem review During the evaluation process, ideas arose for possible USAID projects which could address the key problems identified The team developed a systematic list of criteria which were applied to review and rank possible projects Based on those criteria, we identified a few projects which appear the most promising Note that these recommendations reflect only the team's assessment the mission must make its own judgments about project choice

This report has three major sections Section II presents an overview of the legal and institutional context for environmental management in Morocco Section III discusses the problem review phase of our work, describing each problem area and the resulting impacts on health, the economy and natural ecosystems The table at the end of Section III summarizes the final results of the problem review, the accompanying text highlights the most important environmental problems Section IV discusses the assessment of the project options identified to address key environmental problems Each option is evaluated according to a set of standard criteria, and ranked in order of priority

SECTION II
INSTITUTIONAL CONTEXT

A Legal and Regulatory Framework

The legal framework for environmental protection in Morocco is outdated and highly fragmented Most laws having any bearing on the environment were written with other purposes in mind, many of them decades before current environmental problems arose As a result, existing laws and regulations are inadequate to control pollution or to ensure land use compatible with environmental protection Regulation of late-20th century problems such as hazardous substances, industrial waste, noise pollution, or automobile exhaust is entirely lacking or too general to be enforceable Legally enforceable standards which could provide a basis for requiring industries, motorists or agriculture to reduce their pollution do not exist Further, there is no government institution authorized to monitor emissions to ensure compliance with standards even if they did exist In one law, penalties for non-compliance are set in 1914 French francs, hardly posing a serious penalty to industry in 1995 Land and forest use regulations, particularly important for ensuring sustainable use of natural resources, are based on a mix of custom, Koranic law, and modern law, making for considerable confusion and at times irreconcilable conflict

B Public Sector Organizational Structure

Environmental protection in Morocco is the responsibility of a number of different government ministries, committees, offices, and agencies In 1992, the Under-Secretariat for the Environment (Sous-Secretariat pour l'Environnement) was created within the Ministry of Interior, and given overall responsibility for coordinating environmental protection efforts As a new agency, staffed largely with young, highly trained, but relatively inexperienced people, it has not yet completely found its niche, and many questions still remain about the exact allocation of responsibility for the Moroccan environment A brief review of the major institutions involved will shed some light on the issues

B1 The Sous-Secrétariat d'Etat pour l'Environnement (SSE)[1]

The SSE was created in August 1992 within the Ministry of Interior It is responsible for encouraging and coordinating the implementation of the national environmental strategy and policies The exact divisions of responsibility between the SSE and the sectoral ministries that manage the environment on a routine basis are still being worked out Thus questions about who develops proposed legislation on industrial pollution, or which ministry is to have the authority and technical capacity to monitor compliance, or who is to be empowered to impose sanctions for non-compliance, are still very much up in the air Moreover, the SSE has not yet been fully staffed, in particular, few service heads and directors have been named Consequently, there is still more work to do before the SSE is fully operational, with its mandate clearly defined and accepted by all agencies involved in environmental management

[1] In March 1995 the SSE was made a separate ministry as part of a Moroccan government reorganization

At present the work of the SSE is concentrated in five basic task areas, two of which (monitoring and legislative development) have received by far the most attention

- monitoring environmental quality and pollution
- legislation and regulation
- public awareness, training, and information
- supporting local environmental actions
- coordination
- international collaboration

B2 The Conseil National de l'Environnement (CNE)

The CNE was created in 1980, but not since the creation of the SSE has it played an active role in environmental protection With the decision to create the SSE came the decision to revitalize the CNE It has had several regular meetings since then, and is focusing its work on legislative and regulatory issues, as discussed above The CNE has four regular committees covering judicial issues, international actions and conventions, the Sebou basin, and the national environment strategy In addition, it has created special committees to handle sustainable development, desertification, and natural catastrophes Although these committees are still in the early stages of their work, they constitute the institutional context within which the country is addressing interministerial environmental issues The SSE provides the secretariat for the CNE and coordinates activities of the committees and working groups

B3 Key Ministries

The everyday work of managing the environment, and the more strategic work of participating in the CNE and its committees, commissions, and working groups, is handled by a number of key ministries

- The Ministère de l'Agriculture et de la Mise en Valeur Agricole (MAMVA, Ministry of Agriculture and Use of Agricultural Resources) is responsible for all activities that its name implies, including crop protection and soil conservation Management of forest and range resources and national parks is the responsibility of its Direction des Eaux et Forêts

- The Ministère des Travaux Publics et de la Formation Profession et de la Formation des Cadres (Ministry of Public Works) is responsible for all water projects, dams, water quality measurement, and port construction and management The Office National de l'Eau Potable (national drinking water authority) is under the direction of the MTP

- The Ministere du Commerce et de l'Industrie (Ministry of Commerce and Industry) is responsible for industrial promotion Consequently, it plays a major role in the negotiations concerning industrial emissions standards and subsidies to help meet them It is also the source of data on industrial discharges It in principle controls the government-owned industries, although as a practical matter it has little say over their operations or investments

- The Ministère de l'Energie et des Mines (Ministry of Energy and Mines) is responsible for energy production and promotion of the mining sector It is therefore involved in

negotiating emissions standards for those two sectors, and is a source of data on their discharges

- The Ministere de l'Intérieur (Ministry of Interior) oversees activities of the local collectivities—communes and urban communities It is directly responsible for land use planning at the national, regional, and local levels, and thus for integration of environmental concerns into the planning process Local collectivities are responsible for trash collection, landfills, sewer systems, sewage treatment, and the urban environment in general The ministry has a major role to play in helping them carry out responsibilities, providing technical support, financial analysis data, and finding investment capital The ministry, along with the Ministry of Finance, approves local budgets and expenditures, and thus has control over local initiatives on the environment

- The Ministere de la Pêche Maritime (Ministry of Marine Fisheries) is responsible for promoting exploitation of Morocco's fisheries resources Through its Institut Superieur de la Pêche Maritime it conducts research on marine ecosystems, quality and quantity of the fish stocks, and possible impacts of pollution

- The Ministry of Tourism is carrying out a tourism management strategy that will involve consideration of the environment and assessment of opportunities for resource-based tourism, and an assessment of the impact of beach and urban pollution on the desirability of Morocco as a tourist destination

- The Ministere de l'Education Nationale (Education Ministry) is interested in the environment through university studies and research in related areas

- The Ministere de l'Habitat (Housing Ministry) is responsible for urban housing and improving the quality of the urban environment

B4 Local Government

Local government plays a fairly minor role in the protection of the environment in Morocco Although the local collectivities have been given increasing responsibility over the past few years, and the country maintains a policy of decentralization, both the legal authority and the financial capacity of local authorities to address environmental problems within their jurisdictions is limited Legally, they are hampered by the absence of national emissions standards and the lack of a specific legal framework authorizing control of activities of industries within their borders Financially, they lack the resources to address their own pollution, through construction of sewage treatment plants or sanitary landfills

C Nongovernmental Organizations (NGOs)

NGOs presently play a very limited role in environmental protection in Morocco, but there is substantial interest in increasing their influence There are several dozen environmental NGOs working in the country[2], focusing on issues such as biological diversity, urban pollution, public information about the environment, research on environment and development, recycling, and tree-planting Most of these groups are small, with limited budgets and memberships and tend to

[2] See AFJEM 1994 for an annotated list

focus on a single local issue Environmental NGOs do not play a policy role in Morocco, because the political process does not currently allow for the kind of open debate and effective advocacy that has characterized NGOs in developed countries However, there is considerable interest in strengthening the NGO role in implementing environmental protection measures, especially for community organizing, public information, and building awareness and support for environmental protection in general

SECTION III
PROBLEM REVIEW

A Methodology

The problem review followed the general approach to comparative risk assessment designed by U S Environmental Protection Agency This is a several-step process (discussed in more detail in Annex A)

A1 Identify the Major Environmental Problems Confronting the Country

Identifying environmental problems is relatively straightforward However, the decision about how to structure them is much more difficult After much discussion and several mid-course corrections, the team organized the problems loosely according to the sector of activity generating them Thus environmental problems are considered to be the outcome of specific sectors of economic activity, with "households," in effect, considered to be a sector In this framework, most degradation can be understood as an external problem, industry causes pollution, households cause pollution, and agriculture causes pollution For natural resource-based activity, however, the problem is not one of externalities, but of overuse of the resource base The forestry or fishery sectors for example can overuse their own resource, imposing costs on themselves in the long run Similarly, unsustainable water use for agriculture imposes costs on the agricultural sector itself and potentially aggravates water shortages for industry and human consumption

This approach led to the following major sources of environmental problems general water management issues, domestic pollution of surface and ground water, industrial pollution of water and air, mobile source air pollution, accidental pollution, agriculture and land use, and natural ecosystem-based activities Note that this approach does not distinguish between "green," "brown," "blue," or other-colored issues per se The agricultural, resource-based, and general water management sectors encompass what is conventionally thought of as green problems Domestic pollution of surface and ground water and industrial and mobile source pollution of water and air cover the brown issues Marine pollution is handled primarily through assessment of industrial pollution, time and data limitations preclude a more thorough assessment as part of this effort

A2 Identify the Impacts of these Problem Areas on Health, Economy, and Natural Ecosystems

The problem review focused on the three impact areas identified by the EPA methodology The team members reviewed documents and met with Moroccan government officials, donor agencies, and project staff to develop an understanding of impacts of the various problems in each area Insofar as possible, the team gathered statistical data with which to quantify the impacts Where this was impossible, team members made assumptions with which to estimate impacts, or simply used their own judgment, or the assessments of the other experts contacted to evaluate the impacts of each problem

After much discussion, the team identified the following criteria to judge the impacts of each problem

Health Impact

- Number of people affected
- Severity of health impacts
- Reversibility of health effects

Economic Impact

- The total annual economic cost of the problem (One-time investments are converted to an annual cost) These include actual or potential expenditures necessitated by the problem, in the absence of any changes from existing management systems (e g , no pollutant discharge standards, etc) They also include estimated value of certain non-marketed impacts on economic well-being, for example, loss of women's non-marketed labor due to illness is valued at the average cost of men's marketed labor They do not include valuations of non-marketed impacts on the quality of life, such as willingness to pay for the existence of wildlife or non-economic harm caused by health problems Assessment of such costs is included within the impacts on health and natural ecosystems
- Timing of the economic impacts (repeated costs vs one-time cost)

Natural Ecosystem Impact

- Severity of impact on natural ecosystems
- Uniqueness (degree of endemism) of the ecosystem affected
- Extent of non-marketed human dependence on that ecosystem
- Number of people dependent on that ecosystem
- Timing of impact

The team members scored each problem on a one to five scale according to each of these criteria The scores were then combined to arrive at composite scores for the impact of each problem on each of the three broad impact areas and an overall composite score for the importance of each problem (Details on the exact significance of each score and the formulas used to arrive at composite scores are provided in Annex A) The results suggest the relative importance of the environmental problems identified in the problem review

B Environmental Problems

B1 Moroccan Water Management Issues

B1a Water Resources Problem Description

Water has always been a vital factor in Morocco's economic and social development Annual rainfall in Morocco represents an average of 150 billion m^3 of water, and vary from 50 to 400 m^3 Most of this water is either consumed by evapotranspiration or lost to evaporation or discharge into the sea Only 30 billion m^3 constitute the useful rainfall which contributes to renewable water sources each year This contribution is divided into 22 5 billion m^3 of surface

water and 7 5 billion m^3 of ground water However, only 21 billion m^3 per year are considered usable under conditions which are technically and economically acceptable

These resources are uneven throughout the country The Sebou, Bou-Regreg and Oum-Er-Rbia river basins account for more than two thirds of the hydraulic potential of the country In addition, the flow varies considerably throughout the year Between 60 and 90 percent of surface water resources are available during the rainy season, and most water courses experience severe low periods, sometimes with no flow at all for more than half the year

On the eve of independence in 1956, Morocco had 13 dams permitting irrigation of 135,000 hectares of agricultural land Since then, this number has grown to almost 60 dams, with a total capacity of 10 billion m^3 (representing an irrigation capacity of about 650,000 irrigated hectares), as well as a significant number of smaller local dams, wide-mouth wells, and narrow wells The quantities of water mobilized have grown from 3 billion m^3 in 1955 to 10 5 billion m_3 in 1990, of which 7 5 billion m^3 are surface water and 3 billion m^3 are ground water The number of drinking water intakes has grown from 288 in 1981 to about 400 in 1990, drinking water treatment plants, which numbered 14 in 1981, were 25 in 1990

Although the water mobilization efforts have been sustained since 1960, we must note that due to population growth the availability of water per person has dropped steadily, indicating an increasing scarcity of water resources For this reason Morocco launched a process of surface and ground water planning in 1980 The objective of this process is to prepare a national water plan which assures that water supply will permanently be sufficient to meet the needs of the different sectors of economic and social activity The plan also aims to ensure that water use will be efficient in economic terms and judicious in terms of its impact on the natural environment As a first step in this planning process, the Administration de l'Hydraulique has prepared master plans for individual river basins or groups of basins

B1b Use of Water Resources

Morocco's dams meet 60 percent of its domestic and industrial water needs These facilities also provide one third of the production of hydroelectric energy in an average year In 1990, 0 85 billion m^3 were used for drinking water and industry, representing some 7 8 percent of total resources mobilized 10 05 billion m^3 were destined for irrigation, or 92 2 percent of total resources available Of the resources used for irrigation, 72 6 percent originated in surface water courses and 27 4 percent originated in underground sources

Projected Water Demand for Drinking, Industry and Agriculture (in billions of m^3)

USE OF WATER	1990	2000	2010	2020
Total quantity available	10 90	14 10	18 21	21 00
Drinking water & industry	0 85	2 04	2 95	4 00
Irrigation	10 05	12 07	15 26	17 00
percent Irrigation	92	85	83	80

Source Conseil Superieur de l Eau 6eme session 1992

The intensive use of ground water to meet drinking, industrial, and agricultural needs, combined with the effects of drought in recent years, have led to overuse and continual dropping of certain water tables, particularly those of Haouz, Marrakech, and Souss This drop had led to drying up of water resources used for traditional irrigation, placing the peasant population in jeopardy

B1c Water Resources Management

The objective of Morocco's water development strategy is to ensure that supply is adequate to meet the demand, while protecting the quality of the resource base Over the next 20 years significant water deficits are expected to emerge in certain river basins, as shown on the table below

Supply and Demand for Water Resources in Selected River Basins (in millions of m^3)

SELECTED RIVER BASINS	1989			2020		
	Supply	Need	+ or -	Supply	Need	+ or -
B Rifains Nord	464	403	+ 61	1545	1 052	+493
B Moulouya	1122	1 205	- 83	1670	1 816	-146
B Sebou	2 329	1 704	+ 625	4 768	3 916	+852
B B-Regreg et Cotes	339	327	+ 12	852	902	- 50
B Oum Er Rbia	3 977	2 846	+1131	4 067	4 869	- 802
B Tensift	644	1 607	- 423	1 121	1 630	- 409
B Souss	675	734	258	777	1 175	- 398
B Massa	143	108	+ 25	144	185	- 41

Note Because only selected river basins are included in this table it does not represent the overall water balance of the country for this reason there is no total row (Source Conseil Superieur de l Eau 6ème session 1992)

To deal with the shortages, the fourth session of the Conseil Superieur de l'Eau (CSE) recommended transfers from surplus basins to deficit basins These will include

- Transfers from the Loukkos, Sebou, Bou Regreg and Oum Er Rbia basins to assure steady water supply to the coastal zone between Kenitra and El Jadida, which is expected to show a major deficit starting in the next century This will involve a transfer of about 1,120 million m^3 per year

- Transfers from the Sebou to the Moulouya basins to contribute to the development of irrigation in Eastern Morocco The volume to be mobilized is 120 million m^3 per year

- Further analysis of the proposal to transfer water from the Mediterranean coastal basins and the Moulouya basin, which will involve an annual volume of some 440 million m^3

The costs of these transfers will vary between 0 98 Dh/m^3 (for the Loukkos Rharb transfers) and 5 82 Dh/m^3 (for transfers from the Mediterranean coast to Moulouya) The CSE has also recommended several other strategies that may help increase total water supply

- A more closely linked management of surface and ground water, particularly by artificially recharging the ground water supply
- Increased use of treated wastewater for irrigation
- Increased use of brackish water, which has significant potential

Water transfer addresses the supply side of the water problem Another approach is to promote water conservation to reduce demand, to reduce or delay the massive capital investments needed by the transfer projects and avoid the ecological problems they will create Wasted water is widely considered to be a major problem among all user groups, irrigation, domestic consumption, and industry In the domestic and industrial uses, the wastage is reported to be largely due to poorly maintained equipment In agriculture, however, it is widely recognized that water pricing plays an important role The Government of Morocco prices irrigation water well below its social cost This reflects a policy decision by the government to encourage farmers to stay on their land Whether this subsidy to agriculture, with the capital and possible ecological costs which it entails, is a net benefit to the country is beyond the scope of this effort since it is linked to broad social policy, employment objectives, attempts to control rural-urban migration, and other social issues

Acknowledging that water demand is a problem, the CSE foresees a number of other activities in addition to the transfers

- Control and rationing of water demand and use, protection and preservation of water resources, and protection of dams against siltation
- Aggressive use of economic incentives to ensure efficient water use

B1d Health Impact

Large-scale transfers of water between river basins to meet the anticipated demands from urban areas, could have detrimental effects on human health The decline in water flows in the water-donating basins will result in a lessened ability of these basins to naturally filter water, increasing stagnation This could lead to an increase in water-borne diseases like diarrhea, typhoid, cholera, meningitis, and hepatitis In addition the stagnation of water in donating basins can lead to increases in insect-borne diseases

B1e Economic Impact

The major economic impact of Morocco's water supply problems is the added cost of the construction of dams and water transfer infrastructure These costs are carried by the population through the tax system since water is priced well below the costs of providing it This encourages a greater dependency on agriculture than would be the case if water charges were expected to cover the entire costs of hydraulic infrastructure, since a significant portion of Morocco's agriculture produce might not be competitive if the price of water increased substantially This strategy by the Government of Morocco reflects a set of considerations which go far beyond

24

water conservation and environmental protection, assessing the impacts of this water pricing policy is equivalent to assessing the government's entire development strategy More narrowly, it is possible that other mechanisms for subsidizing farmers could be more efficient than through water pricing These other mechanisms might be less harmful to the environment The difference between other subsidy schemes and the current one would then constitute the costs of the water problems and the government's approach to addressing them In any case, these costs are high and will increase in the future as the government constructs additional dams and begins transferring water from one basin to another

B1f Natural Ecosystems Impact

The transfer of water from a natural a natural riverine system to another area can have severe impacts on biological resources Such a transfer can reduce river water flow The reduction of river flow may increase the concentration of river pollution, reduce river oxygen and induce an environment which is breeds insects and pests An increase in pollution concentration can poison fish and other marine life Pollution can also make wildlife habitats unsuitable for native and migratory birds Increased pollution can also destroy habitat for riverine species upon which birds and other larger animals depend for food A reduction in oxygen resulting from reduced water flow can cause fish and other marine species to die out prematurely

The massive transfers planned by the Government of Morocco in order to address water shortages are likely to carry very high risks As observed in other countries, including the United States, large scale water transfers can bring about unforeseen changes in water tables, the intrusion of saltwater into freshwater systems, major changes in species composition, a decline in ecosystem functioning, and the degradation of key fisheries and fish breeding grounds These risks can be neither fully anticipated nor completely eliminated

B1g Problem Review Results

Water supply is a major problem for the long-run development of the Moroccan economy Current water use practices, and even more, the planned rapid construction of dams and infrastructure to transfer water across river basins, will impose significant economic costs and serious ecological risks

B2 Domestic Pollution of Surface and Ground Water

B2a Problem Description

The population growth and socio-economic progress of the country have led to a rapid growth in domestic and industrial wastes These wastes have harmful impacts on the environment in general and on water in particular The World Health Organization defines water pollution as a "disequilibrium which results from human activity and makes water unsuitable for its prior use " (WHO, 1968) Water pollution in Morocco is due essentially to urban and industrial discharges into the hydrographic network with no prior treatment Agricultural activity also plays a non-trivial role in surface and ground water pollution Finally, accidental pollution constitutes a growing threat whose impact is increasing for water users

Domestic pollution has essentially two components, liquid waste and solid waste The annual volume of wastewater discharges has grown rapidly in the past three decades, from 48 million m^3 to 370 million m_3 between 1960 and 1990 Moreover, predictions indicate that these

25

discharges will continue to grow rapidly, reaching 500 million m^3 in 2,000 and 900 million m^3 in 2,020 (CSE 1992) The principal factors contributing to this growth, according to the same source, are

- An increase in urban population, at the rate of 4 4 percent per year
- An increase in the share of households connected to the drinking water network, which grew from 53 percent in 1972 to 79 percent in 1993
- The increase in average water consumption, from 85 liters per person per day in 1972, to 116 in 1992

At present Morocco, in collaboration with the World Bank, is developing sewerage master plans for several major cities These studies are well advanced, and should lead to the implementation of improved sewage collection and treatment systems Moreover, the management of municipal sewage is currently undergoing a major change Its first step consists of progressively transferring the sector to the companies charged with distributing drinking water and promoting the collection of corresponding revenues, as in Casablanca For smaller cities, the National Drinking Water Office (ONEP) will be responsible for sewerage

Few Moroccan cities have operating wastewater treatment plants Instead, they discharge wastewater directly the environment, particularly surface water bodies This is the case of the major cities of Fes, Meknes, Taza, Khemisset, Khenifra, and Marrakech The Atlantic Ocean receives most of the household waste since the principal Moroccan cities are on the coast The central and north-western economic regions (Casablanca and Rabat-Tangiers) discharge almost 60 percent of the national total of household wastewater These discharges constitute the principle source of organic water pollution, accounting for about 75 percent of biological oxygen demand (BOD) and 85 percent of chemical oxygen demand (COD) (SSE, 1994)

The Sebou Basin is the region most affected by domestic pollution The daily discharges into this basin by some 1 2 million people amount to 110 tons of suspended solids, 70 tons of organic matter, 18 tons of nitrates, and six tons of phosphorous In addition, we must add the pollution in the form of pathogenic microorganisms Thus in river stretches upstream from discharges fecal coliform counts (a good indicator of bacteriological pollution of fecal origin) are on the order of 500 per 100 ml of water Immediately downstream form the discharges, the counts can reach as high as one million per 100 ml of water, with identification of pathogenic germs as far as several kilometers from the discharge points (CSE, 1990) While other river basins are not nearly as polluted as the Sebou, they may be expected to approach this level as population grows, if wastewater treatment systems are not installed

Use of untreated wastewater in irrigation is a significant problem as well A recent survey found that over 7,000 hectares are irrigated with untreated wastewater in peri-urban areas where people grow gardens, fruit trees, and cereals This is the case around the cities of Marrakech, Meknes, Oujda, Fès, El Jadida, Khourigba, Agadir, Beni Mellal, Benguerir, and Tetouan, (CSE, 8ème session) Moreover, the comparison with earlier data shows that this practice is increasing in importance Morocco considers waste waster as a potential hydrological resource, and encourages the development of integrated sewerage-treatment-reuse projects This would have the double advantage of taking advantage of water resources (particularly in water-deficit regions) while reducing to a minimum the environmental nuisances that they create

The production of solid wastes is linked to economic and social development It is estimated at about 10,000 tons per day, up from 1,600 tons per day in 1960 This production is

concentrated in the major urban centers, in 1989 Casablanca produced 2,000 to 2,300 tons per day, or about 30 percent of the total national production (DGCL, 1989)

Solid wastes constitute a cause of considerable nuisance to the natural environment and a certain danger to public health This danger exists directly at the household level if trash is not collected rapidly It exists where trash is deposited, in piles where people leave it, around containers, or in the roads when collection and transport is too hasty Low trash collection rates compound the dangers in certain residential neighborhoods, while nearly 100 percent of the waste is collected in Casablanca and Rabat, the figure is only 40 percent for Tangiers and 85 percent for El Jadida (USAID, 1992) For the country as a whole collection rates are 85 percent in urban areas and 2 percent in rural areas (World Bank, 1994) The dangers of solid waste also exist directly on the landfills, which are often little more than huge trash heaps The most notorious problems are observed around major cities such as Meknes and Rabat The Casablanca landfill, in particular, in the Mediouna quarry, is polluting the ground water and confronts the traveller leaving the city with its appearance, its smoke and dust, and the odors that waft through the city

The physical and biological properties of Moroccan household wastes are distinctly different from those produced in developed countries, notably in Europe Moroccan wastes contain a particularly high proportion of organic matter (more than 65 percent), and the level of humidity (65 to 70 percent) is almost double that of European wastes These characteristics increase the risk of contamination of surface water and groundwater from runoff and infiltration

Other categories of waste are also deposited in the public landfills These include industrial wastes, which amount to 80,000 tons per year, composed of sludge, sand, and metal scraps (72 percent), sub-products (22 percent), and primary material scraps (5 percent) The chemical industries produce 20 percent of these discharges, made up of production waste and chemical product packaging These wastes are deposited either in public landfills or in unmanaged sites adjacent to production facilities Medical wastes are also a matter of concern These are composed of pharmaceutical products and organic debris, including hazardous wastes The largest hospital centers are equipped with incinerators, but many others send their wastes to the public landfills

Recycling of household wastes exists, but it is informal and traditional Recycling occurs throughout the length of the treatment chain, from collection to the landfill, where it may involve entire families A number of intermediaries are involved, from those who collect trash at the base to those who resell it to recycling plants in Casablanca, Kenitra and Tangiers Recycling is concentrated essentially on plastic packaging and cardboard One study estimates that 50 percent of plastic is currently recycled (SSE, 1994)

B2b Health Impact

Domestic pollution affects health through transmission of pathogens which can occur through several different mechanisms Direct contact with wastewater by agricultural workers and their families is one major source of contamination This primarily affects agricultural workers irrigating with urban wastewater Indirect contact can result from drinking contaminated water or consuming vegetables irrigated with wastewater In addition, the infiltration of the "juices" produced by landfills is a certain source of contamination of the ground water in areas where the surface soils are highly permeable This is particularly hazardous in rural areas where people rely on uncontrolled wells for their drinking water

Available public health statistics give a clear picture of the importance of water-borne disease in general, but do not allow us to distinguish the contributions of surface and ground water pollution (and thus, the differences between sewage vs landfill problems) The most widespread water-borne disease is diarrhea, from which each child under five years of age suffers an average of 4 5 times per year, or a total of over 14 million cases per year nationwide According to the Ministry of Health, diarrhea problems are most acute in peri-urban areas—informal settlements at the edge of cities with urban features but without municipal services such as water, roads, or education—where populations are highly concentrated and sanitation is poor Each year over 15,000 children die of diarrhea, some 60 percent of these cases are attributed to water contamination problems (SSE, 1994) These statistics make untreated sewage and uncontrolled landfills unquestionably the most significant source of environmental health problems in the country

Statistics on other water-borne diseases suggest that they, too, are important These include typhoid, conjunctivitis, viral hepatitis, meningitis, and bilharzia Statistics on cholera are not published, but it has apparently also been a problem in recent years There were some 57,300 cases of these diseases in 1994, of which conjunctivitis accounted for about 50,000 (Annuaire Statistique, 1994) Excluding conjunctivitis these are serious illnesses that can easily lead to death if not treated Statistics on death rates are not available, nevertheless, this reinforces the impression that water pollution poses significant health risks

The visibility of sewage problems, the use of wastewater for irrigation, and the relatively slower infiltration from landfills relative to dispersion of surface water contamination, all combine to suggest that wastewater treatment may be a more crucial problem than sanitary landfills However, it is clear that both issues are crucial in addressing the health risks posed by domestic water pollution

Sanitary landfills also pose a health risk to those who work directly on them or live adjacent to them Anecdotal evidence suggests that there may be about 5,000 people working directly on the landfills These people are exposed to a variety of health risks, some of them minor and some potentially serious In particular, the natural burning which occurs on landfills releases volatile organic compounds, polycyclic aromatic hydrocarbons, heavy metals, and other toxic gases However, because they are a small group, this health issue is considered less important than the previous ones Similarly, while some of the health risks to those living near the landfills may be serious, this is a fairly small group of people, so the overall importance of this problem compared to water contamination is relatively low

B2c Economic Impact

The economic costs of domestic pollution can only be approximated For the most part, domestic pollution of water has not yet generated specific costs for drinking water supply, however one treatment plant taking water from the Oued Sebou required specific additional investments valued at about $18 million (ONEP, 1994) As urban areas grow and population densities on the key river basins increase over the next 20 years, the investments required may rise dramatically in the absence of investments in domestic wastewater treatment

The costs of medical care can be approximated based on the levels of disease Thus an estimated $11 5 million in medical expenses and foregone income may be attributed to water-borne diseases other than diarrhea, a fairly moderate economic impact Direct medical costs to treat diarrhea (whether carried by the family or the public sector) are estimated at about $35

million per year, based on the share of cases that lead to doctor visits or administration of medications or rehydration salts For those who die it is assumed that they would have had lower than average income and that the foregone income is much higher than the direct expenditures, estimated to be about $250 million This overwhelms the other economic costs associated with water-borne disease, but it is a quite controversial cost, and some would argue that it should be excluded in our analysis

Domestic water pollution is also having an impact on the hygiene of public beaches, and thus on the tourist industry Public beaches are regularly monitored for bacteria counts, and closed if they pose a health risk, so the health impacts are probably quite low However, only one or two contaminated beaches could have a disastrous ripple effect on Moroccan tourism The importance of this risk is evidenced by the fact that European tour operators take their own measurements of water quality at the beaches prior to bringing groups to Morocco With sharp competition from other resorts around the Mediterranean, the risks are obvious Experts at the Ministry of Tourism suggest that this is not currently a problem However, if municipal sewage continues to flow untreated into rivers and oceans it may be significant in the not too distant future No estimates of total tourist revenues are available, so quantifying this risk is not possible

Economic costs of trash collection problems and landfills are much lower The medical expenditures and foregone income of those working directly on the landfills is estimated at less than $250,000, while those of people living near them is less than $500,000 per year Landfills also have an impact on the value of adjacent properties, or those subject to odors or blowing dust These are impossible to estimate without detailed data on property characteristics and values, not least because there are no properly managed sanitary landfills in Morocco to provide a basis for comparison

Overall it would appear that the most important economic costs currently posed by domestic waste are related to water pollution As the problems grow in the future, all of the costs will grow, however there is no a priori reason to expect the relative importance of water pollution and direct exposure to landfills to change

B2d Natural Ecosystem Impact

The major impact of domestic pollution on biodiversity occurs through the reduced oxygenation of downstream surface waters Although the worst case, the Sebou River, is reported to have no oxygen in it, this is apparently not posing a threat to coastal wetlands or other critical areas defined by the Direction des Eaux et Forêts The river ecosystem is considered to be dead, but there has apparently not been harm to legally protected areas As with other impacts, however this could become much more serious with rapid urban growth in the future

B2e Results of the Problem Review

The combined impacts of domestic pollution on health, economy, and natural ecosystems suggest that untreated liquid wastes probably pose the greatest risks, with trash collection and uncontrolled landfills coming in second Since we cannot identify the source of water-borne illnesses, we cannot clearly distinguish the importance of sewage and solid waste However, since water-borne diseases impose much greater costs than any other problem, we may conclude that solutions intended to treat urban liquid waste prevent landfill infiltration and protect the drinking water supply may be most appropriate response to domestic pollution problems

B3 Industrial Pollution

This section reviews the information available to the team on industrial pollution of air and water in Morocco The section analyzes emissions air and water from conventional industrial sources, as well as from artisanal (small) sources and emissions into air from transportation (mobile) sources The section presents a summary of the major issues related to these emissions, and assesses their impacts on human health, economic growth, and biological diversity

B3a Problem Description

Industrial emissions into the air The emissions from cars, buses and trucks represent a locally important source of air emissions Approximately 1 185 million vehicles are currently in circulation, consuming 384,381 metric tons of gasoline and 1 92 million tons of diesel fuel The primary compounds emitted by vehicles include sulfur dioxide, nitrogen oxides, suspended particles, volatile organic compounds, and lead In addition, the emissions of nitrogen oxides and volatile organic compounds combine, in the presence of sunshine, to produce ozone, also known as "smog "

The extent of these emissions does not pose a significant environmental threat nationally However, in specific urban areas, especially Casablanca, Rabat, Marrakech and Tangiers, pollution from vehicles is likely to be very high because of the use of old, poorly maintained vehicles, poor traffic management, and extensive vehicle congestion during rush hour periods This can result in serious local human health impacts

Industrial fixed sources Approximately 1 million petrol equivalent tons of fuel oil are consumed by industrial sources annually, producing approximately 2 million tons of carbon dioxide (CO_2), 180,000 tons of sulfur dioxide, 10,000 tons of dust and suspended particles, and 7,000 tons of nitrogen oxides The total emissions of atmospheric pollutants in major industrial provinces are summarized in the table below Emissions data are broken down by industry sector as follows

- Cement kilns represent one of the most important fixed sources of emissions into the air The primary types of pollutant are dust (caused by the mixture of large quantities of soil-based products), sulfur dioxide and nitrogen oxide emissions caused by the burning of fossil fuels to create heat as part of the production process, and the release of heavy metals (adhered to the surface of dust particles)

- The two petroleum refineries in Morocco produce emissions of sulfur dioxide, nitrogen oxides, and volatile organic compounds (VOCs)

- The phosphate processing facilities and Safi and El Jadida produce 204,000 tons of fluorine gas, and over 100,000 tons of CO_2 and 80,000 tons of SO_2

- The electric generation facilities consume 1 5 million tons of fuel oil, 1 2 million tons of coal, and 32,000 tons of gasoil

Annual Emissions from Industrial Sources by Province (in tons)

Province	CO_2	SO_2	Particulates	NOx	Hydro-carbons	CO	Fluorine Gas
Agadir	42,600	1,800	3,070	658	42	80	0
Casablanca	451,000	6,600	2,420	1,700	100	160	912
El Jadida	31 000	84,000	30	70	4	5	95,000
Fes	19,000	80	55	290	9	37	0
Kenitra	111,400	2,300	100	260	17	18	0
Marrakech	16,300	810	1,200	330	22	41	0
Meknes	40,000	1,500	830	600	40	70	0
Mohammedia	43,000	3,600	50	100	13	8	0
Safi	156,000	81,000	600	600	34	60	110,000
Tangiers	53,100	220	50	130	6	10	0

Area or Artisanal Sources No data exist on the extent of emissions from artisanal sources, such as potteries and bakeries However, anecdotal information suggests that these sources could represent important, though very localized sources of suspended particles like sulfur dioxide and other pollutants The potteries appear to use automobile tires soaked in gasoline to increase furnace temperatures, resulting in brief emissions of very hazardous pollutants Bakeries are an important consumer of wood, accelerating deforestation

Industrial Emissions into Water The primary pollutants discharged into water resources in Morocco include 100,000 tons of chemical oxygen demand (COD) and 58,000 tons of biological oxygen demand (BOD), over 110 tons of heavy metals, including chrome and 3,300 tons of nitrates The primary sources of these emissions are tanneries, olive processing, and phosphate refining

- The tanning industry uses chrome to enrich the texture of products It has been estimated that approximately 110 tons of chrome is discharged into the Sebou River each year from tanneries based in Fes and Meknès A significant portion of this total is discharged by artisanal tanneries A large portion of these discharges are deposited in local river sediment, while a small portion is carried downstream The deposition of chrome into the river sediments may pose future environmental problems if the sediment is disturbed by floods or development activities

- The olive oil processing industry produces an organic waste byproduct known as margine, which is composed of water, oil and suspended particles These industries emit some 1 4 million cubic meters of used water containing approximately 10,000 tons of margine

- Phosphate processing discharges 6 5 million tons of suspended particles, 200 tons of phosphorus, 110 tons of heavy metals and 3,300 tons of nitrates into the Atlantic ocean The phosphate processing facilities discharge over 1,051,410,000 cubic meters of water effluent, which represents 96 percent of industrial use of water

- The textile industry is responsible for approximately 6,900 tons of suspended particles and 15,000 tons of BOD

- The two refineries produce liquid waste during the oil - water separation process in the form of oil by-products leaking into the surface water systems While little information is available on the amount of this pollution, it is unlikely to be a major environmental problem

B3b Health Impact

Chrome The single most important impact of industrial emissions on health is in the area of heavy metal discharges into the Sebou river from the tanning industry At present over 110 tons of chrome are deposited into the river at the centers of the tanning industry Fes and Meknes The ultimate fate of heavy metal deposition in the Sebou is not known Undoubtedly much of the chrome becomes deposited in the sediments immediately downstream (within a few kilometers) of the emission points A smaller portion, perhaps between 1 percent and 10 percent, remains in suspension depending on water flow characteristics

Humans are exposed to chrome deposits in the Sebou through bathing and drinking and other activities In addition, residents along the river could be exposed through skin contact when using water for bathing and other activities Consumption of fish and invertebrates in the river can also lead to indirect exposure However, ONEP reports that chrome does not exceed World Health Organization standards in drinking water

The health implications of chrome exposure include deterioration in organ function, nervous disorders, and impairment of bone formation This is especially significant for children and young adults, and may result in long-term disabilities The team was unable to estimate the number of people suffering from illnesses or effects of chrome exposure

Lead Air pollution as a whole is not a major problem in most areas However, the data indicates that residents living near areas of high traffic congestion in major urban areas are likely to be exposed to very high levels of lead and other pollutants This exposure has important ramifications for children who are particularly vulnerable to lead's toxic effects High levels of lead in the blood are associated with retardation, neurological problems, reproductive effects, hypertension, learning disabilities, and brain and kidney damage

Other gaseous air pollutants Apart from lead, residents in high traffic congestion areas are also exposed to high levels of NOx, ozone, polycyclic aromatic hydrocarbons (PAHs), and volatile organic compounds (VOCs) These pollutants can produce eye, nose and throat irritation central nervous system depression, liver and kidney damage, headaches, dizziness, angina pulmonary edema, and cancer As with lead, these effects are particularly acute in children and young adults While long-term damage can often be reversed when exposure rates decline, some diseases will persist, especially after chronic long-term exposure

Dust Exposure to dust from cement plants impacts human health in two ways Chronic inhalation of dust can impair respiratory function, and accelerate the development and severity of respiratory diseases such as asthma Additionally, dust particles often contain minute quantities of heavy metals adhered to the surface When inhaled, these heavy metals are absorbed in the lung alveoli, leading to contamination of the bloodstream

Organic discharges into rivers Large discharges of organic matter reduces oxygen levels, leading to a decline in plant and animal species in the river This decline results in a lowering of the river system's ability to be self-cleaning As a result, water-borne diseases such as diarrhea, typhoid, cholera, conjunctivitis, meningitis and hepatitis, become much more prevalent

B3c Economic Impact

The economic impacts of pollution include loss of economic resources such as fishing grounds, potential exclusion from export markets, declines in worker productivity from environmental diseases and illness, increased costs of medical treatment, increases in time and resources expended in obtaining non-polluted water, and increases in costs of maintenance of buildings and cultural and historic sites

Loss of economic resources The emissions of wastewater from the phosphate processing facilities at Safi and El Jadida have occurred at the same time as a rapid decline in sardine populations in the areas adjacent to the outflows, and a corresponding increase in sardine catches further south along the Atlantic coast Overall trends in sardine catches nationwide have not changed, though they are always characterized by wide fluctuations in yields from year to year This has imposed transactions costs on fishermen and canneries, as Tan-Tan has replaced Safi as a major sardine port Whether this will be a serious problem in the future depends on whether, in fact, the shift is due to the phosphate plants Experts in the area do not agree, and further research is now underway which may clarify the issue soon In any case, industrial pollution is certainly a potential threat in the fishing industry

Economic loss from restrictions in market access A greater long-term economic risk to the emissions from the phosphate processing is the increased restrictions in market access, especially the European Community At present, Morocco exports about 29 percent of total phosphate production to the European Community, with Spain representing the single most important export country (see below) The value of these exports is approximately $59 8 million The second largest export country is the United States with almost 20 percent of total production valued at $37 5 million

Exports of Phosphate by Country of Destination (metric tons)
(Data for 1 January - 30 September 1994)

Country of Destination	Exports (tons) Jan - Sept 94	Percent of Total Production
European Community	2,040,000	29 4
United States	1,373,522	19 8
Mexico	749,855	10 8
Poland	436,823	6 3
UEBL	391,310	5 6
Indonesia	346,742	5 0
India	297,584	4 3
South Korea	205,304	3 0
Croatia	178,620	2 6

Source Revue d'Information BMCE, February 1995

The European Community imposes strict standards on production and product standards for all goods sold in the Community countries As part of these standards, the environmental impacts of the products and processes are considered, and products which do not meet these environmental standards will ultimately be banned, even if produced outside the European Community Thus, the high levels of pollution from the phosphate processing facility could result in the restriction, or ultimate prohibition, of exports to the European Community

Productivity losses The loss in worker productivity is likely to be especially acute in artisanal factories, such as tanneries, where workers are exposed to very high levels of toxic substances with little or no protective equipment or practices Productivity losses would include an increase in absenteeism due to medical problems and reduced productivity while at work These productivity losses are not likely to be realized in national accounts, because of the informal nature of this type of employment Additional losses in productivity could also be pronounced for those workers living immediately downstream or downwind of major point sources

Based on the health impacts of industrial and mobile source pollution, it is possible to make some general estimates of the possible productivity losses due to pollution For childhood exposure to lead in automobile emissions, foregone earnings are estimated at about $400,000, a modest amount This is expected to go up in the future as both the number of cars and urban population densities increase For other sources of air pollution, it is not possible to distinguish by source However based on the size of the population exposed to air pollution and the types of disease which can result, foregone earnings are estimated at about $2 million per year, also a fairly moderate sum in the context of other environmental pollution costs

Increased medical costs For individuals exposed to high or chronic levels of industrial pollutants, resulting medical problems will raise the costs of medical treatments Based on the same estimates of exposure as above, medical costs for general exposure to air pollution are estimated at about $2 3 million dollars per year

Increased costs of cleaning and maintenance Sulfur dioxide, nitrogen oxides, ozone and other air pollutants accelerate the decay of the exposed surfaces of buildings and historic sites, increasing maintenance costs and possibly permanently damaging priceless cultural sites and artifacts The increase in maintenance costs extends to houses, buildings, and other property where the costs include more frequent painting and repair and replacement of exterior walls and wall coverings Based on an estimate of an increased cost of $5 per year per urban household, this totals almost $9 million per year This is an extremely rough estimate however Permanent damage to cultural and historic sites imposes incalculable losses beyond mere replacement costs

B3d Impact on Natural Ecosystems

The two most important impacts of industrial pollution on biological diversity are the emissions of heavy metals and organic matter into rivers and the discharges of phosphate processing facilities into the Atlantic Ocean

Discharges into rivers Industrial discharges into rivers, especially the Sebou, have significantly reduced the level of biological diversity downstream This is especially important in the case of fish and invertebrate species, and some plant species The Sebou River is largely devoid of many species found in abundance downstream in Fes and Meknes If not remedied these impacts may be carried out to the wetlands and coastal zones, although they are not currently affecting legally protected areas

Phosphate processing discharges into the Atlantic As noted above, the development of two major phosphate processing facilities at El Jadida and Safi has paralleled a rapid decline in sardine populations in certain areas of Morocco's coastline Anecdotal data suggest that since the construction of the phosphate processing facilities the sardine population has shifted south Expert opinion is divided as to whether this shift is due to pollution, over-fishing, or natural changes in the environment (such as changes in ocean currents or movement of phytoplankton) While sardines themselves are not an endangered species, there is some concern that they may be an "indicator species" whose decline may indicate serious problems for a wide variety of marine life not being monitored

B3e Results of the Problem Review

Industrial and automotive emissions problems of primary importance are

- Emissions into the water of chrome from tanneries
- Organic discharges from the olive processing
- Emissions of suspended particles and heavy metals from phosphate processing
- Emissions of lead from mobile source emissions

A review of expert opinion in Morocco supports the inclusion of the first two issues, but is significantly divided over the importance of the third issue of phosphate processing As noted earlier, data are inconclusive as to the cause (whether natural or the result of pollution) of the movement of the sardine population south of Safi and El Jadida, and whether this movement is a

reflection of overall impact on the oceanic environment of phosphate wastewater discharges A study carried out by the Scientific Institute of Marine Fisheries does show levels of PO_4, cadmium, and other phosphate waste products to be 3 to 10 times higher near the discharge points than elsewhere along the coast (*Evaluation de La Salubrite du Littoral Mediterraneen et Atlantique Nord (Saidia-Safi) durant la periode 1992-1994*, Institut Scientifique des Pêches Maritimes, 1994) The Institute is currently carrying out a more detailed study to assess the impact of phosphate discharges on the marine ecosystem

As discussed earlier lead exposure from mobile source emissions, while possibly serious for a few urban areas, does not appear to be a major problem nationally Problems of secondary importance are

- Mobile source emissions of sulfur dioxide, nitrogen oxides, suspended particulates
- Air emissions from industrial fixed sources
- Air emissions from area or artisanal sources

The results conform to generally held opinion within the environmental community, although the lack of data restricts further analysis An air quality monitoring program would help identify the relative importance of these sources to Moroccan air quality problems

B4 Accidental Pollution

B4a Problem Description

Accidental pollution of surface water constitutes a danger that increasingly threatens water resources The most dangerous accidents recorded between 1981 and 1988 involve spills from tanker trucks transporting hazardous materials Other accidents threatening water supply include

- Pipe breaks which lead to contamination of drinking water by sewage
- Accidental pesticide spills into water bodies upstream from drinking water intakes
- Contamination of reservoirs with hydrocarbons
- Ground water contamination from gas stations

The risk of accident is particularly great because major roads frequently run along water courses Moreover, the resources available to the Civil Protection to provide emergency drinking water supplies in case of accident are very restricted In addition to interrupting the drinking water supply, such accidents can cause major harm to flora and fauna in the water

For example, at a bridge over the Oued Beht a serious hydrocarbon spill occurred in 1988 following a traffic accident The water of the El Kansera Dam and the entire water supply to the Khemisset and Tiflet were threatened with major contamination Rapid control measures prevented the worst The Sebou basin faces important risks of accidental pollution on the length of its rivers and around the reservoirs of El Kansers, Idriss 1er, and Ait Youb Risks are also high where hydrocarbons, industrial chemicals, and agrochemicals are stored These risks call for development of prevention measures to minimize the chance of an accident disrupting water supply

B4c Impact on Health

Accidents are the source of water pollution most feared by those responsible for providing clean safe drinking water Such pollution is not always detected, and can have grave health effects, including toxic contamination and water-borne diseases So far, accidents do not appear to have seriously threatened health, however as the drinking water supply network is more heavily used in the future, the consequences of accidents like those of the past few years will increase, because ONEP's ability to respond quickly will decrease

B4c Impact On the Economy

The economic impacts of accidental pollution are attributable mainly to the treatment of polluted water (both surface and ground water) and to replacement of polluted wastes Although the available data are insufficient to estimate the costs of these problems in the past, probably no one accident so far would lead to damage greater than $1 million The potential risk, of course, is much higher, especially as population growth makes it harder for ONEP to respond quickly to accidents

B4d Impact on Natural Ecosystems

The impacts of accidents on natural ecosystems occur through destruction of water-based fauna and flora by toxic chemicals These may be a problem in riverine ecosystems, but not in legally protected areas However if such accidents occurred in the future near sensitive coastal wetlands, they could have serious impacts on migratory birds or other critical species

B4e Results of the Problem Review

This analysis suggests that accidental pollution could cause serious health, economic or biodiversity problems in the future, although it has not done so yet Available data do not permit us to distinguish among different types of accidents to specify the risk posed by each We can only conclude, therefore, that measures to detect pollution and intervene rapidly are needed to minimize the risk to the public drinking water supply posed by accidents

B5 Agriculture and Land Use

B5a Problem Description

Climate Morocco has a Mediterannean climate that is characterized by mild winters, hot summers, relative aridity, and efficient winter rainfall If Morocco's rainfall came in the hot summer months rather than the cool winter months, the country would be a parched desert Because the rainfall is usually gentle and temperatures are cool during the winter, a cereal crop can be produced in the winter with one-third the moisture required to grow the same crop using irrigation during the summer

The incentives for using all available water resources are high in a Mediterranean climate It is the most responsive climate for irrigated agriculture and it is a desirable climate for human habitation Consequently, developing and protecting water is the top priority of the Moroccan government In Morocco the problems of climate, soil, water, agriculture and land use are closely related

Land Five categories of land were considered for this report

- Water eroded land
- Irrigated land
- Wind eroded land including dune encroachment
- Scenic land
- Urban proximity land

The intensity and extent of environmental risk is much greater in the first three categories, which this section will focus on Water erosion of soil is the most important environmental problem in the mountains Soil salinity and the pollution of water resources with nitrates and pesticides are the most serious environmental problem on the irrigated plains Dune encroachment is the most serious environmental problem in arid regions

The concept of land includes all of the physical, economic and social factors which affect the ability of a given area to respond to given interventions At the implementation level, environmental controls are most often organized and applied on the basis of land (i e , water quality control boards, air quality control boards, and scenic land commissions) A lack of understanding of this fundamental principle among government agencies and donors is a serious problem in Morocco Environmental laws and regulations regarding water and air should not be made on the basis of land, they should be applied on the basis of land

The basic land unit for environmental work in Morocco is the catchment basin A catchment basin is named after the most important river which drains it and refers to all land which drains into the river from its source in the mountains to the point where it drains into the ocean There are six major, well-defined catchment basins in Morocco the Moulouya, the Loukkos, the Sebou, the Oum Er Rbia, the Tensif, and the Souss

In a given catchment basin water resource management (including watershed protection and aquifer protection) and water quality control (including agricultural, municipal and industrial effluent) ideally should be integrated and administered across the entire catchment basin from the mountains to the ocean This is not currently done in Morocco (nor for that matter in most regions of the world) Rather, the responsibilities are diffused across a variety of national, regional, and municipal organizations that generally do not formally coordinate their efforts

Water erosion of soil is a function of climate, soil, slope and farming practice Because Morocco has a warm, dry climate, its soils are low in organic matter and fragile They lose their ability to absorb water quickly Because of the moisture constraint, farmers plant crops at wide distances and keep fields free of weeds The result on slopes is rapid surface runoff and serious soil erosion The problems of soil erosion by water is widespread in Morocco but the Rif and the southern Atlas Mountains, especially the Rif, are where this problem is the most common and serious

On bare ground with a slope of seven percent, average soil loss would be about 89 tons per hectare per year with 39 percent of rainfall lost as runoff These soil losses correspond with measured soil losses in the Rif There are no measurements from the Rif for rainfall lost as runoff but presumably they would also be similar to the 39 percent figure given above The siltation of reservoirs and the loss of agricultural land are the major and obvious results of soil erosion by water However, there are also some more subtle relationships between land, water,

human welfare and biodiversity which are present on wild rivers or on streams above dams in Morocco and which have serious implications for the entire country

Rapid runoff is erosive This runoff destroys land by removing soil and destroying aquatic habitat, by depositing soil in streams The value of a good watershed is that it holds the water and releases it slowly These desirable characteristics are a function of good vegetative cover and of good soil structure Rapid runoff occurs when a watershed is not properly maintained The rate of water release from a watershed determines such crucial factors as base flow, flooding, dilution flow, maintenance flow and aquifer recharge

One effect of a good watershed is that fluctuations in stream flow are not extreme "Base flow" refers to the characteristic minimum flow of a stream On a poorly maintained watershed the minimum flow of a stream is reduced At the extreme, perennial streams become seasonal streams that dry up during the summer and cause flooding during the winter

The concentration of pollutants in a stream is a function of how much water there is in a stream as well as how much pollutants are discharged into the stream The flow required to maintain water quality in a stream is the "dilution flow " Whenever the base flow of a stream becomes less than the dilution flow of a stream the result is serious perennial water pollution problems

The flow required to maintain the aquatic habitat is referred to as the "maintenance flow " When the base flow falls below the maintenance flow, the aquatic habitat is damaged or destroyed

Moisture which is retained in a good watershed is not just released in a more uniform fashion into surface streams It is also released as recharge water into aquifers In aquifers where pollution is a problem, a reduction in recharge water means an increase in the concentration of pollutants in the aquifer In the arid regions of Morocco, dry years are identified with disease problems resulting from the use of water from polluted wells

The environmental risk generated by irrigation and the intensive agriculture which accompanies irrigation is similar in magnitude but different in character from the environmental risk imposed by water erosion of soil For irrigated land, the major risk is pollution of water by chemicals Another environmental risk associated with irrigation is salinization of soil These problems are widespread and serious but relative to the resource base, they are often reversible Except where they impact human health, the environmental risks associated with irrigated land are chronic rather than acute

On irrigated perimeters, it is common to see chemicals being mixed immediately adjacent to and above canals These chemicals are lower than the surrounding terrain and chemical containers being washed in canals and next to wells Many of these chemicals should, at a minimum, be tracked and some should be applied only by qualified personnel The need for training pest control applicators, regulations governing the use of pesticides and sensitizing the general population to the dangers of toxic chemicals is not being met In addition, Moroccan fruit and vegetable exporters will be required to meet more rigorous pesticide residue standards for their produce from their primary export market, the European Union

Wind erosion is usually extensive and marginal in its impact It is also very difficult to control Consequently, wind erosion would not usually be expected to qualify as an important

problem However, in Morocco wind erosion includes the problem of dune encroachment In the context of this report, dune encroachment cannot compete with water eroded land or with irrigated land as a serious problem for Morocco However, dune encroachment can be a very serious localized problem and, when funds are available, Moroccans know how to control dune encroachment Consequently, it is included in this report

B5b Health Impact

The major health problems include

- Among rural populations, the environmental problems posed by eroded and degraded lands are likely to have an impact on health through the concentration of already-present water pollutants

- Intensive, irrigated agriculture often pollutes surface and ground water with plant nutrients, primarily nitrates, and pesticides Some instances of anemia among children seeking treatment at the Beni Mellal hospital have been thought to be a result of nitrates and pesticides in drinking water on the Tadla irrigated perimeter

- Accumulations of salt in the soil result in accumulations of salt in the surface and ground water Hypertension is a human health problem which is known to result from the use of high salinity water for drinking

- Pesticide applicators do not wear protective clothing and are not trained in the judicious use of chemicals or in integrated pest control Thus the toxic chemicals which are applied pose a risk both to themselves and the general population

B5c Economic Impact

- About 22,000 hectares are lost to water erosion of soil each year The present value of the lost productivity would be about $50 million (For assumptions and calculations used to arrive at values for economic impacts see Annex B)

- Siltation destroys enough reservoir capacity each year to hold sufficient water to irrigate about 5,000 ha The present value of this loss is about $90 million

B5d Natural Ecosystem Impact

- The cumulative effect of land loss and population pressure is that 80,000 hectares of new land are brought under cultivation every year in Morocco In most cases this will be wildlife habitat which is of marginal value for agriculture

- The loss of land and wildlife habitat as a result of water erosion of soil is usually irreversible

- Aquatic habitat is damaged or irreversibly destroyed by reduction of base flow, flooding and siltation of streams

B5e Results of the Problem Review

This analysis shows that the major agriculture and land use problems are

- Water erosion of soil
- Water pollution resulting from intensive production practices on irrigated land
- The lack of standards and regulations for people who apply highly toxic pesticides
- Wind eroded soil, dune encroachment

B6 Ecosystem-Dependent Activities

B6a Problem Description

B6a(1). Key Ecosystems

Morocco's natural environment may be divided into several discrete areas, providing different services to wildlife and humans The forest resources, which represent some 4 4 million hectares, or 6 1 percent of the country, provide an important ecological function They reduce water and wind erosion, increase soil fertility and provide habitat for wildlife Of particular importance to Morocco is the fact that forest cover facilitates the infiltration of water into the soil and ground water system Forests are also a major source of energy for rural dwellers, estimated to represent some 40 percent of total energy production in the country In addition, they provide habitat to a number of endangered species, including barbary sheep, barbary macaque, and leopards Some 7,000 hectares are in protected forest areas

Morocco's forests are threatened by a number of different human activities, including agricultural expansion on to marginal lands, fuelwood use, and overgrazing In addition, existing land use laws are not always enforced In particular, 20 percent of the country's forest areas are required by law to be closed to grazing at any one time, but this law is not always enforced The resulting deforestation is estimated by one source at 31,000 hectares per year, of which 22,000 is attributed to deforestation, 6,000 to agricultural expansion, and the remainder to forest fires (SSE, 1994) Destruction of forest resources has significant negative effects, through increased soil erosion and consequent dam siltation and decreases in water retention on marginal agricultural land, as discussed The Department of Water and Forests is beginning to make progress in the management of Morocco's protected areas However, there are a number of important problems, including the lack of a national conservation strategy, uncoordinated rural development planning, and lack of community participation in land use decisionmaking

Morocco maintains approximately 108 indigenous mammals, of which nine are internationally endangered wildlife species cheetah, Cuvier's gazelle, Mhorr gazelle, Moroccan gazelle, Rio de Oro Dama gazelle, Barbary hyena, Monk seal, leopard, and Barbary macaque (U S Fish and Wildlife Service, 1980) Morocco also maintains two nationally endangered wildlife species Barbary sheep and Dorcas gazelle Morocco also maintains important bird, marine and plant species For example, there are an estimated 4,200 plant species of which 800 are found only in Morocco

Range resources constitute a second major ecosystem providing services to humans and other species The country has about 26 million hectares of range land, 3 1 million of Alfa grasslands and the remainder other rangelands outside of the forests Rangeland represents some 35 8 percent of the country's land area Range land supports a number of endangered species

41

Livestock populations are presently beyond the carrying capacity of land in many areas of the country The overstocking of livestock has reduced forage production, contributed to deforestation and increased soil erosion This overstocking is partly due to strategies to reduce the impacts of drought Herders are building up the size of their herds during years of sufficient rainfall In addition, agropastoralists are converting rangelands to the production of cereal crops on marginal lands to provide forage for their animals Through the conversion of rangeland to cereal crops, natural rangeland is continually reduced, further contributing to over-grazing and degradation of the remaining resources

Coastal and wetland areas constitute a third significant ecosystem in Morocco Coastal areas currently support an endangered species, the Monk seal Coastal wetlands provide feeding and breeding grounds for migratory birds from Europe and further north The draining of coastal wetlands for irrigated agriculture has apparently already reduced the number of coastal bird species considerably (USAID, 1980) The Merja Zerga wetland reserve on the coast of northern Morocco is threatened by village expansion and rural development activities (e g , road expansion, tourism development) There have also been cases of people pumping water from protected wetlands illegally for irrigation

Although experts report that at present protected coastal wetlands are not threatened by pollution, these sensitive areas may eventually be at risk from industrialization, rapid urbanization, and use of agrochemicals More than 90 percent of all chemicals, refuse and other materials entering coastal waters remain there as sediments in wetlands, reefs, and other coastal ecosystems (Shumway, 1993) Pesticides, insecticides and fertilizer (nitrate pollutants) are important sources of pollution from the agriculture sector Pesticides can become increasingly concentrated and toxic in fish and other species which are relatively high on the food chain Nitrates from fertilizer increases nutrients in water systems and can result in eutrophication and algal blooms The excessive enrichment of water resources can reduce the productivity of fisheries, pollute drinking water and reduce biodiversity

Potential industrial threats to coastal and marine resources include heavy metals and other chemical effluents from sugar refineries, tanneries, wood pulp plants and oil refineries In addition, plastic and other debris (e g , fragments of fishing nets) entangle and kill a variety of marine animals Untreated urban municipal sewage also contributes to coastal and marine pollution Like agricultural pollution, municipal pollution increases eutrophication of water resources Water pollution by toxic organic compounds and metals or by nutrient loading from sewage or agricultural runoff can cause biological stress on aquatic ecosystems

B6a(2) Ecosystem-dependent Economic Activity Fisheries and Tourism

Morocco has the largest fisheries industry in Africa and has some of the richest fishing areas in the world The industry ranks third in the country's export earnings after phosphate and citrus products Approximately 80,000 people are employed in the industry—35,000 directly and 45,000 in the associated support industries (e g , construction, boat maintenance, fish processing) (USAID, 1988)

It is not known to what extent pollution is having a negative impact on Morocco's ocean fish resources, although this is a matter of considerable discussion Experts on the matter from the government's Institut Superieur de la Pêche Maritime (ISPM) are quite confident that neither household waste nor industrial pollution is harming the country's fishing industry, although they also feel that the available information is not adequate to prove this definitively Although they

acknowledge that this could be a problem in the future, they are more concerned about the possible effect of oil spills than about pollution Possible biological contamination of fish is very closely monitored, as required for export to European Community markets According the ISPM experts this is not showing evidence of any impacts of domestic pollution on fish stocks [1]

They do point out, though, that it is no longer possible to fish in the immediate vicinity of major cities like Casablanca, trawlers near that city brought up only plastic bottles, cans, and old tires Pollution of the river mouths has also led to the degradation of trout fisheries and the disappearance of eels, which are much prized in Europe The construction of dams is also causing serious problems in the fishing industry, preventing the natural migration of shad fish up rivers to breeding sites Formally common in most rivers in Morocco, the shad fish is a threatened species (USAID, 1988)

Tourism is also an important industry in Morocco For example, there were 1,471,000 foreign visitors to Morocco in 1986 (Economic Intelligence Unit, 1988-89) Most of these visitors are drawn by the country's beaches and cultural resources However a number also engage in hunting or visit the few natural parks which have tourist infrastructure, such as Mt Toubkal, which received some 16,000 visitors in 1993 Tourism could affect the resource base through the land use and pollution impacts of hotel complexes on the beach, and through the activities of hunters Of more concern to the Ministry of Tourism, however, is the impact of the domestic pollution on the attractiveness of Morocco as a tourist destination This has already been discussed above in the section on economic impacts of domestic pollution

Improvement of the natural resource base could be a potential source of increased tourist revenue Morocco has the potential more fully to develop the rural tourism sector, this is an area of high priority to the Ministry of Tourism However, the government has yet to develop a national tourism plan for the country One problem appears to be that the Ministry of Tourism and Ministry of Agriculture do not work together The government needs to develop a coordinated approach if it is to more fully develop tourism activities into natural areas

B6b Health Impact

Resource-based economic activities have direct impacts on human health A large percentage of Morocco's rural population is directly dependent on the resource base for fuelwood, agriculture, water, game meat and other resources Any changes in these resources can have negative impacts on human health For example, the absence of potable water resources can increase the incidence of disease Fuelwood is also the primary source of energy for rural communities A reduction or increase in the price of fuelwood may reduce the amount of family income available for food Many rural communities also obtain their medicine from forest and range resources

B6c Economic Impact

The potential economic impacts associated with natural resource utilization may come from a number of sources

[1] A 1994 scare about consumption of Atlantic shellfish was due to an accidental discharge of toxic chemicals from a boat, not to industrial pollution

43

- Degradation of non-timber uses of wood which are compatible with sustainable management of the forest for fuelwood, these include cork oak, medicinal plants, indigenous agricultural crop species

- Reduced availability of livestock grazing lands due to agricultural encroachment Assuming that agriculture is more profitable than livestock, this is not a net economic loss, though it does place a burden on herders

- The loss of long-run wood fuel energy resources due to unsustainable practices This can be quantified, the asset value of the 22,000 hectares lost each year to fuelwood cutting is estimated at about $25 million, based on the present value of the income stream from sustainable management of the resource as a source of energy

- The loss of construction wood resources Trees which can be used for construction are probably more valuable in that use than as fuelwood, so the valuation of the lost 22,000 hectares based on its value as an energy source is certainly an underestimate

- Continued mismanagement and overstocking of Morocco's rangeland has apparently reduced forage production In addition to overstocking, the increase of cereal cultivation and uprooting of woody species for fuel have contributed to the deterioration Approximately 100,000 hectares of range annually are being rendered useless by overgrazing in North Africa For example, deterioration of alfa grasslands is estimated at 10,000 hectares per year in Morocco (USAID, 1980)

- Loss of income from trophy hunting A significant portion of this revenue stays in the local communities, which will be particularly hard hit by ecosystem degradation In addition, although resource-based tourism (other than beaches) is still limited, protection of the resource base, complemented with modest investments in this sector, may lead to significant increases in income for the country

- A number of economic costs due to linkages between natural ecosystems and other sectors have already been discussed above These include the loss of income, agricultural production, potable water resulting from poor watershed protection in the discussion on erosion The potentially serious impacts of domestic pollution on tourism are considered in the section on domestic pollution Similarly, the potential impacts of pollution on fisheries are considered in the industrial water pollution section

The available data place a lower bound on the economic costs of unsustainable use of natural vegetation at $25 million per year, which is moderate compared to economic costs of other environmental problems

B6d Natural Ecosystem Impact

Biodiversity resources in Morocco are under severe pressure as human population increases and formerly sustainable land management practices change A number of economic activities are placing pressure on wildlife habitat, including agricultural expansion onto forest and rangelands at the rate of some 80,000 hectares a year, and forest destruction for fuelwood use at a rate of 22,000 hectares a year This is placing severe pressure on important plant and wildlife habitats, including many threatened and endangered species

Tourism activities in the forests, particularly trophy hunting, do not yet appear to be having a severe impact on biodiversity resources The sport is professionally licensed and managed through the Department of Water and Forests Further, trophy hunting is providing a source of employment and other sources of revenue to rural communities

Construction associated with poorly planned urban sprawl and rural development is having the greatest current impact on coastal and wetland resources Wetlands associated with coastal shorelines and river floodplains merit special attention In every case where these wetlands have been studied, it has been demonstrated that they play critical roles in habitat and water quality Moreover, those which maintain migratory birds are of particular importance in Morocco Birdlife is affected by the pollution which results from the nitrification of water and consequent alteration of habitat Polluted areas may also eventually become unattractive to the migratory birds

Pollution is not yet a problem that affects legally designated protected areas However, this may become a problem in the future Available evidence suggests that pollution is not yet having an impact on the ocean ecosystem

C Results of the Problem Review

The problem review suggests that forest activities themselves are having a significant impact on the economy and on the biodiversity value of important forest ecosystems Agricultural expansion is also having an impact on both forest and range ecosystems, although whether these occur precisely in the areas where endangered species may be found is not clear Other resource-dependent activities—fisheries and tourism—do not appear to have significant negative economic or biodiversity impacts Both industrial and domestic pollution may have important impacts in the future on coastal wetlands and marine ecosystems, these issues are covered in the sections on industrial and domestic pollution

C1 Overall Results of the Problem Review

The tables on the following pages summarize the impacts of the environmental problems on the areas of human health, the economy, and natural ecosystems Although this methodology is far from precise, the comparison across the different areas does give us a general sense of which problems are the worst The table on the following page summarizes the composite scores of major problem areas The full table shows the impact of each problem on health, the economy, and natural ecosystems The annexes provide further detail about how these results were reached

45

PRELIMINARY PROBLEM ASSESSMENT MATRIX
Industrial and Automotive Emissions

Sector	Pollutant/ Activity	Human Health			Economic		Biodiversity				
		Population Affected	Severity	Reversability	Total Cost	Timing	Severity of Impact	Timing	Human/Eco system Interface	Habitat Richness & Uniqueness	No of People Impacted
A Emissions into Air											
1 Mobile Sources (Transport)	Sulfur Dioxide	20	30	20	10	30	10	10	10	10	20
	Nitrogen Oxide	20	20	30	10	30	10	10	10	10	20
	Suspended Particles	20	20	30	10	30	10	10	10	10	20
	Lead	20	30	40	10	30	10	10	10	10	20
2 Industrial Fixed Sources											
Cementeries	Dust	10	10	10	10	30	10	10	10	10	10
	Sulfur Dioxide	10	10	10	10	30	10	10	10	10	10
Refineries	Sulfur Dioxide	10	10	10	10	30	10	10	10	10	10
	Nitrogen Oxides	10	10	10	10	30	10	10	10	10	10
Phosphate	Sulfur Dioxide	20	30	10	20	30	10	10	10	10	20
3 Area/Artisanal Sources											
Potteries	Suspended particles	10	30	20	*	*	10	10	10	10	10
	Other pollutants	10	30	30	*	*	10	10	10	10	10
B Water Emissions Rivers											
1 Tanneries	Chrome	20	50	40	20	20	20	20	30	40	20
2 Oil plants (olive)	Suspended particles (margine)	20	20	10	3	40	10	20	30	40	20
3 Textile Industry	Suspended particles	10	10	10	20	30	10	20	10	40	10
4 Sugar factory	Organic matter	20	10	10	20	30	10	20	30	40	20
5 Chemicals		10	20	30	20	30	10	20	30	40	10
Oceans											
1 Phosphate refining	Suspended particles	20	10	10	20	50	30	50	30	40	20
	Heavy metals	20	30	30	20	50	10	30	30	40	20
	Dissolved residue	20	10	10	20	50	10	10	30	40	20
2 Refineries	Oil Water Separation	10	10	10	*	*	10	20	30	40	10

* No estimate made

PRELIMINARY PROBLEM ASSESSMENT MATRIX
Natural Resources Management

Sector	Pollutant/ Activity	Human Health			Economic		Biodiversity				
		Population Affected	Severity	Revers ability	Total Cost	Timing	Severity of Impact	Timing	Human/Eco system Interface	Habitat Richness & Uniqueness	Impact on People
A Natural Vegetation Utilization		10	10	10	40	30	35	38	42	50	50
1 Forest utilization (resource use as input)	Fuelwood collection	10	10	10	40	30	40	40	50	50	50
	Construction material	10	10	10	40	30	30	40	40	50	50
	Agricultural expansion	10	10	10	40	30	40	40	40	50	50
	Livestock overgrazing	10	10	10	40	30	40	40	50	50	50
	Resource affected by externalities	10	10	10	40	30	40	40	40	50	50
B Terrestrial Wildlife Utilization		10	10	10	10	10	23	20	50	50	30
1 Wildlife utilization	Sport hunting	10	10	10	10	10	20	20	50	50	30
	Game meat hunting	10	10	10	10	10	30	20	50	50	30
	Ecotourism	10	10	10	10	10	20	20	50	50	30
C Coastal Resources		10	10	10	10	10	22	25	28	40	50
Activities that affect resources (externality generating)	Irrigation	10	10	10	10	10	20	40	20	40	50
	Construction	10	10	10	10	10	40	50	50	40	50
	Tourism	10	10	10	10	10	40	30	40	40	50

PRELIMINARY PROBLEM ASSESSMENT MATRIX
Agriculture and Land Use Issues

		Human Health			Economic		Biodiversity				
Sector	Pollutant/ Activity	Population Affected	Severity	Revers-ability	Total Cost	Timing	Severity of Impact	Timing	Human/ Eco system Interface	Habitat Richness & Uniqueness	No of People Impacted
Agriculture											
A Water Eroded and Degraded Land		10	10	10	50	30	50	30	50	50	30
B Irrigated Land		30	30	30	30	30	40	40	40	10	30
C Wind Eroded and Degraded Land		10	10	10	10	10	40	40	40	40	30
	Oasis dune encroachment	10	10	10	50	50	40	40	20	20	30
D Scenic Land		10	10	10	10	10	20	22	35	30	30
E Urban Proximity Land		10	10	10	10	10	20	10	20	10	30

PRELIMINARY RISK ASSESSMENT
Water Supplies Domestic and Accidental Pollution

Sector	Human Health			Economic		Biodervisity				
	Population Affected	Severity	Reversability	Total Cost	Timing	Severity of Impact	Timing	Human/Eco system Interface	Habitat Richness & Uniqueness	No of People impacted
A Water Supply Management	50	10	10	50	10	30	10	40	10	50
B Domestic Pollution										
1 Liquid Wastes	30	37	30	37	50	20	50	20	10	10
Fatal diarrhea	25	50	50	50	50	*	*	*	*	*
Non fatal diarrhea	50	20	10	40	50	*	*	*	*	*
Other diseases	20	40	30	30	50	*	*	*	*	*
Drinking water treatment	*	*	*	30	50	*	*	*	*	*
2 Solid wastes	10	25	15	10	50	20	50	20	10	10
Landfill diseases	10	30	20	10	50	*	*	*	*	*
Near landfill diseases	10	20	10	10	50	*	*	*	*	*
C Accidental Pollution	10	30	30	10	50	10	20	20	10	20

*Not applicable

PRELIMINARY PROBLEM ASSESSMENT MATRIX
Industrial and Automotive Emissions

Sector	Pollutant/ Activity	Average			Composite
		Human Health	Economic	Biodiversity	
A Emissions into Air					
1 Mobile Sources					
Transport	Sulfur Dioxide	2.3	2 0	1 2	1 8
	Nitrogen Oxide	2.3	2 0	1 2	1 8
	Suspended Particles	2 3	2 0	1.2	1 8
	Lead	3 0	2 0	1 2	2 0
2 Industrial Fixed Sources					
Cementeries	Dust	1 0	2 0	1 0	1.3
	Sulfur Dioxide	1 0	2 0	1 0	1 3
Refineries	Sulfur Dioxide	1 0	2 0	1 0	1 3
	Nitrogen Oxides	1 0	2 0	1 0	1 3
Phosphate	Sulfur Dioxide	2 0	2 5	1 2	1 9
3 Area/Artisanal Sources					
Potteries	Suspended particles	2 0	*	1 0	1 5
	Other pollutants	2 3	*	1 0	1 6
B Water Emissions Rivers					
1 Tanneries	Chrome	3 3	2 0	2 6	2 6
2 Oil plants (olive)	Suspended particles (margine)	2 6	3 5	2 4	2 8
3 Textile Industry	Suspended particles	1 0	2 5	2 2	2 9
4 Sugar factory	Organic matter	1 3	2 5	2 8	2 2
5 Chemicals		2 0	2 5	2 2	2.2
Oceans					
1 Phosphate refining	Suspended particles	1 3	3 5	3 4	2 7
	Heavy metals	2 6	3 5	2 6	2 9
	Dissolved residue	1 3	3 5	2 2	2 3
2 Refineries	Oil Water Separation	1 0	*	2 4	1 7

*No estimate made

PRELIMINARY PROBLEM ASSESSMENT MATRIX
Natural Resources Management

Sector	Pollutant/Activity	Average			Composite
		Human Health	Economic	Biodiversity	
A Natural Vegetation Utilization		10	35	44	29
1 Forest utilization (resource use as input)	Fuelwood collection	10	35	46	30
	Construction material	10	35	42	29
	Agricultural expansion	10	35	44	29
	Livestock overgrazing	10	35	46	30
	Resource affected by externalities	10	35	44	29
B Terrestrial Wildlife Utilization		10	10	35	18
1 Wildlife utilization	Sport hunting	10	10	33	18
	Game meat hunting	10	10	36	19
	Ecotourism	10	10	34	18
C Coastal Resources		10	10	33	17
Activities that affect resources (externality generating)	Irrigation	10	10	35	18
	Construction	10	10	46	22
	Tourism	10	10	40	20

PRELIMINARY PROBLEM ASSESSMENT MATRIX
Agriculture and Land Use Issues

Sector	Pollutant/Activity	Average			Composite
		Human Health	Economic	Biodiversity	
Agriculture A Water Eroded and Degraded Land		10	40	42	30
B Irrigated Land		30	30	32	30
C Wind Eroded and Degraded Land		10	10	30	16
	Oasis dune encroachment	10	50	30	30
D Scenic Land		10	10	27	15
E Urban Proximity Land		10	10	18	12

57

PRELIMINARY RISK ASSESSMENT
Water Suppplies, Domestic, and Accidental Pollution

Sector	Average			Composite
	Human Health	Economic	Biodiversity	
A Water Supply Management	23	30	28	27
B Domestic Pollution				
1 Liquid Wastes Overall	32	44	22	38
Fatal diarrhea	40	50	*	45
Non fatal diarrhea	27	45	*	36
Other diseases	30	40	*	35
Drinking water treatment	*	40	*	40
2 Solid Wastes Overall	17	30	22	23
Living on landfill diseases	20	30	*	25
Living near landfill diseases	13	30	*	22
C Accidental Pollution	23	30	16	23

*Not applicable

LEGEND FOR PROBLEM REVIEW RESULTS TABLE

HEALTH

Number of people affected
1 = 0 - 10,000 people
2 = 10 000 - 100 000 people
3 = 100 000 - 500 000 people
4 = 500 000 - 2 000 000 people
5 = more than 2 000,000 people

Severity of the health impacts
1 = Minor inconvenience or irritation
2 = Short-term irritation or irritation
3 = short-term disability or long-term irritation
4 = long-term disability or minor possibility of death
5 = Major probability of death

Reversibility of the health effects
1 = Regular exposures totally reversible
2 = Regular exposures are largely reversible with minor irritation remaining
3 = Regular exposures are partially reversible with long-term partial disability remaining
4 = Regular exposure not reversible with long-term disability remaining
5 = Single exposure not reversible with long-term disability or death resulting

ECONOMY

Total cost
1 = cost < $1 million
2 = cost between $1 million and $5 million
3 = cost between $5 million and $25 million
4 = cost between $25 million and $50 million
5 = cost > $50 million

Timing

1 = Impact will begin 10 years or more in the future
3 = A one-time impact is occurring now
5 = Impact is occurring now and will continue at the same rate

NATURAL ECOSYSTEMS

Severity of impact on natural ecosystems

1 = One time impact in one portion of ecosystem
2 = Less than 25 percent of ecosystem impacted
3 = 25 percent - 50 percent of ecosystem impacted
4 = 50 percent - 90 percent of ecosystem impacted
5 = Immediate destruction of ecosystem

Timing

1 = Potential minor impact in distant future (more than 5 years)
2 = Potential major impact in distant future (more than 5 years)
3 = Definite minor impact in present (within 1 year)
4 = Definite significant impact in present (within 1 year)
5 = Definite major impact in present (within 1 year)

Human/Ecosystem Interface

1 = None of community resources are obtained from ecosystem
2 = Less than 20 percent of community resources are obtained from ecosystem
3 = Less than 40 percent of community resources are obtained from ecosystem
4 = Less than 60 percent of community resources are obtained from ecosystem
5 = All of community resources are obtained from ecosystem

Habitat Richness and Uniqueness

1 = None of community resources are obtained from ecosystem
2 = Less than 20 percent of community resources are obtained from ecosystem
3 = Less than 40 percent of community resources are obtained from ecosystem
4 = Less than 60 percent of community resources are obtained from ecosystem
5 = All of community resources are obtained from ecosystem

Number of people dependent on the ecosystem affected by the problem
1 = 0 - 10 000 people
2 = 10 000 - 100,000 people
3 = 100 000 - 500 000 people
4 = 500 000 2,000,000 people
5 = more than 2,000 000 people

SECTION IV
OPTIONS ASSESSMENT

A Criteria for Options Assessment

The second step in the team's work involved identifying project options, and assessing how well they respond to a number of criteria The process of identifying possible projects was rather fluid Because of the time constraints, it was not possible to complete all of the analytical work on the problem review before beginning to think about projects Therefore project possibilities which arose in the process of gathering information for the problem review were flagged Those which seemed plausible in light of the kinds of interventions which USAID can make and the work of other donors were retained for screening according to the criteria below

The projects identified through this process are not limited to those which address the most serious environmental problems In part, this is because at the time when the team was identifying project options, we did not yet know which problems would turn out to be the worst Projects which respond to unimportant issues clearly were not retained However problems of second-order importance are still quite serious, so effective projects which address them may still be well worth considering

The project review used a scoring system that evaluated how each option would meet a set of criteria identified by the team and the mission In this approach, each option is scored against each criterion, the criteria are ranked against each other, and an overall score is determined that estimates the relative attractiveness of the options The criteria chosen to evaluate the options are

- **Importance of problem** This is the summary result of the risk assessment, and indicates the relative magnitude of the problem area

- **Impact of project** This is an evaluation of the benefits resulting from a project idea This is based on estimates of

  - the direct economic, health, and natural ecosystems benefits
  - the probability of success/project risk
  - the cost/benefit ratio
  - additional benefits stimulated by the project (e g , the demonstration potential)

- **Priority of problem/project area to Government of Morocco** This indicates how highly the GOM rates the problems which this activity addresses

- **Priority of problem/project area to USAID** This indicates the priority to USAID/Morocco and Washington It may also be a measure of the ability to get funding

- **USAID comparative advantage** This indicates whether the U S is particularly well equipped to provide assistance in this area, relative to other donor countries

- **Trade, investment and technical assistance opportunities** This evaluates the potential for the activities to lead to trade, investment and technical assistance opportunities for US firms

- **Sustainability/spontaneity** This indicates the ability of the project activities and benefits to continue after the USAID funding ends It could reflect a significant demand for the benefits, which just require an initial "push" by USAID to get it started, after which it will continue on its own momentum Alternately, it may indicate that the institution-building and components of the project have been effective enough that the GOM can take over the functions provided during the project by USAID technical assistance

- **Related donor activities** This indicates how the activities complement or leverage those of other donors

- **Support to NGOs, women's groups** This indicates the activity's support for NGOs and gender issues

Each of the above criteria was calibrated on a scale from 5 (most favorable) to 1 (least favorable), using both quantitative and qualitative factors (Detail on the rankings is provided in the annex on methodology) The criteria were then weighted relative to each other, based on the experience and judgement of the team Finally, each team member evaluated the project ideas which s/he developed using the criteria discussed above

The results of this weighting are presented in the table which follows the project descriptions When looking at those results, a few points should be kept in mind

- Certain criteria will tend to favor certain types of projects For example, the Trade, Investment, and Technical Assistance Opportunities criterion will tend to favor industrial projects that result in sales of U S goods and services compared with natural resource management projects that offer few such opportunities

- There are a number of opportunities to combine the activities suggested here into larger integrated projects, in addition to the two integrated management projects Thus, for example, eco-tourism might be usefully joined with watershed management, or sewer and landfill work into a single urban management project

- Since team members evaluated their own project ideas, there is danger of biasing the results if a team member is consistently more optimistic or pessimistic than the others

- The large integrated watershed projects (for the Oum er Rbia and Sebou rivers) are probably beyond the resources of USAID and would require a large cooperative effort with other donors

B Project Options

Thirteen projects were developed by the team

1 Protected zones for drinking water intake This project would consist of strengthening the procedures for identifying and establishing protected zones (which ONEP is

51

currently engaged in developing with German support), and applying these procedures in one or more pilot areas, chosen on the basis of ONEP priorities

2 **Sanitary landfill management** The project will consist of working with several local governments on identifying technical needs for a landfill and choice of a site (carrying out necessary studies, negotiating an agreement among interested parties concerning the site), helping local authority to identify investments funds to build the landfill and financial mechanisms to ensure appropriate maintenance, studies to assess the viability of subcontracting or privatization of the different steps involved in trash collection and management, studies to assess commercial viability of recycling trash, training local authorities on the management of the systems identified through the studies (subcontracting, privatization, recycling, public management of all activities) This may involve overseas stays to work with similar organizations, involve a selected national authority in the previous five steps to ensure that this approach can be transferred to other cities

The project could also involve work with local communities and NGOs to build public awareness about better trash management, putting things in trash bins, recycling, bagging and similar environmentally conscious activities

3 **Management support for sewage collection and treatment** Although financing sewerage systems is beyond USAID's capability, it can provide technical assistance, training, and institutional and management development assistance to support these investments For example, the World Bank is now developing major wastewater and sewerage projects in a number of cities USAID can work in one pilot city with appropriate national agencies (probably the Direction de l'Eau et de l'Assainissement, the Direction des Regies, or ONEP) to carry out the technical studies, look at private sector options, design financing, train operators and managers, and develop strategies for transferring this expertise to other cities

4 **Integrated watershed management** An integrated watershed management approach linking upland sustainable land use management practices to lowland water resource use is needed to manage Morocco's watershed resources This approach should include identifying costs and benefits of existing and potential sustainable practices (e g , soil erosion control, water conservation, reforestation, farming systems, alternative energy, small enterprise), recommending policy reforms and cost-effective economic incentives which encourage sustainable watershed management (e g , land and tree tenure, taxation of urban population grazing animals on the mountain environment), developing a cost-effective watershed management plan, establishing community resource management agreements between the government and resource users, and monitoring the link between improved upland watershed management and the availability of benefits (e g , water resources, wildlife conservation, agricultural, income) A potential site is the mountains above the USAID/Tadla Project area

5 **Eco-tourism development in Morocco's interior** An eco-tourism plan for Morocco's interior regions would be developed based on ecological and social field assessments The ecological assessment will identify and assess site ecology A social assessment will evaluate local community utilization (hunting, materials, recreation, etc) A tourism plan will evaluate tourism potential, infrastructure requirements, allocation of economic costs and benefits, enforcement, monitoring, and management responsibilities

6 **Artisanal Tannery Improvement (ATI)** An ATI project would focus on (1) providing technical assistance to local agencies involved in the tanning industry in Fes and Meknes, (2) working with the Agency for the Dedensification of the Medina (ADER) and NGO's to overcome

current obstacles which inhibit the movement of tanneries from the densely populated medina to new industrial zones, and (3) implementing a policy component to develop industry-based standards

The project would work with the tannery cooperatives and other NGO's in the Medina and Industrial zone to provide technical assistance in reducing chrome emissions The project would focus on developing pilot projects in the Medina and developing cost-effective pollution prevention and end-of-pipe measures to reduce pollution while potentially improving productivity Included in this technical assistance (TA), could be a component to promote the development of private sector services to receive and treat tannery wastes, recycle the chrome, and resell the wastes to tanneries at a reduced costs, thus providing additional economic incentives for tanneries to cooperate with the program

7 **Air Quality Improvement and Monitoring (AQIM) project** The AQIM project would focus on providing Technical Assistance to develop air quality monitoring program, identifying primary activities for reducing emissions, developing industry standards, and working with a wide range of stakeholders including industry groups and the SSE to develop ambient standards In addition, specific demonstration projects would be developed at selected factory sites to provide advice on engineering and financial investment topics to assist the firm in designing and financing environmental investments The financial investment assistance could take the form of providing small grants or subsidies to US vendors in installing new emissions control technology, but the primary emphasis would be on helping factories access national and international investment sources

8 **Phosphate Processing Emissions Elimination (P^2E^2) PROJECT** A technical assistance program to reduce water and air emissions would focus on developing monitoring of air and water quality, identifying primary activities for reducing emissions, providing TA to factories, and working with the industry and SSE to develop emission standards The focus of the TA would be the cost-effective pollution prevention actions, including the recycling of solids (for possible sale to the cement industry) and nitrates (to the fertilizer industry) The TA would utilize the extensive expertise available in the United States private sector in reducing emissions from phosphate processing industries

9 **Industrial Pollution Prevention Project (IP3)** The IP3 project would focus its activities on training Moroccan engineers to perform environmental audits and working with industry groups to develop industry-led standards, and demonstrate cost-effective pollution prevention strategies

10 **Water erosion of soils** Several options look attractive for addressing water soil erosion problems In the Rif, a project could demonstrate the use of forage crops to conserve soil The Al Wahda dam on the Ourgha River, to be completed this year, is having a watershed protection study done which will identify attractive pilot projects Pilot projects or drought resistant perennial crops such as almond and prickly pear that demonstrate complementary water harvesting and soil conservation are attractive in the southern Atlas, Agadir, and Kalai de Sraghna region

11 **Dune encroachment control** Fibre cement panels would be used to generate artificial dunes which are 8-10 meters high and thus capable of stopping other dunes Artificial dunes would be further stabilized by biological means

12 The Oum er Rbia River Catchment Basin Management and Environmental Quality Project This large-scale catchment basin project will integrate several areas of environmental concern, including biodiversity, industrial and air pollution, and agriculture and land use By addressing the environmental problems of an entire catchment basin, it would be possible to generate a series of pilot projects and regulatory reforms which would serve as models for the rest of the country

The most important part of this project would be to address the problem of non-regulation of agricultural chemicals on the Tadla irrigated perimeter Other pilot projects would address habitat restoration and watershed management, reduce pollution from sugar mill operation through cost-effective pollution prevention techniques, combat soil erosion through olive orchards, almond trees, and prickly pear cactus, controlling municipal growth on prime agricultural land, and metering wells to monitor ground water drawdown in aquifers threatened by salt water intrusion

13 Sebou Integrated Management Plan Providing technical assistance to local agencies involved in the managing watersheds to promote sound land use practices and expand the capabilities of the watershed to moderate water flow An integrated watershed management approach would link upland sustainable land use practices to lowland water resource use is needed to manage Sebou's watershed resources This approach would include identification of the costs and benefits of existing and potential sustainable practices (e g , soil erosion control, water conservation, reforestation, farming systems, alternative energy, small enterprise), policy reforms and cost-effective economic incentives which encourage sustainable watershed management (e g , land and tree tenure, taxation of urban population grazing animals on the mountain environment), the development of a cost-effective watershed management plan, establishment of community resource management agreements between the government and resource users, monitoring the link between improved upland watershed management and the availability of benefits (e g , water resources, wildlife conservation, agricultural, income), providing technical assistance to industries and municipalities along the Sebou to reduce industrial and municipal emissions of water pollution and improve downstream water quality, targeting the tannery cooperative in the Medina and industrial zones of Meknes and Fes

This table shows the relative attractiveness of the project options identified and assessed by the team Care must be taken with these assessments because much of the data needed to make accurate assessments was not available and thus the team relied heavily on its judgments In addition, because of time constraints these did not have significant inputs or review from either the Government of Morocco or USAID Finally, the projects which appear most attractive are large water basin management projects that USAID probably does not have the resources to implement For example, the World Bank is trying to develop a water basin management effort for the Sebou that will likely cost $200 million or more Thus, USAID will probably need to select a portion of such a project, which will not score as highly

SUMMARY OF OPTIONS SCORING

OPTION		Problem Importance	Project Impact	GOM Priority	USAID Priority	Comparative Advantage	Trade & Investment Opportunities	Sustainab -ility	Other Donors	NGOs	TOTAL
	Weighting	10	10	50	50	50	50	50	30	30	
WATER											
Protected Zones for Drinking Water Intake		33	40	40	40	10	10	35	30	10	30
Sanitary Landfill Management		23	40	40	50	40	30	40	20	30	35
Management Support for Sewage		33	40	50	40	10	30	30	40	10	33
INDUSTRY											
Artisanal Tannery Improvement		40	40	50	50	30	20	20	40	50	38
Air Quality Monitoring		30	30	20	30	40	50	50	40	10	33
Industrial Pollution Prevention		40	50	40	40	30	40	40	30	10	39
Phosphate Processing Emissions Elimination		30	40	10	30	30	40	30	40	10	30
ECOSYSTEMS											
Integrated Watershed Management		29	40	40	50	10	10	40	30	30	32
Eco Tourism Development for the Interior		20	30	30	30	10	10	30	30	30	24
AGRICULTURE/LAND USE											
Water Erosion of Soils		32	30	40	30	40	10	40	30	30	31
Dune Encroachment Control		20	30	20	20	10	10	40	20	20	23
Oum er Rbia Management Plan		50	50	50	50	40	10	50	50	40	45
Sebou Integrated Management Plan		50	50	50	50	40	30	40	50	50	46

ANNEX A
METHODOLOGY

The team developed a formal methodology to structure its analyses and provide a rationale for its conclusions This methodology however must be heavily caveated Although the formal structure and numerical assessments may give an appearance of rigor and objectivity, in reality the lack of data, inaccurate data, differences in opinions, values, and judgements, a lack of time for analysis, and incomplete theoretical approaches to these problems make applying this approach as much art as science However, that does not mean the approach is not worth the effort Properly applied, it forces the user to ask the key questions about what factors are important to the decision, makes clear the uncertainties in the data and analyses, highlights intentional and unintentional biases, and helps identify and evaluate alternatives that can make project options more attractive The following sections discuss the key features of our approach, the procedures used, the assumptions made, and the analyses performed

Phase I Evaluate the Major Problems

The objective of this phase was to identify the major environmental problem areas facing Morocco and assess their relative importance This followed the general approach to comparative risk assessment designed by USEPA The approach had two steps

Step 1 Identify the major environmental problems
Step 2 Assess relative importance of problems

Step 1 Identify the Major Environmental Problems

Although identifying environmental problems is relatively straightforward, structuring them is much more difficult After much discussion, the team organized the problems loosely according to the sector of activity generating them Thus pollution-based environmental problems are considered to be the outcome of specific sectors of economic activity, with "households" in effect considered to be a sector In this framework, most degradation can be understood as an externality problem, industry causes pollution, households cause pollution, agriculture causes pollution, and so on For natural resource-based environmental problems, however, the problem is not one of externalities, but of overuse of the resource base Thus the forestry or fishery sectors can overuse their own resource, depleting them in the long run Similarly, unsustainable water use for agriculture depletes the resource and imposes costs on the sector such as reduced productivity or additional costs for transporting or processing water, as well as potentially aggravating water shortages for industry and human consumption

As a result of the team's review of documents and discussions, the following structure for evaluating major sources of environmental problems was developed

- General water management issues
- Domestic pollution of surface and ground water
- Industrial pollution of water and air

- Mobile source air pollution
- Accidental pollution
- Agriculture and land use
- Natural ecosystem-based activities

Note that this approach does not distinguish between "green," "brown," "blue," or other-colored issues The agricultural, resource-based, and general water management sectors encompass what is conventionally thought of as green problems Domestic pollution of surface and ground water incorporates most of the brown issues now addressed by USAID/Morocco's urban programs Industrial and mobile source pollution of water and air cover the other brown issues, now partially addressed by USAID/Morocco's GEM project

Step 2 Assess Relative Importance of Problems

Once the problem area structure was developed the team assessed the impacts of each problem on health, economy, and natural ecosystems, which were the three impact areas identified by the EPA methodology The team members reviewed documents and met with Moroccan government officials, donor agencies, and project staff to develop a good understanding of impacts of the various problems in each area Wherever possible, the team gathered statistical data to quantify the impacts Where data were unavailable or contradictory, team members developed careful assumptions to estimate impacts, or used their own judgment and the assessments of the other experts contacted to evaluate the impacts of each problem

After much discussion, the team identified the following criteria to judge the impacts of each problem The team members scored each problem for each criterion on a one to five scale according to each of these criteria A "5" score indicated an important problem (e g , many people affected, severe impacts), and a "1" score indicated minimal concerns (e g , very few people affected, non-serious impacts) The criteria and calibrations used for each criterion are

Impact on Health

- Number of people affected

  1 = 0 - 10,000 people
  2 = 10,000 - 100,000 people
  3 = 100,000 - 500,000 people
  4 = 500,000 - 2,000,000 people
  5 = more than 2,000,000 people

- Severity of the health impacts Are the health impacts potentially fatal, or merely a short-term annoyance?

  1 = Minor inconvenience or irritation
  2 = Short-term irritation or irritation
  3 = short-term disability or long-term irritation
  4 = long-term disability or minor possibility of death
  5 = Major probability of death

- Reversibility of the health effects Can the impacts be reversed once the exposure ends, or does it cause permanent damage?

  1 = Regular exposures totally reversible
  2 = Regular exposures are largely reversible with minor irritation remaining
  3 = Regular exposures are partially reversible with long-term partial disability remaining
  4 = Regular exposure not reversible with long-term disability remaining
  5 = Single exposure not reversible with long-term disability or death resulting

Impact on the Economy

- Total annual economic cost of the problem What are the net economic costs of the problem to the economy? The procedures use to evaluate these are discussed in the Annex B, Economic Analysis Generally these include actual or potential expenditures necessitated by the problem, in the absence of any changes from existing management systems (e g no pollutant discharge standards, etc) They also include estimated value of certain non-marketed impacts on economic well-being, for example, loss of women's non-marketed labor due to illness is valued at the average cost of men's marketed labor They do not include valuations of non-marketed impacts on the quality of life, such as willingness to pay for the existence of wildlife or non-economic harm caused by health problems Assessment of these is included within the impacts on health and natural ecosystems

  1 = cost < $1 million
  2 = cost between $1 million and $5 million
  3 = cost between $5 million and $25 million
  4 = cost between $25 million and $50 million
  5 = cost > $50 million

- Timing of the economic impacts Are the costs repeated costs or one-time costs?

  1 = Impacts will occur 20 years or more in the future
  2 = Impacts will occur 10 years in the future
  3 = Impacts occur continuously at the same rate
  5 = Impacts occur now and will continue at the same rate

Impacts on Natural Ecosystems

- Severity of impact on natural ecosystems How extensively is the ecosystem type affected/impacted (e g , forest, wetland, coastal, savanna)?

  1 = One time impact in one portion of ecosystem
  2 = Less than 25% of ecosystem impacted
  3 = 25% - 50% of ecosystem impacted
  4 = 50% - 90% of ecosystem impacted
  5 = Immediate destruction of ecosystem

- Timing of impact Is the impact near-term or long-term (over 5 years)?

  1 = Potential minor impact in distant future (more than 5 years)
  2 = Potential major impact in distant future (more than 5 years)
  3 = Definite minor impact in present (within 1 year)
  4 = Definite significant impact in present (within 1 year)
  5 = Definite major impact in present (within 1 year)

- Human/Ecosystem Interface

  1 = None of community resources are obtained from ecosystem
  2 = Less than 20% of community resources are obtained from ecosystem
  3 = Less than 40% of community resources are obtained from ecosystem
  4 = Less than 60% of community resources are obtained from ecosystem
  5 = All of community resources are obtained from ecosystem

- Habitat Richness and Uniqueness

  1 = None of community resources are obtained from ecosystem
  2 = Less than 20% of community resources are obtained from ecosystem
  3 = Less than 40% of community resources are obtained from ecosystem
  4 = Less than 60% of community resources are obtained from ecosystem
  5 = All of community resources are obtained from ecosystem

- Number of people dependent on that ecosystem affected by the problem

  1 = 0 - 10,000 people
  2 = 10,000 - 100,000 people
  3 = 100,000 - 500,000 people
  4 = 500,000 - 2,000,000 people
  5 = more than 2,000,000 people

The scores are then combined to arrive at composite scores for the impact of each problem on each of the three broad impact areas and an overall composite score for the importance of each problem Considerable discussions were held regarding whether the criteria should be weighted with respect to each other to reflect their relative importance Although in principle this could be done, the team did not agree on the need to do it Since the criterion scores are all presented, relative weightings of criteria to reflect different evaluations of relative importance can easily be performed

Phase II Evaluate the Major Options

Once "Phase I Evaluate the Major Problems" is completed, generic project options need to be evaluated The team did not have the time or resources to identify and develop project options in detail, the generic options evaluated here were indicative of the general types of activities USAID might undertake without specifying exactly what activities these would include or what resources would be available Generally, these options came from discussions with USAID,

GOM, or other personnel or from the team's experience with USAID and other similar projects in other countries Descriptions of the projects are given in the main body of report

Project options were evaluated using a simple scoring approach that assessed how each option would meet a set of criteria developed by the team In this approach, each option is scored against each criterion, the criteria are ranked against each other, and an overall score is determined that estimates the relative attractiveness of the options This approach has several advantages

- It forces us to determine what is important, and how relatively important
- The assumptions and judgments are clearly spelled out
- It can easily be modified to evaluate other assumptions and judgments
- It provides an easily understandable and credible framework for presentation to others

However it does have difficulties

- Evaluating project characteristics and impacts is not easy, and this approach does not reduce or eliminate this requirement

- Determining relative scoring and ranking is difficult to do in a theoretically rigorous manner In this mission the team relied heavily on its experience

- Scoring and ranking has many subtleties For example, there may be cross-impacts (i e , criterion X has these values if criterion Y is this range, and other values if not)

- The simple multiplication/addition approach to determining an overall score may not properly balance tradeoffs in relative importance, particularly for intermediate score values

- Many assumptions and judgment need to be made about what will be done and how effective it will be, that properly is part of the project design and/or may be beyond the control of USAID

- Criteria may overlap, which may lead to "double counting" of benefits and distortion of results

- Attempting to include all considerations can lead to unwieldy numbers of criteria

Nevertheless, this approach is generally effective for identifying very good projects and very poor projects For this mission, it can do a good job of identifying a small number of good project options the Mission can evaluate or develop further

Implementing this approach had the following steps

Step 1 Select and Calibrate Criteria

Discussions with USAID, the Government of Morocco, Moroccan organizations and personnel, and among the team members indicated the following criteria were the most

important For each criterion, a calibration was developed that indicated how well each project met the objectives of that criterion This calibration was made on a scale from 5 (most attractive) to 1 (not attractive) These criteria and their calibrations are described below

- **Importance of problem** This is the summary result of the Problem Assessment, and indicates the importance of the problem area

- **Impact of project.** This is an evaluation of the benefits resulting from a project idea This is based on estimates of

  - the direct economic, health, and biodiversity benefits
  - the probability of success
  - the cost/benefit ratio
  - additional benefits stimulated by the project (e g , the demonstration potential)

  5 = major beneficial impacts, and a high benefit/cost ratio
  4 = major beneficial impacts, and a medium to low benefit/cost ratio
  3 = minor beneficial impacts, and a high benefit/cost ratio
  2 = minor beneficial impacts, and a medium to low benefit/cost ratio
  1 = The project will have no direct impacts on the problem

- **Priority of problem/project area to Government of Morocco** This indicates how highly the GOM rates the activity

  5 = GOM has indicated this project is a top priority, and it will be contributing significant amounts of its own resources to the effort
  4 = GOM has indicated this project is a top priority, but it will not contribute significant amounts of its own resources to the effort
  3 = GOM has indicated this project is important, although not necessarily its top priority, and it will contribute somewhat to it
  2 = GOM has indicated this project is important, although not necessarily its top priority, but it will not contribute significantly to it
  1 = GOM has indicated this project is not important

- **Priority of problem/project area to USAID** This indicates the priority to USAID/Morocco and USAID/Washington It may also be a measure of the ability to get funding

  5 = addresses major mission/bureau priorities, and funding will be available
  4 = addresses major mission/bureau priorities, but funding uncertain
  3 = secondary mission/bureau priorities, but funding possible
  2 = secondary mission/bureau priorities, funding uncertain
  1 = does not address mission/bureau priorities, funding unlikely

- **U S /USAID comparative advantage** This evaluates the uniqueness of the U S /USAID contribution In particular, it rewards those project options where the USAID can provide expertise not readily available from other sources

5 = The expertise is only available from the U S
4 = The expertise is available from the U S and a few other countries
3 = The expertise is widely available from many countries, including the U S
2 = The U S has expertise, but other countries may offer better
1 = The U S has no expertise

- **Trade, investment, and technical assistance** This evaluates the potential for the activities to lead to trade and investment opportunities for U S firms

  5 = Project results in direct, major trade and investment opportunities ($100 million +) for U S firms which they are ready, willing, and able to take advantage of
  4 = Project results in major direct trade and investment opportunities, but U S firms will have difficulty taking advantage of them because they have no local presence, competition is too tough, they don't know about or understand the market, etc , or moderate trade opportunities ($25-100 million) that U S firms can take advantage of
  3 = Project results in moderate trade opportunities ($25-100 million) that U S firms will have difficulty taking advantage of, or minor trade opportunities (less than $25 million) that U S firms can take advantage of
  2 = Project results in minor trade opportunities (less than $25 million) that U S firms will have difficulty taking advantage of
  1 = No trade opportunities are likely to result from project

- **Sustainability/spontaneity** This indicates the ability of the project activities and benefits to continue after the USAID funding ends, e g , there is a significant demand for the benefits that just require an initial "push" by USAID to get it started, after which it will continue on its own momentum

  5 = Project activities/benefits are nearly certain (greater than 90%) to be continued by others when the USAID funding ends, because the market demand is clear, funding sources have been identified and have indicated support, etc
  4 = Project activities/benefits are likely (greater than 75% probability) to be continued after funding ends
  3 = Project activities/benefits might be continued (50 - 75% probability) after funding ends
  2 = Project activities/benefits have a slight chance (25 - 50%) of being continued
  1 = Project activities/benefits are unlikely to be continued (less than 25%) after funding ends

- **Related donor activities** This indicates how the activities complement or leverage those of other donors

  5 = Project directly supports major programs of other donors that would not happen or would be significantly less effective without the USAID effort Other donors indicate the USAID effort is crucial to the success of their efforts, and they are involved in the project activities through cooperative efforts, steering committees, etc There is extensive sharing of data and joint presentations of results

4 = Project provides readily identifiable support to other donor efforts, with some formal coordination of efforts
3 = Project provides some support to other donor efforts, without necessarily having formal coordination
2 = Project is related to efforts of other donors, and discussions are held to reduce or eliminate overlaps and share data
1 = There are no related projects of other donors, or project may adversely affect projects of other donors

- **Support to NGOs, women's groups** This indicates the activity's support for NGOs and gender issues

5 = Project will directly help a broad range of established or new NGOs and women's organizations become significantly more effective through comprehensive technical and financial assistance, training and other support
4 = Project will help one or a few NGOs
3 = Project will provide some assistance to NGOs
2 = Project will provide minor assistance to NGOs
1 = Project provides no NGO assistance, or it may adversely affect NGOs

Step 2 Rank the Criteria Relative to Each Other

The team ranked the criteria relative to each other using its experience and judgement The purpose of this was to ensure the most important factors had the most influence in identifying the most attractive options, and that the other factors were not overlooked In principle, this can be a very difficult process in which differences in calibration within a criterion and between criteria are carefully balanced using a rigorous approach that requires developing an estimate of the relative attractiveness of each of the 45 (= 9 criteria * five values) criterion levels, and determining the trade-offs between the level values and the change in total score In practice, the problem is much simpler since we are only trying to identify the most attractive projects Thus, we can focus determining the upper and lower values, and the final scores will give good identification of the most attractive projects, but with more uncertainty about the relative attractiveness of projects ranked close together The relative criteria rankings determined by the team were as follows

Problem Importance	10
Project Impact	10
Govt of Morocco Priority	5
USAID Priority	5
Sustainability	5
U S Comparative Advantage	5
Trade and Investment	3
Related Donor Activities	3
Support to NGOs	3

Step 3 Rate Each Project Idea for Each Criterion

Each team member developed project options in his or her expertise area, and rated each option according to the rating scales These were discussed among the team and a consensus score developed for each criterion for each project A final weighted average score is determined for each project option which is equal to the sum of criterion score multiplied by the criterion weighting, divided by the sum of the criterion weightings This gives a final score for each project from 1 to 5, with the higher scored projects the most attractive

Using the scores is an art Because of the many uncertainties these final results are best treated as an initial estimate of the relative attractiveness of project options, that must be assessed with intellectual honesty and rigor to develop overall project designs that meet the Mission's major objectives and that represent the most "bang for the buck" given the major uncertainties

ANNEX B
ECONOMIC ENVIRONMENTAL PROBLEMS

A Introduction What Do We Want To Measure?

A1 What Are We Analyzing?

What are we really trying to measure when we ask about the impacts of environmental problems on the economy? The risk assessment literature focuses on the costs imposed by environmental problems [1] These may be of various types

- Defensive expenditures, or those needed to protect against the harms caused by environmental degradation, these may include additional drinking water treatment or treatment of structures to protect against air pollution

- Corrective expenditures, which make up for problems created by environmental degradation These may include costs such as house painting or car washing, medical expenses, or cleaning hazardous waste dumping sites

- Foregone income from economic activity which uses natural resources as an input, such as fisheries, tourism, agriculture, or forestry

- Foregone income due to pollution-related health problems or death

- Foregone benefits or services of the environment, such as the use of fuelwood, and swimming in rivers Such services are sometimes provided through economic markets, and are thus easy to value For example, the price of commercial fuelwood provides the information with which to value wood gathered for cooking fuel Other such services of the environment may be extremely difficult to value, an example might be the security provided by knowing that the air is safe to breath, or the psychological or spiritual benefits of vacation in a pristine natural environment

The non-marketed services provided by the environment constitute the most thorny issue for evaluating the economic cost imposed by environmental degradation The risk assessment approach which USAID is interested in testing focuses on impacts in three different areas, health, economy, and biodiversity The inclusion of health and biodiversity distinct from economies implies that certain values should not or cannot be valued in monetary terms This approach differs from that of some resource economists, who would argue that even such intangibles as spiritual well-being or health can be valued based on people's willingness to pay for them Such valuation through willingness to pay will differ based on income level, wealthy people will certainly allocate more money for vacations than poor people, and they will spend more to ensure the quality of their health care The use of willingness to pay therefore implicitly accepts that the

[1] See, for example, EPA 1994

allocation of such intangibles may be based on income, rather than believing that they are an entitlement that everyone should enjoy irrespective of income In separating out health, the USAID (and EPA) method rejects this approach, preferring to value health on its own terms rather than as people are willing to pay for it In separating out biodiversity, the USAID/EPA method would seem to accept that the natural environment has an intrinsic value beyond the services which it provides to humans, which should not be valued in terms of how much we are willing to give up to protect it For this reason, this analysis does not attempt to give an economic value to non-marketed intangibles such as health and protection of endangered species, rather, they are valued on their own terms within the analyses of health and biodiversity

Following this method, this annex considers the costs imposed by the environmental problems now confronting Morocco Given the short time available to identify data sources, the conceptual difficulties of estimating some non-marketed costs, and the limited data available with which to make estimates, the results cannot claim to be comprehensive However they should be adequate to determine which environmental problems impose the most serious economic costs at present or in the foreseeable future

A2 Cost Analysis vs Cost-benefit Analysis

The EPA risk assessment methodology focuses on the economic costs imposed by environmental degradation However, it does not place them within a cost-benefit framework Eliminating the costs identified by the risk assessment would consume resources, it is the comparison of the costs of living with environmental problems and the costs of solving those problems which would be required to decide what should be done Thus to make a general policy decision about which problems receive attention of the government, it would be necessary to consider both the magnitude of each problem and the effectiveness of expenditures to solve it

This analysis is a responsibility of the Moroccan government, to inform its policy-making about pollution control and other environmental management measures Such analysis must consider not only how much the different options cost, but who bears those costs Like the choice of problems requiring public attention, the allocation of costs is a policy decision Although some Moroccan government documents refer to the theoretical appropriateness of the polluter pays principle, in fact there is clearly an expectation that pollution control costs will be subsidized, particularly those to be asked of industry The decision of how to pay for these costs will affect the state's fiscal situation, the international competitiveness of Moroccan industry, and income distribution within the country All of these issues should be analyzed in the process of developing national environmental protection policy

Such an analysis is not required to inform USAID decision-making about its project activities, because AID is not deciding on overall Moroccan environmental policy However, it would be useful for AID to evaluate the costs of its own possible interventions and to compare them with the resulting benefits

This is only possible to a limited extent It is certainly feasible to estimate the order of magnitude of certain interventions, for example the construction of a sewage treatment plant, or the studies needed to design that plant, or the provision of loan guarantees to a private bank lending the funds to build the plant However, an AID intervention which sensitizes Moroccan officials to the importance of sewage treatment and provides technical assistance in the design of

financing systems would be much harder to quantify, because it could take so many different forms

Since it is not the purpose of this mission to design the specific form of different interventions, but only to suggest directions which they might take, we cannot precisely evaluate the cost-benefit ratio of those interventions Similarly, to the extent that AID supports activities which complement other donor projects, it may not be possible to disaggregate the benefits attributable to AID's contribution from the activity as a whole

A3 Impact of Environmental Degradation or Protection on GDP

Another question concerns whether or not we should assess the impacts of environmental problems on GDP To do so would be misleading, for a number of reasons First, changes in environmental quality are often indirectly rather than directly related to changes in GDP, that is, environmental improvements will decrease GDP while environmental costs typically increase it This is the case of two major costs of pollution, referred to above as defensive expenditures and correction costs These are included in GDP (doctor's salaries, water treatment plants sold by private firms to public water companies, etc), so if the environment is cleaner and they are no longer needed, then GDP will drop correspondingly These problems are among the arguments for developing a modified GDP, sometimes called "green GDP," which would move up or down with, rather than opposite to, the quality of the environment Because of them, it is not appropriate to use impact on GDP as an indicator of the seriousness of an environmental problem

Another problem posed by GDP is that many of the costs imposed by environmental problems are not marketed, thus they are not picked up in the national accounts (National accounts typically do include some non-marketed production, such as subsistence farming, but this concept has not yet been extended to most environmental services) The EPA risk assessment method explicitly considers ecological and health risks separately from economic risks and from the economic dimensions of biodiversity and health, so we do not want to try to quantify all non-marketed costs However there are some easily quantifiable economic costs which are not picked up by GDP but which we do want to include in our analysis, these include such items as the loss of unpaid women's work due to illness

A third problem is that GDP only measures flows, and does not pick up decreases in the value of environmental assets due to unsustainable resource use This may be understood by considering the impacts on GDP of two different forest management strategies If a forest is harvested sustainably—that is, wood is cut at rate at which it grows back, so the asset itself is not depleted—then GDP will include a modest level of forest-based income and the value of the asset itself will be unchanged (all else being equal) If the forest is harvested at a much faster rate, woodfuel revenues will be higher, so GDP will be higher Such practices deplete the asset itself, but that cost does not show up in GDP Future generations will not be able to earn anything from the forest, because it will be gone In the national accounts sustainable forest management practices, which reduce current yields, lead to lower GDP than unsustainable practices, which increase current yield but destroy future yield altogether

A fourth concern over GDP as an indicator is that it will increase if population goes up, even if the quality of life of each person is going down In fact, we may be more interested in

changes in GDP per capita, since this would suggest that people are living better, not simply that total economic output has increased

For all of these reasons, this annex focuses on total costs imposed on the economy, but does not address the impact of environmental problems on GDP

A4. Estimating Future Costs

The costs estimated for the risk assessment should include both those currently being incurred and those which will be incurred in the future if no change is made in current environmental management practices The question therefore arises of how to estimate future costs The approach used is unfortunately constrained by the amount of time available for the analysis A consideration of how we might approach the analysis if more time were available is, nevertheless, useful to get a sense of the nature of future costs

A4a The Nature of Future Costs

Ideally, we would estimate the future costs of environmental problems using a spatial model which incorporates a number of relevant factors

- rural and urban population growth
- economic growth by sector
- industrial emissions
- domestic emissions
- location of industry
- construction of dams
- environmental system—land use, rivers, prevailing winds, ground water system, existence of key natural resources, and use of natural resource, especially water

This would give us a "picture" of a network of interrelated systems, linked essentially by water (and air, though water is more important in Morocco) This system would "grow" over time, as several key variables changed, particularly population, economic activity by sector and location, and the construction of dams As it grows, we can observe changes in key variables which would be indicators of pressure on the system These would concern surface and ground water quality, population density, and quantities of water available (surface and ground)

Changes in the system over time are generally of two kinds The first involves slow growth, a slowly worsening environment, slow degradation of health and ecosystems, and somewhat steadily increasing costs (though they may be lumpy) These are for the most part what have been observed in Morocco so far Pollution gets worse, disease increases, expenditures to treat them rise, and lumpy expenditures to prevent them (drinking water treatment, eventually sewer system investments, etc) are made This degradation would be possible to predict with some reliability, if the necessary data were available

Like pollution problems, the issues related to agricultural growth and water use are primarily of this type Surface and ground water will increasingly be used for irrigation, causing slowly worsening pollution problems and possibly serious impacts on the ground water levels With the proposed water transfers envisioned to address supply problems, there should not be

immediate supply problems (aside from drought), but there could be slowly degrading environmental conditions

The second kind of problem, which will arise if current practices do not change, will involve cracks in the system as a whole This occurs when pressure reaches a level in one place where there is no incremental solution The water problems downstream from Fès, where ONEP has to close drinking water treatment plants every winter, are an example of a crack In this case the cost has been low, because most of the system is still fairly resilient, and drinking water from elsewhere is available to fill the gap Nevertheless, this small crack has had major political repercussions, and has led to a great deal of concern over water pollution issues

Over time, the pressure will grow throughout the system If nothing is done to alleviate it, we can envisage more serious breaks in the future A treatment plant that closes where there is no alternative, so people either drink contaminated water or have none Or an industrial accident where the government does not have the capacity to clean up in time, and many people become sick Or increasingly dense urban areas filling in former industrial waste storage areas, and discovering problems of toxic contamination Such breaks could suddenly create extremely high clean-up and treatment costs They constitute the really serious cost of not addressing environmental issues now Any specific problem is difficult to predict, of course, but we may be sure that something of this nature will happen if the problems are left unaddressed

Breaks in the system are what creates the political will to deal with environmental problems The policy decisions made now about preventing future problems depend, in a sense, on whether the political impetus created by the problems in Fès are sufficient to generate a willingness to take on significant costs now, or whether future more serious cracks will be needed to make that happen

A4b Analytical Approach Applied

Unfortunately, in a short time frame it is not possible to build a model like the one described above With available data, essentially on population and economic growth, but not on the environmental factors that determine when pressure mounts within the system, we can make some very simple estimates of the gradual increases in costs which may be imposed by environmental degradation These give us a lower bound for actual costs, and allow us to compare the relative importance of different environmental problems in the future

The growth rate data used to estimate cost increases are the following

Growth rates	1993	2000	2010
Urban population	3 4	1 26	1 77
Rural population	0 8	1 06	1 15
Total population	2 1	1 16	1 42
Industry	3 0	1 23	1 65
Economy overall	2 0	1 15	1 40
Income per capita	$1,080 00	$1,072 00	$1,062 00

The population growth rates come from the Annuaire Statistique du Maroc (AS), Table 1-3 Industrial growth uses the baseline estimate of the Ministère du Commerce et de l'Industrie The overall economic growth rate is based on Table 20-1 from the Annuaire Statistique, which gives GDP in 1980 dollars for 1989 through 1993 In fact, those data show a considerably lower average growth rate (about 1 2 percent), our estimate seemed more realistic for this purpose Income per capita was calculated from the population and economic growth rates

B Costs Posed by Environmental Problems

B1 Air Pollution

Air pollution imposes estimable costs through several different mechanisms First, the lead in vehicle exhaust has specific impacts on children's learning ability, which may have long-term impacts on their earning ability Second, air pollution affects people's health, causing expenditures on medical care and lost days of work Third, it dirties and degrades infrastructure and buildings, necessitating increased expenditures on cleaning and repairs

B1a Mobile Sources Lead and Children's Learning Ability

No specific data are available on lead levels in children, although a study comparing children in Rabat with those in Temara apparently showed that they are high [2] Based on estimates of the number of people who are likely to be exposed to significant level of lead—essentially those living in downtown area of major cities—it was possible to estimate the economic impacts of lead exposure, as follows

	1993
Lead - number exposed	100,000 estimate based on urban population
Birth rate	0 021 urban birth rate from AS Table 1-10
Number born	2100 calculated
Percent decrease in earnings	10 percent
Foregone earnings per year	226,800 based on 1993 income per cap
Lifetime foregone earnings	$3,891,681 net present value of income stream

Projected future costs	2000	2010
Lead - number exposed	126,370	176,542
Number affected	12,637	17,654 from urb growth rate
Birth rate	0 021	0 021 1993 rate
Number born	2650	3710 calculated
Percent decrease in earnings	10 percent	
Foregone earnings per year	286,607	400,398 using income growth
Lifetime foregone earnings	$4,917,915	$6,870,469 net present value

This assumes that the automobile fleet is growing as a function of growth in income

[2] Cited in Sous-Secrétariat d'Etat 1994, "Monographie "

B1b General Health Impacts

Air pollution can have a variety of health impacts, primarily greater susceptibility to respiratory problems and eye irritation Moroccan health statistics provide information about cases of conjunctivitis, but no data about respiratory problems or other conditions potentially linked to air pollution This section estimates possible impacts by assuming that one working person among 100 of the urban working population misses one day of work per year due to such problems

Health effects	1993	
Big City population	9,264	AS (Table 1-3)
Days worked per year	250	
Rate of days lost	0 00004	one person in 100 misses one day a year
Labor force participation	0 48	AS
Total work days	1,111,680	in 1000s
Days lost	44,467	
Income per capita	$1,080 00	
Income per day	$4 32	
Lost revenue	$192,038 00	
Medical cost	$5 00	per workday lost (estimate)
Total medical cost	$222,336 00	

Projected Costs	2000	2010
Big City pop	11,707	16,355
Days worked per year	250	250
Rate of days lost	0 00004	0 00004
Labor force participation	0 48	0 48
Total work days	1,404,829	1,962,587
Days lost	56,193 00	78,503
Income	$1,072 00	$1,062 00
Income per day	$4 29	$4 25
Lost revenue	$241,020 00	$333,428 00
Medical cost	$5 00	$5 00
Total medical cost	$280,966 00	$392,517 00

B1c Cleaning Costs

Air pollution increases expenditures for cleaning of homes, public buildings, clothing, cars and anything else which may be exposed to it Certain chemicals also degrade buildings in ways which cannot be repaired This is of particular concern for historic buildings and monuments No information is available on expenditures for cleaning and building repair, much less data on the marginal impact of pollution on those expenditures To get an order of magnitude, however, we

might estimate that each urban household spends an average of five additional dollars per year on cleaning expenses This leads us to the following estimated costs in 1993

Cleaning	1993	
Big City pop	9,264	
Urban household size	5 3	Atlas Démographique
No of households	1,747,925 00	
Cleaning expense	$5 00	estimated
Total expense	$8,739,623 00	

Cleaning	2000	2010
Big City pop	11,707	16,355 based on urban population growth
Urban household size	5 3	5 3
No of HQ	2,208,851	3,085,829
Cleaning expense	$5 00	$5 00
Total expense	$11,044,256 00	$15,429,144 00

B2 Industrial Water Pollution

Potentially quantifiable costs currently imposed by industrial water pollution are of several types First, riverine pollution is forcing ONEP to spend additional money on drinking water treatment Second, phosphate pollution in particular may have significant impacts on the fishing industry Third, the introduction of tighter environmental standards by the European Community could in the future lead to the banning of Moroccan exports, particularly phosphates, into Europe

In addition to these specific costs, the current untreated discharges of industrial pollution, if unchecked, will impose significant pressure on the country's drinking water network This will create a risk of environmental disaster, with major health and economic impacts, although where and when such collapse of the system will occur obviously cannot be predicted

B2a Drinking Water Treatment

The pollution of Morocco's rivers has already caused ONEP to make additional investments in drinking water treatment in order to meet WHO standards Such investments have been made in five plants, though ONEP only has data on the marginal costs for a single plant, on the Sebou River downstream from Fès For this plant, ONEP incurred some $10 million in incremental investment costs and spends about $675,000 a year in increased operating costs in order to treat highly polluted water Converted to a lump sum annual cost, as shown below, this comes to an additional cost of some $1 6 million

Investment	88,000,000	Dh - ONEP 1/90
Investment in $	$10,000,000	
Operating cost of pre-treatment	0 296	Dh/m3 - ONEP 2/90
Production of the plant	20,000,000	m3/year - AS table 5-26
Cost per year	5,920,000	
Cost in $	$672,727 00	
Payment period for investment	15	
Interest rate	0 05	
Annual payment on the investment	$963,423 00	
Total annual cost	$1,636,150 00	

The pollution of the Sebou River downstream from Fes is due both to industrial and to household pollution However ONEP attributes these investments to industrial problems because they were necessitated by the seasonal surge in pollutants which occurs in the winter due to olive oil processing There is also a seasonal surge in the spring due to sugar processing, however this one is not high enough to force the water quality above the level that ONEP can treat However, the decision to consider the olive oil producers the cause of the problem, rather than the ambient high pollution level due to lack of sewage treatment, is somewhat arbitrary

ONEP reports that investments were made in four plants other than the Fes one (ONEP 1990, p 19), but they do not provide cost data for these plants If we assume that these costs are lower those in Fès (hence the lack of concern about itemizing them), then total annual marginal cost for drinking water treatment might be between $3 and $4 million

Clearly this is a cost which will increase in the future ONEP now has 34 treatment plants (AS Table 5-26), all of which might be expected to need additional investment in the future Thus we might expect to see some $20 to $30 million a year additional costs spent on drinking water treatment in the future This will solve the problems up to a certain level of water pollution However, as discussed above, and as has already occurred in the Sebou River plant downstream from Fes, additional drinking water treatment will only suffice up to a certain level of pollution Beyond that level, the plants will simply close down, because they will be unable to treat the water to acceptable standards This breakdown in the system, if it occurs, will impose costs far beyond the additional investments and operating costs now needed to treat polluted river water

B2b Phosphate Pollution of The Ocean

The Moroccan phosphate company, OCP, discharges all of its wastes directly into the ocean (see industrial pollution annex for details) Evidence is mixed about the impacts of this pollution on the fisheries industry, particularly for sardines Safi used to be the country's major sardine port, with some 80 canneries Since the OCP plants opened in the early 1980s, sardine catches in Safi have dropped, and at present only about 20 canneries are left there Catches have risen down the coast in Tan-Tan, and many new canneries have opened there The cause of this shift is a matter of question Scientists from the Institut Superieur de la Pêche Maritime (ISPM) don't have definitive proof, but they believe that natural causes explain the shift in the fish populations towards the south Fishermen, and perhaps popular opinion, however, attribute the shift to the phosphate plant discharges Clearly more work is needed to determine the cause of these changes

At present the cost imposed by this shift in the sardine population is the transactions costs of canneries which moved down the coast Total sardine catches have fluctuated widely since the late 1970s (Economist Intelligence Unit, 1989), which is consistent with scientists' and cannery staff descriptions of sardine behavior However the overall trend has been constant Therefore the country as a whole has not lost sardine income, Safi's loss has been Tan-Tan's gain

Pollution has caused another cost to the fishing industry ISPM scientists report that it is no longer possible to catch fish near major cities In particular, trawlers working in the mouth of the Oum Er-Rbia at Casablanca brought up tires, plastic bottles, and cans, but no fish Fishermen based in Casablanca must therefore go further in search of fish than they did in the past The lack of fish in such harbors is probably due to a combination of industrial, domestic, and agricultural pollution, and cannot be ascribed to a single cause The need to travel further would impose marginal additional costs on the fishermen, and probably put some of them out of business When the distance involved is large enough, it will kill the fishing industry out of major cities altogether, forcing fleets to move to waters which are less polluted This does not appear to have happened yet, however

Harm to the fisheries industry could have greater economic impacts in the future As the table below shows, fisheries as a whole now brought in some $528 million in 1993, $152 million of this from the coastal (rather than ocean) fishery Industrial pollution should affect primarily the coastal fishery As urban pollution further degrades current fishing areas, the fleets will presumably to move away from existing cities, to form new ports and processing plant concentrations elsewhere Overall catches may not drop for some time, since cities now cover only a modest portion of Morocco's long coastline, but the transactions costs may be high

Fishing industry 1993	10^3 Dh	Source	10^6 $	Share
Total value of yield	4,646 2	AS Table 3-26	528 0	1 88% of GDP
Value of coastal fishery	1,342 2	AS Table 3-26	152 6	0 54% of GDP
Value of fish exports	3,662 0	AS Table 16-10	416 1	6 26% of FX
Total FX revenues	58,496 6		6,647 3	
GDP 1993	247,682 5	AS Table 20-1	28,145 7	

B2c European Union Standards

The new European Union standards for industrial activity apply to goods imported into Europe as well as to goods produced there The ISO 9000 standards primarily address product quality, while ISO 14000 standards have a bearing on environmental protection in industrial production Once applied, these standards will have significant impacts on all Moroccan export production

As the table below shows, goods exports accounted for some 13 9 percent of GDP in 1993 Of this total, 62 percent went to European Union countries, accounting for 8 7 percent of GDP Since Europe accounts for a large portion of Moroccan export markets, producers are likely rapidly to make to every effort possible to comply with ISO standards, rather than lose their markets This has been the experience with European Union (EU) health standards for canned foods, producers in that industry scrupulously guarantee compliance, and are regularly monitored by European firms carrying out inspections for the EU

Principal Exports 1993	To World	To Europe	% to Europe
Food, drinks, tobacco	9,051	5,645	62%
Energy and lubricants	914	653	71%
Raw materials - organic	974	654	67%
Raw materials - mineral	3,490	1,661	48%
of which phosphates	2,416	853	35%
Intermediate goods	8,369	3,791	45%
of which fertilizer	2,895	1,391	48%
phosphoric acid	3,256	1,109	34%
Producer products	1,704	990	58%
Consumer products	9,864	8,064	82%
TOTAL	34,366	21,458	62%
Share of 1993 GDP	13 9%	8 7%	

Source Annuaire Statistique Table 16-5

Two costs will result from the introduction of such standards (as they would from introduction of Moroccan emissions standards) Some firms will make the needed investments, cutting into their profit margins Other firms will not be able to afford the investments, will lose their European markets, and may go out of business The impact on a given firm or industry sector will depend primarily on the technology of the particular firm or industry and its profit margins Unlike introduction of Moroccan emissions controls, the impact of ISO standards does not depend on Morocco's competitive position relative to other countries, since the standards will apply equally to anyone wishing to compete in European markets Although obviously the total value of exports to Europe serves as an upper bound for these costs, estimating what they will really be is not possible from available data about industrial technology and cost structure

B3 Domestic Pollution

Domestic pollution poses a range of threats to Morocco's economic well-being There are two major sources of domestic pollution, liquid waste, primarily sewage, and solid waste The costs they impose are of several types First, and perhaps most important, is the costs generated by the prevalence of water-borne diseases, particularly diarrhea A second major category of costs result from proximity to sanitary landfills The third category of potential costs stems from the impact of domestic waste on beach sanitation and thus on the tourist industry Note that a fourth category of costs, increased drinking water treatment expenditures, was already addressed in the section on industrial pollution, although these expenditures are a response to both sources of pollution

B3a Diarrhea

Water-borne diseases may be a result of both liquid and solid wastes Although a significant proportion of Moroccan urban residents are connected to municipal sewer systems, there is virtually no sewage treatment in the country, and raw wastes are dumped into the rivers and the ocean The rivers constitute a direct risk to those who live near the rivers, swim in them, wash laundry in them, and so on In addition, in some cities sewage outfalls or riverwater

directly downstream from them are used to irrigate commercial vegetable gardens in or close to urban areas, constituting a risk both to those working in the fields and to those who consume the produce Uncontrolled landfills may also contribute to transmission of water-borne disease The juices which concentrate in the landfills filter into the ground and may contaminate the ground water This may contaminate the drinking water of people living in rural areas in the vicinity of the landfill, who may rely on untreated well water rather than treated water supplies provided by ONEP Although available data on the prevalence of water-borne diseases do not allow us to determine how those diseases occurred, we may estimate that the liquid waste is more importance source of contamination than landfills, because of the number of people at risk from vegetables irrigated with sewage

Diarrhea is by far the most common water-borne disease in Morocco Data from the Ministry of Health and from the Demographic and Health Survey (DHS) conducted in 1992 allow us to estimate the total number of cases per year as shown in the table below The DHS statistics show that in the winter, when diarrhea rates are lowest, 12 7 percent of children whose parents were surveyed experienced a bout of diarrhea within the previous two weeks In the summer, when diarrhea is at its worst, the Ministry of Health surveys show 21 7 percent occurrence rate within the previous two weeks This averages to 17 2 percent for a "typical" two-week period, which is equivalent to 4 472 bouts of diarrhea per child per year for the country as a whole (Ministry of Health calculations) With 3 3 million children under five years of age (the group for which diarrhea is most prevalent), this means 14 8 million cases per year An assumption is made that 60 percent of these cases may be attributable to unclean water, this figure is borrowed from similar work prepared for the Sous-Secrétariat d'Etat pour l'Environnement

Jan-Apr 2-week rate	0 127	DHS page 19
July 2-week rate	0 217	Ministry of Health
Average	0 172	
Annual occurrence/child	4 472	Ministry of Health formula
No of children	3,313,000	Annuaire Statistique Table 1-4
No occurrences	14,815,736	
% due to water-born disease	60%	
No occurrence	8,889,442	

Of these cases, the DHS survey tells us that on average 11 percent visit a clinic, and 11 percent (of total cases, not of those who go to the clinic) receive antibiotics in treatment Fourteen percent of cases are treated with oral rehydration therapy Estimating at (social) cost of $10 per clinic visit, and costs of medications at $6 for antibiotics and $4 for oral rehydration therapy, we arrive at the following annual medical expenditures due to diarrhea

Percent to clinic		0 11	0 11	0 11
Clinic visits	@$10	$9,778,386	$12,356,940	$17,263,002
Percent antibiotics		0 11	0 11	0 11
No antibiotics	@$6	$5,867,031	$7,414,164	$10,357,801
% using oral rehyd therapy		0 14	0 14	0 14
Total using ORT	@$4	$4 978 087	$6,290 806	$8 788 437
TOTAL		$20 623,505	$26,061,910	$36,409,241

These costs are quite high relative to other environment-related expenditures occurring at present Projecting them into the future, based on projections of urban growth, we arrive at about

11 2 million cases and $43 million in expenditures in 2000 and 15 7 million cases and $60 million in expenditures in 2010 Clearly this is a significant impact on the economy

Diarrhea causes an estimated ten thousand deaths a year among children under five years of age This figure is based on DHS data on mortality of children under five years of age (known as "5q0 mortality") and Ministry of Health estimates from 1989 that 26 7 percent of those deaths may be attributed to diarrhea Again, it is assumed that 60 percent of deaths are attributable to water pollution

Diarrhea deaths	Source	1993	2000	2010
Birth rate/1000	AS Table 1-1	27 3		
Births per year	AS Table 1-9	711,684		
5q0 mortality	DHS graphic	0 076		
No deaths		54,088		
% diarrhea 1989	Min Health	0 267		
No diarrhea		14,441		
Share due to environment		60%		
No env-rel diarrhea deaths		8,665	10,950	15,297

These deaths per year may be construed as a loss to the economy of the income which those individuals would have earned This is quite a controversial figure, since some would argue that the individuals who die of diarrhea in infancy are likely to be very poor, and to constitute more of a liability than an asset to the economy Nevertheless the figure is provided, as a point for discussion We assume that an individual works for forty years, and that those who die would earn the average per capita income Then the income loss due to those who die this year is the net present value of their lifetime earnings streams Thus the 8,655 infants who die in 1993 would have earned 1993 per capita income ($1,080) for 40 years Assuming a discount rate of 5 percent, this gives a foregone lifetime income of $161 million for the group as a whole In 2000 the loss will be the income of 10,950 people who die, at estimated 2000 per capita income of $1,072, for 2010 15,297 infants die and per capita income is estimated to be $1,062

Foregone Income	1993	2000	2010
Foregone Inc /year	$9,355,164	$11,741,300	$16,242,986
Years worked	40	40	40
NPV of foregone income stream	$160,526,066	$201,469,979	$278,714,796

B3b Other Water-borne Diseases

Although diarrhea is the most important water-borne disease in terms of number of cases, it is neither the only one nor the most serious A number of other diseases may be attributed to water pollution, the Annuaire Statistique gives data about the number of cases in 1993 (Cholera has also been important in Morocco, however data are not published about its incidence)

Disease	1993	
Typhoid	3,411	
Conjunctivitis	50,000 out of 100,705	AS table 11-14
Hepatitis	1,293 out of 2,586	assignment to waterborne
Meningitis	209 out of 417	diseases based on expert
Bilharzia	2,358	medical opinion
Total cases	57,271	

Assuming medical expenditures of 5,000 Dh per case for all except conjunctivitis (which is not very serious), this gives a total of about 36 million dirhams or $4 1 million dollars per year spent on medical care Projecting this into the future based on urban growth, we arrive at $5 2 million in 2000 and $7 3 million in 2010

Data are not available on deaths from these diseases, only the number of cases Therefore we cannot project foregone incomes due to death By making some assumptions about days missed from work, however, we can estimate foregone income due to illness Thus assuming twenty days lost for each case of the serious diseases, 1993 per capita income of $1,080, and 250 days to a work year, we arrive at foregone income of $4 9 million Note that we have not adjusted the number of cases for labor force participation rates, this implicitly assumes that the unpaid labor of women working at home is of the same value to the economy as the paid labor of those in the work force Projecting this into the future based on urban population growth and evolution of per capita income, we can estimate losses in 2000 of $6 2 million and losses in 2010 of $8 6 million While these costs are important, they are not as high as those associated with diarrhea

B3c Solid Waste - Direct Exposure to Landfills

Morocco's landfills are a cause of a variety of possible health problems Most seriously affected are people who live and work directly on the dumps, engaged in scavenging and recycling These people are exposed to organic wastes, medical wastes, chemical wastes, and smoke from the fires which burn spontaneously in the trash As always, no data are available about their health problems in particular, but we can get an idea of the order of magnitude of these problems with some estimation Observations of the Meknes, Safi and Rabat landfills suggest that there may about 60 people working on each of them If there are 65 major landfills (one per province), and each landfill worker incurs 500 dirhams in work-related medical expenditures per year, then we may estimate the following annual costs for 1993, 2000, and 2010

Medical Expenditures	1993	2000	2010
People per dump	60	83	117
# of dumps (one per province)	65	70	75
Total people	3,900	5,838	8,739
Medical expenditures per person	Dh 500	500	500
Total medical expenditures	1,950,000	2,919,146	4,369,426
Expenditures in $U S	$221,591	$331,721	$496,526

The foregone revenues due to illness by landfill workers are low Assuming five days lost per person per year, daily revenue of forty dirhams (somewhat below per capita income), and an increase in landfill workers related to urban population growth, we arrive at the following estimates for 1993, 2000, and 2010

Income Loss	1993	2000	2010
Foregone days of work	5	5	5
Total days missed	19,500	29,191	43,694
Earnings per day	40	40	40
Total foregone revenue in dirhams	780,000	1,167,658	1,747,770
Foregone revenue in $	$88,636	$132,688	$198,610

Thus the overall costs borne by people working directly on the landfills are quite modest relative to other environmental impacts on the economy

B3d Solid Waste - Proximity to Landfills

The environment around the landfill suffers from a number of environmental nuisances, including smoke, contaminated dust blowing off, trash left on the access road, and so on All of these factors create an environment more unhealthy than the average urban neighborhood Ideally the economic impact of proximity to the landfill should be assessed by comparing property values in neighborhoods which are equivalent in all respects except for proximity to the landfill Unfortunately, this was not practical for this study In lieu of that, we have estimated the population may be affected by landfill disamenities, and the medical costs which they may incur as a result This analysis estimates that the average ten-hectare landfill with a 1700-meter perimeter may impose negative externalities on people living within one kilometer At average rural population density of 36 people per square kilometer (landfills are usually outside of heavily settled urban areas), this means that some 40,000 people may be affected in 1993, 54,000 in 2000, and 81,000 in 2010 If the average additional medical expenditure of these people is 100 dirhams per year, this would mean $450 thousand spent in 1993, $615 thousand in 2000, and $921 thousand in 2010 These expenditures are low compared with other environmental impacts

Proximity to Landfill		1993	2000	2010
Perimeter of dump	meters	1,700	1,700	1,700
area within 1km	km^2	17	17	17
People per km		36	45	64
People affected per dump		612	773	1,080
Total number of dumps		65	70	75
Total people affected		39,780	54,137	81,033
Medical expenditures		100	100	100
Total in $		$452,045	$615,192	$920,829

B3e Beach Contamination and Tourism

The question here is whether solid waste and sewage are contaminating beaches, especially around cities This is a matter of great concern to the Ministry of Tourism They do not have

evidence that at present it is decreasing tourist visits However, foreign tour operators do their own health testing on the beaches to determine that they are safe, so if there any problems they will have immediate repercussions for tourism

Tourism as a source of revenue fluctuates considerably, most recently in response to the Gulf War However, at all times tourism represents a significant portion of GDP The table below shows the evolution of tourist receipts from 1985 to 1993 (Annuaire Statistique Table 9-13)

Tourist receipts millions of Dh

1985	6,100	Annual change
1986	6,730	45 2%
1987	7,800	15 90%
1988	8,276	6 10%
1989	8,614	4 08%
1990	10,548	22 45%
1991	8,822	-16 36%
1992	11,706	32 69%
1993	11,222	-4 14%

1993 receipts from tourism, which amount to $1 275 billion, represent 4 53 percent of GDP Given the close monitoring of beach pollution by tour operators, the possible threat to this revenue source should be taken seriously However unlike other environmental costs, this one is not occurring at present, which makes it of somewhat lesser concern than it would be otherwise

B4 Land

Agricultural land use affects the environment in a several quantifiable ways First, soil erosion forces land to be taken out of cultivation, decreasing agricultural production Second, the yields on marginal land under cultivation decrease sharply in the second or third year Third, soil runoff from eroded land is depositing large amounts of silt in irrigation reservoirs, reducing the amount of water available for irrigation and thus the productivity of irrigated land Fourth, runoff of fertilizers is causing eutrophication of reservoirs, necessitating special expenditures to treat the water if it is used for drinking

A fifth cost of agricultural land use is harder to quantify Soil erosion causes water to run off the land much more quickly during periods of rainfall This means that water does not have time to filter into the ground and recharge the aquifer This may impose long-run costs because the levels of the aquifers could drop, however this possible cost could not be quantified for this study

B4a Soil Erosion Decreases Agricultural Production

Agricultural experts in Morocco estimate that 22,000 hectares of agricultural land are lost each year due to soil erosion (Mediterranean Basin Study) Calculating the lost revenue from this land is fairly straightforward Land lost to erosion is typically relatively unproductive even when it is still cultivated, so the team's agriculture expert estimated average yield at 1000 dirhams per

91

year The value of the land taken out of cultivation may be estimated based on the present value of the foregone future income stream Using a discount rate of 5 percent, the value of land lost in 1993 comes to nearly $50 million Projections to 2000 and 2010 are made by applying the rural population growth rate, assuming that land lost to erosion will grow at the same rate This is a major economic cost compared with other environmental problems

	1993	2000	2010
Land lost per year	22,000	23,262	25,191
Av yield on marginal	1,000	1,000	1,000
Value lost per year	22,000,000	23,261,965	25,191,367
Discount rate	0 05	0 05	0 05
PV of 100-year rev stream	436,654,024	461,701,401	499,995,981
Revenue stream in $	49,619,776	$52,466,068	$56,817,725

B4b Decreased Productivity of Marginal Lands

The team's agriculture expert estimated that 80,000 hectares per year of marginal land are converted from natural vegetation to agriculture These lands are quite productive the first year they are cultivated, but their productivity drops off sharply in the second or third year as they rapidly become eroded The agriculture expert estimates this one-time drop in the value of yield to be 680 dirhams Assuming that the rate of conversion of marginal land to agriculture increases with rural population growth, we derive the following losses in 1993, 2000, and 2010

	1993	2000	2010
Hectares newly cultivated/year	80,000	84,589	91,605
Drop in value from erosion	680	680	680
Total drop (one-time) in dirhams	54,400,000	57,520,496	62,291,379
Total drop in $	$6,181,818 00	$6,536,420 00	$7,078,566 00

B4c Reduced Efficiency of Dams Due to Sedimentation

Siltation of dams is one of Morocco's greatest concerns with respect to the economic impacts of soil erosion When dams silt up, the amount of water available in the reservoirs for irrigation decreases, thus decreasing the amount of land which can be irrigated Irrigated land is quite valuable, so this represents a significant economic loss to the country The team's agriculture expert reports that the equivalent of 5,000 hectares a year of irrigated land are lost each year because of dam siltation The average yield of this land is about valued at 8,000 dirhams The value of this land is calculated as the present value of the lost income stream, in 1993 this come to some $90 million Projections to 2000 and 2010 assume that siltation will increase with rural population growth, as more land is subject to erosion

Land lost to siltation	1993	2000	2010
Loss of productive land in hectares	5,000	5,287	5,725
Av yield on irrigated land in dirhams	8,000	8,000	8,000
Value lost per year in dirhams	40,000,000	42,294,483	45,802,485
Discount rate	0 05	0 05	0 05
PV of future revenue stream	793,916,408	839,457,092	909,083,601
Revenue stream in $	$90,217,774	$95,392,851	***

Clearly this is a very significant economic loss

B4d Cleaning Dams from Eutrophication Problems

Agricultural runoff leads to eutrophication of the water in the reservoirs When the reservoirs are a source of drinking water, additional treatment may be needed prior to the standard drinking water treatment process ONEP is experimenting with introducing carp into the reservoirs to reduce levels of organic matter So far they have tried this in five reservoirs, at a cost of about 800,000 dirhams each

Cost for dam treatment	800,000
Dams treated since 1989	5
Total expenditure	4,000,000
Total expenditure in $	$454,545

So far this cost has been low However it could increase in the future, as agriculture and the use of agrochemicals increases

B5 Natural-Vegetation Based Economic Activity, Forest Resources

Forest resources are used for a wide range of purposes by local communities The most obvious is as a source of fuelwood, others include building materials, crafts materials, game meat, traditional medicines, food sources, tourism, and so on The degradation of forest resources cuts into all of these uses Unfortunately, the only one that can readily be quantified is fuelwood The estimate of the value of lost forest resources must therefore be regarded as a lower bound, which could easily be twice as high if we included the other uses which are compatible with sustainable fores management

Forest resources are being degraded by a number of different activities, including

- overgrazing
- overcutting for sale in urban markets
- overcutting for local use
- cutting in order to convert land to agriculture
- cutting for construction purposes
- forest fires

Statistics disaggregating the loss of forest resources into each of these categories are not available There is a commonly cited estimate that 30,000 hectares of forest land are lost each

year Based on an estimate of the productivity of this land if managed sustainably for fuelwood, we can value this loss as shown below The growth of forest degradation over time is calculated based on rural population growth rates

Forest Loss	1993	2000	2010
Hectares lost/year	30,000	31,721	34,352
Yield per hectare in steres	5	5	5
Kilos per stere	100	100	100
Cost of fuelwood per kilo in Dh	1	1	1
Lost value in dirhams	15,000,000	15,860,431	17,175,932
Lost value in $	$1,704,545	$1,802,322	$1,951,810
discount rate	0 05	0 05	0 05
Lost value of income stream	$33,831,665	$35,772,319	$38,739,358

Note that this assumes that the decrease in supply of forest products is not enough to cause an increase in price of forest-based goods and services, particularly fuelwood As the supply of fuelwood decreases, the value of the remaining resource increases, at least up to the point at which substitute goods or services are more economical for the consumer (e g alternate cooking fuels are less expensive than wood) Thus we could not value the entire forest at the value of what is lost, however in the absence of evidence that fuelwood prices are going up at present, it is acceptable to use the current price to value everything lost

Also note that this does not take into account the value of the agricultural production on the land which is converted from natural vegetation to cultivation Presumably the individual farmer is better off with agricultural land than forest, that is, the yield from the land is greater under cultivation than if harvested sustainably for fuelwood In fact, that is consistent with the data above Harvested sustainably for fuelwood, a hectare of hilly forest land would bring in 500 Dh, if we accept the estimated growth rate of 5 steres/hectares Cultivated, the agricultural data cited above suggest an annual average return of 1000 Dh on marginal land This is compounded by a land tenure system in which farmers can retain land which is cultivated, but forests belong to the state and their harvest is illegal, creating an incentive for farmers to cut forest and convert land to agriculture

C Summary of Economic Impacts

The table below summarizes the economic impacts reviewed in this annex If we include the foregone income from juvenile diarrhea deaths, then sanitation problems impose the greatest economic costs at this time Soil erosion comes in second, it would be first by a wide margin if we didn't include foregone income from diarrhea deaths Forest degradation is next at present Air pollution, industrial water pollution, and domestic solid waste are far below the other cost areas

Future costs present a somewhat different picture, for several reasons First, because urban population is growing rapidly while rural population is growing very slowly, urban problems such as sanitation and industrial pollution are likely to grow faster than rural ones like erosion and forest degradation Second, and perhaps more importantly, several major potential costs are

not being experienced now, but may arise in the future The most important of these is the damage which unsanitary beaches could cause to the tourist industry, which accounts for more than 4 percent of GDP Threats to the fishing industry from industrial and domestic pollution, and to Moroccan export industries from the imposition of the ISO 9000 and ISO 14000 standards in Europe are also a possible source of major costs Because these could be very high, concern about domestic and industrial pollution is essential

Source of Cost	Current Cost	Future Cost*
Air Pollution		
Lead	$3 8 M	$5 5 M
Health impacts of air pollution	$0 4 M	$0 6 M
Cleaning costs	$8 7 M	$13 M
Industrial Water Pollution		
Drinking water treatment	$3 5 M	
Phosphate impacts on fisheries	0	up to $150 M
Domestic Pollution		
Diarrhea medical care	$20 M	$30 M
Diarrhea foregone income	$160 M	$240 M
Other disease - medical care	$4 1 M	$6 2 M
Other disease - foregone income	$4 9 M	7 4 M
Landfill exposure	$0 75 M	$1 35 M
Beach contamination	0?	up to $1,275 M
Land		
Erosion	$49 6 M	$59 6 M
Decreased productivity	$6 1 M	$6 8 M
Siltation	$90 M	$100 M
Eutrophication	$0 5 M	?
Natural Ecosystem Degradation		
Forest Degradation	$33 M	$37 3 M

*Average of 2000 and 2010 projected costs

ANNEX C
STATUS OF SURFACE AND GROUNDWATER

A Basins of Morocco

A1 Sebou Basin

Surface water In general, the quality of the surface water in the Sebou Basin is fair to poor, except in the upstream areas where the quality is good The waterways of the left bank of the Sebou are the most seriously affected by pollution On the other hand, the quality of the water in the waterways on the right bank is much better, except in the area immediately affected by the discharge of municipal waste from the city of Taza

The decline in the quality of the surface water is mainly due to the discharge of wastewater from urban areas such as Fès, Meknes, Sidi Kacem, Sefrou, and Khemisset Moreover, there are discharges from some industrial plants located along the waterways, such as sugar refineries that pollute the Beht Oued and oil refineries that pollute the R'dom Oued The sugar refineries operate when water levels are low, and this causes further deterioration in the quality of the water in rivers

The pollution generated by the city of Fes causes the worst deterioration of water quality in the basin Municipal effluent from Fès is discharged into the Fes Oued which passes through Medina before it empties into the Sebou Oued This effluent is the main cause of health problems and nuisances because the oued's ability to dilute and purify itself naturally are highly limited and unable to assimilate all of these discharges The water there has a very low oxygenation capacity which drops to zero downstream from Fès The water is heavily laden with biodegradable organic matter The content in nitrogen components and phosphorous compounds is high and there are substantial amounts of pathogenic organisms

Groundwater

- **Fès-Meknès water table** The mineralogical, organic and bacteriological quality of the water table is satisfactory The factor that lowers the grade of water quality is nitrate concentration, which exceeds the national drinkability standard (50 mg per liter) at approximately 27 percent of the points This pollution is probably caused by water infiltration from irrigation water laden with nitrogen and local contamination from wells due to hygiene problems

- **Gharb water table** The water is of fair mineralogical quality However, total quality is generally mediocre for oxidizable matter The bacteriological quality is rather satisfactory

- **Maamora water table** Water mineralization is satisfactory overall except for a few wells located on the coastal fringe where quality is very poor Overall water quality has

declined due to the concentration of oxidizable matter that varies from 12 to 40 mg per liter

A2 Oum Er Rbia Basin

Surface water Overall water quality is good to fair except for the area located just downstream from the domestic discharges from the city of Kasba Tadla In this area there is no water oxygenation at all There is a substantial amount of organic matter and the content in nitrogen components and phosphorous compounds is high The mineralogical, organic and bacteriological quality of the water in all the reservoirs in the basin is satisfactory

Groundwater The organic and bacteriological quality of the Tadla water table is satisfactory overall However, the mineralogical quality has declined sharply This is the result of high conductivity values measured mainly in the Beni Amir water table, and the situation is caused by high nitrate concentrations measured at several points in the Beni Amir and Beni Moussa water tables The use of nitrogen fertilizer and the infiltration of domestic and industrial waste water are the principal sources of pollution of the Tadla water table

A3 Tensift Basin

Surface water The quality of the water in the Tensift Oued is fair to very poor Quality is very poor upstream and downstream from the city of Marrakech as a result of discharges of municipal effluent Quality improves slightly midway down the Tensift In addition to organic and bacteriological pollution, a high content of toxic substances of industrial origin has been observed in the waters of Tensift Oued downstream from Marrakech The water of the Tensift Oued's tributaries is generally satisfactory This is also true for the water held back by the Lalla Takerkoust Dam

Groundwater

- **Haouz water table** The overall quality of the Haouz water table is quite satisfactory except at certain points to the Northeast where there is significant mineralization Quality in the Marrakech sector is poor due to the discharge of city sewage Bacteriological contamination and high nitrate content are well above the national drinkability standard of 50 mg per liter, both have been observed at these points

- **Essaouira syncline and Kourimat reservoir** The water table is slightly polluted by nitrates The bacteriological quality of the water is very poor, especially North of the water table

- **Bahira water table** The organic quality of the water is generally satisfactory, but the water is slightly contaminated by bacteria This is due to limited surface protection for most of the wells

A4 Souss Basin

Surface water Overall water quality is generally satisfactory except at the mouth of the oued where the water becomes polluted by the municipal sewage of Greater Agadir The raw municipal sewage from Oulad Taima flows into the middle section of the Souss Oued

Groundwater The coastal water tables have very high salinity levels because of the intrusion of sea water Salinity is highest in the areas where the water table has been seriously overused In the Chtouka Valley, nitrate concentrations reach 60 mg per liter Large farms in this area cause such high concentrations Organic pollution and bacteriological pollution of domestic origin are observed particularly in areas where there are domestic and industrial discharges (Agadir and Oulad Taima) The bacteriological pollution of wells in rural areas due to local pollution is because of insufficient well protection The wells are used for drinking Household waste is responsible for much of the pollution of groundwater, primarily in the region of Greater Agadir This waste is frequently dumped at sites that are vulnerable to pollution, such as quarries and locations near residences

A5 Loukkos, Mediterranean and Tangier Coast Basins

Surface water Surface water quality is relatively satisfactory, except for the areas located downstream due to discharges from the urban areas of Tangier and Tetouan This is true, for example, of the Martil Oued into which all of the sewage flows, both domestic and industrial, from the city of Tetouan Discharges of this effluent cause the receiving body of water to be laden with biodegradable organic matter, pathogenic organisms, and toxic elements of industrial origin

The physical and chemical quality of the surface water in the Loukkos Oued is generally satisfactory except downstream where discharges released by the city of Ksar El Kebir where bacteriological pollution has been observed This pollution may be caused by contamination at certain points from domestic and industrial discharges, most likely from sugar refineries in the lower Loukkos

Groundwater The organic and bacteriological quality of the Martil water table is poor, particularly on the left bank of the Martil Oued The other water tables—R'Mell de Larache, Cherf El Akab, Fnideq, etc ,—have satisfactory water quality However, the quality of the water in the Smir water table is poor locally

A6 Moulouya Basin

Surface water In general, the quality of the surface water in the Moulouya Basin is satisfactory except in the following areas

- The Isly Oued, downstream from the discharges of the city of Oujda, the pollution is mainly organic
- The Cheraa Oued, downstream from the city of Berkane, the bacteriological and organic quality is poor

- Downstream from the Moulouya Oued, water quality is fair due to slight organic pollution caused by discharges from the Zaio sugar refinery

The quality of the water held back by the Mechraa Hommadi and Mohamed V Dams is satisfactory

Groundwater The sheet water in Angads is of poor quality East of Oujda due to high nitrate content The infiltration of sewage destined for the sewage farm is at the root of this problem The sheet water in Triffa is of rather satisfactory quality for organic and bacteriological matter However, the nitrate content exceeds the drinkability standard of 50 mg per liter at several wells located on farms in Triffa

B Impact of Domestic Sewage Pollution

B1 Impact on Health

Impact may be direct or indirect as follows

Direct impact This mainly affects farm workers, as certain parasites such as hookworms and schistosome may pass through the skin There are 7,000 hectares irrigated using wastewater, and the population is estimated to be 100,000 This also affects the children who play or bathe in wastewater, mainly when the water level is low This population is estimated to be 10,000 children Finally, this affects people who use the oued water contaminated by waste water This population is estimated to be 10,000 people

Indirect impact This is due to the consumption of crops from fields irrigated using raw sewage The products are vegetables eaten raw and products of animal origin such as beef (for Taenia) and milk that contains certain toxic substances The number of people impacted is estimated at 30,000

N B The estimates of the number of people affected are not based on any surveys, studies or statistics The estimates provided may be off by a factor of three or more

B2 Impact on the Economy

This impact is caused by

- The decline of surface water quality, with eutrophication of rivers and water held back by dams and groundwater (NB (1) The ONEP did not supply the cost of treating eutrophic water held back by the dams, and (2) Price of drilling a well = Dh 1 5 million per well 100 m deep)

- The threat to fishing resources and tourism (see Annex B)

B3. Impact on Biodiversity

This is the result of the decline of fauna and flora in the aquatic ecosystems These areas are deficient in fauna and flora, so the impact is considered negligible

B4 Impact of Solid Waste

Health The impact is a result of

- The infiltration of "juices" into the water tables from household waste and toxic products in landfills This risk of impact is particularly high in rural areas where water is drawn from wells An estimated 10,000 people are affected by this problem

- Direct contact with garbage by people who collect items for recycling An estimated 10,000 people are affected

- People living near the landfills who inhale polluted fumes This affects an estimated 10,000 people

The economy This impact is caused by the cleanup of contaminated water and the replacement of condemned wells Currently, this cost may be considered negligible, because the actual structures contaminated are wells and springs in rural areas that are not really monitored

B5 Impact of Pollution Incidents

Health This is the result of dumping toxic products into waterways or reservoirs and is caused by

- traffic accidents
- the negligence of people living in the vicinity who discharge pollutants
- the use of pesticides

The repercussions on health may be considered negligible at this time

The economy This is the result of the cost of treating polluted surface water and replacing condemned AEP wells Currently, this cost may be considered negligible

Biodiversity This is due to the destruction of the fauna and flora in the ecosystems, including surface water, groundwater, and the soil The waterways and water tables are deficient in worthwhile microorganisms Consequently, the impact of pollution incidents may be considered negligible

ANNEX D
CONTACTS

Ministry of Agriculture

Mme Bencheikh Hnia	Chef de la Division de la Cooperation

Ministry of Agriculture, Direction des Eaux et Forêts

Mr El Mastour Abdellah	Principle Forestry Engineer
Mr Carbele	Director
Mr Laarbi Didouquen	Forest Engineer, Toubkal National Park, Marrakech
Dr Hlal Elaid	Forest Economist, National Forestry School
Mr Abdelmalek Benabid	Ecologist, National Forestry School
Mr Abdelali Machrouh	Remote Sensing Expert, National Forestry School

Ministry of Commerce and Industry

Mr Jniyeh Ahmed	Chef de la Division Promotion et Environnement
Mr Beneyada Mohammed	Chef du Service de la Protection de l'Environnement

Ministry of Maritime Fisheries

Mr Mohamed Tangi	Director of International Relations
Mr Chafik Abdelghani	Chef, Service Etudes de la Pollution Chimique, Institut Superieur de la Pêche Maritime
Mr Bernouissi Abderrahmen	Chef, Service Microbiologie Marine, Institut Superieur de la Pêche Maritime
Mme Kadiri Khadija	Juriste, Institut Superieur de la Pêche Maritime
Dr Sebai	

Ministry of Tourism

Mr Driss El Khazzani	Director of Investments and Equipment

Ministry of Energy and Mines

Mr El Orf M'hammed	Chef du Service de l'Economie, de l'Energie, et de l'Environnement

Mr Hatimi Abdelmajid	Ingénieur Megallurgiste
Mr Benani Mohammed	Ingénieur des Mines, Chef du Service Minéralurgie et Métallurgie
Mr Abdelhak Fakihani	Director, School of Mines, Marrakech

Ministry of Public Works

Mr Ourzik Abdelouahad	Professeur, Ecole Nationale de l'Administration Public
Mr El Merini M'hammed	Ingenieur d'Etat, Cellule Qualite des Milieux Naturels
Professeur Agoumi Ali	Conseiller du Ministre, "Qualite des Milieux Naturels"
Mr Foutlane Ali	Chef du Departement Pollution et Assainissement, ONEP
Mr Lahoussaine Echihabi Ben Smail	Ingenieur Chimiste, Chef du Departement Eau, Adjoint du Directeur du Laboratoire Qualite des Eaux, ONEP

Ministry of Interior

Mr Bousfiha Abdelhai	Directeur de l'Urbanisme
Mr Lamine Moustapha	Ingenieur Hydraulique, Agence Urbaine de Fes
Mr Ait Ouadi Abdallah	Ingénieur, Direction d'Eau et d'Assainissement, Direction Generale des Collectivites Locales
Mr Reffouh Abdelhatif	Ingénieur, Direction d'Eau et d'Assainissement, Direction Generale des Collectivites Locales

Ministry of Interior, Under-Secretariat for the Environment

Mme Layashi	Director of International Cooperation
Mr Mdarhri Alaoui El Kebir	Coordonnateur Principal
Mr Hadj Mabrouk Ezedine	Conseiller Technique
Mr Boulefiouch Jaafar	Architect, Coordinator of Environmental Impact Studies Unit
Mr Amil Mourad	Hydrogeologist, Environmental Impact Studies Unit
Mme Boazza Bouchra	Economist
Mr Benyahia Mohamed	Ecotoxicologue, Coordonnateur du Project Gestion de l'Environnement
Mme Chefai	Laboratoire

Ministry of Public Health

Dr A Zerrari	Chef de Service de la Sante Infantile

Private Sector

Mme El Haiti Hakima	E A U Globe Environnement, Amenagement et Urbanisme, Fès
Mr Agouzzal Moulay Mouh	Administrateur Délégue, Societe Nouvelle des Huileries de Meknes

NonGovernmental Organizations

Mr Le It Ajana Ahmed Ichi	Coordinator, Royal Federation For Moroccan Hunting, Rabat
Mr Dieter Hoffmann	Coordinator, Bird Life International

USAID Staff

Mr Jeff Allan	Agricultural Specialist
Mr Taylor George	Regional Coordinator - Asia and North Africa, Environment Center
Ms Molly Kux	Bureau Environment Officer, Asia
Mr Chris Perrine	
Ms JoAnne Garbe	Biodiversity Conservation Fellow, Human Capacity Development Center
Ms Tina Rouse	
Mr Alan Hurdus	
Ms Irna Kerst	RHUDO Office, USAID/Morocco
Mr Michael Kerst	
Mr Richard Scott	
Mr Jim Hradsky	Assistant Director, USAID/Morocco
Mr Berrada Tahar	RHUDO Office, USAID/Morocco
Mr Chraibi Mohammed	RHUDO Office, USAID/Morocco
Ms Helen Soos	Program Development Officer, USAID/Morocco
Mr Michael Farbman	Mission Director, USAID/Morocco

USAID Project Staff

Mr Phil Roark	Tadla Project Supervisor, Chemonics International
Mr Mohamed Khatouri	Surveys and Evaluation Specialist, Tadla Project
Mr Arthur Belsey	Irrigation Engineer, Tadla Project
Mr Maurice Knight	Environmental Pollution Protection Project, Washington

Ms Pamela Mandel	Officer in Charge, Morocco, Tunisia, Algeria (USAID/W)

U.S Peace Corps

Ms Romona Muller	Associate Peace Corps Director
Ms Wendy Marshall	Volunteer, Toubkal National Park
Ms Dawn-Marie Roberts	Volunteer, Toubkal National Park
Mr Tom Anderson	Volunteer
Mr Dave Doctor	Volunteer
Mr Kelly Graham	Volunteer
Ms Jessca Jaeoby	Volunteer

U S Embassy

Mr John Wilson	Agricultural Attache
Mr Mike Ratney	Economist

Other Donor Agencies

Ms Laura Raimondo	Economist, Infrastructure Operation Division, Maghreb and Iran, World Bank, Washington D C
Mr Sergio Calegari	Ingenieur Sanitaire Principal, Division Infrastructure, Departement du Maghreb et de l'Iran, World Bank
Mr Hans-Peter Muller	Chef de Projet, Coopération Technique Maroc-Allemande
Dr -Ing Otto Schmidt	Chef de Mission de Coop Maroc-Allemande
Mr Marc Clausse	Conseiller Adjoint pour la Cooperation Scientifique et Technique, Ambassade de France au Maroc
Mr René Roudaut	Conseiller Culturel, Scientifique et de Coopération, Ambassade de France a Rabat
Mr Jean-Paul Fiorese	Attaché de Cooperation Technique, Ambassade de France au Maroc
Mr Andreas Beckermann	Affaires de Coopération, Ambassade de la Republique Federale d'Allemagne, Maroc

Others

Mr Lahcen Ait Abdellah	Tizi Oussem Village Guest House, Toubkal National Park
Mr Mohammed Aboufirassi	Ingenieur en Chef, Resources Ingénierie Resing, Marrakech
Mr Abdelhak Lahman Bennani	Directeur, Production Agricole Ministere de

	l'Agriculture et de la Mise en Valeur Agricole
Mr Touhemi Kadiri Bouehra	Technicienne, 2eme grade Subdivision du SVOP ORMVA Tefhalet Errachidia
Mr Fouzilla El Alami	Ingenieur Agronome Ingénieur Agronome Service de la production agricole Responsable des experimentations a l'ORMVAT Tefhalet Station Ain El Atti (Salinity) Errachidia
Mr Thami El Alami	Division de la Réhabilitation et de la Conservation des Terres Agricoles Ministere de l'Agriculture et de la Mise en Valeur Agricole, Administration du Genie Rural
Mr Jdi El Habib	Ing d'application au Service Forestier de Chefchaoun Chefchaoun
Mr Ahamed El Harmoshi	Chef de Bureau de Pesticide MAMVA
Mr Moha Khana	Ingenieur Agro-Pedologue ORMVA Tefhalet Errachidia
Mr Abdeslam Khardi	Ingenieur Agro-pedologue Cellule de lutte contre la desertification ORMVA Tefhalet Errachidia
Mr Mohamed Khatouri	Specialiste Suivi et Evaluation Projet MRT
Mr Lahcene Ljouad	Division de la Rehabilitation et de la Conservation des Terres Agricoles Ministère de l'Agriculture et de la Mise en Valeur Agricole, Administration de Génie Rural
Mr Abdelali Machrouh	Lecturer Remote Sensing/GIS Ecole Nationale Forestière d'Ingénieurs
Mr Mark Powell	Fellow, Center for Risk Assessment, Resources for the Future
Mr Mohamed Wakrim	Chef de la Division de la Rehabilitation et de la Conservation des Terres Agricoles Ministere de l'Agriculture et de la Mise en Valeur Agricole, Administration de Genie Rural
Mr M Zakaria	Chef de Service des etudes et projets de mise en valeur Production Agricole Ministere del'Agriculture et de la Mise en Valeur Agricole

ANNEX E
NATURAL ECOSYSTEMS

A. Introduction

Morocco is very diverse ecologically There are four major mountain systems which serve as physical barriers separating the interior from southern and eastern Saharan deserts The Rif mountains border on the Mediterranean Sea in the north The Middle Atlas mountains extend in a northeastern-southwestern direction along the eastern third of the country The High Atlas mountains extend from the southern limit of the Middle Atlas mountains toward the Atlantic coast to the west The Anti Atlas mountains extend in a general east-west direction to the south of the High Atlas

There are seven climatic areas Saharan, Arid, Semi-Arid, Sub-Humid, Humid, Pre-Humid and High Montane The percent of rainfall distribution in Morocco can be separated into three broad regions

- 78 percent in the Saharan region (less than 250 millimeters of rain per year)
- 15 percent in the Semi-Arid region (250-500 millimeters of rain per year)
- 7 percent in the Humid and Sub-Humid (more than 500 millimeters of rain per year)

Morocco maintains diverse land use categories These land uses are composed of

- 10 3 percent cultivable land
- 6 1 percent natural forests
- 0 6 percent private/public reforested lands
- 5 0 percent Alfa grasslands
- 31 8 percent rangelands outside of forests
- 46 8 percent non-productive lands
- 1,835 kilometers of coastline

B Natural Ecosystem Problems

B1 Forest Resources

Forest resources provide an important ecological function They reduce water and wind erosion, increase soil fertility and provide habitat for wildlife Of particular importance to Morocco is the fact that forest cover facilitates the infiltration of water into the soil and ground water system

Forest resources have been used for fuelwood and construction materials in Morocco since the time of the Romans Deforestation in Morocco is occurring at a high rate and is most severe in El Hocima, Azilal, Agadir and Taza Between 29,000 and 31,000 hectares of forest are converted to other land uses per year If this trend continues, 30 percent of Morocco's existing forests my be lost by the year 2020 (USAID, 1988) According to the World Resources Institute

(WRI 1992-3), average annual deforestation was 0 4 percent per year between 1981 and 1985 (although for purposes of comparison, the rate was 1 1 percent in all of North Africa and 2 2 percent in West Africa)

Deforestation in Morocco is attributable to a number of causes

- Agricultural expansion on to marginal lands
- Reduced availability of livestock grazing lands due to agricultural encroachment
- The absence of sufficient energy alternatives in the rural areas Wood resources are the most important fuel source in Morocco and represents approximately 40 percent of the total energy consumed (Duval, 1988, USAID CDSS, 1988) Biomass constitutes 90 percent of the energy used by rural populations in Morocco (UNCED, 1992)
- Poor enforcement of Morocco's land use laws (20 percent of the country's forest areas are required by law to be closed to grazing at any one time However, this law is not always effectively enforced) There is also a tradition of essentially unrestricted use of public resources coupled with the breakdown of the traditional control mechanisms (Duval, 1988)
- Population growth Although overall rural growth rates are less than 1 percent per year (Annuaire Statistique, Table 1-3), in some areas they may be much higher, placing pressure on the resource base

Deforestation has been particularly severe in the Rif mountains in northern Morocco The remaining forests include Evergreen Oak (*Quercus sapo*), Cork Oak (*Q suber*), Moroccan Fir (*Abies pensapo*) and Cedar (*Cedrus atlantica*) Deforestation also a problem in the Middle and High Atlas mountains, but usually not as severe Tree species in the southern High Atlas often include Aleppo Pine (*Pinus halepensis*), Phoenician Juniper (*Juniperus phoenicea*) and Evergreen Oak (USAID, 1980)

In the southern High Atlas mountains, the deforestation of Phoenician Juniper is a major problem This tree is often used for fuelwood by farming communities in the region As human population density is increasing, the Juniper trees are becoming more scarce The problem is exacerbated by an increase in the number of goats and sheep in the area These livestock animals are consuming Juniper tree regeneration and destabilizing the soil

Continuous unsustainable use of forest resources is leading to soil erosion, watershed degradation and loss of important plant and wildlife habitat The potential economic impacts associated with deforestation include

- Degradation of non-timber resources (e g , cork oak, medicinal plants, indigenous agricultural crop species)
- Potential loss of broad-based income associated with the expansion of tourism away from the coast and into protected areas located in Morocco's interior

- A loss of income and agricultural production and potable water resulting from watershed protection

- The loss of wood fuel energy resources in rural areas

Specific conditions usually required for the sustainable management of forest resources include

- A sound national and regional policy context (e g , regulations, policies, incentives)
- Capable human resources
- Clear national objectives and management plans
- Information base (e g , regional lessons learned, area specific management plans, database)
- Community participation in forest management
- Utilization of sustainable land use practices (which are supported by government policies)
- Monitoring of biological and economic impacts and ecosystems (The benefits from monitoring should be used for the sharing of lessons learned, use of consistent methodology by international community, monitoring changes in ecosystems)

Morocco has a policy of reforestation which has led to 13,000 hectares reforested annually in Morocco during the period of 1981-1985 (Direction Water and Forests, 1991) These efforts included

- 45 percent production plantations
- 17 percent plantations for protection of watersheds
- 2 5 percent plantations for erosion control
- 13 percent pastoral plantations
- 18 5 percent landscaping
- 4 percent demarcation boundaries (Dept of Water and Forests, 1991)

B2 Range Resources

Livestock management represented approximately 17 percent of Morocco's agricultural employment in 1981 Approximately 95 percent of the population working in the agriculture sector are involved in animal husbandry Of those people, 18 percent are completely dependent on livestock production and 51 percent are involved in both livestock production and agriculture (USAID, 1988)

Livestock populations are presently beyond the carrying capacity of lands in many areas of Morocco For example, the annual production of Alfa grass production is 18 000 metric tons but the annual harvest is nearly 30,000 metric tons (USAID, 1988) More than 10,000 hectares of Alfa grass are deteriorated each year The problem of overstocking is not limited to Morocco In some regions of north Africa a reduction 90 percent of the livestock population is recommended (USAID, 1980)

Livestock management in Morocco depends upon the use of natural rangelands for grazing In order to reduce the impact of drought, livestock herders are building up the size of their herds

during years of sufficient rainfall In addition, herders are converting rangelands to the production of cereal crops on marginal lands to provide forage for their animals Through the conversion of rangeland to cereal crops, natural rangeland is continually reduced The combined increase of livestock numbers and agricultural expansion are leading to severe over-grazing and degradation of rangelands

Morocco maintains approximately 30,300,000 hectares of rangelands These rangelands consist of 4,393,000 hectares of forest rangelands, 3,158,000 hectares of Alfa grass range, and 22 749,000 hectares of rangelands outside of the forest domain (USAID, 1988) According to the World Bank, it is estimated that 1,000,000 cattle, 3,500,000 sheep and 4,000,000 goats graze on the country's rangeland for more than six months a year

B3. Wildlife and Protected Area Management

Morocco maintains globally important resources which need to be sustainably managed and protected The Directorate of Water and Forests (Direction des Eaux et Forêts, E&F) within the Ministry of Agriculture has the administrative responsibility for managing Morocco's protected areas Within the E&F, the Division of Hunting, Fishing and Protection of Nature conducts the daily implementation of policy and field activities

There are eight National Parks in Morocco Talassamtane, Al Hocemia, Tazekka, Ifrane, North High Atlas Oriental, Toubakal, Dakhla, Souss-Massa In the future, there will be ten official national parks in Morocco Seven of the planned national parks have management plans completed The remaining three national park plans are being prepared Germany and the World Bank are providing assistance for the development of these plans

Since 1992, the Division has been in the process of developing an overall National Plan for Parks and Protected Areas with technical assistance from Germany The plan is presently in draft and addresses important national parks, wetlands and coastal resources It also contains project proposal and information on each of the ecosystems

One-hundred and fifty important ecosystem sites have been identified in the plan for management Each of these sites have been placed into one of two priority categories The criteria for placement in these categories are indicated below

Priority 1 Sites

- Existing natural reserves which should be upgraded within five years
- Sites which are at high environmental risk
- Sites which have high importance for biodiversity and provide important ecological functions for the region
- Sites which contribute to the social and economic equilibrium of the region

Priority 2 Sites

- Sites which should be upgraded within ten years
- Sites which have modern pressures of medium magnitude
- Sites which presently have a minimum of protection

- Sites which are important biologically, but not as high a priority as other sites in the region

The Department of Water and Forests is beginning to make progress in management of Morocco's protected areas However, there are a number of important problems, including no national conservation strategy, uncoordinated rural development planning, and lack of community participation in land use decision making

Morocco's protected areas and important flora and fauna are reliant on the sustainable management of watersheds and coastal/wetland ecosystems For example, the Barbary Macaque (the only primate other than man in North Africa) relies on the quality and quantity of Morocco's forest resources (USAID, 1980) The management of these resources requires an integrated rural development approach and innovative policy incentives

In addition to the protection of biodiversity, there is a great potential to increase nature based tourism in Morocco Tourism is an important industry in Morocco For example, there were 189,000 visitors to the country in 1984 However, the protected area system has not yet begun to exploit this potential resource (USAID, 1988)

B4 Coastal and Wetland Resources

A number of environmental problems are associated with the management of Morocco's coastal resources These include construction associated with increased human populations, dam and irrigation construction, tourism development and pollution

The pollution problems associated with Morocco's coastal and wetland resources can be divided into industrial, agricultural and urban household sources Industrial pollution is primarily a threat to coastal waters More than 90 percent of all chemicals, refuse and other materials entering coastal waters remain there as sediments in wetlands, reefs and other coastal ecosystems (Shumway, 1993) The result of this pollution may be an increase in fish mortality, a reduction in fish which are safe for export and/or a reduction in the quality of fish and other species habitat

Industrial threats to coastal and marine resources include heavy metals and other chemical effluents from sugar refineries, tanneries, wood pulp plants and oil refineries In addition, plastic and other debris (e g , fragments of fishing nets) entangle and kill a variety of marine animals

The improper use of pesticides, insecticides and fertilizer (nitrate pollutants) are some of the important sources of pollution in the agriculture sector Water pollution by toxic organic compounds and metals or by nutrient loading from sewage or agricultural runoff can place biological stress on aquatic ecosystems For example, chemical pollution can prove dangerous to the food value of edible fish species and threaten poorly drained sectors with eutrophication (Winrock International, 1987)

Pesticides from agriculture can become increasingly concentrated and toxic in fish and other species which are relatively high on the food chain In addition, nitrates from fertilizer increase nutrients in water systems and can result in eutrophication and algal blooms The excessive enrichment of water resources can reduce the productivity of fisheries, pollute drinking water and reduce biodiversity

Table Morocco's Wildlife Resources

1 General Information

- 7 000 hectares Protected Closed Forests in Morocco in 1980 (WRI 1993)
- 8 National Parks Talassamtane Tazekka Ifrane North High Atlas Oriental, Toubakal, Al Hocemia, Dakhla, Souss-Massa
- 8 Wildlife Reserves Merja Zerga Bokkoyas Marine and Wildlife Reserve, Sidi Boughaba, Kniffiss, Sidi Chiker Réserve de Cerf Elaphe d Espagne Skhirate Island Takherkhort
- 1,600,000 hectares are set aside for protection as parks, reserves and other special management An additional 10,000 000 hectares are closed to hunting every year
- 1 835 kilometers of coastline

2 Wildlife

- 108 indigenous mammals
- Nine internationally endangered mammal species (U S Fish and Wildlife Service 1979)

  Cheetah (*Acinonyx jubatus*)
  Cuvier's Gazelle (*Gazella cuvieri*)
  Mhorr Gazelle (*Gazella dama mhorr*)
  Moroccan Gazelle (*Gazella dorcas massaesyla*)
  Rio de Oro Dama Gazelle (*Gazella dama lozanoi*)
  Barbary Hyena (*Hyaena hyaena babara*)
  Leopard (*Panthera pardus*)
  Monk Seal (*Monachus monachus*)
  Barbary Sheep (*Ammotragus lervia*)

- Nationally endangered mammal species (USAID 1988)

  Dorcas Gazelle (*Gazella doracas*)
  Barbary Macaque (*Macaca sylvanus*)

- Nine Nationally threatened aquatic species (USAID 1988)

  Shad (*Alose alose*)
  Turtle (*Caretta caretta*)
  Turtle (*Chelonia mydas*)
  Turtle (*Demochelys coriacea*)
  Turtle (*Eretmochelys imbricata*)
  Broad Sea Fan (*Eunicella verrucosa*)
  Mediterranean Coral (*Corallium rubrum*)
  Purple Urchin (*Paracentrotus lividus*)
  Spengbis Freshwater Mussel (*Margaritifera auricularia Maroccan*)

3 Plants

- 4,200 plant species (800 of these plant species are only found in Morocco)

Untreated urban municipal sewage is also contributing to coastal and marine pollution Not unlike agricultural pollution, municipal pollution increases eutrophication of water resources There is often a direct relationship between the number of people living next to a river and the amount of nitrates in the river There have also be incidents of people living near wetland areas who are pumping water from protected wetlands illegally for irrigation agriculture

Wetlands associated with coastal shorelines and river floodplains merit special attention In every case where these wetlands have been studied, it has been demonstrated that they play critical roles in habitat and water quality

Wetland habitats which maintain migratory birds are of particular importance in Morocco Birdlife can be affected by the pollution which results from the nitrification of water and consequent alteration of habitat Polluted areas may also eventually become unattractive to the migratory birds

Drainage of coastal wetlands in Morocco for irrigation agriculture has also reduced the number of bird species considerably (USAID, 1980) The Souss-Massa National Park in southern Morocco also has a problem with municipal sewage from Agadir However, the Merja Zerga reserve on the coast of northern Morocco is threatened by village expansion and rural development activities (e g , road expansion, tourism development)

B5 Fisheries Resources

Morocco has the largest fisheries industry in Africa and has some of the richest fishing areas in the world Morocco's fishing industry ranks third in export earnings after phosphate and citrus products Approximately 80,000 people are employed in the fishing industry—35,000 directly and 45,000 in the associated support industries (e g , construction, boat maintenance, fish processing) (Duval, 1988)

The construction of dams is causing serious problems in the fishing industry For example, dams are preventing the natural migration of shad fish up rivers to breeding sites Formally common in most rivers in Morocco, the shad fish is now threatened with extinction (USAID, 1988) Pollution is also blamed for the degradation of trout fisheries and disappearance of eels (formally an important export)

Pollution can also create conditions which are unfavorable for fish and affect the food chain which support fish populations For example, high content of organic matter, petroleum derivatives and heavy metals in water lowers the level of dissolved oxygen and estuarine waters This condition may result in a reduction in ecosystem productivity (e g , potential fish catch reduction) In addition, hydrocarbon water film may attach to wetland plants and disrupt the efficiency of plant metabolism (IUCN, 1994)

It is not known what effects pollution is having on Morocco's ocean fish resources The government of Morocco has specialized equipment to monitor biological impact of pollution on fish and fish changes in populations However, a program has not yet been developed to monitor point source pollution or its impact on marine resources Further, Morocco does not yet have national legislation to require environmental impact monitoring of industrial and fishing activities

B6 Tourism Development

Tourism is an important industry in Morocco Europeans make up nearly two-thirds of the total of foreign tourists France, West Germany, Spain, and the United Kingdom make up the bulk of Morocco's visitors There were 1,471,000 foreign visitors to Morocco in 1986 (Economic Intelligence Unit, 1988-89) Morocco has both natural and cultural attractions which enable it to compete with other countries in the region

However, Morocco has the potential to capture more broad-based benefits from tourism The country has substantial natural resources in the interior of the country which have yet to be fully utilized by the tourism industry Morocco has unique forested areas, wildlife, areas of historic interest and interesting cultures

Tourism may have both positive and negative impacts on health, economy and biodiversity The increase in the cost of living resulting from the influx of tourist may reduce the money available for some rural communities to buy or cook food However, tourism development also often increases the availability of health and education services

Potential environmental impacts associated with tourism are not being monitored Further, environmental assessments or monitoring is not required as part private concessions for tourism activities in natural areas Private tour operators appear to unregulated

If properly managed, an expansion of tourism into other regions of the country could increase the distribution of economic benefits associated with economic development to the rural poor However, the government has yet to develop a national tourism plan for the country Constraints and opportunities have not been fully identified Further, the government has not integrated environmental requirements and monitoring into tourism concessions agreements and licensing of tour operators Without environmental planning and licensing requirements, tourism development cannot be conducted sustainably

DONOR ACTIVITIES
NATURAL ECOSYSTEMS

Selected Natural Ecosystem Management Activities

U S Peace Corps

Conservation Education and Rural Development associated with protected areas (e g , education, camp grounds, tree nurseries, ecological surveys)

German participation

Assistance to Directorate of Water and Forests for

- Overall management assistance of National Plan for Parks and Protected Areas
- Development of management plans for Souss-Massa, Tasaka and Toubkal National Parks
- Introduction of Gazella into National Parks

World Bank

Assistance to Department of Water and Forests for the Management of Souss Massa National Park

African Development Bank

Assistance to Department of Water and Forests for

- The identification of priority protection areas
- Revising forest management plans for 106 000 hectares
- Developing new management plans 673,000 hectares of natural forests and 285,000 hectares of artificial forests (Water and Forest Department, 1991)

Birds International

Have agreement with the Department of Water and Forests to develop conservation education activities in protected wetland areas They are working with other NGOs to

- Identify important wetland habitats
- Organize rural communities, monitoring rural development activities on wetland ecosystems
- Develop a data base on all wetland bird species
- Develop a management plan for the Merga Zerga reserve

ANNEX F
REFERENCES

Administration de l'Hydraulique Tome de Ressources en Eau, Tome 2

Administration de l'Hydraulique 1989 Eau et Developpement, special issue

Administration de l'Hydraulique 1990 Eau et Developpement, No 9

Administration de l'Hydraulique 1991 Etat de la Qualite des Ressources en Eau dans la Region Hydraulique de Souss, Année 1990-1991

Administration de l'Hydraulique 1992 Etat de la Qualité des Ressources en Eau dans la Region Hydraulique de Loukkos, Année 1991-1992

Administration de l'Hydraulique 1992 Etat de la Qualite des Ressources en Eau dans la Region Hydraulique de la Moulouya, Annee 1991-1992

Administration de l'Hydraulique 1993 Etat de la Qualite des Ressources en Eau dans la Region Hydraulique de l'Oum-Er-Rbia, Annee 1992-1993

Administration de l'Hydraulique 1993 Etat de la Qualite des Ressources en Eau dans la Region Hydraulique de Sebou Annee 1992-1993

Agence Nationale de Lutte contre l'Habitat Insalubre 1994 "Programme d'Infrastructures Urbaines et d'Amenagement Foncier" Volet d'Amenagement Foncier, Plan d'Actions pour l'Environnement

AFJEM (Association Femmes Jeunesse dans l'Environnement Maghrebin), Le Carnet d'Adresses Vert

Alaoui, My Youssef 1992 "L'environnement au Maroc Inventaire Bibliographique" 3 volumes Prepared for the Fondation Friedrich Ebert au Maroc

Banque mondiale/Banque europeenne d'Investissement 1990 Programme pour l'environnement dans la Mediterranee La gestion d'un patrimoine collectif et d'une ressource commune Washington,D C /Luxembourg

Benabid, Abdelmalek and Mohamed Fennane 1994 Connaissances sur la Végetation du Maroc Phytogeographie, Phytoscoiologie et Series de Végetation Ecole Nationale Forestière d'Ingenieurs Sale, Morocco (97 pp)

Conference des Nations Unies sur l'Environnement et le Developpement 1992 Royaume du Maroc, Rapport National Rio De Janeiro 1 - 12 Juin 1992

Conseil National de l'Environnement 1994 "Comité Juridique" Revision de la Legislation Environnementale

Conseil National de l'Environnement 1994 "Strategie Nationale de l'Environnement "

CSE (Conseil Superieur de l'Eau, 3eme Session) 1988

CSE (Conseil Supérieur de l'Eau, 3ème Session) 1990

CSE (Conseil Superieur de l'Eau, 6ème Session) 1992 L'Economie de l'Eau dans le Secteur de l'Irrigation Rabat

CSE (Conseil Superieur de l'Eau, 3eme Session) 1984

Debbarh Abdelhafid 1994 Etude Environmentale du Périmetre du Tadla Gestion Quantitative et Qualitative des Ressources en eau et sol des perimetres irrigues de Beni-Moussa et Beni-Amir Chemonics Int'l Projet MRT Tadla

Direction Generale de l"Industrie 1993 Etude de l'Impact des Rejets Industriels sur la Qualité des Eaux de l'Oued Sebou

Direction de la Statistique 1983 Population Légale du Maroc D'apres le recensement général de la population et de l'habitat de 1982

Direction de la Statistique Les Etablissements Economiques

Direction de la Statistique 1994 "Comptes et Agregats de la Nation Resultats provisoires (1) de l'année 1993 "

Direction de la Statistique 1994 Annuaire Statistique du Maroc, 1994

Direction de la Statistique, CERED 1990 Atlas Demographique Maroc

Direction de la Statistique, CERED 1991 Population l'An 2062 Strategies, Tendances

Direction de la Statistique, CERED 1993 Migration et Urbanisation au Maroc Economist Intelligence Unit 1989 Morocco 1988-1989--Country Profile London, United Kingdom (pp 52)

Direction-Générale de l'Industrie 1993 "Etude de l'Impact des Rejets Industriels sur la Qualité des Eaux de l'Oued Sebou" Resume synthetique

Dreckmann, Patrice and Mohamed Ammati 1994 Analyse de la Gestion Quantitative et Qualitative des Produits Agrochimiques Utilises dans le Perimetre de Tadla Chemonics International Project MRT Tadla

13

DRCTA (Division de la Rehabilitation et de la Conservation des Terres Agricoles) (1995 in preparation) Enquette Erosion, Inventaire des Sites Prioritaires a des Actions de Conservation des Sols, Annexe Ministere de l'Agriculture et de la Mise en Valeur Agricole Direction des Aménagements Fonciers Rabat

Economist Intelligence Unit 1992 Morocco To 1992--Growth Against The Odds Special Report No 245 London, United Kingdom (102 pp)

ECODIT 1994 (Provisoire) Strategie Nationale Pour La Protection de l'Environnement et le Developpement Durable Sous-Secretariat d'Etat aupres du Ministre d'Etat a l'Interieur Charge de la Protection de l'Environnement Rabat

ECODIT 1994 (Provisoire) Strategie Nationale Pour La Protection de l'Environnement et le Developpement Durable (Rapports thematique "eau" pour la Strategie) Sous-Secretariat d'Etat aupres de Ministre d'Etat à l'Interieur Chargé de la Protection de l'Environnement Rabat

Gersar-SCP et ANRED 1989 "Traitement et valorisation des dechets menagers, Operation Casablanca" La Collecte des Dechets Menagers a Casablanca

ILACO B V 1985 Agricultural Compendium Elsevier Science Publishers New York

International Resources Group 1991 Méthodologie Permettant de Tester l'Impact du Développement Urbain sur les Ressources Naturelles Tetouan, Morocco (31 pp)

International Union For The Conservation of Nature 1987 Directory of the Protected Areas of North Africa Protected Areas Unit conservation Monitoring Center Cambridge, England

International Union For The Conservation of Nature 1990 Action Plan For African Primate Conservation 1986-1990 Geneva, Switzerland (41 pp)

International Union For The Conservation of Nature 1993 Global Marine Biological Diversity A Strategy For Building Conservation Into Decision Making Island Press Washington, D C (383 pp)

International Union For The Conservation of Nature 1994 Mangroves in West Africa Elements for a Strategy for Sustainable Development Gland, Switzerland (127 pp)

Jackson, Jerry 1994 "Citrus groups cited in well pollution" in *The Orlando Sentinel*, March 9, 1994 Orlando, Florida

KAOUAKIB KADIRI Khadija 1992 "Etude Juridique Aspects Legislatifs et Reglementaires de la Gestion de l'Environnement" Prepared for the Minister of Interior, Direction-Generale de l'Urbanisme, de l'Amenagement du Territoire, et de l'Environnement, by the Group Scandiaconsult International

Kolluru, R V 1994 Environmental Strategies Handbook McGraw-Hill, Inc New York

Ministère de l'Agriculture 1991 La Forêt et l'Environnment au Maroc Direction des Eaux et Forêts et de la Conservation des Sols Rabat, Morocco (18 pp)

Ministère de l'Agriculture 1991 Parc National du Toubkal--Plan Preliminaire d'Aménagement et de Gestion Direction des Eaux et Forêts et de la Conservation des Sols Volume 2 BCEOM-SECA

Ministère de l'Agriculture 1993 Parcs Nationaux de Tazekka et de Toubkal--Occupation des Sols et Lutte Contre l'Erosion Prospection et Recommandations In Cooperation With GTZ Rabat, Morocco (10 pp)

Ministère de l'Agriculture 1993 Projet d'Assistance a la Gestion des Ressources Naturelles PN 92 2097 1 Planification du Projet par Objectifs In Cooperation With GTZ Rabat, Morocco

Ministère de l'Agriculture 1995 Plan Directeur des Aires Protegees du Maroc Direction des Eaux et Forêts et de la Conservation des Sols Rabat, Morocco

Ministère de Commerce et d'Industrie 1993 Etude de l'impact des rejets industriels sur la qualité des eaux de l'oued Sebou Résumé synthétique

Ministère de Commerce et d'Industrie 1994 Situation des rejets industriels

Ministère de Commerce et de l'Industrie 1993 Situation des Industries de Transformation

Ministère d'Etat à l'Interieur Charge de la Protection de l'Environnement 1994 Mesures pour réduire les émissions et proposition des normes d'emissions et d'immissions pour les cimenteries au Maroc

Ministere d'Etat a l'Interieur Charge de la Protection de l'Environnement 1994 Problematique des Margines Produites par les Huileries et Possibilités de Valorisation et de Traitement

Ministère des Transports Les Transports en Chiffres Annee 1993-1994

Ministère des Travaux Publics (undated) "Les Travaux Publics et l'Environnement "

Ministère des Travaux Publics 1993 "Qualite des Milieux Naturels, Plan d'Action 1993 "

Ministère des Travaux Publics 1994 "Programme Qualite des Milieux Naturels, 1994-1995 "

Ministère des Travaux Publics 1994 "Action Environnementale du Ministere en 1994 "

ONEP (Office National de l'Eau Potable) 1990 Utilisation des Eaux Superficielles pour la Production d'Eau Potable Effets de l'Erosion et des Activites Humaines sur la Qualité de l'Eau dans les Bassins Versants Rabat

ONEP 1991 Water Pollution Control Actions Undertaken by ONEP Rabat (English and French versions)

ONEP 1991 Contrôle de la Pollution des Eaux Actions Menees par l'ONEP Lutte Contre l'Eutrophisation du Lac Reservoir Sidi Mohammed Ben Abdellah

ONEP 1994 Contrôle de la Pollution des Eaux Destinées à l'Alimentation en Eau Potable Cas du Bassin du Sebou Rabat

Pride Project 1994 Integrating Enviromental Control Strategies in Morocco PRIDE, Washington, D C

Pride Project 1994 Pollution Prevention in the Moroccan Agro-Processing Industry USAID Project No 398-0365 Washington, D C

"Projet de loi sur la protection et la mise en valeur de l'environnement "

Projet GEM 1994 Audit Environnemental du complexe Textile de Fes - COTEF Project GEM

Projet GEM, Gestion de l'Energie et des Ressources Naturelles au Maroc 1995 "Rencontre Régionale sur la Gestion des Ressources Naturelles Communications" Fes, janvier 1995

Rawson Edward and Roger Stillwater 1994 Environmental Assessment Groundwater and drainage Chemonics International Project-MRT Tadla Morocco

Royaume du Maroc et Banque Mondiale 1994 "Aide-Memoire - Mission de Préparation" Deuxième Projet d'Assainissement et Reutilisation des Eaux Usees

Shumway, Caroly 1993 Forgotten Waters Freshwater and Marine Ecosystems in Africa Strategies For Biodiversity Conservation and Sustainable Development Washington, D C (169 pp)

S K Associates, LTD 1994 Renewable Energy in Morocco Washington, D C (60 pp)

Sous-secretariat d'Etat pour l'Environnement 1994 "Proposition de Mise en Place d'une Procedure d'Evaluation Environnementale au Maroc," version provisoire

Sous-secretariat d'Etat pour l'Environnement 1994 Unpublished documents

Sous-secretariat d'Etat pour l'Environnement 1994 "Monographie Locale de l'Environnement de la Ville de Rabat," version provisoire

Sous-secretariat d'Etat pour l'Environnement 1994 "Rapport Thematique 'Eau'" version provisoire

Sous-secretariat d'Etat pour l'Environnement 1994 "Rapport Thematique 'Dechets'" version provisoire

Sous-secretariat d'Etat pour l'Environnement 1995 "Bilan d'Activités," 1994

11c

Sous-secrétariat d'Etat pour l'Environnement 1995 "Note de presentation de l'Observatoire National de l'Environnement du Maroc (L'ONEM)" Projet PNUD/UNESCO MOR/90/001

Talbot, James J 1993 Water Quality and the Environment, Morocco Water Sector Survey ERM Program Management Company, Exton, Pennsylvania (For the World Bank, MNIAG)

United Nations 1992 Royaume du Maroc--Rapport National Conference des Nations sur l'Environment et le Développement Rio De Janeiro, 1-12, Juin, 1992 (136 pp)

U S Agency For International Development 1980 Draft Environmental Report on Morocco Arid Lands Information Center Tucson, Arizona (90 pp)

U S Agency For International Development 1986 Morocco Country Development Strategy Annex C The Agricultural Sector of Morocco (167 pp)

U S Agency For International Development 1988 The Status of Biological Resources in Morocco Rabat, Morocco (58 pp)

U S Agency For International Development 1988 The Status of Biological Resources in Morocco--Constraints and Options For Conserving Biological Diversity (Leroy Duval primary author) Rabat, Morocco (58 pp)

U S Agency For International Development 1994 Pollution Prevention in the Moroccan Agroprocessing Industry Project in Development and the Environment Washington, D C

U S Environmental Protection Agency 1987 Unfinished Business A Comparative Assessment of Environmental Problems Overview Report

U S Environmental Protection Agency 1994 "Roadmap to Comparative Risk Assessment " Draft

U S Peace Corps 1995 Toubkal National Park Draft Document Rabat, Morocco (15 pp)

Wakrim, M 1994 Proposition de Projects Pilotes de Conservation des Sols et Lutte contre la Désertification Ministere de l'Agriculture et de la Mise en Valeur Agricole, Administration du Genie Rural, Direction des Amenagements Fonciers, Division de la Réhabilitation et de la Conservation des Terres Agricoles Rabat

Wakrim, M 1995 FAO data in preparation for publication Ministere de l'Agriculture et de la Mise en Valeur Agricole, Administration du Genie Rural, Direction des Amenagements Fonciers, Division de la Rehabilitation et de la Conservation des Terres Agricoles Rabat

Wakrim, M , T El Alami and L Jouad 1995 Joint personal communication Ministere de l'Agriculture et de la Mise en Valeur Agricole, Administration du Génie Rural, Direction des Aménagements Fonciers, Division de la Réhabilitation et de la Conservation des Terres Agricoles Rabat

117

Wilaya de Fes, Agence Urbaine de la Wilaya de Fes et de Sauvegarde de Fes (undated) "Environnement dans la ville de Fès "

Winrock International 1987 Ecological Development in the Tropic--Guidelines For Planners Morrilton, Arkansas (362 pp)

World Resources Institute 1992 World Resources 1992-93 A Guide to the Global Environment Washington, D C (385 pp)

Wyatt, Alan, Alison Kenning Massa, Driss Benjelloun, Séfiane Benyahia, and Abdelali Filali Baba 1993 "Programmatic Environmental Assessment Morocco Urban Infrastructure, Land Development and Financing Program HG-IV," Prepared for USAID/Morocco

ANNEX G
AGRICULTURAL AND LAND ANALYSIS

A Introduction

This annex reviews the information available to the team on agriculture and land use, evaluates the major environmental risks, and recommends possible USAID project options Much of the important data necessary to develop quantitative assessments was not readily available However, the major problem areas are obvious and do not need extensive analysis to determine

Of necessity expert opinion has played a key role in this assessment Care should be taken in the use of available numbers, to avoid jumping to conclusion beyond what is supported by accurate data

B Resource Description Quantitative and Qualitative Description of the Resource

B1 Morocco's Climate

Morocco's climate has a Mediterranean climate that is characterized by mild winters, hot summers, relative aridity, and efficient winter rainfall If Morocco's rainfall came in the hot summer months rather than the cool winter months, the country would be a parched desert Because the rainfall is usually gentle and temperatures are cool during the winter, a given cereal crop can be produced with about one-third the moisture which would be required to grow the same crop using irrigation during the summer

The Mediterranean climate is deceptively mild It gives the impression of being temperate when in fact it is at the edge of being arid The transition from a mediterranean climate to an arid climate starts at about 300 mm rainfall per year and is complete at about 100 mm rainfall per year (See rainfall map of Morocco on following page) By definition an arid climate is one where annual crops cannot be raised with just the available rainfall However, rainfall is variable from year to year The isohyte represents average rainfall At the 300 mm isohyte, annual rainfall varies between ample and draught (crop failure) but probably eight years out of ten have ample rainfall As the isohyte decreases, the drought years increase until at about 100 mm every year is a drought year West of the Atlas Mountains, land productivity is generally a function of rainfall In this context, "marginal" defines land where the ratio of ample rainfall years to drought years becomes unfavorable

Between 60 and 90 percent of runoff occurs during the rainy season Most streams have either severely reduced flow or are completely dry for about six months of the year About 90 percent of Morocco would be classified as arid or sub-arid And more than two-thirds of the water resources which can be developed in Morocco are found in three catchment basins The Sebou, the Bou-Regreg and the Oum-Er-Rbia (Conférence des Nations Unies sur l'Environnement et le Developpement, 1992)

The incentives for using all available water resources are high in a Mediterranean climate It is the most responsive climate for irrigated agriculture and it is a desirable climate for human habitation Consequently, developing and protecting water is the top priority of the Moroccan government In Morocco the problems of climate, soil, water, agriculture and land use are closely related

B2 Morocco's Land

Morocco can be divided into 14 geographic regions (Wakrim, 1995) The Rif (12,400 km2) is rugged country with variable rainfall The low quality of soil resource is the limiting factor for agricultural production The Pre-Rif (3,500 km2) is the foothill area south of the Rif The characteristic vegetation is chaparral The topography and the threat of water erosion of soil limit agriculture in this region

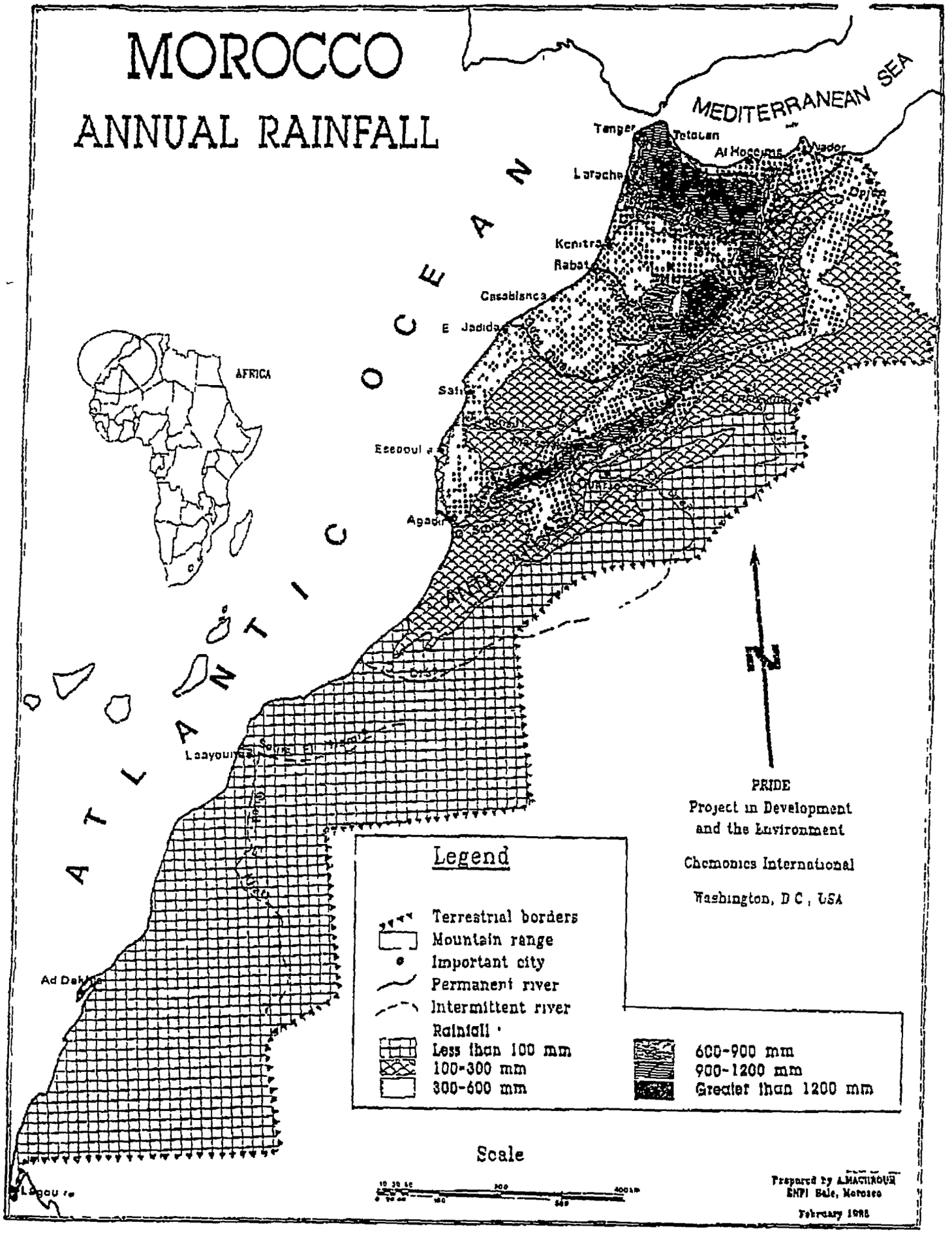
When serious soil erosion is discussed in Morocco, examples usually are taken from the Rif This is where hillside farming and heavy rainfall combine to destroy soil The Rif is rugged but the mountains are not high enough to have a snow pack This increases the importance of a well maintained watershed to modulate runoff Evidence of soil erosion is common And entire mountains stripped of soil down to the bedrock are evidence of serious erosion in the recent past Excessive language is often used to describe soil erosion, the Rif is no exception in this respect However, the soil erosion problems in the Rif are serious Further topographical descriptions include

- The Sebou plateau (11,760 km2) includes the following areas the upper Sebou in the northern part of the catchment basin where the land is undulating and has degraded matorral vegetative cover, the Sais plateau where dryland agriculture flourishes because the soils are deep and fertile, and the central plateau, the Maamora, the Zemmours plateau and the Zairs plateau, all of which have agricultural potential

- The Atlantic plains (23,760 km2) include the plains of Gharb, Loukkos, Doukkaka, Chaouia, Sous-Massa and Chiadma These plains are flat and have deep soil Consequently, the agricultural potential is high

- The interior plains of Tadla and Haouz (26,800 km2) are semi arid and therefore dryer than the Atlantic plans Agricultural potential declines visibly from Tadla to Haouz The Moulouya plain (24,976 km2) varies in its agricultural potential from intensive in the north, or lower Moulouya to pastoral in the mid (central) and upper (southern) Moulouya plain

- The Middle Atlas Mountains (49,479 km2) are the largest and highest mountain range in Morocco The northern watersheds of the central and eastern High Atlas mountains have high rainfall and are covered by forest The southern watersheds are much more arid and have little value as watersheds


MOROCCO
ANNUAL RAINFALL
MEDITERRANEAN SEA
ATLANTIC OCEAN
Tetouan
Larache
Kenitra
Rabat
Casablanca
E Jadida
Essaouira
Agadir
Laayoune
Ad Dakhla
AFRICA
N
PRIDE
Project in Development and the Environment
Chemonics International
Washington, D C , USA
Legend
Terrestrial borders
Mountain range
Important city
Permanent river
Intermittent river
Rainfall
Less than 100 mm
100-300 mm
300-600 mm
600-900 mm
900-1200 mm
Greater than 1200 mm
Scale
Prepared by ALMACHROUR
ENPI Sale, Morocco
February 1988

121

- The High plateaus of Eastern Morocco (32,000 km2) have shallow soils and an arid climate so their most important use is as range

- The Anti-Atlas Mountains (31,760 km2) have an arid climate and limited agricultural production potential

- The Pre-Saharan lands (186,600 km2) stretch from the Atlantic to le couloir de Boudenib and includes Jbel Bani, The Draa and Tafilelt valleys, and the Hamadas

- The Saharan lands (240,000 km2) are a succession of plateaus and ergs The only vegetation is drought resistant, woody, scrub In the east there are some small basins or "graras" where a limited amount of agriculture can be practiced

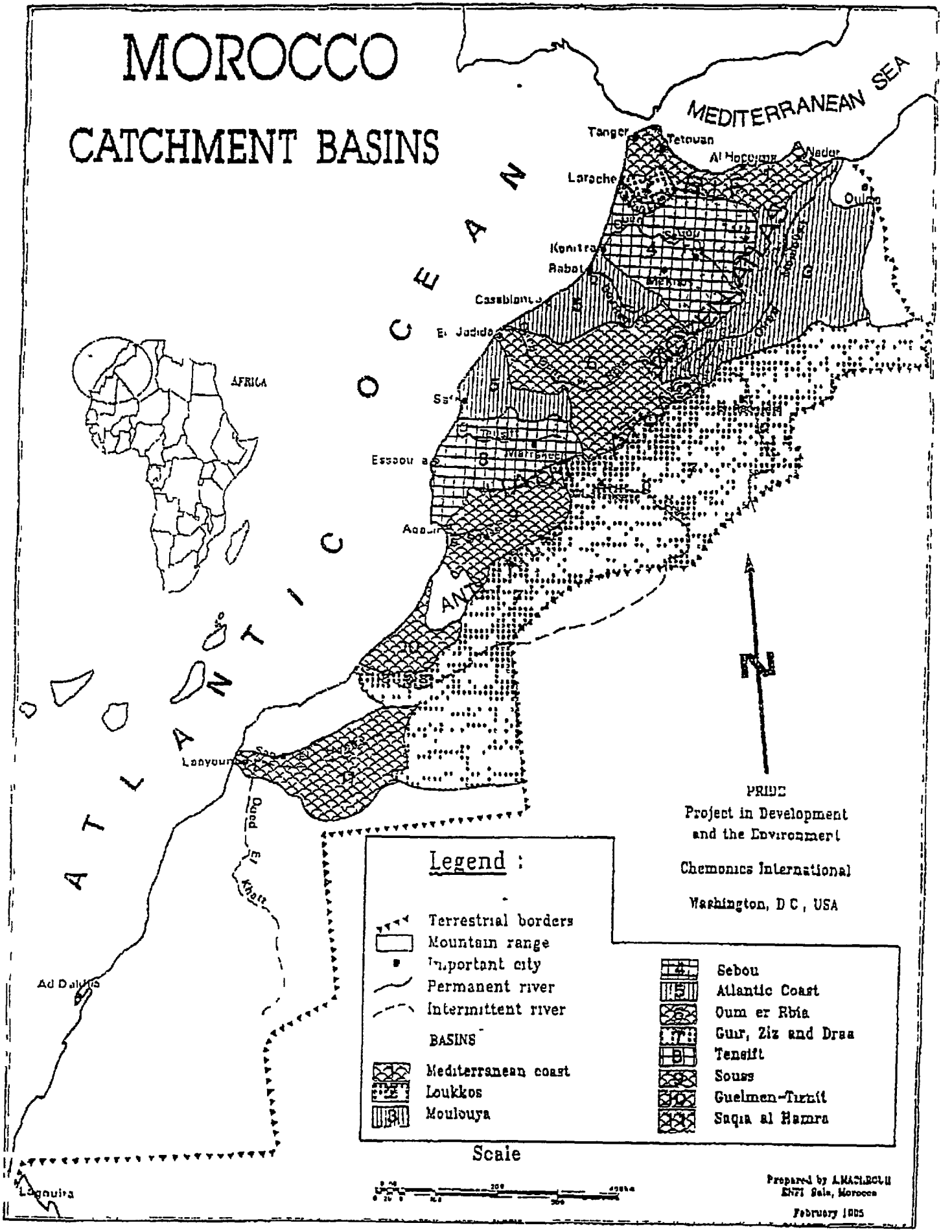
- The Atlantic Fringe (14,240 km2) stretches along the Atlantic coast inland for about 10 km Because of the maritime influence on the climate, it has excellent potential for horticultural crops

- The Mediterranean Fringe (2,400 km2) consists of isolated areas between El Hoceima and Nador The maritime influence on the climate gives it unique potential for the production of high-value crops In this case, the limitations are, shallow, rocky and saline soils

Most of the major cities of Morocco are located in either the Atlantic fringe or the Mediterranean fringe Fes, Meknes and Marrakech would be exceptions to this general rule There are six major, well-defined catchment basins in Morocco the Moulouya, the Loukkos, the Sebou, the Oum-Er-Rbia, the Tensif and the Souss (See catchment basin map on the following page) The most populous area of the country, the "Atlantic Coast," refers primarily to the area from Kenitra to El Jadida although geographically it extends on down to Safi The Atlantic Coast region does not clearly fit into any catchment basin but it is a very important geographic area so it is often listed with the catchment basins Also, there are many minor catchment basins rather than a major catchment basin where the Rif meets the Mediterranean sea and the Atlantic ocean This is an important area so it is referred to as "The Mediterranean Coast" on maps of catchment basins

The basic unit for environmental work in Morocco is the catchment basin A catchment basin is named after the most important river which drains it and refers to all land which drains into the river from its source in the mountains to the point where it empties into the ocean (or into a larger river) Catchment basin and watershed are often used interchangeably but watershed actually refers to the upper part, usually mountainous, of a catchment basin where one of the major uses of land is to harvest water for use in the lower part, usually plains, of the catchment basin

122


MOROCCO
CATCHMENT BASINS
MEDITERRANEAN SEA
ATLANTIC OCEAN
AFRICA
Tanger
Tetouan
Nador
Oujda
Rabat
Casablanca
Essaouira
Agadir
Laayoune
Ad Dakhla
Legouira
PRIDE
Project in Development and the Environment
Chemonics International
Washington, D C, USA
Legend :
Terrestrial borders
Mountain range
Important city
Permanent river
Intermittent river
BASINS
Mediterranean coast
Loukkos
Moulouya
Sebou
Atlantic Coast
Oum er Rbia
Gnir, Ziz and Draa
Tensift
Souss
Guelmen-Tirnit
Saqia al Hamra
Scale
Prepared by A.MACHICHI
ENTI Sale, Morocco
February 1995

The flagship activity for a catchment basin project would probably be a brown project with the goal of cleaning up a stretch of river which is being polluted by a manageable combination of domestic and industrial polluters This should be complemented by small, innovative, flexible green projects Most of Morocco's major environmental problems are found in all of the six largest catchment basins (There are also numerous smaller, tributary catchment basins which might make good target areas for a project) Four of these basins are briefly characterized here

The Sebou River Catchment Basin The only river in Morocco which is completely dead from where it first encounters a major municipality until it finally empties into the sea It has some of the worst of everything soil erosion in the Rif, domestic and industrial pollution, and agricultural pollution The problems are enormous and they will be expensive to remedy The World Bank, with other international donors, is tring to develop a major project in this basin

The Oum-Er-Rbia Catchment Basin A distant second to the Sebou River Catchment Basin in environmental problems and a much more distant second in terms of the money and attention Serious agriculture pollution problems abound (being partially addressed by the USAID Tadla project) Limited but useful possibilities for soil and species protection

The Souss Catchment Basin While not visited by the team, this basin is reported to be an optimum combination of serious environmental problems and significant local support willing to remedy the problems Soil salinity and overdraft of groundwater are major problems here

The Guir, Ziz and Draa Catchment Basins These are eastern catchment basins which cannot compete with western catchment basins in terms of the magnitude of the problem But they probably could compete very well with the western catchment basins in terms of local support of an environmental project Ground water quality, soil salinity and dune encroachment are major problems (Dune encroachment is an interesting environmental risk in that it is a green risk which is intensive rather than extensive in nature In fact, as an environmental risk, dune encroachment has more in common with brown environmental risks than it does with green environmental risks)

Table 1 Population and Industries by Catchment Basin

Catchment Basin	Population (% of total)	Industries and Crafts	Irrigated Land (Ha)
Loukkos	2,164,000 (9%)	Paper, rubber, textiles, creamery, brewery, sugar mills (2)	22,500
Moulouya	1,875,000 (7 5%)	Agro-industry, metallurgy cement, lead and zinc mines	69,600
Sebou	5,367,000 (21%)	11 agro-industries including 5 sugar mills, beverages, paper, leather, chemicals, cement and petroleum products	91,800
Bou Regreg	1,346,000 (5 5%)		
Oum-Er-Rbia	2,344,000 (9%)	Agro industries including three sugar mills, leather, textiles, asbestos, cotton	109,000
Tensift	3,085,000 (12%)	Phosphates, copper mining, fertilizer, agro-industry, leather, textiles	51,300
Souss-Massa	1,846,000 (7%)	Agro-industry, chemicals, paper, rubber, tanning	70,400
Sud	1,685,000 (7%)		95,000
Zone cotiere Atlantic	3,311,000 (23%)		
Total	23,023,000		509,600

Source ECODIT 1994b from STAT 1993 - AH 1992 - MAMVA 1992

The Sebou catchment basin has the greatest concentration of industrial and agricultural activity The Oum-Er-Rbia is the most agricultural of the catchment basins It has one-fifth of the total irrigated land and the corresponding agro-industries The Tensift catchment basin is characterized by mining and the third largest population after the Atlantic coast and the Sebou catchment basin (ECODIT 1994b)

Water quality in Morocco varies by catchment basin In the Sebou catchment basin the river is severely polluted in populated areas In the other catchment basins water pollution is localized in areas immediately below cities and industries (ECODIT, 1994b)

B3 Morocco's Agriculture

Depending on rainfall, agriculture generates from 15 to 21 percent of Morocco's GNP Agriculture accounts for 39 percent of national employment and 80 percent of rural employment

One-third of the value of Morocco's exports is generated by agricultural production One-fourth of the value of Morocco's imports is for agricultural products, primarily soft wheat, sugar, dairy products and vegetable oil (Wakrim, 1995)

Cultivated land in Morocco increased from 7 9 million hectares in 1980 to 9 million hectares in 1992 This amounted to an annual increase of about 80,000 hectares The distribution of agricultural land utilization from 1988 to 1992 was as follows (Wakrim, 1995)

Table 2 Agricultural Land Utilization in Morocco

Crop	Percent	Area in ,000 hectares
Cereals	60	5,382 3
Grain legumes	5	474 0
Industrial Crops	3	308 2
Forage Crops	2	153 6
Market Vegetables	3	197 8
Fruit Trees	7	617 1
Fallow	20	1,873 0

Source Wakrim 1995

B3 Rainfed Agriculture

Rainfed agriculture accounts for 90 percent of tillable ground and supports 70 percent of the rural population (Wakrim, 1995) This includes most of the land devoted to cereals, grain legumes and fallow listed above

In the Rif where erosion is the worst, it results from rainfed agriculture, not deforestation for firewood For example, 70 percent of the watershed for the Al Wahada Dam is used for rainfed agriculture While protecting watersheds is the responsibility of Eaux et Forets most of the problem results from farming rather than to forestry or range management

B3a Irrigated Agriculture

Table 3 Current Situation and Development Potential for Large Irrigation Projects

ORMVA	Potential (ha)	Developed (ha)	Percent developed
Moulouya	65,400	65,400	100
Gharb	220,400	89,678	40 7
Doukkala	125,300	61,300	48 9
Haouz	202,700	53,550	26 4
Tadla	107,900	97,300	90 2
Tafilalet	27,900	27,900	100
Quarzazate	26,400	26,380	99 9
Sous-Massa	32,710	32,710	100
Loukkos	34,300	19,599	57 1
Total	843,000	473,817	56 2

Source ECODIT 1994b

In 1956 Morocco had 200,000 hectares of irrigated agriculture In 1990 Morocco had 830,000 hectares of irrigated agriculture Morocco's potential for irrigated agriculture is estimated to be 1,600,000 hectares Large projects accounted for 495,817 hectares Small- to medium-sized projects accounted for 383,573 hectares Spate irrigation, derived from a traditional form of irrigation which is based on the diversion of flood water onto fields, accounted for 350,000 hectares Table 3 shows that all potential for further development of irrigated agriculture lies in regions west of the Atlas Mountains

In 1960, Morocco imported all of its sugar Now two-thirds of Morocco's sugar is produced on five major irrigation projects Tadla, des Doukkala, du Gharb, du Loukkos, and de la Moulouya Dairy production in Morocco is a function of the alfalfa produced by irrigation and Moroccan citrus, and winter vegetables for domestic and overseas markets are produced by irrigation

C Problem Description

Five categories of land were considered for this report

- Water eroded land
- Irrigated land
- Wind eroded land including dune encroachment
- Urban proximity land
- Scenic land

The intensity and extent of environmental risk is much greater in the first three categories of land listed above Consequently, this report will focus on water eroded land, irrigated land and wind eroded land (dune encroachment) Water erosion of soil is the most important environmental problem in the mountains Soil salinity and the pollution of water resources with

nitrates and pesticides are the most serious environmental problem on the irrigated plains And dune encroachment is the most serious environmental problem in arid regions

C1 Water Eroded Land

Water erosion of soil is a function of climate, soil, slope and farming practices Because Morocco has a warm, dry climate, its soils are low in organic matter and fragile They easily lose their ability to absorb water quickly Because of the moisture constraint, farmers plant crops at wide distances and keep fields free of weeds The result is rapid surface runoff and serious soil erosion on slopes The problem of soil erosion by water is widespread in Morocco, but the most serious problem is in the Rif, with additional problems in the the southern Atlas Mountains

Table 3. Soil Cover and Water Erosion

Vegetation or Cover	Slope (%)	Runoff (%)	Soil Loss t/ha/yr*
Grass 100% cover	36	6 9	0 026
Grass 20% cover	20	29 0	12 0
Natural forest	7-15	2 4	0 24
Citrus + mulch	7	2 6	4 3
Citrus without mulch	7	9 2	18 9
Crops + mulch	7	13 9	13 0
Crops + bare soil or fallow	7	21 0	43 6
Bare soil	7	39 0	89 4
Natural fallow	7		5 3

Source ILACO 1985
*For extreme rainfall intensities soil losses may be considerably higher

For the Rif erosion of 9,000 T/km^2 has been reported with the comment that for soil erosion it represents considerable value as being one of the largest in the world (Conference des Nations Unies sur l'Environnement et le Developpement, 1992) However, this level of erosion on one km^2, or 100 hectares, would correspond to 90 tons per hectare on one hectare Ninety tons per hectare would correspond, according to Table 3, with the level of erosion that would be expected on bare ground with a 7 percent slope This is serious erosion but it is not "worst in the world" serious erosion ONEP,1994, notes that erosion is very pronounced in the tributary basin of Zloul where it reaches 20 tons/ha/yr Soil erosion at the Tafrant station on Oued Aoudour is "very high" at 38 5 tons/ha/yr

While descriptions of erosion are often exaggerated, erosion in the Rif is very serious At current rates, dam siltation will reach 100 million m3 by the year 2,000 and 159 m3 by the year 2030 It is estimated that Moroccan reservoirs lose 50 million m3 of capacity every year out of a total capacity of 9,500 million m3 This is a loss of 0 5 percent per year and represents enough water to irrigate 5,000 hectares To date, Morocco has lost about 500 million m3 of reservoir capacity to siltation

Three dams in Morocco have already been raised because of siltation The Oued Mellah dam was put into service in 1931 and was raised in 1942 The El Kansera dam was put into

service in 1935 and was raised in 1969 And the Lalla Takerkous dam was put into service in 1935 and was raised in 1980 Four reservoirs those from Taghbout d'Ajras, Oued Mellah and Zemrane have been ensilted beyond 50 percent of their capacity In the economics section of this report, the present value of annual lost reservoir capacity resulting from erosion is estimated to be about 90 million dollars Other estimates of losses from soil erosion and soil degradation are given in Table 4

Table 4 Annual Costs for Soil Erosion and Degradation

Description of Cost	Annual cost in millions of 1990 dirhams (% of total)
100 million tons of eroded soil clogs purification plants annually This is particularly true of the Sebou catchment basin with its serious erosion problems Water purification stations equipped with settlement basins process 101,119,000 m^3 annually at a cost of 0 2052 dirhams/m^3	21 (5)
Modeling siltation rates and assuming a price of 1 DH/m^3 for irrigation water and 0 70 DH/kW for energy	360 (86)
The cost of deforestation assuming a price for firewood of 0 80 dirhams /kg and that each hectare of forest would produce 1 ton of wood per year	25 (6)
The cost of overgrazing assuming a daily animal unit value of forage of 1 20 dirhams,	4 8 (1)
The loss of agricultural production assuming an average price of 180 dirhams/quintal for cereal (barley, corn, wheat)	9 (2)
TOTAL (% of GNP)	421 (0 21%)

Source ECODIT 1994a b

The siltation of reservoirs and the loss of agricultural land are the major and obvious results of soil erosion by water However, there are also some more subtle relationships between land, water, human welfare and biodiversity which are present on wild rivers or on streams above dams in Morocco and which have serious implications for the entire country

Table 1 also shows that when 89 4 tons of soil are lost per hectare, about 39 percent of the rainfall is lost to runoff This is runoff which destroys land habitat by removing soil and which destroys aquatic habitat by depositing this soil in streams The value of a good watershed is that it holds the water and releases it slowly This desirable characteristic is a function of good vegetative cover and of good soil structure Excessive runoff occurs when a watershed is not properly maintained The rate of water release from a watershed determines such crucial factors as base flow, flooding, dilution flow, maintenance flow, and aquifer recharge

One effect of a good watershed is that fluctuations in stream flow are not extreme Base flow refers to the characteristic minimum flow of a stream On a poorly maintained watershed the

121

base flow of a stream is reduced At the extreme perennial streams become seasonal streams which dry up during the summer and which cause flooding during the winter

The concentration of pollutants in a stream is a function of how much water is in a stream and how much pollutants are discharged into the stream For example the impact of pollution resulting from sugar mill operation is increased by the fact that they work in the summer when stream flow is low On the other hand pollution from olive oil plants is mitigated by the fact that they work during the winter months when stream flow is high

The flow required to maintain water quality in a stream is the "débit sanitaire" and is referred to as the dilution flow in this report During the summer it is often necessary for water to be released from reservoirs for the sole purpose of maintaining the dilution flow downstream This is an important cost resulting from urban and industrial pollution Whenever the base flow of a stream becomes less than the dilution flow of a stream the result is perennial serious water pollution problems Twenty-one percent of the rural population obtains its drinking water from surface water (CSEC, 1994a quoted in ECODIT 1994b)

The flow required to maintain the aquatic habitat is referred to as the maintenance flow in this report When the base flow falls below the maintenance flow, the aquatic habitat is damaged or destroyed

Moisture which is retained in a good watershed is not just released in a more uniform fashion into surface streams It is also released as recharge water into aquifers In aquifers where pollution is a problem, a reduction in recharge water means an increase in the concentration of pollutants in the aquifer In the arid regions of Morocco, dry years are identified with disease problems resulting from the use of water from polluted wells

Because of the seriousness of the soil erosion problem in Morocco, there have been major efforts to combat it These have been conducted under the direction of the department of Eaux et Forêts in the Ministry of Agriculture

In 1988 la Direction des Eaux et Forêts et de la Conservation des Sols gave the following report on soil conservation work to a watershed seminar in Rabat It was reported that 318,000 hectares had been protected against soil erosion using at least one of the following methods range management, forestry-range management, infiltration structures, fruit tree retaining walls, and terraces and reforestation The regional distribution of this work was as follows

Table 5 Regional Distribution of Soil Conservation Work

Region	Hectares	% of Total
Bordure méditerranéenne	58,100	18
Tensift-Abda-Doukkala	58,159	18
Basin de Sebou	44,560	14
Oum Rabia	45,510	14
Basin de Moulouya	37,660	12
Souss Massa	32,770	10
Bouregreg Chaouia	25,900	8
Atlantique Nord	15,489	6

Source Wakrim 1995

Table 5 represented 3 5 percent of the area which needed attention given to soil erosion problems Since 1980 one of the most important soil conservation programs has been fruit tree distribution The goal is to both increase rural incomes and decrease soil erosion The trees are distributed free of charge During the 1992/1993 season, 1,677,987 trees were distributed The tree distribution program is apparently popular with farmers However, it is not the tree which protects the soil but rather the basin or terrace which is built to help grow the tree which protects the soil Water harvesting and soil protection are complimentary activities so distributing trees should have the effect of protecting soils The types and numbers of trees distributed from 1982/83 to 1992/93 are given in Table 6

Table 6 Trees Distributed for Soil Erosion Control 1982/83 to 1992/93

Type of Fruit Tree	Number of Trees Distributed
Olive	5,341,378
Almond	3,303,369
Apple	438,384
Walnut	477,712
Fig	268,064
Prune	153,502

The area protected by 1994 was 450,000 hectares of which 19,000 hectares were dune stabilization This represented 3 8 percent of the area needing attention In the meanwhile the money committed to protecting soils from water erosion decreased The budget for the protection and restoration of soils and the reforestation program averaged 200 to 250 million dirhams from 1984 to 1988 In 1992, the budget was 27 million dirhams What accounts for the decrease in commitment by the government to protect soils? Several explanations for this are possible

- As the 3 8 percent effectiveness figure would indicate, in spite of major expenditures, very little progress was being made
- Donor agencies tend to be interested in soil protection so this work is being left to them

- Exaggeration of the extent of soils at risk In 1972, when 7,000,000 hectares were being cultivated in Morocco, a study showed that 5,000,000 hectares (71 percent) of this land were threatened by erosion At the time it was recommended that an attempt be made to substitute forage crops for cereal crops (Wakrim, 1995) Excessive claims are common in descriptions of the threat of soil erosion This is an extreme example of such a case If the assertion had been made that 2,000,000 hectares were threatened and 5,000,000 hectares were not threatened, it would have been closer to the truth The unfortunate consequence of such claims is that soil protection work is not focused in the areas where the soils really are threatened and money is wasted on soil protection where it is not needed

- More-of-the-same recommendations for protecting soil from water erosion The World Bank (1992) strongly recommends that Morocco spend 533 million dirhams annually (0 25 percent of GNP) on soil management, reforestation, research and extension to protect her soils

What is needed is to focus available resources on areas where soil erosion by water is serious and then use the methods proposed by the DRCTA That is, to use pilot projects to generate farmer enthusiasm for a project before expanding it to a regional project This is the philosophy behind the almond and prickly pear cactus projects recommended in the report submitted for this study

C2 Irrigated Land

In 1990, the developed water resources of Morocco amounted to 11 billion cubic meters per year Irrigation used 87 percent of these resources essentially on six catchment basins and 9 irrigated projects (453,300) and small and medium projects (120,300 hectares) 13 percent of the resources developed serve for drinking water and industry (ECODIT,1994a)

Table 7 Projected Water Resources Balance for the Year 2020 in Millions of m^3

Catchment Basin	Yield	Imports	Exports	Total available	Needs	Balance
Loukkos	1230			1230	1230	0
Moulouya	1680			1680	1680	0
Sebou	4890		770	4120	4120	0
Bou Regreg	970	890		1860	1820	0
Oum Er Rbia	4160		420	3740	3980	-240
Tensift	1260	300		1560	1620	-60
Souss-Massa	1290			1290	1430	-140
Sud	1530			1530	1530	0
Total	15,044				15,545	

Source WB, 1994 ECODIT, 1994b

Water will be taken from the Sebou and Oum-Er-Rbia catchment basins to supply the population centers along the Atlantic coast Hence, the importance of guaranteeing the quality of the water in these basins (ECODIT 1994b)

Irrigated agriculture is intensive agriculture and intensive agriculture is often a threat to water quality In Morocco this threat to water quality comes in three forms nitrates, pesticides and salinity Irrigated agriculture can be a threat to both surface water and groundwater In Morocco, it is most important as a threat to groundwater Industries and urban areas are more serious threats to surface water Concentrations of animals in a single production facility can also be a threat to surface water quality but this is not a serious problem in Morocco

Groundwater which is protected geologically is usually the best quality water However, pollution problems from insecticides and nitrates coming from fertilizers are a threat in several areas to important aquifers Also, excessive drawdown of groundwater near the coast results in sea water contamination of aquifers The aquifers of Haouz, Souss and Chtoukas are falling because of excessive drawdown

The High Water Council, or Conseil Supérieur de l'Eau (CSE) evaluated the state of pollution of the various water bodies of Morocco and has published a comprehensive summary (CSE, 1988) According to this study the Sebou and Oum-Er-Rbia are the two river basins with the highest pollutant levels For the Sebou the problem originates from urban and industrial discharges, for the Oum Er Rbia, pollution of shallow ground water from agriculture and industrial discharges to the river from sugar and other agroindustries are serious problems

Tables 7 and 8 compare agriculture, mainly irrigated agriculture, with industrial and domestic sources of pollution Table 9 gives national goals for cleaning up water pollution by 2020

Table 7 Effluent in 1990 in ,000 of Tons (ECODIT 1994a)

Effluent	Industrial	Domestic	Agricultural	Total
DBO_5	59	230	0	289
DCO	101	598	0	699
N Total	3	51	27	81
P Total	0 2	13	8	21
Cr	0 4	0	0	0 4

Sources Rejets industriels (MCI 1994a et Banque Mondiale 1994) Rejets domestiques (STAT 1993 et calculs d ECODIT) Rejets agricoles (MAMVA 1992 et calculs d ECODIT)

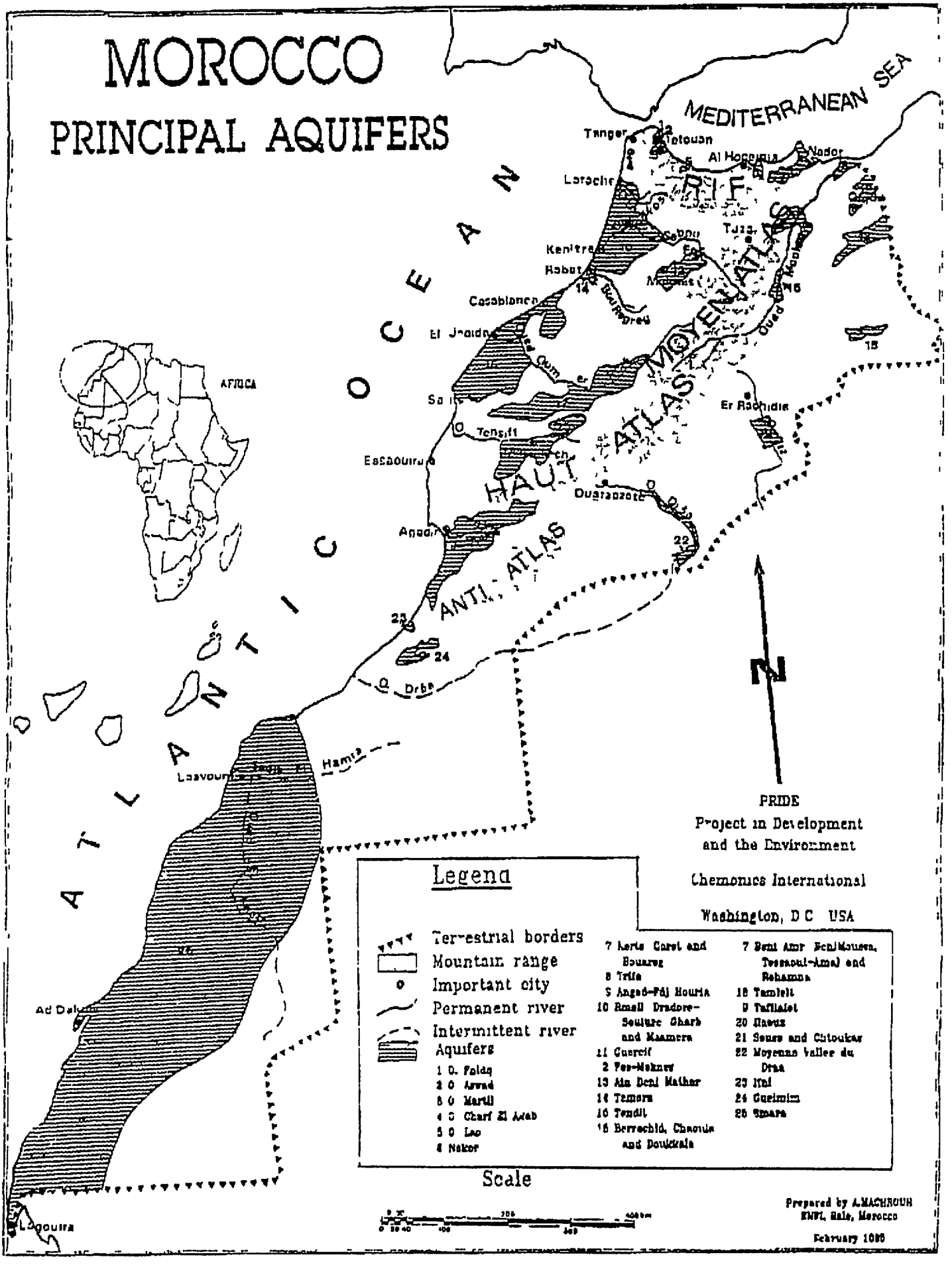

MOROCCO
PRINCIPAL AQUIFERS
MEDITERRANEAN SEA
ATLANTIC OCEAN
RIF
MOYEN ATLAS
HAUT ATLAS
ANTI-ATLAS
AFRICA
Tanger
Tetouan
Al Hoceima
Nador
Larache
Kenitra
Rabat
Casablanca
El Jadida
Safi
Essaouira
Agadir
Tiznit
Ouarzazate
Er Rachidia
Tata
Laayoune
Ad Dakhla
Lagouira
Oued Draa
Hamra
N
Legend
Ter-estrial borders
Mountain range
Important city
Permanent river
Intermittent river
Aquifers
1 O. Foiaq
2 O Arrad
3 O Martil
4 O Charf El Akab
5 O Lao
6 Nekor
7 Beni Amir Beni Mouzen, Tessaout-Amont and Rehamna
7 Kerts Carst and Bouareg
8 Trifa
9 Angad-Fdj Hourra
10 Rmell Dradore-Souiere Gharb and Maamora
11 Guercif
12 Fes-Meknes
13 Ain Beni Mathar
14 Temara
15 Tendit
16 Berrechid, Chaouia and Doukkala
18 Tamlelt
19 Tafilalet
20 Haouz
21 Souss and Chtouka
22 Moyenne Vallee du Draa
23 Ifni
24 Guelmim
25 Smara
Scale
PRIDE
Project in Development and the Environment
Chemonics International
Washington, D C USA
Prepared by A.MACHROUH
ENPI, Rabat, Morocco
February 1988

Table 8 Major Pollutants from Industrial, Domestic and Agricultural Sources in Tons/Year and (%)

Pollution	DBO	DCO	N Total	P Total	Chrome
Industrial	58,000 (20)	100,000 (14)	3,300 (4)	200 (1)	110 (100)
Domestic	230,000 (80)	598,000 (86)	51,000 (63)	13,000 (61)	
Agricultural			26,800 (33)	8,000 (38)	
Total	288,000	698,000	81,100	21,200	110

Table 9 Water Quality Improvement Objectives to Be Achieved by the Year 2020 (ECODIT, 1994a)

Pollutant	Reduction of Effluents (% projected for 2020)
Industrial DBO_5 and DCO	85
Domestic DBO_5 and DCO	80
Nitrogen and Phosphorus	40
Chrome	95

Source World Bank 1994

These tables present agriculture as the least important source of the least important pollutants, nitrogen and phosphorus, with the lowest stated objectives for water quality improvement What these tables fail to convey is that agricultural pollution is a localized phenomenon and as such can be very important for a given area As stated above, on the Tadla plain in the Oum-Er-Rbia agricultural pollution is a major source of pollution

Also, there is a limited but serious special case of water pollution involving agriculture Untreated wastewater was used to irrigate 7200 hectares of vegetables, trees and cereals near urban centers in 1990 (ECODIT, 1994b) This is a major cause of cholera becoming endemic in some areas of Morocco such as the Sebou catchment basin which reports 53 percent of the cases reported annually (MSP, 1994a) According to the ministry of health the cause of cholera is divided evenly between contaminated drinking water and contaminated vegetables from gardens irrigated with waste water in and around urban centers (ECODIT, 1994b)

Table 10 Incidence of Cholera from 1979-1988 (ECODIT, 1994b)

Year	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Incidence per 100,000	0 25	8 75	1 44	15 19	0 00	0 00	0 00	16 02	149 43	252 99

Table 11 Costs for Cholera (ECODIT, 1994b)

	1981-1985	1986-1990
Total number of cases	537	10,149
Deaths (Estimated)	19	355
Total cost	2 3 million dirhams	42 6 million dirhams
Average annual cost	460,000	8 52 million dirhams

Source MSP 1994a MSP 1994b - MSP 1994d

Agricultural pollution of water is primarily pollution by nitrates, pesticides and salt Table 12 gives water pollution standards for salinity and nitrate for Morocco Conductivity is a measure of water salinity

Table 12 Salinity and Nitrate Indicators for Groundwater Quality (ECODIT 1994b)

Quality	Conductivity Us/cm	NO_3 mg/l
Very Good	<400	<5
Good	400-1300	5-25
Average	1300-2700	25-50
Bad	2700-3000	50-100
Very Bad	>3000	>100

Source AH 1992

C2a Nitrates

Irrigated agriculture uses 14 times as much fertilizer on a unit area basis as is used for rainfed agriculture This amounts to 50 percent of the total fertilizer used in Morocco It is estimated that between 8 and 10 percent of the nitrogen applied as fertilizer leaches to an aquifer Most of this leaching would occur in connection with irrigated agriculture (ECODIT, 1994b)

Leached nitrates are more important in the catchment basins where agriculture is important, Sebou, Oum-Er-Rbia and Tensift (see Table 13) This corresponds to the Gharb, Tadla, Doukkala and Haouz irrigation projects

Table 13 Nitrates Leached by Catchment Basin

Catchment Basin	Quantity of Nitrates Leached (metric tons/year)
Moulouya	2,400
Loukkos	1,500
Sebou	6,700
Oum-Er-Rbia	6,100
Tensift	6,000
Sous-Massa	1,000
Sud	3,100
Total	26,800

In Morocco, water is declared to be poor when nitrates reach a concentration of 50mg/l This level of nitrate concentration is common on the Tadla Plain and time lapse studies have shown that in some cases it is increasing by 5 mg/l/yr (ONEP) The United States standard for nitrate concentration in drinking water is 10 mg/l The European standard is the same as the Moroccan standard Israel's standard is 100 mg/l Serious immediate health risk starts at concentrations of about 400 mg/l When writing about nitrate pollution of the perched aquifer under the Tadla plain in 1994, Rawson and Stillwater got it right, "While no immediate remediation appears to be required, specific steps are suggested for monitoring and education of the populace to minimize the risk "

Fertilizer also poses some threat to surface water Nitrogen, phosphorous and potassium often encourage excessive growth by aquatic plants This is called eutrophication of surface water (ONEP, 1994)

The cost of ridding water of the foul taste caused by eutrification is estimated at 7 3 million dirhams per year This includes the cost of silver carp and airation but not the cost of charcoal filtering (ONEP, 1994 from ECODIT, 1994b)

C2b Pesticides

"Health officials say nitrate at levels higher than 10 parts per million in drinking water can cause serious health problems for infants Unlike pesticides, however, nitrates from fertilizer are not acutely toxic and are not considered a health threat to most adults " (Jackson, 1994) Pesticides are much more dangerous to human health than are nitrates But very little work has been done in Morocco on water pollution by pesticides, or on the direct risk of poisoning by pesticides

On irrigated perimeters, it is common to see chemicals being mixed immediately adjacent to and above canals, chemicals being mixed immediately adjacent to unprotected wells which are lower than the surrounding terrain and chemical containers being washed in canals and next to wells Many of these chemicals should, at a minimum, be tracked and some should only be applied by qualified personnel The need for training pest control applicators, regulations governing the use of pesticides and sensitizing the general population to the dangers of toxic chemicals is not being met Furthermore, Moroccan fruit and vegetable exporters are going to be

required to meet more rigorous pesticide residue standards for their produce This is another compelling reason for addressing the problem of unregulated pesticide use

In 1990, pesticide use was estimated to be 9,395 tons including

- 4842 tons of fungicide or 51 percent of the total
- 3661 tons of insecticides or 39 percent of the total
- 919 tons of herbicides or 10 percent of the total

This is the equivalent of 1 27 kg per hectare of tillable ground But the use of these chemicals is very unevenly distributed Most of them are used on irrigated land The Sebou catchment basin uses about 3,600 tons of pesticides annually or about one-third of national annual consumption WHO says that 0- 5 percent to 1 percent of pesticides used on irrigated land will reach surface water This is between 18 and 36 tons per year (ONEP,1994)

Factors which influence pollution of water by pesticides are their solubility, their resistance to physical and biochemical breakdown, the nature of the soil and the volume and intensity of rain (ONEP, 1994)

Pesticides are imported by 28 companies which serve as agents for major chemical companies and are also sold by 426 distributors and resellers

Table 14 Evolution in the Use of Pesticides in Morocco (Dreckmann and Ammati, 1994)

Year	Insecticides		Fungicides		Herbicides		Others		TOTAL	
	MAMVA	DPVC	MAMVA	DPVC	MAMVA	DPVC	MAMVA	DPVC	MAMVA	DPVC
1980	2007	ND	4534	ND	544	ND	ND	ND	7085	
1985	2858	ND	3825	ND	524	ND	ND	ND	7207	ND
1986	ND	1812	ND	1875	ND	875	ND	125	ND	4687
1987	ND	1844	ND	2062	ND	312	ND	562	ND	4780
1988	ND	6062	ND	2375	ND	562	ND	250	ND	9249
1989	ND	1938	ND	2500	ND	375	ND	219	ND	5032
1990	3663	2500	4812	3000	919	94	ND	937	9394	6531

Other chemicals refer to growth regulators, rodenticides and nematicides

Dreckmann and Ammati, (1994) list the following problems and results for pesticide use in Morocco

Problems

- A wide range of products and application levels
- Used reactively and not rationally no care with packaging
- Techniques of application are usually rudimentary and do not consider calibration, equipment maintenance, uniform distribution or recommended intervals (labels)
- No protective clothing, gloves, coveralls, masks, goggles, hand washing

Results

- High crop protection costs
- Development of resistance by pests
- Appearance of new pest species
- Pollution of the environment

The fact is that serious pesticide pollution of water probably exists in connection with irrigated agriculture in Morocco

C2c Salinity

Salinity in Moroccan soils has several sources These include the soil itself, ground water or surface water Pollution of groundwater by saltwater from the ocean occurs when drawdown is excessive or when artificial recharge of deep aquifers is excessive Usually several of these factors are combined and then aggravated by limited water resources and farmers who do not understand proper irrigation techniques Sodium and magnesium are the major elements salt elements in Morocco

Out of 1,600,000 acres studied for irrigation, 350,000 hectares were found to be vulnerable to salinity problems in the short- or the medium-term

No national study has been made of the salinity problem in Morocco but regional studies point to three areas which are generally agreed to have the most serious problems with salinity These are the Gharb plain, the Beni Amir plain in Tadla, and the southeastern zone

Saline water is a serious at Beni Amir and Beni Moussa on the Tadla plain The Tadla irrigation project has wells reporting levels of salinity greater than 3000 ms/cm, thereby exceeding the national potability standard of acceptability of 2700 ms/cm for electrical conductivity

Where the conditions are right for generating salinity problems it is usually a chronic problem rather than an acute problem An exception would be areas where salt water intrusion into an aquifer is occurring This is often an acute problem

Remedies for soil salinity are known but they require an ample supply of good quality water and a system of drainage It is possible to raise crops under quite saline conditions This is especially true if the soils are light However, energy is required for the crop to exclude the salt in the process of water uptake and this means reduced crop yields

C3 Wind Eroded Land

Wind erosion can be serious along the Atlantic coast of Morocco where prevailing winds carry sediments inland Wind erosion is also serious in the Moroccan deserts In the Eastern provinces and especially in the Moroccan Sahara dune encroachment threatens fields, roads and villages

Wind erosion is usually extensive and marginal in its impact It is also very difficult to control Consequently, wind erosion would not usually be expected to qualify as an important problem However, in Morocco wind erosion includes the problem of dune encroachment In the context of this report, dune encroachment cannot compete with water eroded land or with irrigated land as a serious problem for Morocco However, dune encroachment can be a very serious localized problem and, when funds are available, Moroccans know how to control dune encroachment Consequently, it is included in this report

C4 Scenic Lands

The most important scenic lands in Morocco are the coast and the mountains Both are threatened The coast is threatened by urbanization, as will be seen in the next section And the scenic lands of the mountains are threatened by deforestation This problem is addressed in the biodiversity annex

C5 Urban Encroachment Land

Urban populations surpassed 3 4 millions inhabitants in 1960, 8 7 million in 1982, 11 7 million in 1990 and are expected to reach 18 7 million in the year 2005 Consequently, prime agricultural land is threatened In this context the Gharb zone deserves to be mentioned According to a study done by the ORMVA in 1988, out of 5,977 urban hectares, 49 percent or 2,982 had been prime irrigated land before being subdivided This land was chosen because it was flat and had easy access to water It was also some of the most productive land in the area The FAO, as a part of the project MOR/87/001, estimated future urban land needs as follows

Table 15 Land Requirements for Urban Development (ECODIT, 1994b)

Description	Area (hectares)
Current deficit	60,000
Land designated for urban development	252,000
Urban development (Current requirements)	37,000
Urban development (Annual requirements)	76,000

*Urban population 1900 - 420,000, 1982 - 8,670,000, 2012 - 20,600,000
*Now 13,000,000 urban and 13,000,000 rural

Because of the rural exodus, the urban population has increased an average of 3 7 percent per year in the course of the ten last years while the total population has increased by 2 6 percent per year In spite of the efforts of the State to improve living conditions in the countryside, the rate of growth of the urban population should remain high for the next ten years and the urban population could reach 16 million in the year 2000 (ECODIT, 1994a)

In Morocco, "coastal" and "urban" are often synonymous Urbanization corresponds with an increase in population along coastal areas In 1982, the urban population living along the coast was 5 3 millions people 18 years later in 2000 it should be more than 10 million people (CERED) The provinces having access to a coastline will represent in the year 2000 more than 50 percent of the population In 1982, they represented 45 percent of the population (ECODIT 1994a)

D Risk Assessment Summary

D1 Health

Table 16 HEALTH Risk Assessment Matrix for Agriculture and Land Use Issues

Problem	Population affected	Severity	Reversibility	Composite
Water eroded land	1	1	1	1 0
Irrigated land	3	3	3	3 0
Wind eroded land	1	1	1	1 0
Dune encroachment	1	1	1	1 0
Urban encroachment	1	1	1	1 0
Scenic land	1	1	1	1 0

D2 Economic

Table 17 Economic Risk Assessment Matrix for Agriculture and Land Use Issues

Problem	Total Cost	Timing	Composite
Water eroded land	5	3	4 0
Irrigated land	3	3	3 0
Wind eroded land	1	1	1 0
Dune encroachment	5	5	5 0
Urban encroachment	1	1	1 0
Scenic land	1	1	1 0

D3 Biodiversity

Table 18 PRELIMINARY PROBLEM ASSESSMENT MATRIX
Agriculture and Land Use Issues

		Human Health		Economic		Biodiversity				
Sector	Pollutant/ Activity	Severity	Revers ability	Total Cost	Timing	Severity of Impact	Timing	Human/Eco system Interface	Habitat Richness & Uniqueness	No of People Impacted
Agriculture										
A Water Eroded and Degraded Land		10	10	50	30	50	30	50	50	30
B Irrigated Land		30	30	30	30	40	40	40	10	30
C Wind Eroded and Degraded Land		10	10	10	10	40	40	40	40	30
	Oasis dune encroachment	10	10	50	50	40	40	20	20	30
D Scenic Land		10	10	10	10	20	22	35	30	30
E Urban Proximity Land		10	10	10	10	20	10	20	10	30

ANNEX H

INSTITUTIONAL CONTEXT

ANNEX H
INSTITUTIONAL CONTEXT

A Legal and Regulatory Framework

The legal framework for environmental protection in Morocco is outdated and highly fragmented Most laws having any bearing on the environment were written with other purposes in mind, many of them decades before current environmental problems arose As a result, existing laws and regulations are inadequate to control pollution or to ensure land use compatible with environmental protection Regulation of such late-20th century problems as hazardous substances, industrial waste, noise pollution, or automobile exhaust is entirely lacking or too general to be enforceable Legally enforceable standards which could provide a basis for requiring industries or motorists to reduce their pollution do not exist Nor is there any government institution authorized to monitor emissions to ensure compliance with standards, even if they did exist In one law, penalties for non-compliance are set in 1914 French francs, hardly posing a serious penalty to industry in 1995 Land and forest use regulations, particularly important for ensuring sustainable use of natural resources, are based on a mix of custom, Koranic law, and modern law, making for considerable confusion and at times irreconcilable conflict

Attempts to simply survey and describe the existing legislation have identified hundreds of texts related to some aspect of the environment, from sewerage to soils, and from maritime fisheries to nuclear wastes However, while examples abound of the general problem, a clear identification of the laws currently in effect and their limitation is harder to come by A few laws currently in effect appear to be of the most significance to current environmental problems

The Dahir of 25 August 1914 on classified establishments (*etablissements classes*) regulates the activities and location of businesses which could be unhealthy, nuisances, or dangerous Enterprises are divided into three classes, according to their activities and the threat which they pose in terms of security, health, or public convenience Class 1 is the least stringent, and class 3 the most Businesses in class 3 may not open without a survey about its impacts on surrounding areas carried out by the Ministry of Public Works Class 2 businesses require such a survey by the pacha, local representatives of the national government Class 1 businesses require prior authorization to open, but no survey is required In addition, the law gives local governments the authority to limit establishment of class 3 enterprises to specific "indigenous zones," and to limit class 2 and 1 enterprises in the urban area to industrial zones specifically created for this effort

Thus this law gives both the Ministry of Public Works and the local collectivities the right to regulate business activity based on nuisances it creates However, in the absence of standards which clearly define what constitutes an unacceptable nuisance (or level of pollution), public officials have not used this law seriously to regulate industrial activity In an environment where unemployment and economic growth are primary concerns, this law has not been used to require industry to limit its pollution Moreover, firms which were originally required to locate in peri-urban areas on the strength of these laws now find themselves in the urban center, as cities have spread and engulfed them (This is particularly the case of certain textile and cement plants in

Casablanca) Thus, while the law might once have been adequate to force industry away from residential areas, it is not strong enough to keep residential areas from springing up around that industry in later years

A second law concerning industrial pollution is considerably more recent It deals with subsidies to industries investing in energy conservation, water conservation, or environmental protection Investments in equipment used for these purposes may be exonerated from import duties, TVA, and other taxes, amounting to a subsidy of from 20 to 30 percent of the value of the investment This law has had only a limited impact on industrial pollution, since firms are still not required to make any investments at all to reduce their emissions

The inadequate legal framework is widely perceived as the single most urgent bottleneck to resolving Morocco's environmental problems [1] A number of different efforts are underway to address this problem First, a general framework law on the environment, entitled the *Projet de loi sur la protection et la mise en valeur de l'environnement* (proposed law on protection and use of the environment) has been developed and is currently going through the slow process of review and eventual adoption This law calls for the development of norms and standards for environmental quality, based on the quality and absorptive capacity of the ambient environment, the requirements of national development, the profit margins of the affected economic sector, and health considerations It authorizes government agencies to require environmental impact statements for projects likely to have any negative environmental impact that describes the project, the initial state of the site, the possible consequences of the project, and the measures intended to prevent, reduce, or mitigate those consequences In addition, the law addresses specific issues related to human settlements and land use planning, natural resources and protected areas, and biological, chemical, or toxic pollution of air, water, and land Penalties for non-compliance with the decrees applying this law include fines as high as 500,000 Dh and imprisonment for up to two years The law also authorizes the development of financial incentives to industry to invest in pollution control, and creates a special fund for protection and use of the environment, which will receive 50 percent of the fines collected This law is now awaiting review and approval by the Secretary General of the Government (SGG), in the course of the normal review process for laws

The work of preparing a complete and up-to-date environmental code has been begun by the Conseil National de l'Environnement This involves classifying the existing legislation, identifying gaps, and filling in those gaps with amendments, new laws, or application decrees This work was initiated within the ministerial departments whose routine activities touch on the environment It was then picked up at a broader level by a commission, divided into four sectoral working groups

- The working group on natural resource management addressed issues related to forest, range land, the ocean and fishing resources, soil and the coast They found that a revision of a set of laws related to forest management, planation forestry, the forestry profession, erosion control, natural ecosystem protection, and environmental impact studies for projects having an impact in these areas had already been prepared, and is now waiting review by the SGG Other laws already prepared or in preparation address

[1]Based on discussions with national and local public officials, donors, and industry representatives

hunting, pastoral zones, use and protection of fisheries, and protection of the marine and coastal environments

- The working group on infrastructure, public works, and water resources looked at questions of water, maritime fisheries, communications lines, telecommunications, meteorology, classified industries, and quarries Among the most important laws which they have reviewed include a national water law, transmitted to the SGG in September 1992, which deals with water resources planning and protection, and proposed laws on classified industries (updating the Dahir of August 1914), public roads, and air traffic security This group has called attention to environmental issues not addressed by existing (or updatable) laws, particularly air pollution, noise, toxics, discharge standards, environmental impact studies, and emergency plans Most of these will be covered by the Loi Cadre and pursuant application decrees

- The working group on energy, mines and industry has identified the limitations of the Dahir of August 1914 and legislation on energy sector emissions, though it has not undertaken to update them On mines, it identified a decree already under development which addresses pollution, clean technology, waste management, pollution monitoring, noise control, impact studies, and so on This proposed decree is currently being assessed by mining operators, following normal procedures for review approval of decrees Like the previous group, this one also called for legal measures to specifically address industrial emissions, to be prepared jointly by the ministries of energy and mines, commerce and industry, public works, and transport

- The working group on human settlements identified a number of gaps or contradictions in the laws pertaining to human habitat, public health, and urban development They suggested recommendations to strengthen local institutions to address public health, and clarification of the roles of the local and national agencies responsibility for health

In addition, the Sous-Secrétariat d'Etat pour l'Environnement (SSE, under-secretary of state for environment) is working on several other environmental laws, including

- A law on protection of continental water, particularly the Sebou River Basin
- A law detailing the requirements for environmental impact studies,
- A law creating of an Agence Nationale de l'Assainissement (ANA) This body would oversee the planning and management of sewer systems and solid waste, coordinate investment programs in these areas, and help local government seek financing and technical assistance
- A decree concerning the management of the Souss-Massa national park This is the first national park created by the country since its independence, so its management is a matter of some interest
- A law on air pollution controls This was recommended by the CNE in June 1994, and is being developed with German support In general, it will prohibit any emissions above standards to be developed, and anticipates sanctions against those who exceed those limits The overall methodology involves working with polluting industry branches (work has begun with cement producers) to identify feasible pollution control technologies, set acceptable standards, and negotiate branch contracts concerning the standards to be met and who will bear the costs

Further work on the strengthening of the legal framework and development of industrial emissions standards is anticipated through the World Bank's Projet de Gestion de l'Environnement, (PGE, Environmental Management Project), discussed below

B Public Sector Organizational Structure

Environmental protection in Morocco is the responsibility of a number of different government ministries, committees, offices, and agencies In 1992, the Under-Secretariat for the Environment (Sous-Secretariat pour l'Environnement, SSE) was created within the Ministry of Interior, and given overall responsibility for coordinating environmental protection efforts As a new agency, staffed largely with young, highly trained, but relatively inexperienced people, it has not yet completely found its niche, and many questions still remain about the exact allocation of responsibility for the Moroccan environment A brief review of the major institutions involved will shed some light on the issues

B1 The Sous-Secrétariat d'Etat pour l'Environnement (SSE)

The SSE was created in August 1992 within the Ministry of Interior It is responsible for encouraging and coordinating the implementation of the national environmental strategy and policies The exact divisions of responsibility between the SSE and the sectoral ministries which manage the environment on a routine basis are still being worked out Thus matters such as who develops proposed legislation on industrial pollution, which ministry will have the authority and technical capacity to monitor compliance, or who will be empowered to impose sanctions for non-compliance, are still very much up in the air Moreover, the SSE has not yet been fully staffed, in particular few service heads and directors have been named Consequently, there is still more work to do before the SSE will be fully operational, with its mandate clearly defined and accepted by all agencies involved in environmental management

At present the work of the SSE is concentrated in five basic task areas, of which monitoring and legislative development have received by far the most attention so far

- **Monitoring environmental quality and pollution** A significant portion of the current activities of the SSE come within this area of activity They are managed through several different donor projects, financed by the World Bank, UNDP, and the Germans

L'Observatoire National de l'Environnement du Maroc Much of the SSE work in the past two years has been through the Observatoire National de l'Environnement du Maroc (ONEM, Morocco National Environmental Observatory), created with support from UNDP and the World Bank ONEM is organized into four units The studies evaluation and audits unit coordinates the preparation of local and regional monographs on environmental problems and protection, and will coordinate preparation of a national environmental action plan beginning in 1995 This has received considerable support from the UNDP environmental management project which has been underway for the past two years

The environmental data and information system unit (referred to as SIDE, the systeme d'information et de données sur l'environnement) expects to build a network among data producers and users to promote use and sharing of data needed for environmental management, as well as being a center for analytical work Support for SIDE will be one of four major

components of the World Bank's PGE The terms of reference for consultant assistance to work in this area are currently being developed SIDE is also involved in developing a database on coastal resources, with support from the European Union, Spain, and the Mediterranean Environment Technical Assistance Program (METAP)

The biodiversity and desertification unit is carrying out a national study on biodiversity, following the recommendations of Agenda 21 and the international convention on biodiversity This study will eventually lead to the develop data resources in the area, and to develop a protection strategy within the context of the environmental action plan It is receiving support from the United Nations Environment Program

The environmental impact studies unit is developing EIS regulations and procedures to be followed by private promoters of projects potentially affecting the environment The unit will eventually be responsible for reviewing those EIS's and advising on the acceptability of the projects in question It is currently engaged in carrying out the EIS's required for the World Bank's upcoming sewerage project, in order to fully learn what is involved in conducting and reviewing such studies It is receiving technical assistance from a Canadian consulting firm in this work, with support from the German project

The laboratory The Laboratoire National d'Etudes et de Surveillance de la Pollution et des Nuisances (National laboratory for studies and monitoring of pollution and nuisances) was created in 1991 with support from Germany and the UNDP It is involved in environmental monitoring of key areas and analytical studies of specific environmental problems On the monitoring side, its work is focused on the Sebou basin, beach pollution, the Mediterranean coast, and the Martil coastal zone Its analytical work has focused on a number of areas Of particular interest is its work with the cement industry in evaluating its pollution, identifying technical mechanisms to reduce discharges, negotiating emissions standards, and developing the legal and regulatory framework to deal with air pollution This work is serving as a model for similar regulatory efforts to be undertaken in other sectors

- **Legislation and regulation** The SSE is responsible for coordinating the updating of Morocco's environmental framework, as described above It serves as the secretariat of the Comité National de l'Environnement, and participates in the commissions and working groups addressing specific legislative issues In this activity it will receive significant support from the PGE The first major component of that project is focused on building the institutional and juridical framework for environmental management in Morocco This includes a complete review of existing and future legislation, building on the work already underway through the commissions and working groups The project will provide a team of international consultants to work with the Moroccan institutions for a period of two years in this area Particular focus will be on the management of toxic wastes, recognizing that the German work is already focused on air pollution

The second major component of the PGE will be technical support to develop emissions standards in five industrial sectors, tanneries, olive oil production, sugar processing, textiles, and chemicals (including phosphates) This work, to be provided by a different consultant team from the first component, will involve technical analyses of the pollution reduction options and economic analyses of the ability of the industries involved to support the costs in light of their cost structure and international competitiveness industries Based on the analysis, the work will

involve negotiating contracts with the industry groups which spell out emissions standards and subsidies (referred to more often as financial incentives) be offered to help defray the private sector costs

Complementing the second component of the project, the PGE also envisions four pilot projects to implement the agreed-on standards and financial incentives These are to focus on tanneries olive oil in Fes, the sugar refinery and alcohol distillery of Sidi Allal Tazi, and solid waste management in Safi Funds for these pilots will not be provided through the PGE They are available for olive oil and solid waste from the European Union and the Japanese, respectively, but are still being sought for tanneries and sugar processing

- **Public awareness, training, and information** SSE work in this area is focused on disseminating information about the environment in general, the importance of protecting it, and which activities place it at risk Particular target groups are the media, educators, NGOs, socio-political institutions, public decision-makers, and the public in general In this area the SSE is also concerned with continuing education for public officials through seminars, round tables, and meetings This effort should receive some support from the fourth component of the PGE, which is focused on environmental education and training

- **Supporting local environmental actions** The SSE has a program of specific technical assistance which it is providing to local governments to help them address environmental problems Over two million dirhams were allocated to these activities in 1994, with aid going to such issues as repair of a waste water treatment plant in the province of Boulemane, construction projects to reinforce a landfill in the province of Sefrou, rehabilitation of ocean dunes in the province of Settat, and construction and management of public taps in Sale

- **Coordination** The SSE coordinates the activities of many interministerial bodies involved with the environment, the most important of which is the Conseil National de l'Environnement

- **International collaboration** The SSE is the focal point for donor assistance in the environment area and for Morocco's participation in international meetings and implementation of international treaties

B2 The Conseil National de l'Environnement (CNE)

The CNE was created in 1980, but until the creation of the SSE it has not played an active role in environmental protection With the decision to create the SSE came the decision to revitalize the CNE It has had several regular meetings since then, and is focusing its work on legislative and regulatory issues, as discussed above It has four regular committees, on judicial issues, international actions and conventions, the Sebou basin, and the national environment strategy In addition, it has created some special committees dealing with sustainable development, desertification, and natural catastrophes Although these committees are only in the early stages of their work, they constitute the institutional context within which the country is addressing interministerial environmental issues The SSE provides the secretariat for the CNE, and coordinates activities of the committees and working groups

B3 Key Ministries

The everyday work of managing the environment, and the more strategic work of participating in the CNE and its committees, commissions, and working groups, is handled by a number of key ministries

- The Ministère de l'Agriculture et de la Mise en Valeur Agricole (MAMVA, Ministry of Agriculture and Use of Agricultural Resources) is responsible for all activities which its name implies, including crop protection and soil conservation Management of forest and range resources and national parks is the responsibility of its Direction des Eaux et Forêts

- The Ministère des Travaux Publics et de la Formation Profession et de la Formation des Cadres (MTP, or Ministry of Public Works) is responsible for all water projects, dams, and water quality measurement, as well as port construction and management The Office National de l'Eau Potable (ONEP, national drinking water authority) is under the direction of the MTP

- The Ministere du Commerce et de l'Industrie (MCI, Ministry of Commerce and Industry) is responsible for industrial promotion Consequently, it plays a major role in the negotiations concerning industrial emissions standards and subsidies to help meet them It is also the source of data on industrial discharges

- The Ministère de l'Energie et des Mines (MEM, Ministry of Energy and Mines) is responsible for energy production and promotion of the mining sector It is therefore involved in negotiating emissions standards for those two sectors, and is a source of data on their discharges

- The Ministere de l'Interieur (Ministry of Interior) oversees activities of the local collectivities (communes and urban communities) It is directly responsible for land use planning at the national, regional, and local levels, and thus for integration of environmental concerns into the planning process Local collectivities are responsible for trash collection, landfills, sewer systems, sewage treatment, and the urban environment in general The ministry has a major role to play in helping them carry out their responsibilities, technical support, financial analyses, and investment capital The ministry (along with the Ministry of Finance) approves local budgets and expenditures, and thus has control over local initiatives on the environment

- The Ministère de la Pêche Maritime (MPM, or Ministry of Marine Fisheries) is responsible for promoting exploitation of Morocco's fisheries resources Through its Institut Superieur de la Pêche Maritime it conducts research on marine ecosystems, quality and quantity of the fish stocks, and possible impacts of pollution on available resources

- The Ministry of Tourism is carrying out a tourism management strategy, which will involve consideration of importance of environment to tourism and assessment of opportunities for resource-based tourism other than beaches, as well as an assessment of

the impact of beach and urban pollution on the desirability of Morocco as a tourist destination

- The Ministère de l'Education Nationale (Education Ministry) is interested in the environment through university teaching and research in related areas

- The Ministère de l'Habitat (Housing Ministry) is responsible for urban housing and thus for improving the quality of the urban environment

B4 Local Government

Local government plays a fairly minor role in the protection of the environment in Morocco Although the local collectivities have been given increasing responsibility over the past few years, and the country maintains a policy of decentralization, both the legal authority and the financial capacity of local authorities to address environmental problems within their jurisdictions is limited On the legal side, they are hampered by the absence of national emissions standards and by the lack of a specific legal framework authorizing them to control the activities of industries within their borders On the financial side, they lack the resources to address their own pollution, through construction of sewage treatment plants and sanitary landfills However, several mechanisms allow them some opportunities for protecting their environment

- As mentioned above, the Dahir of August 1914 on classified industries allows local collectivities to regulate the location of such enterprises, to separate them from other activities

- In extreme cases, local authorities could use the police power to halt noxious pollution, however, this is not likely to be effective as a routine way to manage industrial pollution

- Some municipalities have included treatment of emissions as a requirement for firms wishing to locate within an industrial zone, or have limited such zones to class 1 and 2 activities

- The water, sewer and electric companies of some cities (notably Agadir and Casablanca) have required industries wishing to hook up to the networks to pretreat their wastes Since water, sewer, and electricity are all provided by the same company, they can, at least in theory, refuse water and electricity to firms which do not comply with the sewer regulations These companies have adopted European standards for industrial discharges, but assume that they could be replaced with Moroccan ones once they are available

- Local collectivities have the authority to charge fees (*redevances*) for services they provide to their citizens If the right to dump wastes into the community's water resources is construed as a service, then at least in theory the collectivities could institute industrial effluent charges as a kind of fee for service This has not been tried, and it is not clear that it would be approved by the Ministries of Interior and Finance if a community tried to implement such an approach

C Nongovernmental Organizations (NGOs)

NGOs presently play a very limited role in environmental protection in Morocco, but there is substantial interest in increasing their importance in the future There are several dozen environmental NGOs working in the country[2], focusing on issues such as biological diversity, urban pollution, public information about the environment, research on environment and development, recycling, and tree-planting Most of these groups are very small, with limited budgets and membership Environmental NGOs do not play a policy role in Morocco, because the political process does not currently allow for the kind of open debate and effective advocacy that has characterized NGOs in the developed countries However, there is considerable interest in strengthening the NGO role in implementing environmental protection measures, especially for community organizing, public information, and building awareness and support for environmental protection in general

[2]See AFJEM 1994 for an annotated list of some of them

152

ANNEX I
INDUSTRIAL AND AUTOMOTIVE EMISSIONS

A Introduction to Annex

This Annex reviews the information available to the mission team on industrial and automobile emissions and their impact on natural resources in Morocco The section analyzes emissions from traditional (i e conventional) industrial sources, as well as from artisanal (small) sources and transportation (mobile) sources The section presents a summary of the major issues related to these emissions, and assesses their impacts on human health, economic growth and biological diversity

B Industrial and Automotive Emissions

B1 Introduction to Section

This section reviews the information available to the mission team on industrial emissions of pollutants into natural resources in Morocco The section analyzes emissions from traditional industrial sources, as well as from artisanal (small) sources and transportation (mobile) sources

Overall in Morocco, the more than 6,000 industrial facilities are concentrated in Casablanca, Rabat, Fès and Tangiers Casablanca, however, contains almost 50 percent of all industries in the country (Table 1)

Table 1 Location and Number of Industrial Units in Morocco

Wilaya or Province	Number of Industrial Units	Percentage of Total
Casablanca	2,990	49
Rabat	443	7
Fes	381	6
Tangiers	341	6
Agadir	219	4
Marrakech	211	3
Meknes	186	3
Kenitra	159	3
Other Areas	13,137	19
Total	6,067	100

B2 Air Emissions

B2a Mobile Sources

The exhaust from cars, busses and trucks represent a locally important source of air emissions Approximately 1 185 million vehicles are currently in circulation, consuming 384,381 metric tons of gasoline and 1 92 million tons of diesel (gasoil) The primary compounds emitted by vehicles include sulfur dioxide, nitrogen oxides, suspended particles, volatile organic compounds, and lead In addition, the emissions of nitrogen oxides and volatile organic compounds combine, in the presence of sunshine, to produce ozone, also known as "smog "

Mobile source emissions do not pose a significant environmental threat, except in localized areas In specific urban core areas, especially Casablanca, Rabat, Marrakech and Tangiers, pollution from vehicles is likely to be very high because of poor traffic management and extensive vehicle congestion during rush hour periods On a national level, these emissions are not considered significant, although the local human health impacts on residents living in these areas may be important

B2b Industrial Fixed Sources

Approximately 1 million petrol equivalent tons (pet) of fuel oil are consumed by industrial sources annually, producing approximately 2 million tons of carbon dioxide (CO2), 180,000 tons of sulfur dioxide, 10,000 tons of dust and suspended particles, and 7,000 tons of nitrogen oxides The emissions of atmospheric pollutants in major industrial provinces are summarized in Table 2

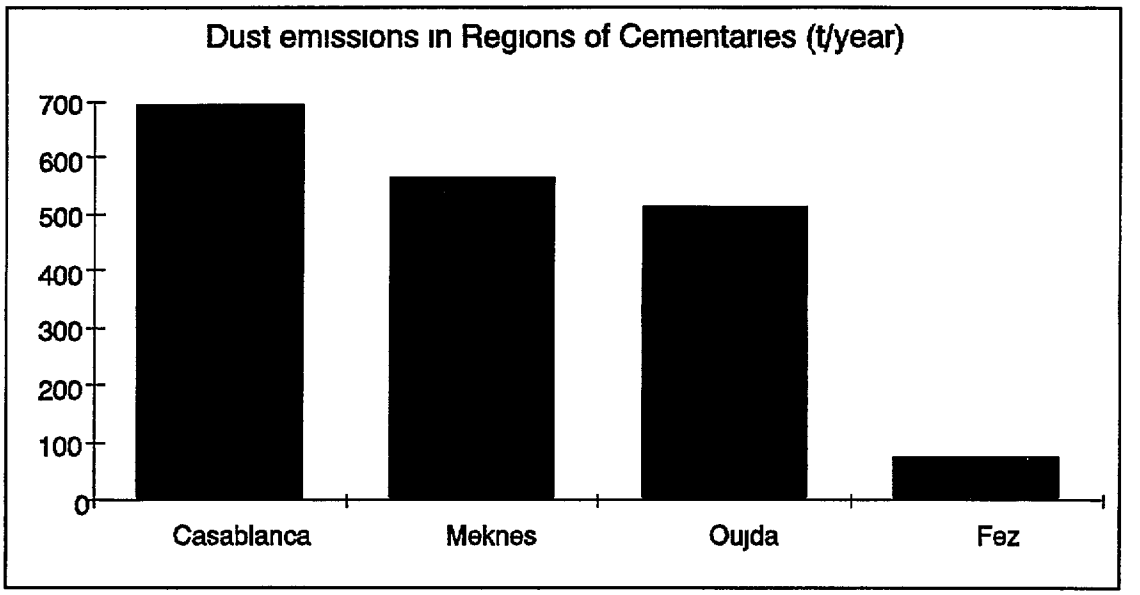
Table 2 Annual Emissions from Industrial Sources by Province (in tons)

Province	CO2	SO2	Particulates	NOx	Hydro-carbons	CO	Fluorine Gas
Agadir	42,600	1,800	3,070	658	42	80	0
Casablanca	451,000	6,600	2,420	1,700	100	160	912
El Jadida	31,000	84,000	30	70	4	5	95,000
Fes	19,000	80	55	290	9	37	0
Kenitra	111,400	2,300	100	260	17	18	0
Marrakech	16,300	810	1,200	330	22	41	0
Meknes	40,000	1,500	830	600	40	70	0
Mohammedia	43,000	3,600	50	100	13	8	0
Safi	156,000	81,000	600	600	34	60	110,000
Tangier	53,100	220	50	130	6	10	0
Total	944,400	181,910	8,405	4,738	287	489	205,912

Cement manufacturing The cement manufacturing industry represents one of the most important fixed sources of emissions into the air The primary types of pollutants are dust (caused by the mixture of large quantities of soil-based products), sulfur dioxide and nitrogen oxide emissions (caused by the burning of fossil fuels to create heat as part of the production process), and the release of heavy metals adhered to the surface of dust particles

Relatively few data are available on air quality in regions affected by emissions from cement production The data from the German Development Agency (GTZ) report indicates that total dust emissions in four regions with cementaries are estimated as follows

Figure 1 Total Dust Emissions from all Sources in Four Regions with Cement Manufacturing Facilities



The air quality at three of the factory sites studied is significantly impacted by these emissions and has been monitored by the GTZ project These data show that the emissions of the three production facilities have a major impact on air quality in terms of dust particles in the air (total suspended particles (TSP) and the deposition of dust (see Figures 2 and 3)

The cement industry has taken a lead in beginning to develop industrial standards and norms for emissions of dust Working with the German Assistance Agency GTZ and USAID's GEM program, the industry has developed emission standards which have been accepted by all firms manufacturing cement in the country

These standards will significantly reduce the emissions of dust and thereby improve ambient air quality As can be seen in Figure 2, the overall concentration of dust in the air will decline by as much as 75 percent Similarly, the amount of dust deposited in the region will decline by as much as 80 percent once the standards are fully implemented This will be a major environmental improvement and benefit the health of the populations living in the region of cement manufacturing facilities

Figure 2 The Concentration of Suspended Particles in Ambient Air Near Cement Factories, and the Levels Anticipated with the Implementation of Industrial Emission Standards

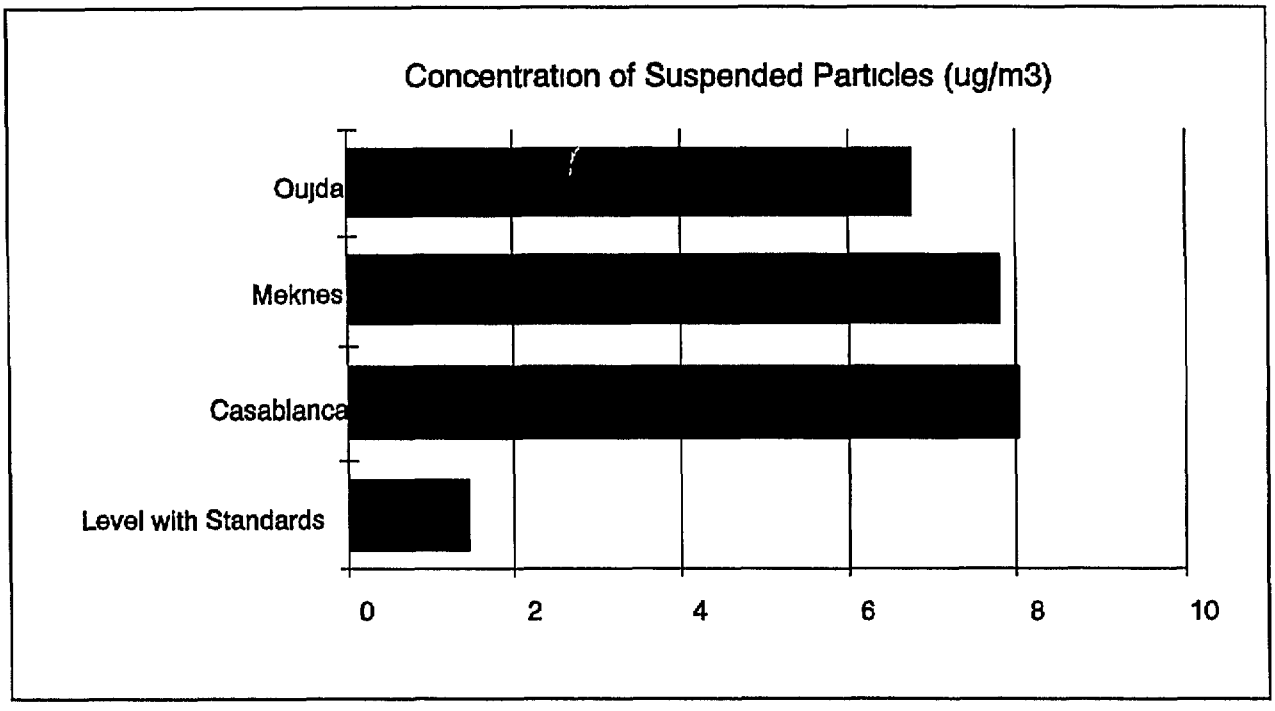
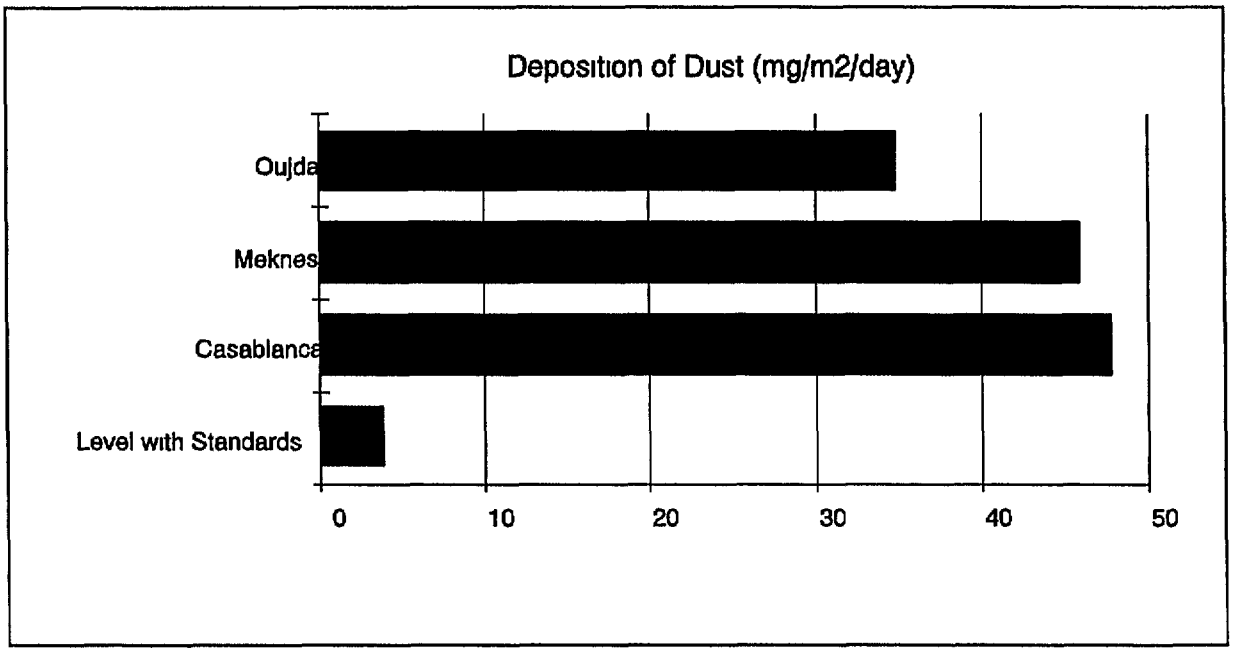


Figure 3 The Level of Dust Deposited (Dry Deposition) Near Cement Factories, and the Level Anticipated after the Implementation of Industrial Emission Standards



While the development of industry standards is an important first step, no follow-on activities have been developed to assist the industry in implementing these standards At present, few firms possess the technical expertise to estimate their emissions levels Additionally, a number of factories have installed post-combustion and post-processing emissions control technology which is not currently functional For example, at the Cinouca facility in the town of

156

Settat (near Casablanca), production line #1 includes a 15-year-old Flakt® baghouse and production line #2 includes a newer American Air Products® baghouse These baghouses are designed to remove between 95 to 99 percent of the dust created by the production process However, neither baghouse is operational due to a lack of spare parts, and no local service is available Factory management noted that the lack of local service vendors results in slow and expensive manufacturer response, and lengthy delays in getting the baghouse back on-line

Petroleum refineries The two refineries in Morocco produce emissions of sulfur dioxide, nitrogen oxides, and volatile organic compounds (VOC's)

Phosphate processing The phosphate processing facilities and Safi and El Jadida produce 204,000 tons of fluorine gas, as well as over 100,000 tons of CO_2 and 80,000 tons of SO_2 As these facilities are near the ocean and far from human habitation, these emissions do not appear to be environmentally significant

Energy generation The electric generation facilities consume 1 5 million tons of fuel oil, 1 2 million tons of coal and 32,000 tons of gasoil This represents a small fraction of the total emissions into the air from other sources, especially mobile sources

Area or artisanal sources No data exists on the extent of emissions from artisanal sources, such as from potteries and bakeries However, anecdotal information suggests that these sources could represent important, though very localized sources of suspended particles, sulfur dioxide and other pollutants The potteries appear to use automobile tires soaked in gasoline to increase furnace temperatures, resulting in brief emissions of very hazardous pollutants Bakeries are an important consumer of wood, accelerating deforestation

B3 Industrial Emissions Into Water

B3a Water Use

In total, industry in Morocco utilizes approximately 1,088 x 10^6 cubic meters of water per year These water includes water from the ocean, rivers and surface water (Table 3)

Table 3 Total Use of Water by Industry by Source

Origin of Water	Usage (10^6 m^3)	Percentage of Total Use
Ocean	877	81
Surface Water	153	14
Water from City Supplies	47	4
Water from Deep Well	11	1
Total	1,088	100

Of the water used by industry, the chemical industry used approximately 97 percent, most of which comprised of the phosphate processing facilities' use of sea water The breakdown of water use by major industry sectors is presented in Table 4

Table 4 Use of Water by Industry Type and by Water Source (in 10^3 cubic meters)

Industrial Sector	From City Water Supplies	Water from Deep Wells	Surface Water	Sea Water	Total
Agriculture	14,200	3,400	4,750	1,600	23,960
Textiles and Leather	9,130	1,940	0	0	11,070
Chemical and Fertilizer	22,390	5,920	147,600	875,500	1,051,410
Mechanical, Metallurgical	1,690	190	210	0	2,100
Total	47,410	11,450	152,570	877,110	1,088,540

B3b. Industry Emissions into Water

The primary pollutants discharged into water resources in Morocco include 100,000 tons of COD (chemical oxygen demand), 58,000 tons of BOD (biological oxygen demand), over 110 tons of heavy metals including chrome, and 3,300 tons of nitrates The primary sources of these emissions are tanneries, olive processing, and phosphate refining Table 5 presents the emissions from industrial sources into water

Table 5 Total Emissions into Water Per Year (by Pollutant)

Pollutant	Total Quantify Rejected (metric tons)
Suspended Particles	6,465,500
Chemical Oxygen Demand	12,600
Biological Oxygen Demand	4,300
Oil	1,780
Phosphore	11
Fluorine	37,700
Phosphate (P_2O_5)	54,840
Chorines (Cl)	1,900
Mercury	0 015

Tanneries The tanning industry uses chrome to enrich the texture of garments It has been estimated that approximately 111 tons of chrome is discharged into the Sebou River each year from tanneries based in Fes and Meknès (Table 6) A significant portion of this is total is discharged by artisanal tanneries A large portion of these discharges are deposited in river sediment, while a small portion is carried downstream The deposition of chrome into the river sediments may pose future environmental problems if the sediment is disturbed by floods or development activities

Table 6 Emissions by Textile and Tannery Industries (Tons Per Year)

Pollutant	Quantity Emitted	Percentage of Emissions from Industry as Percentage of Total Emissions of Pollutant
Suspended Particles	7,600	0 12
Biological Oxygen Demand	15,400	26 5
Chrome	111	100
Sulfur	140	100

Olive processing (huileries) The olive oil processing industry produces an organic waste byproduct known as margine, which is composed of water, oil and suspended particles These industries emit some 1 4 million cubic meters of used water containing approximately 10,000 tons of margine This is the major source of water pollution in the Fès area, where each year during the olive processing season water purification plants must close because they cannot handle the pollution levels

Phosphate refining Phosphate processing discharges 6 5 million tons of suspended particles, 49 tons of phosphorus, 110 tons of heavy metals and 3,300 tons of nitrates into the Atlantic ocean The phosphate processing facilities discharge over 1,051,410,000 cubic meters of water effluent, which represents 96 percent of industrial use of water The emissions from the two phosphate processing facilities at Safi and El Jadida are presented in Table 7

Refineries The two refineries produce liquid waste during the oil-water separation process in the form of oil by-products leaking into the surface water systems While little information is available on the amount of this pollution, it is unlikely to be a major environmental problem

Table 7 Liquid Emissions from Phosphate Processing at Safi and El Jadida (in Tons Per Year Unless Otherwise Noted)

Pollutant	Safi - Quantity Emitted	El Jadida - Quantity Emitted	Combined Percentage of Emissions from both Sites as Percentage of Total Emissions of Pollutant
Suspended Particles	3,446,600	3,017,760	99 5
Chemical Oxygen Demand	1,154	1,850	3 0
Biological Oxygen Demand	704	1,100	3 0
Fluorines	20,100	17,600	100 0
Phosphates (P^2O^5)	29,240	25,600	100 0
Total Emissions	3,497,798	3,063,910	N/A

C Impacts of industrial and Automotive Emissions

C1 Human Health Impacts

The key human health impacts are from the discharge of chrome into water resources, and the emissions of various air pollutants such as sulfur dioxide, nitrogen oxides, particulates and lead from point and mobile sources

Chrome The single most important impact of industrial emissions on human health is in the area of heavy metal discharges into the Sebou river from the tanning industry At present over 110 tons of chrome are deposited into the river at the centers of the tanning industry Fès and Meknès The ultimate fate of these heavy metal deposition in the Sebou is not known Much of the chrome becomes deposited in the sediments immediately downstream (within a few km) of the emission points, especially during dry periods when river flow is low A smaller portion, perhaps between 1 percent and 10 percent, remains in suspension depending on water flow characteristics This percentage will be higher during rainy periods, when increased river velocity (flow rate) carries a greater portion of the chrome downstream

Humans are exposed to chrome deposits in the Sebou through bathing, drinking and other activities In addition, residents along the river could be exposed through skin contact when using water for bathing and other activities Consumption of fish (such as shad) and invertebrates in the river can also lead to indirect exposure

The human health implications of chrome exposure include deterioration in organ function, nervous disorders, and impairment of bone formation This is especially significant for children

and young adults, and may result in long-term disabilities The team was unable to estimate the number of people actually suffering illnesses or other effects of chrome exposure

Lead While overall exposure to emissions from mobile and fixed sources of air pollution are not a major problem at present, the data do indicate that residents who living near areas of high traffic congestion in the major urban areas are likely to be exposed to very high levels of lead This exposure has particularly important ramifications for pediatric health, as children are particularly vulnerable to lead's toxic effects High levels of lead in the blood are associated with mental retardation, neurological problems, reproductive effects, hypertension, learning disabilities, and brain and kidney damage The team was not able to identify measurements of lead levels, especially in children's blood, during this effort Previous studies in Bangkok and Cairo have indicated lead from mobile sources as a major health hazard potentially resulting in reductions in children's IQs of four percent This is not likely to be as major a problem now in Morocco, because it doesn't have the automobile congestion or population densities of these cities However, it may become more of a problem in the future

Other gaseous air pollutants Apart from lead, residents in high traffic congestion areas are also exposed to high levels of NOx, ozone, polycyclic aromatic hydrocarbons (PAHs), and volatile organic compounds (VOCs) These pollutants produce a wide variety of health impacts including eye, nose and throat irritation, central nervous system depression, liver and kidney damage, headache, dizziness, angina, pulmonary edema and cancer As with lead, these effects are particularly acute in children and young adults While long-term damage can often be reversed when exposure rates decline, some diseases will persist, especially after chronic long-term exposure

Dust Exposure to dust from cement factories affects human health in two ways Chronic inhalation of dust can impair respiratory function, and accelerate the development and severity of respiratory diseases such as asthma Additionally, dust particles often contain minute quantities of heavy metals adhered to the surface When inhaled, these heavy metals are absorbed in the lung alveoli, leading to contamination of the bloodstream

Organic discharges into rivers Large discharges of organic matter reduces oxygen levels in rivers, leading to a decline in aquatic plant and animal species This decline results in a lowering of the river system's natural self-purifying ability As a result, water borne diseases such as diarrhea, typhoid, cholera, conjunctivitis, meningitis and hepatitis, become much more prevalent The Sebou and Oum er Rbia watersheds are the most important starting points and propagation zones for these diseases The Public Health Ministry has described Fes as "cholera's hub "

C2 Economic Impacts

The economic impacts of pollution include loss of economic resources such as fishing grounds, potential exclusion from export markets, declines in worker productivity from environmental diseases and illness, increased costs of medical treatment, increases in time and resources expended in obtaining non-polluted water, and increases in costs of maintenance of buildings and cultural and historic sites

Loss of economic resources The emissions of waste water from the phosphate processing facilities at Safi and El Jadida have corresponded with a rapid decline in fish populations in the areas adjacent to the outflows The available data do suggest that the emissions have had a major impact on fishery populations, which represent a very valuable economic resource Anecdotal data and information from fishery experts suggest that since the construction of the phosphate processing facilities the sardine population has shifted south While it can not be ascertained if this shift is due to pollution, over-fishing, or natural changes in the environment (such as changes in ocean currents), the impact of the emissions is likely to have been significant or substantial

Economic loss from restrictions in market access A greater long-term economic risk to the emissions from the phosphate processing is the increased restrictions in market access, especially the European Community At present, the European Community purchases some 29 4 percent of total phosphate exports, with Spain representing the single most important export country (Table 8) The value of phosphate exports is approximately $U S 59 8 million The second largest importing country is the United States with almost 20 percent of total exports valued at $U S 37 5 million

Table 8 Exports of Moroccan Phosphates by Country of Destination (metric tons) (Data for 1 January - 30 September 1994)

Country of Destination	Exports (tons) Jan - Sept 94	% of Total Production
European Community	2,040,000	29 4
United States	1,373,522	19 8
Mexico	749,855	10 8
Poland	436,823	6 3
UEBL	391,310	5 6
Indonesia	346,742	5 0
India	297,584	4 3
South Korea	205,304	3 0
Croatia	178,620	2 6

Source Revue d'Information BMCE, February 1995

The potential economic risk stems from the acceptance of ISO 9000 and ISO 14000 standards by the European Community These codes adopt tight production and product standards for all goods sold in the Community countries As part of these standards, the environmental impacts of the products and processes are considered, and products which do not meet these environmental standards could ultimately be banned from import into the European Community Thus, the high levels of pollution from the phosphate industry could be restricted under ISO codes, and could be banned from the European Community

Productivity losses The loss in worker productivity is likely to be especially acute in artisanal factories, such as tanneries, where workers are exposed to very high levels of toxic substances with little or no protective equipment or practices Productivity losses would include an increase in absenteeism due to medical problems, reduced productivity while at work, increased number of breaks required by workers, on-the-job problems of headaches, dizziness and fainting These productivity losses are not likely to be realized in formal national accounts, because of the informal nature of this type of employment Additional losses in productivity could also be pronounced for those workers living immediately downstream (or downwind) of major point sources

Increased costs of medical treatments For individuals exposed to high or chronic levels of industrial pollutants, resulting medical problems will raise the costs of medial treatments Without additional data, the magnitude of these costs can not be accurately assessed

Time spent securing clean resources For the tens of thousands of persons depending on the Sebou and other polluted rivers for primary water sources, economic costs can be associated with filtering water, accessing less polluted stretches of river, and other behaviors

Increased costs of maintenance Sulfur dioxide, nitrogen oxides, ozone and other air pollutants accelerate the decay of the exposed surfaces of buildings and historic sites, increasing maintenance costs and possibly permanently damaging priceless cultural sites and artifacts The increase in maintenance costs extends to houses, buildings and other property where the costs include more frequent painting and repair and replacement of exterior walls and wall coverings The permanent damage to cultural and historic sites imposes a cost significantly higher than mere replacement costs

C3 Impacts on Biological Diversity

The two most important impacts of industrial pollution on biological diversity are the emissions of heavy metals and organic matter into rivers (such as the Sebou) and the discharges of phosphate processing facilities into the Atlantic Ocean

Discharges into rivers Industrial discharges into rivers, especially the Sebou, have significantly reduced the level of biological diversity downstream This is especially important in the case of fish and invertebrate species, as well as some plant species The Sebou River is largely devoid of many species originally found in abundance downstream of Fes and Meknes It is considered effectively dead for at least 22 miles downstream of Fès These impacts may be carried out to the wetlands and coastal zones as well

Phosphate processing discharges into the Atlantic As noted above, the development of two major phosphate processing facilities at El Jadida and Safi has paralleled a rapid decline in sardine populations in certain areas of Morocco's coastline Anecdotal and fisheries data suggest that since the construction of the phosphate processing facilities the sardine population has shifted south This shift may be due to a variety of factors working singly or in concert These factors include pollution, over-fishing, or natural changes in the environment (such as changes in ocean currents or movement of phytoplankton) At present, the impact of the emissions is not fully known, but is likely to be significant or substantial While sardines themselves are not an endangered species, there is some concern that they may be an indicator species for overall

biological diversity in those areas If so, then the discharges could be having a major impact on a wide variety of marine life

D Conclusions Comparisons of Industrial and Automobile Emissions

The Problem Assessment Matrix for Industrial and Automotive Emissions (see below) suggests that environmental problems facing Morocco can be broken down into two main categories These are problems of primary importance and those of secondary importance

D1 Primary Environmental Issues

The Problem Assessment Matrix identifies four major types of primary environmental issues facing Morocco in the area of industrial and automobile emissions These are

- Emissions into the water of chrome from tanneries in the Meknes and Fes region
- Organic discharges from the olive processing into the Sebou River in the area of Meknes,
- Emissions of suspended particles and heavy metals from phosphate processing into the Atlantic Ocean in the areas of Safi and El Jadida, and
- Emissions of lead from mobile source emissions in areas of high traffic congestion in major urban centers such as Casablanca, Marrakech, Tangiers and Rabat

A review of expert opinion in Morocco would support the inclusion of the first two issues as very high priority environmental concerns However, expert opinion is significantly divided over the importance of phosphate processing emissions on the biological diversity of the Atlantic coast region As noted earlier in this report, data are inconclusive as to the cause (whether natural or the result of pollution) of the movement of the sardine population south of Safi and El Jadida, and to whether this movement is a reflection of overall impact on the oceanic environment of phosphate waste water discharges A study carried out by the Scientific Institute of Marine Fisheries does show very high levels of PO^4, cadmium and other phosphate waste products to be 3 to 10 times higher near the discharge points than elsewhere along the coast (*Evaluation de La Salubrite du Littoral Mediterraneen et Atlantic Nord (Saidia - Safi) Durant La Periode 1992-1994*, Institut Scientifique des Pêches Maritimes, 1994) The Institute is currently carrying out a more detailed study to assess the impact of phosphate discharges on the marine ecosystem

The importance of lead exposure from mobile source emissions is, on a country-wide basis, somewhat less important than suggested by the Problem Assessment Matrix However, the analysis does correctly indicate that in certain localized urban centers, the problem of mobile source pollution may be of greater magnitude in its impact, than is generally acknowledged in Morocco at present

D2. Problems of Secondary Importance

The results of the Problem Assessment Matrix indicates that three types of emissions from industrial and automotive sources are of secondary importance to human health and biological diversity These three issues are

- Mobile source emissions of sulfur dioxide, nitrogen oxides, suspended particulates
- Air emissions from industrial fixed sources
- Air emissions from area or artisanal sources

These results conform to generally held opinion within the environmental community, although the lack of data inhibits further analysis An air quality monitoring program would help identify the relative importance of these sources to Moroccan air quality problems

ANNEX J
PROJECT SUMMARIES

A Project Options

This section provides brief summaries of the project options identified by the team Each summary describes the problem, the main project features, the estimated costs and benefits where appropriate, indicators to help monitor the project results, evaluations against the scoring criteria, related activities of other donors, possible interactions with other donor activities, and other factors to be considered in project development and implementation

Thirteen projects are described on the following pages

1 Protected zones for drinking water intake
2 Sanitary landfill management
3 Management support for sewage collection and treatment
4 Integrated watershed management
5 Eco-tourism development in Morocco's interior
6 Artisanal tannery improvement
7 Air quality improvement and monitoring
8 Phosphate processing emissions elimination
9 Industrial pollution prevention
10 Water erosion of soils
11 Dune encroachment control
12 Oum er Rbia River catchment basin management and environmental quality
13 Sebou integrated management plan

Project 1 Protected Zones for Drinking Water Intake

Project description The project would consist of strengthening the procedures for identifying and establishing protected zones which ONEP is currently engaged in developing with German support, and applying these procedures in one or more pilot areas, chosen on the basis of ONEP priorities, and if reasonable so as to complement other USAID efforts to reduce ground water contamination The effectiveness of this work will depend on the GOM implementing the legislation necessary to mandate the procedures developed by ONEP Such legislation is not under ONEP control

Problem description Wells used for drinking water are not protected against possible contamination of groundwater Such protection is assured using protected zones within which all polluting activity is regulated Such protected zones do not yet exist in Morocco

Indicators

- Technical procedures for identifying and establishing protected zones are accepted by ONEP
- ONEP has taken all steps under its jurisdiction to ensure legal recognition of these procedures
- Protected zone and acceptable activities within it are identified for at least one pilot site

Cost $300K, 6 months of TA plus local travel, incidentals

Benefits $0 5-$1 0 million At present, if a well is faced with short-run contamination, it is shut down immediately to protect the water supply For chronic pollution such as agricultural runoff, closing the well temporarily is not an option, and it must be closed and replaced One well costs about $170,000 However, as the population density increases over time and water demand increases, it will not always be possible to replace wells Therefore avoiding these costs is preferable Moreover, several wells are typically grouped together, and would have a single protection zone Therefore the benefits of avoiding one contamination incident might be between $0 5 and $1 million Moreover, once the procedure is established it can be applied to all wells in country

Evaluation

Importance of problem	3 25	
Impact of project	4	
Priority of GOM	4	Water protection is a high priority of the Moroccan government
Priority of USAID	4	Responds to two program outcomes
U S comparative advantage	1	
Opportunities for U S firms	1	
Sustainability	3 to 4	Moroccans will be trained to do it but it depends on legislation being approved by government
Donor activities	3	This complements German work, and little formal collaboration needed
NGOs	1	

Interactions Work with ONEP, collaborate with Germans This should be straightforward Eventually implementing the zones will require legal authority and collaboration with affected firms This may require a process of negotiation, particularly for firms already in place

Other needed activities Held discussions with ONEP to see how far their German-supported work has gone and what additional work is needed to establish procedures Select the pilot region(s)

Project 2 Sanitary Landfill Management

Project description The project will consist of working with several local governments on

- Identification of technical needs for a landfill and choice of a site (carrying out necessary studies, negotiating an agreement among interested parties concerning the site)
- Helping local authority to identify investments funds to build the landfill and financial mechanisms to ensure appropriate maintenance
- Studies to assess the viability of subcontracting or privatization of the different steps involved in trash collection and management
- Studies to assess commercial viability of recycling trash
- Training local authorities on the management of the systems identified through the studies (subcontracting, privatization, recycling, public management of all activities) This may involve overseas stays to work with similar organizations
- Involve a selected national authority in the previous five steps to ensure that this approach can be transferred to other cities

Project could also involve work with local communities and NGOs to build public awareness about better trash management, putting things in trash bins, recycling, bagging trash, etc

Problem description There are currently no sanitary landfills in Morocco Existing trash dumps cause a variety of environmental hazards Local governments lack both the financial and the human resources to introduce proper solid waste management

Indicators

- Household waste correctly managed (collection, storage) in the pilot city

- National authority is working with 3-4 other cities to help them go through the same process

Cost 1 person full time for 3-4 years, $1 M
Training of local staff, national agency personnel, private sector, etc , $1M
Logistics, $500K
Rough total, $2 5M

Benefits Better management of waste in the cities concerned, resulting in improved urban quality, less threat to ground water, reduced disease particularly in adjoining rural areas where people use well water, reduced pressure on the drinking water system Transfer of new approaches to other cities through the national agency which is involved Overall magnitude of the problem involved is large, as are potential benefits

Evaluation

Importance of problem	2 3	
Impact of project	4	
Priority of GOM	4	Concern about water supply
Priority of USAID	5	It addresses all three program outcomes
U S comparative advantage	4	
Opportunities for U S firms	3	Possibility of some opportunities in privatization or contract management of trash
Sustainability	4	If national officials are well trained, the approaches should be transferable to other cities This depends on finding the initial investment funding and on the local government managing the financing responsibly to ensure adequate maintenance
Donor activities	2	
NGOs	3	

Interactions 2 GOM agencies and local governments only No other donors involved at this time

Other needed activities Identify the correct national authority Identify cities to begin work

Project 3 Management Support for Sewage Collection and Treatment

Project description The infrastructure required to collect and treat human waste is beyond the financial ability of USAID to provide However, USAID is in a position to provide the technical assistance, training, and institutional and management which will be need to make the most of capital investments in sewerage when they are available The World Bank is now developing a major project through which they will make loans available to make the needed capital investments in a number of cities A useful USAID activity would be to provide the complementary management support needed to help the Moroccans make the most of these investments This would involve work in one pilot city and with appropriate national agencies (probably the Direction de l'Eau et de l'Assainissement, the Direction des Régies, ONEP, or others) to do the following

- Work with Moroccan engineering consultants to carry out the technical studies needed for the pilot city
- Helping the local authority determine how it will cover its loan payments and operating costs for the new system, following the World Bank's principle (a requirement for their loans) that operating costs must be covered by those benefitting from the system
- Assess the viability of privatizing or contracting out the construction or operation and maintenance of parts or all of the sewage collection and treatment system
- Train local authorities (and private enterprises, if privatizing or subcontracting is viable) on how to operate, maintain, and manage the new system For some people this may

involve working in similar organizations in France to get hands-on experience
- Work with the national authorities involved to develop strategies for transferring this expertise to other cities

Problem description The discharge of raw sewage into streams, rivers and the ocean is considered by many people to be Morocco's most serious environmental problem As population grows in the next 20 years, Morocco's rivers will increasingly resemble open sewers, drinking water supply will be threatened, disease rates will rise, and the physical environment in which poor people live will be simply abysmal

Indicators

- In the pilot city, personnel trained, construction of the system contracted for, viable cost recovery plan developed, etc Timing of the project may not allow the completion of the system to be an indicator

- National authorities are working with 3-4 other cities to go through the same process, perhaps also in conjunction with World Bank capital support

Cost	1 person full time for 4 years	$1 M
	Short term TA, 20 months	$0 5 M
	Training	$1 M
	Logistics	$0 5 M
	Rough total	$3 M

Benefits Better wastewater management in the pilot city, leading to improved urban quality, less disease, and less threat to drinking water supply By devoting much of the effort to working with national authorities, the chances are great that the learning will be transferred to other cities, and benefits will be widespread However, this depends on availability of investment capital from other sources

Evaluation

Importance of problem	3 27	
Impact of project	4	
Priority of GOM	5	Sewerage is very high priority to the GOM
Priority of USAID	4	This works toward 2 program outcomes - pilot activities and national institutional strengthening (assuming national institutional support without policy reform is part of program outcome 1)
U S Comparative Advantage	1	
Opportunities to U S firms	3	Possible opportunities in private sector management, introduction of treatment technologies
Sustainability	3	The training provided to national officials will ensure sustainability of technical skills, but this depends on loans being available from other sources

		to build the systems
Donor activities	4	This activity will complement the World Bank's Second Sewerage Project
NGOs	1	

Interactions The World Bank is discussing major financing for sewerage projects, and it is trying to develop a $200 million project for the Sebou river that would contain many of the features discussed here

Other needed activities Discuss the project with the World Bank, the DEA, other national institutions, and target cities

Project 4 Integrated Watershed Management

Project description An integrated watershed management approach linking upland sustainable land use management practices to lowland water resource use is needed to manage Morocco's watershed resources This approach should include identifying costs and benefits of existing and potential sustainable practices (e g , soil erosion control, water conservation, reforestation, farming systems, alternative energy, small enterprise), recommending policy reforms and cost-effective economic incentives which encourage sustainable watershed management (e g , land and tree tenure, taxation of urban population grazing animals on the mountain environment), developing a cost-effective watershed management plan, establishing community resource management agreements between the government and resource users, and monitoring the link between improved upland watershed management and the availability of benefits (e g , water resources, wildlife conservation, agricultural, income) A potential site is the mountains above the USAID/Tadla Project area

Problem description Unsustainable forest utilization, agricultural practices and livestock management are leading to watershed degradation, soil erosion, declining agricultural productivity and loss of important wildlife habitat, and are also destroying the rural populations primary source of fuelwood resources These are also causing siltation of reservoirs, leading to reductions in electric power production and irrigation water, loss of fuelwood, and loss of wildlife habitat Because of the many complex ecosystem interactions, piecemeal approaches addressing single aspects of the problem are ineffective, and a more comprehensive approach is needed

Indicators Development of a regional watershed management plan approved by national and local officials and the affected local communities, implementation of improved watershed management and ecosystem conservation practices, reductions in the rates of land degradation, loss of land due to erosion, deforestation, and endangered species preservation, and increases in agricultural productivity

Evaluation

Importance of problem	2 9	(See Problem Description above)
Impact of project	4	This project will increase rural income by reducing

		loss and degradation of land, increasing agricultural productivity, increasing fuelwood resources, improving water quality, protecting important wildlife and plant habitats, and promoting adoption of sustainable practices conserving resources for the future It can serve as a model for similar activities in other regions
Priority of GOM	4	The GOM has indicated a strong interest in watershed management to USAID/Morocco
Priority of USAID	5	USAID is interested in and has experience in these areas
Trade	1	Minimal
Sustainability	4	Good, since some rural mountain communities have shown receptivity to innovative ideas and techniques, and economic focus implies benefits should be self-sustaining
Donor activities	3	The German Development Agency (GTZ) and the African Development Bank are supporting protected area management plans, but there are no comprehensive management planning activities for remote areas
NGOs	3	The Peace Corps provides technical assistance, and Birdlife International is assisting the Department of Water and Forests in related activities We do not know of major local NGO activities

Project 5 Eco-tourism Development in Morocco's Interior

Project description A tourism plan would be developed based on ecological and social field assessments The ecological assessment will identify and assess site ecology A social assessment will evaluate local community utilization (hunting, materials, recreation, etc) A tourism plan will evaluate tourism potential, infrastructure requirements, allocation of economic costs and benefits, enforcement, monitoring, and management responsibilities

Problem description Morocco can capture economic benefits from eco-tourism in interior areas which have unique forested areas, wildlife, areas of historic interest and interesting cultures However, if not properly managed harm can result from uncontrolled development, disruptions in rural communities, and degradation and destruction of remote ecosystems The government has no national tourism plan balancing environmental and economic needs

Indicators A national tourism strategy and action plan for interior areas agreed to by national and local government officials and affected communities, and implementation of this process for at least three sites, site economic, ecological, and social benefits

Evaluation

Importance of problem	2	(See Problem description above)
Impact of project	3	The project will contribute to both economic development and the conservation of protected areas in Morocco A major uncertainty is how many eco-tourism areas are economically viable
Priority of GOM	3	Moderate
Priority of USAID	3	This provides economic development while assisting endangered ecosystems
Trade	1	Minimal
Sustainability	3	Some market demand is evident
Donor activities	3	Peace Corps provides technical assistance The French support tourism development in the Toubkal National Park area The GTZ and the African Development Bank support protected area management plans
NGOs	3	Birdlife International is assisting the Department of Water and Forests monitor tourism impacts in protected areas and working with local NGOs and donors

Project 6 Artisanal Tannery Improvement (ATI) Project

Project description USAID has an excellent opportunity to tackle the chrome emissions from tanneries in Fès through a program targeting artisanal emitters Although small, these emitters contribute a significant portion of the total chrome emissions A project intervention could provide low-cost pollution prevention technologies and leverage USAID's investment in concert with World Bank and European Community projects focusing on improving water quality in the Sebou River While artisanal activities are the toughest to get to do anything—poor levels of education, suspicion of new techniques, high risk aversion, expensive to reach—the ATI project would focus on providing a participatory environment, coupled with emphasis on NGO's and local groups to overcome these obstacles Because the ATI would focus on low-cost pollution prevention and educational activities at the NGO level, the project would have a high benefit cost ratio

An ATI project would (1) provide technical assistance to local agencies involved in the tanning industry in Fès and Meknès, (2) work with the Agency for the Dedensification of the Medina (ADER) and NGO's to overcome current obstacles which inhibit the movement of tanneries from the densely populated medina to new industrial zones, and (3) implement a policy component to develop industry-based standards

The project would also work with the tannery cooperatives and other NGO's in the Medina and Industrial zone to provide technical assistance in reducing chrome emissions The project would focus on developing pilot projects in the Medina and developing cost-effective pollution

prevention and end-of-pipe measures to reduce pollution while potentially improving productivity Included in this technical assistance (TA), could be a component to promote the development of private sector services to receive and treat tannery wastes, recycle the chrome, and resell the wastes to tanneries at a reduced costs, thus providing additional economic incentives for tanneries to cooperate with the program

Additional TA could be targeted to industries, local government, and the SSE to assist in the development of industry-based environmental management performance standards and a Sebou monitoring system to assess the impacts of the project on chrome concentrations in the river In addition, the ATI should include a public education component, informing city residents, school and university students and local government officials of the importance of reducing industrial emissions and their impact on human health and the environment

Problem description Approximately 110 metric tons of chrome are deposited annually into the Sebou River, causing significant human health and biological diversity impacts A significant portion of these discharges emanate from small artisanal tanneries

Indicators Amount of chrome in the river, amount of chrome recycled, the number of tanneries implementing project paper (PP) procedures, the active endorsement of tannery cooperatives and industry groups, and the attendance of artisanal tanneries at pollution prevention seminars

Evaluation

Importance of problem	4
Impact or project	4
Priority of GOM	5
Priority of USAID	5
U S comparative advantage	3
Trade	2
Sustainability	4
Leverage	5
NGOs	5

Project 7 Air Quality Improvement and Monitoring (AQIM) Project

Project description The AQIM project would focus on providing Technical Assistance to develop air quality monitoring program, identifying primary activities for reducing emissions, developing industry standards, and working with a wide range of stakeholders including industry groups and the SSE to develop ambient standards In addition, specific demonstration projects would be developed at selected factory sites to provide advice on engineering and financial investment topics to assist the firm in designing and financing environmental investments The financial investment assistance could take the form of providing small grants or subsidies to US vendors in installing new emissions control technology, but the primary emphasis would be on helping factories access national and international investment sources

While this project would not address the most important environmental issues facing Morocco, it would have a relatively low political risk, and could put USAID at the forefront of air quality efforts in the country In addition, significant U S trade opportunities could exist for providers of environmental products and services, where the U S has a clear competitive advantage on the world market The project would also leverage the work being done by the German Development Agency (GTZ) and GEM in air quality issues surrounding the cement industry

Problem description Air quality in localized urban areas, and adjacent to specific factories of significantly exceeds any internationally recognized standards The primary sources are vehicles and specific industries (both modern and artisanal) At present no comprehensive program addresses air quality, insufficient data exist to implement an effective air quality management project, and few of the major emitters have information on their own emission levels

Indicators Reductions of emissions from key emitters, development of a monitoring program, improvement in air quality (sulfur dioxide, dust, nitrogen oxides, and ozone)

Evaluation

Importance of problem	3
Impact of project	3
Priority of GOM	2
Priority of AID	3
U S Comparative Advantage	4
Trade	5
Sustainability	5
Leverage	4
NGO	1

Project 8 Phosphate Processing Emissions Elimination (P^2E^2) PROJECT

Project description A Technical Assistance program to reduce water and air emissions would focus on developing monitoring of air and water quality, identifying primary activities for reducing emissions, providing TA to factories, and working with the industry and SSE to develop emission standards The focus of the TA would be the cost-effective pollution prevention actions, including the recycling of solids (for possible sale to the cement industry) and nitrates (to the fertilizer industry) The TA would utilize the extensive expertise available in the United States private sector in reducing emissions from phosphate processing industries

The implementation of cost-saving pollution prevention techniques would serve as an excellent example to other industries of the financial and environmental benefits of this approach The P^2E^2 project would have significant trade opportunities for U S environmental technology and service providers The GEM project has shown that working with industries to develop

standards can be highly cost effective The primary project risk, however, is the strong political position of the industry within the government, and the receptivity of the company to outside assistance Initial conversations with senior members of the Ministry of Industry and Mines does suggest, however, that the correct approach to the government could overcome many of these political risks

Project problem Wastewater emissions could be causing significant harm to the oceanic biological diversity and fisheries industries

Indicators Reductions in air and water emissions

Evaluation

Importance of problem	3
Impact or project	4
Priority of GOM	1
Priority of USAID	3
U S comparative advantage	3
Trade	4
Sustainability	3
Leverage	4
NGO	1

Project 9 Industrial Pollution Prevention Project (IP3)

Project description The IP3 project would focus its activities on environmental auditing and working with industry groups to develop industry-led standards and demonstrate cost-effective pollution prevention strategies Additional project activities should be developed after the upcoming evaluation on the GEM project is carried

The IP3 project would build on the successes of the GEM project and target pollution prevention and environmental auditing activities As such, it represents a low risk, high impact project leveraging AID's previous investments The project would leverage the investments in pollution prevention being carried out (or to be carried out) by the World Bank, European Community, and place USAID in a position of leading the pollution prevention effort

Problem description Few industries have developed standards for air and water pollution emissions The GEM project has demonstrated, in the case of the cement industry, that the development of industry-sponsored standards, through sector cells (i e industry associations) is the most appropriate paradigm for initiating environmental management practices in Morocco A IP3 project would focus on the private sector, continuing the pollution prevention audits of the GEM project, and expand areas of activity to include training and information dissemination The sectors which IP3 should target include sugar refineries, textile producers, agro-industries, and other industries not targeted by the World Bank and European Community projects

Indicators Reductions in air and water emissions from facilities

Evaluation

Importance of problem	4
Impact of project	5
Priority of GOM	4
Priority of AID	4
Comparative Advantage	4
Trade	3
Sustainability	4
Leverage	3
NGO	1

Project 10 Water Erosion of Soils

Eight project options are grouped together here because they share many of the same characteristics They will assist efforts of the Division of Land Rehabilitation and Conservation (DRCTA) that was established in 1993 as a part of the Administration du Genie Rural in the Ministry of Agriculture to deal with the problems of land protection which are not addressed by either forestry or irrigation

Option 1 Rif Soil Erosion Control Project Because of its reliable rainfall the Rif has a wide range of soil conserving production practices which could be introduced Forage crops are one of the best protections against soil erosion Given the rainfall conditions, forage crop production is an option in the Rif Improving olive production by using retaining walls has already been introduced into the Rif and is being adopted

Option 2 The Al Wahda Dam Project This dam is currently under construction and is scheduled for completion this year When it is completed it will be the second largest dam in Africa after the Aswan High Dam in Egypt It is located on a tributary of the Sebou River, the Ourgha River, about 60 miles north of Fes The catchment basin covers 614,000 hectares of which 70 percent is used for dryland agriculture The study for watershed protection is not yet completed but it is expected that three sites will be identified for pilot projects

Option 3 The Tangiers Project In Tangiers Province 64,000 hectares have been identified as being at risk There is one reservoir in the target region but the project is not limited to its catchment basin Opportunity cost on the land which is at risk has been established at from 800 to 2,500 dh/ha/yr No work has been started on this project

Option 4 The Southern Atlas Soil Erosion Control Project Two drought resistant perennial crops, almonds and prickly pear cactus, will be used to encourage soil conserving tillage practices Both of these crops are already valued in the regions where they will be used for soil conservation In this project the fact that water harvesting and soil

conservation are complementary activities will be exploited in the selection of planting sites and retaining wall construction

Option 5 The Agadir Project A total of 118,000 hectares have been identified as being at risk in the provinces of Agadir, Essaouira, Narrakedi, Azilal and Tiznit The local population approach the Ministry of Agriculture and the IAV for help in reestablishing almond production in the region A pilot project of 18,000 hectares has been identified near Agadir Under dryland conditions almonds will generate revenues of about 1,200 dh/ha/yr It would be the retaining walls which would be built to nurture the trees and not the trees themselves which would protect the soils Trees would be located where the complimentary processes of water harvesting and soil conservation by the retaining walls would be facilitated

Option 6 The Kalae des Sraghna Project A total of 50,000 hectares have been identified in the provinces of Khouribga, Safi, Taroudant, Beni-Mellal, Azilal, Mariakede, Guelmine, Khenifra and Chichania A pilot project of 6,000 hectares has been identified near Kalae des Sraghna In this project it is proposed to introduce prickly pear cactus as a soil protecting crop This crop is well known in Morocco The fruit is important for human consumption and is valued at 1350 dh/ha/yr The leaves are used as forage which is valued at 450 dh/ha/yr There is not any known research in Morocco on this crop But it is a very hardy, drought resistant plant and its growth habit would indicate that it would be good for protecting the soil and for providing wildlife habitat

Option 7 Rif Soil Erosion Control Project The Rif has the worst soil erosion problem in Morocco It is a high rainfall area with dense natural vegetation under undisturbed conditions The availability of fuelwood is not a problem so population density is not a consideration The cause of the erosion problem in the Rif is the conversion of forest and range land on steep slopes to agricultural uses There are numerous possibilities for soil erosion projects in the Rif Two representative projects will be presented here

Option 8 The Southern Atlas Soil Erosion Control Project This is an arid region The soil erosion problems are more traditional than those in the Rif Vegetative cover is sparse Population pressure is increasing Rain does not come very often buy storms can be violent And, whenever the rain comes, the ground is usually bare so it is vulnerable to serious erosion

Indicators Number of farmers participating and the number of hectares protected

Evaluations

Importance of problem	3 2	
Impact of project	3	
Priority of GOM	4	The GOM established the DRCTA in 1993 and is in the process of passing legislation for the specific purpose of addressing the problems which are addressed by these projects

Priority of USAID	3	Health, economic, and biodiversity problems are all directly addressed by these projects
U S comparative advantage	4	Forestry and agriculture people in the western United States have developed equipment and expertise which is directly applicable to Morocco's soil erosion problems
Trade	1	
Sustainability	4	In one case, the Agadir project, the idea for the project came from the target population In all cases, sustainability and spontaneity would be judged before starting a project Anecdotal reports on these elements are positive
Donor activities	3	The World Bank, UNDP and the Food and Agriculture Organization (FAO) are all active in soil erosion projects However, the problem of soil erosion is so pervasive in Morocco that each project gives the impression of being isolated
NGOs	3	Women's Groups Local community activities exist which relate to the problem of soil erosion

Project 11 Dune Encroachment Control

Project description Fibre cement panels would be used to generate artificial dunes which are 8-10 meters high and thus capable of stopping other dunes Artificial dunes would be further stabilized by biological means

Problem description Dune encroachment threatens 30,000 hectares of productive land which support 80,000 people in Ouarzazate Province and it threatens 25,000 hectares which 200 000 people in Errachidia Province When oasis are threatened, as is often the case, a unique wildlife habitat and human community is threatened Moroccan technology in dune stabilization is advanced However, funding is inadequate to protect a significant number of threatened farms and villages

Indicators

- Number and effectiveness of artificial dunes generated
- Local participation in project
- Establishment and maintenance of biologic stabilization

Evaluation

Problem Importance	2	Regionally important
Project Impact	3	Very effective intervention but limited in extent
Priority of GOM	2	High priority for regional government
Priority of USAID	2	Unknown

Trade	1	None
Sustainability	4	Excellent given a modest initial infusion of funds
Donor activities	2	ORMVAs are active in this work and the ORMVAs are in turn partially funded by the World Bank
NGOs	2	

Project 12 The Oum er Rbia River Catchment Basin Management and Environmental Quality Project

Project description One of the strengths of land use projects is that they are well adapted to use for integrating several areas of environmental concern In this case the three areas integrated are biodiversity, industrial and air pollution and agriculture and land use The most logical land unit for planning and implementing an integrated environmental project is a catchment basin By addressing the environmental problems of an entire catchment basin, it would be possible to generate a series of pilot projects and regulatory reforms which would not be costly and which would serve as models for the rest of the country

The most important part of this project would be to address the problem of non-regulation of agricultural chemicals on the Tadla irrigated perimeter This would help solve serious health risks connected with agricultural chemical use on the Tadla perimeter and it would serve as a model for irrigation projects throughout the country Other pilot projects would be selected from among the following possibilities

- Habitat restoration and watershed management
- Reducing pollution from sugar mill operation
- Water erosion of soil Beni Mellal province has 3000 hectares which would benefit from the establishment of soil conserving olive orchards with retaining walls and 5,000 hectares which would benefit from the introduction of prickly pear cactus for erosion control Azilal province has 15,000 hectares which would make a good pilot project demonstrating the use of almond trees for erosion control and 5,000 hectares where erosion control with prickly pear cactus could be demonstrated
- Municipal growth on prime agricultural land The city limits of Beni Mellal are being reviewed for possible expansion by the end of 1996 Prime agricultural land, flat irrigated land, will be protected if it is mapped The price would be about 500,000 dh The necessary knowhow is already present in the DRCTA
- Metering wells to monitor ground water drawdown in aquifers threatened by salt water intrusion

Problem description The most serious problem in this catchment basin is the unregulated use of agricultural chemicals Other serious problems include industrial pollution, saltwater intrusion in coastal aquifers, municipal growth on prime agricultural land, endangered species

and soil erosion

Problem importance The seriousness of the combination of environmental problems of the Oum er Rbia rival those of Oued Sebou Primary among these is the pollution or the risk of pollution to the water supply of both rural populations and urban population centers The other major problem being addressed is the lack of a land based approach to environmental problems in Morocco The biodiversity, industrial pollution and land use problems of the Oum Er Rbia are sufficient to serve as models for the rest of the country

Project impact This project could become a model for land, or more broadly, geography based approaches to environmental problems throughout Morocco Establishing regulations for pesticide use could also be expected to have an influence nationally

Indicators

- Establishment of water quality control guidelines
- Establishment of pest control applicators standards
- Number of environmental projects modeled after this one
- Number of pilot projects started
- Number of pilot projects which are replicated outside of this project

Evaluation:

Importance of problem	5	
Impact of project	5	
Priority of GOM	5	The Director General of Hydraulique identified water pollution in the Oum er Rbia catchment basin as being of major concern to the government
Priority of USAID	5	AID already has an environmental/irrigation project at Tadla
U S comparative advantage	4	The U S is very strong in water quality control, pesticide regulation and land based approaches to environmental problems
Trade	1	
Sustainability	5	The health and economic returns on this project would be high so it is likely that sustainability/spontaneity would also be high
Donor activities	5	Because of the wide array of activities in this project, there would be major opportunities for cooperation with other donors
NGOs	4	Again, because of the wide array of activities in this project, there would be major opportunities for working with NGOs

Project 13 Sebou River Basin Integrated Management and Environmental Quality Program

Problem description The Sebou River Basin is the most polluted and threatened water basin in Morocco Its primary watershed is based in the Rif Mountains in the northern part of the country The benefits of the watershed are seriously threatened due to siltation of the reservoir, loss of fuelwood and loss of wildlife habitat Some of the watershed problems include

- Agricultural management problems (e g , soil erosion, pesticide pollution)
- Uncontrolled deforestation which is resulting in the lowering of river water flow and the loss of important fuelwood resources

Downstream, industrial use of the river is resulting in large amounts of organic water pollution from agro-industries In addition, approximately 110 metric tons of chrome are deposited annually into the Sebou River This pollution is causing significant negative impacts on human health and biological diversity The low river water levels and high industrial pollution discharges is resulting in abnormally high river and coastal zone pollution levels

An integrated program would focus on addressing issues facing the Sebou river in a fully integrated and comprehensive manner

Project description This project will support efforts in watershed management, agricultural resource management, and industrial and municipal pollution control

Watershed management The project will provide technical assistance to local agencies involved in the managing watersheds to promote sound land use practices, and expand the capabilities of the watershed to moderate water flow An integrated watershed management approach would link upland sustainable land use practices to lowland water resource use, and is needed to manage Sebou's watershed resources This approach would include

- Identification of the costs and benefits of existing and potential sustainable practices (e g , soil erosion control, water conservation, reforestation, farming systems, alternative energy, small enterprise)
- Policy reforms and cost-effective economic incentives which encourage sustainable watershed management (e g , land and tree tenure, taxation of urban population grazing animals on the mountain environment)
- The development of a cost-effective watershed management plan
- Establishment of community resource management agreements between the government and resource users
- Monitoring the link between improved upland watershed management and the availability of benefits (e g , water resources, wildlife conservation, agricultural,

income)

Agricultural resource management The program will focus on providing technical assistance to agriculture in the Rif to reduce soil erosion The first step would be to establish contact with local farmers and discuss their priorities The fruit tree/retaining wall projects appear to be popular in the Rif so they would probably be replicated Forage crops would be tested for soil retention use The complimentary activities of water harvesting and soil conservation would be tested as a means of reducing drought risk and prolonging crop growth into the dry summer months

Industrial and municipal pollution control The program will provide technical assistance to industries and municipalities along the Sebou to reduce industrial and municipal emissions of water pollution and improve downstream water quality This program will target the tannery cooperatives in the Medina and Industrial Zones of Meknes and Fès to provide technical assistance in reducing chrome emissions The project would focus on developing pilot projects and developing cost-effective pollution prevention and end-of-pipe measures to reduce pollution while potentially improving productivity Included in this Technical Assistance could be a component to promote the development of private sector services to receive and treat tannery wastes, recycle the chrome, and resell the wastes to tanneries at a reduced costs, thus providing additional economic incentives for tanneries to cooperate with the program

Additional TA could be targeted to industries, local government, and the SSE to assist in the development industry-based environmental management performance standards and a Sebou monitoring system to assess the impacts of the project on chrome and organic concentrations in the river

In addition, the ATI should include a public education component, informing city residents, school and university students and local government officials of the importance of reducing industrial emissions and their impact on human health and the environment

Indicators

Watershed Management The management practices and incentives listed below would be intended for eventual application in watershed areas throughout the country Workshops would be held with resource users throughout the region to share lessons learned and to incentives for adoption of improved interventions

- Strengthened regional capacity for integrated land use planning and management resulting more effective use of resources
- Increase in potable water
- Increase in wood fuel energy resources in rural areas (Wood resources forty-percent of the total energy consumed)
- Adoption of sustainable soil, water and agricultural techniques resulting in protected

water resources and increased agricultural productivity

- Established systems for community participation in watershed management resulting in shared responsibility

- Protection of important wildlife and plant habitat resulting in a potential increase in rural income and services (e g , trophy hunting, medicinal plants)

- Potential increase in broad-based income associated with the expansion of tourism away from the coast and into protected areas located in Morocco's interior

Agricultural management The number of farmers participating in the fruit tree/retaining wall program The number of new ideas generated by discussions with farmers Number of farmers accepting innovative practices beyond the fruit tree/retaining wall program A spot check of farmers fields to see if the anti-erosion measures are working

Industrial pollution Amount of chrome and organic matter in the river, amount of chrome recycled, the number of industries implementing pollution prevention procedures, the active endorsement of industry cooperatives and associations, and the attendance of industry staff at pollution prevention seminars

Summary USAID has an excellent opportunity to tackle the major issues facing the Sebou River Basin, one of the most degraded and overused ecosystems in Morocco This project would focus on providing a participatory environment, coupled with emphasis on NGO's and local groups to overcome these obstacles The goals would be to stop the steep decline of environmental quality in the Rif mountains and to restore the environmental integrity of the of the Sebou river on the plains

Project description An integrated program would focus on addressing issues facing the Sebou river in a fully integrated and comprehensive manner The program would focus on

Evaluation

Importance of problem	5
Impact of problem	5
Priority of GOM	5
Priority of AID	5
U S comparative advantage	4
Trade	3
Sustainability	4
Leverage	5
NGOs	5