PN-ABS-639

isn 70322

DRAFT

METHODOLOGY TO TEST URBAN IMPACTS ON NATURAL RESOURCES

TETOUAN, MOROCCO

October 1991

Prepared by:

International Resources Group
1400 I Street, N.W.
Suite 700
Washington, DC 20005

DPRA Incorporated
910 17th St. N.W.
Suite 220
Washington, DC 20006

RDA International Inc.
801 Morey Drive
Placerville, CA.
95667

For the:

Bureau for Asia and Private Enterprise/Office of Housing
(APRE/H)
and
Bureau for Europe and the Near East/Office of Development Resources
(ENE/DR)

U.S. Agency for International Development
Washington, DC 20523

Contract # PDC-5517-I-00-0104-00
Delivery Order #7

TABLE OF CONTENTS

Section	Page No.
CONTENTS	i
EXECUTIVE SUMMARY	iii
1. BACKGROUND/SCOPE	1
2. CONCEPTUAL FRAMEWORK	1
3. THE METHODOLOGY	2
3.1 Introduction	2
3.2 Socioeconomic and Land Use Framework	3
3.2.1 Forests	4
3.2.2 Agricultural land	6
3.2.3 Rangeland	7
3.2.4 Coasts	8
3.2.5 Urbanized land	9
3.3 Water	10
3.3.1 Groundwater	10
3.3.2 Surface water	12
3.3.3 Fisheries	14
3.4 Biota	15
3.4.1 Identifying the representative habitats and key human activities	16
3.4.2 Measurable human impacts	16
3.4.3 Questions remaining to be answered	16
3.5 Air	19
3.6 Ranking Technique	19

TABLE OF CONTENTS (Continued)

Section	Page No.
4. PRE-SITE ANALYSIS: TETOUAN, MOROCCO	20
4.1 Data Collection	20
4.2 Urban Growth Trends	21
4.3 Land Resources	21
4.4 Water Resources	22
4.5 Biota Resources	23
4.6 Air Resources	23

TABLES

1. Habitat Types and the Urban Influences	17
2. Organisms and the Urban Influences	18

APPENDICES

Appendix A: Impact Matrix	24
Appendix B: Bibliography	25
Appendix C: List of Organizations and Individuals Contacted	28

EXECUTIVE SUMMARY

Population growth in developing countries over the past 25 years has led to a dramatic increase in rural to urban migration, primarily as a result of deteriorating conditions in rural areas and the perception that better ones exist in urban areas. The result has been a substantial increase in the size and population of urban areas. As the process has been age selective, with the majority of the immigrants being of child bearing age, urban populations are expected to grow at an even more accelerated rate due now to their own rapid internal growth.

In recent years, the U.S. Agency for International Development has devoted more attention to urbanization and its effect on the environment in the developing world. This study will assess environmental impact of urbanization in Tetouan, Morocco. It is sponsored jointly by the Bureau for Asia and Private Enterprise/Housing Office (APRE/H) in conjunction with the Bureau for Europe and Near East/Development Resources Office (ENE/DR).

The study will consist of two stages. Stage one involves the development of a methodological framework for testing the relationship between urban activity and natural resource impact as well as a pre-site analysis of data available on present conditions at the chosen site. Stage two will entail the application of the methodology in the field.

Although the focus of this study is Tetouan, an outgrowth of the project will be the refinement of the methodology to allow for its application in other areas that are also facing rapid urbanization.

The application of the methodology in Tetouan will enable USAID to verify whether or not the methodology is a useful tool for assisting in the planning of host country environmental project agendas, the development of A.I.D programs, and the identification of areas requiring further investigation.

Preceding studies have attempted to apply a methodological framework for investigating the impacts of urbanization from two other perspectives, human health and economic development. The present study is undertaken from an essentially ecological perspective. The tool developed for recording urban/natural resource interactions is an impact matrix. The matrix allows one to identify and describe the impacts (physical and chemical) of human activities upon relevant natural resource bases. In addition to direct human impacts, the matrix allows for the identification and description of secondary impacts. Secondary impacts occur when a change in one resource effects change in another, as in the case of deforestation and subsequent soil erosion and surface water sedimentation.

An initial methodological framework has been developed which involved survey and analysis of data from secondary sources both on the general area of urbanization and environmental impacts as well as the current situation in Tetouan. A pre-site analysis of the available data was conducted. This analysis was intended to identify key resources at risk and establish linkages to urban activities which may be threatening these resources. Project constraints preclude an exhaustive analysis of the entire list of natural resources at risk from urban activities in Tetouan, however, results of the pre-site analysis point to a number of natural resource/urbanization interactions which clearly need to be examined in the context of this project. They include the following:

- Agricultural and other land use encroachment
- Coastal lands, wetlands and marine habitat degradation
- Surface water degradation
- Groundwater degradation
- Deforestation and watershed degradation

The methodology is intended to be resource driven therefore boundaries for study of each resource will depend upon its relationship and linkage to specific urban activities. For example, if deforestation appears to be resulting in se· ıs resource depletion it will be examined only in relation to the urban activities which are a direct contributing factor i.e., the cutting for fuel wood or building poles.

Further data, available in Morocco and again from primarily secondary sources will be reviewed and analyzed. Interviews and direct field observations will define the conditions in Tetouan and allow for refinement of the methodology.

1. BACKGROUND/SCOPE

During recent years considerable attention has been paid by the U.S. Agency for International Development to the phenomenon of increasing urbanization and its relationship to the environment in developing countries. As a part of this focus the Office of Housing and Urban Programs has undertaken a number of activities aimed at better understanding this relationship and its impact on the development process. The current study is part of those on-going activities and is jointly sponsored by the Housing Office (APRE/H) in conjunction with the Bureau for Europe Near East/Development Resources Office (ENE/DR).

This is the third application of a methodology in a tri-part series aimed at analyzing the impacts of urbanization from three distinctly different perspectives,the first two being human health and economic development. The present study is being undertaken from an essentially ecological perspective. The study will attempt to develop and test a methodology aimed at investigating the relationship between the activities of an urban area and its surrounding natural resource bases. The methodology will seek to identify, quantify and rank by degree of degradation, resources of the eco-system directly impacted by urban related activity.

The intent is to develop a methodology sufficiently universal in scope to enable replicable applications in sites with varying conditions.

A subsequent field test of the methodology will enable USAID to determine whether the methodology proves a useful tool for assisting in the identification of criteria for further investigation and the development of future environmental action plans.

2. CONCEPTUAL FRAMEWORK

Population growth in the developing world has placed tremendous pressure on rural economies, predominantly agricultural, to support this growth. The result has been a dramatic increase over the past 25 years in the trend toward rapid urbanization. This increase in urbanization is primarily the result of rural to urban migration driven by deteriorating conditions in rural areas and the perception that more favorable ones exist in urban areas.

As a result of the process being age selective, with most of the immigrants being of child bearing age, this phenomenon is expected to occur at an even more accelerated rate due now to rapid internal urban growth. It is projected that by the year 2000 major percentages of the populations of developing countries will live in urban areas.

Cities, as centers of production and consumption, require raw materials (resources) as input and need to expel waste byproducts as output of these two activities (and all their subsets). This process of urban-rural interaction on the natural resource base is the core of the approach to this study.

An example may serve to clarify the concept. As the catalyst activity, consider uncontrolled urban growth. As rural-urban migration mounts, lack of housing within the city often results in the unplanned expansion of the urban area, "urban sprawl" onto land formally used for alternative purposes such as agriculture or forest reserve. The increase in population is often accompanied with increased demand for food production, hence other land often marginal or ill suited for agriculture i.e., hillsides or watershed areas, are brought under cultivation, more often than not with the increased use of fertilizers and pesticides to bolster productive capacity.

The result of the encroachment of agriculture onto forestland is deforestation (with subsequent loss of wildlife habitat), which in turn leads directly to soil erosion. Soils erode and silt into rivers, lakes, and reservoirs, the sedimentation seriously interfering with their function.

While these urban-based activities are creating this chain reaction pressure on resources, the consumption/production cycle within the city is also utilizing resources. Clean water for example, is a requisite for residential, industrial and commercial development. Water used in the various processes mentioned above finds its way into surface and ground water. If the cycle is allowed to occur without treatment not only does the water resource become degraded but downstream resources, fisheries, coral reefs, beaches etc., are also the recipients of pollution loadings and they too are seriously impacted.

The synergistic effects of the impacts of urban activities on natural resource bases constitute the basic conceptual framework for this methodology.

3. THE METHODOLOGY

3.1 Introduction

In order to assess the effect of urbanization on regional natural resources while incorporating the synergistic relationships described above, the methodology includes five distinct steps:

1. Selecting the key resources to be examined in a particular site;

2. Quantifying those resources in physical, geographic, productive and/or economic terms;

3. Identifying the urban-based human activities which impinge upon the resources;

4. Quantifying the degree of impact of each of those activities on each resource;

5. Ranking the resources according to the severity of their degradation.

Site-specific conditions will dictate the selection of those resources considered most relevant or most likely to be considered vulnerable (Step 1). The quantification step (Step 2) is also designed to be resource-driven: for example agricultural land would not only be measured in terms of irrigated v. rain-fed hectares under cultivation, but also crop composition and baseline productivity under normal post-fallow conditions. Human activities include all potentially positive and negative actions that affect the quality and/or quantity of the resource (Step 3). In the agricultural example, this might include increasing urban demand for domestically grown produce, resulting in increased use of fertilizers to improve soil productivity. The method of quantifying the degree of impact of those activities (Step 4) will vary according to the nature of the impact: percent spoliated, yield increase etc. Whether or not specific quantified data is available for measurement of an impact, the level of impact should be estimated on the basis of available data: severe, moderate, slight.

The tool envisioned for recording these interactions is an impact matrix (Appendix A), setting human activities against identified resources. The activities listed along the vertical axis of the matrix are designed to be determined in each site application under the general headings of chemical and physical impacts. Once the impacts identified are quantified and ranked high, medium or low, the matrix may be used to compare the extent of degradation and the relative importance (or scarcity) of the resources in physical terms. In addition to direct human impacts, the matrix permits description of the interdependent impacts among resources, for example the increased rate of soil erosion due to deforestation. The matrix may be used as well to track relative impacts over time through successive data recordings of the same activities and resource impacts.

It should be noted that the rapid assessment techniques to be used by any team in gathering field data will probably not permit the degree of depth and breadth outlined in this methodology. The data indicated are intended to represent a best-case goal; the choices of what kinds of data are most appropriately gathered with reference to which resources must be made on a site-specific and team-specific basis.

3.2 Socioeconomic and Land Use Analysis

The purpose of this task is to provide the foundation for the impact assessment, specifically the land, the people, and the people's behavior toward the land. It is intended to provide a snapshot of Tetouan as it is today in order to project the growth of the city and the impact of that growth on the natural resource base. The data collected and arrayed in this task will serve largely as input to the resource-driven evaluation. Determination of development trends is a key component of this task.

- Briefly describe Tetouan and its region in terms of its historical development and current development trends that may have significant impacts on the natural environment.

- Identify, categorize, and quantify general land use within the defined study area. Applicable categories will include:

  - forest land
  - agricultural land
  - rangeland
  - wetlands
  - coastal lands
  - urbanized land

- Determine constraints to development. These might include physical impediments such as waterlogged or saline soils unsuitable for agriculture or urban development or legal constraints such as land tenure issues.

- Determine development trends. With mapping or aerial photography as available, a picture will be drawn of how Tetouan has developed over time. Then, combining the results of this task with those of Step 2, determination will be made of where development might proceed and be accommodated in future.

- Develop a profile of the local population, together with projections. This should include total population by sex and age, number of households, and household size. This will enable the determination of typical population density to aid in future projections of land absorption.

- Develop a current employment profile together with potential future industrial development in order to examine certain types of human behavior toward the environment.

- Describe cultural patterns of the local populace as they might impact the environment.

3.2.1 Forests

- Quantifying the resource:

  - Determine the relative areas of natural forest, plantation, primary/secondary growth forest, and/or closed/open forest, as well as the species composition and mean annual increment (MAI) of growth per species;

- Quantify the forest resources in terms of the economic activity they generate, i.e., the proportion of income and employment which production of this resource contributes to the regional and national economy; and

- Determine the rights regime for access to the resource: permits, ownership opportunities, leasing options and access approval requirements of government management agencies.

- Key human activities:

People harvest trees for use as energy and building materials, and collect a myriad non-forest products. Key human activities to be examined include:

- Commercial and informal gathering of fuelwood (most often a residual "free good" following production of other kinds;

- Commercial production of building materials and non-wood commodities (medicinal plants, exportable animals etc.);

- Collection of building materials and non-wood products for household use or sale on local markets;

- Wood consumption patterns of urban populations;

- The demand for alternative use of forest land, e.g., for agriculture, housing etc., and the nature of its acquisition (burning, clearcutting etc.); and

- The extent of agroforestry projects in areas used primarily for agriculture, and the degree to which such projects meet demand for fuelwood and building materials.

Placing all of these activities in the context of existing reforestation projects, agroforestry projects and natural forest management plans (NFM) will reveal the relative impact of whatever human mitigation activities are already underway.

- Measurable impacts:

- The loss of forest area from overcutting for fuelwood, charcoal production, logging, and agricultural conversion, as well as waste inefficiencies in each activity;

- Changes in urban and regional consumption of forest products by households, industry and services;

- The number and productivity of existing agroforestry projects; and

- Changes in relative prices for wood and non-wood commodities and the elasticities of supply and demand over time, to determine whether fiscal policy interventions could effectively slow the rate of deforestation without extreme negative impacts on household income.

3.2.2 Agricultural land

- Quantifying the resource:

  - Distinguish the relative extent and quality of arable and farmed land in suburban regions, and whether the land is used primarily for rain-fed or irrigated agriculture. Cultivation of low v. high value-added cash crops and the extent of subsistence farming also represent basic quantifying measurements.

  - Some estimate of the role of agriculture in the regional economy, again in terms both of employment and contribution to income, is essential to understanding the nature of the resource. Likewise, a determination of the land tenure regime governing access to agricultural land: permits, ownership, inheritance, traditional community use, sharecropping etc.

- Key human activities:

  - Changes in urban demand for agricultural produce, relative to changes in income and population, constitute the most important independent variable with respect to agricultural land.

  - Physical interventions to improve productivity in response to this demand (windbreaks, fallowing, contouring, dikes, irrigation, terracing, variable cropping patterns, and others), and their relative effectiveness vis-a-vis erosion abatement and increased yields deserve attention. No less important are the chemical interventions to improve productivity: fertilizers and pesticides.

  - Knowledge of the associations formed by farmers for price setting and marketing in urban regions is key to understanding the urban/rural interface with respect to the use of agricultural land. Infrastructural development for transportation and marketing in urban areas must be included in this analysis.

- Measurable impacts:

  - Urban encroachment on former agricultural land.

  - Land used previously for other purposes, i.e., forest or watershed, or marginal land now brought under agriculture as a result of urban sprawl.

  - Changes in soil productivity and erosion rates.

  - Trends in agricultural production, costs and changes in physical and chemical interventions.

  - Relative farm gate and market prices over time of regional produce.

3.2.3 Rangeland

- Quantifying the resource:

  - Determine the extent and quality of rangeland in the impact region. The relative proportions of rangeland used for support of cattle v. sheep v. goats etc., should be drawn in the context of the land's economic productivity in relation to the regional and national economy, especially with respect to employment levels and income generation.

  - Determine the land tenure regime for access to the resource: the system of traditional use rights permits, ownership opportunities, leasing options and access approval requirements of government management agencies.

- Key human activities:

  - The rangelands are crucial to urban populations in terms of supplies of meat and milk and the cultural role of livestock as a source of wealth and security.

- Measurable impacts:

  - Urban encroachment on former rangeland.

  - Land converted from other uses as rangeland in response for increased demands for livestock products.

  - Changes in soil productivity and erosion rates on rangeland.

- Trends in livestock production including costs and other variables.

- Changes in relative market prices for livestock products over time.

3.2.4 Coasts

- Quantifying the resource:

  - Determine the quantity and quality of existing coastal resources: beaches aquatic flora, natural erosion rates, propensity for siltation, water quality and potential ecosystems vulnerable to tourism development.

  - Estimate the economic role of coastal resources in the context of the regional and national economy, specifically in terms of employment and income.

  - Determine the rights regime for access to the resource: permits, ownership opportunities, leasing options and access approval requirements of government management agencies.

- Key human activities:

  - Land and offshore waste disposal are key activities to be examined but coastal areas also serve as sites for commercial and non-commercial fishing, human habitation, wood gathering and charcoal production, non-commercial recreation and tourism.

- Measurable impacts:

  - Impacts to be measured include the types, degree, and trends of use of coastal resources by urban populations. Water quality and beach waste can be described and quantified as can estimates of the fishing yield trends. To what extent is the land settled by low, medium, and high-income neighborhoods?

  - Some estimate should be made of the extent (and implied capacity) for tourism development, the existing structure of competition for use of the resource, relative price regimes and infrastructural development. If time permits, a cost/benefit analysis of various development and waste treatment schemes can be conducted from the private, public and social viewpoints.

3.2.5 Urbanized land

- Quantifying the resource:

  - Determine amounts of land, both within the urban area, i.e., within the legal boundaries and actively planned extent of Tetouan, and the urbanizing area. The latter comprises the Peri-urban area where spillover growth that can no longer be accommodated within the confines of the city. It is usually characterized by leapfrog development in the form of uncontrolled clandestine settlements that alter other land uses (such as agriculture), leaving large vacant areas and exacerbating the difficulty and cost of providing services.

  - Key uses of urbanized land that will be quantified include residential, commercial, industrial, institutional, and open space. Open space is an inclusive category that comprises such things as parks, wildlife preserves, recreation areas or simply non-built areas.

- Key human activities:

  - In the context of this study, urbanized land is not a resource in the same sense as forest or rangeland, land is the resource. Urban development and associated activities create a demand for land that can conflict with other land uses. An understanding of how people live, work, and play in Tetouan is critical to determining the amount of land that will be required for these activities in the future.

- Measurable impacts:

  - The impacts to be measured are related to the amount of land needed for future urbanization and the amounts still available for this purpose that are relatively unconstrained by such considerations as physical unsuitability for construction or culture constraints related to land tenure or religions systems. As a result of these constraints, development pushes out into lands currently in other types of uses. The conclusion of this task is to depict alternative scenarios of where that development might go, and thus enable an estimation of the measurable impact it would have on the range of other land uses.

3.3 Water

Components of water resources are essentially surface (rivers and its tributaries...) and groundwater (aquifers). Sea water can also be considered a resource inasmuch as it therefore houses marine life and particularly fish; thus fisheries will be considered the resource of interest in this methodological approach. Each resource will be considered under quantitative (physical) and qualitative (chemical) aspects.

3.3.1 Groundwater

- Quantifying the resource:

  - Delimiting the watershed within the area under consideration. This will include establishing the geographical boundaries of the watershed, in addition to a numerical quantification of the size and location of aquifers as well as assessing the recharging pattern in terms of sources and magnitude.

  - For each aquifer, information should be gathered on the historical trends of the water table levels and its variation using available piezometric data. All of the above information will allow the analyst to establish an overall idea of the potential volume of water present in the system, and establish an idea on whether or not the groundwater potential in the site under investigation is being exhausted.

  - The rates of groundwater use per category of usage will then be established (percentage of groundwater used in agriculture, drinking water and industrial use) and compared to the total volume present in the system. This can be achieved by analyzing rates of groundwater pumping for each category of usage. The results of this survey will help determine the trends of utilization as a function of activity. The ultimate objective is to establish exploitation indexes that can be translated into economical terms. For example, for each category of usage (irrigation, drinking, industrial) well drilling costs by different kinds of wells, pumping techniques used, and lifespan of present pumps under utilization will be established.

  - This will lead to an estimate of the cost of one m3 of groundwater pumped per category of usage. This data will then be compared to similar figures generated for surface water.

  - In addition, water quality in locations upstream of any pollution source should be determined in order to serve as a base line physico-chemistry of the groundwater before being impacted by human activity.

- Key human activities:

Activities that might impact on the size and quality of groundwater will be established. The potential activities that have potential deleterious effects include:

  - Overpumping

  - Deforestation that might decrease soil permeability and hence the recharging potential,

  - Chemical and bacteriological contamination through seepage into the aquifers from unsanitary solid waste landfills, from industrial sources and from direct wastewater discharge into artisan wells.

- Measurable impacts:

  - The impact of overpumping can be two-fold: a reduction in the size of the aquifer and an intrusion of the salt water (from the sea) into the aquifer. Both impacts can be quantified by measuring drawdowns at different locations, especially in critical locations like the coastal zones, and analyzing the corresponding patterns in addition to the measurement of conductivity in groundwater samples.

  - The chemical and bacteriological impacts can be quantified, by first locating the sources of contaminations (locations of landfills, industries, and points of wastewater discharge) with respect to the water table of each aquifer, establishing a hypothetical transport pathway into the aquifer, estimating rates of discharge from each source, and finally, calculating the pollution load that the aquifer is receiving. This methodology can be performed for each chemical compound or bacteriological indicator under consideration.

  - The verification procedure includes comparing available data on the chemical composition and the bacteriological quality of groundwater samples with the calculated loading. This exercise is crucial for estimating the future impact of an increase in the above human activities as a result of urban growth.

  - Finally, the extent of the impact can be determined by comparing the collected, estimated, and calculated data with internationally accepted water quality standards.

3.3.2 Surface water

- Quantifying the resource:

  - The quantification process will begin by establishing a geographical survey of all rivers and their tributaries in the site under investigation. The characterization of the surveyed systems will include the following: basic climatological data, location of the river mouth, length, flow regimes in wet and dry seasons in order to estimate seasonal water balance and points of discharge into the sea.

  - The same methodological approach applied for groundwater should then be undertaken in order to determine the surface water usage by category (irrigation, drinking, industrial) and the rates of utilization.

  - The physico-chemical composition of the water at the source of the river should also be determined and used as a base line reference.

- Key human activities:

  - Direct discharge of untreated wastewater and untreated industrial effluents into the river.

  - Direct discharge of solid wastes into the river.

  - Agriculture practices upstream or adjacent to the river that might lead to a substantial increase of mineral fertilizers (N, P, K) and organic pesticide loadings in the river.

  - Deforestation activities for urban growth purposes (housing construction) or for agricultural purposes (to satisfy growing urban needs), that might lead to increase loads of suspended solids (silts, gravels, vegetative debris...) in the water, and damaging of the river beds as direct result of soil erosion, especially in steep areas.

  - Extraction of soil material for construction needs in quarries situated along the banks of the river. The physical impact on the water composition in terms of suspended matter and siltation might be significant.

These activities are direct consequences of urban development and growth. High water demand and consumption result in increased reliance on surface water as a resource, parallel to an increase in the volumes of discharges (physical, biological, and chemical) into the same resource thereby provoking a quantitative shortage of a clean resource readily available in addition to a severe qualitative degradation. The economic cost associated with this phenomenon is to be evaluated in terms of additional cost of treatment and the necessity to rely on other sources of water supplies (reservoirs situated at remote distances from the city).

- Measurable impacts:

The impact of each of the potential human activity listed above must be quantified first by identifying the source of the activity that is provoking the impact and second by numerically quantifying the impact in terms of the physical, chemical, and biological and chemical loads that the river is receiving:

- Wastewater discharge: the need is to analyze the present status of the sewerage system in terms of percent of sewered and unsewered population, layout and size (diameter of sewers) of present sewer system, locations and number of outfalls into the river, present and projected per capita BOD_5 and suspended loads into the river, levels of dissolved oxygen including daily and seasonal variations and the fraction of sewage disposed on lands. This methodological process will help establish estimates of loadings not only on the river but also on fisheries, wetlands and other sensitive areas, as the pollutants plume moves downstream into the sea. Those loadings will be analyzed based on theoretical knowledge and compared to standards and norms.

- Industrial effluents: industries' locations and types along or adjacent to the river and its tributaries should be established. The types of residuals for each industry should be determined along with an estimation of the quantities discharged. Present and projected loads should be estimated for each compound or class of compounds. Loadings will be analyzed for the purpose of establishing ranking of levels of contamination for existing and projected conditions.

- The phenomenon of solid wastes discharged into the river will be analyzed in terms of occurrence, location, and magnitude. Its effects on beach littering will be assessed as related to tourism.

- Agricultural practices that contribute to increased loadings of minerals and pesticides will be identified. Loadings that might lead to eutrophication phenomena, will be estimated based on known utilization rates of fertilizers and pesticides, and on measured levels of those minerals in the river. The effect of those agricultural discharges on oxygen levels will also be estimated.

- Deforestation activity characterized in another part of 3.2.1 of the methodology will serve as basis for estimating the loads of suspended matters originating from soil erosion.

- Quarries will be geographically surveyed and analyzed for the present and future amounts of suspended solids discharged into the river. The effect on water siltation will be examined and loads established.

3.3.3 Fisheries

- Quantifying the resource:

  - After determining the quantity and quality of existing fisheries, some estimate of the species composition, the regular offtake and the mean annual increment, should be determined from secondary sources, including industry reports. The relative importance of fisheries as a regional employer and income generator should be estimated from the relative size of the industry.

  - The team should also determine the rights regime for access to the resource including licensing, permits, fishing associations and traditional community-based use patterns. If fisheries constitute a resource for generating high value-added exports (and thereby foreign exchange), the relevant government regulations must also be assessed.

- Key human activities:

  - The main urban-based activity to be considered is direct or upstream waste disposal, and all effluents and solid waste flows should be examined with respect to their effect on the productivity of the resource.

  - Other human activities include urban consumption of fish and fish by-products, and demand trends.

- Measurable impacts:

  - Changes in yield constitute the most important impact to be quantified. Expressed in terms of time spent fishing in open waters, the catch over time will indicate the degree of degradation.

  - Chemical and biological conditions of the fisheries habitat--including but not limited to B.O.D., toxicity, and levels of fecal coliform--is also crucial to understanding the relative impact of urban waste on the productive resource.

  - Other relevant data include producer and retail price trends and industrial production cost trends to determine the marginal costs and benefits of whatever mitigation measures may be already underway.

3.4 Biota

In recent years, the preservation of biodiversity has been repeatedly identified as a prime goal of sustainable development. For USAID the legislative mandates for the protection of biodiversity and tropical forests are found in Sections 118 and 119 of The Foreign Assistance Act. Urban activities have the potential to exert particularly severe pressures on biodiversity.

The preservation of biodiversity has two important aspects. Clearly, the protection of rare, endangered, and/or endemic species is an important element of the preservation of biodiversity. However, it is recognized that this is not always possible. It may be impossible to identify endangered species early enough, particularly when those species are small and inconspicuous. Additionally, the preservation of certain species is extremely costly or difficult to realize (e.g., the California condor). Finally, the preservation of particular species may come into direct conflict with economic or development interests (e.g., the Pacific spotted owl and logging). For these reasons, recent conservation efforts have been placed on the preservation, not of endangered species, but rather of endangered spaces: representative areas of habitat capable of sustaining the majority of species that use a particular area.

The methodology to assess the impact of urbanization on biodiversity in a particular area suggested for this study involves the following steps.

- Identification of the major habitat types in the area of interest;

- Identification of the species of particular ecological note (e.g., endangered, endemic, etc.) that are either indigenous or that require the area during migration;

- Characterization of the urban activities that (potentially) impinge upon the persistence of species and of spaces;

- Estimation of the severity of stress that those activities impose;

- Prioritization of conservation activities.

3.4.1 Identifying the representative habitats and key human activities

A complete list of habitat types in a particular area can be compiled only after inspecting the site. Similarly, the urban activities likely to affect those habitats depend upon local conditions. Table 1 presents a tentative list of habitats, and the urban activities hypothesized to most strongly influence them, based on the case of Tetouan. This list could be easily modified to incorporate local conditions elsewhere.

A complementary approach is to consider the impact of urban activities on particular groups of organisms, since the sensitivity to particular urban activities may vary markedly among groups. Table 2 summarizes these effects. To a considerable extent, Tables 1 and 2 represent different views of the same problem.

3.4.2 Measurable human impacts

Human impact will be evidenced by a number of different symptoms. Most often, habitat simply disappears: wetlands are drained, forests are cut, grasslands are tilled. In some cases, habitat is fragmented into pieces too small to permit the persistence of species that require large territories or relatively undisturbed conditions for breeding.

In other cases, habitat degradation is caused by the presence of residuals. This is particular crucial in the case of aquatic habitats, where loading with inorganic nutrients (e.g., N, P), metals or xenobiotic organics can intoxicate organisms, or can promote the growth of a few species to the exclusion of others.

3.4.3 Questions remaining to be answered

- Which species are indigenous to the area? Which habitats do they use? Are there species of particular ecological note?

- Based on the first item, is the list of habitat types complete?

- Which urban activities threaten those habitats? Do Tables 1 and 2 overlook any activities?

Table 1. Habitat Types and the Urban Influences

A partial list of habitat types and the urban influences most likely to exert deleterious effects on them.

Habitat	Potentially deleterious urban activity
Natural forest	- overcutting for firewood, polewood, etc. - fragmentation - hunting
Grasslands scrublands desert	- over-grazing - shifting agriculture
Wetlands Estuaries	- modification of the water flow regime - loading with metals or toxic organics - salinity variation
Lakes	- cultural eutrophication (loading with nutrients and organic carbon) - airborne contaminants (e.g., acidification)
Coastal marine habitats	- over-harvesting - river-borne residuals - physical damage from tourists

Table 2. Organisms and the Urban Influences

A partial list of types of organisms and the types of urban influences most likely to exert negative influences upon them.

Group of organisms	Potentially deleterious urban activity
Terrestrial plants	- forestry practices - land clearing - grazing by domestic animals - locally intense pollution (e.g., smelters) - erosion
Birds Mammals	- fragmentation of habitat into pieces smaller than territory sizes - hunting - quite low levels of toxic organics (e.g., DDT)
Reptiles Amphibians	- habitat availability - xenobiotics
Freshwater organisms	- eutrophication - industrial effluents - acidification - water supply - disturbance of breeding areas
Estuarine organisms	- water supply - metals and toxic organics
Marine organisms	- over-harvesting - intense pollution from rivers or coastal development - thermal variation - reefs are sensitive to just about everything

- Are particular species threatened? Are there temporal trends in species' densities? Are there particular species that have become much more abundant? If so, how do the latter influence the other species in the community?

- How serious or pressing are each of the threats? Which urban activities are relatively innocuous, and which are especially deleterious?

3.5 Air

Air pollution issues will be addressed inasmuch as natural resources are affected by urban activity related air deterioration. For example, if industrial air pollution seems to affect wildlife habitats or certain organisms (biota), attempts will be made to identify the source of the pollution, quantify it and evaluate long term effect.

3.6 Ranking Technique

The goal of this study is to provide guidelines that will assist A.I.D. and the host government to identify the resources most urgently threatened by urbanization. To do this, one must provide two rankings. First, for each resource, rank the intensity of pressure exerted by various urban activities. Second, identify those resources most urgently threatened by urbanization.

The ranking process is impeded by the nature of the data that is likely to be available. Clearly, data will often be fragmented, qualitative, or indirect. Therefore, the team will characterize impacts qualitatively as severe, moderate, or slight. A severe impact is defined as one that is likely to produce a substantial decline in the utility of the resource within 10-20 years. Moderate impacts are those that would be detectable, but of minor magnitude, over the same period. Slight effects are those that should take a century or more to be judged as significant.

Ranking the resources themselves according to the degree of threat is more difficult. Clearly, the team cannot judge which resources are worthy of protection. For example, is disappearance of wildlife habitat more or less pressing than disappearance of easily accessible fuel wood? Value judgments of this sort are beyond the scope of this study. We therefore propose to rank the cumulative threat to resources according to the following criteria.

- Present extent of degradation of the resource, relative to the pristine state (severe/moderate/slight). Is the resource already severely degraded? If so, the resource may either merit immediate attention, or it may be beyond useful salvaging.

- Condition of the remaining resource (good/fair/poor). This should aid in deciding if the resource merits attention. In particular, a resource that is severely degraded, except for a small part, may be particularly worthy of attention. For example, if most surface waters are polluted, except for one particular source, that source may be particularly critical to preserve.

- Threat to the resource (severe/moderate/slight), given projected urban development (explained above).

- Economic value or potential of the resource (great/ moderate/ slight). Under this heading, the team will estimate the potential or realized contribution of the resource to the economic well-being of regional residents.

Based on the four indices described above, A.I.D. and the host government should be able to independently evaluate cost-effective means of addressing the most pressing environmental problems.

4. PRE-SITE ANALYSIS: TETOUAN, MOROCCO

4.1 Data Collection

Sources of information on the state of environmental conditions in developing countries remains scarce. This holds true for available data on Morocco and specifically Tetouan. As a result, information was obtained primarily from the secondary sources listed in the bibliography (Appendix B) and by interviews with organizations and individuals listed in Appendix C. In addition current topographical maps were utilized but essential satellite imagery was not available.

The methodology employs a variety of sources which include reports carried out under The World Bank's Environment Program for the Mediterranean, papers prepared for the U.S. Agency for International Development, World Resources Institute, United Nations Environment Program, United Nations Development Program, and The Bryler Corporation. Furthermore, interviews were conducted with representatives and consultants from The World Bank, USAID, and The Bryler Corporation. A complete list of people contacted appears in Appendix C. Data resources have been identified in Morocco and include the following: The Bryler Corporation, Government Ministries, Al Hassan II University and the Faculté des Sciences Tetouan in addition to meetings set up with key contacts prior to the team's arrival. Consequently, the team will be able to expedite in-country data collection in support of the methodology.

4.2 Urban Growth Trends

Tetouan is located along the Mediterranean coast within Morocco's rich agricultural basin. The proposed study area includes the city of Tetouan and some portion of its provincial setting, the "actual boundaries" will be determined in the field and based on the extent of perceived impact of each resource (see description of varying resource impact boundaries).

The study area includes a variety of urban, rural and coastal environments and is dominated by the city of Tetouan, which is located nine kilometers from the Mediterranean coast along the Rio Martil.

The city of Tetouan, identified as one of Morocco's six high-growth industrial areas, doubled in population between 1956 and 1982. Urban population now stands at approximately 240,000, a third of the provincial total. The region's annual population growth rate is believed to be 2.5 percent but may be higher. Estimates for the region indicate that the population will reach between 350,000 to 400,000 by the turn of the century. In 1981, 38.2 percent of the city's residents lived in clandestine housing and close to 50 percent of the dwellings which had been constructed over the previous ten years were unauthorized. Housing continues to encroach on the steeper slopes of the hills surrounding the city, placing a strain on services and ecosystems, because neither are physically suited to support heavy urban development. The Dersa Samsa neighborhood, for example, which grew up helter skelter on the steep and unstable slopes of the eastern fringe of Tetouan, was home to 54,000 people in the mid-1980s living in 9500 households. Of the 7500 lots they occupy, as many as 3300 lots illegally occupy municipal land, and most of the remaining on private land not yet surveyed. Furthermore, it is projected that urban population will reach 364,000 by the year 2000 resulting in further demand for housing.

Morocco's location on the Mediterranean coast adjacent to the Straits of Gibraltar make it a prime location for tourism development. This location also makes the country well suited to the provision of exported goods and services to Spain, and through Spain to the rest of the European Community, Morocco's primary trading region. The pressure for development has strained the capacity of water supply, telecommunications and energy supply networks throughout the region, but with particularly serious consequences in urban Tetouan.

4.3 Land Resources

Urban Tetouan lies on the lower slopes of a hill which extends down to the Rio Martil and up into forested land. Encroachment of unauthorized settlements up the hillside into steeper gradients has reduced soil permeability and increased the downflow of mud, rocks and solid waste into lower lying urban areas. Urbanization therefore has had a direct impact on the immediate resource base as well as on land resources farther afield.

Use of the land resource for solid waste disposal is also likely to represent a major area of concern. Solid waste generated from Tetouan totals 0.7 kg/pc/day with a density of 200 kg/m3. Therefore, daily waste generation in Tetouan is 140 tons/day, and is expected to increase to 260 tons by the year 2000. Volume of trash now totals 700 m3/day, and will almost double to 1300 m3/day by 2000. Lack of municipal sanitation services, particularly in informal areas, has led to uncontrolled dumping outside the city and even within residential areas. The impact of this uncontrolled dumping on groundwater and surface water quality are likely to be significant.

Coastal land along the Mediterranean north and south of the Alila and Martil rivers will constitute a major focus of the study given the pressures for tourism development, lack of existing infrastructure and the spoliation of coastal waters and beaches from the plume of contaminated water emanating from the outflow of the Rio Martil. The extent and nature of the damage is not yet known, but preliminary data indicate that urban effluents from the city are impacting the quality of coastal resources. Similar pressure is being felt on fragile wetlands located in the corridor of the migratory bird flyway that traverses the northwestern edge of Morocco and crosses the Gibraltar Straits.

Although encroachment on the 200,000 ha of regional forests may have occurred at an alarming rate, prompting a general reforestation campaign since the early 1980s, the team anticipates that the relative demand for fuel and building materials in urban Tetouan, is not increasing as fast as population since local cement industries and electrification are meeting an increasing proportion of the demand for these products. Seventy-four percent of Moroccan households are electrified and by 1995, electricity will meet 40 percent of total energy demand across the country. Physical encroachment of the forest for alternative use, settlement or agriculture, is likely to constitute a more serious threat.

4.4 Water Resources

Surface water and groundwater resources in the Tetouan region have generated intense study in the past and continue to warrant close attention. As a consumable resource, water is drawn from the Martil, as well as from aquifers. The water budget for the Mediterranean coast deficit is expected to bottom out in the year 2000, reverting to a surplus by 2020 with increased delivery infrastructure. An estimate of potable water demand for drinking purposes is 54,345 m3/day, with a peak of 61,000 m3/day; the demand is being met satisfactorily from reservoirs and groundwater. General demand for water use is expected to increase from 130 liters/pc/day (1987) to 250 liters/pc/day: in the year 2000, total volume demand could reach 125,750 m3/day.

More worrisome than the quantity of water to meet growing urban needs is water quality. The Rio Martil has served as a sink for industrial and household effluents for centuries. The variable seasonal flow ranges from 60 m3/second in January to near zero in July, reducing the river basin to an open running sewer fed by at least eleven unitary outflow sources, discharging both domestic and industrial wastes. Domestic effluents average 43

grams of BOD per capita per day, and the total BOD load presently is 10,000 kg/day, projected to increase to 20,000 by the year 2000. Wastewater discharge from industry totaled 33,400 m3/day in 1987, and is expected to almost double by the year 2000. Total suspended solid load is also expected to double over the same period, from a baseline of 14,000 kg/day. Data from 1983-84 indicates the phosphorus concentration in the Rio Martil at 2.1 mg/liter and nitrogen at 2.4 mg/liter. Only trace amounts of heavy metals in the water have been recorded. Groundwater resources seem also to suffer both qualitatively and quantitatively from leaching of pollutants from solid waste landfills and excessive pumping with leaching to lower water table and salt intrusion into the aquifer, in addition to significant bacterial count.

Water as a habitat for commercial fisheries will be studied while in the field. Review of preliminary data seems to indicate that the pollution loading deposited by the Rio Martil and the resultant plume is having an impact on marine life near the town of Martil. Fisheries including shell fish and reef habitat, will be examined.

4.5 Biota Resources

The World Bank and the European Investment Bank (1990) have identified the region from Tetouan to the Straits of Gibraltar as one of the most ecologically sensitive areas in the Mediterranean basin. Migrant birds from the western third of Europe use the area, and its wetlands in particular, during biannual migrations to and from the tropics. The remains of first-growth cedar forests remain in the mountains, and the adjacent Mediterranean waters are home to a large number of marine mammals and fish.

A major threat to these biotic resources is the modification of the natural habitats. Large mammals have largely disappeared from the region due to the disappearance of habitat. It is not known to what extent suitable patches of habitat still exist. The wetlands that support many species of birds (including the many of the most popular species of game birds) and plants are threatened by draining, diking and poisoning with water-borne residuals. In particular, it has come to the team's attention that a plan is being considered to divert wastewater into wetlands along the Rio Martil is being considered in order to provide inexpensive water treatment. Habitat alteration of this sort can have dire consequences for the preservation of regional biodiversity, and certainly merit further attention.

4.6 Air Resources

Due to the fact that air quality does not appear to present a significant impact on natural resources, it will not constitute a major focus of this study.

Appendix A. Urbanization's Effect on Natural Resources

Boxes to contain X, I, O (severe, moderate, slight) and measured physical impact

City: _____

Dependent Variables: Resources

Independent Variables: Human Activities	Land					Water			Biota		Air
	Forests types	Ag/soil types	Pasture	Coasts	Urbanized	Surface	Ground	Fisheries	Species types	Habitat types	
Chemical											
Effluents											
types											
Solid waste											
types											
Fertilizer											
types											
Hazardous waste											
types											
Physical											
Extraction: Rates											
types											
Yield v. MAI: Productivity											
types											
Encroachment											
types											
Nature of Linkages											
Land: Forests											
Ag/soil											
Pasture											
Coasts											
Urbanized											
Water: Surface											
Ground											
Fisheries											
Biota: Species											
Habitat											
Air											

APPENDIX B

BIBLIOGRAPHY

Annuaire Statistique du Maroc, Office of the Prime Minister, 1988.

Biswas, Asit, K., T.N. Khoshoo and Ashok Khosla, Environmental Modeling for Developing Countries, Tycooly Publishing, 1991.

Cave, Alison, Urban Environment Working Paper, (background for the Environmental Program for the Mediterranean) August 23, 1991.

Clark, William, C., "Managing Planet Earth," Scientific American, Volume 261, No. 3, September 1989.

Colchester, Marcus, Guatemala: The Clamour for Land and the Fate of the Forests, The Ecologist, Vol. 21, No. 4, July/August 1991.

Foreign Area Studies, Morocco: A Country Study, University of Washington, D.C., U.S. Government Publishing, 1987.

Leitman, Josef, Energy-Environment Linkages in Urban Sector
Urban Management and Environment (Discussion Paper), April 1991.

Leonard, Jeffrey H., Environment and the Poor: Developing Strategies for a Common Agenda, Overseas Development Council, Washington, D.C. 1989.

Peterson, George, E., and Jeffrey P. Telgarsky, Urban Economies and National Development, The Urban Institute, Washington, D.C., prepared for USAID.

Schramm, Gunter and Jeremy J. Warford, Environmental Management and Economic Development, World Bank Publication, June 1991.

"The Environmental Problems Associated with India's Major Cities," Centre for Science and Environment India, Environment and Urbanization, Vol. 1, No. 1, April 1989.

United Nations, Commodity Trade Statistics (Morocco), Series D, Vol. xxxix, No. 1-13, 1989.

USAID, Development Impact Extraction: An Alternative Method of Financing Urban Development in Less Developed Countries, December 1990.

USAID, Draft Environmental Report on Morocco, Arid Lands Information Center Office of Arid Lands Studies, University of Arizona Tucson, Arizona, February 1980.

USAID, The Impact of Investments in Urban Infrastructure on Municipal Revenues and the Integration of Informal Sector Activities, The Abidjan Experience, Office of Housing and Urban Programs, September 1990.

USAID, Morocco, National Upgrading Agency Low Income Housing Program, Asia and Near East Project Advisory Committee, September 1988.

USAID, Morocco, Initial Environmental Examination, Morocco National Upgrading Agency Low Income Housing Program, October 1988.

USAID, Ranking Environmental Health Risks in Bangkok, Thailand, Office of Housing and Urban Programs, Volume 1 and 2, December 1990.

USAID, The Role of Urbanization in National Development: Bridging the Rural Urban Divide, July 1989.

USAID, Urbanization and Environmental Quality, Office of Housing and Urban Programs, November 1989.

USAID, Urbanization and the Environment in Developing Countries, Office of Housing and Urban Programs, November 1989.

USAID, Viewing Environmental Protection as Investment in Urban Infrastructure, September 1989.

USAID, Working Paper: Towards A Strategy and Action Plan for Helping developing Countries to Manage Urban and Industrial Pollution.

USDA, Agricultural Situation in Morocco, Annual Report 1991.

World Bank, Conservation and Management of Cultural Patrimony in the Mediterranean Region, Working Paper #6.

World Bank Environmental Program for the Mediterranean, Natural Resource Management, Working Paper #2.

World Bank, Industrial Pollution in the Mediterranean, Working Paper #5.

World Bank, The Economics of Urbanization and Urban Policies in Developing Countries, A World Bank Symposium, Washington, D.C. 1987.

World Bank, Morocco Analysis and Reform of Economic Policy, Economic Development Institute of the World Bank, EDI Development Policy Case Series Analytical Case Studies, November 4, 1990.

World Bank, Morocco Environmental Discussion Paper, Environment Division Technical Department, Europe, Middle East and North Africa Region, July 1990.

World Bank, The Environmental Program for the Mediterranean, Preserving and Shared Heritage and Managing a Common Resource, 1990.

World Bank, The Use of Satellite Images for Urban Planning, A Case Study from Karachi, Pakistan, May 1989.

World Bank, The World Bank and the Environment, First Annual Report Fiscal 1990.

APPENDIX C

LIST OF ORGANIZATIONS AND INDIVIDUALS CONTACTED

U.S. Agency for International Development:

Office of Housing and Urban Programs; Washington, DC

Ms. Sonia Hammamm, Assistant Director
Ms. Alexi Panehal, Housing and Urban Development Officer
Mr. Matthew Auer

Regional Housing and Urban Development Office, Rabat, Morocco

Mr. Harry Birnholz, Housing and Urban Development Officer
Mr. Tahar Berrada,

The World Bank, Washington, DC

Mr. Andre Fargeix
Mr. Stephen Lintner, Senior Environmental Specialist
Ms. Faith Halter

World Resources Institute

Mr. Thomas Fox, Director
Mr. Dan Tunstall

The Bryler Corporation

Mr. Pierre Leger, President
Mr. Marco Mondesir, Sanitary Engineer
Mr. Frank Carroll, Enviromental Engineer

U.S. Department of Agriculture, Washington, DC

Mr. Ron Jones, Office of International Cooperation and Development
Mr. Wilber Sherman

United Nations Environmental Program

United Nations Development Program

Al Hassan II University, Rabat, Morocco

Private Consultants

Mr. Stu Sessions
Mr. Steven Klein