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MOROCCO SOIL AND WATER CONSERVATION PROJECT PROPOSAL

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MOROCCO SOIL AND WATER CONSERVATION PROJECT PROPOSAL

Prepared for the USAID Mission to Morocco
Under ISPAN Activity No. 696C

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PREFACE

This consultancy was performed under a contract between the A.I.D. Mission to Morocco and the Irrigation Support Project for Asia and the Near East (ISPAN). The objectives of the consultancy were to:

- Conduct technical, economic, financial, and social analyses of watershed management in Morocco;
- Recommend improved policies, programs and practices for sustainable resource management in Morocco's watersheds;
- Assess downstream issues related to water use efficency; and
- Recommend measures to improve water use efficiency downstream of the major watersheds.

Although the analyses and recommendations are intended to have national relevance, the team was requested to concentrate on three watersheds of the Oum Er Rbia river basin in Azilal Province and the Tadla irrigated perimeter downstream from the largest of the three watersheds.

The team consisted of American and Moroccan experts. The American experts were:

Roger Poulin	Financial Analyst and Team Leader
Steven Dennison	Forester
John H. Eriksen	Agricultural Resource Economist
William Fleming	Watershed Management Specialist
Alice Morton	Social Scientist
Donald C. Slack	Irrigation Engineer

The Moroccan experts were:

Mohamed Ait Kadi	Irrigation Systems Advisor
Nejib Bouderbala	Institutional and Legal Advisor
Mohamed Khatouri	Forestry Advisor
A. Merzouk	Soil Science Advisor

The social scientist became ill one week after her arrival and had to be medically evacuated. Consequently, analysis of social and institutional issues is lacking from the upstream sub-project portion of this report.

The consultation was conducted between 22 October and 13 December 1990. The first ten days was taken up with consultations at ISPAN, AID and the World Bank in Washington. The first American team members travelled to Morocco on 30 October and had orientation meetings with USAID Mission staff and representatives of the Government of Morocco in Rabat for the balance of the week.

The third week was spent reviewing background documents and in meetings with government officials and USAID staff. During this week, consultancy tasks were allocated and the joint team was split to allow the analyses and preliminary designs of two sub-projects -- i.e. the watershed management sub-project in Azilal Province and the water resource management sub-project in the Tadla irrigated perimeter -- to proceed independently.

Team members then conducted a series of short field trips. The watershed management team travelled to Azilal Province, met with Ministry of Agriculture and Agrarian Reform staff, and visited the three watersheds. The water resource team initially travelled to three large-scale irrigation systems of the Oum Er Rbia river basin -- i.e. the Tadla, Haouz and Doukkala ORMVAs and later returned to Tadla for two more days of project design work with the Tadla ORMVA director and staff.

The balance of the consultancy in Morocco was spent in meetings in Rabat with USAID staff, government officials, and representatives of other donors. A draft final report was written in Rabat and was submitted for USAID Mission review during the last week in November 1990. Based upon team discussions with USAID and Government of Morocco officials, the draft final report was revised and finalized in draft during the team's final week together in Morocco.

This final report was produced after the last American members of the team returned to the United States on 9 December 1990.

In submitting this report, the joint team wishes to express its appreciation to the many Moroccans and Americans in both official and private capacities who provided information to team members and otherwise greatly assisted with the successful execution of this consulting mission.

LIST OF ACRONYMS

AID	Agency for International Development -- used to denote AID headquarters in Washington, D.C. as distinguished from field mission denoted as USAID.
ASAL	Agricultural Sector Adjustment Loan (executed between the Government of Morocco and the World Bank in 1987 for the period 1987 to 1992)
CMV	Centre de Mise en Valeur/Development Center
CNCA	Caisse Nationale de Credit Agricole/National Agricultural Credit Bank
CRCA	Caisse Regionale de Credit Agricole/Regional Agricultural Credit Bank
DEF	Direction des Eaux et Forets/Direction for Water and Forests within the Ministry of Agriculture and Agrarian Reform
DER	Direction de l'Equipement Rural/Direction for Agricultural Equipment within the Ministry of Agriculture and Agrarian Reform
DERRO	Developpement Economique Rural du Rif Occidental/Project for Economic Rural Development in the Western Rif Mountains
DRS	Defense et Restoration des Sols/Direction for Soil Protection and Conservation in the Ministry of Agriculture and Agrarian Reform
DRS Fruitiere	Program of Fruit and Nut Tree Planting within the Direction for Soil Protection and Conservation
FAO	Food and Agricultural Organization of the United Nations
GDP	Gross Domestic Product
GOM	Government of Morocco
IMF	International Monetary Fund/Fonds Monetaire International
INRA	Institut National de la Recherche Agricole/National Institute of Agricultural Research
LSI	Large-Scale Irrigation Scheme/Perimetres de Grande Irrigation
MARA	Ministere de l'Agriculture et de la Reforme Agraire/Ministry of Agriculture and Agrarian Reform

MIS	Management Information System/Systeme d'Information pour la Gestion
O&M	Operation and Maintenance/Operation et Entretien
ORMVA	Office Regional de Mise en Valeur Agricole/Regional Agricultural Development Office
ORMVAD	Office Regional de Mise en Valeur Agricole de Doukkala/Doukkala Regional Agricultural Development Office
ORMVAH	Office Regional de Mise en Valeur Agricole de Haouz/Haouz Regional Agricultural Development Office
ORMVAT	Office Regional de Mise en Valeur Agricole du Tadla/Tadla Regional Agricultural Development Office
PAGI	Projet d'Amelioration de la Grande Irrigation/Large-Scale Irrigation Improvement Project (designated as PAGI I and PAGI II for the First and Second World Bank-funded Projects).
PID	Project Identification Document
SAL	Structural Adjustment Loan
USAID	United States Agency for International Development

EXECUTIVE SUMMARY

I. INTRODUCTION

The project proposed in this report has been designed to strongly reinforce the main objectives of the USAID Mission's development assistance program for Morocco as articulated in USAID Morocco Programming for the 1990s -- A Concept Paper of July 1990 and to be incorporated in the Mission's new Country Development Strategy Paper in early 1991.

The project is composed of two sub-projects in adjacent areas of the Oum Er Rbia river basin which are linked by several common themes. The interventions of the two sub-projects will complement activities already underway or planned in the general context of Mission support for the Government of Morocco's structural adjustment and natural resources conservation programs. Specific objectives to be advanced under the project are:

- Improved conservation and allocation of domestic resources -- chiefly water and soil -- in the context of continued market and trade liberalization;
- Increased privatization of investment and management of key economic sectors, coupled with disengagement from these sectors by public and parastatal agencies;
- Promotion of higher value agricultural crops and private sector agro-industrial enterprises in the context of an export-driven economy;
- Stabilization of the economy through reducing the present variability in agricultural production and increasing the reliability of wage good transfers to the modern sector;
- Job creation and reducing urban/rural income disparities; and
- Development of strong regional interest groups with respect to resource conservation and promotion of agro-industrial commodities as an aid to increasing effective participation in development decision-making and in the broader Moroccan political process.

The project was designed in the context of an economy which suffered from a series of severe external and domestic shocks and their fiscal ramifications in the early 1980s but has recently entered a period of economic recovery and consolidation. Since the inauguration of a comprehensive economic structural adjustment (SAL) program in 1983 and agricultural sector adjustment program in 1984, economic growth has been sustained, with real growth in gross domestic product (GDP) averaging 4.6 percent per annum. However, while economic growth over the latter half of the decade has been reasonably satisfactory, the average rate of GDP increase masks wide fluctuations related largely to interannual variability in precipitation and its effects on agricultural production.

The government is proceeding on a core economic growth path which stresses a balanced approach to development among sectors, with critical development activities in light industry, agriculture, mining and tourism. It has progressively established a more open foreign trade regime where domestic resource allocations are increasingly governed by world market forces and prices. In the process, the Moroccan economy has moved away from its previous orientation in import substitution, pervasive protectionism of inefficient domestic industries and agriculture, and heavy and direct state involvement of economic management at all levels. There is a new realization that development of a balanced, export-driven economy will require a more active and equal partnership between the public and private sectors, with public disengagement from commercial activities and much more emphasis on private investment and management in these key areas.

If the Moroccan economy is to proceed along its present growth path, all key sectors have a common need for reliable supplies of high quality water. Without this resource, the growing work force in urban areas cannot be sustained, many industrial enterprises cannot function efficiently, energy from hydropower plant cannot contribute to reducing Morocco's dependence on imported oil, and, most importantly, domestic agricultural and agro-industrial production cannot be stabilized to provide critical wage goods for domestic economic growth and for exploitation of export opportunities.

The emphasis in Moroccan development planning, therefore, is on maximizing the capture of the country's surface water resources and providing for their optimal use in irrigated agriculture, potable water supplies, industrialization and energy generation. This directly reflects the government's central concern over this critical resource and its conservation.

Enormous capital resources have already been invested in the essential infrastructure to control surface water flows in Morocco. Infrastructure to capture and utilize about two-thirds -- or 10 billion cubic meters -- of the available surface water potential is in place and four major infrastructure projects are in advanced stages of planning and/or implementation to capture most of the remaining 5 billion cubic meters of potential by the end of the 1990s.

As Morocco nears the end of the infrastructural phase of its national water development plan, emphasis is beginning to shift to the more sophisticated and difficult tasks of ensuring socially optimal and technically efficient allocation of the existing water resources among competing consumer groups and better protecting this resource for the benefit of future generations. This task is ever more complex given Morocco's relatively high population growth rate (2.4 percent per annum), the higher rate of migration from rural to urban areas (6 to 8 percent per annum), and increasing evidence of the economy's vulnerability to domestic and external economic shocks.

Major risks facing Morocco now are that available water, which has been captured at such great cost, will not be used efficiently in the present and that Morocco's ability to secure future stocks will be threaten by destructive land use practices in the upland portions of the major river basins. If this happens, the country will not be able to optimize the returns to its economy from all the investments to date -- indeed those investments will ultimately be destroyed.

Since Moroccan sub-surface water resources are limited and generally expensive to exploit in both financial and environmental terms and desalination of seawater has not yet proven to be a cost-effective technology, conservation and optimal use of the existing surface water resources is a sine qua non for the country's successful economic development in the 1990s and beyond.

II. THE GOAL AND PURPOSE OF THE PROJECT

The overall goal of the project is to improve resource management in the regional economy of the Oum Er Rbia river basin -- including the upland areas of Azilal Province and the downstream irrigated perimeters on the Tadla plain -- in line with the Government of Morocco's agricultural sector adjustment program and evolving strategy for natural resource conservation.

The purpose of the project is to develop, test and disseminate improved practices for allocation and management of natural resources -- chiefly water and soil -- in the Oum Er Rbia river basin in the context of a more open and market-oriented economy.

III. THE RESOURCE CONSERVATION SUB-PROJECT IN AZILAL PROVINCE

A. Background

Morocco's watersheds provide water for 34 major reservoirs. These reservoirs provide 60 percent of Morocco's municipal water requirements and, during years of adequate rainfall, account for 30 percent of the country's electricity. Their main contribution, however, is to the nine large-scale irrigation perimeters and many small and medium-scale systems which cover over 800,000 hectares of cropland. The irrigated areas that receive 88 percent of the water flowing from these reservoirs.

The government is, therefore, extremely concerned that soil erosion in the watersheds not cause the reservoirs to fill up prematurely with sediment from the uplands. Sedimentation of these reservoirs would translate directly into less water being available for the irrigation and other uses downstream.

Despite this growing concern, the problem of soil erosion in critical watershed areas has been addressed rather haphazardly -- mainly through donor-funded projects in relatively small areas of the most critically affected watersheds. Since the 1950s, interventions financed by the government and external donors have affected only about 400,000 of the 11 million hectares in Morocco's watersheds.

In the 1980s, the government was made increasingly aware of the fact that its previous efforts in improved watershed management have not had impacts that were either significant or sustainable. As a consequence, FAO, the World Bank and USAID were asked to undertake major new programs in watershed management and resource conservation.

In 1988, FAO began implementing a three-year project to establish a nationwide watershed planning capacity in the Ministry of Agriculture and Agrarian Reform (MARA). In 1989, the World Bank began discussions with the government concerning a possible national watershed

management project to begin in 1992. As a result, a two year study financed by the Japanese is currently underway. This study is expected to result in a national watershed management plan for Morocco and a major project to be funded by the World Bank.

Additionally, the USAID Mission funded a watershed management study in 1989. This study was the basis for the Project Identification Document (PID) submitted to AID/Washington for a watershed management project in Azilal Province. This province contains three major watershed areas feeding the Oum Er Rbia river -- the second largest river basin in Morocco.

The PID as submitted attempted to justify a project largely on the grounds of reducing inflows of sedimentation into the reservoirs from the upland areas of Azilal Province and its attendant benefits in protecting the water resource for use downstream. At the PID review, AID/Washington requested that further analysis be completed to assess the importance of watershed management activities to overall economic growth in Morocco, with particular emphasis on downstream constraints to increased water use efficiency.

The report presents ISPAN team findings on the technical and economic benefits of watershed management in two specific areas of Morocco. Based on these analyses, a revised and substantially reduced watershed management sub-project is proposed for Azilal Province and a second sub-project addresses water management and use policies and practices downstream on the Tadla plain.

B. Major Findings

With respect to the contributions of watershed management to the national economy, key ISPAN team conclusions are:

- Reservoir sedimentation per se will not significantly reduce the amounts of water available for irrigation and other purposes in Morocco in the short to medium-term because the "dead" storage -- i.e. the space designed into reservoir at the construction stage to collect sediment -- will not be filled in most reservoirs for many years -- i.e. filling is at least 25 years away in even the most erosion prone dams. Morever, even after the "dead" storages are filled, it will be an additional 100 years or more before the "live" storages in most of the major reservoirs are even half filled. This means in economic terms that the net present values of investments aimed at preventing the eventual losses of water storage capacity for irrigation and other downstream uses are very low and that investments for this purpose alone are not justified at this time.

- The true economic impacts of soil erosion in the Azilal watersheds will only be evident in the very long term. Existing reservoirs will eventually be filled resulting in a permanent loss of water for irrigation and other purposes. Depleted soils within the watersheds will be unable to support even minimal vegetative cover, resulting in the denuding of uplands and the permenent loss of the province's resource base. All this means that most watershed management in Morocco must be justified in terms of long-term environmental preservation,

rather than on the basis of short and medium-term economic gains. Interventions to reduce degradation and conserve upland soil and water resources, then, are clearly in Morocco's economic self-interest but they must be carried out in ways that incur few, if any, net costs to the economy.

- Watershed management programs often pay for themselves because the same interventionsl that decrease erosion will increase agricultural productivity at the same time. These productivity increases often result in benefits that exceed costs in only a few years, thus making the program economically viable in the short-term.

Several other team findings are important in formulating an overall strategy for watershed management in Morocco:

- The economic costs of traditional government-financed soil conservation measures -- e.g. check dams, bench terraces, and reforestation projects -- usually exceed their economic benefits. And, because these interventions are so expensive, the government with limited financial resources can only afford to carry them out in a small percentage of the country's watersheds.

- The basic cause of soil erosion in the watersheds is destructive land use practices by local populations. Sustained reductions in soil erosion rates can only be achieved by changing these land use practices.

- Soil conservation programs entail short-term costs in exchange for future benefits. However, markets in Morocco, as elsewhere, tend to undervalue externalities caused by misuse of resources -- i.e. pollution, soil erosion, loss of water -- and, therefore, the benefits of soil conservation measures are often not fully reflected in short-term market terms. The result is that the short-term costs of soil conservation measures will exceed the present value of future benefits at market prices. Given this problem, it is important that local farmers and herders in Azilal at least understand, if not fully agree with, what is being asked of them.

These findings indicate the need for the following policy changes with respect to watershed management in Morocco:

- Watershed management programs must focus on changing the land use practices of the local population rather than financing expensive site-specific interventions implemented by the government.

- The government must recognize that the local population has few viable options to the existing overexploitation of natural resources. Efforts to introduce resource conservation measures must be based on dialogue and must include productivity increasing measures as much as possible.

- Although resource conservation measures require a measure of regulation and coercion, these cannot be enforced without the willing participation of the local population. This calls for a collaborative rather than adversarial approach.

C. A Proposed Watershed Management Sub-Project for Azilal Province

The proposed watershed management sub-project for Azilal Province focuses on changing land use practices through participatory approaches. Most traditional interventions financed and implemented by the government are excluded. The specific purpose of the sub-project would be to reduce soil erosion rates in the three provincial watersheds. Soil erosion in demonstration areas in each watershed would be reduced by 30 to 40 percent.

The sub-project will develop and demonstrate methods of addressing the socio-economic and institutional constraints to changing land use practices among farmers and herders, especially as they pertain to common lands. This critical first step is essential in achieving widespread and sustained reductions in soil erosion in Morocco's watersheds.

The proposed interventions for achieving sub-project objectives are:

1. The establishment of a forest management plan for at least one forest in each watershed. The plan would be directed at maximizing sustained yields of wood products and forage. Increased vegetative cover in these areas will reduce soil erosion by at least one-third. These areas account for an estimated 50 percent of the soil erosion in the three watersheds. An appropriate local institution would implement these forest management plans and the local populations would retain the benefits from the increased production.

2. The establishment of a range management plan in at least one common pasture area in each watershed, with institutional arrangements necessary for the local population to implement each plan.

3. The introduction of improved soil conservation practices in rainfed agricultural areas that will reduce erosion rates by 50 percent. These areas account for an estimated 35 percent of the soil erosion in the three watersheds. This would be achieved through a combination of extension services and carefully selected economic incentives.

4. Reduction of grazing pressures in forests and on pasturelands by increasing the area in irrigated cropland -- much of which would be used for forage production.

The estimated cost of the sub-project interventions is about $ 10 million. Funds would be used for long and short-term expatriate technical assistance, local and international participant training, and construction of a small number of diversion dams for small-scale irrigation systems in Azilal province.

III. IMPROVED WATER MANAGEMENT AND USE ON THE TADLA PLAIN

The sub-project presented below proposes to work downstream of Azilal province in the Oum Er Rbia river basin and, specifically, in the area containing the Tadla irrigation perimeter. The interventions of the sub-project would potentially affect the quantity and quality of water available to produce a whole range of high value agro-industrial products for export and domestic markets. Presently, virtually all of Morocco's high value agricultural exports are produced in and processed near the Tadla and the nine other large-scale irrigation perimeters.

The sub-project interventions could also have significant impacts on the availability of potable and industrial water supplies for two of the largest urban concentrations in the country -- i.e. the Casablanca/Rabat coastal strip and the Marrakech area.

Thirdly, interventions to allow more efficient allocation of the available water in the upper Oum Er Rbia basin could allow for better utilization of that resource for hydropower generation throughout the area. This potential is by no means an insignificant factor given Morocco's growing dependency on external energy sources and the place of expenditures on imported petroleum in the country's balance of payments.

In addition to being squarely in the core growth path of the Moroccan economy, linked to key policy changes being affected in the agricultural sector, and directed at reinforcing key elements of the USAID country development strategy, the proposed sub-project would be strongly complementary with parallel activities of the World Bank, the other major external donor concerned with natural resource management and irrigation development in Morocco.

At the macroeconomic and sectoral levels, many of the major reorientations in government economic policies in the 1980s are the direct results of government interactions with the IMF and the World Bank and have been supported by credit facilities and loans from these international agencies. These new economic policy orientations form the matrix within which the proposed sub-project will operate. Sub-project interventions have been designed to have strong linkages to the implementation and reinforcement of key elements of Moroccan SAL and ASAL programs. Among the key elements to be addressed are: greater decentralization of and participation in economic decision-making and resource management; public disengagement from commercial enterprises and assumption of these activities by private sector agents; reorientation of agricultural production in the context of open markets and competitive pricing; greater development of agricultural commodities for export; and fostering the viable agribusiness enterprises and professional associations.

At the project level, the proposed interventions would be highly complementary to the activities being undertaken in the national-level World Bank projects aimed to improving performance in irrigated agriculture. Under these projects -- i.e. Projets d'Amelioration de la Grande Irrigation (PAGI), designated as PAGI I and II for the First and Second World Bank-funded projects -- the Bank is working with the Ministry of Agriculture and Agrarian Reform (MARA) to formulate and implement specific policy changes in the irrigation sub-sector. The specific policies include:

1. Redefining the mandates of the ORMVAs and confining their future role to that minimum number of activities deemed to be necessary to the public interest -- i.e. reliable water delivery to farmers and agricultural extension, both public goods.

2. Strengthening the autonomy of the ORMVAs as client-oriented service agencies through decentralization of decision-making authority and putting them on a "pay-as-you-go" status through improved financial management.

3. Increasing cost recovery from farmers in irrigation perimeters through revisions of water user fees so as to entirely cover the operation and maintenance costs of water delivery and contribute to capital cost reimbursement.

4. Disengagement of the ORMVAs from commercial enterprises and turning them over to private sector agents.

5. Increasing farmer participation in decision-making at all levels within the irrigation perimeters so as to be more responsive to market forces and prices.

6. Rehabilitating selected infrastructure within the nine LSI schemes so as to improve operational capacities and system flexibilities.

Sub-project interventions, as presented below, are designed to reinforce and complement these basic policy orientations and to make many of them concrete realities at the level of the Tadla perimeter.

Sub-project proposes to address the existing productivity and institutional gaps with respect to resource management in the regional economy of the Tadla plain within the Oum Er Rabia river basin.

In this context, the productivity gap is defined as the difference between the water use and agricultural production potentials of the Tadla plain and the existing levels of resource use as expressed in actual crop and livestock production in the area over the last decade.

The institutional gap is defined as that transitional void created as the ORMVAT redefines its operational mandate and begins the process of implementing national policy directives to disengage from those public sector activities deemed to be commercial in nature and the time needed for private sector economic actors to develop capacities and assume new roles and responsibilities vis-a-vis the rural population on the Tadla plain.

The goal of the sub-project is to improve overall resource management in the regional economy of the Tadla plain in line with the Government of Morocco's new strategy for agricultural sector adjustment.

The purpose of the sub-project is to develop, test and disseminate improved practices for allocation and management of natural resources -- chiefly water and land -- on the Tadla plain in the context of a more open and market-oriented economy. These are expected to include:

- More comprehensive and flexible approaches to water resource management at the system-level;
- Interventions to improve farm-level management of water and land resources in response to market forces and existing constraints;
- Interventions to improve ORMVAT management capacity to discharge its redefined mandate; and
- Measures to increase effective community participation in resource allocation and development activities.

Four types of intervention are proposed in the sub-project. There are:

- Improving knowledge and management of water resources at the system-level in ORMVAT so as to better guarantee the reliable delivery of irrigation water and related services to the farm-level;
- A diagnostic activity to first analyze existing resource utilization patterns and farm household motivations and decision-making with respect to resource constraints and then to propose and test pilot activities to improve on-farm resource use;
- As ORMVAT disengages from commercial activities and redefines its core operational mandate, interventions aimed at strengthening its capacity to gather and analyze critical information and to execute its remaining operational and client-oriented support functions with greater efficiency and flexibility; and
- Providing practical assistance to emerging private sector actors -- i.e. professional associations, agricultural input suppliers, marketing agents and agro-industrial businesses -- as they assume their new roles and responsibilities in the regional economy.

Initial projections of USAID investment in this sub-project place the cost between $ 12.5 and $ 18 million. Grant funding would provide for long and short-term expatriate technical assistance, short-term Moroccan consultants in special areas of expertise -- most appropriately from the Hassan II Institute of Agronomy and Veterinary Medicine, water management and automated weather monitoring equipment, computer systems and appropriate software packages, and local currency for field activities.

Initial estimates indicate that the internal rate of return on USAID investments from water savings alone is 38 percent. The estimate of the internal rate of return on combined USAID

investments and Government of Morocco recurrent expenditures from water savings alone is 34 percent.

RESUME ANALYTIQUE

I. INTRODUCTION

Le projet que propose le présent rapport a été conçu pour renforcer les principaux objectifs du programme d'aide au développement de la Mission de l'USAID au Maroc, tel qu'il est contenu dans le document USAID Morocco Programming for the 1990s -- A Concept Paper, de juillet 1990 et tel qu'il doit être repris, au début de 1991, par le nouveau document de la Mission, intitulé Country Development Strategy Paper.

Le projet se compose de deux sous-projets portant sur des zones voisines du bassin d'Oum Er Rbia, qui ont en commun plusieurs caractéristiques. Les interventions des deux sous-projets viendront compléter des activités déjà en cours ou prévues dans le contexte général du soutien que la Mission apporte aux programmes d'ajustement structurel et de conservation des ressources naturelles du Gouvernement du Maroc. Les objectifs dont la réalisation doit progresser dans le cadre du projet sont les suivants:

- Amélioration de la conservation des ressources nationales -- surtout eau et sol -- dans le contexte de la poursuite de la libéralisation du marché et du commerce;

- Intensification de la privatisation des investissements et de la gestion des principaux secteurs économiques, conjuguée au découplage des organismes publics et parapublics de ces secteurs;

- Encouragement de cultures agricoles à haute valeur et d'entreprises agro-industrielles du secteur privé dans le contexte d'une économie dont les exportations sont le moteur;

- Stabilisation de l'économie grâce à la réduction de la variabilité actuelle de la production agricole;

- Création d'emplois et réduction des disparités de revenus entre zones urbaines/rurales; et

- Développement de puissants groupes régionaux s'intéressant à la conservation des ressources et à la promotion de produits agro-industriels pour aider à faire augmenter une participation effective à la prise des décisions concernant le développement économique du Maroc.

Le projet a été conçu dans le contexte d'une économie qui a subi, au début des années 1980, une série de chocs profonds, externes et internes, mais vient de reprendre la voie de la relance et de la consolidation économiques. Depuis la mise en place, en 1983, d'un programme d'ajustement structurel (PAS) et, en 1984, d'un programme d'ajustement du secteur agricole, la croissance économique a été soutenue, le produit intérieur brut (PIB) atteignant une croissance réelle de 4,6 pour cent par an en moyenne. Cependant, alors que, pendant la deuxième moitié de la décennie, la croissance économique a été raisonnablement satisfaisante, le taux moyen de progrès du PIB masque de vastes fluctuations, qui sont en grande partie liées à la variabilité des précipitations d'une année à l'autre et aux efforts que ces variations exercent sur la production agricole.

Le Gouvernement emprunte, pour obtenir la croissance économique, une voie qui cherche essentiellement à établir un équilibre entre le développement des divers secteurs, tout en accordant une importance critique à l'industrie légère, à l'agriculture, aux mines et au tourisme. Il a progressivement institué un régime plus ouvert de commerce extérieur, dans lequel les affectations des ressources internes se font de plus en plus en fonction des forces et des prix du marché mondial. Ce faisant, l'économie marocaine a abandonné la voie qu'elle empruntait précédemment: protectionnisme latent d'industries et d'une agriculture peu efficaces, et forte intervention directe de l'Etat dans la gestion économique à tous les niveaux. On se rend désormais compte que, pour obtenir une économie équilibrée animée par les exportations, il faudra que s'établisse une base plus égale, un partenariat plus actif entre les secteurs public et privé, le secteur public cessant ses activités commerciales, et qu'on accorde une place plus grande, dans ces domaines clés, aux investissements et à la gestion privés.

Si l'on veut que l'économie marocaine avance sur la voie de la croissance dans laquelle elle s'est actuellement engagée, tous les principaux secteurs ont un besoin commun: ils doivent être assurés d'un approvisionnement fiable en eau de bonne qualité. Sans cela, les travailleurs qui sont de plus en plus nombreux à vivre dans les zones urbaines manqueront d'emploi, un grand nombre d'entreprises industrielles ne pourront pas fonctionner efficacement, l'énergie fournie par les centrales hydro-électriques ne pourra pas permettre au Maroc de devenir moins tributaire du pétrole étranger et, ce qui est le plus important, il ne sera pas possible de stabiliser la production agricole et agro-industrielle du pays de manière à fournir les biens salariaux qui sont absolument indispensables pour la croissance économique nationale et pour l'exploitation des possibilités d'exportation.

Au Maroc, la planification du développement cherche donc, en priorité, à capter au maximum les eaux superficielles du pays et à les utiliser de façon optimale pour l'agriculture irriguée, l'approvisionnement en eau potable, l'industrialisation et la production d'énergie. Elle exprime l'importance primordiale que le Gouvernement attache à cette ressource critique et à sa conservation.

On a déjà investi d'énormes capitaux dans l'infrastructure indispensable pour maîtriser les eaux superficielles du Maroc. L'infrastructure permettant de capter et d'employer les deux-

tiers environ -- soit 10 milliards de mètres cubes -- du potentiel disponible en eau superficielle est en place et quatre grands projets d'infrastructure sont à des étapes avancées de planification ou d'exécution; ils doivent permettre de capter, à la fin des années 1990, la plus grande partie des 5 milliards de mètres cubes qui restent encore disponibles.

Au moment où le Maroc en arrive à la fin de la phase d'infrastructure de son plan national de mise en valeur de l'eau, il commence à aborder la tâche plus complexe et plus difficile qui doit assurer que l'attribution des ressources hydrauliques aux divers groupes de consommateurs est efficace sur le plan technique et optimale sur le plan social, tant en protégeant mieux cette ressource au profit des futures générations. Cette tâche est d'autant plus complexe que le Maroc a une croissance démographique relativement forte (2,4 pour cent par an), un taux plus élevé de migration des campagnes vers les villes (6 à 8 pour cent par an), au moment même où on se rend de plus en plus compte que le pays est vulnérable aux chocs économiques d'origine externe et interne.

Les principaux risques que court actuellement le Maroc sont que l'eau disponible, dont la captation a coûté si cher, ne soit pas utilisée efficacement en l'état actuel des choses et que les moyens dont il dispose pour obtenir de nouveaux apports d'eau soient menacés par les pratiques destructrices d'utilisation des terres sur les hauteurs des grands bassins fluviaux. S'il en est ainsi, le pays ne pourra pas optimiser, au bénéfice de son économie, la rentabilité de tous les investissements qu'il a effectués jusqu'ici -- en fait, ces investissements finiront par être réduits à zéro.

Comme le Maroc n'a que de modestes ressources en eaux souterraines, dont l'exploitation coûte en général cher et présente des risques écologiques, et comme la désalinisation de l'eau de mer n'est pas encore une technique efficace par rapport aux coûts, la conservation et l'utilisation optimale des ressources en eaux superficielles devient une condition sine qua non si le pays veut réussir son développement économique durant les années 1990 et au-delà.

II. BUT ET OBJECTIF DU PROJET

Le projet a pour but général d'améliorer la gestion des ressources dans la région du bassin d'Oum Er Rbia -- y compris les bassins versants de la Province d'Azilal et les périmètres irrigués en aval dans la plaine de Tadla -- conformément au programme d'ajustement du secteur agricole mis en place par le Gouvernement et à la stratégie qu'il est en train d'élaborer pour la conservation des ressources naturelles.

Le projet a pour objet d'élaborer, de mettre à l'essai et de diffuser des méthodes améliorée d'attribution et de gestion des ressources naturelles -- principalement eau et sol -

- dans le bassin d'Oum Er Rbia dans le contexte d'une économie plus ouverte et orientée vers le marché.

III. LE SOUS-PROJET DE CONSERVATION DES RESSOURCES DANS LA PROVINCE D'AZILAL

Les bassins versants du Maroc fournissent de l'eau à 34 grands réservoirs. Ces réservoirs assurent 60 pour cent des besoins municipaux en eau et, quand les précipitations sont suffisantes, fournissent 30 pour cent de l'électricité du pays. Cependant, ils servent surtout à alimenter les neufs grands périmètres d'irrigation et un grand nombre de petits et moyens systèmes d'irrigation dans lesquels se trouvent plus de 800.000 hectares de terres cultivées. Ces superficies irriguées reçoivent 88 pour cent de l'eau qui sort de ces réservoirs.

Le Gouvernement craint que l'érosion des sols des bassins versants n'amène pas les réservoirs à se remplir prématurément de sédiments venus d'amont. En effet, si ces réservoirs se sédimentent, il y aura moins d'eau pour l'irrigation et pour d'autres utilisations en aval.

Malgré ces préoccupations grandissantes, le problème de l'érosion du sol dans les zones critiques des bassins versants a été abordé de manière assez fortuite -- surtout dans le cadre des projets que des bailleurs de fonds finançaient dans les bassins versants les plus durement touchés. Depuis les années 1950, les interventions financées par le Gouvernement et par les bailleurs de fonds étrangers n'ont porté que sur environ 400.000 hectares, sur une superficie totale de 11 millions pour tous les bassins versants du Maroc.

Durant les années 1980, le Gouvernement s'est de plus en plus rendu compte que, jusqu'alors, ses efforts pour améliorer la gestion des bassins versants n'avaient pas donné de résultats importants ou durables. Il a donc demandé à la FAO, à la Banque mondiale et à l'USAID d'entreprendre de nouveaux grands programmes de gestion et de conservation des ressources des bassins versants.

En 1988, la FAO a commencé l'exécution d'un projet pour créer, au sein du Ministère de l'Agriculture et de la Réforme agraire (MARA), un service national de planification des bassins versants. En 1989, la Banque mondiale a commencé à examiner avec le Gouvernement la possibilité de réaliser, à partir de 1992, un projet de gestion des bassins versants. A la suite de cette décision, une étude a été entreprise, sous financement japonais; elle doit déboucher, au bout de deux ans, sur un plan national de gestion des bassins versants du Maroc et donner lieu à un projet financé par la Banque mondiale.

La Mission de l'USAID a également financé en 1989 une étude de la gestion des bassins versants. Cette étude a servi de base au document d'identification de projet soumis à l'AID/Washington pour un projet de gestion des bassins versants dans la Province d'Azilal.

Cette province renferme trois grands bassins versants qui alimentent l'Oum Er Rbia -- qui vient au deuxième rang des bassins fluviaux du Maroc.

Le document d'identification essayait de justifier un projet en se fondant surtout sur la réduction de la sédimentation des réservoirs en provenance des hauteurs de la Province d'Azilal, ce qui permettrait de protéger l'eau afin de l'utiliser en aval. Lors de l'examen du document d'identification, AID/Washington a demandé qu'on procède à une analyse supplémentaire pour évaluer l'importance des activités de gestion des bassins versants dans le contexte de la croissance économique générale du Maroc, et notamment les obstacles qui, en aval, empêchent d'améliorer l'efficacité de l'emploi de l'eau.

Le rapport présente les conclusions de l'équipe d'ISPAN au sujet des impactes techniques et économiques de la gestion d'eauet de sol dans le bassin de l'Oum Er Rbia. Sur la base de ces analyses, il est proposé de réaliser dans la Province d'Azilal un sous-projet de gestion des bassins versants, alors qu'un deuxième sous-projet porterait sur les politiques et pratiques de gestion et d'utilisation de l'eau en aval, dans la plaine de Tadla.

En ce qui concerne les contributions de la gestion des bassins versants à l'économie nationale, les principales conclusions de l'équipe s'ISPAN sont les suivantes:

- La sédimentation des réservoirs ne va pas, en soi, réduire sensiblement, à court et à moyen termes, le volume d'eau disponible pour l'irrigation et à d'autres fins au Maroc parce que l'espace "mort" -- c'est-à-dire l'espace aménagé dans le réservoir, lors de sa construction, pour collecter les sédiments -- ne sera pas rempli, dans la plupart des réservoirs, avant de nombreuses années. Pour la plupart des reservoirs, le remplissage ne se fera pas avant 25 ans au moins. En outre, après que les espaces "morts" seront remplis, il faudra attendre encore 100 ans ou plus avant que les espaces "utiles" de la plupart des grands réservoirs soient remplis même à moitié. Cela signifie, sur le plan économique, que la valeur actualisée nette des investissements visant à empêcher des pertes éventuelles de capacité des reservoirs est très faible et que des investissements effectués à cette seule fin ne se justifient pas en l'état actuel des choses.

- Les répercussions économiques de l'érosion des sols dans les bassins versants d'Azilal n'apparaîtront qu'à très long terme. Les réservoirs existants finiront par se remplir, entraînant une perte permanente d'eau pour l'irrigation et à d'autres fins. Dans les bassins versants, les sols épuisés ne seront pas en mesure de porter une couverture végétale, entraînant la dénudation des hauteurs et la perte permanente des ressources vegetales de la province. Tout cela signifie qu'au Maroc la plupart des activités de gestion des bassins versants doivent se justifier par la préservation à long terme de l'environnement, au lieu de l'être par des gains économiques à court et à moyen termes. Les interventions visant à réduire la dégradation des hauteurs

et à conserver leurs ressources en sol et en eau vont dans le sens des intérêts économiques du Maroc, mais elles doivent se faire de manière à n'entraîner que peu ou pas de coûts nets pour l'économie.

- Souvent, les mêmes interventions qui font diminuer l'érosion font augmenter la productivité agricole. Ces accroissements de productivité se traduisent souvent par des avantages qui, en peu d'années, dépassent les coûts, ce qui rend certains programmes de gestion des bassins versants économiquement viable à court terme.

Les autres conclusions de l'équipe sont importantes pour la formulation d'une stratégie globale de gestion des bassins versants au Maroc qui sont les suivantes:.

- Les coûts des mesures de conservation du sol que finance l'Etat -- par exemple les barrages de retenue, les terrasses en gradin et les projets de reboisement -- dépassent leurs avantages. Et, comme ces interventions coûtent tellement cher, le Gouvernement, dont les moyens sont limités, ne peut s'occuper que d'un petit pourcentage des bassins versants.

- L'érosion du sol dans les bassins versants d'Azilal est essentiellement la résultante des pratiques destructrices des populations locales -- notamment le surpâturage sur les terres communales et la culture sur des pentes abruptes aux sols instables. On ne peut pas atteindre une reduction permanente les taux d'érosion du sol sans modifier ces pratiques d'utilisation des terres.

- Les programmes de conservation du sol exigent qu'on engage des dépenses à court terme de la part des producteurs en échange d'avantages futurs. Cependant, au Maroc comme ailleurs, les prix des marchés ont tendance à sous-évaluer les effets induits par l'érosion des sols, donc les bénéfices des mesures de conservation du sol ne trouvent pas entièrement une expression à court terme sur le marché. Dans ces conditions, les coûts à court terme des mesures de conservation du sol au niveau de producteurs dépasseront la valeur actualisée des futurs avantages aux prix du marché.

Ces conclusions montrent qu'on a besoin de modifier comme suit les politiques de gestion des bassins versants au Maroc:

- Les programmes de gestion des bassins versants doivent chercher avant tout à modifier les pratiques de la population locale en matière d'utilisation des terres, au lieu de financer des interventions ponctuelles coûteuses par les pouvoirs publics.

- Le Gouvernement doit se rendre compte que la population locale n'a guère d'options viables pour remplacer la surexploitation actuelle des ressources

naturelles. Si l'on veut mettre en place des mesures de conservation des ressources, il faut les fonder sur un dialogue; ces mesures de conservation doivent etre accompagnées d'interventions qui augmentent autant que possible la productivité.

- Bien que les mesures de conservation des ressources exigent des règlements et, jusqu'à un certain point, le recours à la coercition, on ne peut pas les mettre en oeuvre si la population locale n'y participe pas volontiers. Il faut donc aborder les problèmes dans un esprit de collaboration, et non pas de confrontation.

Le sous-projet de gestion des bassins versants qu'il est proposé de réaliser dans la Province d'Azilal cherche essentiellement à modifier les pratiques d'utilisation des terres grâce à des interventions fondées sur le principe de la participation. Il exclue la plupart des interventions coûteuses qui doivent être financées et mises en oeuvre par le Gouvernement. Le sous-projet aura pour objet précis de réduire l'érosion du sol dans les trois bassins versants de la province. Dans les zones de démonstration de chaque bassin versant, l'érosion sera réduite de 40 à 50 pour cent. Une fois le projet terminé, l'augmentation de productivité qui sera réalisé grâce à ces nouvelles pratiques amèneront à les utiliser à plus grande échelle à travers la province.

Le sous-projet fera la démonstration, des méthodes permettant de surmonter les obstacles socio-économiques et institutionnels qui empêchent les agriculteurs et les éleveurs de changer leurs habitudes d'utilisation des terres, notamment sur les terrains communaux. Cette première étape critique est essentielle pour obtenir des réductions généralisées et permanentes de l'érosion des sols sur de nombreux bassins versants du Maroc.

Les interventions qui sont proposées pour atteindre les objectifs du sous-projet sont les suivantes:

1. Mise en place d'un plan de gestion forestière portant au moins sur une forêt de chaque bassin versant. Le plan visera à porter au maximum les rendements soutenus en bois et en fourrage. L'accroissement de la couverture végétale dans ces régions réduira d'au moins un tiers l'érosion des sols. Selon les estimations, 50 pour cent de l'érosion des sols des trois bassins versants a lieu dans ces zones. Une administration locale appropriée mettra en oeuvre ces plans de gestion forestière et les populations locales tireront parti de l'accroissement de la production.

2. Mise en place, dans chaque bassin versant, d'un plan de gestion des terrains de parcours dans une zone de pâturages communaux dans chaque bassin versant, assorti de dispositions institutionnelles permettant à la population locale d'exécuter chaque plan.

3. Adoption de pratiques améliorées de conservation du sol dans les zones d'agriculture non-irriguee, ce qui permettra de réduire l'érosion de 50 pour cent. C'est dans ces zones que se produit, estime-t-on, 35 pour cent de l'érosion du sol dans les trois bassins versants. On obtiendra ces résultats grâce à des services de vulgarisation conjugués à des stimulants économiques soigneusement choisis.

4. Réduction des pressions de pacage dans les forêts et les pâturages en élargissant la superficie des cultures irriguées -- dont une grande partie servira à la production fourragère.

On estime que les interventions du sous-projet coûteront une dizaine de millions de dollars. Les fonds serviront à payer une assistance technique expatrié, et marocaine, la formation des participants dans le pays et à l'étranger, et la construction de barrages de diversion pour les petits périmètres irrigués de la province d'Azilal.

IV. AMELIORATION DE LA GESTION ET DE L'EMPLOI DE L'EAU DANS LA PLAINE DE TADLA

Le sous-projet présenté ci-après est situé en aval de la province d'Azilal, dans le bassin d'Oum Er Rbia et, plus précisément, dans la région qui contient le périmètre d'irrigation de Tadla. Les interventions du sous-projet offriront la possibilité d'améliorer le volume et la qualité de l'eau disponible pour obtenir toute une série de produits agro-industriels de valeur élevée destinés aux marchés d'exportation et au marché intérieur. A l'heure actuelle, la quasi-totalité des exportations agricoles à valeur élevée du Maroc proviennent de Tadla et des neufs autres grands périmètres d'irrigation.

Les interventions du sous-projet pourraient aussi avoir d'importantes répercussions sur l'alimentation en eau potable et en eau industrielle de deux des plus grandes concentrations urbaines du pays -- c'est-à-dire la bande côtière Casablanca/Rabat et la région de Marrakech.

En troisième lieu, les interventions visant à améliorer les attributions de l'eau disponible dans la partie supérieure du bassin d'Oum Er Rbia pourraient permettre de mieux s'en servir pour produire de l'électricité dans toute la région. Il s'agit là d'une possibilité qui est loin d'être négligeable vu la dépendance grandissante du Maroc vis-à-vis des sources externes d'énergie et la place des dépenses consacrées aux importations de pétrole dans la balance des paiements du pays.

Non seulement le sous-projet se trouvera au centre de la stratégie de croissance de l'économie marocaine puisqu'il est lié aux modifications profondes de politique qui sont en

cours dans le secteur agricole, et vise à renforcer les principaux éléments de la stratégie de l'USAID pour le développement du pays, mais il sera aussi un complément important des activités parallèles de la Banque mondiale, l'autre grand bailleur de fonds qui s'intéresse à la gestion des ressources naturelles et au développement de l'irrigation au Maroc.

Aux niveaux macro-économiques et sectoriels, les principales réorientations de la politique économique du Gouvernement durant les années 1980 sont souvent le résultat direct de la collaboration du Gouvernement avec le FMI et la Banque mondiale et ont bénéficié de facilités de crédit et de prêts de ces institutions internationales. Ces nouvelles orientations de politique économique forment la matrice dans laquelle s'inscrira le sous-projet envisagé. Les interventions de celui-ci ont été conçues pour établir des liaisons étroites avec la mise en place et le renforcement des principaux éléments des programmes PAS et PASA du Maroc. Parmi ces éléments figurent: une plus grande décentralisation des prises de décision économiques et de la gestion des ressources avec participation plus intense des intéressés; le découplage des services publics et des entreprises commerciales et la reprise de ces activités par des agents du secteur privé; la réorientation de la production agricole dans le contexte de marchés ouverts et de prix compétitifs; un développement plus énergique de la production agricole destinée aux exportations; et l'encouragement d'entreprises et d'associations professionnelles viables dans le domaine de l'agro-industrie.

Au niveau du projet, les interventions envisagées viendront compléter étroitement les activités qu'entreprennent au niveau national les projets de la Banque mondiale visant à améliorer les résultats de l'agriculture irriguée. Dans le cadre de ces projets -- par exemple, les projets d'amélioration de la grande irrigation (PAGI), appelés PAGI I et II, -- la Banque collabore avec le Ministère de l'Agriculture et de la Réforme agraire (MARA) pour formuler et mettre en oeuvre des modifications expresses de la politique du sous-secteur de l'irrigation. Il s'agit de:

1. Redéfinir les mandats des ORMVA et borner leur futur rôle au nombre minimum d'activités jugées nécessaires dans l'intérêt public -- c'est-à-dire un approvisionnement fiable des agriculteurs en eau et vulgarisation agricole, qui sont dans les deux cas des biens publics.

2. Renforcer l'autonomie des ORMVA en tant qu'organismes au service de leurs clients, grâce à la décentralisation des pouvoirs de décision et à leur transformation, à la suite d'une gestion financière améliorée, en organismes à gestion à ajustement périodique.

3. Accroître le recouvrement des coûts auprès des agriculteurs dont l'exploitation se trouve dans les périmètres d'irrigation grâce à des révisions des redevances d'usagers d'eau, de manière à couvrir entièrement les frais d'exploitation et d'entretien des ouvrages d'adduction d'eau et à contribuer au remboursement des coûts d'équipement.

4. Découpler les ORMVA des entreprises commerciales pour les transformer en agents du secteur privé.

5. Accroître dans les périmètres d'irrigation la participation des agriculteurs à la prise de décision à tous les niveaux de manière à mieux s'adapter aux forces et aux prix du marché.

6. Remettre en état certains ouvrages d'infrastructure dans les neuf programmes LSI de manière à améliorer les moyens opérationnels et à donner plus de souplesse au système.

Telles qu'elles sont présentées ci-après, les interventions du sous-projet sont conçues de manière à renforcer et compléter ces orientations fondamentales et à transformer un grand nombre d'entre elles en réalités concrètes au niveau du périmètre de Tadla.

Le sous-projet propose de combler les lacunes existantes de la productivité et des institutions en matière de gestion des ressources dans l'économie régionale de la plaine de Tadla, dans le bassin d'Oum Er Rbia.

Dans ce contexte, la lacune de productivité se définit comme étant la différence entre les potentiels d'utilisation de l'eau et de production agricole de la plaine de Tadla et les niveaux existants d'utilisation des ressources tels que l'exprime la production de l'agriculture et de l'élevage de la région durant la dernière décennie.

La lacune institutionnelle se définit comme étant le vide temporaire qui existe entre le moment où l'ORMVAT redéfinit son mandat opérationnel et commence à mettre en oeuvre les directives nationales afin de cesser ses activités du secteur public jugées de caractère commercial et celui où les acteurs économiques du secteur privé ont acquis les moyens nécessaires et assument de nouveaux rôles et de nouvelles responsabilités vis-à-vis de la population rurale de la plaine de Tadla.

Le sous-projet a pour but d'améliorer la gestion générale des ressources régionales de la plaine de Tadla, conformément à la nouvelle stratégie du Gouvernement du Maroc concernant l'ajustement du secteur agricole.

Le sous-projet a pour objectif de mettre au point et de diffuser des méthodes améliorées d'affectation et de gestion des ressources naturelles -- notamment eau et terres -- dans la plaine de Tadla dans le contexte d'une économie plus ouverte et mieux orientée vers le marché. Il s'agit des éléments suivants:

- méthodes plus générales et plus souples de gestion des ressources en eau au niveau du système;

- interventions visant à améliorer, au niveau de l'exploitation, la gestion des ressources en eau et en terre en fonction des forces du marché et compte tenu des obstacles existants;

- interventions visant à améliorer la capacité de gestion d'ORMVAT pour se décharger de son nouveau mandat; et

- mesures visant à augmenter la participation effective des communautés à l'attribution des ressources et aux activités de développement.

Il est proposé quatre types d'interventions pour le sous-projet. Ce sont:

- l'amélioration des connaissances et de la gestion des ressources en eau au niveau du système des ORMVAT de manière à mieux garantir l'apport fiable d'eau d'irrigation et de services connexes au niveau des exploitations agricoles;

- un diagnostic visant, d'abord, à analyser les modalités existantes d'utilisation des ressources et, dans ce domaine, les motivations et les décisions des ménages agricoles à propos des contraintes imposées par les ressources, pour proposer ensuite, et mettre à l'essai, des activités pilotes visant à améliorer l'utilisation des ressources au niveau des exploitations;

- au fur et à mesure que l'ORMVAT cesse ses activités commerciales et redéfinit son mandat de base, interventions visant à renforcer les moyens dont il dispose pour réunir et analyser des informations critiques et exécuter les fonctions qui lui incombent encore sur le plan de l'exploitation et du soutien des clients, en faisant preuve d'une efficacité et d'une souplesse plus grandes; et

- prestation d'assistance technique aux nouveaux acteurs du secteur privé -- par exemple associations professionnelles, fournisseurs de facteurs de production agricoles, agents de commercialisation et entreprises agro-industrielles -- au fur et à mesure qu'ils assument leurs nouveaux rôles et leurs nouvelles responsabilités dans l'économie régionale.

Les premières projections d'investissements de l'USAID dans ce sous-projet établissent une fourchette de 12,5 à 18 millions de dollars. Un financement prendra la forme de dons correspondant à une assistance technique à court et à long terme par des experts expatriés, des consultants marocains à court terme possédant des compétences spéciales -- notamment par l'Institut Hassan II d'agronomie et de médecine vétérinaire -- un matériel de gestion de l'eau et un matériel automatique de surveillance météorologique, des ordinateurs avec des ensembles appropriés de logiciels, et des fonds en monnaie locale pour les activités à réaliser sur le terrain.

Les premières estimations montrent que le taux de rentabilité interne des investissements de l'USAID atteint 38 pour cent pour les seules économies d'eau. On estime le taux de rentabilité interne combiné des investissements de l'USAID et du Gouvernement du Maroc, au titre des dépenses renouvelables, à 34% au titre des seules économies d'eau.

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PART A

THE PROPOSED WATERSHED MANAGEMENT SUB-PROJECT FOR AZILAL PROVINCE

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MAIN REPORT

I. SUMMARY

A. Background

Morocco's watersheds provide water for 34 major reservoirs. These reservoirs provide 60 percent of Morocco's municipal water requirements and, during years of adequate rainfall, account for 30 percent of the country's electricity. Their main contribution, however, is to the nine large-scale irrigation systems and many small-scale systems that cover over 800,000 hectares of cropland. These irrigated areas receive 88 percent of the water from the major reservoirs.

The government, therefore, is extremely concerned that soil erosion in the watersheds not cause the reservoirs to fill up prematurely with sediment. The sedimentation of these reservoirs translates directly into less water being available for irrigation and other downstream uses.

Despite this growing concern, the problem of soil erosion has been addressed rather haphazardly, mainly through donor-funded projects in the most critically affected watersheds. Since the 1950s, interventions financed by these projects have affected about 400,000 hectares out of a total of about 11 million hectares in all of Morocco's watersheds.

The government has become increasingly aware that past programs have not had significant or sustainable impactS on soil erosion at the national level. Consequently, it asked the Food and Agriculture Organization of the United Nations (FAO), the World Bank and United States Agency for International Development (USAID) to undertake major new programs in this area. In 1988, FAO began implementing a three year project to establish a nationwide watershed planning capacity in the Ministry of Agriculture and Agrarian Reform (MARA). In 1989, the World Bank began discussions with the government concerning a possible national watershed management project to begin in 1992. A two year study is underway that will result in a national watershed management plan for Morocco and a major project to be funded by the World Bank.

The USAID Mission funded a watershed management study in 1989. This study was the basis for the Project Identification Document (PID) submitted to AID in Washington for a watershed management project in Azilal Province. This area includes the three major watersheds of the Oum Er Rbia River, the second largest river basin in Morocco. The project was justified largely on the basis of reduced reservoir sedimentation and its attendant benefits of preserving irrigation capacity downstream. AID requested further analysis of the relevance and importance of watershed management activities to overall economic growth in Morocco, with particular emphasis on downstream constraints to increased water use efficiency.

The purpose of this Part A report is to address AID's concerns. This section of the report presents findings on the economic benefits of watershed management in Morocco. On the basis of this analysis, a revised and substantially reduced watershed management project is proposed for Azilal Province. The Part B report addresses policy and other issues related to water use

efficiency downstream.

B. Major Findings

The key findings regarding the contributions of watershed management to the national economy are:

- Reservoir sedimentation will not significantly reduce the amounts of water available for irrigation in Morocco in the near to medium-term. This is because the "dead storage" -- i.e. the space designed to collect sediment without affecting reservoir capacity -- in most reservoirs will not be filled for many years -- e.g. 25 years or more. Even after the dead storages are filled, it will be more than 100 years before most of the major reservoirs are half filled. This means that the present value of eventual losses in irrigated area is minimal and does not in itself justify major expenditures to reduce soil erosion in the watersheds.

- The economic impact of soil erosion in the watersheds occurs only over the very long-term. Reservoirs will eventually be filled, resulting in a permanent loss of water for irrigation. In the watersheds, depleted soils will be unable to support vegetative cover resulting in denuded lands and the permanent loss of the productive resource base. This will occur over the long-term. Watershed management in Morocco, therefore, is justified only in terms of long-term environmental preservation, not short and medium-term economic gains. Interventions to conserve upland soil and water resources, then, are clearly in Morocco's economic self-interest but only if they can be carried out at little or no net costs to the economy.

- Watershed management programs often pay for themselves because interventions that conserve soils and decrease sedimentation rates also increase on-site agricultural productivity. These productivity increases can result in benefits that exceed costs in only a few years.

Several additional findings are important in formulating an overall strategy for watershed management in Morocco:

- The economic costs of traditional government-financed soil conservation measures -- e.g. checkdams, soil conservation fruit tree terraces and reforestation projects -- generally exceed their economic benefits under conditions that prevail in Morocco. And, because they are so expensive, the government can only afford to cover a small percentage of the country's watersheds with these types of interventions. In other parts of the country, however, these interventions may cost effective.

- The basic cause of soil erosion in the watersheds is the land use practices of the local populations, especially overgrazing on common lands and cultivation of fields on steep slopes and unstable soils. Sustained reductions in soil erosion rates can only be achieved through changes in local land use practices. The top-down, state-managed approaches of the past have not addressed the central issue of land use practices.

- Open markets in Morocco, as elsewhere, tend to undervalue future losses of natural resources. One result is that short-term costs of resource conservation measures usually exceed the present value of future benefits valued at market prices. Given this problem, farmers and herders will not carry out soil conservation measures unless these are associated with short-term increases in on-site productivity. Furthermore, laws to impose these measures are generally unenforceable unless it can be demonstrated that the long-term benefits are worth the short-term sacrifices.

C. A Proposed Sub-Project for Azilal Province

Based on these findings, the proposed watershed management sub-project for Azilal Province focuses on changing land use practices through participatory approaches. Most traditional interventions that must be financed and implemented by the government are excluded from the sub-project.

The specific purpose of the sub-project would be to reduce soil erosion rates in the three watersheds of Azilal Province. Initially, soil erosion in the demonstration areas in each watershed would be reduced by 40 to 50 percent. More importantly, the sub-project would develop and demonstrate methods of addressing the socio-economic and institutional constraints to changing land use practices among farmers and herders, especially as they pertain to common lands. This critical first step is essential in achieving widespread and sustained reductions in soil erosion in Morocco's watersheds.

The proposed interventions for achieving this overall objective are:

1. The establishment of a forest management plan in at least one forest in each watershed to maximize sustained yields of wood products and forage. The increased vegetative cover will reduce soil erosion by at least one-third. An appropriate local institution would implement the management plan and the local population would retain the benefits of the increased production.

2. The establishment of a range management plan in at least one common pasture in each watershed and set up the institutional arrangements necessary for the local population to implement the plan.

3. The introduction of improved soil conservation practices in rainfed agricultural areas that will reduce erosion rates by one half. This would be achieved through a combination of extension services and carefully selected economic incentives.

4. The reduction of grazing pressures on the forests and rangelands by increasing the area under irrigation, which is used for forage crop production.

The estimated cost of these interventions would be about $ 10 million, consisting primarily of technical assistance from the United States, technical assistance from Moroccan institutions, training in Morocco and abroad, and the construction of a small number of diversion dams for small-scale irrigation systems.

II. WATERSHED MANAGEMENT AT THE NATIONAL LEVEL

The two main reasons for carrying out watershed management programs in Morocco are:

1. To reduce the rate of sedimentation in the major reservoirs; and

2. To conserve forest, range and agricultural resources in the watershed areas.

The situation in terms of both the nature and severity of the problem varies greatly between watersheds. The most serious problems are in the Rif mountains where the soil erosion rates are highest and where, because of the high population density and fertile soils, the economic cost is greatest.

A. The Current Situation

The main source of data on soil erosion in Morocco is the Ministry of Public Works, which monitors sedimentation in the major reservoirs. Dividing the annual sedimentation rate by the size of the watershed provides an estimate of "specific erosion" designated in metric tons per hectare.[1] Data presented at the National Seminar on Watershed Management in January 1988 (Karmouni, 1987) show that in certain small watersheds in the Rif mountains, specific erosion rates reached 40 to 60 metric tons per hectare (Loukkos and Neckor). In most other areas of the Rif, specific erosion rates were estimated at 10 to 20 metric tons per hectare. At the other

[1] The term "specific erosion" as defined in several Moroccan studies substantially understates actual on-site erosion because not all eroded soils become sediments in reservoirs. A sediment delivery ratio is usually applied to measured soil erosion to arrive at a sedimentation rate. This ratio can be as low as 0.1 and rarely exceeds 0.5. This means that the specific erosion rates discussed below should be multiplied by an unknown delivery factor to arrive at actual erosion rates. For the purposes of this report, a factor of about 3 would provide a general indication of the erosion problem in Moroccan watersheds.

extreme, the Oum Er Rbia, Souss-Massa and Tensift watersheds had specific erosion rates of less than 10 -- and usually less than 5 -- metric tons per hectare. Text Table A-1, taken from a draft World Bank consultant report (Heusch, 1990), shows the variations in each of Morocco's major watersheds. It is clear that intensive soil erosion is concentrated in the Western Rif and Pre-Rif areas.

Text Table A-1
Estimated Soil Losses in Morocco

Region	Area in Millions of Square Kilometers	Estimated Soil Loss in Millions of Metric Tons per Year	Population of the Region in Thousands of Persons
Eastern Rif	11	33	900
High Atlas	80	24	500
Pre-Rif	7	10	700
Eastern Rif	9	3	400
Middle Atlas	2	1	100
Anti-Atlas	10	1	50
Total for all of Morocco	710	100	24,000

Soil erosion rates are determined by vegetative cover, slope, soil type, intensity of rains, and land use. The Rif areas subject to the highest erosion rates are characterized by high rainfall (1,000 to 1,500 millimeters per year), highly erodable soils and relatively high population density -- often exceeding 100 persons per square kilometer. The main economic activity in these areas is crop production which, when practiced on hillsides without soil conservation measures, has by far the highest rate of soil erosion. An FAO study of soil erosion in Morocco (FAO, 1975) cited in Hagen and Grosenick (1989) provided the following figures for the Rif:

- An average soil loss of 5.8 metric tons per hectare for badly degraded natural forests;
- An average soil loss of 18.4 metric tons per hectare for a watershed with a mix of cropland and natural vegetative cover; and
- An average soil loss 93.7 metric tons per hectare for a watershed area entirely under cultivation.

The end result is large areas of denuded "badlands", numerous deep gullies and a high rate of sedimentation of reservoirs relative to the size of the watershed.

Much of the High Atlas, on the other hand, is characterized by low rainfall -- less than 500 millimeters per year, low population density -- 40 persons per square kilometers in Azilal Province) -- extensive methods of livestock production, and soils relatively resistant to erosion. Consequently, while there is significant degradation of forests and rangeland, mostly from overgrazing, average specific soil erosion rates remain under 5 metric tons per hectare.

B. Economic Impact

Soil erosion in Morocco's watersheds has both upstream and downstream costs. The government's main concern is the impact of sedimentation on the reservoirs that provide most of the water for downstream irrigation and water supply systems. For the government, soil erosion in the watersheds leads to reduced reservoir capacity which translates directly into reduced irrigated area. Virtually all of the papers at the 1988 National Watershed Seminar presented the watershed management issue in the context of the impact of sedimentation on the irrigation infrastructure. One paper (Belkheiri, 1987) noted that during the 1980s sediment was accumulating in Morocco's reservoirs at the rate of 40 million cubic meters per year which, when compared to a total reservoir capacity of 10 billion cubic meters, amounts to 0.4 percent per year. The same paper noted that Morocco has thus far lost 600 million cubic meters of reservoir capacity which is equivalent to 60,000 hectares of lost irrigated area -- i.e. 10,000 cubic meters of storage capacity is needed to irrigate one hectare.

Text Table A-2 presents the situation for each of Morocco's major irrigation systems. Text Figure A-1 shows the geographic location of the dams that supply these systems. Of the three dams with dead storage mostly filled, two were constructed in 1935. The third -- Mohamed V dam on the Moulouya -- is recognized to have a serious sedimentation problem.

The conclusion to be drawn is that there is little downstream economic cost in present value terms from not carrying out management programs of most Moroccan watersheds. What is also clear, however, is that these reservoirs will one day be filled, thereby eliminating much of Morocco's irrigated agricultural production. Interventions to postpone this end result are clearly in Morocco's interest but only if they can be carried out at little or no net cost to the economy.

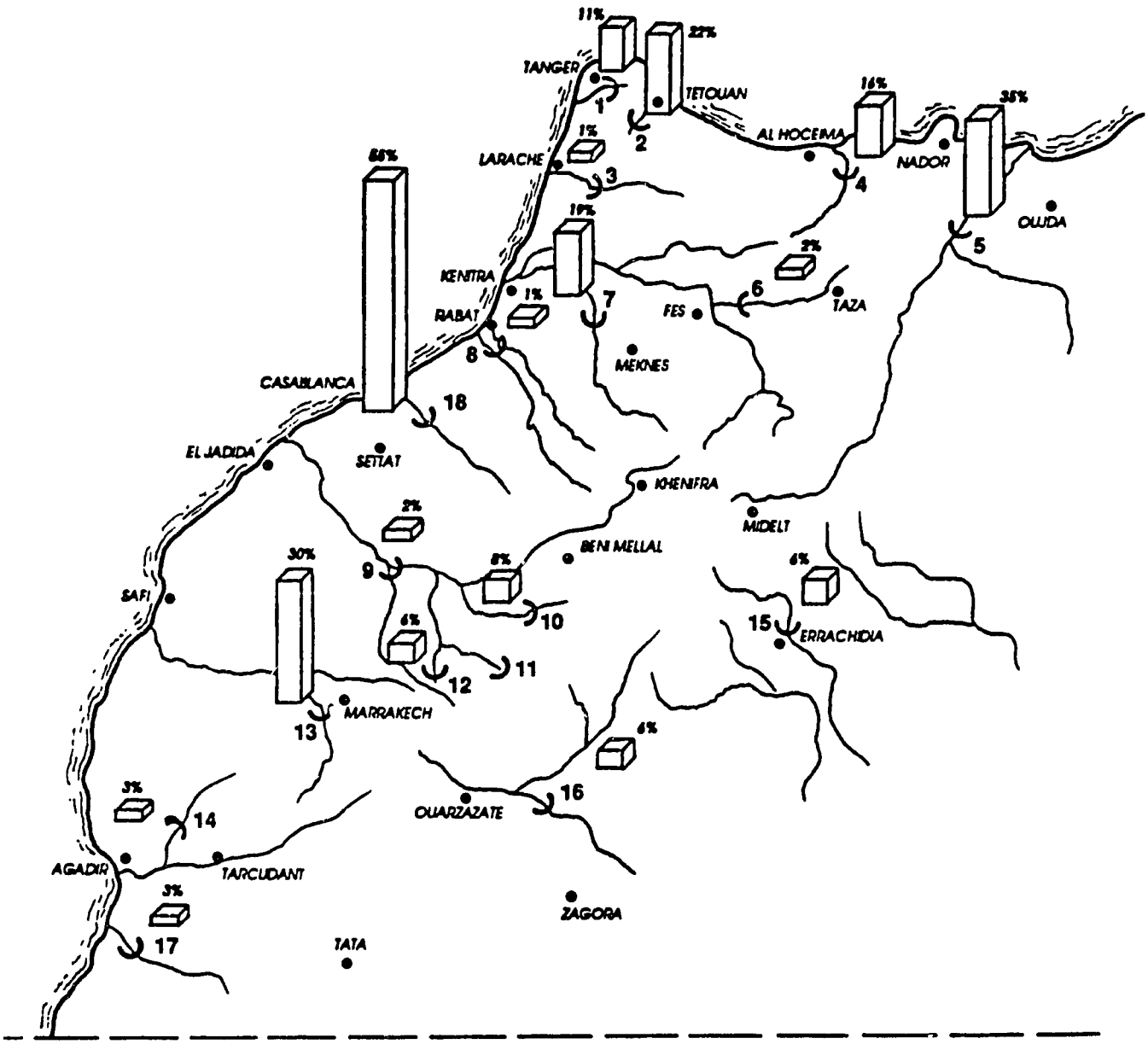
The situation is analogous in the watersheds where economic costs of soil erosion occur only in the long-term. In Morocco, the main causes of soil erosion are improperly cultivated agricultural lands, the over-utilization of forests, mainly from grazing and fuelwood harvesting, and the overgrazing of rangelands. The soil loss is causing marginal declines in agricultural productivity but, overall, the populations in the watersheds appear to be maintaining production in the face of increasing soil erosion.

Text Table A-2
Rate of Sedimentation of Major Reservoirs and Implications for Large-Scale Irrigation

ORMVA	Present Area in Irrigation in Hectares	Dam	Percent of Dead Storage Filled	Years Before the Reservoir is 50 Percent Full
Basse Moulouya	65,400	Mohamed V	70	23
Gharb	76,750	El Kansera	72	135
		Idriss I	17	301
Doukkala	59,700	Al Masira	12	554
Haouz	30,500	Moulay Yousef	27	143
		Hassan I	1	225
		Lala Taker	100	227
Tadla	97,050	Bin El Ouidane	13	200
Tafilalt	27,900	Hassan Adakhil	31	139
Ouarzazate	26,000	Mansour Adahbi	28	83
Souss Massa	32,760	Y.B. Tachfine	15	151
Loukkos	16,000	O.E. Makhazine	19	340
Total Area	431,610			

Sources: Ministry of Public Works (1990); Heusch (1990); Belkheiri (1987).

In the agricultural areas, as soils are depleted, farmers move into neighboring areas of natural vegetation. This increases the area subject to high erosion and reduces the size of the productive forest. In the forests and rangelands, growing numbers of sheep and goats are gradually denuding the vegetative cover and reducing long-term yields. This increases soil erosion but is not significantly reducing herd productivity. Production levels are maintained by depleting the stock of forests and grasses at ever increasing rates. The economic cost is not the loss of value added but rather the value of the soils that are lost. Eventually, the vegetative cover on the impoverished lands declines to the point where yields are too meager to support economic activity.



1. IBN BATTOUTA
2. NAKHLA
3. OUED EL MAKHAZINE
4. SIDI MOHAMMED B ABDELKRIM ALKHATTABI
5. MOHAMMED V
6. IDRISS
7. EL KANSERRA
8. SIDI MOHAMMED BEN ABDELLAH
9. AL MASSIRA
10. BIN EL OUIDANE
11. HASSAN I
12. HOULAY YOUSSEF
13. LALLA TAKERKOUST
14. ABDELMOUMEN
15. HASSAN ADDAKHIL
16. MANSOUR EDDAHBI
17. YOUSSEF BEN TACHEIN
18. OUED MELLAK

FIGURE A-1
PERCENTAGE OF LOST CAPACITY DUE TO SEDIMENTATION IN MAJOR DAMS IN MOROCCO

Thus, in terms of soil erosion, the downstream and upstream situations are similar. Important resources will be permanently lost in the absence of improved watershed management but their present economic value does not justify large investments in their preservation. However, because many watershed management interventions, in addition to reducing soil loss, increase the productivity of agricultural, herding, and wood production activities in the watersheds, upstream and downstream resources can be conserved as an indirect benefit at little or no net costs to the economy. The economic returns to various watershed management interventions will be discussed in more detail in the economic analysis section of this report.

C. Ongoing Government Programs

The Government of Morocco (GOM) soil conservation program Defense et Restoration des Sols (DRS) has been ongoing since 1951 under the Direction des Eaux et Forets (DEF). Until the mid-1970s, this program was heavily oriented toward direct government interventions in reforestation, rangeland improvement, terrace construction for forest plantations, fruit trees, and cereals, and checkdams to stabilize gullies. These interventions covered about 300,000 hectares over a 25 year period. Beginning in 1980, the DEF discontinued most of these programs, mainly because they were too expensive. Since then, the soil conservation program has consisted largely of subsidies to plant fruit trees (DRS Fruitiere) and extension. In practice, there has been very little soil conservation extension. DEF does not serve an extension function and the agriculture and livestock extension services are oriented toward production rather than conservation. All three services feel that government interventions are the key to a successful soil conservation program. Their experience is that extension programs have not been effective in getting farmers and herders to adopt soil conservation measures.

At present, most major soil conservation activities are being carried out in the context of development projects. All of these projects are located in the Rif mountains. They include the Loukkos Integrated Development Project covering 59,000 hectares, the Fes-Karia-Tissa Integrated Rural Development Project in the Sebou watershed covering 350,000 hectares, the Neckor Watershed Management Project, and the Developpement Economique Rural du Rif Occidental (DERRO) Project covering several provinces in the western Rif. Implementation of the DERRO Project has recently been turned over to the local authorities. These projects all fund expensive traditional erosion control interventions with varying degrees of success. Only the Neckor Project is focused primarily on reducing soil erosion. Its resources are concentrated on the 20,000 hectares that contribute the most to sedimentation in the reservoir on the Neckor River.

Although the government has been carrying out programs to reduce soil erosion in the watersheds since the early 1950s, there is no national policy or strategy for watershed management. Recently, there have been indications that this is changing. In January 1988, the GOM and FAO organized a national seminar on watershed management. Later in 1988, FAO started a project to set up four watershed management centers. The role of these centers will be to prepare and monitor watershed management plans for all of Morocco,s watersheds that have major dams. These plans will be implemented under the overall direction of the DEF.

In mid-1989, the GOM and the World Bank began discussions on a possible national watershed management project. Following these discussions, Japan agreed to fund a two year $ 500,000 study of watershed management in Morocco. The study is being carried out by a local consulting firm under World Bank supervision.

The main purposes of the study are to:

- Assess past watershed management experiences in Morocco, including the reasons for non-achievement of project objectives;
- Assess the level of knowledge in Morocco with respect to:
  1. The nature and extent of soil erosion problems;
  2. The economic impact of soil erosion;
  3. The cost effectiveness of erosion control interventions; and
  4. The socio-economic factors affecting the use of natural resources by local populations.
- Analyze the legal and institutional framework for watershed management;
- Propose a national watershed management plan; and
- Identify a project to implement the first phase of the national watershed management plan.

The study is scheduled to be completed in mid-1992 and to be followed by a World Bank project which will start in 1993.

The impetus for the national seminar as well as for the World Bank project is concern over the sedimentation of Morocco's major reservoirs. It can be expected that the national watershed management plan that will be recommended by the World Bank study will be oriented primarily toward reducing the sedimentation rate in these reservoirs.

In this respect, the issue of cost-effectiveness and economic feasibility will loom large. As noted above, the total area affected by past soil conservation programs is probably less than 400,000 hectares; whereas Morocco's watersheds cover an area of over 12 million hectares. It should also be noted that few of these measures will have a significant sustainable impacts because they do not address the socio-economic factors that are causing soil erosion and resource degradation in the watershed areas. Quite aside from the sustainability issue, past approaches are not likely to make much impact on the overall soil erosion problem simply because they are so expensive. For example, a watershed management plan recently prepared for the Lakhdar watershed, which has

relatively mild erosion problems, had a budget of $ 30 million for interventions covering a total of 60,000 hectares.

What is needed is a watershed management strategy that is affordable for the GOM and has sustained impact on the rate of resource degradation in Morocco's watersheds. The remainder of this report will focus on the three watersheds of the Oum Er Rbia river basin in Azilal Province: the El Abid (520,000 hectares), the Lakhdar (260,000 hectares) and the Tessaout (125,000 hectares). Azilal Province will be used as a case study to define an approach to sustainable watershed management that will have applicability for all of Morocco's watersheds.

III. THE EXISTING SITUATION IN AZILAL PROVINCE

A. The Economy

Azilal Province covers an area of 10,000 square kilometers and has a population of about 450,000. The province is mountainous with most of the population living and farming at altitudes of between 500 and 2,000 meters. Although the province contains the three major watersheds for the Oum Er Rbia River, most of the area is semi-arid. Annual rainfall ranges from 300 to 800 millimeters. According to a major study of Azilal Province completed in 1986 (FAO 1987), the overall pattern of land use in the province is as shown in Text Table A-3.

Text Table A-3
Pattern of Land Use in Azilal Province

Land Use	Hectares
Forests, mostly open forests used for grazing	330,000
Rainfed Agricultural Land	207,000
Irrigated Agricultural Land	23,000
Common Pastures	220,000
Unusable or Undetermined	220,000
Total	1,000,000

Source: FAO (1987).

The economy of the area is based on traditional agricultural and livestock production. The estimated volume and value of the major agricultural products in 1985 are presented in Text Table A-4.

Text Table A-4
Estimated Agricultural Production in Azilal Province
in Metric Tons and Millions of Moroccan Dirhams
1985

Commodity	Production in Metric Tons	Value of Production
Cereals	122,000	180.0
Olives	9,500	26.2
Almonds	3,600	98.7
Vegetables	17,600	23.7
Beef	2,100	35.6
Mutton and Lamb	3,600	60.7
Goatmeat	2,900	41.0
Milk	7,700	19.5

Source: FAO (1987), Volume I.

Although crops account for the largest share of value added in agriculture, yields are very low. Average cereal yields in the rainfed areas are estimated by the provincial extension service to be about 700 kilograms per hectare. Most of the crop production is in the low rainfall areas (300 to 500 millimeters per year) and most fields are on moderate to steep slopes with poor stony soils and a high rate of soil erosion.

The livestock sector consists of extensive small ruminant production throughout the province and small but more intensive cattle production concentrated in the agricultural lowlands. There are 550,000 sheep, 460,000 goats and 70,000 cattle. A higher value of production is estimated for intensive cattle production relative to the traditional small ruminant production methods. It should be noted, however, that meat production figures understate the value added of sheep and goat production. Traditional production systems deliberately keep offtake rates low in order to increase animal numbers. If increases in the stock of animals were taken into account, the contribution of small ruminants would probably be at least double what is reflected in the FAO estimates.

Azilal Province is a small net importer of cereals and a net exporter of meat, vegetables, fruits, nuts and firewood. Fifteen percent of household incomes is derived from labor remittances from outside the region and this percentage is increasing. The climate, soils and topography of the province limit the possibilities for significant agricultural modernization and productivity increases. As discussed below, this argues for a watershed management program that:

1. Focuses on areas of comparative advantage -- i.e. livestock products, mostly meat, under extensive production methods; tree crops, especially almonds; and

2. Aims at maintaining a sustainable balance in the use of the region's limited natural resources.

A strategy based on the modernization and intensification of agricultural production would not be sustainable. Moreover, by tending to reduce the rate of out-migration to more productive areas, it would be detrimental to the area and the overall economy in the long-term.

B. Conditions and Trends with Respect to Resource Degradation

There are five basic land use categories in Azilal province, each of which is experiencing a different degree and process of resource degradation.

- High altitude pastures (220,000 hectares)

  These are collective grazing areas used seasonally according to traditional grazing rights. Due to population pressures, these areas are increasingly overgrazed by sheep and goats during the summer months and are subject to moderate soil erosion. Soil loss is estimated at about 10 metric tons per hectare.

- Open Forests (240,000 hectares)

  This area is subject to two types of degradation. First, the area is heavily overgrazed. Although these forests are owned by the state and under the jurisdiction of the DEF, the local population continues to have unlimited traditional grazing rights. Although there are traditional systems for allocating these rights, population pressures have resulted in these forests becoming gradually denuded. In many areas, overgrazing is preventing any regeneration. As a result, large tracts of open forests will be almost completely denuded beginning in about 25 years.

  Second, these forests are subject to encroachment by farmers who are expanding their fields by clearing the adjoining forest lands. Agricultural lands in Azilal Province are estimated to be growing at the rate of 2.5 percent per year at the expense of forest lands. At present, erosion rates on overgrazed open forests can be estimated at about 25 metric tons per hectare. The areas cleared for agriculture are subject to much higher erosion rates as will be discussed below. In terms of total volume, this land use category accounts for the largest soil loss in the province.

- Dense forests (90,000 hectares)

  These are potentially commercial forests that can be managed for sustained yields of wood products, mostly firewood for use in the province and for export outside the province. These areas are being more effectively managed by the DEF than the open forests but are being overgrazed in some areas. Cutting trees for firewood is not a major cause of degradation in these forests. This is the area that is least subject to soil erosion, with a rate of about 5 metric tons per hectare.

- Rainfed agricultural areas (207,000 hectares)

  These are privately owned lands and are subject to different land use pressures than the common lands discussed above. The resource degradation is due partly to the high rates of erosion associated with crop cultivation and partly to inappropriate cultural practices. Soil erosion rates are estimated to average about 40 metric tons per hectare -- the highest of any land use category in the province. This area accounts for the second largest total soil loss after the open forests. The problem is being addressed by the agricultural extension service by providing soil conservation advice to farmers and by subsidizing soil conservation measures -- i.e. constructing stone walls on contour and planting fruit trees to help stabilize the soils. In general, farmers prefer to clear forest land as their fields lose soil cover rather than adopt practices that will reduce the rate of soil loss.

- Irrigated agricultural lands (23,000 hectares)

  These highly productive lands along river valleys are subject to very little erosion. They present no major problems in terms of resource degradation.

In summary, there are three main causes of resource degradation in Azilal Province. First, the forests are being overgrazed. This is causing reduced forest density and low forest regeneration. Second, forests are being cleared for agriculture at the rate of 5,000 hectares per year. Although these lands become temporarily more productive in terms of value of production per hectare, they are mostly unsuitable for cultivation over the long-term. The inevitable end-result is permanent loss of vegetative cover. Finally, traditional rainfed agricultural lands are experiencing high rates of soil erosion because crops are planted in areas that should remain under natural vegetation. A comprehensive watershed management plan for Azilal Province must address each of these problem areas.

C. Causes of Resource Degradation

The underlying cause of resource degradation in Azilal Province is the growing population. The economy of the area is based on methods of extensive agricultural and livestock production. Grazing is controlled by traditional methods that were able to protect the resource as long as the population of the area remained stable. At the same time that population growth put increasing

pressure on common areas, the state assumed ownership of the forest areas. On the one hand, increased enforcement over a relatively small portion of the forest tended to reduce the rate of degradation. On the other hand, the forests came to be perceived as belonging to someone else thus increasing the incentives to overuse and gradually deplete the resource. As noted above, this has resulted not only in overgrazing but also in the clearing of forests for crop production. Lands cleared in this way have tended to become de facto private lands.

The problem is twofold. First, there is no effective control over the common lands. In the absence of controls that are understood and generally accepted by the population and that can be effectively enforced by a recognized authority, individual economic interests will always conflict with and eventually overwhelm the need to conserve the common resource. Although all users of the common resource realize that their actions are leading to its inevitable disappearance, no single user can take unilateral action because other users will continue to overuse the resource in response to short-term market incentives. There are only two basic solutions, each with as many variations as there are cultures and social and legal systems:

1. To privatize the common lands so that there is a direct link between the short-term costs of responsible management and the long-term benefits; or

2. To establish a set of legal controls and create an authority capable of enforcing them.

The second aspect of the problem is that there are few technologies that can increase the productivity of these marginal lands. Consequently, it is not possible to increase incomes significantly through more intensive methods of agriculture and livestock production. All of the economic growth needed to support the growing population or to increase standards of living must come from either expanding the agricultural areas into increasingly marginal and unstable lands or increasing the stocking rates on common grazing lands that are experiencing steadily declining yields. The situation amounts to a downward spiral that cannot be easily reversed. In the absence of sustained changes in land use practices, the resource base will continue to degrade until it can no longer support economic activity and the population will be forced to leave. The remainder of this section discusses a possible approach to the reversal of this process.

IV. A PROPOSED PROJECT FOR WATERSHED MANAGEMENT IN AZILAL PROVINCE

A. Overall Strategy

It is proposed that the overall strategy for watershed management in Azilal Province have the following elements:

- Programs to reduce soil erosion rates must account for the fact that soil erosion is due mainly to the loss of vegetative cover caused by land use practices. Sustained reductions in soil erosion cannot be achieved without changes in the land use practices of the local populations. This favors participatory, rather than interventionist approaches, to watershed management.

- Farmers and herders must perceive clear and direct benefits from what is being asked of them. Most farmers and herders are living at a subsistence level and cannot afford reductions in income. Therefore, the package of soil conservation measures must combine reduced use of resources with increased productivity.

- Soil conservation programs must be based on a combination of government regulation and the willing participation of the population. Most soil conservation measures entail some short-term costs to farmers and herders which will naturally be resisted. They must at least understand, if not fully agree with, what is being imposed on them. This argues for a collaborative rather than adversarial approach to watershed management.

- Watershed management programs must be affordable to the government over the long term. This argues for:

  1. A concentration on programs to prevent degradation, rather than programs to restore degraded areas; and

  2. Activities that can be carried out by farmers and herders themselves, rather than interventions that must be funded and implemented by the government.

- The benefits of soil conservation interventions, properly valued, must exceed the costs of those interventions, properly valued. This generally argues against site specific interventions that can have a dramatic impact on soil erosion on a small area but whose impact on the overall soil erosion problem does not justify their exceedingly high per hectare costs.

B. Policy Framework

1. Existing Situation

The government does not currently have an overall watershed management policy or program, but there are several laws and policies that determine how watersheds are managed. In practice, soil conservation in the watersheds has not been a priority concern of the government. Its main concern, as noted earlier, is the sedimentation of reservoirs supplying water to the large-scale irrigation systems. In the absence of the sedimentation problem, it is unlikely that the conservation of soils in the mountain areas would be perceived as a high priority need.

The government explicitly addresses soil conservation in the Code des Investissements Agricoles. This law provides for subsidies to farmers to carry out soil conservation measures and enables the government to declare certain watersheds "of national interest" -- i.e. soil erosion is threatening a reservoir -- in which case soil conservation measures may be imposed. In practice, this law has had little effect on soil conservation practices or on the overall problem of soil erosion in the watersheds. One reason is that the agricultural extension services are understaffed relative to their assigned responsibilities and, until recently, have been almost fully occupied providing supporting services -- e.g. selling agricultural inputs -- that should have been the function of the private sector.

A second law affecting watershed management is the Forestry Law of 1917. This law designated Morocco's natural forests as state owned and exclusively under the management of the DEF. The law was amended by the Forestry Law of 1976 which stipulates that the income from commercial activities in the state-owned forests be given to the commune. The stated objectives of the law were to conserve the nation's forests, maximize sustained yields of forest products, including firewood and forage, and preserve the forest cover to minimize soil erosion.

The traditional rights of grazing and gathering dead branches and trees for firewood have been retained by the population, although the DEF has the authority to protect temporarily up to 20 percent of the forest from grazing as a conservation measure (mise en defense in French). In practice, the DEF does not have the resources to manage the forests effectively. Consequently, they are rapidly becoming degraded as a result of overgrazing and overcutting for firewood.

Finally, there is a complex set of traditional rights with respect to the use of common grazing areas. These rights are intended to:

1. Assure that common areas are shared equitably among different tribes and clans; and

2. Help prevent overuse and degradation.

The second objective is becoming increasingly difficult to achieve due to population pressures. The result is the steady denuding of rangelands and consequent increases in soil erosion.

2. Required Policy Changes

The policy changes that are needed as a prerequisite to effective watershed management are national in scope but most can be applied initially in Azilal Province. They fall into four categories:

a. Overall Approach to Watershed Management

The focus of watershed management programs needs to shift from interventions that are financed and implemented by government, such as reforestation programs and the construction of check-

dams and terraces, to changing the land use practices of farmers and herders. The first step is to understand why local populations use natural resources the way they do. In most cases, the result of this analysis will be that they have no other options. From their standpoint, they are using their labor and land optimally. Once their motivations are understood, it will be easier to arrive at sustainable interventions. These are likely to involve a combination of soil conservation regulations and low-cost extension programs. This approach places a premium on effective dialogue. Regulations will not be enforcable if they are too draconian or if they are not understood by the population. This approach also recognizes that there are no quick fixes. Land use practices will change slowly and the impact on soil erosion will be perceptible only over the long term.

b. The Approach to Common Lands

In Morocco, common lands consist mostly of state-owned forests and collective grazing areas. A large part of the soil erosion problem stems from the uncontrolled overuse of these lands. The problem divides itself according to the main categories of land use: the dense forest, the open forest, and the rangelands that are mostly seasonal high altitude pastures. For Azilal Province, the commercial forests are a small percentage of the total forest. These potentially high-value forests are now being overgrazed and depleted due to the lack of effective control. One approach would be to concentrate DEF's resources on the management of these forests for maximum yield and to combine the open forest and common rangelands into a resource to be managed with the participation of the local population.

This decentralization approach recognizes that the national authorities do not have effective control over these areas and the local populations are more likely to manage them more responsibly if they are in a position to exercise authority and receive the benefits from the conserved resource. It is essential that the local authorities selected to manage these resources represent the interests of the local population, rather than elite groups with their own special interests. Implementing this approach will require a sustained effort over many years to educate local populations and to devise institutional arrangements that are effective and socially sustainable over the long term.

c. Institutional Framework

The institutional issues are difficult because watershed management is intrinsically multi-sectoral requiring a high degree of inter-agency coordination. The present institutional framework is as follows:

- The DEF is the only institution with a strong resource conservation orientation but its area of responsibility is limited to forests. Due to lack of resources, the area of effective management is further limited to the dense commercial forests. It has little effective control over grazing and therefore over the large forest areas in Azilal Province and elsewhere that are used primarily for this purpose.

- The Agricultural Extension Service is responsible for carrying out soil conservation programs on agricultural lands as provided for in the Code d'Invesstissements Agricoles. This organization is primarily production-oriented and concentrates on disseminating new agricultural technologies such as the use of improved seeds and fertilizers. It does, however, administer two important soil conservation programs in Azilal Province -- i.e. subsidies for constructing stone walls along contours on sloping fields and subsidies for planting fruit trees on terraces for soil conservation purposes. This provides an effective base on which to build an expanded program assuming that soil conservation can receive a higher priority within the Ministry of Agriculture and Agrarian Reform.

- The Livestock Service is responsible for rangeland management but is almost exclusively concerned with increasing animal production. At present, this is being achieved mostly through animal health interventions. Other activities that have a high priority within the Livestock Service are genetic improvement, animal nutrition and herd management. Overgrazed rangeland is perceived by the Livestock Service as an intractable common lands problem about which it can do very little.

- The Ministry of Interior has funded reforestation and other soil conservation programs under its Promotion Nationale program. Activities under this program are highly visible small-scale efforts that have political, rather than environmental, objectives. More importantly, the Ministry is also responsible for local government and in this capacity would be a key participant in efforts to strengthen grazing controls and transfer part of the enforcement responsibility from national agencies to local authorities. Based on past experience, the Ministry of Interior is not likely to be a strong advocate of more stringent grazing controls if they cause discontent among the local population, which they almost certainly would.

As can be seen, the main institutional void is with respect to the common grazing areas. What is lacking is a grazing law based on social and economic realities at the farm and herder level and government institutions responsible for and capable of implementing the law. Specifically, range management capabilities and responsibilities could be added to DEF and the Livestock Service to address overgrazing in the forests and common pastures, respectively. The former would require that DEF shift its orientation from enforcement to a combination of enforcement and extension. The latter would require that the Livestock Service broaden its expertise and objectives to include range management as well as animal productivity. The Livestock Service would have to complement its existing staff with specialists in range management.

C. Interventions

A watershed management sub-project in Azilal Province would have as an overall goal to demonstrate a sustainable approach to reducing soil erosion that would be applicable in all of Morocco's watersheds. Implementation of sub-project activities should be accompanied by a

policy dialogue leading to a reorientation of Morocco's watershed management programs away from expensive interventions toward more participatory approaches. Specific actions that would indicate that this objective is being achieved would include an explicit commitment to participatory approaches in the national watershed management plan that is now being prepared with World Bank support -- i,e, the Agro-Concepts study, the replication of activities financed by the sub-project in Azilal in other watersheds, and the spontaneous spread of improved resource management practices throughout Azilal Province.

The key to the achievement of this overall objective is a willingness on the part of the government to forego programs with highly visible but unsustainable, short-term results for programs with sustainable results that are visible only in the long-term and therefore less appreciated by the local population.

The specific purpose of the sub-project would be to develop approaches to watershed management that are technically, economically and socially feasible for the three watersheds of Azilal Province. By the end of the sub-project, the following objectives will have been accomplished on at least one demonstration site in each watershed:

- The local population, with the advice of DEF and the Livestock Service, will be managing the open forest land.
- Improved rotational grazing systems will have been accepted by the local population in open forests and in common pastures.
- Management plans for maximizing sustained forage and wood yields in open forests will have been successfully developed and demonstrated.
- Widespread use of soil conservation measures by dryland farmers will have resulted in reduced clearing of forests for crop cultivation.
- Project interventions will have resulted in increased production of forage crops on irrigated land in conjunction with reduced stocking rates on common lands.

The key assumption for achieving the above objectives is that the recommended soil conservation practices will also increase yields sufficiently and within a short enough time frame to induce the local population to adopt the practices. This assumption will have to be studied further during the next phase of project design.

If the above objectives are achieved, soil erosion will be measurably reduced in the areas affected by the sub-project. The productivity increases accompanying the erosion control measures will cause them to be replicated in other parts of Azilal Province.

Four sets of interventions are proposed to achieve the sub-project purpose.

1. Improved Management of the Natural Forests

The focus of this intervention will be on controlling grazing and managing the forest for optimal forage yields. A secondary objective will be to achieve sustained increases in firewood production. This will be achieved through a system of community forest management. By the end of the sub-project, increased vegetative cover on the managed forests will have reduced erosion rates by 40 percent.

The key first step will be to increase the role of the local population in managing the open forest, with technical advice from DEF and the Livestock Service. This will be done in one demonstration area in each of the three watersheds. Once agreement is reached with the local community, the next steps will be to:

- Set up a forest management committee made up of a local land users' group -- e.g. a cooperative or other appropriate organization -- and representatives from DEF, the commune and the fraction, which is the lowest level of traditional local government.

- Set up a forest land management plan. This plan will concentrate on green oak, which is one of the most common species in Azilal Province and the one with the most value as firewood and forage. The plan will cover both grazing and cutting for firewood. This plan will be prepared by professional foresters in consultation with the forest management committee.

- Set up a management system for implementing the plan, including provisions for enforcing the plan and resolving disputes.

- Set up a technical monitoring system to measure the impact of management practices on vegetative cover, soil erosion, and value of the production increases. This will include setting up erosion control plots in forest areas with and without improved management.

For these actions to achieve their objective it will be necessary that the benefits accruing to the local population be substantial and within a short enough time frame to maintain interest. The income foregone during the early years cannot be more than the local population can afford.

The inputs needed for this intervention include:

- Short-term local technical assistance to prepare the management plan;

- Short-term local and expatriate technical assistance to organize and work with the local management groups;

- Training in range management for DEF and Livestock Service staff, including travel to other countries where forests are being managed for forage;

- Baseline studies of existing conditions on a detailed scale, including aerial photos and field verification; and

- Long-term staff to monitor implementation of the management plan and its impact on the managed forest.

2. Improved Management of the Collective Upland Pastures

These areas are subject to moderate erosion but are not a major cause of overall soil loss in the region. The pastures, however, are being overgrazed with a consequent loss in yields and stock carrying capacity as well as increased soil erosion. The objective of this intervention will be to establish an improved rotational grazing plan for a maximum of three common pastures. The plan's purpose will be to reduce the rate of degradation of the pasture and reduce soil loss by increasing the vegetative cover. The key assumptions in the achievement of this objective are that:

- The herders perceive the degradation of the pasture as serious enough to warrant significant changes in their grazing practices; and

- There is in fact a social mechanism for enforcing the management plan.

The actions involved in implementing this intervention are similar to those for the grazing forest discussed above. The first step will be to locate pastures where grazing rights are well established and where pasture degradation is perceived by the population to be a serious problem. The management plan will be prepared by the Livestock Service in consultation with the local grazing management committee. However, since the Livestock Service has no ownership rights over the common pastures, it will be limited to an advisory role in the implementation of the plan. Detailed discussions with the local population regarding the economic benefits of the management plan and the means by which it will be enforced will be required before the plan can be implemented. In addition, relevant experiences of similar activities elsewhere in Morocco as well as in other countries should be taken into account.

The inputs needed for this intervention include:

- Short-term local technical assistance for preparing the grazing plan and organizing the grazing committee;

- Training for the Livestock Service in socially-based range management; and

- Long-term technical monitoring of the managed pasture -- perhaps with assistance from the Peace Corps -- including the establishment of erosion plots.

It may be necessary to exclude some heavily degraded areas from grazing for one or two years before installing the new range management plan. In these cases, feed may have to be provided to the herders who are being deprived of the rangeland.

3. Soil Conservation in the Dryland Agricultural Areas

The objective of this intervention is to reduce soil erosion on cultivated lands by at least 50 percent -- i.e. from 40 to 20 metric tons per hectare. This still may be more than double sustainable rates but a more ambitious objective would be unrealistic and not useful as a basis for designing feasible interventions.

The main activity to be carried out under this intervention is the promotion of soil conservation practices by the extension service. One practice already widely used is the construction of stone walls on contours. These walls are constructed in the process of clearing new fields. Over time, they catch eroding soil and have a terracing effect. This practice is currently being subsidized by the government and will continue to be promoted under this sub-project. In addition, if farmers wish to plant high value fruit or nut trees in conjunction with the construction of the stone walls, the government provides the seedlings free. A key sub-project objective will be to continue phasing out the subsidies for the stone walls but not the fruit trees over a five year period. An alternative approach also being subsidized by the government is the much more expensive construction of entire terraces for fruit tree cultivation. This approach is in the process of being phased out because the stone wall or contour program achieves the same objective at much lower cost.

A related activity will be the introduction of microcatchment areas to harvest water for fruit trees. This practice is already being adopted in other areas of Morocco. Other soil conservation practices aimed at increasing the vegetative cover on cultivated fields will also be promoted. These include the use of fertilizers and the possibility of zero tillage for certain crops. Some of these practices may have to be tested on applied research plots before being disseminated to farmers.

It should be emphasized that increasing the use of soil conservation practices by farmers -- even on private land -- is essentially an extension function, usually combined with a system of subsidies and regulations. Open markets generally undervalue future long-term losses in natural resources. It is the role of government to assure that over the long-term private sector users of natural resources pay the full economic value of the resources that they use, including costs of externalities caused by misuse. An additional activity under this intervention will be to carry out a policy study to identify a set of regulations and incentives that would increase the use of soil conservation measures in the Moroccan context.

The inputs needed for this intervention consist primarily of short-term technical assistance to:

- Short-term technical assistance to:

  1. Develop a set of soil conservation measures appropriate to the rainfed agricultural areas of Azilal Province; and

  2. Devise an overall approach for addressing the problem of soil erosion on agricultural lands within the context of the Code des Investissements Agricoles;

- Limited applied research on non-traditional soil conservation practices.

4. Increased Forage Production on Irrigated Lands

The potential for increased small irrigated areas in Azilal Province is about 7,000 hectares. These lands are subject to very low erosion rates and their development is consistent with the overall objectives of this sub-project. The main objective of this intervention, however, is to increase forage production in association with reduced stocking rates on common lands. Groups in river valleys who own sheep and goats and have access to underdeveloped irrigable land would be approached in the context of a grazing control program in open forests or common pastures. In exchange for participating in the program, the sub-project would finance the construction of diversion dams. The farmers would assume responsibility for developing the irrigated area downstream from the dam. These areas could range from 50 to 100 hectares per dam.

If an agreement is reached, the procedure described above for the first and second interventions is followed. The only sub-project input required for this intervention would be the cost of the dam, which in most cases would cost less than $ 100,000.

V. FINANCIAL AND ECONOMIC ANALYSIS

A. Financial Analysis at the Government Level

The total costs of this sub-project are estimated at about $ 9 million, excluding contingencies and inflation. The foreign exchange costs are about $ 4 million, of which $ 3 million is for technical assistance. This includes two long-term advisors: a forester and a social scientist; and numerous short-term advisors in the fields of range management, soil conservation, land use rights and other specialties needed for sub-project implementation.

The local costs consist of dam construction for small scale irrigation systems -- $ 2 million -- and about $ 1.5 million in local personnel costs for long-term Moroccan technical advisors.

There will be little or no increase in government recurrent costs a result of this sub-project. The main ongoing programs will be forest management, range management and soil conservation. Most of the activities will be carried out by the local population and much of the administration will be the responsibility of local authorities. In fact, a major objective of this sub-project is to

disengage the government from direct involvement in the management and conservation of natural resources. The advice to be provided by government technical services will be performed by existing staff whose duties will be redefined as supporting local activities rather than implementing government interventions.

B. Financial Analysis at the Producer Level

At the producer level, the key financial issue is whether the benefits of soil conservation measures to farmers and herders exceed the costs. This will differ according to land use category.

1. Forest Management for Wood Production

The area of largest intervention is the open forest. The costs consist of income foregone in the short-term in exchange for sustained increases in future income. The primary area of intervention is the green oak forests which have the most value both as firewood and forage. At present, these forests are being overcut and overgrazed. FAO estimates that if these practices continue, the green oak forest will disappear in about 50 years. In the meantime, the yields of these forests as measured in annual growth of wood and forage are steadily declining.

The proposed changes in forest management practices can increase wood product yields -- mainly firewood -- by 60 percent and forage yields by 100 percent while, at the same time, halting the steady reduction in forest area. As explained in Annex 1, the increased wood product yields can be achieved through different cutting practices with little reduction in annual offtakes even in the short-term. The actual yield increases become evident only after 10 to 15 years, which is the duration of the cutting rotation cycle. Thus, whereas the benefits can be considered long-term from the producer's standpoint, there may be little or no short-term costs. The actual difference between the quantity of wood currently harvested and the quantity harvested under optimal management will be determined during sub-project implementation.

2. Improved Management of Grazing Areas

The situation for forage is slightly different. The yield increases start occurring in three to four years but they entail short-term costs in terms of reduced stocking rates. The calculation for the producer is whether the lost animal production in the short-term will be exceeded by increased animal production in the long-term.

The numbers are straightfoward. With present forage yields, the open forests can support two small ruminants per hectare and common pastures can support one per hectare. This is one-half of what the carrying capacity would be had there been no overgrazing. Furthermore, continued overgrazing will reduce the carrying capacity even more until grazing is no longer economically viable. A user group with access to 1,000 hectares of forest grazing land would have two alternatives. Either continue present practices in which case they can now graze 2,000 small ruminants and expect carrying capacity to continue declining. Or, they can reduce stocking rates

until yields begin to double in three to five years and then graze 4,000 small ruminants indefinitely under an improved grazing management plan. It would seem that, if these numbers prove accurate, that the proposed sub-project interventions relative to grazing are financially sustainable at the producer level.

3. Soil Conservation in Dryland Agricultural Areas

The situation with respect to the dryland agricultural areas is known to be more marginal from the producer's standpoint. Most soil conservation measures entail either increased labor time or increased costs of inputs. The techniques are well known and many of them have been extended to farmers in Azilal for years. Soil conservation practices include contour plowing, alley cropping, and building stone walls along contours which eventually have a terracing effect.

The full package of conservation measures can increase yields by 25 percent but only at the cost of increased labor time which may be the critical constraint the farming system. In addition, soil erosion can be reduced through yield-increasing new technologies. These involve the increased use of modern agricultural inputs -- i.e. fertilizers and improved seeds. Thus far, these have either not been available or have been too expensive for farmers to purchase.

A major reason why soil conservation measures are not more widely practiced in Azilal is that from the producer's standpoint they are too expensive relative to other alternatives. In the short-term, the least costly option for Azilal farmers is to keep depleting the soils and keep clearing additional land in the adjoining forests.

The solution is two-fold. First, make it more difficult to move into forest areas. This involves increasing the productivity of the forests and giving the local communities more of a vested interest in preserving forest land. It should be pointed out that in the short-run, using land for agriculture will almost always be more profitable that keeping it in forest, even under improved forest management conditions. Second, the package of soil conservation measures needs to focus more on increasing productivity. One way is to introduce more high value crops -- e.g. fruit and nut trees. Another is to increase the availability and reduce the costs of agricultural inputs that are appropriate to growing conditions in Azilal Province and improve opportunities for the commercialization of agricultural products. This will increase vegetative cover through increased plant density thereby reducing soil erosion on farmers fields, but may also have the negative effect of motivating farmers to increase the area under crops. As previously noted, this land use entails the highest erosion rates.

The issue of the financial feasibility of soil conservation measures in dryland agricultural areas will require further study before the final sub-project design.

C. Economic Analysis

The main objective of watershed management is to reduce soil erosion in the watersheds and conserve water for downstream uses. The economic benefits fall into two categories: the present

value of the conserved resources and the on-site productivity increases that are associated with soil conservation measures.

1. Economic Value of Conserved Natural Resources

Watershed management interventions conserve soil and water. The reductions in soil losses resulting from sub-project interventions are calculated in Annex 1. It is estimated that if the recommended soil conservation measures were applied throughout the three watersheds of Azilal Province, the average soil erosion rates would be reduced by 36 percent from 20 to 13 metric tons per hectare. There is little present economic value from these reduced soil losses because the yield impact is minimal. The economic impact comes when soils can no longer support vegetative cover. At that time, the loss is measured in terms of what would have been the most productive use of the resources -- probably a combination of wood, livestock, crop production and tourism. In the meantime, economic value added in Azilal Province will be maintained at existing levels by continuing to overexploit the vegetative cover.

Watershed management conserves water by increasing the life of the reservoirs that supply water for downstream uses -- i.e. irrigation, potable water, hydropower generation. The sedimentation calculations presented in Annex 1 indicate that the impact of the proposed watershed management program on the three reservoirs in Azilal Province is as presented in Text Table A-5.

Text Table A-5
Estimated Impact of Proposed Watershed Management Program on the Three Reservoirs in Azilal Province

		Estimated Life of Reservoir in Years	
	Bin El Ouidane	Moulay Youssef	Hassan I
At Present Sedimentation Rate	399	316	318
At Reduced Sedimentation Rate	571	531	468
Difference	172	215	150

However, because the dead storage in these reservoirs will not be filled for at least 25 years, the present value of these benefits is negligible.

2. The Economic Value of Productivity Increases

It is clear from the above figures that major resource conservation investments in the watersheds of Azilal Province cannot be justified on purely economic grounds. The issue in economic terms for the government is how much it is willing to spend to preserve the country's natural resources. As noted in the financial analysis, soil conservation measures have production impacts that can exceed their costs. This seems to be the case with forest and range management interventions but the situation is less clear with respect to soil conservation in agricultural areas. This is because the production benefits have to be measured against the costs to the producer. The production response data was not available in sufficient detail to carry out a cost-benefit analysis but it appears that the production benefits of a watershed management program in Azilal Province are sufficient to justify the sub-project, particularly in light of the low-cost interventions being proposed. A detailed analysis of each proposed intervention will have to be conducted during the final design. The data and expertise needed for this analysis is discussed in the next section.

VI. FEASIBILITY ISSUES

There are a number of feasibility issues that will require further analysis during the final design of this sub-project.

A. Technical Issues

There are three sets of technical issues. The first has to do with the rate of degradation. This is important in determining the economic and environmental costs of present land use practices. Existing aerial photographs should be studied. Where inadequate information exists, the generation of the necessary data should be provided for in sub-project implementation. The second issue concerns the agricultural lands. In the absence of a soil scientist, this consulting team was unable to recommend a full set of soil conservation measures for rainfed agriculture and assess the costs and benefits of these measures in terms of farm-level productivity. An agronomist would have to be added to the sub-project design team to address these concerns. Finally, the design of grazing interventions will require inputs from range management and livestock production specialists. Neither of these specialties was part of this team.

B. Social and Institutional Issues

The key social and institutional issues are the following:

- Project interventions have to be based on a sound understanding of traditional land use rights and practices. A legal and social analysis is required to understand how decisions are now made and the process by which rights and practices can be changed in the context of the sub-project.

- There needs to be a thorough analysis of the role of the Ministry of Interior and the various local authorities in local government and in matters relating to land use practices. The Project Paper should include an assessment of the institutional and legal feasibility of increasing the role of local authorities in the management of natural resources.

- A third issue concerns the relationships between DEF, the Livestock Service and the local authorities in the management of open forests. An analysis is needed to determine what is legally possible and what steps will be needed to overcome institutional constraints.

C. Economic and Financial Issues

The first issue concerns the financial feasibility of proposed changes in land use practices at the producer level. This requires updates of the farming and herding systems data that was gathered by FAO during the five year study of Azilal Province that ended in 1986 (FAO, 1987). The best way to gather this producer-level data during the sub-project design is by using a rapid reconnaissance approach. These data will have to be supplemented by data on the yield impact of proposed soil conservation measures. The objective is to identify the producer-level financial constraints to the introduction of soil conservation measures carried out by farmers and herders with their own resources.

The second issue concerns the cost benefit ratio of the proposed sub-project. The costs consist mainly of:

1. Government operations; and

2. The resource conservation efforts of the farmers and herders -- mostly labor costs -- and the income foregone because of the reduced overexploitation of the natural resource base.

The resource conservation benefits consist of present value of the preserved soils upstream and the longer life of the irrigation systems downstream. The production benefits consist of the higher yields that will be obtained from the forests, agricultural fields, and pastures in the sub-project area. The design team should include an agricultural and a natural resource economist to carry out this analysis.

PART B

THE PROPOSED DOWNSTREAM SUB-PROJECT IN THE TADLA ORMVA

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MAIN REPORT

I. SUMMARY AND RECOMMENDATION

A. Summary

The Moroccan economy, after suffering from a series of severe external and domestic shocks and their subsequent fiscal ramifications in the early 1980s, has recently entered a period of economic recovery and consolidation. Since the inauguration of a comprehensive economic structural adjustment (SAL) program in 1983, economic growth has been sustained, with real growth in gross domestic product (GDP) averaging 4.6 percent per annum. However, while economic growth over the latter half of the decade has been reasonably satisfactory, the average rate of GDP increase masks wide fluctuations related largely to interannual variability in precipitation and its effects on agricultural production.

The government is proceeding on a core economic growth path which stresses a balanced approach to development among sectors, with critical development activities in light industry, agriculture, mining and tourism. It has progressively established a more open foreign trade regime where domestic resource allocations are increasing governed by world market forces and prices. In the process, the Moroccan economy has moved away from its previous orientation in import substitution, pervasive protectionism of inefficient domestic industries and agriculture, and heavy and direct state involvement of economic management at all levels. There is a new realization that development of a balanced, export-driven economy will require a more active and equal partnership between the public and private sectors, with public disengagement from commercial activities and much more emphasis on private investment and management in these key areas.

If the Moroccan economy is to proceed along its present growth path, all key sectors have a common need for reliable supplies of high quality water. Without this resource, the growing work force in urban areas cannot be sustained, many industrial enterprises cannot function efficiently, energy from hydropower plant cannot contribute to reducing Morocco's dependence on imported oil, and, most importantly, domestic agricultural and agro-industrial production cannot be stabilized to provide critical wage goods for domestic economic growth and for exploitation of export opportunities.

The emphasis in Moroccan development planning, therefore,is on maximizing the capture of the country's surface water resources and providing for their optimal use in irrigated agriculture, potable water supplies, industrialization and energy generation. This directly reflects the government's central concern over this critical resource.

Enormous capital resources have already been invested in the essential infrastructure to control surface water flows in Morocco. Infrastructure to capture and utilize about two-thirds -- or 10 billion cubic meters -- of the available surface water potential is in place and four major infrastructure projects are in advanced stages of planning and/or implementation to capture most

of the remaining 5 billion cubic meters of potential by the end of the 1990s.

As Morocco nears the end of the infrastructural phase of its national water development plan, emphasis is beginning to shift to the more sophisticated and difficult task of ensuring socially optimal and technically efficient allocation of the existing water resources among competing consumer groups. This task is ever more complex given Morocco's relatively high population growth rate (2.4 percent per annum), the higher rate of migration from rural to urban areas (6 to 8 percent per annum), and increasing evidence of the economy's vulnerability to domestic and external economic shocks.

The major risk now is that water which has been captured at such great cost will not be used efficiently and that Morocco, therefore, will not be able to optimize the returns to its economy from all the investments to date. Since Moroccan sub-surface water resources are limited and generally expensive to exploit in both financial and environmental terms and desalination of seawater has not yet proven to be a cost-effective technology, conservation and optimal use of the existing surface water resources is a sine qua non for the country's successful economic development in the 1990s.

The sub-project presented below proposes to work in the second largest river basin in Morocco -- i.e. the Oum er Rbia -- and, specifically, in the upper basin area consisting the Tadla irrigation scheme, one of nine large-scale irrigation schemes (LSI) in the country. The interventions of the sub-project would potentially affect the quantity and quality of water available to produce a whole range of high value agro-industrial products for export and domestic markets in three of the nine LSI areas of the country -- i.e. in the Tadla, Haouz and Doukkala perimeters. Presently, virtually all of Morocco's high value agricultural exports are produced in and processed near these nine irrigation perimeters.

The sub-project interventions could also have significant impacts on the availability of potable and industrial water supplies for two of the largest urban concentrations in the country -- i.e. the Casablanca/Rabat coastal strip and the Marrakech area.

Thirdly, interventions to allow more efficient allocation of the available water in the upper Oum er Rbia basin could allow for better utilization of that resource for hydropower generation throughout the area. This potential is by no means an insignificant factor given Morocco's growing dependency on external energy sources and the place of expenditures on imported petroleum in the country's balance of payments.

At the sectoral level, irrigated agriculture has a high priority in Morocco. Irrigation is viewed as providing the means by which Morocco will be able to meet the needs of its growing population and expand exports both of commodities and processed agricultural products in order to earn more foreign exchange and contribute to redressing imbalances in the country's external trade account.

In assessing the Moroccan development strategy in 1990, one is strongly drawn to the conclusion that both better water resource management and more economical development of the country's irrigation potential are critical components of Morocco's core growth path strategy. The sub-project, however, proposes to deal with water resource management primarily in the context of irrigation agriculture for two even more fundamental reasons:

1. Water use for irrigation accounts for 88 percent of total surface water use in Morocco, as opposed to 8 percent for potable water supplies and 4 percent for industrial use. Therefore, if significant efficiency gains in water resource conservation are to be affected in the medium-term, work must initially be focussed on irrigation as the largest and, probably, the most wasteful consumer of that water.

2. Since the irrigated perimeters of Morocco produce essentially all of the high value export crops -- i.e. the rainfed agricultural areas are devoted primarily to production of import-substitution such as cereals and edible oil crops -- interventions of the proposed sub-project would make an additional contribution to production of these crops in the context of Moroccan agri-business development.

The proposed sub-project has been designed to strongly reinforce the main objectives of the USAID Mission's core development assistance program for Morocco as articulated in USAID Morocco Programming for the 1990s -- A Concept Paper of July 1990 and to be incorporated in the Mission's new Country Development Strategy Paper in early 1991.

The interventions of the sub-project will complement activities already underway or planned in the general context of Mission support for the Government of Morocco's structural adjustment program. Specific objectives to be further under the sub-project are:

- Improved conservation and allocation of domestic resources -- chiefly water, land, labor and management -- in the context of continued market liberalization;

- Job creation and reducing urban/rural income disparities;

- Increased privatization of investment and management of key economic sectors, coupled with disengagement from these sectors by public and parastatal agencies;

- Promotion of high value agricultural crops and private sector agro-industrial enterprises in the context of an export-driven economy;

- Stabilization of the economy through reducing the present variability in agricultural production and increasing the reliability of wage good transfers to the modern sector;

- Development of strong regional and commodity interest groups as an aid to increasing effective participation in the Moroccan political process;

In addition to being squarely in the core growth path of the Moroccan economy, linked to key policy changes being affected in the agricultural sector, and directed at reinforcing key elements of the USAID country development strategy, the proposed sub-project would be strongly complementary with parallel activities of the World Bank, the other major external donor concerned with natural resource management and irrigation development in Morocco.

At the macroeconomic and sectoral levels, many of the major reorientations in government economic policies in the 1980s are the direct results of government interactions with the IMF and the World Bank and have been supported by credit facilities and loans from these international agencies. These new economic policy orientations form the matrix within which the proposed sub-project will operate. Sub-project interventions have designed to have strong linkages to the implementation and reinforcement of key elements of Moroccan SAL and ASAL programs. Among the key elements to be addressed are: greater decentralization of and participation in economic decision-making and resource management; public disengagement from commercial enterprises and assumption of these activities by private sector agents; reorientation of agricultural production in the context of open markets and competitive pricing; greater development of agricultural commodities for export; and fostering the viable agribusiness enterprises and professional associations.

At the project level, the proposed interventions would be highly complementary to the activities being undertaken in the national-level World Bank projects aimed to improving performance in irrigated agriculture. Under these projects -- i.e. Projets d'Amelioration de la Grande Irrigation (PAGI), designated as PAGI I and II for the First and Second World Bank-funded projects -- the Bank is working with the Ministry of Agriculture and Agrarian Reform (MARA) to formulate and implement specific policy changes in the irrigation sub-sector. The specific policies include:

1. Redefining the mandates of the ORMVAs and confining their future role to that minimum number of activities deemed to be necessary to the public interest -- i.e. reliable water delivery to farmers and agricultural extension, both public goods.

2. Strengthening the autonomy of the ORMVAs as client-oriented service agencies through decentralization of decision-making authority and putting them on a "pay-as-you-go" status through improved financial management.

3. Increasing cost recovery from farmers in irrigation perimeters through revisions of water user fees so as to entirely cover the operation and maintenance costs of water delivery and contribute to capital cost reimbursement.

4. Disengagement of the ORMVAs from commercial enterprises and turning them over to private sector agents.

5. Increasing farmer participation in decision-making at all levels within the irrigation perimeters so as to be more responsive to market forces and prices.

6. Rehabilitating selected infrastructure within the nine LSI schemes so as to improve operational capacities and system flexibilities.

Sub-project interventions, as presented below, are designed to reinforce and complement these basic policy orientations and to make many of them concrete realities at the level of the Tadla perimeter.

Sub-project proposes to address the existing productivity and institutional gaps with respect to resource management in the regional economy of the Tadla plain within the Oum Er Rabia river basin.

In this context, the productivity gap is defined as the difference between the water use and agricultural production potentials of the Tadla plain and the existing levels of resource use as expressed in actual crop and livestock production in the area over the last decade.

The institutional gap is defined as that transitional void created as the ORMVAT redefines its operational mandate and begins the process of implementing national policy directives to disengage from those public sector activities deemed to be commercial in nature and the time needed for private sector economic actors to develop capacities and assume new roles and responsibilities vis-a-vis the rural population on the Tadla plain.

The goal of the sub-project is to improve overall resource management in the regional economy of the Tadla plain in line with the Government of Morocco's new strategy for agricultural sector adjustment.

The purpose of the sub-project is to develop, test and disseminate improved practices for allocation and management of natural resources -- chiefly water and land -- on the Tadla plain in the context of a more open and market-oriented economy. These are expected to include:

- More comprehensive and flexible approaches to water resource management at the system-level;

- Interventions to improve farm-level management of water and land resources in response to market forces and existing constraints;

- Interventions to improve ORMVAT management capacity to discharge its redefined mandate; and

- Measures to increase effective community participation in resource allocation and development activities.

Four types of intervention are proposed in the sub-project. There are:

- Improving knowledge and management of water resources at the system-level in ORMVAT so as to better guarantee the reliable delivery of irrigation water and related services to the farm-level;

- A diagnostic activity to first analyze existing resource utilization patterns and farm household motivations and decision-making with respect to resource constraints and then to propose and test pilot activities to improve on-farm resource use;

- As ORMVAT disengages from commercial activities and redefines its core operational mandate, interventions aimed at strengthening its capacity to gather and analyze critical information and to execute its remaining operational and client-oriented support functions with greater efficiency and flexibility; and

- Providing practical assistance to emerging private sector actors -- i.e. professional associations, agricultural input suppliers, marketing agents and agro-industrial businesses -- as they assume their new roles and responsibilities in the regional economy.

Initial projections of USAID investment in this sub-project place the cost between $ 12.5 and $ 18 million. Grant funding would provide for long and short-term expatriate technical assistance, short-term Moroccan consultants in special areas of expertise -- most appropriately from the Hassan II Institute of Agronomy and Veterinary Medicine, water management and automated weather monitoring equipment, computer systems and appropriate software packages, and local currency for field activities.

Initial estimates indicate that the internal rate of return on USAID investments <u>from water savings alone</u> is 38 percent. The estimate of the internal rate of return on combined USAID investments and Government of Morocco recurrent expenditures <u>from water savings alone</u> is 34 percent.

B. Recommendation

The consultant team believes that the sub-project as proposed herein merits development to the Project Identification Document (PID) stage.

II. PROGRAM FACTORS

A. Sub-Project Relationship to Morocco's Overall Development Strategy

1. Macroeconomic Appraisal

The Moroccan economy, after suffering from a series of severe external and domestic shocks -- e.g. declining prices for key exports, sharply rising costs for critical imports, prolonged drought -- and their subsequent fiscal ramifications in the early 1980s, entered a period of recovery and consolidation in the latter half of the decade. Since the inauguration of a comprehensive economic structural adjustment in 1983 program, economic growth has been sustained, with real growth in gross domestic product (GDP) averaging 4.6 percent per annum.

While economic growth over the latter half of the decade has been reasonably satisfactory, the average rate of GDP increase masks wide fluctuations related largely to interannual variability in precipitation and its effects on agricultural production. Moreover, the economy continues to be encumbered by a necessary commitment to debt servicing -- i.e. total indebtedness amounted to 83 percent of GDP in 1990 -- and an almost total dependence on imported oil to meet growing national energy requirements.

Nevertheless, in the context of its structural adjustment program, the government is proceeding on a core economic growth path which stresses a balanced approach to sectoral development, with critical development activities in light industry, agriculture, mining and tourism. It has progressively established a more open foreign trade regime where domestic resource allocations are increasing governed by world market forces and prices. In the process, the Moroccan economy has increasingly moved away from its previous structural orientation in import substitution, pervasive protectionism of inefficient domestic industries and agriculture, and heavy and direct state involvement of economic management at all levels. In this regard, there is a new realization in Morocco that development of a balanced, export-driven economy will require a more active and equal partnership between the public and private sector participants, with public sector disengagement from commercial activities and much more emphasis on private investment and management in these key areas.

If the Moroccan economy is to proceed along its present growth path, all key sectors have a common need for reliable supplies of high quality water. Without such guaranteed supplies, the growing work force in urban areas cannot be sustained, many industrial enterprises cannot function efficiently, energy from hydropower plant cannot contribute to reducing Morocco's dependence on imported oil, and, perhaps, most importantly, domestic agricultural and agro-industrial production cannot be stabilized to provide critical wage goods for domestic economic

growth and for exploitation of export opportunities.

The emphasis in Moroccan development planning on maximizing the capture of the country's surface water resources and providing for their optimal use in irrigated agriculture, potable water supplies, industrialization and energy generation directly reflects the government's central concern over this critical resource.

Enormous capital resources have already been invested in the essential infrastructure to control surface water flows in Morocco -- i.e. in dams, transfer and conveyance canals, hydropower facilities, irrigation structures, and potable and industrial water distribution systems in major urban areas. Infrastructure to capture and utilize about two-thirds -- or 10 billion cubic meters -- of the available surface water potential of the country is already in place and four major infrastructure projects are already in advanced stages of planning and/or implementation to capture most of the remaining 5 billion cubic meters of potential in the 1990s.

As Morocco nears the end of the infrastructural phase of its national water development plan, the emphasis is beginning to shift from capital expenditures on construction of dams and related hydropower projects to the more sophisticated and difficult task of ensuring socially optimal and technically efficient allocation of the existing water resources among competing consumer groups. This task is becoming ever more complex given Morocco's relatively high population growth rate (2.4 percent per annum), the even higher rate of migration from rural to urban areas (6 to 8 percent per annum), and increasing evidence of the economy's vulnerability to domestic and external economic shocks.

The major risk now is that water which has been captured at such great cost will not be used efficiently and that Morocco, therefore, will not be able to optimize the returns to its economy projected from all the investments to date. Since Moroccan sub-surface water resources are limited and generally expensive to exploit in both financial and environmental terms and desalination of seawater has not yet proven to be a cost-effective technology, conservation and optimal use of the existing surface water resources is a sine qua non for the country's successful economic development in the 1990s.

The sub-project presented in this paper proposes to work in the second largest river basin in Morocco -- i.e. the Oued Oum er Rbia -- and, specifically, in the upper basin area consisting the Tadla irrigation scheme, which is one of nine large-scale irrigation (LSI) schemes in the country. The interventions of the sub-project would potentially affect the quantity and quality of water available to produce a whole range of high value agro-industrial products for export and domestic markets in three of the nine LSI areas of the country -- i.e. in Tadla, Haouz and Doukkala. Presently, virtually all of Morocco's high value agricultural exports are produced in and processed near these nine irrigation perimeters.

The sub-project interventions could also have significant impacts on the availability of potable and industrial water supplies for two of the largest urban concentrations in the country -- i.e. the Casablanca/Rabat coastal strip and the Marrakech area -- in the overall context of the

National Water Development and Allocation Master Plan being developed for the Conseil Superieur de l'Eau -- i.e. the Royal Council on Water Development. Of these two urban areas: the former is the most densely populated urban area in the country and the major industrial and commercial center of Morocco; the latter is one of the major tourist areas, in addition to being the largest commercial and administrative center in southern Morocco.

Thirdly, interventions to allow more efficient allocation of the available water in the upper Oum er Rbia basin could allow for better utilization of that resource for hydropower generation throughout the area. This potential is by no means an insignificant factor given Morocco's growing dependency on external energy sources and the place of expenditures on imported petroleum in the country's balance of payments.

2. Sectoral Appraisal

Irrigated agriculture has a high priority in Morocco. Irrigation development is viewed as providing the means by which Morocco will be able to meet the needs of its growing population and expand exports both of commodities and processed agricultural products in order to earn more foreign exchange and contribute to redressing imbalances in the country's external trade account.

Government policy in the agricultural sector has always favored investments in the irrigation sub-sector. These investments have accounted for more than 60 percent of the total sectoral capital expenditures since 1965. At a result, of the approximately 7.7 million hectares of arable land and 1.2 million hectares of potentially irrigable land, about 900,000 hectares already have irrigation systems in place.

In assessing the Moroccan development strategy in 1990, one is strongly drawn to the conclusion that both better water resource management and more development of the country's irrigation potential are critical components of Morocco's core growth path strategy. The sub-project, however, proposes to deal with water resource management primarily in the context of irrigation agriculture for two even more fundamental reasons:

1. Water use for irrigation accounts for 88 percent of total surface water use in Morocco, as opposed to 8 percent for potable water supplies and 4 percent for industrial use. Therefore, if significant efficiency gains in water resource conservation are to be affected in the medium-term, work must initially be focussed on irrigation as the largest and, probably, the most wasteful consumer of that water.

2. Since the irrigated perimeters of Morocco produce essentially all of the high value export crops -- i.e. the rainfed agricultural areas are devoted primarily to production of import-substitution such as cereals and edible oil crops -- interventions of the proposed sub-project would make an additional contribution to production of these crops in the context of

Moroccan agri-business development.

The irrigation sub-sector in Morocco is composed structurally of both LSI schemes (20,000 to 250,000 hectares each) and small and medium-scale perimeters (generally less than 5,000 hectares each). The LSI schemes represent major new investments in civil works for water regulation and conveyance and have modern water distribution systems. They consume the vast bulk of the surface water resources captured by dam construction to date.

Prior to the mid-1980s, the Morocco was implementing a highly "interventionist" approach to these LSI schemes, as embodied in the provisions of the 1969 Code for Agricultural Investments. The Code constituted the original framework for promoting the rational use of resources within the LSI schemes and was regarded by government as a contract between the State and the farmers to build the national economy through irrigation development. It set the priorities for dam and infrastructure development, the operations of the irrigation schemes, and necessary on-farm development. It also provided credit, selected seeds, farm equipment, and certain mechanized operations usually at subsidized prices. Finally, it guaranteed prices for major crops such as sugar beets, sugar cane, rice, wheat and cotton through contracts. In turn, farmers were obligated to plant certain crop rotations on their irrigated land in the "national interest", to follow the norms imposed by the government for use of the land, and to repay the State for this privilege through a land improvement tax and water charge levies.

The Code regulations applied with particular force to all of the nine LSI schemes in Morocco. Each irrigation perimeter was to be developed and managed by a decentralized public agency -- i.e. an Office Regional de Mise en Valeur Agricole (ORMVA) -- with full responsibility for all aspects of irrigated agricultural development. These ORMVAs were responsible for the design, construction, operation and maintenance of the irrigation networks. They were charged with integrating all of the production support services for farmers under a single management structure -- e.g. distributing inputs, providing extension and mechanized services, supervising short-term credit and even providing for genetic improvement and health control services for livestock within the perimeters.

Since the mid-1980s, however, the government, in the context of its Structural Adjustment and its Sectoral Adjustment Programs, both supported by loans from the International Monetary Fund (IMF) and the World Bank, has taken many steps to dismantle its "interventionist" structure in the irrigation perimeters:

1. The Code for Agricultural Investment has been extensively rewritten to allow for greater private sector participation in development and management.

2. Domestic commodity markets have been opened to competition.

3. Crop prices have been either completely liberalized or tied closely to prevailing world market prices.

4. The ORMVAs have been ordered to strictly confine their future activities of those elements of their former mandates deemed to be essential functions -- primarily efficient provision of irrigation water for farmers and agricultural extension activities.

5. Parastatal agro-industrial enterprises are being privatized and their private sector successors are expected to increasingly take over the commercial functions formerly ascribed to the ORMVAs.

6. And, finally, farmers and their professional associations are expected to take over much greater responsibilities for investments in land improvements and irrigation system maintenance, setting their crop rotations in response to market forces, securing their inputs through contractual arrangements with agro-industrial processors or from other private sector suppliers, and in marketing their crops.

All of these policy changes have been articulated by the government and strongly supported by the international donor community. They provide for radical different approaches to decision-making and management of resources in the irrigation perimeters in the context of a much more participatory and market-oriented agricultural economy.

B. Sub-Project Relationship to AID's Country Development Strategy

The proposed sub-project has been designed to strongly reinforce the main objectives of the USAID Mission's core development assistance program for Morocco as articulated in USAID Morocco Programming for the 1990s -- A Concept Paper of July 1990 and to be incorporated in the Mission's new Country Development Strategy Paper in early 1991.

The interventions of the sub-project will complement activities already underway or planned in the general context of Mission support for the Government of Morocco's structural adjustment program. Specific objectives to be further under the sub-project are:

- Improved conservation and allocation of domestic resources -- chiefly water, land, labor and management -- in the context of continued market liberalization;

- Job creation and reducing urban/rural income disparities;

- Increased privatization of investment and management of key economic sectors, coupled with disengagement from these sectors by public and parastatal agencies;

- Promotion of high value agricultural crops and private sector agro-industrial enterprises in the context of an export-driven economy;

- Stabilization of the economy through reducing the present variability in agricultural production and increasing the reliability of wage good transfers to the modern sector;

- Development of strong regional and commodity interest groups as an aid to increasing effective participation in the Moroccan political process;

Improved conservation and allocation of water in the Tadla perimeter would lead directly to greater technical and economic efficiencies in the production of the high value export crops. Reducing water costs per unit of agricultural output would not only affect increases in net farm incomes in the perimeter itself but have potential for lowering input costs in the related agro-industrial enterprises of the region and ultimately for increasing the competitiveness of Moroccan agricultural exports in world markets.

In addition, since the Tadla, Haouz and Doukkala irrigation schemes are soon to be linked in a regional water distribution network, conservation of water resources in the Tadla portion of the upper river basin would result in increasing the potential for more reliable intersystem water transfers to Haouz and Doukkala. These transfers are important to the regional system because, in the case of Haouz, they would permit full development of the Tassaout Aval sub-perimeter and would allow more water to be transferred from the Haouz perimeter to the potable water supply for Marrakech. In the Doukkala, they would contribute to guaranteeing reliable water supplies not only for crop production but for treating problematic salinity problems. And, ultimately, more reliable water supplies from the upper Oum er Rabia basin might allow more potable water to be transferred from northern Morocco directly to the Casablanca/Rabat coastal area without having to first transit through the irrigation schemes.

In addition, better water management and delivery systems in Tadla are essential to the achievement of increased efficiencies in the allocation of other resources -- i.e. land, labor and management -- devoted to agricultural production in the area. This would allow local farmers to move toward closing the gap that exists between the very significant agricultural potential of the area and existing levels of production -- particularly for higher value crops -- and to better respond to changing open market conditions.

With respect to job creation and income disparities, the sub-project interventions by promoting and facilitating increased production of high value crops would provide the basis for job creation across a broad spectrum of agricultural and agribusiness opportunities. This would be particularly so because production of high value crops in Morocco -- e.g. fruits and vegetables, cut flowers and horticultural plants, tree crops -- both inherently and due to the smallholder structure of the agricultural enterprises, is much more labor-intensive than production of cereals, forages and extensive cash crops. This same labor intensity carries over into the processing, export preparation and marketing of these crops. Finally, growth of this type of agriculture tends to generate increased economic activity with respect to development of agricultural service enterprises in input and commodity marketing, transport, financial planning and informational services for the farming community.

Improved efficiencies in production and processing of high value crops and better water management should have direct effects on net farm incomes through increases in crop revenues and lowering of water costs per unit of production. Multiplier effects on agro-industrial enterprises and agricultural service enterprises should also contribute toward mitigating present urban/rural income disparities.

One of the principal reasons for proposing this sub-project is the anticipated role it would play in facilitating the successful disengagement of the Office Regional de Mise en Valeur Agricole du Tadla (ORMVAT) -- i.e. the Tadla Regional Agricultural Development Office -- from those activities in its present operational mandate which are commercial in nature and capable of being taken over by private sector agents. Since the activities in question are critical to farmers and agribusinesses in the Tadla area -- i.e. input delivery, negotiation and management of crop production credit between producers and the agricultural credit bank, negotiation of crop plantings and scheduling between producers and agro-industrial processors and marketing agents, etc. -- it is important that the transition from public to private participation in these activities by handled adroitly. In this regard, one of the major thrusts of the sub-project is to assist in making the declared disengagement/privatization policy of the government a concrete reality in the Tadla area.

In addition to the central case of ORMVAT disengagement, several other public and parastatal enterprises currently operating in the Tadla -- e.g. sugar beet processors, a seed company, cotton ginneries, etc. -- are scheduled for privatization under the government's agricultural sector adjustment program. Although the sub-project itself will not deal directly with these privatization efforts, it will through its support activities for private sector agents endeavor to facilitate producer group and market agent responsiveness to the new opportunities and changing market conditions.

As explained below, the sub-project will be working to increase flexibility and improve efficiency at the Tadla irrigation system-level and to promote better farm-level utilization of available resources within the perimeter. These efforts are expected to result in a gradual movement toward increased production of higher value crops in response to market opportunities and within the technical constraints imposed by the capacities of the existing irrigation system.

Improvements in the reliability of water delivery to farmers and better allocation of available resources at the farm-level would result in greater realization of the agricultural production potential of the Tadla plain. Such improvements would make a significant contribution to stabilization of regional agricultural production and provide greater scope for provision of wage goods at reasonable prices to the modern sector -- either directly in commodity form or through provision of foreign exchange earnings for importation of necessary cereals, edible oils and other commodities.

Finally, the sub-project proposes to assist in the formation and strengthening of regional and commodity interest groups in the Tadla area. Such interventions would be directed at assisting these nascent private sector groups to analyze their real economic interests in a changing market

environment, organize creative responses to new opportunities, defend their group interests, mobilize resources and generally develop greater capacity to manage their affairs.

In sum, the proposed sub-project is not only compatible for USAID Mission development objectives as stated but, if successfully implemented, would provide an example of how highly desirable policy changes articulated at the national level can actually be realized in concrete terms at the local level.

C. Sub-Project Relationship to Other Donor Activities in Morocco

In addition to being squarely in the core economy growth path of the Moroccan economy, linked to key policy changes being affected in the agricultural sector, and directed at reinforcing key elements of the USAID country development strategy, the proposed sub-project would be strongly complementary with parallel activities of the World Bank, the other major external donor concerned with natural resource management and irrigation development in Morocco.

1. At The Macroeconomic and Sectoral Levels

Many of the major reorientations in government economic policies in the 1980s are the direct results of government interactions with the IMF and the World Bank and have been supported by credit facilities and loans from these international agencies. These new economic policy orientations form the matrix within which the proposed sub-project will operate. Sub-project interventions have designed to have strong linkages to the implementation and reinforcement of key elements of Moroccan SAL and ASAL programs. Among the key elements to be addressed are: greater decentralization of and participation in economic decision-making and resource management; public disengagement from commercial enterprises and assumption of these activities by private sector agents; reorientation of agricultural production in the context of open markets and competitive pricing; greater development of agricultural commodities for export; and fostering the viable agribusiness enterprises and professional associations.

2. At The Project Level

At the project level, the proposed interventions would be highly complementary to the activities being undertaken in the nation-level World Bank projects aimed to improving performance in irrigated agriculture. Under these projects -- i.e. Projets d'Amelioration de la Grande Irrigation (PAGI), designated as PAGI I and II for the First and Second World Bank-funded projects -- the Bank is working with the Ministry of Agriculture and Agrarian Reform (MARA) to formulate and implement specific policy changes in the irrigation sub-sector. The specific policies include:

1. Redefining the mandates of the ORMVAs and confining their future role to that minimum number of activities deemed to be necessary to the public interest -- i.e. reliable water delivery to farmers and agricultural extension, both public goods.

2. Strengthening the autonomy of the ORMVAs as client-oriented service agencies through decentralization of decision-making authority and putting them on a "pay-as-you-go" status through improved financial management.

3. Increasing cost recovery from farmers in irrigation perimeters through revisions of water user fees so as to entirely cover the operation and maintenance costs of water delivery and contribute to capital cost reimbursement.

4. Disengagement of the ORMVAs from commercial enterprises and turning them over to private sector agents.

5. Increasing farmer participation in decision-making at all levels within the irrigation perimeters so as to be more responsive to market forces and prices.

6. Rehabilitating selected infrastructure within the nine LSI schemes so as to improve operational capacities and system flexibilities.

Sub-project interventions, as presented below, are designed to reinforce and complement these basic policy orientations and to make many of them concrete realities at the level of the Tadla perimeter.

In addition, the sub-project design has benefitted significantly from the excellent record of the Bank's successes and failures as reported in the evaluation documents of its projects in the Loukkos and Doukkala irrigation perimeters over the last fifteen years. Access to the conceptual documents being produced in the context of a new World Bank effort in national resource conservation and watershed management has also enriched team deliberations on the design of this sub-project.

III. SUB-PROJECT DESCRIPTION

A. The Perceived Problem(s) to be Addressed

Sub-project proposes to address the existing productivity and institutional gaps with respect to resource management in the regional economy of the Tadla plain.

In this context, the productivity gap is defined as the difference between the water use and agricultural production potentials of the Tadla plain and the existing levels of resource use as expressed in actual crop and livestock production in the area over the last decade.

The institutional gap is defined as that transitional void created as the ORMVAT redefines its operational mandate and begins the process of implementing national policy directives to disengage from those public sector activities deemed to be commercial in nature and the time

needed for private sector economic actors to develop capacities and assume new roles and responsibilities vis-a-vis the rural population on the Tadla plain.

B. Sub-Project Goal and Purpose

The goal of the sub-project is to improve overall resource management in the regional economy of the Tadla plain in line with the Government of Morocco's new strategy for agricultural sector adjustment.

The purpose of the sub-project is to develop, test and disseminate improved practices for allocation and management of natural resources -- chiefly water and land -- on the Tadla plain in the context of a more open and market-oriented economy. These are expected to include:

- More comprehensive and flexible approaches to water resource management at the system-level;
- Interventions to improve farm-level management of water and land resources in response to market forces and existing constraints;
- Interventions to improve ORMVAT management capacity to discharge its redefined mandate; and
- Measures to increase effective community participation in resource allocation and development activities.

C. Proposed Sub-Project Interventions

Four types of intervention are proposed in the sub-project. They are:

- Improving knowledge and management of water resources at the system-level in ORMVAT so as to better guarantee the reliable delivery of irrigation water and related services to the farm-level;
- A diagnostic activity to first analyze existing resource utilization patterns and farm household motivations and decision-making with respect to resource constraints and then to propose and test pilot activities to improve on-farm resource use;
- As ORMVAT disengages from commercial activities and redefines its core operational mandate, interventions aimed at strengthening its capacity to gather and analyze critical information and to execute its remaining operational and client-oriented support functions with greater efficiency and flexibility; and

- Providing practical assistance to emerging private sector actors -- i.e. professional associations, agricultural input suppliers, marketing agents and agro-industrial businesses -- as they assume their new roles and responsibilities in the regional economy.

The conceptual orientations of each of the four sub-project interventions are presented below.

1. Improving knowledge and management of water resources at the system level in ORMVAT

Management of water resources at the system level in the Tadla perimeter requires the integrated management of several different elements of a complex system. Irrigation water is supplied to the ORMVAT from two primary surface sources.

A diversion dam on the Oum Er Rbia river at Kasba Tadla, with a storage capacity of 120,000 cubic meters provides water to the Beni-Amir portion of the ORMVAT. The Beni-Amir sub-perimeter covers an area of about 27,000 hectares at present and is serviced by a gravity flow irrigation system. A "dead-head" canal connects the Kasba Tadla dam to a regulating reservoir at Kasba Zidinia, several kilometers downstream on the left bank of the Oum Er Rbia. This reservoir has a regulating storage of 100,000 cubic meters. The water then discharges through an electric turbine into a siphon which carries it to the right bank of the river and into the main canal for the Beni-Amir sub-perimeter.

Since these water storage structures have only limited storage capacities, the Beni-Amir sub-perimeter can be considered a "run-of-the-river" system. For this reason, ground water development has become an important feature of water supply in the sub-perimeter and conjunctive use of surface and ground water is an important consideration in overall system management for this area.

The Beni-Moussa sub-perimeter is situated on the left bank of the Oum Er Rbia river and has about 69,000 hectares of land under surface irrigation at present. Water for this sub-perimeter supplied from the Bin El Ouidane dam on the El Abid river in Azilal province. Water flows from the main dam to a regulating dam immediately below it and through a tunnel to a hydropower plant at Ait Ouarda Afourer. Below the hydropower plant, the water discharges into two main canals of the Beni-Moussa sub-perimeter system.

In managing the water resources of the ORMVAT, consideration must be given to the operations of the two main dams and regulating reservoirs as well as management of the groundwater resources within the Tadla perimeter. Several interventions in water management are, therefore, proposed to improve the knowledge and management of water resources at the system level in ORMVAT. All proposed interventions are primarily "software" type interventions in that they do not require sub-project investments in construction or rehabilitation of system infrastructure. Investments to improve and rehabilitate critical system infrastructure will be undertaken by the World Bank in the context of the PAGI II. The sub-project interventions described in this report

are meant to compliment those Bank investments.

As the ORMVAT strives to become more client-oriented under its redefined mandate, senior personnel of the organization have concluded that their primary management objective for the Tadla water delivery agency should be to meet the water demands of farmers in both time and space. They stress that in order to meet this objective they need to know more precisely how much water is in the system at a given point and a given time. Currently, such information can only be estimated based on the original system design parameters and operating characteristics. Such estimates become less accurate measures of performance as the irrigation system is increasingly operated in a manner which conforms more closely to farmers' requirements but deviates substantially from the rigid design and crop rotation requirements of the original system.

Under the original irrigation system design, farmers were to plant four or five major crops -- i.e. sugar beets, cotton, alfalfa, soft and hard wheat, vegetables -- in strictly prescribed crop rotation patterns with rigidly defined planting and harvesting dates. Under the new irrigation policies, farmers are to increasingly choose for themselves which crops they wish to grow and in what rotations. Cropping patterns in the future are to be determined by farmers in response to the supply and demand conditions for agricultural commodities they face in competitive export and domestic markets. They are no longer to be set simply as a function of government dicta and the constraints imposed by a rigid and inflexible system of managing the irrigation system.

The core rationale for activities proposed under this intervention is that the ORMVAT must be able to react in a much more flexible way under its new client-oriented mandate if it is to service the needs of a system where farmers determine cropping patterns and have much more latitude in the allocation of the resources they command. Under this system, ORMVAT system managers must have a deeper knowledge of the true capability of the Tadla hydraulic system, as well as its hydrologic constraints and system water allocation demands.

The operational characteristics and capabilities of an hydraulic network as large and complex as that of Tadla cannot be adequately analyzed for a wide range of irrigation scenarios without resort to a large network hydraulic computer model. Within the ORMVAT system, there are 200 kilometers of main canal, 360 kilometers of primary and secondary canals, and 1,800 kilometers of tertiary canals. The system delivers water to 22,000 farm "owners" and their households on 97,000 hectares of irrigated cropland. [2]

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[2] Farm "ownership" is an exceedingly slippery term with respect to irrigated land in Morocco because government laws prohibit sub-division of land by inheritance or sale into parcels of less than five hectares. Five hectares is legally considered to be the minimum area necessary to provide an adequate standard of living for an average farm household.

In the case of Tadla, while a single head of household is nominally designated as the farm "owner" of each parcel of five hectares or more, in reality many of the minimum size

Thus, in order to assist ORMVAT system managers to better understand their existing hydraulic system, the sub-project proposed to supply the Office with a computerized hydraulic system model and to tailor the model to the hydraulic characteristics of the ORMVAT perimeter. The first step in applying such a model is to develop a complete "hydraulic" description of the discrete systems operating within the Tadla perimeter. This is a complex task given that the surface water delivery infrastructures of the two sub-perimeters within Tadla -- i.e. Beni-Amir and Beni-Moussa -- constitute two hydraulically separate irrigation systems.

Application of a canal management model to the Tadla system will allow the ORMVAT to determine irrigation system responsiveness under the variety of different operating scenarios. This knowledge will, in turn, permit the ORMVAT in the future to operate the water delivery system in a manner which is most responsive to the needs of the farmers served by the system. The model provided under the sub-project would be refined over the life of the project and would serve as a critical management tool for the ORMVAT in meeting its new mandate.

In this intervention, canal and system characteristics would be described in sufficient detail to allow application of an existing canal model including hydro-dynamic and control modeling capabilities -- e.g. using the Utah State University hydraulic systems model or an "improved" variant of this model developed at the Hassan II Institute of Agronomy and Veterinary Medicine (IAV) in Rabat. Either of these models are capable of accurately describing the disposition of water in the Tadla system in both temporal and spatial terms. Such models require collection of a minimum data set of system information as follows:

a.) <u>Branch Linkages</u>

These data specify the physical layout of the system in terms of branch connections. A branch is defined as a group of reaches connected in series. Presence of a control structure determines the end of a reach. The branches can be connected in series or parallel depending on the actual layout of the network.

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parcels have been further sub-divided by inheritance and/or other means. These means that minimum parcels of five hectares may in fact be composed of two, three or more sub-parcels, each of which is owned and may be managed separately.

Actual farm ownership in the Tadla perimeter, therefore, is almost certainly significantly higher than the nominal "ownership" recorded. The actual resident population of the Tadla plain is between 450,000 and 500,000 in 1990 and virtually all of these inhabitants derive their livelihoods -- directly or indirectly -- from agricultural activities in the perimeter. In addition, an unknown but significant population of migrant agricultural workers arrives in the perimeter on a seasonal basis for crop harvesting and other operations.

b.) System Dimensions

System dimension data specify the number of branches, the number of reaches per branch, and the number of turnouts per reach.

c.) Configuration Data

These data include the following for each reach:

- The reach length in meters;
- The canal longitudinal slope in meters per 100 meters;
- The canal cross section in cubic meters;
- The roughness coefficient;
- The seepage or leakage rate in millimeters per day;
- The bottom elevation change upstream or downstream of control structures; and
- The gate settings.

d.) Control Structure Data

The following data are required depending on the type of control structure:

- The width or diameter of control structures in meters;
- The weir sill width in meters;
- The sill or culvert height in meters; and
- The upstream or downstream elevation drop in meters.

e.) Turnout Structure Data

Turnout structures are used to take quantities of water from the canal into a lower level canal or a field. The following data are required depending on the type of turnout:

- The discharge coefficient;
- The width in meters;

- The height in meters;
- The elevation difference between bottom of canal and bottom of the turnout in meters;
- The depth of flow downstream of an orifice turnout when flow through turnout is zero in meters; and
- The slope of linear stage-discharge relationship used to approximate flow depths on the downstream side of orifice turnouts.

f.) Inflow Hydrograph

These data define the inflow rate as a function of time at the upstream end of the first branch of the first reach.

g.) Turnout Demands

These data define the water requirements at each turnout in the system as a function of space and time.

Depending on the particular canal model selected, additional or different data may be required. While some of these data may be available from original system or rehabilitation plans for Tadla, it is important that the system be described as it actually exists. It will probably be necessary to perform an accurate leveling survey of the entire Tadla system as part of this intervention. In addition, it will be necessary to accurately locate and identify the operating characteristics of each of the control structures in the system and to verify canal cross-sections at selected locations.

Use of an hydraulic model will require acquisition for the ORMVAT of either a powerful micro-computer or a mini-computer. At least one high-speed micro-computer of the 386 or 486 class will be required with math co-processing capabilities, 2 megabytes of internal random access memory (RAM), an 80 megabyte hard disk drive and two high-density disk drives. An alternative system would be a mini-computer setup which could be used jointly by specialists involved in the farm-level studies proposed under Intervention 2 and the management information systems (MIS) proposed under Intervention 3.

In addition to data describing the physical layout of the water delivery system, it will be necessary to install accurate water depth and/or flow measuring devices at key control points within the Tadla system. These devices will be used in monitoring system operations, as well as verifying the accuracy with which the model simulates overall system operation and performance. Electronic devices are desirable for this purpose as they can monitor the entire Tadla system in real-time and provide inputs for the ORMVAT perimeter management system.

In order to operate the Tadla system in response to user water requirements, it would be necessary to install accurate automated weather stations at strategic locations throughout the two sub-perimeters. Each agro-climatological zone within each sub-perimeter would have to have one such weather station. ORMVAT has already identified nine such zones within the perimeters (ORMVAT, 1990).

These stations would record, as a minimum, solar radiation, wind speed, dry bulb temperature, and relative humidity or wet bulb temperature. Each of the stations would have a data logger which would record the required information on a continuous basis and be capable of using the data to directly calculate reference crop evapo-transpiration rates. The data logger would also be capable of transferring both the reduced and raw data to a microcomputer at ORMVAT headquarters for further analysis and use in system operations and control. One 386 class microcomputer with a microprocessor, one megabyte of internal RAM and a 40 megabyte hard drive would be acquired and dedicated to processing data flowing from this agro-climatological network. Data loggers from each meteorological station would be linked directly to the microcomputer through high quality phone lines or radio links. With such a system, each station would be interrogated automatically by the computer once per day -- e.g. at 0200 hours -- and the resulting information would be available for participating farmers and ORMVAT managers the next morning.

In addition to surface water flows, groundwater from individual farm wells is a significant element in the operations of both sub-perimeters. At the last census in 1985/1986, there were 6,000 wells in the Beni-Moussa sub-perimeter with an estimated output of 90 million cubic meters and 3,220 wells in the Beni-Amir sub-perimeter with an output of 70 million cubic meters.

The ORMVAT currently monitors some of these wells as part of a program to manually assess groundwater levels in the sub-perimeters on a monthly basis. In order to improve management of the groundwater resources in the Tadla perimeter, a network of automated water level recording stations would be developed under the sub-project and these data would be used as part of the overall water resource management system. This activity component is important to overall system management because water table management is critical to crop production in some areas of the perimeter, where the sub-surface water has risen to within one meter from the surface.

In some of the areas with high water table problems, there is also a salinity problem. However, salinity is not a problem in every case where water logging is a problem. Based on observations of water levels and an analysis of pumping rates throughout the year, a program of improved management of the groundwater resources would be developed to compliment the improvements anticipated in use of the surface water resources. In conjunction with monitoring of groundwater levels and water withdrawals, an investigation should be undertaken to determine the best way to ameliorate the salinity problems as high water table problems are brought under control. This initial investigation would be followed by field interventions to address the salinity problems -- e.g. through programs for periodic leaching and vertical drainage.

In sum, then, three primary activities are proposed under this sub-project intervention to improve understanding of the capabilities, limitations and ultimate management of the water resources of the ORMVAT. The first is the application of hydraulic modeling techniques to clearly define the capabilities of the surface water hydraulic system. Subsequent application of the model would be used to improve operational flexibility of the Tadla system in response to farmer demand. The second activity is development of a meteorological network -- with near-real-time data analysis capability -- to better define the demands of the irrigation system in agro-climatological terms. The third is an automated system of groundwater level monitoring and monitoring of water withdrawal rates from wells to improve the understanding of the interaction of the groundwater-surface water systems in the Tadla. These data can subsequently be used to develop an operational plan for conjunctive use under the changing management of the surface systems.

It is envisioned that each of the activities in this intervention will be undertaken in two phases. The first phase is projected to last project years 1 and 2 -- during which time, necessary equipment will be installed, initial training completed, and the computer models developed and/or verified. For example, data for the hydraulic model need to be collected and the model calibrated and verified under conditions currently existing in the two sub-perimeters. Similarly, the meteorological stations would be installed during this first phase, data analyses conducted, and algorithms developed for use in predicting crop water requirements. Groundwater and pumping monitoring networks would be established and an analysis undertaken to determine water table pumping relationships throughout the year and how they correlate with surface water use.

Expenditures during the first phase are estimated at $ 2.5 to $ 3.0 million, depending on equipment acquisition and installation costs and the intensity of the technical assistance needed for model development and related staff training.

The second phase would last for five years and would be the "application phase" of the sub-project. During this time, results of modeling and data analyses from phase one would be used to implement a new integrated system of water resources management, which would have as its objectives optimum use of the water resource, both surface and subsurface, in a manner most responsive to the needs of the farmers in the Tadla perimeter. For example, during this phase, information concerning actual cropping patterns, farmer irrigation practices, and crop water demands would be used as inputs into the hydraulic model to determine the best way to operate the system to meet the demands while conforming to cropping patterns developed by farmers in response to market forces. Thus rather than following rigid guidelines for operation based on system design, systems operations would be modified over time to meet changing needs of farmers within the perimeters.

Similarly, the groundwater monitoring system would allow the groundwater system to be managed in conjunction with surface water supplies and deliveries in a dynamic way. Results of the investigation on the salinity problems would be use to devise and test field interventions to reduce the problems of salinity where it poses a significant threat to crop productivity. Expenditures during this phase of the project will be primarily for technical assistance, training,

and pilot interventions. Funding for this phase is roughly estimated at about $ 2 to 2.5 million. The estimated funding level for Intervention 1 over the seven years of the sub-project should be in the range of $ 4.5 to 5.5 million.

Each activity under this intervention, as noted above, would entail five primary components: technical assistance, equipment acquisition, software acquisition, training of personnel, and field experimentation. It is envisaged that the technical assistance component will consist of essentially of short-term expertise for such things as equipment installation, model calibration, date analyses, etc.. Staff training is also expected to be short-term in nature over the life of the project. Most training will take place in Morocco, although it might prove useful for water system management staff to have one or more short-term observational tours of similar perimeters in irrigation districts in California or Arizona.

2. Understanding and Improving Resource Allocations at the Farm-Level

The activities under Intervention 1 are designed to develop a better understanding of the hydraulics and hydrology of the Tadla system. However, they will have limited applicability to the economy of the Tadla plain if the improved water management system is not intimately linked with and responsive to what is actually happening at the farm-level. ORMVAT management of the water delivery system in Tadla must be directed toward the goal of being more client-oriented to the needs of the farmers in the sub-perimeters or it runs the distinct risk of becoming simply an academic exercise.

With this in mind, the activities under Intervention 2 of the sub-project are designed toward the objective of finding out what is actually happening at the farm-level in terms of the owner/manager decision-making process for selecting and managing crop rotations, allocating scarce resources toward attainment of household objectives, and selecting irrigation techniques. This is necessary because, after even a brief tour through the Tadla perimeter, one is left with the strong impression that the actual farming practices and crop rotations in place bear little or no resemblance to the almost Cartesian precision of the crop rotations anticipated when the Tadla irrigation systems were designed.

For all the discussion in the Moroccan irrigation literature about the benefits of the "Trame A" and "Trame B" irrigation systems -- or variants thereof -- it appears evident that farmers, at least on the Tadla perimeter, have succeeded in modifying the original rigid engineering approach to irrigation to meet their own technical and socio-economic objectives and resource constraints. Recognition of this basic fact is central to being able to design successful interventions at the system and farm levels in Tadla. It is also clear that the managers at ORMVAT, while possessing much factual information about perimeter, have less than adequate knowledge of the motivations and objectives of the farm households in the perimeter or of the probable directions agricultural enterprises will take under conditions of a more liberal and market-oriented economy.

On one level, farm management information will be important to the development of the system-wide hydraulic model because it will determine if and how the system can be operated to more

adequately respond to changing demands of the water users. Since farm enterprises have evolved considerably since the Tadla system was originally designed and constructed, the ORMVAT needs to know how these enterprises are currently constituted, how they actually function in as decision-making units, what farmers perceive as their scarce resource(s) and what constraints they face, and, finally, what they see as their prospects for the future in the changing economic environment. In sum, the managers at the ORMVAT need to know their clients much more intimately than they appear to now if they are to be successful in discharging their reduced and more focused mandate in the medium-term.

In addition to addressing the immediate informational requirements of the ORMVAT, Intervention 2 would also actively seek to broaden the knowledge base of the farm community as to what is technically possible and economically feasible within the Tadla perimeter. This element would address the reverse problem of that described above -- i.e. it would instruct farmers as the technical constraints imposed upon their farming operations by the physical and managerial realities inherent in the Tadla hydraulic system as designed.
The objective would be to present farmers with practical information as to how far they can stretch the capabilities of the Tadla irrigation system in their attempts to better adapt their farm enterprises to new market forces. The central premise being that successful entrepreneurs need increasingly detailed and precise information on all aspects of the economic environment in which they must operate if they are to make sound resource allocation decisions.

It is proposed, therefore, that Intervention 2 be comprised of four principal activities. They would be:

1. Developing an accurate and current inventory and typology of all farm enterprises in the Tadla perimeter;

2. Conducting a detailed diagnostic study of a representative sample of those farm enterprises over, at least, two full cropping cycles -- i.e. winter and summer crop rotations over a two year period;

3. Identifying critical constraints in farm-level resource allocations and specifying pilot interventions to be tested at the farm -- and ORMVAT -- levels to alleviate these constraints; and

4. Testing of these pilot interventions at the farm-level and disseminating of results -- both successful and unsuccessful -- to interested farmers.

With respect to the first activity, ORMVAT staff have already amassed a considerable amount of inventory information on the types and distributions of farm enterprises in the Tadla perimeter. After detailed review and updating of these data, farm enterprise typologies would be developed and used to draw a representative sample of farms to be studied in detail under the diagnostic study. This activity would be completed in the first six months of Project Year 1.

The primary diagnostic study would be conducted during the first two full agricultural years after the start of the sub-project. Specifically, the study period would be from the start of first winter crop season in Project Year 1 to the end of the second summer crop season in Project Year 2 or 3. The study would be designed in such a way that data collected could be fully processed and analyzed on a season by season basis. Data collected during the first full agricultural year of the sub-project would also constitute a baseline case information file to be used at various points later in the life of the project to assess changes in economic activities at the farm level.

The function of the primary diagnostic study, however, would be to serve as a factual basis for identifying farm-level constraints in resource allocation and specifying pilot interventions to be tested and evaluated to alleviate the constraints over the life of the sub-project. At the paucity of detailed farm enterprise data from the Tadla perimeter at present, it is impossible to specify a priori what constraints farmers see as impinging upon their resource allocation decisions or what the contents of specific pilot interventions at the farm-level might be in the medium-term.

From the outsider's perspective, it would appear that farmers might face significant constraints on their supply responsiveness and resource allocation in the following areas:

- The tradeoffs between providing for the subsistence requirements of the extended farm household and being fully responsive to commercial opportunities and market forces;
- Problems posed by the increasing fractionalization of land holdings within the perimeter and the potential divorcing of the ownership and management functions in resource allocations;
- Problems involved in matching water deliveries from the system-level with crop requirements and efficient water use at the farm enterprise level;
- Inadequate knowledge of crop production techniques and potential on the one hand and real market possibilities on the other;
- Financial constraints on reorientation of the farm enterprise in the face of new opportunities; and
- Labor constraints with respect to producing, harvesting and marketing higher value crops.

Detailed estimates of the costs entailed in implementing the first -- i.e. the initial three activities above -- and the second phases under this intervention are impossible at this stage of sub-project development. Very rough estimates would place the cost of the first phase at $ 1 to 1.5 million and the second phase at $ 2 to 4 million, depending on the number and complexity of the pilot farm-level interventions to be tested.

3. Strengthening ORMVAT Management and Client-Orientation During Disengagement

In the context of its disengagement effort, ORMVAT is shifting away from being an input-oriented institution to one that is more client- and output-oriented.
There is, therefore, a "felt need" on the part of key ORMVAT personnel to establish a management information system (MIS) that will provide accurate, useful and timely information. This will not only enable the organization at its various levels to execute the tasks in its reduced but critical mandate more efficiently and effectively but also and equally important contribute to the modification of organizational behavior by increasing its responsiveness to external changes. It is worth mentioning at this stage that ORMVAT is considered to be the pioneer Office in the implementation of the government's disengagement policy and, therefore, the MIS will also provide national policy makers with objective information on the results of such policy changes. Finally, the ORMVAT is best placed to collect information which might be essential for effective performance of other relevant bodies at the regional and national levels.

The ORMVAT needs to develop a new evaluative mind-set which would enable it to appraise its performance objectively with respect to its primary and secondary clients, reflect on what has been learned for future use, and adjust its internal policies and activities on the basis of the knowledge acquired on a periodic basis.

Under the new national policy agenda, ORMVAT -- and the counterpart Offices in the other LSI schemes -- is expected to achieve and maintain complete financial autonomy in its operations in the medium-term. Water charges and other services provided to farmers are to be costed to cover 100 percent of the actual costs of ORMVAT operations and management. Government subsidies to the ORMVAT are to be progressively withdrawn and replaced by farmer water fees and service charges. This being the case, the disengagement and reorientation process at ORMVAT must be handled very carefully so that financial autonomy is attained in the context of increasing managerial effectiveness to keep operating costs to farmers as low as possible and commensurate with farmers' ability to pay for the services. If disengagement is not intimately coupled with a concentrated effort to increase managerial effectiveness, there is the real danger that the organizational and operational inefficiencies acquired by ORMVAT after many years of government subsidies and patronage will continue and the costs will be passed on to the farmers through increased water fees and service charges.

In this instance, improved management of ORMVAT means development of an increased capability to gather and process information and then to make better informed managerial decisions based on that information. The sub-project, therefore, proposes assistance to ORMVAT in development of an internal management tool which would be responsive to the Office's management needs and capabilities in direct information to that level of management where it may be best utilized. The management success of ORMVAT depends not only on the timeliness of the information it has at its disposal but also on the quality, comprehensiveness and form in which such information is channeled into the decision-making process.

A great deal of data and information has been collected by ORMVAT but the Office has a major problems in processing the data in a timely manner and management-friendly form. The monitoring and evaluation systems now in place in a few of the ORMVAs -- i.e. Loukkos -- are set up in such a way that relevant information in useable form does not reach the people who need it on a continuous and timely basis. These systems are isolated, number-crunching units with no effective communication links to management. The wrong data, data incorrectly collected and analyzed, raw data rather the management information, and delays in transmission make these units largely irrelevant to real time management at the ORMVAs.

Managing the flow of data and information is a critical activity for effective and modern management at ORMVAT. This can be done by the design, installation and maintenance of a MIS that is integrated across organizational units in a way that allows for the timely flow of management information to control day to day activities and to provide a basis for longer term review and evaluation of ORMVAT's progress in achieving its disengagement and reorientation objectives.

The process of establishing a MIS within ORMVAT will be complex since a great deal of additional data needs to be collected, relevant management indicators need to be developed, and a system needs to be established for processing and channeling information in form(s) suitable for review and action by pertinent managers and officers throughout the organization.

Developing the proposed MIS will entail the following steps:

- Analyzing ORMVAT redefined mandate and objectives, activities and functional organization;

- Defining appropriate parameters and performance assessment indicators -- e.g. reliability of water distribution, adequacy of water supplied, agricultural productivity, system stability, environment impacts, user participation, institutional development, personnel performance, structural and financial controls;

- Determining the minimum data sets which need to be collected for managerial purposes;

- Developing standard procedures, methods and organization for data collection and processing; and

- Developing channels for dissemination, feedback and action-oriented decision-making.

The ORMVAT MIS needs to be a computer-based system which offers great flexibility and range. Increasing use of microcomputers will afford the opportunity to achieve significant economies in staff time and costs. ORMVAT staff will be more available to respond to clients'

needs, instead of constantly being absorbed in and preoccupied by routine paper work using outdated manual methods.

Presently, ORMVAT has only two microcomputers dedicated to administrative and accounting tasks. These computers are virtually inaccessible to other potential user groups within the Office. Under the sub-project, microcomputers would be linked in a management network throughout ORMVAT, including its operational field units -- i.e. sub-divisions and the Centres de Mise en Valeur (CMVs) -- as permitted by existing or new communication facilities. Such networking will offer the possibility for managed, integrated data bases and greatly improved internal communication processes. It would also provide the capacities to interface with remote monitoring and control equipment -- e.g. weather stations, flow control equipment, etc. -- throughout the two Tadla sub-perimeters.

Establishing a workable MIS within ORMVAT would be done in three phases:

- Developing the system in Project Year 1 as outlined above;
- Establishing the MIS within ORMVAT in Project Year 2; and
- Field testing and institutionalizing the MIS as a management tool in Project Years 3 and beyond.

Initial estimates of sub-project inputs for Intervention 3 are as follows:

- Short-term technical assistance at $ 1 to 1.5 million; and
- Computer hardware for the network and appropriate software programs at $ 1 million.

4. <u>Strengthening Private Sector Participation in Regional Agricultural Enterprises</u>

The activities under Intervention 4 would complete the task of addressing all the relevant economic actors in the Tadla perimeter. Interventions 1 and 3 addressed the specific needs of ORMVAT in becoming a more client-oriented water delivery agency. Intervention 2 addressed the needs at the farm household level for improved technologies in water use efficiency and crop production. Intervention 4 would be designed to address the needs of those private sector firms and professional groups who will increasingly be called upon to provide inputs for on-farm enterprises -- i.e. fertilizers, seeds, agricultural chemicals, credit, informational services, etc. -- and to process and market agricultural commodities to both external and domestic consumers.

In the short time available to the team, it was impossible to inventory in precise detail all of the private sector firms and professional groups likely to play major roles in the economic evolution

of the Tadla plain between now and the end of the century. Some are already present in the Tadla area and more are expected to merge as the government proceeds with its privatization program for agricultural public and parastatal agencies.

Given that precise identification of the private participants will take time, this Intervention 4 is envisaged as a phased exercise with four principal activities. They are:

1. Identification of the principal private sector actors operating in the Tadla perimeter to supply agricultural inputs and process and market agricultural commodities;

2. Detailed analyses of a selected number of the agro-industrial chains from production through processing to marketing -- the filieres in French;

3. Identification of critical bottlenecks in the present operations of these filieres; and

4. Undertaking practical and targeted actions in cooperation with private firms and/or professional groups to alleviate the specific bottlenecks.

At present, examples of possible activities are:

1. Detailed studies on new export market opportunities for high value crops;

2. Working with processors and farmers to better schedule crop production in line with specific export market windows;

3. Working with private firms to introduce new processing and packaging techniques to lower unit output costs and/or increase product attractiveness to consumers;

4. Working to ensure that competitive conditions are created and maintained in agricultural input markets;

5. Working to strengthen commodity-oriented professional groups so that they might assume greater responsibilities in organizing, presenting and defending farmers' interests in a changing economic environment; and

6. Working with agro-industrial processors to ensure that their operations do not contribute to increased pollution of the surface and ground water in the Tadla perimeter or have other negative externalities.

The major sub-project inputs for Intervention 4 would be technical assistance -- primarily short-term specialists -- and funding for pilot interventions to demonstrate new techniques. The

technical assistance component is estimated in the range of $ 1 to 1.5 million. The pilot interventions could cost in the range of $ 2 to 3 million, depending again on the number and complexity of the actions to be undertaken.

The total cost of the four sub-project interventions, then, is estimated to be in the range of $ 12.5 to 18 million.

D. Expected Outputs

The expected outputs from the proposed sub-project are listed below. The potential and relative contribution of each output to the overall sub-project in technical and economic terms can be determined only at the final design stage -- i.e. in the Project Paper design exercise.

1. Improving knowledge and management of water resources at the system level

- A more comprehensive understanding of the hydraulic and hydrologic capabilities and limitations of the hydraulic systems in the Tadla perimeter;
- Flexible system operating capabilities and procedures which are responsive to farmers' needs and evolving with cropping systems;
- Improved overall system water delivery and application efficiences;
- Near real-time measurement of crop water requirements and climatic variability within the perimeter;
- Daily weather data available to farmers, agro-industrial processors and other private sector actors on a near real-time basis for improved decisions on all agricultural operations related to weather; and
- Improved management of groundwater levels and control of salinity problems.

2. Understanding and Improving Resource Allocations at the Farm-Level

- An improved definition and understanding of actual cropping, land use and tenure patterns and how they are evolving;
- An improved understanding by farmers of the capabilities and limitations of the Tadla water delivery system and how these relate to and affect their enterprise resource allocation decisions;

- An improved understanding by the ORMVAT of farmers' decision making processes and enhanced Office capability to be more responsive to their clients' requirements;

- An understanding of constraints on the hydraulic system and economic efficiency at the farm-level;

- A series of tested pilot activities for dissemination to alleviate constraints to water use efficiencies and economic performance at the farm-level; and

- Improved water delivery efficiencies to farm and improved water application use efficiencies at the farm-level.

3. <u>Strengthening ORMVAT Management and Client-Orientation During Disengagement</u>

- A functioning management information system in place in the ORMVAT;

- A microcomputer network, linking databases in system operation, system management, weather and groundwater levels for more timely system management decisions and responses;

- Improved quality in management decisions and improvement in the ORMVAT's ability to respond to farmers' needs in a more flexible and timely manner; and

- Improved efficiency in overall Tadla perimeter system management, as reflected in lower costs for water delivery and other services to farmers and government subsidies to the ORMVAT.

4. <u>Strengthening Private Sector Participation in Regional Agricultural Enterprises</u>

- An improved understanding of the private sector actors in the Tadla economy, the scope of their involvement and their capabilities and needs;

- A deeper understanding of operative commodity <u>filieres</u> at all stages -- i.e. production, processing and marketing;

- Improved marketing of agricultural products and enhanced responsiveness at all levels to export and domestic market forces;

- Improved competitiveness of local agro-industrial enterprises and businesses providing support services to farmers;

- Increased participation of commodity-oriented professional groups in agro-industrial sector.

- Increased value-added generated for agricultural commodities and products in the regional economy; and

- Increased participation of the private sector in provision of key agricultural inputs and services, agricultural production enterprises, agro-industrial processing and marketing of agricultural products.

In sum, then, the principal outputs -- and, hence, direct economic benefits -- of the sub-project could be classified under the following:

- Cost savings from more efficient and reliable water delivery at the system-level;

- Cost savings and increased net farm incomes through better allocation of water and other resources at the farm-level affecting both the mix of crops grown and their yields;

- Cost savings to the government from disengagement of the ORMVAT from commercial activities and more efficient execution of its reduced operational mandate; and

- Cost savings through more efficient private sector agribusiness activities in the Tadla plain.

The indirect effects of sub-project activities could yield additional economic benefits in two areas:

- Increased effectiveness of the capital investments provided under the World Bank-funded PAGI II;

- Increased quantities of water available for alternative uses outside the Tadla perimeter -- i.e. as irrigation water for the Tessaout Aval perimeter in the Haouz ORMVA and as potable water for urban areas, particularly Marrakech;

IV. FACTORS AFFECTING SUB-PROJECT SELECTION AND FURTHER DEVELOPMENT

A. Technical Considerations

Most of the technical problems have been adequately identified in this document. In order to develop the project, it will not be necessary, for example, to identify which particular hydraulic model to use. That should be left to the project implementation team and could be done by the ORMVAT with technical assistance from a short term advisor. It will be important in this particular instance, however, to select the model early in the project so that any field work necessary to acquire data for the model be undertaken as in a timely manner so that it will be available for use in the model as soon as possible.

Similarly, types and numbers of flow measuring devices should be selected within the project by ORMVAT, in collaboration with a technical adviser. This also needs to be done as early in the project as possible. The particular hydraulic model selected will also determine, to a great extent, the specifications for the computer hardware to be used with the model. A computer system should be selected which will allow the users to realize the full potential of the model, including possible upgrades in the software within the next decade. Thus, speed, memory capacity and input-output devices should initially be programmed to exceed present software requirements in all cases to build capacity for subsequent modifications.

There is a similar hardware-software compatibility concern regarding the automated weather stations and radio or telephone communications hardware that will be used in conjunction with the computer system. The ORMVAT, with the advice of short-term consultants, should first select the weather stations and communications equipment -- assuring mutual compatibility -- and then select a computer system which exceeds the hardware and software requirements of the field equipment. Obviously, the computers acquired for these functions should be compatible with or integrated with the computer requirements of the MIS component of the project.

Groundwater monitoring can be done on a sample network of wells selected from the more than 9,000 wells in the two sub-perimeters. It should not be necessary to construct observation wells for this purpose. Electronically- controlled water level sensing devices, such as a pressure transducer could be used within this network, with data recorded on a data logger and periodically (weekly) downloaded into a computer data base. This equipment should be selected during the early phase of the project and should be compatible with the computers and data loggers utilized in other aspects of the project.

B. Financial and Economic Considerations

This section of the report presents a preliminary economic analysis of the projected water savings which are possible under the proposed sub-project. The value of the water savings is then compared against the projected sub-project cost stream. Thirdly, the problems of assessing the additional benefits to be derived from a shift to higher value crops at the farm level, more private

sector involvement in agribusiness at the regional level, ORMVAT's improved performance in its reduced role vis-a-vis perimeter operations, and increasing the efficiency of Government of Morocco/World Bank investments under PAGI 2 are discussed. Finally, there are summary comments with respect to the government's current policies on irrigation management and water allocations.

1. Water Savings Under the Sub-Project

A study of irrigation efficiency in the Tadla perimeter funded by the Belgium government (ORMVAT, 1986) determined that canal delivery efficiency in the perimeter was about 80 percent -- i.e. 80 percent of the water entering the head end of the canal was available at farmers' fields -- and that field application efficiencies were 60 to 65 percent -- i.e. 60 to 65 percent of the water applied to the field finds it way to the root zone where it can be used beneficially by the crop. The overall efficiency of the system, therefore, is between 48 to 52 percent.

Estimates of the field application efficiency and the overall efficiency appear high. Based on team observation of irrigation techniques in the Beni-Moussa sub-perimeter, Slack estimates that field application efficiencies of 40 percent are more likely with an overall efficiency of 35 to 40 percent.

In addition to estimating efficiencies, the Belgian study also determined that 6 percent of the irrigation water entering the head end of the main canals was being lost out the other end due to ORMVAT's inability to manage the perimeter canal system dynamically. This 6 percent loss was included in the 80 percent delivery efficiency estimate noted above so that, if all of the 6 percent were to be saved, the delivery efficiency would be increased to 86 percent.

The magnitude of this problem was confirmed during the team's visits to ORMVAT. Engineers responsible for canal management indicated at that time that a substantial amount of water was being lost out the end of the canals because the existing system has a long response time before changes in system demand are reflected at the farm level -- i.e. ten days to two weeks.

The ORMVAT activity report for 1989 (ORMVAT, 1989 and ORMVAT, 1990 -- the annual ORMVAT activity report is issued in two section, each covering six months) reports that 710 million cubic meters of water was diverted from Ben El Ouidane dam through the Beni-Moussa irrigation sub-system. Based on this report, it is also estimated that 290 million cubic meters of water was diverted via the Kasba Tadla dam from the Oum Er Rbia river through the Beni-Amir irrigation sub-system. Total water diversions for irrigation in the Tadla perimeter from the two sources was, therefore, 1,000 million cubic meters for 1989.

The 1988 activity report (ORMVAT, 1988 and ORMVAT, 1989) provides similar figures for the perimeter. In addition, an ORMVAT brochure (ORMVAT, undated) indicates that groundwater pumping provides about 160 million cubic meters of water each year in the perimeter -- i.e. 70 million in the Beni-Amir sub-perimeter and 90 million in Beni-Moussa sub-

perimeter. Presumably most of this water does not travel any significant distance in the sub-perimeter canal systems. For this reason, few, if any, savings in groundwater will be derived from improved canal delivery efficiencies.

The interventions proposed in this sub-project to improve canal management should, over the life of the sub-project, result in complete elimination of water losses out of the end of the canals. This would result in maximum annual water savings estimated at 60 million cubic meters -- i.e. 6 percent of the 1,000 million cubic meters. Slack further estimates that a significant proportion of these savings could be achieved within two years after initiating implementation of an improved ORMVAT canal management strategy. By the end of Project Year 3, therefore, it is projected that this type of water loss would have been reduced to 4.5 percent of the total and to 3 percent at the end of Project Year 4. Thereafter, water savings would increase linearly so that by the end of Project Year 7 such losses would have been completely eliminated.

The proposed sub-project interventions do not directly address other aspects of the canal delivery efficiency which account for an additional water loss of 14 percent. However, assuming that 14 percent of the water is lost by leakages and other related causes throughout the system, if improved management results in 60 million cubic meters of water no longer flowing out the end of the system, then the fraction of this amount that was previously lost by leakage would also be saved. Thus, there is a direct savings of 14 percent of 60 million cubic meters -- or another 8.4 million cubic meters of water per year. These savings would be achieved at the same rate as those above -- i.e. 50 percent achieved by the end of Project Year 4 and 100 percent by the end of Project Year 7. Total savings from increased canal delivery efficiencies attributable directly to improved management of the Tadla perimeter are projected at 68.4 million cubic meters per year by the end of the sub-project.

Moreover, water savings will be enhanced by the World Bank PAGI 2 interventions which are to be directed at rehabilitating sections of the Tadla canal system and reducing losses from canal leakage. While PAGI 2 addresses field application efficiences directly with infrastructural interventions -- e.g. gated pipe, field leveling, and use of siphon tubes -- the benefits from these improvements cannot be fully realized without the improved knowledge of crop requirements provided by the proposed sub-project intervention with automated meteorologic stations and the improved canal management.

With the proposed sub-project interventions and those of PAGI 2 in place, overall system efficiency in Tadla should be increased from 50 percent to about 70 percent -- with canal delivery efficiency at 90 to 95 percent and field application efficiency on the order of 70 percent. Slack believes that with such improvements, it is reasonable to attribute half the projected gain in field application efficiency to the PAGI 2 infrastructure interventions and half to the interventions proposed under the sub-project. However, it is doubtful that the PAGI 2 interventions in and of themselves would achieve any improvements in field application efficiencies.

If after the projected water savings in the Tadla perimeter, net water flows into the two sub-

perimeters remained at the current level of 931.8 million cubic meters per year and the canal delivery efficiency was 90 percent, then the amount of water arriving at the field level would be 836.6 million cubic meters per year. A field application efficiency of 60 percent would then mean that 335 million cubic meters per year -- 40 percent of 836.6 million cubic meter -- would be lost due to inefficiencies in water application at the field level. If this efficiency rate is increased to 70 percent, the loss is reduced to 251 million cubic meters -- i.e. a savings of 84 million cubic meters per year. If one attributes 50 percent of this cost saving to sub-project interventions, then this savings would amount to 42 million cubic meters per year.

These savings, however, are projected over a longer time period than those for canal management savings. Slack estimates that 10 percent of the total could be achieved in Project Year 3 and that this savings would increase linearly to 50 percent of the field level cost savings by the end of the sub-project. One hundred percent of projected savings would be achieved 15 years after Project Year 1 with annual linear increases from years 8 to 15. This longer period is seen as necessary because the process of achieving higher field efficiencies is seen as more evolutionary -- i.e. it will involve a considerable number of changes in the way the ORMVAT and farmers currently interact and it requires a certain level of farmer responsiveness to new information.

Finally, the proposed interventions will save groundwater through improvements in field application efficiencies. Given that the current groundwater use amounts to 160 million cubic meters per year and assuming essentially no canal losses associated with this type of water use, a current field application efficiency of 60 percent implies that 64 million cubic meters of this groundwater are lost to irrigation after being pumped to the field surface. An increase in field application efficiency to 70 percent would reduce this field loss to 48 million cubic meters per year -- i.e. a net savings of 16 million cubic meters per year, with 8 million cubic meters of this savings attributable to sub-project interventions. The rate of achievement of these savings is projected to be the same as that for the field efficiency savings of canal water above.

Text Table B-1 presents a summary of projected water savings in millions of cubic meter by year.

2. The Value of Water Savings as Compared with the Costs of the Sub-Project

The value of the projected water savings in the Tadla perimeter depends on how the water saved is actually used. Since experts believe that water has its highest average value per cubic meter in Morocco -- i.e. approximately 0.85 dirhams or $ 0.11 at the current exchange rate per cubic meter -- when used for irrigation purposes, this analysis confines itself to irrigation as the assumed end-use for water saved. However, within this end-use category, ORMVAT system managers would have the option of using in water saved within the Tadla perimeter in two ways: to develop new irrigated lands within the Tadla perimeter or to provide supplementary water allotments to existing irrigated fields.

TEXT TABLE B-1
Projected Water Savings Under the Sub-Project
in Millions of Cubic Meters per Year

YEAR FROM START OF PROJECT	WATER SAVING FROM IMPROVED SYSTEM LEVEL CANAL MANAGEMENT	WATER SAVING FROM IMPROVED FARM LEVEL WATER MANAGEMENT	WATER SAVING FROM IMPROVED GROUNDWA-TER MANAGE-MENT	TOTAL ANNUAL WATER SAVINGS
1	0	0	0	0
2	0	0	0	0
3	17.1	4.2	0.8	22.10
4	34.2	8.4	1.6	44.20
5	45.6	12.6	2.4	60.60
6	57.0	16.8	3.2	77.00
7	68.4	21.0	4.0	93.40
8	68.4	23.6	4.5	96.50
9	68.4	26.2	5.0	99.60
10	68.4	28.8	5.5	102.70
11	68.4	31.4	6.0	105.80
12	68.4	34.0	6.5	108.90
13	68.4	36.6	7.0	112.00
14	68.4	39.2	7.5	115.10
15	68.4	42.0	8.0	118.40
16	68.4	42.0	8.0	118.40
17	68.4	42.0	8.0	118.40
18	68.4	42.0	8.0	118.40
19	68.4	42.0	8.0	118.40
20	68.4	42.0	8.0	118.40

Our working assumption in this preliminary analysis is that the marginal value of water applied on newly irrigated land is significantly higher than that of supplementary water alloted to existing fields. To illustrate this difference in our analysis, then, we have used 1.10 dirhams or $ 0.139 per cubic meter as the average marginal value of water over the range in question when applied to new irrigation areas and 0.70 dirhams or $ 0.089 as the value of water applied to existing fields. Since the Tadla perimeter has approximately 6,000 hectares of land with irrigation potential remaining to be developed, we would postulate that the best use of the water saved would be in developing this area and that this infrastructure could be in place by Project Year 7. Therefore, after Project Year 7 we assume that 60 million cubic meters of the water saved by sub-project interventions is allocated to 6,000 hectares of new irrigation and the remainder is used for supplementary allotments on pre-existing fields.

Based on these preliminary assumptions, Text Table B-2 presents the value of projected water savings under the sub-project.

TEXT TABLE B-2
Value of Projected Water Savings Under the Sub-Project in Millions of U.S. Dollars per Year

YEAR FROM START OF PROJECT	VALUE OF WATER SAVINGS FROM IMPROVED SYSTEM LEVEL CANAL MANAGEMENT	VALUE OF WATER SAVINGS FROM IMPROVED FARM LEVEL WATER MANAGEMENT	VALUE OF WATER SAVING FROM IMPROVED GROUND-WATER MANAGE-MENT	VALUE OF TOTAL ANNUAL WATER SAVINGS
1	0	0	0	0
2	0	0	0	0
3	1.52	0.37	0.07	1.96
4	3.04	0.75	0.14	3.93
5	4.06	1.12	0.21	5.39
6	5.07	1.50	0.28	6.85
7	6.09	1.87	0.36	8.32
8	9.09	2.10	0.40	11.59
9	9.09	2.33	0.45	11.87
10	9.09	2.56	0.49	12.14
11	9.09	2.79	0.53	12.41
12	9.09	3.03	0.58	12.70
13	9.09	3.26	0.62	12.97
14	9.09	3.49	0.67	13.25
15	9.09	3.74	0.71	13.54
16	9.09	3.74	0.71	13.54
17	9.09	3.74	0.71	13.54
18	9.09	3.74	0.71	13.54
19	9.09	3.74	0.71	13.54
20	9.09	3.74	0.71	13.54

Text Table B-3 presents a comparison of the projected benefits and costs of the sub-project.

TABLE B-3
Comparison of Projected Benefits of Water Savings and Sub-Project Costs in Millions of U.S. Dollars per Year

YEAR FROM THE START OF THE SUB-PROJECT	SUB-PROJECT COSTS	TOTAL VALUE OF WATER SAVINGS	NET BENEFIT STREAM FOR WATER SAVINGS
1	5.00	0	- 5.00
2	2.50	0	- 2.50
3	4.50	1.96	- 2.54
4	3.00	3.93	0.93
5	1.50	5.39	3.89
6	1.00	6.85	5.85
7	0.50	8.32	7.82
8	0	11.59	11.59
9	0	11.87	11.87
10	0	12.14	12.14
11	0	12.41	12.41
12	0	12.70	12.70
13	0	12.97	12.97
14	0	13.25	13.25
15	0	13.54	13.54
16	0	13.54	13.54
17	0	13.54	13.54
18	0	13.54	13.54
19	0	13.54	13.54
20	0	13.54	13.54

As projected above, sub-project costs -- i.e. USAID grant funds only -- would amount to a maximum of $ 18 million undiscounted over the seven year life of project. This investment is projected to yield a total of $ 194.6 million in undiscounted benefits from water savings alone over twenty years from project initiation. The net present values of the net benefit stream discounted at 10, 20, 30 and 40 percent are, respectively $ 52.95 million, $ 17.50 million, $ 4.15 million, and $ - 0.60 million. The internal rate of return on the investment was computed at 38.41 percent.

It appears, therefore, that the water savings alone to be derived from Interventions 1 and 2 are more than sufficient to justify consideration of this sub-project. This is so even if there were to be no additional benefits forthcoming from Interventions 3 and 4 -- which is certainly not the case as explained below.

Moreover, the projected net benefits from water savings provide a very substantial cushion for adding in an estimate of the real additional recurrent costs to the ORMVAT incurred in assuming sub-project activities over a twenty year period. Since essentially all of the technical personnel required to implement the sub-project activities are already in place at ORMVAT, it is not anticipated that recurrent expenditures for personnel will be a very significant cost item. Some expenditures over time will be needed to replace and/or update system-level equipment, computer hardware and software and possibly to secure the services of Moroccan consultants for short-term special assignments at ORMVAT after the life of the project.

If a preliminary recurrent expenditure estimate is included in the sub-project cost stream at the high level of $ 500,000 per year over twenty years, the internal rate of return for the sub-project <u>based on the benefits from water savings alone</u> is still 34.29 percent and the net present value of the net benefit stream is $ 14.58 million discounted at 20 percent.

3. Calculation of Other Complementary Benefit Streams

The assessment above concentrated on the benefits to be derived solely from water savings in the Tadla perimeter. The sub-interventions as designed, however, would have positive effects on other aspects of the regional economy. At least four other potential benefit streams were be identified by the consultants. Unfortunately, time and data constraints precluded detailed analyses of these four streams during this mission. They should, however, be analyzed in detail at the Project Paper stage if the sub-project moves forward. These potential additional benefits flow from:

- Increases in net farm incomes derived from a gradual shift away from uneconomic industrial and food crops -- i.e. sugar beets, hard and soft wheats, etc. -- to higher value crops in the Tadla perimeter;

- Efficiency gains and cost savings to be derived from increased private sector participation in agribusiness in the regional economy and privatization of inefficient government public and parastatal businesses;

- Efficiency gains and cost savings to the government from ORMVAT's disengagement from commercial activities and better management of its residual mandate; and

- Efficiency gains in PAGI 2 infrastructural investments derived from the complementary activities under taken in the sub-project.

As the rate of return calculations above already take into account the total USAID project investment costs -- and, in the second instance, an estimate of the local recurrent costs as well -- any quantifiable benefits from these additional benefit streams would have the effect of increasing the economic attractiveness of the proposed sub-project even further.

C. Social and Institutional Considerations

The objective of the sub-project is to evaluate the overall management of resources -- primarily water and land -- in the context of a more open economy. The objective of these considerations is to briefly investigate the socio-economic implications of improvement of this management.

1. A Better Understanding of the Structures of Land Holdings and Agricultural Production

It is important to know who the landowners and agricultural operators are within the irrigated perimeters. In fact, the owners and operators are -- each in matters concerning them -- simultaneously interlocutors with the State and direct actors in resource management.

In principle, a preliminary consideration in any land consolidation should be very precise information about a property. In reality, when the government consolidates "land titles" on private -- i.e. melk in French -- and collective land, it is not always aware of the details concerning each title. On the collective land, the State does not know precisely how many rightful owners there are for any particular parcel; nor does it always know who is actually producing on the land or how parcels are sub-divided among those doing so. On private land, which are nearly always jointly owned, the State is often unaware of how each property is sub-divided among co-inheritors and who among these individuals and other non-owners actually works the land. Often the State is only knowledgable about the most basic aspects of the legal situation for a land parcel and knows essentially nothing about the actual situation. In the case of irrigated land, this prejudicial ignorance is made worse for two reasons. First, after consolidation, the overall layout of plots within an irrigation block -- with its geometric precision and alignment -- gives a false impression of order and accuracy when in reality agricultural production is scattered, disorderly and sub-divided. Second, the overall efficiency of the land improvement plan rests on complete respect for the overall development system -- i.e. minimum size of properties and agricultural operations, operations by plots, respect for cropping patterns and rotations. But, because of the anarchic nature of the underlying organization of plots, system conditions are not and cannot be respected.

What can be done to resolve this problem?

In areas where irrigation potential existis but systems have not yet been laid out, it is necessary and possible to adopt more flexible system layouts, particularly for small properties; and to use surveys to learn about the actual status of land ownership on collective and jointly-held private lands before redistributing the properties within a consolidated irrigation block.

In developed perimeters, it is possible to conduct a survey on the real organization of plots within irrigation blocks, taking into consideration all farm-level enterprises and activities and proposals made by farmers with respect to block operations. And, second, using this information, develop with the cooperation and consent of the affected farmers possibilities for improving overall block operations.

2. The Development Model for Large Scale Irrigation Perimeters: The Opposing Logics of Farmers and Government Developer

The Moroccan model for large-scale perimeter development entails a very high level of internal rationality and coherence that makes it intellectually very attractive. The solutions it proposes are extremely elegant but obey a technical logic which does not always take into consideration the complexities of farmers' real situations. The large-scale perimeter model, for example, coherently links the choice of sites, the size of irrigation systems, the shape of plots, the choice of crops, and the location of agro-industrial enterprises. And, as a result, a large-scale perimeter in Morocco only works efficiently if this internal coherence is maintained at all times and at every point in the system. The model is, therefore, fragile and any interruption in the provision of water to crops during the dry season or any breakdown in agro-industrial plant and equipment in the middle of the harvest can have serious repercussions throughout a perimeter.

The large-scale perimeter model is oriented toward centralized control of irrigation operations. The very size of the perimeters and the coherence of the operational model used creates a strong tendency toward centralized management. The importance of the public investments in irrigation forces the centralized authority to limit farmers' free use of irrigation water. It imposed many obligations on farmers as spelled out in the Agricultural Investment Code of 25 July 1969. The crop rotations, production norms and cultivation techniques are established by annual decree published in the Official Bulletin. They are mandatory and carry appropriate sanctions in the event they are violated.

The operative model assumes an ideal type of operation in which:

- A sufficiently large operation of, at least, five hectares in maintained and sub-division by either sale or successional division is prohibited by the Code.

- A plot is operated as a single enterprise with mandatory consolidation where the objective is to reassemble and register the properties in a geometric layout.

- A stable farming operation managed by the owner or under regulated lease. The Code prohibits all forms of association except during harvest operations and only permits leasing for a period equal to a whole number of crop rotations -- i.e. leases for 5, 10 or 15 years in the case of a five year crop rotation.

- A balanced operation of mixed farming where agricultural and animal husbandry are closely integrated. This kind of production assumes a central "command" unit and a continuity in decision-making that is not often found because family joint ownership complicates operations.

Under the model, the State does almost everything in the large-scale perimeters. It conceives, decides and runs on-site and off-site infrastructure used in production. It chooses the crop rotations; imposes crop and irrigation techniques; distributes water and establishes its price; grants agricultural credit; buys, transports and processes agricultural commodities under contract; and, finally, establishes the prices for these commodities.

3. The Real Situation and Farmer Practices

Despite several instances of undeniable success, the large-scale perimeter model does not always attain its objectives. This is so in some instances because the theoretical layout of plots within a block does not correspond at all with the realities of farm-level operations. These operations are very often smaller than anticipated by the model and many plots are less than the minimum five hectares in size. The sub-division of plots, which is forbidden by law, continues to get worse in reality, especially because of inheritance laws. Farm operations, particularly on collective lands, are often unnecessarily sub-divided with the result that affected groups find themselves with more scattered plots than they had originally. Moreover, actual field operations are not always perpendicular within a block and many fields are planted to more than one crop in violation of the anticipated rotation. For all these reasons, the crop rotations, production norms and cultivated techniques decreed by the government cannot be respected in reality.

In establishing the large-scale model, therefore, the government unilaterally established a very centralized and controlled operation and declared it obligatory. It gave priority to procedures for control and sanctions in the event that farmers violated set procedures. These procedures, however, are rarely effective and can only function if infractions are the exception -- otherwise execution of the model requires daily monitoring of each farmer within a perimeter. This would imply in turn that the government has the capacity to monitor the innumerable, unstable and often covert divisions of properties among joint owners on private land and the operations of former legal owners of collective land. Since this task is clearly unattainable, it would be preferable for the government to discontinue this attempt.

On the other hand, farmers in irrigated perimeters do not continue practices that violate the Code out of ignorance or ill will. They have their reasons. For example, they wish to maintain a certain distribution of land which, thanks to a diversification of resources, allows them to avoid placing all their eggs on one basket and to continue fighting against risk and insecurity.

Moreover, farmers who own good land within a perimeter often do not cultivate them but prefer to lease land with no infrastructure outside the perimeter in order to cultivate it after installing at their own expense a pump to raise sub-surface water for irrigation. On the surface, this seems illogical. It is not. The price of water has increased so much inside the large-scale perimeters that it is more economical for these farmers to invest outside the perimeters and to grow crops of their own choosing.

In these situations, the government often complains of the passivity of the farmers and of their unreasonable demands for child labor in their enterprises. But, as has been seen on the large-scale perimeters, the State does all -- or nearly all -- of the major operations. The farmer is permitted there as a spectator to the development and improvement of his land. "A hen under the basket, that's what I am" says one farmer. Then why is it surprising that he uses his time and know-how to get government help, encouragement and all kinds of support, rather than taking private steps to improve the productivity of his land and water?

In irrigated perimeters, more than in other areas, the user of water and the producer stand isolated before the State. Now, the disciplines of resource management cannot be imposed by the government on a few isolated individuals. No improvement in resource management can take place without a minimum of organization of agricultural and rural producers. The organizational forms that currently exist -- i.e. the rural town, commodity associations, Agricultural Chambers of Commerce -- do not correspond to the appropriate level of organization. The Jmaa collective is no longer operational, the rural village is too large and the Agricultural Chambers of Commerce are not active enough and are not strongly representative.

Now that the State has adopted a disengagement policy and is progressively pulling out of commercial agricultural activities in the perimeters, it is important that this disengagement be accompanied by the development of institutions which can organize producers. In this regard, the following guidelines might be helpful.

1. It is necessary to observe the practices of farmers in order to understand their internal logic. Without accepting the rationality of their choices made within their own system of constraints, it is hardly possible to propose to them in a way acceptable to them the changes deemed necessary. Therefore, the first task is to conduct a survey of their practices and, to this end, implement "on-going observations of farmers' practices" conducting regular surveys of a stable sampling of representative operations.

2. It is necessary to encourage the organization of agricultural production so that, at a very local level, this organization can serve as representative interlocutors. These groups could be formed at the level of villages.

3. Specificially, identify proposed measures for the improvement of natural resource management.

4. Define in agreement with the user groups a program for improvement and the roles of users and other operators. In all instances where a particular effort will be required of the users, it will be realistic to propose compensation or other incentives for them.

REPORT ANNEXES

ANNEX 1

A TECHNICAL ASSESSMENT OF WATERSHED MANAGEMENT PROBLEMS AND OPPORTUNITIES IN AZILAL PROVINCE

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I. INTRODUCTION

Watershed management programs were initiated in Morocco over twenty years ago to reduce rates of sedimentation in major reservoirs and to conserve the long term productivity of forest, range and agricultural resources. Inappropriate land use practices have caused natural erosion rates to become accelerated, increasing siltation and depleting resources faster than they can be sustained. Although the role of watershed management in significantly reducing reservoir sedimentation has been exaggerated with regard to short term economic benefits, there remains a critical need for watershed conservation programs to preserve soils and long-term resource productivity. In the very long-term, there are significant economic and environmental benefits accruing to watershed management programs, both in terms of reducing reservoir sedimentation and preserving sustainable productivity on agricultural and forest lands.

Moroccan watersheds and forests are essentially at the disposition of the country's pastoral populations and are viewed primarily for the development of local and national economies downstream. A number of studies have indicated that 80 percent of the primary production of the forests is valued in some form as forage by herders. This is compared to only a 5 percent figure for construction and fuelwood. This important component of the agricultural sector of the economy is being seriously endangered by overexploitation, foremost by heavy and extensive grazing by domestic livestock and, secondly, by land clearing activities to increase the area for agricultural production.

The situation is most serious in the mountainous areas of the country. In Azilal Province, for example, the rate of land clearing approaches 5,000 hectares per year. Under these conditions, the protective function of vegetative cover is in jeopardy and the ability of the forests to service local needs -- forage and fuelwood -- may cease to exist within a quarter of a century (Lillelund and Staatsen, 1986). Large population centers adjacent to these mountain areas -- i.e. Meknes, Beni-Mellal and Marrakech -- also depend on these regions to supply their wood energy demand.

It is well known that a dense vegetative cover serves as a primary line of defense against soil erosion. Depending on the soil type and the degree of slope, grass and forest cover can afford as much as 40 times the protection of open agricultural land. This is the main argument for the extensive projects in the country aimed at soil conservation (DRS) and site rehabilitation in the more degraded areas -- e.g. the DERRO project. It is important to note, however, that even with large outlays of resources, DRS works and reforestation in semiarid and arid zones that are typical of much of the mountainous areas of Morocco have little chance of changing the natural "rhythm of erosion" (Heusch, 1990).

Slowing the rate of vegetative degradation in the mountain areas is not a simple process that can rely solely on technical/physical "fixes" on the landscape. Because the mountain areas rely largely on a pastoral economy, it will be necessary to first alter or improve the traditional forage production system -- either by forest management, improved forage and range management, more culturally adaptive agricultural techniques, or through a combination of processes. Heusch (1990) notes that, in Portugal, green oak forests are managed in many areas exclusively for their forage,

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with fuelwood and charcoal products excluded from the management system. In these areas, attention is given to increasing the density of new shoot growth that is preferred by the grazing animals, and to clearing the forest understory to encourage grass production under the trees. Le Houerou (1980) proposes a list of 34 different forage species, including vines, acacias, atriplex and others, that might be readily adapted to Morocco's complex mountain environment with its variations of rainfall, temperature, and soil conditions. These and others are management options that can be considered when the decisions are made to put more of a premium on conserving watershed resources.

Annex 1 presents a technical assessment of the physical and biological situation that exists on the three upper watersheds in Azilal Province. It also presents a series of interventions that can begin to address the serious environmental degradation that is now confronting the province's natural resources.

II. EXISTING RESOURCE DEGRADATION SITUATION IN AZILAL PROVINCE

A. Reservoir Sedimentation and On-site Erosion

It is important to distinguish between reservoir sedimentation -- sometimes called "sediment yield" -- and on-site erosion rates in the upstream watershed.

1. Reservoir Sedimentation

Reservoir sedimentation is the amount of sediment finally measured in the bottom of a reservoir. The most accurate method of measurement is with a series of bathymetric -- topography of the reservoir bottom -- surveys, preferably at temporal intervals of five years or so from the time of dam completion, resulting in a comparison of deposition over time. A less satisfactory way to estimate sedimentation is with periodic measurement of suspended sediment in tributary streams. Unfortunately, much sediment is missed because sampling is not continuous. In a detailed survey of reservoir sedimentation rates in Morocco, Belkheiri (1988) notes that the sedimentation rate for Hassan I reservoir in the Lakhdar watershed was estimated by suspended sediment measurements before the dam was completed in 1987. Rates for Bin El Ouidane and Moulay Youssef reservoirs in the El Abid and Tessaout watersheds were measured with bathymetric surveys. Reservoir sedimentation can be expressed in two ways:

- Sediment yield from a watershed; and
- Reservoir life.

2. Sediment Yield from a Watershed

The amount of sediment ending up in a reservoir can be defined in terms of metric tons per square kilometer of the watershed contributing the sediment -- sometimes referred to as "specific erosion rate" -- not to be confused with "on-site erosion rate". The following Annex 1 Table 1 uses data on watershed area and annual sedimentation from Belkheiri (1988) to calculate

sediment yield for the three watersheds in Azilal Province. Conversion from cubic meters to metric tons assumes an average sediment density of about 1.3 metric tons per cubic meter (FAO, 1987).

For the Tessaout watershed, the FAO report (1987) notes a sediment yield -- degradation specifique in French -- of 1,000 cubic meters per square kilometer per year -- or about double the rate listed by Belkheiri (1988). No technical report is cited by the FAO for this estimate. Since the Belkheiri report is a more recent compilation of all of the major reservoirs in the country and comes from the Ministry of Public Works, it is considered more definitive. The FAO report confirms that measurements of the Tessaout sediment yield were done with a bathymetric survey in Moulay Youssef Reservoir five years after completion of the dam. The important conclusion is that sediment yields for all three watersheds are in the range of 5 to 10 metric tons per hectare per year and that variations between watersheds do not appear to be large.

Annex 1 Table 1
Estimated Sediment Yields from Azilal Province Watersheds

Watershed	Area in Square Kilometers	Annual Sediment in Millions of Cubic Meters	Annual Sediment in Millions of Metric Tons	Sediment Yield in Metric Tons per Square Kilometer per Year	Sediment Yield in Metric Tons per Hectare per Year
El Abid	6,400	3.40	4.42	691	6.9
Tessaout	1,441	0.59	0.77	532	5.3
Lakhdar	1,667	0.84	1.09	655	6.5

Source; Adapted from Belkheiri (1988)

a. Reservoir Life

Sedimentation fills up the "dead space" of a reservoir first -- i.e. the space allocated specifically for sediment during design -- and then the rest of the volume. When the dead space is full, sediment starts to interfere with outflow structures and the reservoir begins a gradual decline in efficiency until the entire capacity is filled. As noted by Brooks et al (1982) in an analysis of the economic impacts of sedimentation in the reservoir at the base of the Loukkos watershed, "shortages of irrigation water would be unlikely during each year following the total loss of dead storage, however, the risk of severe shortages of water during critical dry periods would become greater as the reservoir fills with sediment beyond the dead storage capacity."

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Information from Belkheiri (1988) is used to calculate the total remaining life of the three reservoirs. Data in Annex 2 Table 2 indicate that all three reservoirs have total lives in excess of 300 years from 1990.

Another way to view reservoir life is to quantify the number of years of dead space remaining. This analysis for Azilal's reservoirs is shown in Annex 1 Table 3.

Annex 1 Table 2
Estimated Reservoir Life Based on Total Capacity

Reservoir	Initial Capacity in Millions of Cubic Meters	Sedimentation Rate in Millions of Cubic Meters per Year	Total Life in Years	Remaining Life in Years from 1990
Bin El Ouidane in El Abid Watershed	1,484	3.40	436	399
Moulay Youssef in Tessaout Watershed	198	0.59	336	316
Hassan I in Lakhdar Water-shed	270	0.84	321	318

Source: Adapted from Belkheiri (1988)

These data show that the annual rate of dead space sedimentation is highest in the Moulay Youssef Reservoir in the Tesssaout watershed at 2.5 percent per year and lowest in the Bin El Ouidane Reservoir in the El Abid watershed at 1 percent per year. The 1 percent rate for the Bin El Ouidane Reservoir is confirmed by the FAO report (1987, Annex 6.2, p.10). The Moulay Youssef Reservoir has the least dead space life remaining from 1990 -- i.e. 21 years. The Bin El Ouidane Reservoir has the most -- i.e 58 years.

A different approach is taken by Heusch (1990), who estimates the life of reservoirs based on the number of years to fill to 50 percent of total capacity calculated from 1990. Implicit in this approach is an assumption that a reservoir has lost its useful storage capacity when it has lost half of its capacity. Using this criterion, Heusch estimates Bin El Ouidane reservoir to have a useful life of 200 years, Moulay Youssef 143 years and Hassan I 225 years.

Annex 1 Table 3
Reservoir Life Based on Remaining Dead Space

Reservoir	Dead Storage Capacity in Millions of Cubic Meters	Total Dead Storage Life in Years	Years to Filling from 1990	Percentage Filling Rate
Bin El Ouidane	324	95	58	1.0
Moulay Youssef	24	41	21	2.5
Hassan I	40	48	45	2.1

Source: Adapted from Belkheiri (1988)

3. Erosion Rates in the Watersheds

On-site erosion rates are generally greater than reservoir sedimentation (except for extremely small catchments) because of the lag time between when erosion takes place and when it finally reaches a reservoir. The term used for this phenomenon is called a "sediment delivery ratio" and is defined as the percent of eroded material that becomes sediment in a reservoir. The ratio is technically difficult to estimate because on-site erosion data from erosion plots is often unavailable for enough land use types to reasonably quantify the amount. Adding to the measurement problem is the fact that sedimentation also results from channel erosion and mass movement -- e.g. landslides -- in addition to upland erosion from natural and human-caused processes.

The delivery ratio for the Loukkos watershed was estimated by Brooks et al (1982). Using the Modified Universal Soil Loss Equation, a watershed-wide erosion rate for all land use types was estimated to be about 90 metric tons per hectare per year. A reservoir sedimentation rate, based on bathymetric surveys of El Makhazine Reservoir at the base of the Loukkos watershed, was calculated to be 35.2 metric tons per hectare per year. The sediment delivery ratio was therefore 39 percent.

The most reliable method of estimating on-site erosion rates is with small erosion plots on different land use types. In a recent paper on watershed management research needs in Morocco, Heusch (1990) confirms the need for small, inexpensive plots as one of the highest priority applied research needs. An FAO watershed management project currently underway in Morocco has as one of its objectives the installation of low-cost erosion plots near four watershed management centers, one of which is in Marrakech (Seminario, personal communication, 1990). The only reference to a measured erosion rate in Morocco is by Heusch (1990), who briefly

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describes an area near Ouezzane with a soil loss of 5 metric tons per hectare per year before treatment with banquettes, which resulted in a seven-fold reduction to 0.7 metric tons per hectare per year.

A more generic way to estimate a sediment delivery ratio is on the basis of watershed size -- i.e. the larger the size, the smaller the ratio with graphs relating delivery ratio to watershed size having been published for the midwestern part of the United States. Another consideration is the shape of the watershed, with long and narrow watersheds having a lower delivery ratio than those with a more rounded shape. In the absence of specific information from the three watersheds in Azilal Province, the average watershed size can be calculated and compared to the Loukkos estimate. The average size of the El Abid, Tessaout and Lakhdar watersheds is about 3,100 square kilometers, larger than the 1,820 square kilometers of the Loukkos watershed. Therefore, the sediment delivery ratio for the Azilal watersheds is probably smaller than the 39 percent figure calculated by Brooks et al (1982) for the Loukkos watershed.

To arrive at an estimate of on-site erosion rates in Azilal Province, it is assumed that a sediment delivery ratio of 30 percent is reasonable. It is lower than the Loukkos figure because of the larger average watershed size. An average erosion rate for all land use types in the watershed area above the reservoirs may be on the order of 20 metric tons per hectare per year as calculated by dividing the sediment yield of 6.2 metric tons per hectare per year by a sediment delivery ratio of 0.3. This erosion rate is equivalent to about 2,000 metric tons per square kilometer per year.

A useful exercise is to speculate on approximate erosion rates for the several land use types in the watershed area upstream from the three reservoirs in Azilal Province. Unfortunately, no erosion plot data from different land uses are available for Morocco. Data from Belkheiri (1988) indicate that the combined area upstream from the reservoirs is about 9,500 square kilometers. Using the 20 metric tons per hectare per year figure, total soil loss is estimated at about 19 million metric tons per year. Percentages of land use in various categories are not available for watershed areas upstream from the reservoirs, with the exception of the Lakhdar watershed (CREAM, 1989). The FAO study (1987) determined land use areas for the entire province, biasing estimates toward a higher percentage of dryland cultivation, much of which lies downstream from the three reservoirs. For this reason, Annex 1 Table 4 of land use area and soil loss is based on the same land use percentages determined by CREAM (1989) for the Lakhdar watershed. These percentages are considered to be representative of land use distributions upstream from the reservoirs.

Annex 1 Table 4

Soil Loss Estimates from Land Use Types Upstream from the Reservoirs in Azilal Province

Land Use Category	Area in Hectares	Percent of Total Area	Erosion Rate in Metric Tons per Hectare per Year	Soil Loss in Millions of Metric Tons
Irrigated Agriculture	28,500	3	5	0.14
Dryland Cultivation	161,500	17	40	6.46
Overgrazed Open Forest	351,000	37	25	8.79
Dense Forest	76,000	8	5	0.38
Overgrazed Upland Pasture	294,500	31	10	2.95
Unproductive Alpine Land	38,000	4	1	0.04
Total	950,000[1]	100		18.76

Note: [1] Areas differ from Annex 1 Table 5 because of extrapolation from Lakhdar watershed for estimating erosion upstream from reservoirs.

Erosion rates for different land use types are best estimates based on observations in the field, FAO studies (1987), Hagen and Grosenick (1989) and professional judgement. Irrigated cultivation is mainly on gentle slopes with some terracing. Dryland cultivation is on land varying in slope from nearly flat to more than 30 percent, especially in areas where conversion from forest is occurring. This land use type remains fallow for several months of the year and only a small area has been treated with terracing techniques. Overgrazed open forest is on moderate to steep slopes with a rapidly deteriorating vegetative cover. Overgrazed upland pasture has a very thin natural soil depth with a substantial rock cover, and even though the vegetative cover is rapidly deteriorating, the resultant soil loss probably does not exceed 10 metric tons per hectare per year. The estimated rates were adjusted, within reasonable ranges, to arrive at a total soil loss of 18.8 million metric tons per year, which approximates the amount calculated with the independent technique of reservoir sedimentation of about 19 million metric tons annually.

This largely theoretical quantitative exercise helps to put into perspective conclusions made qualitatively through field observations and discussions with field personnel. These conclusions are summarized as follows:

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1. The two categories of land use which appear to exceed a "tolerable erosion rate" are dryland cultivation and overgrazed open forest. A tolerable erosion rate is defined as about 10 metric tons per hectare per year. For relatively deep midwestern soils in the United States, a tolerable rate is defined as 11 metric tons per hectare per year. For the thinner soils of Azilal Province, a lower tolerable rate may apply but without research conclusions it is difficult to choose a basis for a different determination.

2. Although overgrazed open forest probably has a lower average erosion rate than dryland cultivation, this category may have a greater total soil loss in the province because of its larger area -- i.e. more than double the area of dryland cultivation.

3. From an erosion perspective, overgrazing is probably the primary cause of soil loss in the province. Overgrazed open forest and overgrazed upland pasture may account for nearly 13 million metric tons of annual soil loss -- or nearly 70 percent of the total of 19 million metric tons. Soil loss from dryland cultivation is responsible for most of the remainder. It should be emphasized that a substantial part of the soil loss on steep and geologically unstable slopes is natural erosion which a watershed conservation program would not address.

4. It is not economically prudent to attempt to design a watershed management program to reduce erosion rates below "tolerable" levels -- tentatively defined here as about 10 metric tons per hectare per year -- even though these levels may not be as low as geologic or natural erosion rates. A program which resulted on average in reducing a dryland cultivation rate of 40 metric tons per hectare per year to 20 metric tons per hectares per year and overgrazed forest from 25 to 15 metric tons per hectare per year could be considered successful. With this type of success, total soil loss would be reduced to about 11 million metric tons annually -- or a reduction in loss of somewhat less than 40 percent. A long-term goal should be the reduction of erosion to the point where agricultural and forestry activities in the province will be ultimately sustainable. That level of erosion remains to be defined through appropriate research.

B. The Existing Forest Resource Situation in Azilal Province

Forests and shrubland currently cover about 33 percent of the total area of the Azilal Province. Documentation on the forest vegetation in Azilal Province (FAO/PNUD 1987) indicates an area of about 263,000 hectares of delimited forests; 190,000 hectares are contiguous and 73,000 hectares are in scattered blocks. An additional 126,000 hectares are estimated to be forested but not yet delimited. It is this latter area that is most prone to land clearing for agriculture. The same report also estimates that forested land is being cleared at a rate of about 3,000 to 5,000 hectares per year. The Forest Service in Azilal Province reported a figure of about 2,000 hectares per year during the team's visit. According to one estimate (Lillelund and Staatsen 1986), the forested area in Azilal Province will completely disappear within 35 years if nothing

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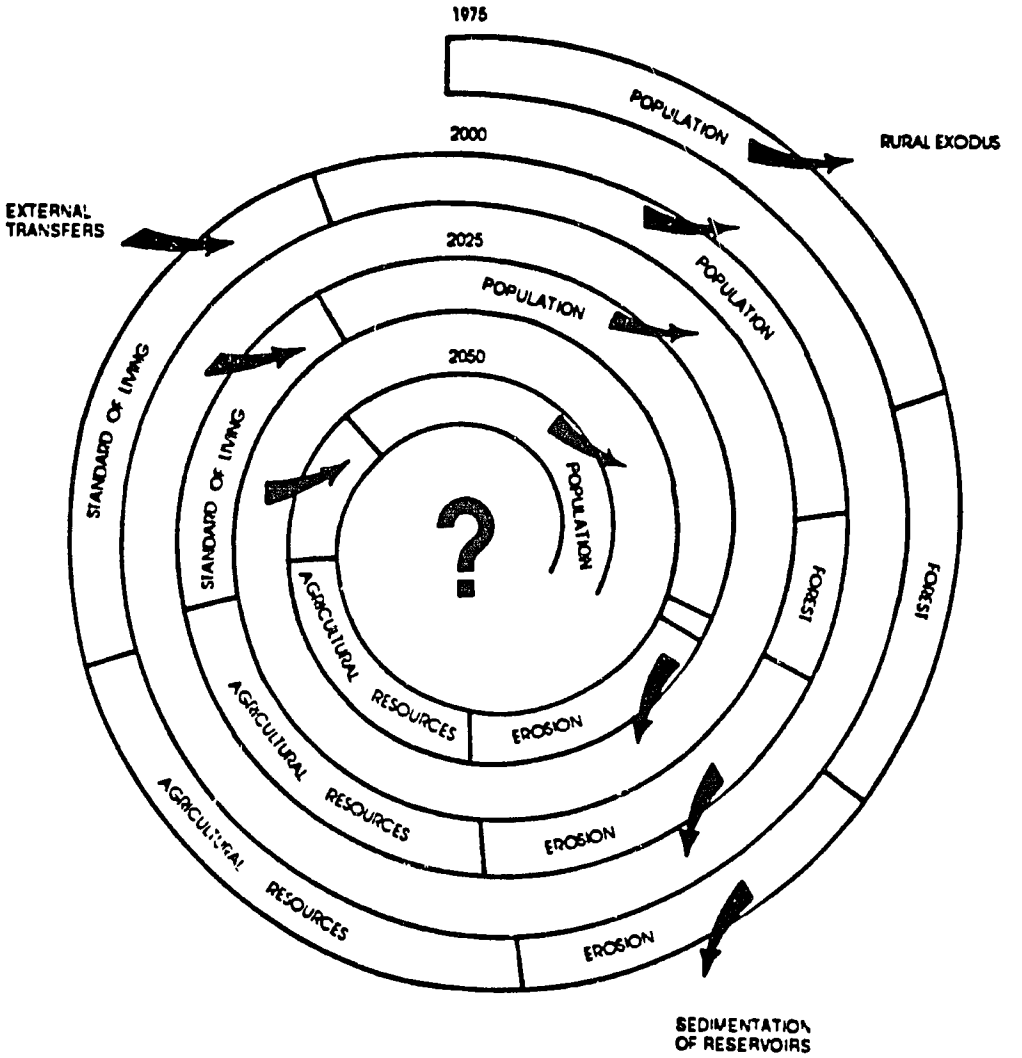
is done to change the current land use pattern. Annex 1 Figure 1 is indicative of the spiral of resource degradation that exists in the Province and what may occur if no action is taken.

The statistics presented above are indicative of the land use situation in the mountainous areas of the country. The delimited zones in Azilal are predominantly those with a dense forest cover -- about 95,000 of the 263,000 hectares that are delimited -- and are more or less under the control of the Forest Service. Large areas exist, however, where the forests are more open -- 172,000 hectares -- and grazing by local herders is extensive and largely uncontrolled (see Annex 1 Table 5). The more dense and contiguous areas of forest cover occur primarily in the more remote areas where pressure from human settlements is less.

The predominant species are green oak (Quercus ilex), Aleppo pine (Pinus halpensis), juniper (Juniperus spp.), and thuja (Callitris articulata). Although each of these species do appear in pure stands, they usually grow in association of two or more species. Green oak and other deciduous species predominate accounting for 58 percent of the total forested area. (FAO/PNUD 1987).

Other than their predominant use for grazing, Azilal's forests are also an important source of fuelwood and charcoal. Under government statute, local populations are allowed to gather only dead wood from the forest for their personal consumption. The open and overgrazed condition of the majority of the green oak forest associations are indicative of their heavy use by the local population. They are also evidence of the lack of respect for live trees and the minimum amount of control that is exercised by government and community authorities.

In the delimited forests, there has been more success in maintaining the forest vegetative cover. These zones supply most of the wood products via commercial harvesting operations. The Forest Service, using an estimate of the standing volume on a predetermined area, follows a bidding procedure for the harvesting of mature stands of trees. Woodcutters from Beni-Mellal and Marrakech outside the province usually bid on these lots and arrive with their own crews to harvest and transport the wood to sites beyond the provincial boundary. The local population rarely participates in these endeavors. Following a harvest operation, the cutover zone is essentially off-limits to grazing and other uses by the local population for a number of years. The actual exclusion period is determined by the local forester taking into account stocking density, the rate of regeneration, and other factors. Enrichment planting of other species -- often a coniferous species -- may also occur but the major reason for exclusion is to allow time for natural regeneration to occur.



ANNEX 1 FIGURE 1
A POSSIBLE SPIRAL OF DEGRADATION OF THE RESOURCE SITUATION IN AZILAL PROVINCE ASSUMING ALL THINGS REMAIN EQUAL
(Lillelund and Staatsen, 1986)

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Annex 1 Table 5
Forest Cover Types by Species Groups in Azilal Province

Green Oak and Other Deciduous Trees	Area in Hectares
-- Dense Forest (Foret dense)	55,000
-- Open Forest (Foret claire)	100,000
-- Mixed with Cultivated Land and Pasture	35,500
Sub-Total	190,500
Aleppo Pine, Juniper and Other Conifers	
-- Dense Forest (Foret dense)	40,000
-- Open Forest (Foret claire)	72,000
-- Mixed with Cultivated Land and Pasture	28,400
Sub-Total	140,400
Total Forest	
-- Dense Forest (Foret dense)	95,000
-- Open Forest (Foret claire)	172,0000
-- Mixed with Cultivated Land and Pasture	63,900
Total	330,900

Source: FAO/PNUD. (1987). Volume II, Annexe 1.

Receipts from these woodcutting operations minus small amounts for taxes and fees are returned entirely to the commune where the forest is located. A minimum of 20 percent of these monies are to be earmarked for reinvestment in forest activities within the commune. The actual rate of this reinvestment and the efficiency of the expenditure of these funds is, however, difficult to determine.

The Forest Service is not involved in any formal forest management process other than delimiting forested areas, protecting those areas against illegal cutting activities, and supervising the forest harvest/sale process. Although many of the trained professional cadre are knowledgeable about forest management planning, they usually lack the staff and time to conduct the necessary

activities themselves. As a consequence, most forest management planning, when it is done in Morocco, is accomplished through bids to the private sector and often with funds from an external donor under the umbrella of a larger project. The Forest Service in Azilal reports that the development of management plans for the delimited forests has not yet begun. During the team's visit, management planning for two forests in Azilal were requested via an international bidding process. It was learned later that a Moroccan firm won the two year contract to develop the management plans for the two forests, plus a third near Marrakech.

The use of forest lands for grazing in Azilal Province is a critical component of the grazing economy. Total range resources in the Province contribute about 54 percent of the estimated needs of the livestock herd in the region. As indicated in Annex 1 Table 6, well over half of the grazing area (parcours in French) is located within the forests of the province.

Annex 1 Table 6
Estimated Grazing Land in Azilal Province in Hectares

Forest Grazing Land	389,000
Non-Forest Grazing Land	291,000
Total	670,000

Source: FAO/PNUD. (1987). Volume II, Annexe 3.

The above table shows that most of the grazing land (parcours and forêt claire areas) is in green oak species associations. This is primarily due to two reasons:

1. The green oak forest, sometimes with juniper associations -- a species that is also grazed -- are more readily accessible than the higher open pasture land during all times of the year; and

2. Forage units per hectare in the forest lands are much higher.[1]

The average productivity for all rangelands in the province is on the order of 180 forage units per hectare (FAO/PNUD, 1987). World Bank/FAO (1988) estimates place green oak productivity at about 330 forage units per hectare in a dense forest situation. Forage productivity obviously varies greatly across the province and is a function of the overall health and accessibility of the pasture, the type of vegetation on the pasture, and the rate at which the land is grazed. The forest range manager with the FAO/PNUD project (1987) estimated that the overall average production

[1] Two hundred forage units are needed to sustain one adult sheep or goat for one year.

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of green oak in the province to be about 350 forage units per hectares in grasses, tree shoots and branches.

Grazing on the forested lands is controlled largely through traditional systems -- e.g. douar, fractions or simply lineage. Actual control is typically lax and results in overgrazing in most of the forests. Delimited forests under more formal control of the Forest Service are generally in better condition.

C. Dryland Cultivation

According to the FAO report (1987), the province has about 207,000 hectares (20 percent) in dryland cultivation. About 75 percent of this land produces cereals; 5 to 7 percent is in almonds, olives and other tree crops; and 20 percent on average remains in fallow during any given year because of traditional crop rotation practices. The FAO report estimates that, between 1982 and 1986, the area of dryland cultivation increased at an average annual rate of 4,000 to 6,000 hectares per year because of encroachment into forest and scrub land. This is equivalent to an average annual increase of about 2.7 percent.

From an erosion point of view, this encroachment is serious because it generally takes place on marginal land which is both steep and unstable because of decreasing vegetative cover. Conversion to dryland cultivation is usually accompanied by burning of remaining forest and shrubs so that tillage, unaccompanied by contouring or other soil conservation measures, can begin. In the Lakhdar watershed, conversion was observed to be taking place on slopes in excess of 30 percent where long-term sustainable cultivation is unlikely. Some areas were observed to have rills which probably will become gullies. Using the preceding erosion estimates, soil loss rates could nearly double from 25 to 40 metric tons per hectare per year with the conversion of overgrazed forest to dryland cultivation.

Compounding erosion problems in this land use category is the fact that the land has a very sparse vegetative cover when the fall rains come in late October or November. Tillage and planting operations expose largely bare soil to sheet erosion and rilling on steep and unstable slopes. These marginal slopes have already been degraded by severe overgrazing prior to conversion to cultivation. Although surprisingly few gullies were seen during the short field excursion, they probably occur in other areas such as the Tessaout watershed where bedrock and soils are more naturally unstable.

D. Irrigated Agriculture

Excluding the provincial area within the Tadla perimeter, there are about 15,800 hectares of irrigated agriculture in the province (FAO, 1987). This land is in valley bottoms with perennial streams and is irrigated from traditional gravity systems which have been used in the High Atlas Mountains for centuries. There are some 260 perimeters irrigated in this way, resulting in an average area of about 60 hectares for each perimeter. Cereal crops and fruit and nut trees are the primary produce, with about 70 percent of the area used for forage production to feed sheep and

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goats.

Erosion problems are rare in these largely flat valley bottoms where irrigation opportunities have led to a sustainable level of soil and water management. Erosion rates are, on average, estimated to be less than 5 metric tons per hectare per year in an area where well-constructed terraces are common. According to the FAO (1987), there are opportunities to increase the area of irrigated agriculture by 7,000 hectares, which should be encouraged because it would increase forage production and presumably reduce grazing pressure in overgrazed forest and upland pastures.

III. PROPOSED INTERVENTIONS

A. Overall Approach

In order to identify and prioritize interventions that would be both sustainable and cost effective from a public participation standpoint, team technicians utilized a modified Delphi technique. Following the field visits, a list of as many types of interventions that would be appropriate for soil and water conservation purposes in Azilal Province was "brainstormed" by the team. Then, each specialist was asked to rank each item on the list according to a hierarchy of 1, 2 or 3, with one being the most important and three the least. These rankings were assigned to four different criteria: impact on soil conservation, impact on other resource conservation, cost effectiveness, and sustainability of benefits. Finally, based on professional judgement, an overall ranking was assigned to each item listed. A sample of the matrix can be found in Annex 1 Attachment 1.

Following this exercise, team members met again to discuss their rankings. Where large variations occurred in the overall scores, justification for the ranking was asked for by each member. When consensus was achieved, priority ranking for each of the interventions was determined using a high, medium, and low priority corresponding to the 1, 2, and 3 ranks on the overall list. Annex 1 Table 7 presents the results. The high priority items became the interventions that are elaborated in this report and are discussed in the following sections.

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ANNEX 1 TABLE 7
OVERALL RANKINGS FOR POSSIBLE WATERSHED MANAGEMENT INTERVENTIONS IN AZILAL PROVINCE USING A DELPHI TECHNIQUE

LIVESTOCK	FORESTRY	AGRICULTURE
	HIGH PRIORITY	
Improved Grazing Controls on Common Pastures	Improved Forestry Unit Planning	Stone Walls on Contours Without Subsidies
Improved Information and Cooperation	Improved Management For:	Increasing Area of Local Irrigation Systems
	– Wood Production	Improved and Expanded Fruit/Nut Tree Culture
	– Forest Grazing	Improved Information and Cooperation
	– Soil Protection	
	– Recreation and Tourism	
	– Harvesting Techniques	
	Improved Information and Cooperation	
	MEDIUM PRIORITY	
Planting to Improve Existing Species Density on Common Pastures	Reforestration and Plantations	Stone Walls on Contours With Subsidies
Increased Animal Productivity Through Improved:	Improved Production of Secondary Forest Products	Promotion of Water Harvesting Techniques
– Animal Health		Biological Streambank Protection Measures
– Animal Production Systems		
Increasing Forage Production on Local Irrigation Systems		
	LOW PRIORITY	
Planting Improved Forage	Improved Wildlife Conservation Programs	Physical Streambank Protection
Improving Water Points	Managing Forests to Improve Water Supply and/or Water Quality	Promoting Increased Use of Chemical Fertilizers
Purchasing Forage	Research for Species Improvement	Building Gully and Ravine Checkdams
Improving Herd/Animals via Genetic Improvement	Road Building	Banquette Construction
Stall Feeding		

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B. Natural Forest Management

1. Objective

The major objective of natural forest management in Azilal Province is to diminish the rate of forest land degradation that is occurring in the watersheds and to improve the condition -- and consequently the yields -- of forest-based resources that are available to the local populations.

2. Justification

One recommended approach for achieving this objective is community forest management. The system presently in place exerts a top-down approach from the local government authorities which places the local population, the primary users of the forest land resources, in an adversarial position with the Forest Service. Important legal forest removals are contracted with outside entities and are sold in markets that are primarily outside of the province. The local population receives no direct benefits and, as a result, has no vested interest in sustaining the resource. Although revenues from the commercial sale of forest products are returned to the commune, a 1976 law stipulates that at least 20 percent of this amount is earmarked for forest activities. And even then, the expenditure of these funds on forest management is dubious at best, due primarily, to other prevailing interests of local elected communal authorities.

This system is obviously not working as evidenced by the largely uncontrolled degradation of existing vegetation and continued loss of forest land to land clearing activities for agriculture. A more community-based system of management where local populations have a vested interest in their forests and grazing lands, where they realize direct benefits on a regular basis, could help to rectify the situation. In addition, in order to insure sustainability of such a management scheme, the recurrent costs must be of a magnitude that can be borne by the same beneficiaries.

3. Basic Approach

a. Other Management Model Experiences

Variations of the community management type of model are now being successfully applied in similar types of livestock-based economies in the semi-arid zones of sub-Saharan Africa. Although these experiences are small-scale and have only recently gotten underway, a number of them appear to be working (Wright and Bonkoungou, 1984; Heermans et al, 1987; Soto, Flandez et Dilema, 1990; Dennison, 1990). Several others are also about to be implemented or are under study (McKay et al, 1990; Obermiller, 1989; Denev et al, 1990). The basic premise of all of these experiences is that the local population actively participates in the management -- e.g. deciding land use priorities, monitoring the sale of grazing and fuelwood cutting permits -- of the forest and grazing resources and that they are the primary recipients of the management benefits -- i.e. cash from fodder and fuelwood sales, improved site conditions.

b. A Framework for Azilal Province

In Azilal Province, the approach is most apt to succeed in the green oak forest associations that are traditionally used by people from nearby douars/fractions. The open forest areas in the province are extensively used for grazing and as a source of fuelwood. Although thuja and juniper are used to some degree for construction wood and poles, most of the coniferous forest species are not used locally to any large measure. Their greatest value continues to be their soil protection function -- under the aegis of Forest Service control -- and as higher value timber products outside of the region. The Forest Service needs to continue to oversee commercial harvest operations on the forest cover types with higher densities and to monitor forest grazeland management on the open forest land.

The commune would continue to be responsible for monies received from commercial harvesting activities but more emphasis would be given to the portion of those receipts that are designated for forestry-related activities. Specific arrangements need to be established for using these funds in areas of the commune that require assistance for establishing forest land management activities.

The community-based forest resource management envisaged for these green oak forests will require strong and cohesive cooperation between three organizational structures:

1. The douars, fractions or specific user groups representing the resource users/beneficiaries;

2. The commune, with its general oversight responsibilities for the area and as an initial source of forestry activities monies from commercial tree harvesting done in the area; and

3. The Forest Service, with its technical expertise, serving as advisors and monitors for the various management activities.

A fourth entity -- the provincial Livestock Service -- also needs to be actively involved in helping to assess forest range capacity and advising on management decisions involving small ruminants that rely on the forage resources -- trees and herbaceous material -- found on forested land.

In a project context, these groups could obviously benefit from the technical assistance of a sociologist with natural resource management experience. This technical assistance would focus on helping these groups establish criteria for setting management priorities and overseeing the distribution and management of the commune forestry activity funds.

The primary incentive for participation by the local population will be the right to receive the direct benefits including cash from surplus yields of the management activities on the forested lands. These will include the traditional use of the forest as grazing areas for their herds, with some modification based on management prescriptions arrived at by the user group. In order to

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make the approach sustainable, it is also proposed as a major deviation from current practices that recognized user groups be permitted to harvest live wood under a management prescription. The harvested wood will be for local consumption, with the option to sell any surplus and the revenues accruing directly to the user group. The Forest Service will assist the users in determining an annual allowable cut that is consistent with the annual growth of the existing forest.

c. Pilot Operations

Implementation of the community forest management intervention should be conducted as a pilot operation in each of the three major watersheds in the province. In each of the watersheds, a contiguous unit of green oak open forest should be carefully chosen for the intervention. The area should be representative of the watershed and involve a limited number of douars or fractions. Other criteria -- i.e. the degree of degradation, proximity to roads to markets, willingness of the population to participate -- also need to be considered but the overall goal is to help simplify establishing the improved management process.

d. Defining Management Units

This area would be divided into management units of approximately the same size. The number of areas will be dependent on the biological rotation age for harvesting open green oak for fuelwood for local consumption. Data from the Middle Atlas (Khatouri, 1990), under similar ecological conditions, indicates that this will probably range from 10 to 15 years. Management operations would then progress on an annual basis from one unit to another. In consultation with the government services, the user groups (groupements in French) would determine the objectives for each unit and arrive at appropriate sylvicultural and grazing prescriptions to be applied and followed.

Natural forest management does not preclude tree planting activities for forage or higher value products such as poles, timber, fruit and nut trees. This would be done in the context of the management priorities established by the local population with advice from the government's technical services. If planting is an elective, seedlings would be purchased from from a local tree nursery with funds generated from forest management related activities. The objective is to cover recurrent cost items from benefits that accrue from the forest.

4. Technical Assistance

In a project context, technical assistance will be needed from a community forest manager to help oversee the establishment of the management system in each of the three pilot areas. As noted above, a sociologist or community development specialist with good community negotiating skills and natural resources experience will be required to assist the government services and user groups to work with their constituencies and develop a process to create a natural resources management plan. A Moroccan forest range specialist at the provincial level will also be needed to underscore the importance of the forest range resource and to assist with the range

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management activities in each area.

The pilot areas selected for management will need more recent aerial photography -- the FAO/PNUD 1987 study used 1984 Landsat imagery -- and at a scale that will allow detailed mapping and facilitate range and forest land inventory estimates.

A complement to the photography and mapping exercise will be a thorough assessment of range/forest resources culminating in a land use plan. Most, if not all, of the short-term expertise for this activity can be found in the country. Careful attention needs to be given, however, to the fact that accurate volume estimates for green oak, particularly in the open forest are sorely lacking. It is suspected that bids for commercial cuts in green oak areas are often based on low volume estimates which results in a considerable gain for the woodcutter and a loss of revenue for the commune. Special consideration in the form of short-term technical assistance should be afforded to develop and test an inventory methodology that is appropriate and accurate for first and second growth green oak in Morocco.

Although a considerable amount of information and expertise can be found concerning coniferous species in Morocco, surprising little is known about sylvicultural techniques as they are applied to green oak. Site index tables for dense stands have been developed from data in the Middle Atlas but these are related almost exclusively to dense forest cover sites where clear-cutting techniques have been employed. To make community forest management more efficient, studies need to be conducted on other harvesting and thinning techniques. These could include selective cutting, pruning strategies associated with livestock browsing, and regrowth and productivity estimations in cubic meters per hectare per year, particularly as they relate to the more open and heavily grazed green oak types targeted for this intervention. These data should also be of value to the Forest Service as it oversees the commercial harvesting operations -- now done exclusively with clear-cutting techniques.

More consideration for utilizing the green oak forest primarily as a fodder resource is also needed. The World Bank (FAO/World Bank, 1988) reports that its value as a forage resource is on the order of 330 forage units per hectare. Previous natural resource assessments in the province have pointedly stated that the species should be more intensively managed for grazing (FAO/PNUD, 1987; CREAM, 1989; Lillilund and Staatsen 1986). In conjunction with the project, a more in-depth analysis of the green oak forage resource should be done. One component of the study should be to visit Spain, Portugal and other appropriate sites where green oak forest cover types are being managed exclusively for forage (Heusch, 1990). The forest range management specialist assigned to the province would be responsible for coordinating and monitoring this activity.

5. Intervention Outcomes

a. Short-Term

In the first five to ten years following the start of this intervention, a community forest management system should be functioning in at least one pilot zone in each of the watersheds. Flexibility will be required on the part of each of the "management committees" to adapt and adjust to constraints that are unique to each area. A management plan for each pilot zone will have been developed and activities outlined in each plan will have started.

Each of the zones will have been mapped and inventoried for forest and forage volume. Complementary studies on forest and range productivity will have been carried out and the information shared with the local management groups to allow for adjustments in their management plans. The major problems encountered -- and hopefully solved -- when establishing such a community-based system will be known and this will also include methods adopted for distributing benefits and paying for recurrent costs. Methods for dealing with infractions by the local population will also have been established.

The management plans will cover wood harvesting for fuelwood, selective cutting for forage and improving stand density and productivity and a rational use for grazing on each of the management units by local herds. The local groups will have received increased benefits from the cutting of live wood on at least five of the management units.

The provincial technical services in Azilal will have increased their capacity to manage forest and resources on a community scale, based on experience gained from working with the long-term sub-project specialists -- e.g. community forest manager, forest range manager, sociologist -- and from study trips to other regions. Additional knowledge will also have been gained from completed and continuing studies on the inventory and growth studies on green oak for wood and forage. Initial data will also have been collected on the response and efficacy of different wood/forage harvesting systems that can be applied to open green oak forest cover type associations.

b. Long-Term

In the long-term -- 20 years -- the pilot zones will have fully implemented the prescribed management activities at least once in each of the management units. On those managed for wood production, yields will be increased by the cutting operations. Forage production will also be increased due to more intensive management in the zone which will result in a higher percentage of vegetative cover and reduced rates of soil erosion.

By this time, management planning efficiency should also be approaching an optimum due to increased understanding of the system by all the users in the pilot area. Modifications to the system should be able to be made more easily, even though priorities will change over time.

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Government agricultural services primarily the Forest and Livestock sections will have increased their capacity to provide sound technical advice based on experiential gains and knowledge acquired from the completion of growth and yield studies on green oak cover types. The Forest Service specifically will be able to apply improved management prescriptions and conduct more thorough management unit planning in the other delimited forest areas based on the experience and knowledge gained from this type of intervention.

Overall incomes to the user groups and the communes from forest and range related activities will have increased significantly due to increased production from all green oak forest cover types. Hopefully, the more intensive management of the open forest will result in decreased pressure on the dense forest. This coupled with gains from improved sylvicultural methods -- e.g. in the area of selective cutting -- will help to increase overall production yields and thus incomes that will accrue locally.

C. Overgrazed Communal Upland Pastures

Referred to as parcours in Morocco, these communal pastures were observed to be overgrazed. Because they are communally owned, individual herders do not have a high incentive to keep grazing pressure at a sustainable level. However, the previous analysis of erosion rates suggests that an estimated rate of 10 metric tons per hectare per year may be within a reasonable or tolerable rate. It was concluded that this land use type is not a priority area from an immediate erosion control point of view. Although the common pastures are overgrazed and sheet erosion is evident, serious erosion problems -- e.g. gullies and landslides -- were not seen during the short field trip. These problems probably exist in areas of naturally unstable bedrock and soils -- e.g. some parts of the Tessaout watershed -- where overgrazing has reduced vegetation density and exacerbated pasture deterioration.

Even though overgrazed upland pastures are not as high in priority as overgrazed forest and dryland cultivation land use types, the forage in the pastures is visibly in poor condition. It can be presumed that if no interventions occur, upland pastures (31 percent of the area upstream from the reservoirs) will eventually become "badlands" which would have little productive value. Therefore, a rotational grazing intervention with three implementation steps is recommended:

1. The preparation of grazing management plans;

2. Livestock exclusion for certain time periods on critical areas; and

3. Rotational grazing in all areas.

A second intervention of reseeding with the same or introduced species is not considered to be economically viable in these marginal areas where simple exclusion and rotation techniques would have a similar result at far less expense.

1. Pilot Grazing Management Plans

Some success in preparing and implementing management plans for controlling grazing is reported for upland communal grazing land in the Timahdite area near Azrou of the Middle Atlas Mountains (APTAL, 1989). Range management committees were established for communes where grazing rights have been legally established through a local adjudication process. Personnel from the Ministry of Agriculture and Agrarian Reform worked with local communes to document seasonal patterns of grazing by the holders of grazing rights. The impact of these patterns and numbers of animals was assessed and, through a process of mutual negotiation, a rotational schedule was developed which reduced overgrazing during critical range growth periods and allowed recovery periods for severely degraded areas.

A site near Timahdite was observed where one hectare exclusion areas were established two years ago. The two sites had not been reseeded but had vegetation densities which were three to four times greater than the normally grazed communal pastures outside the enclosures. These types of demonstration plots, which combine at low costs the benefits of scientific information on impacts as well as public demonstration for herders and farmers, need to be part of a management plan for Azilal Province. For the measurement of erosion control benefits from grazing control, erosion plots need to installed on treated and untreated plots. The installation and maintenance of the plots should be closely coordinated with the regional watershed management center in Marrakech, which has already begun installing plots. According to Seminario (personal communication, 1990), the FAO watershed management project is developing the technical expertise necessary to install and manage erosion plots for long term applied research needs and demonstration value.

A major problem with this approach is that many communal grazing areas have not been legally delimited or adjudicated in terms of grazing rights. Grazing management plans were not attempted for these areas in the Timahdite program and instead work was focused on areas where disputed claims had been settled. In the Azilal area, pastures are found at lower elevations as well as the high parcours. The pastures in the low altitudes may be easier to start with as initial demonstration sites.

This approach is people-oriented, rather than technically based, and would require initial technical input only in developing communal plans. Longer term monitoring to ensure adherence to the management plan and to assess the impacts of the program would be necessary. This may be an area of involvement appropriate to a United States Peace Corps level of technicity. The Timahdite "success" has been discussed as a model for this type of intervention by World Bank personnel in Washington (O'Sullivan, 1990) and this approach should be considered for Azilal Province.

Because of the strong social and small technical components of this possible intervention, the importance of a social analysis for a proposed pilot area needs strong emphasis. If herders are not receptive to the preparation and implementation of a management plan, the reasons need to be well documented and the chances for success realistically assessed. From an erosion point of

view, these lands are not priority areas and the social complexity involved in organizing such a program should not be underestimated. In short, this should be regarded as a high risk venture in terms of future success.

This intervention is the second step in establishing a grazing management plan and would be appropriate for selected areas where deterioration has reached a critically serious level. This approach would probably require compensation for grazing forgone in the early stages of the program while severely degraded areas are in the process of recovery. This would be only a short-term exercise, which would be supplemented by a sustainable rotational grazing program as soon as vegetation recovery has been established.

The ultimate aim of a successful grazing plan is one that establishes a rotational grazing schedule which will sustain vegetation on individual pastures in the long term. A rotational schedule agreed to by a communal grazing committee would estimate the number of animal units which could be grazed in each pasture on a sustainable basis during each month of the year. Beneficial impacts may not be increases in pasture productivity but rather a reduction in the present rate of pasture deterioration. Reseeding with indigenous or new grass species is probably not economically justified unless valid grass trial studies in the field showed that a sound rotational grazing program would not halt present rates of deterioration. The main benefit of a rotational grazing program would be to halt the present decline in forage productivity while at the same time reducing somewhat the rate of sheet erosion on more fragile areas.

2. Training and Technical Assistance Requirements

To carry out the preparation of management plans and the implementation of rotational grazing programs for three demonstration areas -- one in each watershed -- training and technical assistance are considered necessary. First, a training session lasting three to four weeks is recommended for the introduction of range management techniques and the preparation of participatory grazing plans. This session would be taught by a joint Moroccan/expatriate team consisting of range managers and social scientists experienced in forming user groups.

Secondly, a team consisting of institutional, social and legal advisors needs to examine the three watersheds and prepare a methodology for grazing management which is suited to the specific cultural and institutional conditions of Azilal Province. The team then needs to initiate the establishment of a user group in each of the three watersheds on a pilot scale. Thirdly, a long-term Moroccan advisor needs to oversee the implementation of the three pilot scale programs for the duration of the project.

3. Predicted Impacts

The preparation and implementation of a grazing management plan specifying specific rotational grazing would be initiated in a small pilot areas -- one in each of the three watersheds. The major benefit would be to change a rapidly degrading pasture into a sustained yield grassland which would be rotationally grazed in a sustainable way. Erosion control and reservoir

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sedimentation benefits would be minimal. It is likely that forage production would increase but no studies have been carried out to indicate the magnitude of this likely benefit. Field inspection of the enclosures at Timahdite in the Middle Atlas Mountains suggests that exclusion appears to increase vegetation density three or four times. Based on experience in other parts of the world, it is likely that a sound rotational grazing program would result in at least a doubling of range productivity on a long-term basis.

The chances of success for this intervention even on a pilot scale are not considered to be high because of the complex social and legal issues associated with communally controlled pasture land in Morocco. Although the Timahdite example suggests some reasons for cautious optimism, activities in this area must be very carefully considered with large inputs of prior planning. A detailed social investigation needs to carried out by a qualified social scientist and a range management expert would be required for guidance on the preparation and implementation of grazing management plans.

D. Dryland Cultivation Interventions

As noted, the highest erosion rates occur on this land use type, averaging of 40 metric tons per hectare per year. The most common intervention is DRS fruitiere, which is a terracing technique combined with fruit and nut tree plantings. These are expensive structures costing 4,000 to 5,000 Dirhams per hectare (FAO, 1987; CREAM, 1988). In some areas with moderate slopes, they appear to be "over-engineered" for the intended purpose. They should be considered only where high value fruit, olive and nut trees are planted on steep slopes and even in these areas a less expensive alternative makes more economic sense. According to Hagen and Grosenick (1989), the Forest Service supplies technical assistance and free tree seedlings while the farmer constructs the terrace, plants the trees and maintains the terrace. Examples of large, productive trees on long stable terraces observed in Azilal Province attested to the long-term sustainablility of this technique. An estimated 125,000 fruit and nut tree seedlings were planted on DRS terraces in the province between 1986 and 1988 (Hagen and Grosenick, 1989).

According to analyses performed by Hagen and Grosenick (1989), the economics of some forms of DRS fruitiere appear favorable for some parts of Morocco. The financial rate of return for this type of terraces was calculated to be 15 percent for olive trees with a forage crop under the trees. However, most of the data for the calculations is from watershed management projects in the Loukkos and Nekor area of the Rif mountains. Because olives are grown mainly at lower elevations in Azilal Province, these conclusions do not appear to be valid for dryland cultivation in watershed areas upstream from the three reservoirs.

1. Stone Wall Terracing

A less expensive terracing technique which has similar erosion control benefits is the construction of stone walls on the contour observed to be a commonly used technique, particularly in upland areas where erosion problems are more severe because of steeper slopes and less stable soils. Because this technique eventually results in a terrace when the terrain upslope from the rock wall

fills with soil from above, it is clearly the most cost-effective soil and water stabilization procedure observed in the province.

Building the structures is subsidized by the Agricultural Extension Service by giving farmers 30 percent of labor costs if the walls are built properly on the contour. Farmers routinely clear rocks from fields without official encouragement and are learning that arranging rocks in a stable configuration along the contour has soil and water retention values, as well as earning them a subsidy. Whether or not the subsidy encourages the conversion of grazed forest to dryland cultivation is not clear but in any case the program may continue to stabilize cultivated hillsides without the subsidy. Elimination of the subsidy is a modification that should be considered. The technique appears to be popular with farmers and is probably sustainable in the long term without a subsidy.

While costs are not available for this technique, labor inputs are clearly less that for DRS terraces, which cost about 4,000 to 5,000 Dirhams per hectare. Since rocks are in abundance on nearly all cultivated and potentially cultivated land in the province, the only cost is some technology transfer and farmer labor. Fruit and nut trees could be provided by the Water and Forest Department just as in the DRS fruitiere program. It is likely that per hectare costs would be less than half of those associated with DRS fruitiere. An estimate of 1,000 to 2,000 Dirhams per hectare may be reasonable for a technique which should eventually cover much of the 207,000 hectares of dryland cultivation in the province.

This technique seems to be the most cost-effective technique for soil and water conservation on agricultural land. However, guidelines need to be established for use on different slope angles and stabilities. As slopes increase, the distance between walls should decrease and technical criteria need to be established and disseminated so the technique can be used sustainably on a wide variety of slopes and soil stabilities. The more expensive DRS terraces could be limited to critically steep and unstable areas where the more expensive technical approach is warranted. The DRS terraces probably can be justified only where a particularly high value crop is grown.

2. Microcatchment Water Harvesting Techniques

Variations on the stone wall technique can be used to construct microcatchments for water harvesting. Crescent-shaped stone walls curved upslope at both ends have been observed in other parts of Morocco and are used effectively in other semi-arid zones. Their widespread use in Azilal Province could result in substantial water and soil conservation benefits.

Microcatchments would be especially useful when applied in conjunction with a cordon en pierre structure as a method to trap additional water and sediment upslope and around high value fruit and nut trees. The cost of adding microcatchments to cordon en pierre structures might increase costs by perhaps 500 Dirhams per hectare. The cost effectiveness and long- term sustainability of this activity is considered to be high.

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3. Technology Transfer of Soil Conservation Techniques

A range of soil conservation techniques -- e.g. contour furrows, diversion channels, alley cropping, grassed waterways and other standard procedures -- need to be demonstrated to farmers. In addition, agroforestry concepts -- e.g. planting fruit, nut and forage trees along the edges of cultivated plots -- need to be introduced to more farmers.

It is proposed that a training session taught by a combined Moroccan/expatriate staff be organized to teach the transfer of soil conservation techniques through agricultural extension methods. This would be a three to four week course to teach extension agents how to best get the message to farmers. Technical experts on soil conservation techniques would be involved, as well as experts in the communication of conservation concepts to farmers.

4. Horticulture Training

An expatriate horticulturist needs to be brought in for two months to teach techniques for augmenting dryland cultivation production with additional fruit, nut and forage trees along the edges of cultivated plots. The horticulturist could return for two one-month consultancies to evaluate progress. There are excellent opportunities to plant trees in cultivated plots, which would have two objectives: soil erosion would be reduced and production of forage and cash crops would be increased on the farm. Hopefully, this would encourage more forage feeding closer to farms.

5. Demonstration Plots

The design and construction of demonstration plots in each of the three watersheds should be part of the package. Erosion plots in each of the three watersheds should be established for several land use types -- i.e. overgrazed upland pasture, overgrazed forest, natural forest and dryland cultivation. Side-by-side plots one with a conservation measure and the second without are the most effective for both demonstration and research purposes.

Plots have been constructed near Marrakech by the regional watershed management center of the Ministry of Agriculture and Agrarian Reform to quantify erosion rates on agricultural land with and without eucalyptus planting (Seminario, 1990). These plots are small (5 by 30 meters) and inexpensive ($ 3.000 per plot including automatic data recorders). Other plots are planned for several land use types near the four watershed management centers in the country -- Marrakech, Agadir, Fez and Al Hoceima. The plots were designed by Kenneth Renard of the United States Agricultural Research Service in Tucson, Arizona and four Moroccans are being trained in techniques of erosion control research. This expertise, which is a training component of the FAO program under the direction of Seminario, should be used in the establishment of plots in Azilal Province. In addition, demonstration sites for teaching sound soil conservation practices should be established for extension training purposes.

6. Predicted Impacts

There is considerable uncertainty involved in estimating the impacts of watershed management interventions in Morocco. The World Bank has recognized that, although the country has implemented several watershed management plans, little analysis has been done to quantify the "expected benefits relative to costs and the feasibility of the scheme with regard to farmer acceptability". The World Bank has, therefore, commissioned a $ 500,000 study currently in the process of being carried by the Moroccan firm Agro Concepts, which will review past experience to determine the most promising technical and social directions.

It is anticipated that a combination of cordon en pierre and water harvesting techniques would have substantial erosion control and productivity benefits. Although data are lacking to quantify benefits with any degree of certainty, it is hoped that these techniques would substantially reduce the presently estimated rate of loss of 40 metric tons per hectare per year to a tolerable and sustainable level on treated areas. The extension of irrigation possibilities in valleys located on perennial streams would increase the production of forage and reduce pressure on overgrazed forest and range lands.

E. Small Scale Irrigation

There are opportunities to add about 7,000 hectares of irrigated agriculture in about 100 small perimeters in valley bottoms with inexpensive gravity diversions (FAO, 1987). These traditional systems are now used to irrigate some 15,800 hectares in 260 small perimeters in the province (FAO, 1987). The systems appear to be very economically viable and, with a small initial investment in diversion structures, have been shown to attract a very high percentage of local participation in other parts of the world. For example, in Nepal an evaluation indicated a local participation rate of 70 percent in canal construction to irrigate fields which would benefit from the activity (Fleming, 1988).

In addition to be being a very sustainable type of activity, small scale irrigation would help in the conservation of resources in the province, particularly in terms of erosion caused by overgrazing. Additional forage produced in valley bottoms may encourage intensive animal feeding closer to farms, rather than extensive grazing, particularly in open forests.
Those farmers willing to participate in the irrigation benefits would need to agree to feed a specified percentage of forage from increased on-farm production and to reduce grazing pressure in specified parts of overgrazed forest land. On forest land, where grazing pressure was reduced to a sustainable level, soil loss could be reduced from an estimated 25 to 10 metric tons per hectare per year.

The FAO (1987) estimates that this activity would cost on the order of 10,000 Dirhams per irrigated hectare including both diversion and canal construction costs. Part of this cost would be borne by farmers in the form of labor to construct canals and laterals to irrigate individual fields. This form of local participation can be expected to increase the likelihood of long term sustainability (Fleming, 1988).

IV. POTENTIAL IMPACT OF PROPOSED INTERVENTIONS

A. Erosion Rate Benefits of the Program

Two land use types -- dryland cultivation and overgrazed open forest -- would be the major erosion control beneficiaries of a watershed conservation program. It is estimated that in the long term (10 to 20 years), erosion rates on dryland cultivation would be reduced from 40 to 20 metric tons per hectare per year and on overgrazed pasture from 25 to 15 metric tons per hectare per year. If all of the dryland cultivation area -- estimated at 161,500 hectares upstream from the reservoirs -- were eventually treated, about 3.2 million metric tons of soil per year could be saved from individual farms. If all of the overgrazed open forest -- estimated at 351,500 hectares upstream from the reservoirs -- were eventually treated, about 3.5 million metric tons of soil per year could be saved. Since the on-site soil loss without the program was estimated at about 18.8 million metric tons per year, the 6.7 million metric tons per year amounts to about a 36 percent reduction.

B. Reservoir Sedimentation Benefits of the Program

The annual erosion savings estimated at 6.7 million metric tons can be converted to cubic meters by dividing by the assumed density of reservoir sediment (1.3 metric tons per cubic meter) to arrive at an estimate of 5.2 cubic meters. This figure must then be multiplied by the sediment delivery ratio (estimated at 0.3) to calculate the savings in reservoir sedimentation --i.e. 1.55 million cubic meters per year.

To calculate years of extended life through watershed conservation, this amount must be apportioned among the three watersheds on the basis of watershed area -- i.e. 1.04 million cubic meters for the El Abid reservoir, 0.24 million cubic meters for the Tessaout, and 0.27 million cubic meters for the Lakhdar. Therefore, the proposed program would cut annual sedimentation by these amounts for the three watersheds from 3.4 million to 2.36 million cubic meters the El Abid reservoir, from 0.59 to 0.35 million cubic meters for the Tessaout, and from 0.84 to 0.57 million cubic meters for the Lakhdar.

With the assumption that the conservation program would not have a measurable impact on soil erosion until the year 2000, present sedimentation rates are assumed for the next ten years. After that, the lower sedimentation rates are assumed for the calculation of extended years of reservoir life. Calculations show that the life of Bin El Ouidane reservoir in the El Abid watershed would be extended from the present 399 years to 571 years, Moulay Youssef reservoir in the Tessaout watershed from the present 316 years to 531 years, and Hassan I reservoir in the Lakhdar watershed from the present 318 years to 468 years. To summarize, the life of Bin El Ouidane reservoir would be extended by 172 years, Moulay Youssef by 215 years and Hassan I by 150 years.

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C. Increased Production from Improved Vegetative Cover

1. Wood Production

Current rates of wood removals in Azilal Province are on the order of 515,000 cubic meters per year -- or about 10 cubic meters per household -- from a standing forest volume of between 14 and 15 million cubic meters. Annual growth of the forests in the province is slightly less than 234,000 cubic meters per year with about 60 percent of this figure being in green oak associations. If current consumption continues at its present level, all of the forest inventory will be depleted in less than 50 years.

The forest management interventions proposed in this document focus on the green oak forests in the province. Current management practices deal almost exclusively with the dense forest cover types which are clearcut and sold outside the province. The open green oak forests, which are used for grazing land, browse, and fuelwood for local needs are not managed. As a result, their growth is stagnating and the overall area under forest cover is being reduced. Annual growth on these open green oak forests is less than 0.8 cubic meters per hectare per year as compared with 1.5 cubic meters per hectare per year on the dense green oak areas (FAO/World Bank, 1988).

The sustained yield practices proposed with the natural forest management intervention will help to improve the overall productivity of these forests and reduce the total forest area required for present woodfuel demand in the province. Rotational cutting strategies and selective cutting methods including top pruning of trees can help to improve green oak productivity to levels as high as 1.3 cubic meters per hectare per year twelve years following a cutting operation. Maintaining a 10 to 15 year rotation should also keep these forests in a more productive state over the long term.

With less area needed to produce the same -- or additional -- amounts of fuelwood, there will be reduced pressure on other areas. The overall forest cover and residual stand health in the province will improve as a result of these practices. Finally, management on the dense forests is also expected to improve as the Forest Service gains more experience with sylvicultural methods and management planning on the green oak types. It is not unreasonable to expect yields on dense forest areas to improve to 1.8 cubic meters per hectare per year in the medium to long term.

With more active management of the forest resources by local users, it is also expected that a surplus of wood will be available beyond local needs. There are ready markets in the nearby cities of Beni-Mellal and Marrakech where this wood can be sold.

2. Forest Forage

Forests and open range areas in Azilal Province presently provide over 120 million forage units to the local livestock population of about 1 million sheep and goats and 45,000 head of cattle.

The forest grazing land, dominated by green oak, produces about 250 forage units per hectare from herbaceous material and an additional 100 forage units per hectare from green oak foliage. As this forest area dwindles due to land clearing for agriculture and poor tree cutting practices the total forage units available are also decreasing.

The forest management interventions discussed in this report could considerably alleviate this problem. Green oak forests in Spain and Portugal that are managed exclusively for grazing (called Dehesa and Montado systems respectively) have more than doubled forage yields. In the open forests in Azilal Province, management for grazing will add to forage productivity with a 3 to 5 year time frame. The FAO (1987) estimates that, under a managed situation, these open forests have the potential to produce the following:

Type of Forage	Forage Units per Hectare per Year
Understory grasses	350
Tree shoots	350
Branches	60
Total potential	760

With proper management planning by the local user groups and government technical services, short-term reductions in grazing activities could be coordinated with forest cutting to minimize the impact on the beneficiaries. This type of system makes a change from an extensive use to an intensive one which will make an overall positive contribution to the vegetative cover of green oak on the watersheds in the province. Once the methodology is implemented by the local population, the impact on the areas under management can be observed in a relatively short period of time -- i.e. 2 to 4 years.

Without a change in current land use practices, there will also be a higher risk of loss of biodiversity in flora and fauna in the province. In addition, tourism potential is also likely to diminish due to the loss of variety in the natural resource base that exists due to the presence of vegetative cover. These are presently nonquantifiable benefits that the region risks losing without a watershed management project that contains a natural forest management component.

3. Pasture Forage

High altitude pastures in Azilal Province, also a substantial resource for livestock, are being overgrazed. Although most of the area offers only season pasture, the current estimated average forage production is only about 180 forage units per hectare annually -- only enough to support one animal unit. Many areas of the open pasture yield much less. A study in the Central Plateau region of the Middle Atlas (Maroc Développement, 1978) found that the potential on private grazing land could be as high as 11 animal units per hectare.

The grazing land interventions as discussed in this document outline activities that will double

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current pasture productivity with participatory management techniques. Experiences in the Rif and the Oriental regions of the country (Heermans 1990) indicate that a doubling and tripling of forage production can occur in as little as three years under more controlled conditions.

4. Rainfed Agriculture

Traditional cropping systems in Azilal Province produce average yields of wheat and barley of about 700 kilograms per hectare. Areas recently cleared probably produce considerably more but begin to decline within a few years following the clearing operation due to the erosion of the valuable humus layer of the soil. By keeping more of the soil on site, the interventions proposed for this project on rainfed agricultural lands will help increase average yields to about 900 kilograms per hectare.

This yield increase will be achieved through the construction of small stone walls on the contour and other physical structures such as V-microcatchments that serve to harvest more water on the site. These walls and microcatchments will also trap sediments and create more favorable growing conditions for traditional crops uphill from the structures. By increasing yields on presently cleared land, the need to remove more vegetative cover in the forested areas will be reduced, thus keeping intact valuable natural resources that serve to protect the watershed.

Improving and increasing the area planted to fruit and nut trees, primarily almond, is also part of the dryland intervention. Azilal, with its cooler climate, already has a comparative advantage in almond production. Nationally, it is second only to Meknès Province in almond production. Improved methods of almond culture and harvest, proposed as activities for the dryland intervention, could improve yields on trees older than 5 years to about 800 to 1,000 kilograms per hectare, up from the 350 to 700 kilograms per hectare that the province currently averages. This increase will come from improved cultural and harvesting techniques as well as from construction of microcatchments that will improve water infiltration. Although walnuts are also an important commercial species in the region and will be part of the intervention, their slow-growing nature will not allow substantial yield benefits to be realized during the life of the project.

5. Irrigated Land

Increased yields of crops that are grown on small irrigated perimeters in the river bottom lands will also result from interventions planned for this project. Twenty new diversion dams are targeted and once constructed will help improve production from the current 700 to 2,000 kilograms per hectare. This increase will be a direct result of irrigating the land that was previously under rainfed agriculture.

6. Cumulative Production Impact

Annex 1 Table 8 provides a brief summary of the estimated yields of vegetative cover on different land use types with and without the interventions discussed in this document.

Annex 1 Table 8
A Comparison of Estimated Production in Azilal Province
With and Without the Proposed Project Interventions

Intervention	Estimated Annual Yields Without Intervention	Estimated Annual Yields With Intervention
Improved Forest Management		
Fuelwood in Open Forests	0.8 cubic meters per hectare	1.3 cubic meters per hectare
Fuelwood in Dense Forests	1.5 cubic meters per hectare	1.8 cubic meters per hectare
Forage Production	350 forage units per hectare	760 forage units per hectare
Improved Pasture Management		
Forage Production	180 forage units per hectare	360 forage units per hectare
Improved Agricultural Production		
Rainfed Grain Production	700 kilograms per hectare	1,000 kilograms per hectare
Irrigated Grain Production	700 kilograms per hectare	2,000 kilograms per hectare
Almond Production	500 kilograms per hectare	1,000 kilograms per hectare

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ANNEX 1 ATTACHMENT 1

A Matrix of Possible Watershed Management Interventions in Azilal Province by Importance Ranking[1]

Type of Intervention	Soil Conservation	Other Resource Conservation	Cost Effectiveness	Sustain-ability	Overall Ranking
Livestock					
Rotational Grazing					
Exclusion Zones					
Planting Improved Forage					
Planting to Improve the Density of Existing Forage					
Improving Water Points					
Improving Animal Health					
Purchasing Forage					
Improving Production Systems					
Stall Feeding					
Increasing Forage on Local Irrigation					

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Forestry					
Reforestation and Replanting					
Improved Management Planning for:					
Wood Production					
Forest Grazing Land					
Secondary Products					
Soil Protection					
Recreation and Tourism					
Biodiversity					
Wildlife Conservation					
Water Supply					
Water Quality					
Site Rehabilitation					
Improved Harvesting Systems					

Forestry					
Species Improve-ment					
Road Building					
Improved Forestry Planning/ Inventory					
Agriculture					
Cordon en Pierre with Subsidies					
Cordon en Pierre without Subsidies					
Banquette Construction					
Improved Water Harvesting					
Physical Streambank Protection					
Biological Streambank Protection					
Gully/ Ravine Control					

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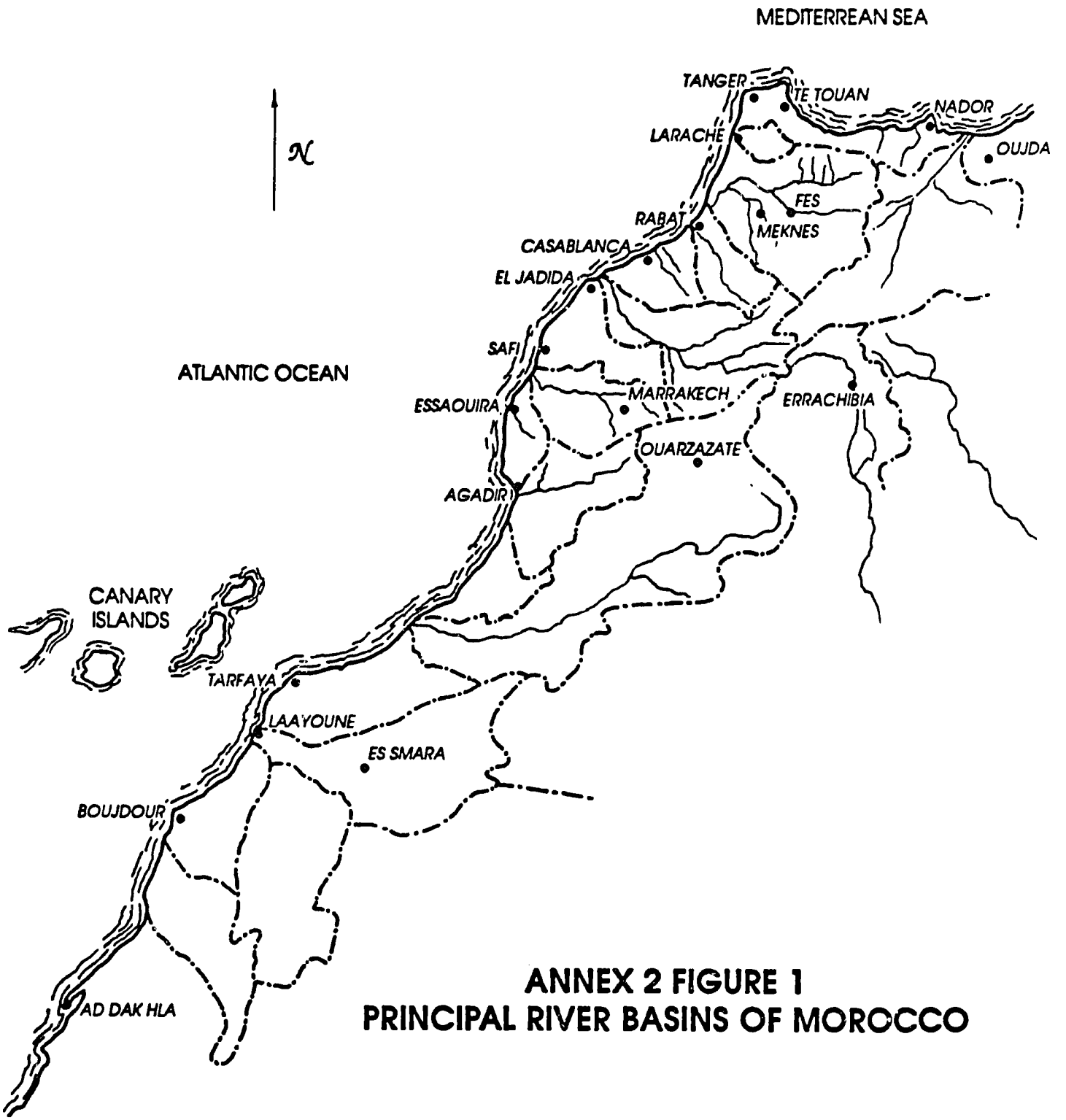
Improved Fruit and Nut Tree Culture					
Use of Chemical Fertilizers					
Improved Information Exchange Systems					

Note: [1] Each type of intervention was given a ranking from 1 to 3, with 1 being the most important.

ANNEX 2

TARGET AREA MAPS



ANNEX 2 FIGURE 1
PRINCIPAL RIVER BASINS OF MOROCCO

SOURCE: Conseil Superieur de l'Eau. (1988). "La Pollution de l'Eau et la Reutilisation des Eaux Usees au Maroc". Conseil Superieur de L'Eau, Rabat, Maroc.

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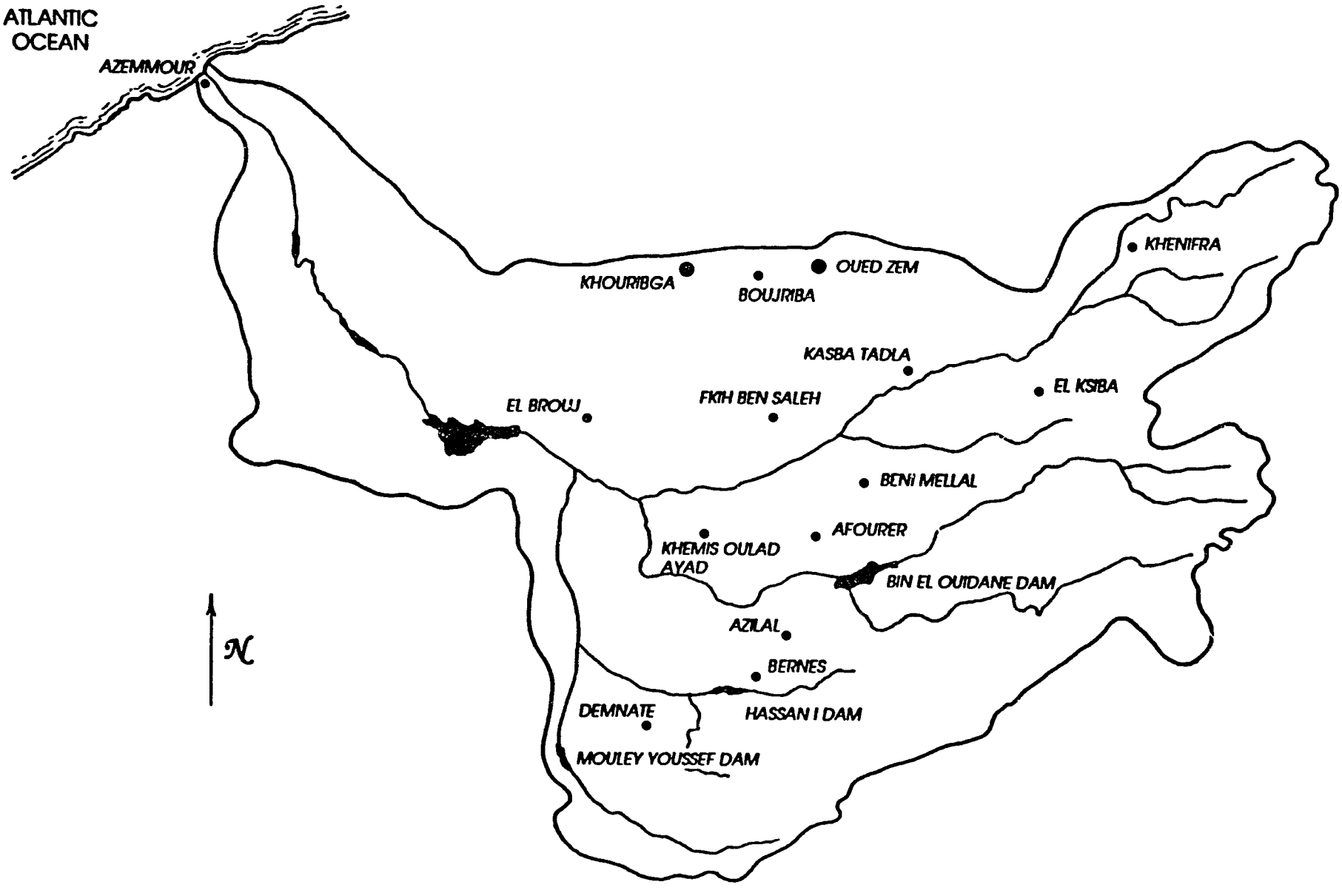
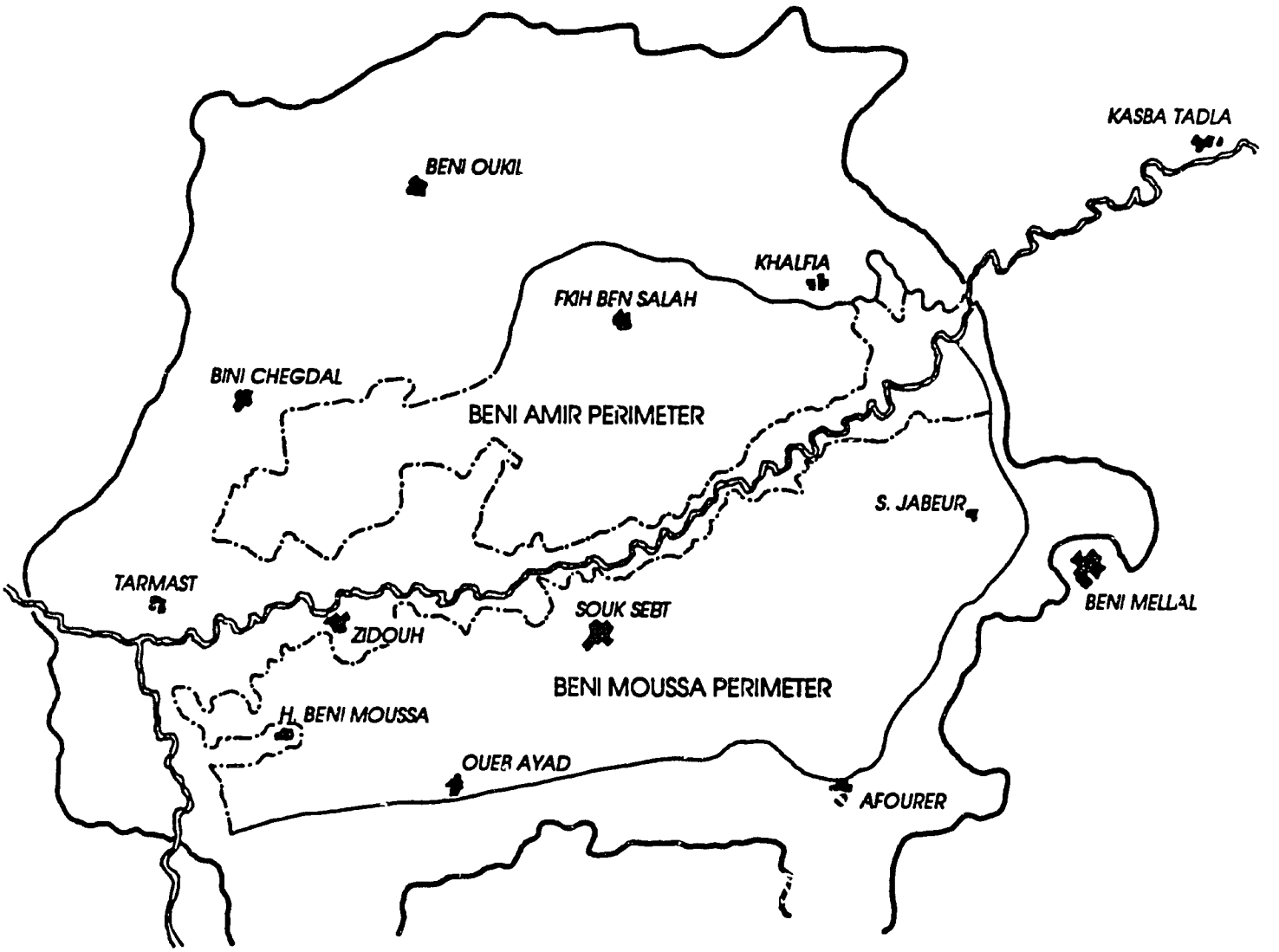


ANNEX 2 FIGURE 2
LOCATION OF THE TADLA PERIMETER WITHIN THE OUM ER RBIA BASIN



ANNEX 2 FIGURE 3
MAP OF THE TADLA PERIMETER SHOWING LOCATION OF IRRIGATED PERIMETERS AND DEVELOPMENT CENTERS WITHIN EACH PERIMETER

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ANNEX 3

BASIC INFORMATION ON THE TADLA PERIMETER

The Tadla plain is situated 200 kilometers southeast of Casablanca along the Oum Er Rbia river at a mean altitude of 400 meters. It covers an area of 3,600 square kilometers. It is bordered on the south and east by the High Atlas mountains and on the north by the Phosphate Plateau.

The ORMVAT zone of activity is situated immediately downstream from the town of Beni Mellal. It is largely within Beni Mellal province, with a small eastern area in Azilal province. This perimeter is shown in Annex 2 Figure 3. The population within the ORMVAT zone of activity was estimated at 424,000 inhabitants in the mid-1980s, with 106,000 urban and 318,000 rural dwellers. The administrative offices of the ORMVAT are located in Fkih Ben Salah in the Beni-Amir sub-perimeter.

The climate is arid to semi-arid, with a dry season from April through October and a winter rainy season from November through March. Mean annual rainfall during this wet season is 350 millimeters. Mean annual temperature is 17 degrees Centigrade, with a maximum in August of 38 degrees Centigrade and a minimum in January of 3.5 degrees Centigrade. Soils in the area are brown isohumic and brown calcareous, with adequate depth and suitable texture for irrigated agriculture.

The Tadla perimeter covers a total area of 320,000 hectares on the plain. Of this, about 300,000 hectares are devoted to agricultural production. Ninety-seven thousand hectares of this total are irrigated under the LSI perimeter scheme, 5,000 hectares are irrigated in small and medium perimeters, and 12,000 hectares are cropped using pumped groundwater. Of the remaining area, 137,500 hectares are cropped under rainfed conditions (en bour in Moroccan terminology), 17,000 hectares are classified as forests, and 28,000 hectares are grazing lands.

The Tadla perimeter is two hydraulically separate sub-perimeters divided by the Oum Er Rbia river. The Beni-Amir sub-perimeter is located on the right bank of the river. It has 27,000 hectares of land irrigated from the Oum Er Rbia river via the Kasba Tadla diversion dam. This dam was constructed in 1929 and is the oldest dam in Morocco. The reservoir supplying the sub-perimeter has an operating storage of about 120,000 cubic meters and provides water through a canal along the left bank of the river which is connected to a smaller regulating reservoir -- 100,000 cubic meters of storage -- at Kasba Zidania about 20 kilometers downstream of the dam. Water discharges from this reservoir through a small hydropower plant into a siphon back under the Oum Er Rbia river and into the sub-perimeter's main canal. It has a maximum capacity of 8 cubic meters per second. The Beni-Amir sub-perimeter is the oldest modern irrigation perimeter in Morocco and was developed between 1938 and 1940.

The second Tadla sub-perimeter -- i.e. Beni-Moussa -- is located on the left bank of the Oum Er Rbia river and covers about 70,000 hectares of irrigated land. It is supplied with water from the Bin El Ouidane dam on the Oued El Abid river in Azilal province. This dam was completed

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in 1954. With a height of 132.5 meters, it was, at the time of its construction, the highest dam in Africa. It has a total storage capacity of 1,500 million cubic meters with a regulated storage of 1,100 million cubic meters. The hydropower plant associated with the dam has a maximum capacity of 135 megawatts, with a mean annual production of 200 million kilowatt-hours.

The Beni-Moussa irrigation works were completed in 1974. Water for the Beni-Moussa sub-perimeter is supplied from a regulating dam at Ait Ouarda immediately downstream of the Bin El Ouidane dam. From this second dam, it passes through a 10.5 kilometer long tunnel to the hydropower plant at Afourer. This second plant has a maximum capacity of 86 megawatts, with a mean annual production of 400 million kilowatt-hours. Water from the hydropower plant at Afourer discharges directly into the two main canals -- i.e. canals "GM" and "D" -- of the sub-perimeter. The upper reach of the GM canal also serves as a regulating reservoir.

The principal hydraulic infrastructure for the two large scale sub-perimeters, in addition to those mentioned above, includes 200 kilometers of main canals, 360 kilometers of primary and secondary canals, and 1,800 kilometers of tertiary canals in addition to many more kilometers of unlined field ditches --- or quaternary canals. Drainage is provided by a network of surface drains totaling 1,700 kilometers in length. Annex 3 Figure 1 schematically illustrates the location and main features of the two large scale irrigation sub-perimeters within the Tadla system.

The principle crops produced in the Tadla perimeter are cotton, sugar beets, hard and soft wheats, alfalfa and bersim clover, vegetables, citrus and olives. Annex 3 Table 1 shows the breakdown of these crops in terms of area planted, average yield per hectare, and percentage contribution to the total national production.

In addition to the crops listed in Annex 3 Table 1, a private firm with international investment has recently introduce contract production of paprika peppers for farmers on about 3,000 hectares of the perimeter. These peppers are processed in a new local facility and are exported to European markets. Roses are also grown in about 100 hectares of plastic greenhouses within the perimeter for export as plants. Finally, minor hectarages of maize and soybeans have been planted in recent years.

Livestock enterprises are important within the Tadla perimeter. There are about 110,000 head of cattle, including 50,000 head of dairy cattle. Annual milk production from dairy cattle is 70,000 metric tons of which 32,000 metric tons marketed commercially. There are about 500,000 head of other livestock in the Tadla perimeter, primarily sheep and goats.

A number of agro-industrial processing facilities are located within or near the Tadla perimeter, as shown in Annex 3 Table 2.

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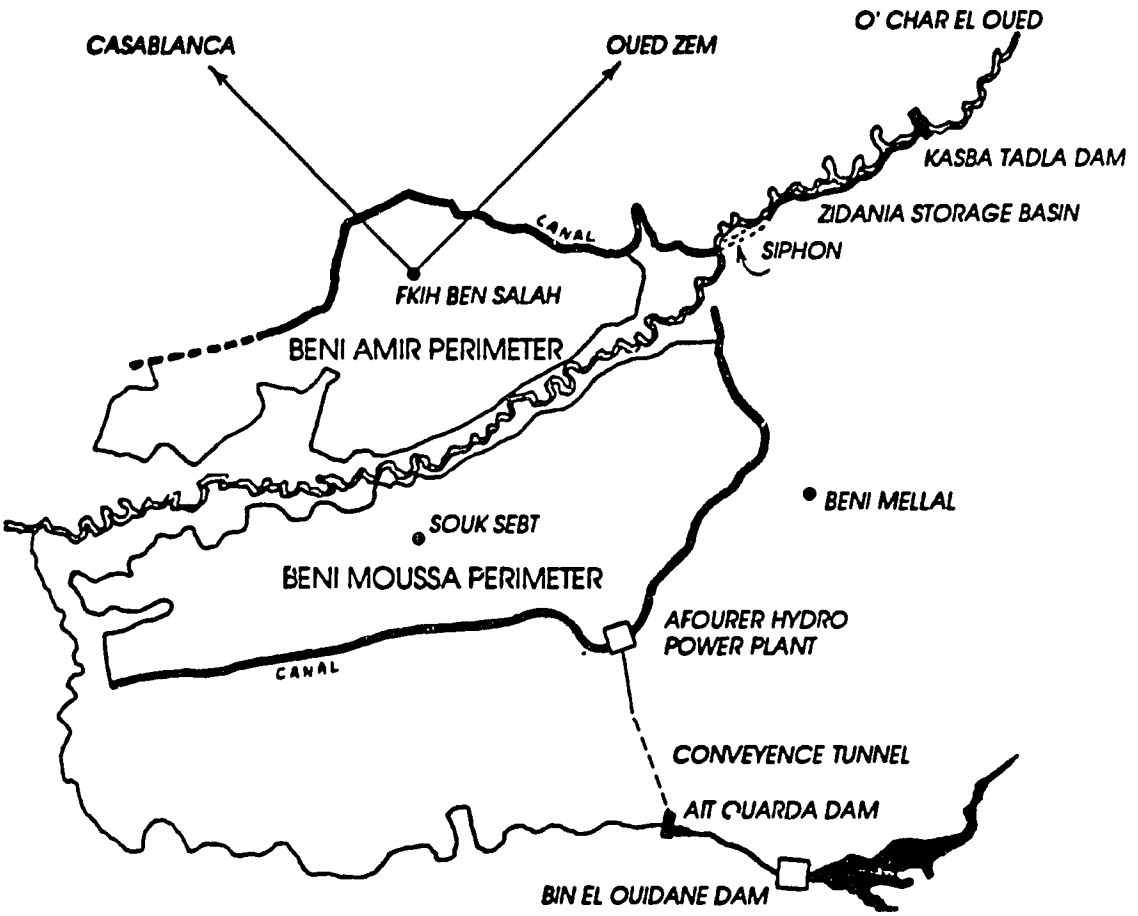

ANNEX 3 FIGURE 1
SCHEMATIC OF THE TADLA PERIMETER AND ASSOCIATED HYDRAULIC WORKS

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ANNEX 3 TABLE 1
Crop Production in the Tadla Perimeter
Area Planted, Average Yields and Percentage of National Production

Crop	Area Planted in Hectares	Average Yield in Metric Tons per Hectare	Percent of National Production
Irrigated Crops:			
Cotton	12,000	1.8	90
Sugar Beets	20,000	53.0	33
Wheat	44,000	4.2	4
Forage Crops	15,000	12.0	15
Vegetables	8,500	22.0	12
Citrus	7,500	18.0	10
Olives	10,000	3.9	11
Total Irrigated Crops	117,000		
Dryland Crops:			
Wheat and Barley	130,000	0.95	
Forage Crops	2.000	3.5	
Total Dryland Crops	132,000		
Total Crops	249,000		

Source: Ministere de l'Agriculture et de la Reforme Agraire. (Undated). Office Regional de Mise en Valeur Agricole du Tadla. MARA, Rabat, Maroc.

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ANNEX 3 TABLE 2
Agro-Industrial Processing Facilities in the Tadla Perimeter

Type of Industry	Number of Plants	Plant Capacity
Sugar Refineries	3	14,400 metric tons per day
Dairy Processing Plant	1	70,000 liters per day
Livestock Feed Mill	1	20,000 metric tons per year
Flour Mill	1	360 metric tons per day
Olive Oil Processors	8	40,000 metric tons per year
Citrus and Other Packing Plants	8	40,000 metric tons per year
Cotton Gins	3	25,000 metric tons per year
Cold Storage Plant	1	2,000 metric tons of storage

Source: Ministere de l'Agriculture et de la Reforme Agraire. (undated). Office Regional de Mise en Valeur Agricole du Tadla. MARA, Rabat, Maroc.

Within the Tadla perimeter, about 85 percent of the land is privately owned, with the remaining 15 percent divided between State and cooperative lands. Farm size varies considerably as does farm ownership. As can be seen from Annex 3 Table 3, 82 percent of the farms in the perimeter have less than 5 hectares of land. These farms comprise 41 percent of the total cultivated area in the perimeter. At the other end of the spectrum, 2 percent of the farms have more than 20 hectares and they cover 27 percent of the total cultivated area.

ANNEX 3 TABLE 3
Distribution of Land Holdings in the Tadla Perimeter

Farm Size in Hectares	Percent of Total Area	Percent of Total Farms
< 5	41	82
5 to 10	20	12
10 to 20	12	4
> 20	27	2
Total	100	100

Source: Ministere de l'Agriculture et de la Reforme Agraire. (undated). Office Regional de Mise en Valeur Agricole du Tadla. MARA, Rabat, Maroc.

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ANNEX 4

LIST OF PERSONS CONTACTED

WORLD BANK

Rory O'Sullivan	EMENA (Europe, Middle East & North Africa)/Chief of the Agricultural Division
Isabel Schirmer	EMENA/Watershed Management Specialist
John Hall	EMENA/Livestock Specialist
Sikander Rahim	EMENA/Acting Division Chief and Country Economist
Jean-Pierre Villaret	Senior Irrigation Engineer (Contacted in Rabat)
Jaques Coudol	PERL Task Manager

AID/WASHINGTON

Don Masters	ENE Bureau
Mike Crosswell	APRE/DP

USAID/RABAT

Dennis Chandler	Mission Director
Linda Morse	Deputy Mission Director
Jim Lowenthal	Agricultural Development Officer (ADO)
John Schamper	Deputy Agricultural Development Officer
Eric Loken	Environmental Project Officer
Fenton Sands	Agricultural Economist
Mark Krackiewicz	Program Economist
M'Hamed Hanafi	Program Specialist
R. Scott	Program Officer

MINISTRY OF AGRICULTURE AND AGRARIAN REFORM

Othman Demnati	Minister
Oualid Cherif	Head of the Direction de l'Equipement Rural (DER)
Taib Benchekroun	Head of the DER Experimentation Service
M. Youcubi	PAGI Coordinator
A. Karmouni	Head of the Department of Water and Forests
L. Hissem	Department of Water and Forests
M. Omerani	Chief of Reforestation Service
M. Askarn	Chief of Soil Conservation Service

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ORMVAT (Office Regional de Mise en Valeur Agricole du Tadla)

M. Boubia	Director
M. Mikoi	Deputy Director and Head of the Livestock Production Division
M. Ikama	Head of the Equipment Division Head of the Operations and Maintenance Division
M. Antaqe	Head of the Irrigation and Drainage Management Division Head of the Planning and Programming Division

ORMVAH (Office Regional de Mise en Valeur Agricole du Haouz)

M. El Hallaini	Head of the Management Division

Provincial Directorate of Agriculture in Azilal

A. Ahizoune	Provincial Director of Agriculture
M. El Moatamid	Chief of Provincial Agricultural Service
M. Bouri	Chief of Provincial Water and Forests Service
M. Chakdi	Chief of Provincial Livestock Service
M. Bouam	Chief of Provincial Rural Equipment Service

FAO

Mr. Seminario	Watershed Management Advisor to the Water and Forests Directorate

Agro-Concepts

H. Benabderrazak	Director of World Bank Study of Watershed Management in Morocco
O. Aloui	Economist, World Bank Study of Watershed Management in Morocco

Catholic Relief Services

M. Wiest	Country Representative
H.S. Roberts	Assistant Representative

OTHERS

John Heermans	Consultant in Forestry and Natural Resource Management/World Food Programme
N.S. Peabody III	Program Office, Winrock International (Formerly USAID/ANE/TR/ARD)
Abdelaziz Merzouk	Professor of Soils at Hassan II Institute of Agronomy and Veterinary Medicine (IAV)

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ANNEX 5

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