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MOROCCO WATERSHED PROTECTION AND MANAGEMENT

FINAL REPORT



January 2005

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MOROCCO WATERSHED PROTECTION AND MANAGEMENT PROJECT

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The author's views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

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ACRONYMS

ADPN	Agency for the Development of Northern Provinces
ADS	Agence de Développement Social
CT	Centre de Travaux de Ben Karrich
DPA	Provincial Directorate of Agriculture
DREF	Ministry of Water and Forests
DRH	Regional Directorate of Hydraulics
EAU	Environmental Alternatives Unlimited
EIA	Environmental Impact Assessment
FODEP	German Fund for Pollution Prevention and Control
GIS	Geographic Information System
ONEP	National Potable Water Agency
ORMVA	Regional Offices for Agricultural Development
RAMSA	Agadir Water Utility
RBA	River Basin Agency
USAID	United States Agency for International Development
WPM	Watershed Protection and Management
WRS	Water Resources Sustainability
WUA	Water Users Association

Executive Summary

The Morocco Watershed Protection and Management (WPM) project was developed to contribute to USAID/Morocco's strategic objective 6 (SO6) to improve water resources management in the Souss-Massa River Basin by promoting the efficient and sustainable use of forest, soil, and water resources in the Souss-Massa and Nakhla watersheds. The project had two specific objectives that will further the sustainable management of renewable natural resources in the Nakhla and Souss-Massa watersheds:

1. In the Nakhla watershed, the objective was to expand the successful Water Resources Sustainability (WRS) pilot project's agroforestry and soil erosion control activities to the entire watershed, thereby reducing the siltation of the Nakhla reservoir and prolonging its useful life.
2. In the Souss-Massa watershed, the objective was to identify, design, and implement new watershed protection activities to control soil erosion, reduce the spread of desertification, and protect water quality.

Accomplishing these objectives will improve management of the two watersheds and ensure sustainable, clean water flow for potable water, agricultural production, and economic development. In addition, achievement of the objectives will strengthen human and institutional capacity for natural resource management and help empower local communes and the private sector to participate in environmentally sound economic development activities.

The WPM project begins where the Morocco Water Resources Sustainability (WRS) project ended. The WRS project was designed to improve water resources management in the agricultural, industrial, and urban sectors through the implementation of pilot projects. From 1996 to 2002, WRS implemented three such projects: a wastewater treatment and reuse project in Drarga, near Agadir; a chromium recycling plant in Fes; and a soil erosion control and watershed management project in Nakhla in northern Morocco

These projects paved the way for WPM by demonstrating best practices, testing innovative methodologies, and teaching project implementers important lessons. Using what we had learned over the course of the project, the WRS team prepared a dissemination strategy to facilitate the implementation of future projects in the areas of wastewater treatment and reuse, industrial pollution prevention and control, and integrated water management. The success of WRS led USAID to develop the WPM project to begin that dissemination process.

Other fundamental features of WPM were to foster ownership of activities by Moroccan institutions and to demonstrate that it is possible to replicate best practices in water management relying primarily on local resources. Therefore, the WPM project was funded mostly in local currency, depended predominantly on local consultants, and advocated partnerships with local institutions to implement the project's various activities.

Project Methodology

The basic methodology for WPM was based on the pillars developed under WRS:

1. ***Use of the participatory approach*** to involve communities and beneficiaries from the beginning of the project.
2. ***Implementation of appropriate technologies*** adapted to and best suited for local conditions.
3. ***Broad institutional partnerships*** that involve all institutions that can contribute to and benefit from the project. Seal the partnership through a negotiated collective agreement specifying roles and responsibilities.

At the start of the project, we benefited from the relationships and partnerships we had cultivated throughout the WRS project. Not only were we well-acquainted with a tested pool of local consultants who had honed their skills under WRS, but also we had established relationships with Moroccan institutions at the national and local levels including: the Ministry of Environment, the Ministry of Agriculture, the Directorate of Hydraulics, the Ministry of Water and Forests (DREF), the National Potable Water Agency (ONEP), the Agency for the Development of Northern Morocco (Agence du Nord), the Wilaya of Tetouan, the Wilaya of Agadir, and the Souss-Massa River Basin Agency.

Because of our previous work on WRS, we also had at our disposal proven methodologies to implement watershed management projects successfully; examples of successful pilot projects to serve as models for new activities; established dissemination and marketing strategies; and the lessons learned from WRS to emulate successful practices and avoid mistakes.

In addition, we benefited from the experience of the project management team who had served under the WRS project. Their institutional knowledge and relationships with project partners ensured the development of strong partnerships, the leveraging of project funds, and the rapid implementation of project activities within a limited timeframe. Thus, the project methodology was focused, pragmatic, and results-oriented.

Results and Impact

Under the WPM project, we undertook four different activities: reducing soil erosion in the Nakhla watershed; wastewater treatment and reuse in Sidi Bibi; reducing industrial pollution at the COPAG dairy in Taroudant; and integrated watershed development in Abdelmoumen.

Reducing Soil Erosion in the Nakhla Watershed

In Nakhla we carried out both direct and indirect interventions to reduce soil erosion in the watershed. Over the course of the project, we planted thousands of almond, olive, and fruit trees

benefiting nearly 2,000 residents of the watershed. In the forested areas, we parceled 255 ha of land according to ownership and planted it with fruit, almond, and olive trees, whose root systems will help to retain the soil.

Besides planting trees, our team installed rock barriers on 10 ha and grass strips and vines on an additional 40 ha of land to further prevent erosion. We also trained farmers in more efficient plowing methods that will lead to the retention of topsoil, which allows for better crop production levels in the watershed. We built 3,800 m³ of gabions and planted acacia, eucalyptus, and carob along 5.36 km of ravines. These soil conservation measures prevent topsoil from being carried away towards the dam after heavy rainfalls, and prevent the expansion of existing ravines and the creation of new ones.

In addition, the project has built 13 water reservoirs with a storage capacity of 10 m³ each at sites of natural springs that run during the rainy season, allowing access to water in these areas during the dry season. We rehabilitated 9.2 km of irrigation canals. Thus, water is retained in the watershed for irrigating crops and young trees and water losses are reduced.

The WPM project team and our partners introduced several activities that had the dual purpose of generating income for the residents of the watershed while indirectly curtailing the rate of soil erosion. The activities included development of cuniculture or rabbit production, modernization of apiculture or beekeeping, the introduction of modern cookstoves. We also provided extensive training for project beneficiaries in these areas.

The impact of the project in the Nakhla watershed has been tremendous in terms of both the reduction in soil erosion and the improvements in the daily lives of the project beneficiaries. Adoption of sustainable natural resources management and agricultural practices will protect the area's natural resources through reduction of soil loss and protection of natural resources, and will also provide sustainable income to the local population. Due to the success of WPM's income-generating activities there are new opportunities for productive employment, and men who had long ago left the region in search of work are returning to their homes and their families.

Furthermore, we have planted the seeds of sustainability throughout the project to make sure that its benefits continue into the future. Participation by Moroccan partners and project beneficiaries themselves has allowed for a transfer of knowledge and methodologies that can continue long after the project has ended.

Residents of the area are more hopeful about their future and have seen production increase after previous years of steady decline and are now confident in their ability to change their own conditions. New opportunities have reduced emigration and will provide a better future for watershed residents.

Wastewater Treatment and Reuse in Sidi Bibi

With our partners, we implemented an effective wastewater collection system, consisting of a treatment plant and a piping network, for the villages of Kherba, Oulad Mimoun, and Swalem. The WPM team also devised plans to reuse the treated wastewater and the residual sludge that inevitably results from treatment. Treated wastewater will be used to irrigate crops, and the sludge will be used for composting.

The wastewater treatment plant will significantly reduce risks to human health and the environment from raw wastewater discharges. In addition, the plant will be financially self-sustaining and is expected to save farmers 17 m³ of water per day. The economic benefits of wastewater reuse will include water savings of 2,250 dirhams per hectare per year, and fertilizer savings of 2,580 dirhams per hectare per year.

The more enduring impact of the project is a renewed sense of hope and optimism for the future among the people living in the villages served by the project. With the potential threats to the water supply eased and with a cleaner and safer environment, the people of Sidi Bibi are poised to take advantage of the region's economic opportunities in tourism, agriculture, and manufacturing.

Reducing Industrial Pollution at the COPAG Dairy

The WPM team identified the COPAG dairy in Taroudant in the Souss-Massa region as the ideal partner for replicating the WRS project's successful industrial pollution prevention and control component. Not only did the dairy have a pressing wastewater problem to resolve, but it also had a dynamic management team interested in solving the problem and willing to put up some money to help. It has an excellent technical staff and corporate culture, and it is willing to serve as an example for others to follow.

The WPM team conducted a feasibility study to determine how the plant used water, which processes generated wastewater, and how much wastewater was sent to the settling ponds. We then identified opportunities for recycling and saving water.

Water conservation at COPAG is already underway. Workers at the dairy implemented process changes that include recycling water used for cooling and cleaning equipment; collecting and reusing condensate water; and optimizing water use in the production of orange juice. These changes save approximately 25,500 m³ of water per year, resulting in monetary savings of about \$20,400 per year.

Though these savings are modest, the biggest impact of WPM's partnership with COPAG will be seen after the wastewater treatment plant has been built. The completion of the wastewater treatment plant will bring about significant changes ranging from the elimination of health risks posed by the settling ponds to the population in the surrounding area to even greater water savings for the plant.

Integrated Watershed Development in Abdelmoumen

In Abdelmoumen we conducted several activities to reduce soil loss, increase economic opportunities, improve the resource base of the watershed, and make more efficient use of existing resources, including water. Because these goals closely resemble those of the previous WRS project in Nakhla, the team has been able to effectively build upon and adapt the best practices of integrated watershed management activities in Nakhla in order to improve water resources management in the Souss-Massa river basin in southern Morocco.

We collaborated with a private contractor to rehabilitate about 1,000 m of irrigation canals in the watershed. The project has resulted in substantial social and health benefits, and according to ORMVA-SM, the efficiency rate of harnessing mountain spring runoff water has increased from 40 percent to 95 percent. The irrigated surface area served by these improved canals has risen from 50 ha to 380 ha, allowing supplemental production of potatoes, onions, tomatoes, and other produce. Estimates for the income-generating potential of this new farmland are approximately 517,500 dirhams per 50 hectares.

In the forestland of the watershed, the WPM team replanted a total of 4,737 argan trees in the watershed forestland along contour lines, with stone strips along the lines and cuvettes around the trees to trap sediments and collect water. We installed small catchments around 2,400 older, naturally grown argan trees as a water harvesting technique to be introduced in the area. We also fenced off 250 ha of forestland to prevent goats from grazing and make natural regeneration of argan trees possible. The project has also introduced prickly pear cactus, caper plants, and carob trees into the area to protect the soil from erosion and eventually provide income to farmers in the watershed.

The WPM project was instrumental in starting an argan oil extraction cooperative for women in the region. The project even constructed a new building where cooperative members can meet, work, and sell their product, which eliminates their need to sell their products through brokers. In addition, the project team created four beekeeping associations and distributed a total of 400 modern beehives to the new groups. Some of the honey they produce is sold and consumed locally, but many of the beekeepers plan to market their goods at the women's argan cooperative, to tourists who pass through the area.

The project also distributed 22 improved cookstoves throughout the area. Women who use the ovens praise their fuel efficiency, which not only lessens the environmental strain of cutting firewood but also drastically reduces the time the women spend collecting firewood.

Just as the goals and methodologies of the activities in Abdelmoumen mirrored those of Nakhla, so did the impact of the project. Because the project was based on partnership with various local institutions and a participative approach with project beneficiaries, its positive effects are likely to continue. By involving the local community from the start, the project team succeeded in transferring technical knowledge and giving them greater responsibility for the outcome.

In addition to introducing the community to improved livestock management, modernized apiculture methods, and marketing methods, the project team also sensitized the population to the importance of safeguarding natural resources. The impact of the project is visible in the watershed. Incomes have increased from the production of argan oil, essential oils, and improved goat herding. The rehabilitated canals have provided more water to the villages, and reduced conflicts between upstream and downstream villages. The expansion of the argan tree forest will ensure an expansion of the resource base and its sustainable management. The introduction of cookstoves has slowed the cutting of firewood and provided women with more time to engage in productive activities. The plantation of fruit trees in irrigated areas will provide additional resources.

As a result of WPM, the landscape has changed in the watershed above the Abdelmoumen dam. The project has left behind strong community associations and institutional partners to deepen this change; and the expressions of hope from the men, women and children of the watershed are a testimony to WPM's enduring legacy.

Lessons Learned

Replication is a lot easier when building on the successes and applying the lessons learned from a previous project (WRS). While WRS pioneered pilot projects in water resources management in Morocco, WPM benefited from and built on the successes and lessons learned from WRS.

Institutional partnerships take time and energy to develop, but are essential for project success. The WPM experience reinforced a key lesson we had learned in WRS: forging institutional partnerships is not easy, but it is crucial to project success.

Involvement of key local decision-makers is essential. Strong support from local leaders can ensure local participation, help the project team settle disputes, and keep the project moving under tight deadlines.

Negotiating collective agreements before starting implementation is crucial. As we did in WRS, we expended a lot of time and effort in WPM to negotiate collective agreements in which the roles and responsibilities of each project partner were spelled out clearly.

Give partner institutions a key role and value their inputs. It is very important to value and use the input of partner institutions.

Identify and rely on local champions. Every project needs a local champion to ensure its success. Champions are usually community leaders who are well respected, able to secure a consensus, and trusted to make sound judgments for the benefit of the community, and the involvement of these community champions made it easier to attract financing partners and to speed up implementation activities.

Trust and empower local partners to carry on the work. Using local partners enhanced our ability to deliver results and freed our consultants for other activities. By empowering local partners, the WPM project saved both time and money.

Document project methodologies. One of the most successful initiatives we undertook under WPM was the preparation and publication of methodological guides for the three types of pilot projects undertaken under WRS and WPM. The methodological guides have been very popular and are now used by Moroccan institutions interested in replicating and expanding projects similar to those implemented under WRS and WPM.

Identify opportunities for internal study tours. Projects often organize overseas study tours. While these tours are often valuable, organizing internal study tours would be an inexpensive and potentially very beneficial alternative in which beneficiaries from different regions can interact directly with one another, share experiences and lessons, and come away with new ideas.

Let project partners take the credit. During the WPM close-out ceremonies, project partners and beneficiaries conducted most of the presentations about the project. Their presentations about the work they performed demonstrated ownership by the partner institutions and showed their commitment to continue supporting project activities after the departure of the technical assistance team.

Leverage resources through financial partnerships. In all WPM activities, we sought financial contributions from national institutions and local partners. The key is to identify converging interests in a project and to convince potential partners that they can benefit from being associated with a project that furthers their own goals and is consistent with their mandate.

Conclusion

The WPM project demonstrates that significant results can be achieved with limited resources using an approach that (1) involves beneficiaries from the start, (2) leverages project funds through partnerships, (3) relies on local talent, and (4) applies lessons learned and best practices from previous activities. The lasting impact of WPM will be due to the trained Moroccan talent that can carry the torch of sustainable water and watershed management by applying sound methodologies, participative approaches, and the efficient use of financial resources. The partners and beneficiaries that have participated in the project are the best ambassadors for the further expansion of best practices in water management throughout Morocco. The challenge of sustainability has been met, and we are hopeful that, largely due to the assistance of USAID, Moroccans will be able to better preserve and managed their scarce water resources for a promising future.

Section 1

Introduction

This report presents the activities and achievements of the Morocco Watershed Protection and Management project (WPM) from October 2001 to September 2004. As WPM ends, we take stock of what we set out to do, what we did, how we did it, what we learned in the process, and what the lasting impacts of the project will be. Throughout the report, we feature project beneficiaries, partners, community champions, consultants, and members of the project team. While WPM's objectives were to reduce soil erosion, improve water quality, reduce pollution, and improve watershed management, ultimately this project, as any development project, is about improving people's lives. That is why this report focuses on not only results (e.g., how many olive trees were planted), but outcomes (how will productive olive trees change the lives of farmers and their families).

Background

In Morocco, increasing water scarcity impedes economic growth. While Morocco has made great strides in mobilizing water resources, a growing population, recurring drought episodes, pollution, and over-extraction of aquifers compromise the sustainability of water resources. Water is unevenly distributed, and the effects of its management are felt everywhere.



The varied landscapes of Morocco

In the north, mountainous terrain and heavy rainfall cause severe soil erosion, resulting in the siltation of important dams. The Nakhla Dam in northern Morocco has lost 45 percent of its

capacity and was identified by the Moroccan Ministry of Water and Forests as one of twenty priority dams for intervention to reduce siltation.

In the south, aquifer depletion, pollution, and drought threaten the future of a vibrant economic region. These multiple threats to sustainable water management are evident in the Souss-Massa region. The watershed above the Abdelmoumen dam, north of Agadir, is plagued by low rainfall, poor water retention, and inefficient agricultural practices. In the Commune of Sidi Bibi, water supply systems for small towns, built through community funds, are threatened by the contamination of the aquifer by raw wastewater discharges. Near the city of Taroudant, the rapidly expanding COPAG dairy is discharging daily large quantities of contaminated wastewater, threatening precarious environmental resources. All these issues were addressed by WPM.

Project objectives

When we started out, USAID Morocco laid out two objectives for the WPM project:

1. In the Nakhla watershed, the objective is to expand the successful Water Resources Sustainability (WRS) pilot project's agroforestry and soil erosion control activities to the entire watershed, thereby reducing the siltation of the Nakhla reservoir and prolonging its useful life.
2. In the Souss-Massa watershed, the objective is to identify, design, and implement new watershed protection activities to control soil erosion, reduce the spread of desertification, and protect water quality

WPM at a Glance	
Timing:	October 2001 – September 2004
Budget:	US \$910,710 MAD 21,000,000
Staff:	5 full-time staff and 14 consultants (all Moroccan)
Main partner:	Moroccan Ministry of Environment

Accomplishing these objectives will improve management of the two watersheds and ensure sustainable, clean water flow for potable water, agricultural production, and economic development. In addition, achievement of the objectives will strengthen human and institutional capacity for natural resource management and help empower local communes and the private sector to participate in environmentally sound economic development activities.

The Legacy of WRS

The WPM project begins where the Morocco Water Resources Sustainability (WRS) project ends. In the early 1990s, USAID made improved water resources management one of the cornerstones of its program. The WRS project was designed to improve water resources management in the agricultural, industrial, and urban sectors, notably through the implementation of pilot projects. From 1996 to 2002, WRS implemented three such projects:

- A wastewater treatment and reuse project in Drarga, near Agadir
- A chromium recycling plant in Fes

- A soil erosion control and watershed management project in Nakhla in northern Morocco



Water management prevents soil erosion

These projects paved the way for WPM by demonstrating best practices, testing innovative methodologies, and drawing important lessons. Using what we had learned over the course of the project, the WRS team prepared a dissemination strategy to facilitate the implementation of future projects in the areas of wastewater treatment and reuse, industrial pollution prevention and control, and integrated water management.

The WRS dissemination strategy included the following elements:

- Development of tools and methodological guides for similar projects
- WRS project beneficiaries become ambassadors for new activities
- Proven technologies and best practices serve as models
- Demonstration of the financial viability of projects
- Partner institutions actively engage in dissemination
- Identification of potential dissemination targets

All these factors became an integral part of the WPM work planning process.

The success of WRS led USAID to develop the WPM project to begin that dissemination process. Furthermore, a key feature of WPM was to foster ownership of activities by Moroccan institutions and to demonstrate that the replication of best practices in water management were possible relying primarily on local resources. Therefore, the WPM project was funded mostly in local currency, depended predominantly on local consultants, and advocated partnerships with local institutions to implement the project's various activities.

Project Methodology

The basic methodology for WPM was based on the pillars developed under WRS:

1. **Use of the participatory approach.** Involve communities and beneficiaries from the beginning of the project.
2. **Implementation of appropriate technologies.** Implement technical solutions adapted to and suited for local conditions.
3. **Broad institutional partnerships.** Involve all institutions that can contribute to and benefit from the project. Seal the partnership through a negotiated collective agreement specifying roles and responsibilities.

At the start of the project, we benefited from the relationships and partnerships we had cultivated throughout the WRS project. Not only were we well-acquainted with a tested pool of local consultants who had honed their skills under WRS, but also we had established relationships with Moroccan institutions at the national and local levels including: the Ministry of Environment, the Ministry of Agriculture, the Directorate of Hydraulics, the Ministry of Water and Forests (DREF), the National Potable Water Agency (ONEP), the Agency for the Development of Northern Morocco (Agence du Nord), the Wilaya of Tetouan, the Wilaya of Agadir, and the Souss-Massa River Basin Agency.



Involvement of beneficiaries

The WPM project also benefited from the features established under WRS to enhance and ensure that the project's results were sustainable. Because of our previous work on WRS, we had at our disposal proven methodologies to implement watershed management projects successfully; examples of successful pilot projects to serve as models for new activities; established dissemination and marketing strategies; and the lessons learned from WRS to emulate successful practices and avoid mistakes.

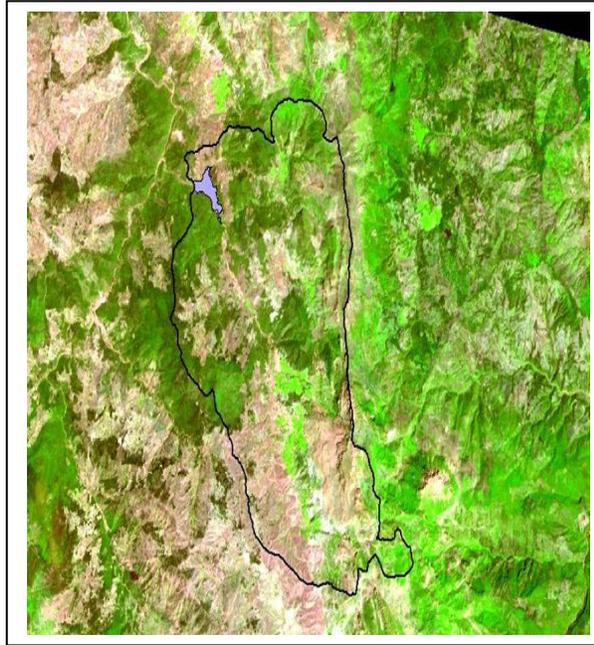
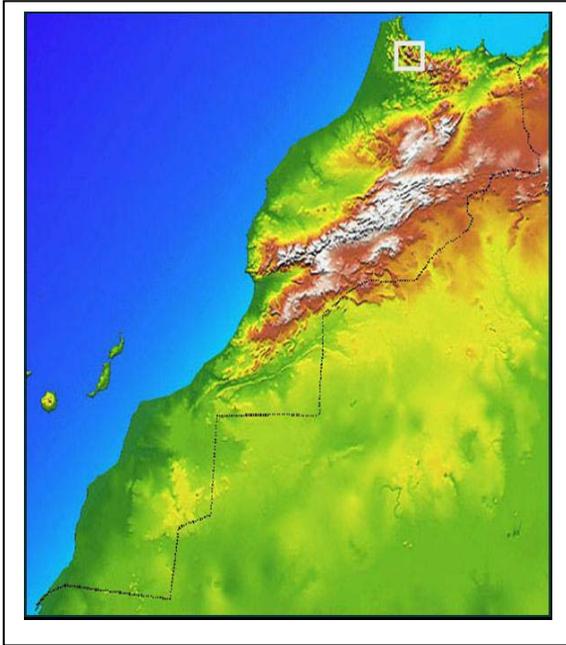
In addition, we benefited from the experience of the project management team who had served under the WRS project. Their institutional knowledge and relationships with project partners ensured the development of strong partnerships, the leveraging of project funds, and the rapid implementation of project activities within a limited timeframe. Thus, the project methodology was focused, pragmatic, and results-oriented.

The sections which follow describe what the project did, how we did it, and the results of our activities. Beyond these results is a project philosophy based on partnership and fostering sustainability. In every activity, we leveraged project funds with those of institutional and community partners; the project was implemented with an all Moroccan staff; and at the closing ceremony on September 24, 2004, it was clear that the partners have ownership of these activities, which bodes well for the sustainability of these actions.

Section 2

Reducing soil erosion in the Nakhla Watershed

The Nakhla watershed has an estimated population of 8,000 inhabitants that centers around a series of villages associated with springs. Irrigated areas on terraces around the villages account for 10 percent of the total agricultural area where farmers cultivate olive, fig, pear, and orange trees among others. Rain-fed crops like wheat, barley, and maize make up a large portion of the watershed's cultivated area, but because the small size of landholdings, the productivity of the land is very low. The average yield for major crops is generally well below the national average.



The Nakhla watershed

Livestock production, however, plays an important role in the economy of the watershed and provides a major source of revenue for farmers. The animals kept in the watershed primarily include goats, sheep, and cows, with goats being the most prevalent.

The Nakhla watershed's physical characteristics, including steep slopes and relatively high rainfall, foster soil erosion and contribute to the siltation of the Nakhla Dam. Built in the early 1960s, the dam has already lost 40 percent of its reservoir capacity. For these reasons, the Moroccan government has made Nakhla a priority watershed requiring immediate action.

Main characteristics of the Nakhla watershed

- Size: 116 m²
- Elevation: 200 to 1800 m
- Climate: sub-humid (precipitation: 800 mm/yr)
- Dam:
 - Initial capacity – 9 million m³
 - Current capacity – 4.8 million m³
- Average erosion rate : 62 tons/ha/yr

Beginning in 1996, the WRS project team realized that the Nakhla watershed was an ideal location to implement pilot projects to help reduce soil loss and contribute to sustainable water resources management. The project's activities included planting trees, stabilizing ravines, and completing a variety of direct and indirect actions designed to raise the income of the farmers in the watershed. In addition, the team helped create village committees and a woman's cooperative and provided training to farmers on improved agro-forestry and soil conservation techniques.

The challenge

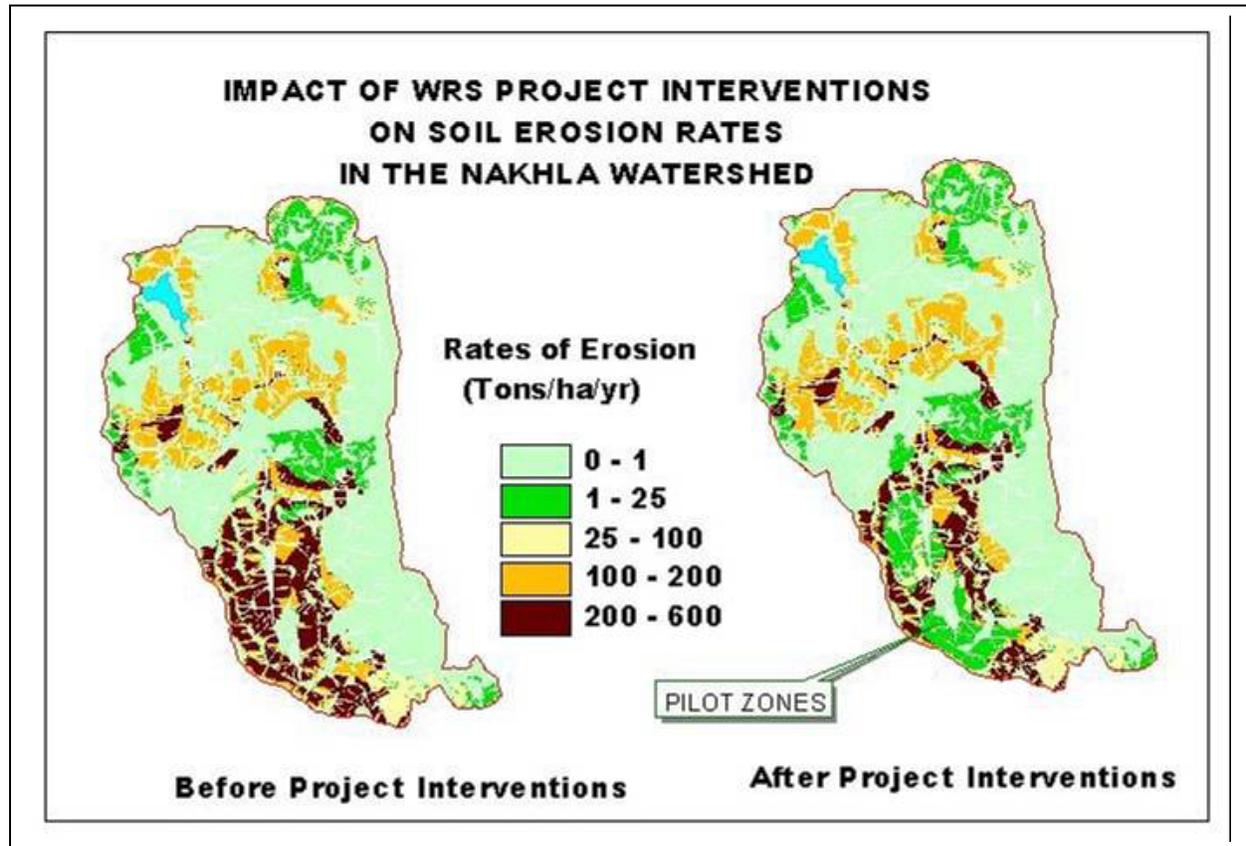
The WPM project had the challenging task of expanding and disseminating the success of the soil erosion control activities in the Nakhla watershed conducted under its highly successful predecessor, the WRS project. Through the actions of the WRS project in four selected pilot zones located southwest of the watershed, we expect to reduce the rate of soil erosion in the watershed by 20.7 percent.



The Nakhla reservoir

However, we knew that we could further reduce soil loss by extending activities to other areas of the watershed and by consolidating the results obtained from current activities. The GIS modeling study developed for the Nakhla pilot project showed that with the extension of the

WRS activities to the entire watershed, the rate of soil erosion will be reduced to 6.9 tons/hectare/year, which represents a reduction of 90% from the initial rate. This will have a significant impact in prolonging the useful life of the Nakhla dam and increasing the storage of water resources. WPM's activities were a continuation of work started under WRS, focusing on soil erosion control and integrated watershed development activities.



Reduction of soil erosion rate in watershed area

The methodology

Our specific objectives under WPM were to reduce soil degradation and preserve vegetative cover, strengthening our partnerships, improving public participation and local institutions, and increasing incomes to improve the quality of life of the watershed's residents.

As a first step in the process, we expanded the strong partnerships we had forged with our partners under WRS, notably the Direction Provinciale de l'Agriculture de Tetouan (DPA) and its affiliate the Centre de Travaux de Ben Karrich (CT); the Agency for the Development of Northern Morocco (Agence du Nord), and the Direction Régionale des Eaux et Forêts du Rif (DREF-Rif), and Loukkos River Basin Agency.

We specifically created an expanded role for DREF, giving them responsibility for seeding ravines for biological stabilization, protecting forest areas, and supervising the implementation of improved cookstoves. The DPA, which had been our primary partner under WRS, also took on increased responsibilities under WPM, carrying out many of the tasks that had been performed by WRS consultants such as creating village committees, supervising the distribution of trees, working with herders on improved goat management, and training farmers on tilling techniques, fertilizer application, and catch basin maintenance. The Agence du Nord significantly increased its financial contributions to the project, from one million dirhams (about \$100,000) under WRS to 6 million dirhams (about \$600,000) under WPM.



Siltation of the Nakhla reservoir

On the basis of these renewed partnerships, we developed a work plan for expanding watershed management activities in Nakhla. The first step in this process was to identify areas suitable for new activities through a diagnostic assessment. Next, we analyzed the needs of the watershed, and we determined what specific direct and indirect actions we would undertake. Direct actions included: tree plantations; installation of grass strips along contour lines; stabilization of ravines; repair of irrigation canals; and construction of water holding tanks.

Actions that would indirectly reduce soil erosion included: improving animal production; introducing improved cookstoves in villages; introduce new apiculture techniques; establishing cooperatives, especially for women; and training farmers. Finally we signed a collective agreement outline the responsibilities of each of the projects partners.

Throughout the process, we made sure the project's beneficiaries were involved by expanding village committees we had organized under the WRS project. The committees allowed the farmers to participate in the execution, monitoring, and evaluation of all project activities from the start. They, therefore, had a greater stake in the project's outcome and developed a high level of trust with the project team and its institutional partners.

Results

In the Nakhla watershed, project activities produced both direct and indirect results. The most significant direct result was the reduced siltation of the reservoir, which will prolong the life of the dam. There were also several indirect results that followed from the actions of the project. Activities such as tree plantation and breeding of goats that graze more efficiently will not only prevent soil erosion, but also will generate more income for people in the area. Because of the increased income and increased soil productivity, the overall quality of life for the inhabitants of the watershed has improved.

Direct Results

Our team undertook several direction actions to reduce soil erosion in the Nakhla watershed including protective tree planting, installation of grass strips and rock barriers, and building reservoirs.

Tree Plantation

Over the course of the project, we planted thousands of almond, olive, and fruit trees benefiting nearly 2,000 residents of the watershed. In the forested areas, we parceled 255 ha of land according to ownership and planted it with fruit, almond, and olive trees, whose root systems will help to retain the soil.

Previously, farmers did not know which trees belonged to whom, and did not take care of the trees. After the land was parceled and tree ownership became clear, 90 percent of tree recipients are effectively taking care of their trees, which in addition to reducing soil erosion have the benefit of providing income generating produce for farmers.

Direct interventions in rainfed areas

- Plantation of 126,000 olive trees
- Plantation of 4,000 almond trees
- Plantation of 20,200 vine plants
- 930 hectares planted
- More than 1,000 beneficiaries

The people have already begun selling olives produced by their trees. Trees become productive in their fifth year, with 0.35 kg of olives produced per tree. In Year 6 they produced 2 kg/tree and in Year 7 they produced 3 kg/tree. In the future, the Agency for Development of Northern Provinces plans to develop an olive oil processing plant to further increase income.

Fruit plantations on irrigated lands

- Plantation of 54,000 fruit trees (apple, apricot, prune, pomegranate, peach, quince)
- Plantation of 170 hectares with more than 850 beneficiaries

Tree-planting activities improve vegetative cover in non-farm areas of the watershed, prevent further deforestation, and secure the active participation of the Ministry of Water and Forests. Tree planting in rainfed areas reduced soil loss, increased vegetative cover, prevented siltation of the Nakhla dam, and increased the income of farmers. The plantation of fruit trees on irrigated land increased the income of farmers in the watershed and helped reduce soil loss.

Soil conservation measures

Besides planting trees, our team installed rock barriers on 10 ha and grass strips and vines on an additional 40 ha of land to further prevent erosion. We also trained farmers in more efficient plowing methods that will lead to the retention of topsoil, which allows for better crop production levels in the watershed. Another action was the mechanical and biological treatment of ravines. We built 3,800 m³ of gabions and planted acacia, eucalyptus, and carob along 5.36 kilometers of ravines. These soil conservation measures prevent topsoil from being carried away towards the dam after heavy rainfalls, and prevent the expansion of existing ravines and the creation of new ones.



Stone strips along contour lines

Another of the project's direct interventions has ensured that water will be used more efficiently throughout the Nakhla watershed. The project has built 13 water reservoirs with a storage capacity of 10 m³ each at sites of natural springs that run during the rainy season, allowing access to water in these areas during the dry season. We also rehabilitated 9.2 kilometers of irrigation canals. Thus, water is retained in the watershed for irrigating crops and young trees and water losses are reduced.



Water reservoir in Nakhla

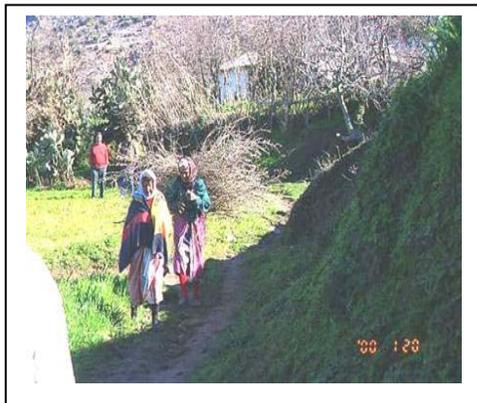
Indirect Results

The WPM project team and our partners introduced several activities that had the dual purpose of generating income for the residents of the watershed while indirectly curtailing the rate of soil erosion. The activities included development of cuniculture or rabbit production, modernization of apiculture or beekeeping, and the introduction of modern cookstoves.

Revenue enhancing activities

- Introduction of rabbit production
 - Creation of a women's cooperative
 - Purchase of 270 cages, 107 rabbits, feed and vaccines
- Modernization of beekeeping activities
 - Creation of 4 beekeepers cooperatives
 - Distribution of 300 full modern beehives with ancillary equipment
- Implementation of an olive oil processing unit
 - Creation of an association of olive oil producers
 - Construction of a building for the association
 - Equipment purchased by the ADNM

Cookstoves



Women gathering firewood

WPM and its partners provided 58 improved cookstoves to the women of the Nakhla watershed. The project purchased two stoves, while the ADNМ supplied fifty, and the UNDP delivered six. Previous cookstoves were outside, exposed to the elements and required 60 kg of wood per day to use. The new stoves produce 64 loaves of traditional high quality bread per day, and are 70 percent more efficient than traditional stoves and require only 5 kg of wood per day, saving the women at least two mornings a week they would otherwise spend gathering wood.

During their newly found free time, the women attend literacy classes, and there is increased social cohesion among them. They enjoy sharing the cookstoves because they are able to see each other more often, and it is easy to keep their children with them. The previous cookstoves were out in the open, so when it rained the bread would become soggy and the coals would be extinguished. The new cookstoves are indoors and are fully functional no matter what the weather. Because they require so much less wood, the new cookstoves allow for regeneration of the surrounding forest, which in turn reduces erosion of soil.



New cookstoves help conserve firewood

Exhibit 2-1 – Benefits of Stoves Purchased under WPM

Year	Number Of stoves	Number of beneficiaries	Wood Saved (kg/yr)	Value (DH)	Time Saved (days/yr)	Value (DH)	Total Gain (DH)
2001-02	1	18	52,560	15,768	468	23,400	39,168
2002-03	1	27	131,400	39,420	1,170	58,500	97,920
Total	2	45	183,960	55,188	1,638	81,900	137,088

Households in the Nakhla region, as throughout rural Morocco, use small outdoor clay ovens to bake bread for every meal, and searching for wood to fuel these stoves is grueling as well as very time-consuming for women. WPM introduced collective cookstoves in the area, intending both to alleviate their workload and to reduce the consumption of limited natural resources.

Searching for the Mijaf village cookstove requires not so much asking for directions as simply following one's nose. Fragrant odors of baking bread waft through the air and lead to a small building containing a large metal oven and a cluster of women clad in brilliant scarlet skirts, traditional attire in the Rif mountain chain. Offering a delicious taste of the piping-hot staple, they invite their guests inside to describe the cookstoves in greater detail.

The amount of wood the new ovens save is astonishing: they now use only 5 kilos versus 60 kilos per day, which provides for roughly 70 loaves of bread. The women have arranged a rotating schedule regarding who attends to baking. This efficient arrangement, in addition to saving time from collecting firewood, has allowed the women more time to address other daily duties and even to take literacy classes.

A young girl offers her opinion of the community oven: "We love it. It's much better than before, especially since now that we're inside—when it used to rain our bread would be ruined and our coals would go out." Habiba Ali Ben Yamoun, a gregarious representative of the group, adds that the ovens are ideal for making cakes during Ramadan. "We are very thankful for the cookstove. Stay here a little while longer and we'll make you bread to take back to the United States."

Cuniculture

WPM provided 80 rabbits to a women's association in the village of Amtel as an income-generating project. The project also supplied cages, equipment, food, and vaccinations. The participants invested in the project too, with each woman contributing 50 dirhams (\$5) for rabbits and supplies. By the end of 2003, the women had sold 50 rabbits, generating 4,500 dirhams in revenues. The stock of adult rabbits at that time was 96. This project promises to be an explosive income-generating venture and will have the added benefit of adding protein to the local diet. Each female rabbit can give birth eight times per year, and rabbits sold at souk weigh between three to five kgs and can fetch 28 dirhams per kg.



Sanaa Nia and Bouchra Khaladi

The women in the association adhere to a rotating schedule that requires only two people two hours a day to clean the cages and care for the rabbits. With 10 to 12 people in rotation, each woman only tends to the rabbits less than once a week. The women enjoy this project and the income they are earning, and have expressed that in their free time they would like to do more projects like this one. When asked what they plan to do with the money they earn from selling rabbits they respond encouragingly that they plan to undertake further projects.

Nakhla Training activities

- Training on improved goat management techniques
- Training on modern beekeeping techniques
- Training on improved farm management techniques
- Training on rabbit raising and cookstoves management
- Study tour for women to look at other cooperatives
- Study tour for Nakhla farmers to the Abdelmoumen watershed in the South
- Participation of farmers in agricultural fairs

Improved Goat Herding

In another dual effort to both curb soil erosion and improve the well-being of Nakhla's residents, the WPM project distributed 50 male Spanish goats throughout the region. Cross-breeding of goats produced sturdier, larger offspring that graze more efficiently, reducing the impact they have on the watershed's vegetation. Also, female hybrid goats produce much more milk than traditional goats, which the families use for their own consumption.



Improved goats

The project team also conducted vaccination campaigns with nine demonstration trials on goats and two on cows. The program reduced diseases that were decimating the goat population. The combination of sturdier herds and vaccinations provided healthier goats that reached selling weight more quickly and therefore spent less time grazing in the watershed.

Apiculture and honey production

The project provided beekeeping equipment and a total of 180 beehives to two beekeeper associations organized by our team. These beekeeping associations are not yet profitable because there were several unproductive beehives in 2003 due to bad weather and to the spread of a virus. Currently all the money raised by honey production goes toward food and medicine for the bees. However, the beekeepers are optimistic about their future. The beekeepers are very interested in producing the best possible quality of honey. They look forward to seeing profits from their bees, and have expressed the need for more protective suits. Beehives encourage people to not cut down the shrubs that the bees need for pollination.

Winding through the verdant Rif Mountains near Tetouan, a passing motorist may notice vast stretches of shimmering olive groves. This impressive plantation of olive as well as fruit trees is in fact part of the WPM project. Residents have not only benefited from the introduction of these trees but also from an entire host of projects including beehives.

Six members of the Association Apicole Jmaa Baida meet to share their story over strong tea and delicate pastries. Mohamed Mrabet, the president, explains that their beekeeping project began in July 2003 with 80 hives and that they plan to add 20 more. The recent weather in these cold northern Moroccan mountains has prevented the bees from venturing out of their hives and thus from producing honey, but they are happy to announce that the first collection will take place this September. Mohamed maintains that “the group remains focused on keeping the bees healthy and producing the finest quality honey possible”; and with the immense variety of flowering vegetation available in these mountains, there is potential to produce a vast array of honey as well.

Discussing sources of honey while taking in the sweeping green landscape below us, the conversation naturally turns to tree planting. The stout Hajj Mohamed Nadi, treasurer of the beekeeping association, notes emphatically that 90% of area recipients take excellent care of their fruit and olive trees, and that they are already selling olives at souk. Mohamed Halhouli, another association member, lauds the project for its land parceling program and describes the situation before the arrival of WPM: “Difficult. It was very difficult. Before [WPM] we had no idea whose olive trees were whose, and there was a lot of fighting, but now everyone takes care of his own trees and gets along. Yes, everything is much better than before—it was total anarchy.”



Beekeepers: from left to right, Med Abdesslam, Halim Hamid Mrabet, Med Mjouf, and Alami Mjouf



Abdesslam Mrabet, Mohamed Halhouli, Hajj Mohamed Nadi, Hassan Oulad Omar, and Mohamed Mrabet

The overall increase in income generated by the WRS and WPM projects in the Nakhla watershed is summarized in Exhibit 2-2. From 1998 to 2004, we estimate that over 1.2 million Dirhams (approximately \$150,000) in income from nearly 25,000 work days related to project activities have been generated.

Exhibit 2-2: Income generated by WRS and WPM projects

Year	Work days by component					Total Income (DH)
	Olive trees	Fruit trees	Rabbits	Beehives	Total	
WRS						
1997-98	1,096				1,096	54,800
1998-99	2,529				2,529	126,450
1999-00	1,567				1,567	78,350
2000-01	2,375	686			3,061	153,050
WPM						
2001-02	4,860	1,378			6,238	311,900
2002-03	6,763	1,488	300	420	8,971	448,550
Total	20,190	3,552	300	420	24,462	1,223,100

Impact

The impact of the project in the Nakhla watershed has been tremendous in terms of both the reduction in soil erosion and the improvements in the daily lives of the project beneficiaries. Adoption of sustainable natural resources management and agricultural practices will protect the area's natural resources through reduction of soil loss and protection of natural resources, and will also provide sustainable income to the local population. Due to the success of WPM's income-generating activities there are new opportunities for productive employment, and men who had long ago left the region in search of work are returning to their homes and their families.

Furthermore, we have planted the seeds of sustainability throughout the project to make sure that its benefits continue into the future. Participation by Moroccan partners and project beneficiaries themselves has allowed for a transfer of knowledge and methodologies that can continue long after the project has ended.

Residents of the area are more hopeful about their future and have seen production increase after previous years of steady decline and are now confident in their ability to change their own conditions. New opportunities have reduced emigration and are providing a more hopeful future for watershed residents.

Section 3

Wastewater Treatment and Reuse in Sidi Bibi

The Commune of Sidi Bibi lies south of Agadir in the Souss-Massa plain at the foothills of the anti-Atlas mountains. The people from this area, known as Soussis, are enterprising, hard-working, and imbued with a great communal spirit. The region has seen significant emigration due to the weak economy. Many Soussis opening small grocery stores in Europe and send the money they earn back home to support their families. The Commune of Sidi Bibi is typical of the Souss-Massa area. Small villages dot the landscape, surrounded by agricultural land on the vast plain between the Souss and Massa rivers. The villages of Briej, Kherba Oulad Mimoun, and Swalem are home to about 2,800 people, and the population is expected to grow to 4,000 by the year 2020.

While the area has strong agricultural potential, water scarcity is the greatest impediment to its development. The Souss and Massa river beds are dry because dams have been built upstream to mobilize water for irrigation and to supply water for larger cities. Furthermore, the region's aquifer is rapidly depleting due to over-pumping to irrigate an expansive web of green houses and citrus groves owned by large-scale exporters. Potable water consumption in the villages is around 140m³ per year. Currently, wastewater ends up in unlined pits or is released directly in nature, causing major concerns regarding contamination of the aquifer and an increase in incidences of waterborne diseases.

In the absence of a strong government presence, the inhabitants of villages in Sidi Bibi have formed civic associations to help provide for community needs. Receiving substantial monetary contributions from community members who live and work in Europe, the associations provide water, collect solid waste, maintain the mosque and the cemetery, provide vocational training to women in cooking and handicrafts, provide literacy classes, and set up and run a library for the youth of the villages.

Participatory water management

In the Souss-Massa plain, there is an old culture of participatory water management. Communities harnessed the water coming from the mountains and flowing from the Souss and Massa rivers, and developed communal systems of water management. A water chief called "Amazal" was elected and determined which farmer received how much water and when. The collective management of water exists to this day, with many water users associations existing in the area.

In a way, they are re-creating an ancient communal system (see text box). They prefer to collect funds and do things themselves rather than wait for services from the government that take a long time to materialize. In the villages of Swalem, Kherba Oulad Mimoun, and Briej, three water users associations dug wells, installed pumps, and small water treatment units to provide potable water to their communities. Thus, over 2,500 people with no direct access to potable water were able to receive piped water in their homes in the early 1990s.



The citizens of the Commune of Sidi Bibi have developed strong civic associations to provide basic services that are not provided by the government

The Challenge

Sidi Bibi is experiencing a resurgence of sorts, after significant emigration in the 1960s and 1970s. Citizens are upgrading houses in the villages and building roads, and they want access to basic services like electricity, water, and sanitation. While water users associations have installed access to potable water in the villages, they have also generated a wastewater problem. Because most houses in the villages of Sidi Bibi dispose of sewage in unlined pits or simply evacuate it in the street, there is a danger that wastewater will contaminate the aquifer from which the villagers draw their water. Discharges of raw wastewater pose serious threats to both the water table and the health of local populations. Obviously, this situation greatly concerned the community's leaders, and they began searching for ways to deal with this challenge.

The methodology

When WPM consultants started looking for an area to expand best practices in wastewater treatment and reuse, modeled after the successful Draga project under WRS, the communal spirit in Sidi Bibi became a big selling point. The project team selected the

The Mosque and the Water Tower

Brahim Soudi, WPM consultant, is a professor and somewhat of a philosopher. COP Mario Kerby recalls that on one trip to Sidi Bibi, Brahim said "look at these villages; they all have one thing in common. The two highest points are always the mosque and the water tower. Somehow, water is always close to God for people of this area".

villages in Sidi Bibi for the dissemination of a wastewater treatment and reuse project because it had an urgent wastewater problem to resolve; public land was available for building a wastewater treatment plant; and the commune had active and successful water users associations willing to enter a partnership to get the job done.

In light of the urgent wastewater situation in Sidi Bibi, the project objectives were clear and simple: to protect groundwater quality and preserve human health; to protect sources of potable water that are critical to future urban development; and to reuse the treated wastewater and other by-products of the wastewater treatment plant.

After the project team selected the villages of the Commune of Sidi Bibi as the site of the wastewater treatment plant replication project, they prepared a feasibility study to determine the best site for a wastewater treatment plant and the best solution for a wastewater transport piping network. Another objective of the feasibility study was to create the most cost-effective design for the plant that would meet acceptable treatment and reuse criteria. Finally we studied various options for the reuse of treated wastewater and for using by-products of the plant (e.g., residual sludges or biogas).

The methodology used to select the most appropriate technological combination for wastewater collection, treatment, and reuse included the following steps:

- Collect basic data on physical and socio-economic factors
- Identify potential technologies that can be used to treat wastewater
- Identify costs and benefits of each technology
- Present technological options to project partners
- Detail the preferred options for the collection, treatment, and reuse components
- Prepare engineering design and bid documents
- Arrange financing
- Begin construction

In addition to selecting appropriate technologies for the treatment plant, it was also very important for the WPM project team to forge partnerships with institutions and local stakeholders to obtain project buy-in and to leverage limited financial resources. By forming and strengthening these partnerships, we also planted the seeds of sustainability, so the treatment plant would remain in operation and even expand once WPM's role ended. We developed partnerships with a variety organizations and government agencies, and each played a specific and crucial role:

- The Ministry of Environment provided technical assistance.
- The Province of Chtouka Ait Baha coordinated local participation, facilitated administrative procedures, and contributed financially to the project.
- The Agence de Développement Social provided financing for the wastewater treatment plant.

- The Agence de Bassin Hydraulique du Souss-Massa, as part of the technical oversight committee, ensured that the project conformed to the water management master plan for the Souss-Massa area.
- ONEP (National Potable Water Agency) also participated on the technical oversight committee to ensure compliance with Moroccan wastewater treatment guidelines.
- The Direction Régional de la Santé, another member of the technical oversight committee made certain that health risks from wastewater treatment and reuse are addressed.
- The ORMVA Souss-Massa, also serving on the technical oversight committee made certain that guidelines for wastewater reuse for irrigation are followed.
- The Communes of Sidi Bibi and Ait Amira have administrative jurisdiction over the project areas and provided proper permits and contributed financially to the project.
- The water users associations (WUAs) of the villages of Briej, Kherba Oulad Mimoun, and Swalem, as direct beneficiaries of the project, collected funds, provided the land, and mobilized to ensure that the project was a success at the local level.

We made sure that public participation was the cornerstone of the project methodology during the various steps of implementation. For example, the WUAs were involved in all stages of the project, and we undertook many activities to inform and raise awareness among the population.

Self-sufficient and self-financed, the Association Oulad Mimoun, located in the Sidi Bibi commune near Tiznit, is a model association. Major Moroccan media outlets and representatives from a remarkable 150 associations throughout Morocco have visited Oulad Mimoun, whose dynamic members are happy to provide their visitors with information regarding their success.

The Oulad Mimoun Association was formed in 1994 to provide potable water to the surrounding community. After accomplishing its initial goal, the association has since blossomed into a thriving entity that sponsors 15 diverse activities ranging from a preschool to literacy classes to soccer teams. They have recently eliminated the use of 110 wells by installing a water pump and 248 water meters that now serve the entire community. The WPM project was responsible for implementing a wastewater system in the area, eliminating the need for old septic tanks that threatened the integrity of the water table.

Over breakfast, Khaled Alayoud, the Association's gregarious president, explains the contributions of the WPM project: "All that Oulad Mimoun has accomplished- the water system, the women's sewing classes, our library, to name a few- would not continue to exist without WPM's contributions. Its wastewater project is vital to the success and even survival of our association, because our initial goal of supplying potable water would be seriously threatened without a sewage system. If we continued to use individual septic tanks, the water table would eventually be contaminated."

Later that afternoon we met several of the project's beneficiaries, an engaging group of 16- to 19-year-old girls and their mentors Mbarka and Souad. Today Souad is running her cooking workshop and the kitchen is a blur of chopped cilantro, couscous, roast chicken, tempting desserts, and of course, students. She is well aware of the effect the project has had on Oulad Mimoun: "USAID is at the core of all that goes on here. You have breathed even more life into this association." While Mbarka, the matriarch of the group, helps to teach the cooking and sewing (the latter serves as an income-generating activity for the girls), she has also benefited from literacy classes. "I'm an old lady so learning to read is going slowly, but I'm excited that I've learned numbers. I can now tell time, and I now know which bus goes to the city. It's great."



Project beneficiaries in Sidi Bibi, from left to right: Mbarka, Souad, Amina, Fatima Zahra, Hafida and Latifa

The results

With our group of dedicated partners, we implemented an effective wastewater collection system, consisting of a treatment plant and a piping network, for the villages of Kherba Oulad Mimoun and Swalem. The treatment plant itself is made up of pre-treatment units, 2 anaerobic basins, 1 facultative basin, three maturation basins, and a biogas recovery mechanism. It is connected to the villages by a network of pipes that transport the effluents generated by the villages to the site of the wastewater treatment plant.



Construction begins for the piping network for the wastewater treatment system in Sidi Bibi.

The WPM team also devised plans to reuse the treated wastewater and the residual sludge that inevitably results from treatment. Treated wastewater will be used to irrigate crops, and the sludge will be used for composting.

All of this construction can be costly, so the project team secured an impressive financing package to build the plant with contributions from the Agence de Développement Social (ADS), the water users associations, the Communes of Sidi Bibi and Ait Amira, the Province of Chtouka

Ait Baha, and Oxfam Quebec. The commitment for the major portion of the financing (2 million dirhams from ADS) was sealed at the WPM close-out ceremony on September 23, 2004.

Exhibit 3-1: Sidi Bibi Project Financial Partnership

Partner	Contribution (dirhams)
Communes of Sidi Bibi & Ait Amira	300,000
Province of Chtouka Ait Baha	160,000
Water Users Associations	600,000
WPM Project	500,000
Oxfam Quebec	70,000
Agence de Développement Social (ADS)	2,000,000
Total	3,630,000

The impact

The wastewater treatment plant will significantly reduce risks to human health and the environment from raw wastewater discharges. In addition, the plant will be financially self-sustaining and is expected to save farmers 17 m³ of water per day. The economic benefits of wastewater reuse will include water savings of 2,250 dirhams per hectare per year, and fertilizer savings of 2,580 dirhams per hectare per year.

Exhibit 3-2: Estimated Performance of the Wastewater Treatment Plant

Parameter	Before Project Pollution (t/yr)		After Project Pollution (t/yr)		Percent Reduction
	2002	2020	2002	2020	
BOD5	42	68	8	12	82%
COD	105	170	29.4	48	78%
NTK	15	25	11	19.5	32%
Parasites	2.5	4.2	1.25	2.1	50%

The more enduring impact of the project is a renewed sense of hope and optimism for the future among the people living in the villages served by the project. With the potential threats to the water supply eased and with a cleaner and safer environment, the enterprising and creative people of Sidi Bibi are poised to take advantage of the region's economic opportunities in tourism, agriculture, and manufacturing.

Section 4

Reducing Pollution from the COPAG dairy in Taroudant

Within a few short years, the Jaouda brand of yogurt, sold in large supermarkets and small *epiceries*, has become the most popular in Morocco. Jaouda is the jewel in the crown of COPAG, a dairy and juice making cooperative started in the mid-1990s. COPAG started serving the regional market around Taroudant and Agadir with quality and safety as its primary selling points. With its visionary president, Moulay Ahmed Oualtiti at its helm, COPAG recognized that with expansion comes responsibility. With the market is expected to grow at 14 percent this year alone, the increasing production demands on the plant and the rapid expansion of new product lines, including pasteurized milk, orange juice, and yogurt drinks, generated large amounts of wastewater.



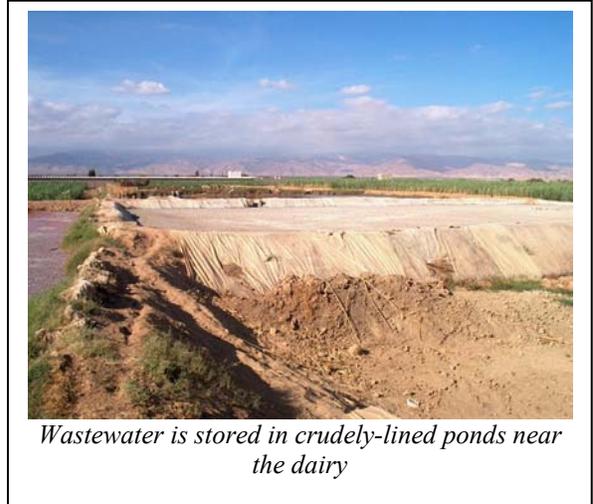
A truck at the COPAG dairy plant prepares to transport popular Jaouda products throughout Morocco

As a first response, COPAG built some wastewater storage ponds with a crude plastic lining. With the increased production and resulting wastewater releases, the ponds quickly filled up. The effluents stagnate, engendering foul odors and mosquitoes in the summer. COPAG understands

that this situation can't continue. It is not good for its image as a maker of quality products, and it is not good for its relations with the community from where most of its workers come.

The methodology

When WPM started looking in the Souss-Massa region for a partner with which to replicate the WRS project's successful industrial pollution prevention and control component, COPAG quickly jumped to the top of the list because it met all of the requirements. Not only did the dairy have a pressing problem to resolve, but it also had a dynamic management team who wanted to get things done and was willing to put up some money to help. It has an excellent technical staff and corporate culture, and it is willing to serve as an example for others to follow.



After determining that COPAG presented the best opportunity for replicating a pollution prevention and control project in the Souss-Massa area, the WPM team looked for additional partners. As the word got around that a project may be underway, COP Mario Kerby received a call from Bouchaib Bouguenouch, the newly appointed head of the Souss-Massa River Basin Agency (RBA). Mr. Bouguenouch was looking for a way to demonstrate that the RBA could work constructively with the private sector to alleviate threats to water resources. The opportunity to partner with WPM provided him with a way to leverage his resources. Mr. Kerby agreed that the partnership would be beneficial to all parties involved, and the seeds of an effective partnership were planted. The project team also secured the assistance of other parts of the Moroccan government.

At first, COPAG was wary of the participation of government agencies in the project and wanted to make sure that expensive technical options would not be imposed on them. After several months of negotiations, their fears evaporated, and a collective agreement was sealed, assigning each partner a specific role. The WPM team would provide technical assistance to COPAG and conduct the feasibility study for the project. The Souss-Massa RBA would finance the design of the wastewater treatment plant, but COPAG would agree to build the plant only if they found the design to be acceptable.

Other signatories to the collective agreement provided even more assistance. The Ministry of Environment conducted the sampling and analysis campaign to characterize effluents from the dairy and reviewed the project for eligibility for financing under an existing German fund for pollution prevention and control (FODEP). The Wilaya of Taroudant and the Commune of Ait Izza, where COPAG is located, encouraged local support of the project. Finally, a project oversight committee was created that was comprised of the signatories to the collective agreement, and representatives from technical institutions like ONEP, the Ministry of Industry, and the Ministry of Agriculture.

The feasibility study was launched in the spring of 2002. First, our consultants conducted an audit of COPAG to answer several basic questions: Where did the plant use water? Which processes generated wastewater? How much wastewater was sent to the settling ponds and how polluted was it? We then identified opportunities for recycling and saving water. For example, we suggested that water used for rinsing that was barely contaminated could be recycled for use in the refrigeration system. We also found many places where COPAG could save water by improving the sequencing of the equipment. Following the audit, COPAG implemented most of our solutions resulting in savings of both water and money.

However, despite gains in efficiency and water savings, it was clear that COPAG's rapidly increasing production was going to continue to generate contaminated wastewater. As the offsite basins reached capacity, the need for building an adequate wastewater treatment plant became apparent. But a wastewater treatment plant is not built overnight. It requires studies, appropriate land to build on, and a design that takes into account not only physical, technical, and financial constraints, but also the requirements for a treated effluent that meets quality criteria for its intended use. It also requires an environmental impact assessment, which is needed to fulfill requirements of both USAID and the Government of Morocco. This is the work we accomplished with our partners during the second and third years of the project.

Water Saving Measures Instituted at COPAG

- Cleaning the floor: The system of pressurized jets of water used to clean the floor was replaced by carriages that use significantly less water.
- Cleaning of milk tanks: Flat-bottomed tanks have been replaced by conical tanks, reducing the quantity of water used for cleaning and reducing the quantity of milk lost when the tanks are drained.
- Cooling water for pumps: On several pumps, water is recovered, cooled in an exchanger, and recycled again in the pumps. By joining the two steps, COPAG saves water.
- Recovery of condensates: COPAG collects and recycles condensate water resulting from thermic operations in the exchangers, saving both water and energy.
- Monitoring leaks: COPAG managers vigilantly watch for water leaks inside the factory.
- Monitoring water consumption: COPAG has installed meters on most water outlets.

In the project's second year, we assisted COPAG in securing funds from the German fund for industrial pollution prevention (FODEP). FODEP has agreed to provide 40 percent of the funding to build the wastewater treatment plant, and COPAG will supply the remaining 60 percent. The ceremonial groundbreaking for the construction of the treatment plant was held on September 17, 2004, as part of the closing ceremonies of the WPM project. We expect the plant will begin operations in 2006.

Results

As mentioned above, water conservation at COPAG is already underway. Workers at the dairy implemented process changes that include recycling water used for cooling and cleaning equipment; collecting and reusing condensate water; and optimizing water use in the production of orange juice. These changes save approximately 25,500 m³ of water per year, resulting in monetary savings of about \$20,400 per year.



Jets of water clean oranges to prepare them for processing

Though these savings are modest, the biggest impact of WPM's partnership with COPAG will be seen after the wastewater treatment plant has been built. The completion of the wastewater treatment plant will bring about significant changes ranging from the elimination of health risks posed by the settling ponds to the population in the surrounding area to even greater water savings for the plant.

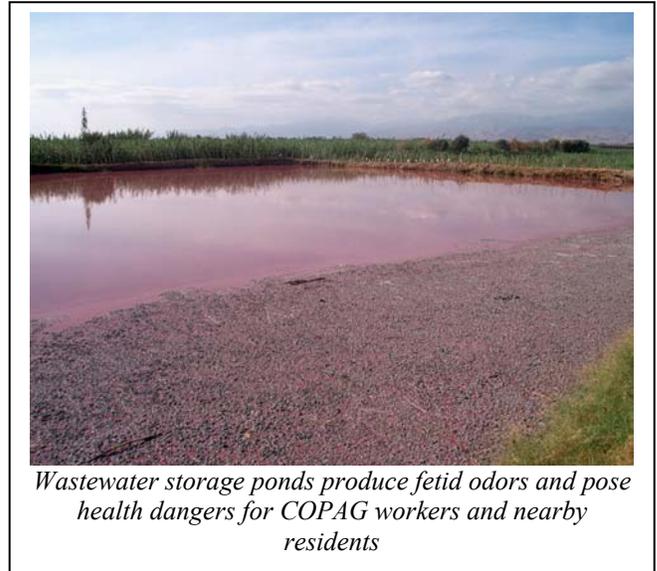
Not far from the famous red walls of Taroudant lies the COPAG Dairy, a highly successful cooperative that produces the regarded Jaouda brand milk and yogurt products. "Jaouda" is Arabic for "quality," and in keeping true to the name, COPAG has decided on its own accord to improve the environmental standards of its plant, and in turn the well-being of its community.

"COPAG stinks." Without hesitation, a young boy offers his opinion of what it's like to live near a dairy processing plant. In slightly more diplomatic terms, Khalid Zaonoun, a COPAG representative, agrees that the odors produced by wastewater from the plant are indeed quite unpleasant. In addition to the odor, the wastewater holding tanks encourage the proliferation of mosquitoes and could potentially harm the water table of Ait Aizza, the closest town.

Revamping the holding tanks is an ideal way for COPAG to pursue its goals of attaining ISO certification while preserving the company's good image. Upon visiting the WRS wastewater treatment and reuse station in Drarga commune, COPAG members decided to team with WPM to present a feasibility study on the implementation of its own wastewater purification system. The potential benefits are substantial: not only will they save water through purification and reuse, but effluent amounts will decrease drastically, thereby improving its standing among members of the community. One such individual, Mohamed Ajmaa, is very excited about COPAG's plans for improvement. The local farmer says that with the present system, "as soon as the sun comes up the smell is unbearable. You just pull your hat down and your shirt up over your face. And when the wind blows it's even worse. You'll definitely never see any cars or trucks around here with their windows rolled down." Thus the dairy and the locals alike will benefit from the successful partnerships fostered by WPM to build the treatment plant.

Impact

The expected health benefits alone make this public-private partnership worthwhile. The plant employs 1,161 people, and many of them live in the area immediately surrounding the plant. The foul odors and mosquitoes from the settling ponds pose grave health risks to workers and residents alike. The pollutants in the wastewater create breeding grounds for disease-carrying mosquitoes in the warm summer months. Additionally, direct consumption of the contaminated water from nearby wells can cause diarrhea, typhoid, and viral hepatitis. Because the wastewater will be treated rather than left in the settling ponds, the fetid odors and the health risks will be eliminated, and the community's quality of life will improve greatly.



The community also will benefit from the treatment plant because its water resources will be protected. When the settling ponds eventually evaporate, the danger of their contents infiltrating and contaminating the water table will disappear. Residents will not have to worry about risking their health when they drink water drawn from their own wells.

Besides the improvements for local residents and workers, each of the partners will benefit from the project. The Ministry of Environment can showcase a project that not only reduces environmental risks, but also demonstrates an effective model of public-private partnership for industrial pollution prevention. The benefits of a successful public-private partnership are not lost on the Souss-Massa RBA, either. It shows that the RBA in conjunction with a private company can protect scarce water resources in the region through integrated water management. Similarly, the Province of Taroudant improves the environment of the province and enhances its reputation because it worked with an important industrial player and other institutions to preserve water resources in the province. The Commune of Ait Izza eliminates nuisances to its population from the foul-smelling settling ponds, protects its environment, and increases land values around the plant.

Finally, COPAG itself benefits by treating its wastewater, reusing the treated effluents to irrigate grazing areas, and improves its image within the community, thereby making them more competitive and winning over new customers. It is still growing and still exploring ways to use water more efficiently. After the wastewater treatment plant begins operations, COPAG plans to save even more water than they are already. Mr. Ouiliti envisions using the treated wastewater to irrigate the pastures currently irrigated with only fresh water for the co-op's dairy cows. With a management team committed to environmentally sound practices, COPAG has become an integral player in the preservation of water quality in the Souss-Massa River Basin.

The fact that each of the project partners have seen such positive results and that it is supported by the local community will help to ensure its sustainability. The success of COPAG will encourage other industrial polluters to pursue similar projects. In fact the Souss-Massa RBA has already identified seven other projects that will follow WPM's winning approach to cleaning up industrial pollution through public-private partnerships and hopes to disseminate the methods throughout Morocco.

COPAG's Recognition and Thanks

"We can barely express our full indebtedness to your organization, and will never forget the vital support we benefited from since the first days of our cooperation. We appreciate your priceless help and value your know-how in both technical and financial assistance, and we solemnly state that your intervention has helped iron out a great deal of predicaments."

"We think that it is fitting and proper to highlight some of the main benefits of the project we joined together to achieve. Our region will gain a lot in economizing water, saving and protecting groundwater, and finally achieving a wastewater treatment unit that will really become one of the most significant accomplishments in recent times in our country. "

- The COPAG Management Team,
in a letter to the WPM Project Team

Section 5

Integrated watershed development in Abdelmoumen

The Abdelmoumen dam was built in 1981 to provide water for the city of Agadir and to irrigate parts of the Souss-Massa plain. The Dou Tama watershed is directly above the Abdelmoumen dam and covers an area of 38.25 km². The elevation in the watershed ranges from 620 meters to 1,650 meters above sea level. The climate is arid with an average rainfall of 282 millimeters per year. The initial capacity of the dam was 263 million m³. Even though rainfall is low, the erosion rate of the Dou Tama watershed is 15 tons/hectare/year. This soil loss increases the siltation of the dam and reduces the productivity of the soil in the watershed.

The Dou Tama watershed is home to 3,000 inhabitants, living in small villages near sources of water. Water is indeed the major constraint in the watershed. Many of the springs are salty and contain elevated levels of sulfates. Although this water is used for irrigation around the villages, it is unfit for human consumption. The major economic activities in the area revolve around agriculture. Irrigated lands are located in oases near sources of water and contain a combination of fruit trees and crops. Olive trees are predominant, and other fruit trees grown in the area include apple, pear, prune, almond, quince and date palm. Cereals are the primary crops grown, along with cash crops, forage crops, and pulses.



The Abdelmoumen Dam is located below the Dou Tama watershed in the Souss-Massa river basin.

Rainfed areas are essentially located close to irrigated lands, outside the reach of available water resources. These areas are used for cereal crops, and are planted with argan, carob, olive and almond trees.

There are two levels of forested areas. Above 800 meters, argan, thuya, and oleaster trees can be found; along with thyme, lavender and other species of shrubs. Below 800 meters, argan trees predominate, with a few carob and oleaster trees. The forest is used for many purposes including grazing, wood, medicinal plants, and harvesting of the argan nut. The argan nuts are collected to produce the highly prized argan oil, which is an important source of income in the area. Carob trees are primarily used for their leaves that feed animals.

The productivity of agriculture in the area is relatively low and can be improved with the use of better practices. The yields of major agricultural products grown in the area are summarized in the table below.

Exhibit 5-1: Yields of agricultural products in the Dou Tama watershed

Crop	Yield in rainfed areas	Yield in irrigated areas
Barley	3 – 5 bushels per hectare	7 – 11 bushels per hectare
Olive	10 – 20 kilograms per tree	50 – 80 kilograms per tree
Almond	0.25 – 2 kg harvested per tree	6 – 8 kg harvested per tree
Argan	1 – 5 liters of oil per tree	N/A
Carob	30 – 40 kg per tree	60 – 100 kg per tree

Animal herding is an important part of the economy of the area. The 1996 agricultural census in the watershed identified 10,013 goats; 3,668 sheep; 687 donkeys; 465 mules; 145 cows; and 3 camels. Goats predominate throughout the watershed and are popular due to their versatility and adaptability to local conditions. Sheep and cows are found close to villages and irrigated areas

The Challenge

At the start of the WPM project, the major constraints to agricultural production identified in the area included: the lack of water and repeated droughts; soil degradation and the loss of topsoil; land tenure patterns which results in micro-properties; the lack of technical know-how by farmers; and the lack of assistance by state institutions.

Because of the difficulties in making a living in the watershed, there had been significant emigration over the years. Those who emigrate usually come back for festive occasions and send money to support their families. The severe droughts that have plagued the area since the mid-1990s have contributed to an acceleration of emigration.

Why do people leave?

“There is nothing to gain in the village, not even a dirham. In these lean years, emigration is necessary to make a living. We have had drought since 1996.”

Resident of the Dou Tama watershed - 2002

Thus, the goal of the WPM project in the Dou Tama watershed above the Abdelmoumen dam was to implement a series of watershed development activities that would reduce soil loss, increase economic opportunities, improve the resource base of the watershed, and make more efficient use of existing resources, including water. Because these goals closely resemble those of the previous WRS project in Nakhla, the team has been able to effectively build upon and adapt the best practices of integrated watershed management activities in Nakhla in order to improve water resources management in the Souss-Massa river basin in southern Morocco.

The methodology

The methodology used in the integrated watershed development activities in the Abdelmoumen dam was modeled after the Nakhla project successfully undertaken in WRS. The key steps we followed included:

- Analyze existing data (maps, climatic data, hydrology, erosion, socio-economic information)
- Conduct a rapid rural appraisal using participatory techniques to identify constraints and the relationships between human activities and the degradation of the resource base
- Combine the technical information and the appraisal results to identify potential technical solutions
- Prepare a feasibility study to identify specific actions to develop the watershed and reduce soil erosion
- Negotiate a collective agreement with project partners (DREF-SM, ORMVA-SM, Agence du Bassin Hydraulique de Souss-Massa, and local non-governmental organizations) to leverage resources and ensure sustainability
- Implement project activities

After an exhaustive analysis of the hydrological, geological and socio-cultural variables of four potential sites in the Souss-Massa region, WPM selected the Dou Tama watershed surrounding the Abdelmoumen Dam as its focus.

Results

Knowledge sharing

One of the first steps in replicating the successes of WRS involved sending actual project beneficiaries from the north down to Abdelmoumen in the south. For many inhabitants of rural Morocco, it is rare to even travel to the provincial capital, so this exchange was all the more meaningful for the participants. So, WPM organized a study tour for 28 farmers from four Nakhla douars, as well as two technical experts/facilitators, to visit the Dou Tama watershed. The participants attended presentations and discussed the various soil erosion interventions implemented in both watersheds. Northern beneficiaries also visited successful associations and cooperatives in Abdelmoumen.

Irrigation improvements

A crucial component of water resource management is properly harnessing natural water sources. Beginning in May 2003, WPM collaborated with a private contractor to rehabilitate the irrigation network—about 1,000 m of irrigation canals in total—in four hillside douars of the watershed: Tazarine, Tasguint, Agadir Ida Ouswar and Goungui. While the project has resulted in substantial social and health benefits, the projected environmental and economic benefits are even more impressive. According to ORMVA-SM, the efficiency rate of harnessing mountain spring runoff water has increased from 40 percent to 95 percent. In addition, the irrigated surface area served by these improved canals has risen from 50 ha to an astonishing 380 ha, allowing supplemental production of potatoes, onions, tomatoes and other produce.

Estimates for the income-generating potential of this new farmland are approximately 517,500 dirhams per 50 hectares, using market estimates of potatoes and barley, both valued at 1500 dirhams/ton).

Tree plantation

Like the tree planting activities in the Nakhla watershed, tree planting throughout Abdelmoumen has been introduced in a dual effort to curb soil erosion and serve as an income source. The project team distributed 13,250 almond trees and 6,600 olive trees in early 2003 to farmers from the douars of Tasguint, Tazarine, Sinit, Alemzi, Goungui, Agadir Ida Ousouarh, and Bigoudine, to plant over a total surface of 150 hectares. The trees will undoubtedly produce income for the beneficiaries, but because both almond and olive trees do not produce fruit until after four years of growth, income numbers will not be available until 2007-2008.

Forest area and rangeland activities

Although the hardy argan tree, relatively plentiful in southern Morocco, is known to withstand tough periods of drought, it is common belief that “artificially” regenerating the trees by planting seedlings is all but impossible. However, in collaboration with DREF-SM and local residents, WPM replanted a total of 4,737 argan trees in the watershed forestland along contour lines, with stone strips along the lines and cuvettes around the trees to trap sediments and collect water. In addition to planting new argan trees, the project aims to maintain the older argan trees in the area. To help the old argan trees collect water during rain events, we installed small catchments around 2,400 naturally grown argan trees as a water harvesting technique to be introduced in the area.

The main source of irrigation in the Bigoudine watershed is provided by mountain springs, which is traditionally distributed through open mountainside rivulets. The WPM project has since constructed irrigation canals and reservoirs to reduce erosion and to distribute water more efficiently.

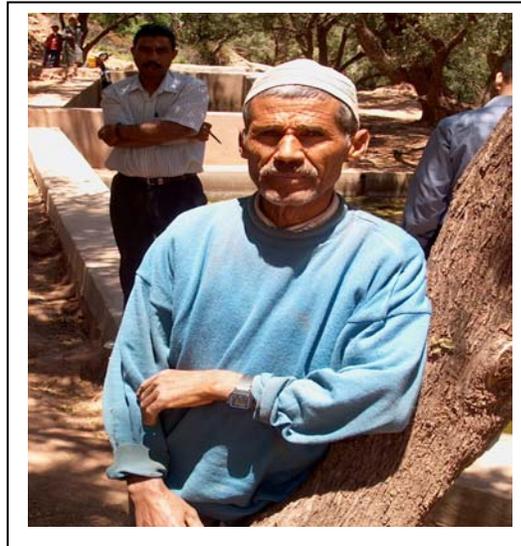
Gathered in the shade of a lush olive grove, farmers from the douars of Agadir Id Oussouar are discussing the results of a recent USAID project. When asked if life is better with the new irrigation system, Mohamed Maazouz, clad in a traditional *foqia* topped with a camouflage jacket, says “of course it is—before, only the upper douars got most of the water, but now it goes all the way to the bottom of the mountain so we all receive the same amount.”

In addition to improved allotment of water per village, his neighbor Hussein El Manzou further explains that the farmers can practice irrigation scheduling thanks to the installation of several reservoirs, thereby reducing potential flooding and providing crucial irrigation during periods of little rainfall. He adds that the lateral distribution of water has greatly improved as well—where there were only a few olive trees and small wheat fields gathered tightly near the mountain streams, the irrigation canals have allowed for a greater and more diverse crop cover away from the source. A shy little girl named Khadouj whispers that she has noticed more fig and almond trees since the arrival of the irrigation system. She then notes that now, she and her family do not have to travel as far from their house to collect water, and that the water is much cleaner. True, the water is now safe to drink because a covered pipe carries it directly from the spring.

Mohammed Bel Lahcen (photo) has a weathered face and wears an embroidered skullcap over his closely cropped hair. His prognosis is optimistic: “You just have to tell the government what you need and they’ll help you. I mean, we do help each other out but there’s only so much we can do ourselves. We need to give big thanks for this water project –government aid helps a lot, and we really hope they’ll continue with future projects.”



Irrigation canals in upper Dou Tama



Mohammed Bel Lahcen of Dou Tama

An area of about 250 ha of forestland, has been fenced off to serve as a protected area, which prevents goats from grazing and makes natural regeneration of argan trees possible. This protected forestland has also served as an ideal medium for the introduction of prickly pear cactus, caper plants, and carob trees. WPM has planted or distributed 3,400 carob seedlings, 17,600 cactus plants and 4,250 caper plants in the perimeter. Like the almond and olive trees, cactus and caper will play a double role by protecting the soil from erosion and providing income to farmers in the watershed.



Tree planting in the watershed

Outside of the protected areas, the villages have received an additional 20,000 argan trees, 55,900 cactus plants and 28,000 carob trees, and DREF-SM plans to plant 42,500 more carob trees by next year. We planted an additional 10,000 cacti to serve as fences along the plantation perimeters in the forest areas of the watershed.

This labor-intensive effort has also provided much needed employment in the Abdelmoumen basin. Planting and caring for tens of thousands of plants is no small undertaking, and the local population engaged in this task logged 12,061 work days and earned 603,050 dirhams for their efforts. Also, two full-time guards each earn 500 dirhams every month to watch over the protected forestland. After the project ends, the guards will continue to be paid by the Ministry of Water and Forests.

Women's cooperatives and associations

In the second quarter of 2003, the project team held numerous meetings with women of the area to explain the benefits of joining associations or cooperatives—including enhancing their ability to sell their products. Forming a women's association in an area that is at once impoverished and conservative is no easy task. It must be noted that the success of such a project depends on the decision of husbands, in part to support their wives' decision to participate and to spend extra time away from home, and also to produce the 100 dirhams membership fee.

Several women also appeared hesitant about joining due to their perceived lack of experience, concern about division of labor among the members of the cooperative, and their preference to work individually. So, we decided to work with the women individually at first, and once they gained more experience and accepted the idea of working as a group, we were able to create an argan oil extraction women's cooperative. While searching for potential members we organized a trip for 20 women from the watershed to visit another women's cooperative working in the same sector. After the visit, 126 women expressed interest in joining the cooperative, 39 of whom have already officially registered.

Construction of the cooperative, which includes an open courtyard, argan press, several extraction and processing rooms, a kitchen and a tourist welcome center and gift shop, is almost completed. Local builders were hired to construct a structure along the “*route du miel*” tourist circuit, adhering to the style of local architecture.



Dou Tama Women's Argan Cooperative



Argan fruit

The women of the cooperative are excited for various reasons. Since they will have the ability to market their argan oil, among other products, in the center’s gift shop, they will no longer need to sell it in souk via brokers who may not have always provided a fair price. According to the cooperative’s president, “we were never aware of market prices; the broker gave us whatever he wanted, and we had no way to verify [fair prices]. The [leverage of the] cooperative will bring us closer to the souk.”

The money these women are hoping to earn is estimated through the following calculations: at the women’s disposal are about 3,000 argan trees, each of which yields 15 kg of fruit. Since 100 kg of fruit yields only two liters of argan oil, the women can expect to produce about 900 liters of oil per year. With an average sale of 220 dirhams per liter, the cooperative could produce incredible gross revenue of 198,000 dirhams.

Moreover, they are enthusiastic about the potential for an improved quality of life: “thanks to earning money we’re going to change for the better...we will eat better, we will dress better, and the men will respect us if we bring money home.”

With the arrival of employment opportunities created through the Watershed Protection and Management project, Dou Tama has witnessed a revitalization of its community and a reversal of the crippling rural exodus that has laid claim to the village for so many years. Community members describe the effect of bringing jobs back home:

The road leading from the Abdelmoumen Dam and up through the Anti-Atlas mountains winds past a large, beautiful traditional-style building, the type that could serve as a country getaway to an Agadir businessman. This handsome reinforced mud structure, however, will soon house the Women's Argan Cooperative, whose creation has benefited both men and women. Rugged argan trees dot the entirety of southern Morocco's landscapes, and their small golden fruit is used to produce a rich and prized oil used in cooking and cosmetics.

Aïcha Boumahti, a soft-spoken yet confident woman, is the *taraïst* (president) of the cooperative. She describes how at first she and her peers were reluctant to form an association: "We were simply used to doing things individually, in our homes, but now that we can produce argan oil together, it's better and saves time. We can see more of each other when we're at the co-op, and it will also give us more time to do other things." Hajja Sabri, another member of the association, nods her head in agreement and adds that everyone is happier. "We'll be able to sell our argan oil and crafts at the cooperative, and we hope that lots of tourists come. *Marhaban!* (Welcome!)"

Aïcha's husband Mohamed Aghla spent almost 11 years away from his family while searching for masonry jobs in Agadir and Tan Tan. "I did what I could for work- one week here, two weeks there. The hardest was traveling to look for jobs. Even if you can't find any (employment) you still have to pay for transportation. But now, *qaway a labila*, I'm making 25 dirhams a day back at home." Mohamed's valuable skills as a mason are evident in the craftsmanship of the cooperative behind him.

Ahmed Bensaid (photo, left) has worked on the WPM project by helping to plant additional argan trees and by serving as a guardian for the protected areas of the argan forest. Like Mohamed, he traveled far from Dou Tama and spent 14 years in Agadir, Tiznit and Goulmime looking for odd jobs to support his wife and seven children. When asked about any benefits of the project, the lanky gentleman responds with a matter-of-fact "Now I can eat!" He further describes the increase in his standard of living, as that of his neighbors: many of them previously purchased goods at the store on credit but can now pay in cash thanks to their salaries from the project. Moreover, virtually every member of the community proudly notes that the extra revenue has paid for the electrification of the village. Ahmed explains that before the USAID project arrived, "people here didn't even talk to one another. Now we work together, and we've even provided ourselves with electricity."



Ahmed Bensaid, left, and colleague Brahim, right

Introduction of improved cookstoves

After conducting a needs survey of the local population in the watershed, the project introduced one collective oven in the pilot douar of Tazarine, and because of the positive reception by beneficiaries, we introduced 21 more throughout the watershed. Eighteen groups of houses agreed to comply with conditions set by the WPM project, which state that each group of houses must identify one person who will sign a contract to provide a shelter where the oven will be installed, allow free access to the oven by all group members, and maintain the oven for the group.

Women who use the ovens praise their fuel efficiency, which not only lessens the environmental strain of cutting firewood but also drastically reduces the time the women spend collecting firewood.

In addition to improving social and environmental conditions, the effects of this project can also be translated into economic terms. Estimating a price of 200 dirhams/ ton for firewood and 40 dirhams/ day, we arrive at substantial cost savings in the following table:

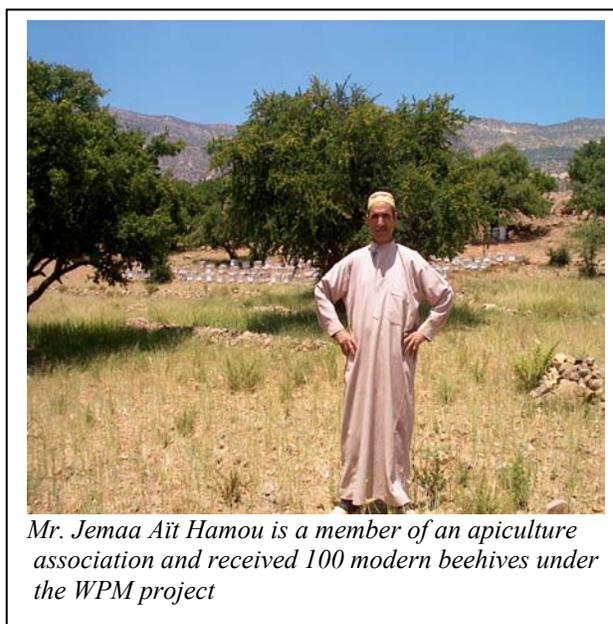
Exhibit 5-2: Gains generated from introduction of improved collective ovens

Year	# of ovens	Beneficiary households	Firewood Saved		Time Saved		Total (DH)
			Kg/year	Value (DH)	Days/ year	Value (DH)	
2002-03	8	132	192,720	38,544	3432	137,280	175,824
2003-04	22	442	645,320	129,064	11492	459,680	588,744
Total	22	442	838,040	167,608	14,924	569,960	764,568

Apiculture

The creation of four beekeeping associations in the Abdelmoumen region promises positive results, firstly because traditional beekeeping already exists and because high quality honey can fetch attractive market prices. The farmers, who are aware of the improved performance of modern beehives relative to that of traditional beehives, were quite interested in joining the regional associations and receiving the new hives. Each association, consisting of 7-12 members, has received approximately 100 hives, for a total of 400.

Currently, 310 hives are actively producing honey (about 2kg per hive per season); 70 initial active hives in 2002-03 and additional 240 active hives in 2003-04, for a total of 810 kg. These hives produce two types of honey: orange flower honey and highly prized thyme honey. The first group of hives produced thyme honey that sold for at an average of 200 dirhams/ kg, totaling 28,000 DH in gross revenue. For several reasons including high bee mortality rates and scarcity of pollinating plants during colder weather, the beekeepers chose to produce orange flower honey in the



Mr. Jemaa Ait Hamou is a member of an apiculture association and received 100 modern beehives under the WPM project

second year. At a selling price of 65 DH/kg, associations earned 31,200 DH, generating revenue totaling nearly 60,000 dirhams in only two years.

Of course a portion of the results are sold and consumed locally, but an interesting note is that the beekeepers' plan to market their goods at the women's argan cooperative, to tourists who pass through the area on the aptly named *Route du Miel*, the honey road.

Small boys wave fistfuls of fresh thyme at the heavy trucks lumbering along the busy highway from Agadir to Marrakech, hoping to sell the herbs for about 5 dirhams (40 cents) a bunch. Only a short distance away through foothills surrounding the Abdelmoumen Dam, local associations are hoping these valuable herbs will play a part in a much more lucrative practice: beekeeping.

With the help of WPM, residents have created four apiculture associations that manage a total of 310 hives. Mr. Jemaa Aït Hamou (see photo in main text), a project beneficiary from the Association Apicole Tassgint I Ousrane, states that he is very excited to have received one hundred hives. He gives a tutorial on the honey making process and explains that while it is not labor intensive, a fair amount of patience is required: after a few months, the bees are still in the process of producing honey from thyme flowers that dot the nearby hillsides. Nevertheless the end product will be worth the wait. Because thyme honey is considered highly medicinal, one kilogram could fetch 400 dirhams on the market, compared to 65-80 dirhams for a kilo of orange flower honey.

The boys along the highway are all but certain to continue their quest for hard-earned pocket money, but the immense value added from thyme honey is a welcome source of new income for the Abdelmoumen community.

Improved animal production

As in Nakhla, WPM distributed 12 improved male goats and one sheep throughout six douars to genetically improve the local goatherds. 1,160 goats were also part of WPM project's vaccination and parasite treatment campaign at the end of 2002. The mortality rate has been very low and the overall performance of the vaccinated animals was better than that of the animals that were not vaccinated. In addition, the team distributed barley grain to farmers who were selected for the nutritional and management demonstration trials. Although results are not yet statistically significant, these actions are expected to positively impact local revenues by enhancing reproduction and market value of farmer-owned goats.

Impact

Just as the goals and methodologies of the activities in Abdelmoumen mirrored those of Nakhla, so did the impact of the project. Because the project was based on partnership with various local institutions and a participative approach with project beneficiaries, its positive effects are likely to continue. By involving the local community from the start, the project team succeeded in transferring technical knowledge and giving them greater responsibility for the outcome.

In addition to introducing the community to improved livestock management, modernized apiculture methods, and marketing methods, the project team also sensitized the population to the importance of safeguarding natural resources. The impact of the project is visible on the watershed. Incomes have increased from the production of argan oil, essential oils, and improved goat herding. The rehabilitated canals have provided more water to the villages, and reduced conflicts between upstream and downstream villages. The expansion of the argan tree forest will

ensure an expansion of the resource base and its sustainable management. The introduction of cookstoves has slowed the cutting of firewood and provided women with more time to engage in productive activities. The plantation of fruit trees in irrigated areas will provide additional resources.

As a result of WPM, the landscape has changed in the watershed above the Abdelmoumen dam. The project has left behind strong community associations and institutional partners to deepen this change; and the expressions of hope from the men, women and children of the watershed are a testimony to WPM's enduring legacy.

Section 6

Lessons Learned

This section summarizes the key lessons learned from the implementation of the WPM project. Some of these lessons reinforce what we had already learned through WRS, while others are more specific to WPM activities.

Replication is a lot easier when building on the successes and applying the lessons learned from a previous project (WRS). While WRS pioneered pilot projects in water resources management in Morocco, WPM benefited from and built on the successes and lessons learned from WRS. Using the WRS project's achievements as examples of what new activities could accomplish greatly facilitated implementation in several ways. First, we could easily convince potential partners to participate because we could show them WRS successes. Also, the project teams were already familiar with the methodologies for implementation, and partner institutions that had been involved in WRS were fully engaged from the start of WPM. We were also able to tap the extensive network of contacts we had developed in key local institutions, and we had already developed extensive knowledge of the critical water issues in the Souss-Massa river basin and the Nakhla watershed.

Institutional partnerships take time and energy to develop, but are essential for project success. The WPM experience reinforced a key lesson we had learned in WRS: forging institutional partnerships is not easy, but it is crucial to project success. In the COPAG project, we faced several challenges in making the partnership work. When the Souss-Massa River Basin Agency (RBA) expressed the desire to be involved in the project, COPAG was very reluctant to have them play a lead role. The WPM team had to find a compromise in which the RBA would have access to COPAG to conduct part of the feasibility study while COPAG retained the option to refuse to implement a technical solution to its wastewater problem if it was too expensive or onerous. In the end, the partnership worked because all parties were able to tout their participation in the project's success.

Involvement of key local decision-makers is essential. This is another lesson that was reinforced from the WRS experience. The COPAG project required that a wastewater transport network from the plant to the treatment site go through lands held by the Commune of Ait Izza. The president of the commune initially refused to issue the permit allowing the transport network to be built, so we asked the governor of the province of Taroudant to mediate the dispute. The governor's personal intervention was crucial to removing this obstacle so the project could move forward. In the Sidi Bibi project, the strong support of the governor of Chtouka Ait Baha was also very important in keeping the project moving under tight deadlines.

Negotiating collective agreements before starting implementation is crucial. As we did in WRS, we expended a lot of time and effort in WPM to negotiate collective agreements in which the roles and responsibilities of each project partner were spelled out clearly. Although the collective agreement for the Nakhla project was prepared and signed very quickly (as it was a continuation of a project started under WRS), the other collective agreements took over a year to

negotiate. The COPAG agreement was particularly difficult due to the issues mentioned above. However, once the agreements were signed, the project implementation phase proceeded quickly for each of the activities, and we were able to achieve our objectives by the end of the project.

Give partner institutions a key role and value their inputs. It is very important to value and use the input of partner institutions. In the Abdelmoumen integrated watershed management project, the Department of Water and Forests (DREF) complained early on that they were not given the lead role in the project. This responsibility had been given to the ORMVA Souss-Massa, which is responsible for agricultural development in rain-fed areas. However, we instead provided DREF with clear and substantial responsibilities for managing the components of the project related to preservation and plantation of the argan forest and made its staff an integral part of the project team. DREF became one of the most valuable and productive partners in WPM.

Identify and rely on local champions. Every project needs a local champion to ensure its success. Champions are usually community leaders who are well respected, able to secure a consensus, and trusted to make sound judgments for the benefit of the community. In the Abdelmoumen watershed project, Taoufik Sabri, a young entrepreneur, became a project champion and became deeply involved in making sure the community was on board with the project's objectives. In the Sidi Bibi project, the president of the Oulad Mimoun Water Users Association, Khaled Alayoud, made sure the project had constant community support. The involvement of these community champions made it easier to attract financing partners and to speed up implementation activities.

Trust and empower local partners to carry on the work. In the Nakhla watershed, the partnership we had forged under WRS with the DPA of Tetouan and the CT of Ben Karrich bore fruit. Under WPM, we significantly reduced the involvement of WPM consultants in favor of the direct coordination of implementation activities by staff from the DPA and the CT who had been trained under WRS and had gained the trust of the local population. Using the DPA and CT staff enhanced our ability to deliver results and freed our consultants for other activities. By empowering local partners, the WPM project saved both time and money.

Document project methodologies. One of the most successful initiatives we undertook under WPM was the preparation and publication of methodological guides for the three types of pilot projects undertaken under WRS and WPM. The project team prepared guides on: (1) the implementation of soil conservation pilot projects, (2) the implementation of wastewater treatment and reuse pilot projects, and (3) the implementation of industrial pollution prevention and control pilot projects. The methodological guides have been very popular and are now used by Moroccan institutions interested in replicating and expanding projects similar to those implemented under WRS and WPM.

Identify opportunities for internal study tours. Projects often organize overseas study tours. While these tours are often valuable, organizing internal study tours would be an inexpensive and potentially very beneficial alternative in which beneficiaries from different regions can interact directly with one another, share experiences and lessons, and come away with new ideas. Under WPM, we organized study tours for farmers in the Abdelmoumen watershed in southern Morocco to go to Nakha in northern Morocco, and vice-versa. For most participants, this was

their first opportunity to visit other regions of Morocco. The direct exchange between farmers produced many ideas about how to do things differently and opportunities to learn from each other. For example, farmers in Abdelmoumen became intrigued with the possibility of growing cactus plants in their region after they saw these plants thrive in the Nakhla watershed. The project organized and financed the plantation of cactus in the Abdelmoumen watershed with great success.

Let project partners take the credit. During the WPM close-out ceremonies, project partners and beneficiaries conducted most of the presentations about the project. Their presentations about the work they performed demonstrated ownership by the partner institutions and showed their commitment to continue supporting project activities after the departure of the technical assistance team.

Leverage resources through financial partnerships. In all WPM activities, we sought financial contributions from national institutions and local partners. The key is to identify converging interests in a project and to convince potential partners that they can benefit from being associated with a project that furthers their own goals and is consistent with their mandate. For example, in the Nakhla watershed project, we were able to secure 7 million Dirhams (\$750,000) from the Agence du Nord, which promotes the development of Northern Morocco. In the COPAG industrial pollution prevention project, we helped the COPAG dairy apply for and secure financial assistance for the construction of a wastewater treatment plant under a German funded pollution control program administered by the Ministry of Environment. By having multiple partners contribute towards the project's objectives, the impacts of the project were much greater than if we had relied on USAID funding alone.

Section 7

Conclusion

The WPM project demonstrates that significant results can be achieved with limited resources using an approach that (1) involves beneficiaries from the start, (2) leverages project funds through partnerships, (3) relies on local talent, and (4) applies lessons learned and best practices from previous activities. The lasting impact of WPM will be due to the trained Moroccan talent that can carry the torch of sustainable water and watershed management by applying sound methodologies, participative approaches, and the efficient use of financial resources. The partners and beneficiaries that have participated in the project are the best ambassadors for the further expansion of best practices in water management throughout Morocco. The challenge of sustainability has been met, and we are hopeful that, largely due to the assistance of USAID, Moroccans will be able to better preserve and managed their scarce water resources for a promising future.



Annex A

Financial summary

This annex summarizes the expenditures of the WPM project, including contributions for project partners. The project was financed with a combination of US Dollars (\$910,710) and Moroccan dirhams (21 million DH). At the end of the project in September 2004, we had expended all the allocated dirhams and virtually all the available dollars.

Dirham expenditures

In the WPM contract, part of the dirham budget was divided to cover activities in the Nakhla watershed and activities in the Souss-Massa river basin. The Nakhla expenditures cover the extension of soil erosion control activities begun under the WRS project in the Nakhla watershed. The Souss-Massa expenditures cover the implementation of three activities: the watershed protection and management project in the Abdelmoumen watershed; the wastewater treatment and reuse project in the Commune of Sidi Bibi; and the COPAG industrial pollution prevention and control project in the Province of Taroudant.

The project spent all of the allocated dirhams for each region: 6 million dirhams in Nakhla and 15 million dirhams for the Souss-Massa. Exhibit A-1 shows the breakdown of dirham expenditures by region. In terms of local labor, the project spent 1.6 million dirhams in Nakhla and 3.74 million dirhams in the Souss-Massa. These figures include the apportionment of the time for full-time local professional and support staff to the two regions as well as short-term local consultants used in each region. The largest expenditures were for project implementation activities, representing 2.65 million dirhams and 5.16 million dirhams in the Nakhla and Souss-Massa regions, respectively.

Exhibit A-2 shows the breakdown of Dirham expenditures by category. Project implementation accounted for 37 percent of all local expenditures, while local labor and ODCs each represented 25 percent of total costs. Travel and per diem made up 12 percent of all costs, and subcontracts accounted for only 1 percent. This category includes local rent and utilities for the one year that COP Mario Kerby worked on the project.

Dollar expenditures

Under the WPM contract, dollar expenditures include expatriate labor, a dollar multiplier of 85 percent on all local expenses, travel and per diem for expatriates, home office other direct costs (ODCs), and a 5 percent general and administrative (G&A) fee on both Dirham and dollar expenses.

Exhibit A-3 shows a breakdown of WPM dollar expenses. Over the course of the project, we spent \$298,700 on expatriate labor; \$494,300 on local labor multiplier; \$20,700 on home office ODC's; and \$73,000 on G&A costs. Thus, the total dollar expenditures amount to \$886,700.

The WPM expenditures reflect (1) the substantial amount of local labor used in implementing the project, (2) substantial expenditures in project implementation for the benefit of project partners, and (3) rigorous cost control to avoid any overruns.

Exhibit A-1

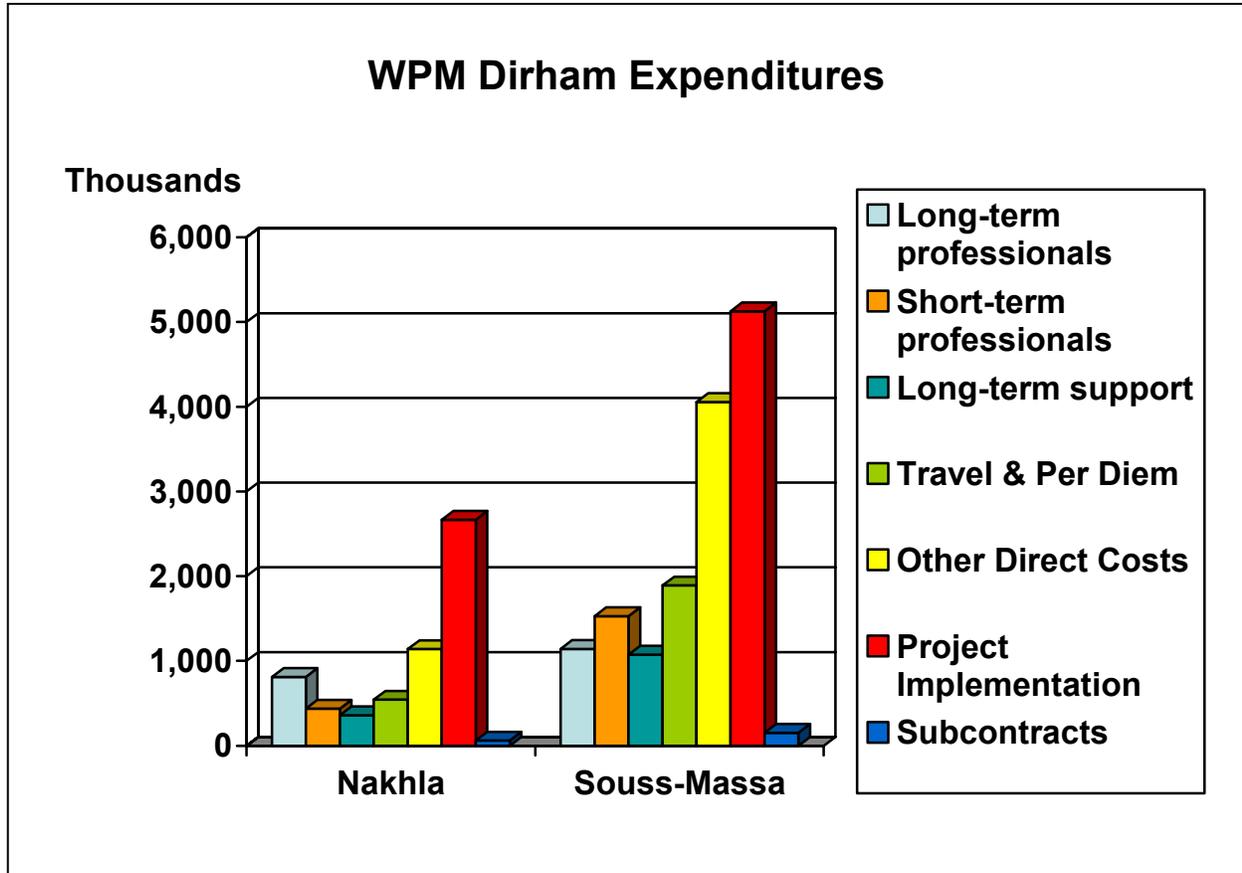


Exhibit A-2

Breakdown of WPM Dirham Expenditures

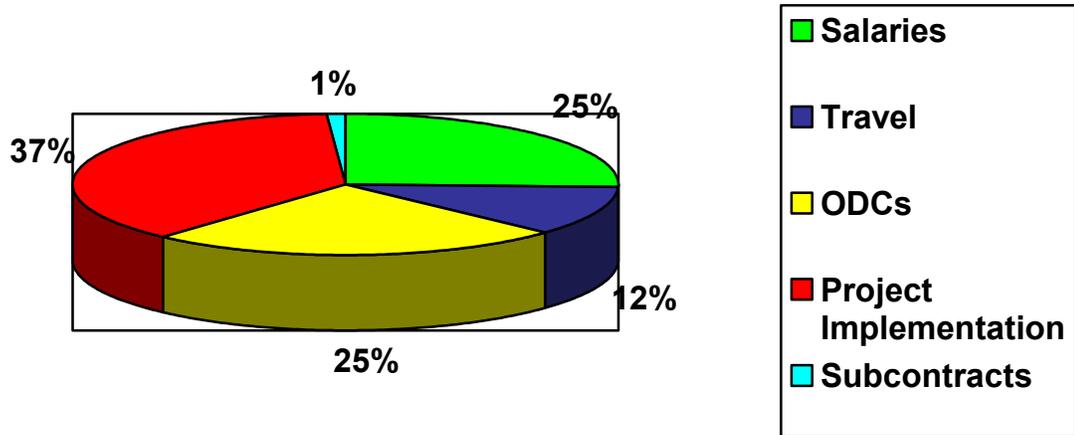
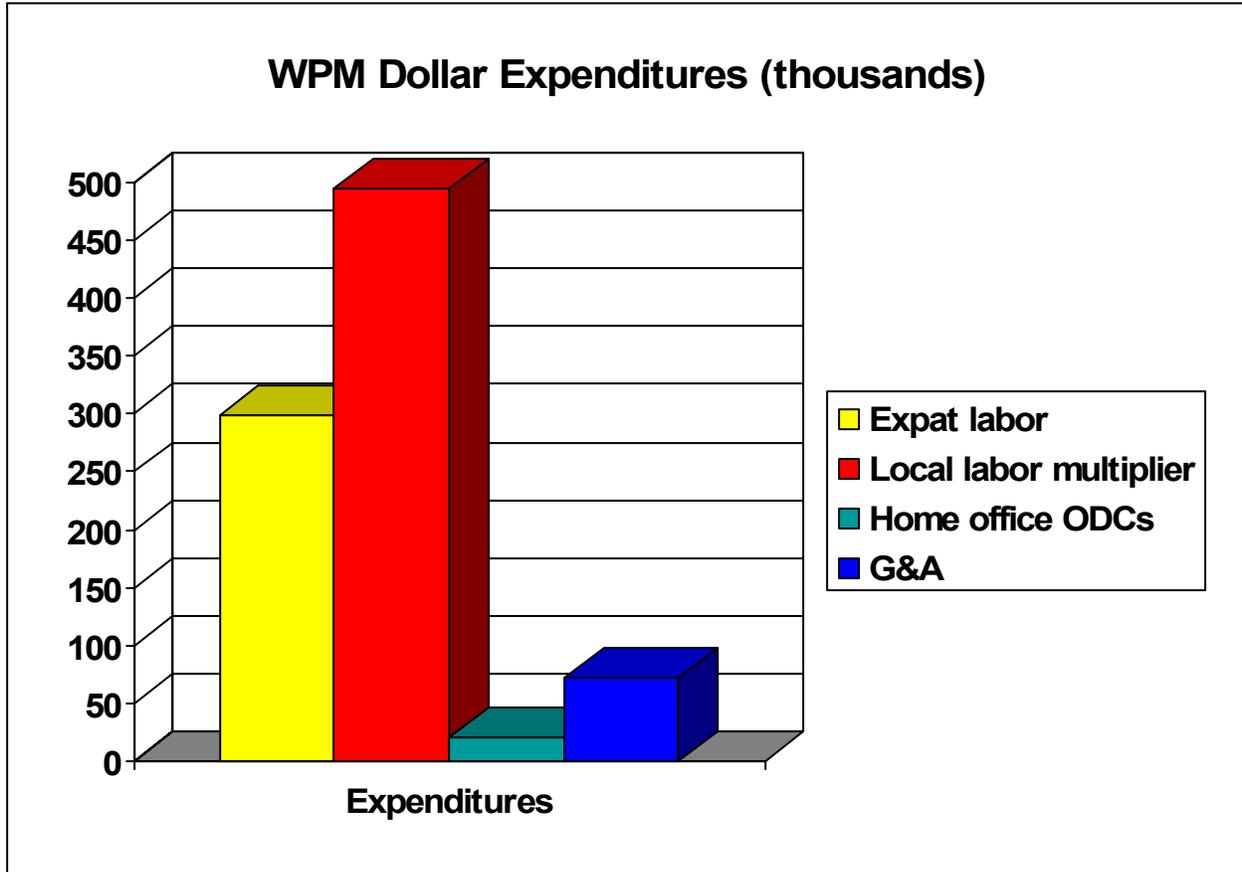


Exhibit A-3



Project partner contributions

The success of the WPM project is due largely to the active involvement of project partners and beneficiaries. From the outset, a major goal of the project was to disseminate successes of WRS with a more active technical and financial participation of local partners. And this is exactly what happened.

We estimate that Moroccan partners contributed over 3,000 days of level of effort (LOE) to the project. Their contributions ranged from extension agents in the CT of Ben Karrich working with farmers in the Nakhla watershed to implement project activities; to an agronomist from the Ministry of Environment designing and implementing a unit to extract essential oils from natural vegetation in the Abdelmoumen watershed; to staff from the Ministry of Environment and the Souss-Massa RBA laboratories conducting sampling and analysis of the wastewater effluents of the COPAG dairy in Taroudant; to members of the water users associations in Sidi Bibi assisting with surveying and soil characterization. Table A-1 below summarizes the LOE contributions of project partners.

Table A-1
Level of Effort Contributions to WPM from Project Partners

Institution	Number of Staff	Level of Effort (Days)			
		Year 1	Year 2	Year 3	Total
Nakhla					
DPA	5	80	80	80	240
CT Ben Karrich	4	200	400	400	1,000
DREF – Rif	2	60	60	60	180
Loukkos RBA	2	10	20	20	50
M. of Environment	4	60	60	60	180
Subtotal		410	620	620	1,650
Souss-Massa					
<i>Abdelmoumen</i>					
DREF-Souss	3	60	120	200	380
ORMVA-SM	2	60	60	60	180
SM-RBA	2	10	20	20	50
M. of Environment	3	40	80	80	200
Subtotal		170	280	360	810
<i>COPAG</i>					
SM-RBA	2	20	40	40	100
ONEP	1	20	20	20	60
M. of Environment	5	30	80	40	150
Subtotal		70	140	100	310
<i>Sidi Bibi</i>					
ONEP	1	10	20	20	50
SM-RBA	1	10	20	10	40
Commune	2	20	20	20	60
Water Users	4	60	40	40	140
Subtotal		100	100	90	290
Total LOE					3,060

Project partners also made significant financial contributions to the WPM project. In the Nakhla watershed, the Agence pour le Développement des Provinces du Nord (Agence du Nord) contributed 7 million dirhams to project activities. Specifically, the Agence du Nord financed the rehabilitation of canals, an olive oil processing unit, the resurfacing of roads, and the purchase of cookstoves. The Direction Régionale des Eaux et Forêts du Rif (DREF-Rif) also contributed financially to the project by financing the biological stabilization of ravines.

In the Souss-Massa river basin, project partners also contributed significantly to project activities. In the Abdelmoumen watershed, the DREF-Souss-Massa financed the plantation of argan tree seedlings and the enclosure to protect the new argan forest. In the COPAG industrial

pollution prevention and control project, the Ministry of Environment, through the German pollution prevention fund, FODEP, contributed 4.8 million Dirhams towards the construction of the dairy's wastewater treatment plant. Under terms of the agreement, COPAG is financing 7.2 million Dirhams of the project costs through a combination of direct investment and bank loans. The Souss-Massa River Basin Agency contributed to the project by financing the design of the wastewater treatment plant with a contribution of 500,000 dirhams.

In the Sidi Bibi wastewater treatment and reuse project, the Agence de Développement Social (ADS) is providing 2 million dirhams towards the building of the wastewater treatment plant. The rest of the funding will come from many sources including the Communes of Sidi Bibi and Ait Amira; the Province of Chtouka Ait Baha; the water users associations in the villages of Briej, Swalem, and Kherba Oulad Mimoun; and a small grant from Oxfam Quebec. The financial contributions of WPM partners, totaling over 23 million dirhams, are summarized in Table A-2

Table A-2
Financial Contributions of WPM Project Partners

Partner	Amount (Dirhams)
Nakhla watershed	
Agence du Nord	7,000,000
DREF-Rif	200,000
Subtotal	7,200,000
Souss-Massa River Basin	
<i>Abdelmoumen watershed management</i>	
DREF-Souss-Massa	200,000
Subtotal	200,000
<i>COPAG industrial pollution prevention</i>	
Ministry of Environment (FODEP)	4,800,000
COPAG	7,200,000
Souss-Massa River Basin Agency	500,000
Subtotal	12,500,000
<i>Sidi Bibi wastewater treatment and reuse</i>	
Agence de Développement Social (ADS)	2,000,000
Communes of Sidi Bibi and Ait Amira	300,000
Province of Chtouka Ait Baha	160,000
Water Users Associations of Briej, Swalem and Kherba	600,000
Oxfam Quebec	70,000
Subtotal	3,130,000
TOTAL	23,030,000

Annex B

Deliverables and Technical Reports

A. Deliverables required by the contract

1. Projet pilote de développement intégré en zone de montagne Bassin versant de Nakhla, Rif Occidental
2. WPM Work Plan (English and French) October 1st, 2001 - September 30th, 2004
3. Quarterly Progress Report - Fourth Quarter 2001
4. Projet pilote de développement intégré en zone de montagne : B. V. Dou Tama, Amont du Barrage Abdelmoumen Rapport de Diagnostic
5. Diagnostic des sites potentiels de mise en place d'un système de traitement et de valorisation des eaux usées épurées dans la région de Souss-Massa
6. Analyse économique et financière du projet de Nakhla
7. Projet pilote de développement agricole intégré en zone de montagne, Bassin versant de Nakhla : Rapport de faisabilité
8. Quarterly Progress Report - First Quarter 2002
9. Quarterly Progress Report - Second Quarter 2002
10. Projet pilote de développement agricole intégré en zone de montagne - Bassin versant Dou Tama, Souss-Massa : Rapport plan d'actions
11. Etude de diagnostic et monographie de la zone d'Ait Mimoun retenue pour la réalisation de l'étude de faisabilité détaillée pour l'assainissement, le traitement et la valorisation des eaux usées épurées
12. Economie d'eau et dépollution industrielle dans le Souss-Massa : Cas de la COPAG - Note méthodologique
13. Quarterly Progress Report - Third Quarter 2002
14. Convention relative à la réalisation du projet de développement intégré en zone de Montagne : Cas du bassin versant de Nakhla
15. Convention relative à la réalisation d'une étude de faisabilité pour la mise en place d'un système de traitement des eaux usées : Cas des douars Oulad Mimoun à Sidi Bibi

16. Convention relative à la réalisation d'une étude de faisabilité d'une station de traitement des eaux usées d'une unité industrielle Cas de la COPAG
17. Convention relative à la réalisation du projet de développement intégré en zone de montagne : Cas du bassin versant d'Abdelmoumen
18. 2002 Annual Progress Report (English and French)
19. Etude de mise en place d'un système de traitement et de réutilisation des eaux usées, localité d'Ait Mimoun : Monographie de la zone d'étude, filière technologique d'épuration et options de réutilisation - (Final)
20. Aspects juridiques et de gestion à Sidi Bibi
21. Economie d'eau et dépollution industrielle dans le Souss-Massa, Cas de la COPAG - Diagnostic du processus de production de la filière laitière de l'unité industrielle COPAG et recherche d'une solution optimale pour l'économie de l'eau - Mission I, Dossier définitif
22. Quarterly Progress Report - First Quarter 2003
23. Quarterly Progress Report - Second Quarter 2003
24. Quarterly Progress Report -Third Quarter 2003
25. 2003 Annual Progress Report (English and French)
26. Quarterly Progress Report -First Quarter 2004
27. Guide méthodologique pour la réalisation de projets pilotes de traitement et de réutilisation des eaux usées domestiques
28. Guide méthodologique pour la mise en oeuvre de projets pilotes de conservation des sols
29. Guide méthodologique pour la réalisation de projets pilotes de dépollution industrielle
30. Quarterly Progress Report -Second Quarter 2004
31. Final Report (English and French)

B. Reports not required by the contract

1. Prospection et identification des sites potentiels pour l'extension et la réplication des actions du PREM
2. Rapport de prospection des sites pour un projet de contrôle de l'érosion des sols dans le Souss-Massa
3. Bigoudine sub-watershed location in the Abdelmoumen watershed - Elements for the 2002 Work-Plan
4. Economie d'eau et dépollution industrielle dans le Souss-Massa
5. Extension du Projet PREM - Bassin versant de Nakhla
6. Projet pilote de développement agricole intégré en zone de montagne : Bassin versant Dou Tama, Souss-Massa : Rapport de l'atelier de validation
7. Projet pilote de développement agricole intégré en zone de montagne : Bassin versant Dou Tama, Souss-Massa : Etude pédologique
8. Economie d'eau et dépollution industrielle dans le Souss-Massa : Cas de la COPAG - Etat d'avancement
9. Etude détaillée de la réhabilitation des réseaux d'irrigation dans cinq zones d'action de la zone du projet (PMH) -
10. Campagne de prélèvement et d'analyses des rejets liquides de la COPAG -
11. CPS pour la réalisation des travaux d'aménagement hydro-agricoles dans les périmètres Bettara, El Ouaddyine et Bouattou
12. Rapport sur l'introduction de fours améliorés dans le bassin versant de Nakhla
13. Contrat d'exécution des travaux de réhabilitation de partenariat pour le réseau PMH -
14. Etude de mise en place d'un système de traitement et de réutilisation des eaux usées, localité d'Ait Mimoun : Monographie de la zone d'étude, filière technologique d'épuration et options de réutilisation - (Draft)
15. Etude d'assainissement des douars Oulad Mimoun, El Breij et Soualem - MISSION II Avant Projet Sommaire (Draft)
16. Economie d'eau et dépollution industrielle dans le Souss-Massa : Cas de la COPAG - Projets d'économie d'eau et de dépollution
17. Correction torrentielle dans le bassin versant de Nakhla

18. Evaluation du taux d'érosion au niveau du bassin Dou Tama (Bigoudine) par le Système d'Information Géographique (SIG)
19. Etude d'assainissement des douars Oulad Mimoun, El Breij et Soualem - MISSION II Avant Projet Sommaire - (Final)
20. Construction of water reservoirs in Nakhla watershed
21. Caractérisation des rejets liquides de la COPAG incluant l'unité de jus d'orange
22. Caractérisation des rejets liquides de la station de traitement des eaux usées à Drarga -
23. Etude d'assainissement des douars Oulad Mimoun, MISSION II - Avant-projet détaillé du réseau
24. Etude d'assainissement des douars Oulad Mimoun, MISSION III - Avant-projet détaillé du réseau et de la station d'épuration
25. Assainissement du Douar Soualem – Commune d'Ait Hamra Realisation de réseau d'assainissement
26. Etude d'assainissement des douars Oulad Mimoun, El Breij et Soualem – MISSION II Avant-projet détaillé – Note Technique Soualem
27. Assainissement des douars Oulad Mimoun, Commune de Sidi Bibi et douar Soualem, Commune d'Ait Hamra : Réalisation de la station d'épuration des eaux usées, réalisation des bassins anaérobiques, facultatifs et de maturation – D.C.E.
28. Etude géotechnique de Sidi Bibi
29. Economie d'eau et dépollution industrielle dans le Souss-Massa Cas de la centrale laiterie COPAG – MISSION II Avant-projet détaillé de l'Assainissement Liquide – (Dossier définitif)
30. Etude d'impact environnemental du projet de traitement et de réutilisation des eaux usées de la localité d'Ait Mimoun
31. Etude de la qualité d'eau et de la prévention de la pollution de la centrale laiterie COPAG: dossier de concours pour la consultation des entreprises pour la réalisation de la station d'épuration Mission III – Dossier définitif
32. Evaluation économique intermédiaire
33. Projet pilote de développement agricole intégré en zone de montagne : Cas du bassin versant Nakhla, NOTE DE SYNTHÈSE

34. Projet pilote de développement agricole intégré en zone de montagne : Cas du bassin versant Dou Tama, NOTE DE SYNTHÈSE
35. Mise en place d'un système de traitement et de réutilisation des eaux usées épurées et des sous produits dans la localité d'Ait Mimoun, NOTE DE SYNTHÈSE
36. Economie d'eau et dépollution industrielle : Cas de la COPAG, NOTE DE SYNTHÈSE
37. Convention relative à la réalisation d'une étude de faisabilité pour la mise en place d'un système de traitement des eaux usées : Cas des douars d'Oulad Mimoun à Sidi Bibi, CONTRIBUTIONS FINANCIÈRES
38. Unité de trituration des olives, Etude de faisabilité économique
39. Etude d'impact environnemental relative à l'installation d'une unité de traitement des effluents de la COPAG
40. Fiches Techniques: Conservation des eaux et des sols