

Wastewater Treatment and Sanitation Policy in Morocco:
The Potential Role of Women as Water Managers

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Background

From September 2007-August 2008, I received a Fulbright Scholarship to study water management policy in Morocco. During this time I worked with Dr. Rachid Bouabid and Dr. Hakima Bahri at the National Agricultural School in Meknès, who introduced me to many prominent members of Morocco's water agencies.

I also worked as an intern for five months (April – August 2008) at the National Organization for Drinking Water (ONEP) under Dr. Asma El Kasmi, a former professor at Al Akhawayn University and UNESCO Chair for “Water, Women and Decision Power”. Under her guidance, I had the opportunity to organize and take part in the Rabat-American Circle's visit to Dayat Ifrah. This village visit gave me insight into the lives of many Moroccan rural women and their importance as household water managers.

Working under the direction of these fine professors grounded my understanding of water agencies and the role of women in Moroccan society. Without this foundational knowledge, I would be unable to write this report today. I wish to convey my deepest gratitude and respect for Dr. Bouabid, Dr. Bahri, and Dr. El Kasmi in their support and guidance throughout my time in Morocco.

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Executive Summary

Over the past decade, Morocco has deployed considerable efforts to mobilize community water resources. However, efforts to implement sustainable sanitation networks and wastewater treatment facilities have not been developed as rapidly. This study analyzes the current system of wastewater treatment and sanitation in Morocco through an extensive literature review and use of qualitative methodology tools. Background studies and this analysis show that in further developing sanitation and wastewater treatment projects, those done in conjunction with women will likely be more effective and sustainable. This analysis further illustrates that, due to women's firsthand knowledge of water use in their homes and communities, they have an incentive to ensure both households and communities are not at risk from unsafe water.

This paper recommends that Morocco's water agencies and water managers consider involving women in sanitation and wastewater treatment development projects from the household to ministerial levels. This analysis identifies five key recommendations to improve water and sanitation efforts in Morocco: empowering women in local communities to participate in water management decisions; increasing the participation of women in commune authorities through elected representation; updating and centralizing water and sanitation indicators through the Ministry of Energy, Mines, Water and the Environment; involving women in identifying appropriate treatment methods to the benefit of communities; and educating youth, utilizing university partnerships and creating jobs in the water sector for a growing youth population.

Rapport Sommaire

Au cours de la dernière décennie, le Maroc a déployé des efforts considérables pour mobiliser les ressources d'eau communautaires. Cependant, ces efforts pour implanter des réseaux sanitaires durables et des stations d'épuration n'ont pas été développés aussi rapidement. Cette étude analyse le système actuel des stations d'épuration et de l'assainissement au Maroc par une vaste revue littéraire et l'utilisation d'outils de méthodologie qualitative. Des études approfondies et cette analyse ont démontré que, lorsqu'un pays fait des efforts pour développer des projets dans les secteurs de l'assainissement et des stations d'épuration, ceux faits avec l'aide des femmes sont plus efficaces et durables. Par ailleurs, cette analyse illustre aussi que, grâce à la connaissance des femmes sur l'utilisation de l'eau dans leurs maisons et dans les communautés, ces femmes ont alors tout intérêt à s'assurer que les foyers et les communautés ne soient pas mis en danger par de l'eau dégradée.

Ce rapport recommande que les agences de l'eau et les gestionnaires de l'eau au Maroc considèrent à plus impliquer les femmes dans les projets pour améliorer les secteurs d'assainissement et de traitement de l'eau. Cette analyse identifie cinq recommandations clés pour améliorer les systèmes de l'assainissement et de traitement de l'eau au Maroc : donner aux femmes le pouvoir de participer dans la prise des décisions concernant la gestion de l'eau ; augmenter la participation des femmes dans les conseils municipaux par une représentation élue ; mettre à jour et centraliser les indicateurs de l'eau et de l'assainissement avec le Ministère de l'Energie, des Mines, de l'Eau et de l'Environnement ; inclure les femmes dans les décisions pour identifier les méthodes de traitement appropriées pour être bénéfiques aux communautés ; et instruire les jeunes, utiliser les partenaires académiques, et créer des emplois dans le secteur d'eau pour les jeunes générations à venir.

A Visit to Dayat Ifrah

In 2008, the Rabat-American Circle (RAC) in Rabat, Morocco, took a tour to the small village of Dayat Ifrah, once known for its sprawling lake in the rural countryside. The group, comprised of water agency leaders, decision-makers, and influential members of Morocco's elite classes, saw this tour as an opportunity to discuss with villagers the dramatic shrinking of the lake – a recent development – and what this meant for the livelihood of the village. Both men and women in the village relayed their concerns about the diminishing lake levels and their loss of a secure water source. This community stressed that having enough water to continue with daily activities of cooking and irrigating, as well as conducting daily religious rituals of cleaning before daily prayers, was vital to their existence.

Although the conversations focused primarily on the concerns surrounding water quantity, the issue of water quality was also raised. The village had only rudimentary sewage collection and thus no method to treat used wastewater. Someone from the RAC brought up how new cost-effective water technologies – measures for signaling whether water is clean enough to drink and pellets to clean water – were making a difference for the health of many communities. Most of the villagers had never heard of these technologies or realized that water resources from surrounding riverbeds may not always be safe. The Moroccan Government had already taken actions to provide some citizens with clean drinking water, but they were just beginning to treat that water after use. Exploring how this wastewater (water contaminated with an overload of nutrients, excreta, or used water – “greywater”) can be treated to benefit both communities and the environment is integral to the health and development of communities such as Dayat Ifrah.

INTRODUCTION

Rationale for Study

The story of Dayat Ifrah demonstrates the vast need for effective wastewater treatment in Morocco. While many Moroccan towns are equipped with sewage networks, over 58% of generated wastewater is discharged on the coasts, and the remaining effluent is dumped into rivers and tributaries. This increases health risks for environmental and human health, increases the threat of water scarcity, and lowers food production.¹ Moreover, based on my research, Morocco currently has no extensive studies linking sanitation and wastewater initiatives to the role of women as water managers.

Purpose and Structure of Report

The purpose of this paper is threefold. First, the aim of this paper is to discuss the implications of Morocco involving women in decision-making and management roles at household and country levels. Second, this paper serves to analyze the state of sanitation efforts and wastewater treatment in Morocco. Finally, this paper offers recommendations for country-level strategies and concludes with opportunities for further research.

Wastewater Treatment and Sanitation in Morocco

The government of Morocco implemented its first national water law in 1995 in recognition of the need to conserve both the quantity and quality of limited water resources available throughout the country. This water law divided Morocco into river basins and established methods of Integrated Water Resources Management (IWRM) to improve communication regarding water quantity and quality across all basins within the country. As providing safe drinking water to citizens is largely recognized as a pre-requisite for economic development,² this water law spurred efforts to bring clean drinking water to the majority of Morocco's population.

Because providing safe drinking water is inextricably linked to collecting and treating wastewater, water management is typically comprised of three components:

- 1) Producing and distributing clean drinking water
- 2) Collecting wastewater through sanitation connection systems
- 3) Treating wastewater for proper disposal

Morocco's government has already made significant progress in the first of these initiatives, but wastewater treatment and sanitation collection, which includes building sewer systems to collect and bring wastewater out of a community, have largely been left on the sidelines. To date, only 75% of urban populations and 35% of rural populations have access to sanitation collection and wastewater treatment.^{3,4}

Studies have shown that incorporating women into the decision making process improves the effectiveness and sustainability of sanitation and wastewater initiatives.^{5,6} This link is particularly prominent in rural areas where women are the primary caregivers. In safeguarding family health, women have a vested interest in ensuring that their households have enough clean water to carry out daily activities. In this de-facto role as household managers of water, “women often have had no voice and [therefore] no choice in decisions about the kinds of services – water supply, sanitation, health – that are provided to protect their family’s well-being.”⁷

The role that women play in managing household water resources was illustrated in 2009 when the UNESCO Chair for “Water, Women and Decision Power”, along with a number of Africa’s leaders in water quality management, visited the remote village of Ain al-Khail to talk about simple measures of keeping water supplies clean. One of the main challenges faced by water agencies is the high rate of illiteracy among rural women, which often requires agency leaders to use innovative methods to explain how to improve water quality.⁸

One woman in the village was very interested in hearing what the experts would say about her method of cleaning water, which involved filtering water through a piece of cloth and storing it in a container. Despite its ineffectiveness, this method is commonly thought of as a way to avoid contracting disease.⁹

According to the UNESCO Chair, “Rural women often do not see the link between polluted water and poor health... It is common in rural Morocco for women to be in charge of water management at home and for cooking but [not] see the relationship between water and the diseases that affect children in particular.”¹⁰ This problem extends across North Africa, as resources are both scarce and at risk of contamination due to the lack of sanitation. According to Reuters, water in rural areas is sometimes reused without being treated.¹¹

II. METHODOLOGY

Overview

To gain a broad knowledge base regarding the methods and perspectives of sanitation and wastewater treatment policy in Morocco, I first drew upon experiences and interviews conducted while living in Morocco between September 2007 and August 2008. The primary research methodology was Participatory Action Research (PAR) which involves all relevant parties in the examination of a certain issue deemed of concern and needing improvement, with the goal of working together toward positive change. As such, this approach aims to be active co-research, by and for those who are directly affected by the issue or problem. After stating the conclusions of the research, the examined issues are oftentimes changed and addressed again according to specific area needs.¹² This type of methodology is used by many development agencies to research complex situations on the ground and make recommendations based on firsthand knowledge.

The PAR methodology I used included participant observation, semi-structured interviews, site visits, and a literature review. The experience through internships, site visits, and semi-structured interviews provided the foundational knowledge for a greater understanding of the role of women in Moroccan society, the urban-rural divide, the status and scope of water management agencies, and the fundamental underpinnings of Morocco's water law. These grounding concepts also provided the knowledge needed to interpret and frame the literature on the connection between wastewater treatment, development, and the role of women.

Three years have passed. Since 2008, Morocco has implemented new initiatives to develop wastewater treatment and expand sanitation collection. I was able to collect information on this progress through an information and literature research, as well as through maintaining contact with a few key water policy experts in Morocco. My personal

experience living in Morocco, coupled with the skills obtained from my current degree program, has resulted in a more in-depth approach for my analysis today.

This paper analyzes the progress of Morocco's sanitation and wastewater treatment programs using a combination of the following methods to identify opportunities for improvement:

1. Participant Observation

I worked as an intern with the National Organization for Potable Water (ONEP) based in Rabat between April-August 2008. I primarily worked under the UNESCO Chair for "Water, Women and Decision Power" who was interested in looking at the link between gender and sanitation perspectives. This direct insight into how water agencies interact, manage, and document infrastructure projects helped me understand ONEP's role in implementation a national water plan for Morocco. In this role I had access to crucial documents that explained how water agencies in Morocco were managed. My discussions and interviews with key staff in the agency furthered my understanding of the implications of Morocco's water law, thus furthering my understanding of national water management practices in the country.

2. Semi-Structured Interviews

To better understand Morocco's overarching water management goals, I conducted interviews with representatives from various institutions between 2007 and 2011. Key interviews included staff, officials, and professors from several institutions and organizations dealing with water issues, including: the National Office of Drinking Water (ONEP); the Department of Water of the Ministry of Territorial Management; the Ministry of Agriculture; the U.S. Agency for International Development; the U.S. Embassy; Al Akhawayn University in Ifrane; the Ecole National d'Agriculture in Meknès; the Tourism School in Tangier; the UNESCO Chair for "Water, Women and Decision Power"; and Peace Corps volunteers.

3. Site Visits

In order to better understand the research findings in relation to water resources and populations directly affected by Morocco's water policy, I visited several wastewater treatment sites in Rabat, Ain Toujdat, and M'ritt between February-August 2008. A common theme within these sites was determining the economies of scale to make projects feasible in specific areas. For example, many of the sites in rural areas only treat wastewater to a minimal extent, which is just enough to reduce the risk of disease-transfer or environmental pollution. For smaller communities, this type of primary treatment is more cost-effective than treating water to standards for irrigation reuse, which requires more energy and resources. In contrast, ONEP's headquarters in Rabat had a much more technical wastewater treatment plant which treated wastewater to a point where it could be reused for irrigation. This type of plant required a greater knowledge of operations and maintenance procedures, and cost much more than simpler treatment methods typically used in rural villages.

LITERATURE REVIEW:

The Global State of Water

Across the globe, over one billion people lack access to safe drinking water, and over three billion people lack access to adequate sanitation.¹³ The United Nations Education, Science and Cultural Organization (UNESCO) defines safe drinking water as, “the proportion of the total population with access to an improved drinking water source as their main source of drinking water”. UNESCO defines sanitation as, “the proportion of the total population with access to an improved sanitation facility (for defecating).”¹⁴ Despite efforts by world aid organizations, development agencies, governments and non-governmental organizations to mitigate water scarcity and increase water quality, water-related problems continue to hinder development across the globe. Consider the following quotes from the organization Water.org, an agency that links donor and staff members to communities in need of safe drinking water:

“The water and sanitation crisis claims more lives through disease than any war claims through guns.” (2006 UN Human Development Report)

“Lack of sanitation is the world’s biggest cause of infection.” (Water Supply and Sanitation Collaborative Council, 2008)

“In the developing world, 24,000 children under the age of five die every day from preventable causes like diarrhea contracted from unclean water.” (UNICEF, WHO 2009)

“Millions of women and children spend several hours a day collecting water from distant, often polluted sources.” (2006 United Nations Human Development Report)

“Investment in drinking water and sanitation would result in 272 million more school attendance days a year. The value of deaths averted, based on discounted future earnings, would amount to US\$ 3.6 billion a year.” (Department for International Development, Sanitation Reference Group, 2008)

“More than 80% of sewage in developing countries is discharged untreated, polluting rivers, lakes and coastal areas.” (2004, Wastewater Use in Irrigated Agriculture)

While global efforts in the 1990s resulted in over a billion people gaining access to potable water,¹⁵ over one billion people are still exposed to unsafe water resources. The sanitation situation is even more ominous: 2.6 billion people live without improved sanitation.¹⁶

These sanitation collection and wastewater treatment components are critical aspects for fostering healthy societies and environments. According to the World Health Organization (WHO), waterborne diseases are one of the leading causes of mortality for children under five worldwide, and more people die from degraded water quality than violence.¹⁷ The UN Environmental Program (UNEP) found that “Unsafe water and lack of sanitation and hygiene make up 18% of under-age-five deaths, and is one of the leading causes of mortality among children in developing countries.”¹⁸

Most of these water-related diseases are a result of using unclean water for drinking and washing, leading to diarrheal diseases such as cholera and typhoid. Every year approximately “1.8 million people die from diarrheal diseases, 88% of which are attributed to unsafe water supplies or inadequate sanitation and hygiene.”¹⁹ Diarrheal related diseases like cholera or dysentery, and infections caused by diarrhea such as malaria and measles are particularly harmful to young children due to massive fluid losses.²⁰ The International Water and Sanitation Centre (IRC) argues that a broad range of options are needed to address these sanitation issues, such as treating water to meet ecological and environmental standards and reducing the level of pathogens in wastewater to prevent infection and reduce pollution.²¹

According to the World Health Organization, “Sewage treatment even in the most developed nations is not universal or fully effective, and effluent discharged into rivers and coastal areas constitutes a health risk to bathers, among others.”²² Further studies delineate the burden caused by inadequate wastewater treatment by noting that, “There is a strong link between repeat or chronic diarrhoeal disease, malnutrition, and the poor educational and physical growth that can seriously affect the ability of children to reach their full potential.”²³

In developing countries, unsafe water sources impact men and women differently due to the division of work and extent of decision-making. Understanding these differences provides insight for how men and women might jointly manage programs related to improving hygiene and public health. In addition to bearing the responsibility for collecting water, women are often responsible for caring for sick family members who fall ill due to unsafe water.²⁴

Unsafe water and lack of sanitation and hygiene directly relate to the amount of sanitation collection and wastewater treatment infrastructure in a society. According to the United Nations (UN), “Every day, two million tons of sewage and other effluents drain into the world’s waters.”²⁵ In addition, “The most significant sources of water pollution are lack of inadequate treatment of human waste and inadequately managed and treated industrial and agricultural wastes.”²⁶

This improper handling of wastewater has detrimental impacts to a household’s health, water resources, livestock, fish populations, girls’ schooling, infant mortality, education levels, and economic development.²⁷ According to UNEP, “In developing countries, 1.3 billion women and girls live without access to a private sanitary toilet...the lack of safe sanitation at school also dissuades girls from attending school after menstruation, further limiting educational equality for girls.”²⁸

The urban-rural divide is also stark. Those with less access to water and sanitation are more likely to live in rural areas that have virtually no connection to urban areas, or even peri-urban areas on the outskirts of cities. Globally, people in rural areas are half as likely to have access to a toilet than those in urban areas.²⁹ These populations are also less likely to have access to health care and carry a stable job.³⁰

Given these findings, the growth of a country’s economic development depends on the ability of its citizens to access an adequate supply of freshwater resources. Development

theory suggests that access to clean, freshwater resources reduces the risk of disease, increases public and environmental health, and allows citizens to stay both healthy and productive.^{31,32,33} This link between improved sanitation and development is further supported by the WHO which notes that in times before modern medical care, industrialized countries reduced the levels of waterborne diseases by implementing good water management systems. The WHO goes on to state that improved public health provides an “effective gateway for development and poverty alleviation.” Over 3.4 million deaths from water-related diseases could be prevented annually through improved hygiene and sanitation measures at the household level.³⁴ Examples of these interventions are illustrated by World Bank and UN reports, which have shown that including women in the management of water resources yields higher gains in efficiency and equity when implementing water quality programs.³⁵ At the same time, water development projects that *exclude* women *negatively* affect the efficiency and effectiveness of projects.³⁶

According to a UN Water Report,³⁷ in most societies women hold the primary responsibility of managing household water supplies by ensuring proper sanitation collection and overseeing the family’s health. This same report argues that due to women’s firsthand knowledge of water supply, use, and disposal, women should be central in decision-making efforts to manage water at both local and national levels. UN studies that incorporate approaches involving women note positive impacts in that “Facilities are more likely to be technically appropriate, conveniently situated, well used and maintained where both women and men have been consulted...water supplies are better used and the consequent benefits are therefore greater.”³⁸

In addition, the International Water and Sanitation Centre’s (IRC) study of community water and sanitation projects across 88 communities in 15 countries found that projects that include women in the central decision-making process of water projects are far

more likely to be both effective and sustainable.³⁹ In turn, such projects increase the level of development in a society. Further support for these results comes from an earlier World Bank study that found a strong association between the participation of women and the effectiveness of water and sanitation projects that aim to reduce the levels of water related disease.⁴⁰

Authors of the book, *The World's Water*, and prominent members of the global water community, Peter Gleick, Heather Cooley and David Katz argue that “Women play a significant role in how water is collected, managed, and used... [Therefore, water managers] must consider women’s sociocultural role in society and not in a vacuum.”⁴¹ In the past, men’s assumptions about household use of water were detrimental to women’s access to using and managing water. Therefore, the authors conclude that “Good water governance will help protect women’s water rights by also addressing imbalances between men’s and women’s ownership rights, division of labor, and incomes.”⁴² Directly involving both men *and* women at all levels of water management, from international organizations to local governments, is a crucial component for effective water management.

A Water Sanitation and Hygiene (WASH) program in two small rural villages in Ethiopia noted a number of positive impacts that empowered women through sanitation and hygiene initiatives. When addressing water-related needs from the perspective of women, community members reported that water collection increased, time fetching water decreased, and hygiene practices increased. Women also reacted positively in that 34% felt more empowered, 67% felt improvements in equity and 68% felt their control over household resources had improved. When hand washing stations near latrines were installed, women were “6.62 times more likely to have said they felt significantly more empowered,” and “5.10 times more likely to have reported feeling much more equality in the household.”⁴³

Despite these empowerment efforts, social barriers continue to exist that inhibit some women from participating in water management. The UK Department for International Development noted that in practice, the empowerment of women occurs for only a small percentage at the top who sacrifice a great deal to reach a position with some semblance of power.⁴⁴ This development agency stressed the importance of finding a common definition of empowerment and aligning gender-studies work with that of water practitioners.

The State of Water in Morocco

In response to the global implications of unsafe water, the United Nations declared 2008 as the “Year of Sanitation” to find a solution for low levels of access to potable water and basic sanitation to improve living conditions and conserve water resources.⁴⁵ This initiative sparked a series of wastewater treatment and sanitation-focused programs in Morocco that has set the country on a track to develop wastewater treatment and sanitation collection infrastructure. Such programs include the National Sanitation Plan (Planification Nationale de l’Assainissement, PNA), a number of World Bank funded projects, and the designation of a UNESCO Chair for “Water, Women and Decision Power” in 2008 (Dr. Asma El Kasmi) to assess the link between sanitation improvements and the role of women as water managers.

The UNESCO Chair provided her preliminary findings of women as water managers at a conference on “Women in Water Management” held in Ifrane, Morocco in 2007. The Chair, Dr. Asma El Kasmi (ONEP) and Francis Segond (UN Women Health Education Program, WHEP) argued that strengthening the role of women as water managers was justified by several reasons. First, they noted that involving women in the design, implementation, monitoring and evaluation of projects tends to increase the efficiency and sustainability of water-related projects. Second, they stressed that “greater and more

effective participation” by women would further equality, gender empowerment, and poverty alleviation goals in Moroccan society.^{46,47}

The World Bank did a similar assessment in 2005 with the implementation of a Rural Water Supply and Sanitation Project in Morocco. This project aimed to decrease the amount of time girls spent fetching water in order to spend more time attending school. At the end of the program, school attendance by young girls increased by 20% in four years, and time spent collecting water was reduced by 50-90%.⁴⁸

According to Dr. Rachid Bouabid from the National Agricultural School in Meknès (MENA), a Water Management Project conducted by the U.S. Agency for International Development (USAID) in the rural areas of Imouzzer Ida Outanane (near Agadir) found that the limited attendance of girls to schools was due to the unavailability of restrooms within remote schools. Due to the vast distance between homes and schools, children are often at school the entire day, and thus need access to sanitation facilities such as restrooms. USAID noted that a link may exist between the lack of restrooms in school and the illiteracy of young girls in some rural areas. The study noted that this phenomenon was true in other areas as well.⁴⁹

Despite the increased prominence of women in academia and government, opportunities for women are still limited by low literacy, urban/rural disparities of social inclusion, and limitations in direct domestic and community involvement. According to a study by the International Water Resources Association (InWent) in 2001, the involvement of professional women in water-related institutions is less than 20% in Morocco,⁵⁰ even though women make up nearly half of the overall workforce.⁵¹ In 2005, the UN International Decade for Action, “Water for Life” campaign aimed to increase the participation of women in water-related development efforts. According to their report, the number of women appointed as water and environment ministers in developing countries had increased to 40 by

2005.⁵² Morocco is included in these countries. Mrs. Benkhadra has been the Minister of the Ministry of Energy, Mines, Water and the Environment since 2008. However, the role of women as central decision-makers for water and sanitation projects at the local level has yet to keep pace.

Better sanitation collection and wastewater treatment can have direct, positive effects for women in the areas of childbirth, life expectancy, education and well-being. When Morocco is compared to other countries in the Middle East and Northern Africa (MENA) region, Morocco generally does better when comparing across health development indicators, and worse when comparing environment and literacy indicators. Infant mortality in Morocco is lower than both MENA and world levels (42 verses 52 and 55, respectively), and life expectancy is slightly higher than both MENA and world indicators (70.5 years verses 69.6 and 69.1, respectively). However, access to improved sanitation still falls behind the MENA region: 86% of urban populations and 44% of rural populations in Morocco saw an improvement in access to sanitation in 2003, whereas 91% of urban populations and 70% of rural populations in the MENA region saw such an improvement.⁵³ Perhaps the most telling statistic is that of education: while female literacy rates are increasing (15% of women were literate in Morocco in 1980; over 20% in 1990, and upwards of 38% in 2002), across the MENA region approximately 61% of women are literate, and globally the rate is higher at 75%.⁵⁴

ANALYSIS: SANITATION COLLECTION AND WASTEWATER TREATMENT

Before discussing the environmental and economic impacts on communities, it is important to provide common definitions for sanitation collection and wastewater treatment. In this analysis I describe the development of wastewater treatment and sanitation policy in Morocco and the impacts for women. From there, I outline the current types of wastewater treatment in Morocco and the economies of scale options for local community members to consider when determining an adequate type of treatment method. Finally, I describe country goals and provide examples for best practices in wastewater treatment and reuse which have been shown to have positive impacts on women and families living in those communities.

Grounding Concepts

A common definition of sanitation is needed to set the context for the remainder of this paper. According to UNESCO, sanitation refers to:

An improved sanitation facility is defined as a facility used for excreta disposal whereby the human excreta are hygienically separated from human contact or their immediate environment, thus reducing the risk of fecal-oral transmission to its users. Such facilities include: Toilet with sewer connection or septic tank, pour flush toilet/pour flush latrine to sewer, septic tank or pit, Ventilated Improved Pit (VIP) latrine, latrine with a slab, and ecological sanitation.⁵⁵

According to Morocco's National Sanitation Plan (PNA), the country's low infrastructural base for water networks has resulted in a national sewage connection rate far lower than that of potable water connections.⁵⁶ However, it is difficult to determine the current state of water and sanitation access in Morocco. Several agencies have attempted to track Morocco's levels of access to potable water and the extent of sanitation, oftentimes showing a wide variation in results. A main reason for this disparity is that many of these indicators rely on different definitions.

According to the International Bank for Reconstruction and Development in 2009, 93% of Morocco's population had access to an *improved water source*.⁵⁷ The World Bank

did a similar study that same year, indicating that 98% of the urban population had *access to clean water*, and whereas only 60% of the rural population had access.⁵⁸ This differs slightly from other data from Morocco's National Sanitation Plan in 2007 that place *access to clean water* figures at 100% for urban areas and 77% for rural areas.⁵⁹

Similar complications occur for figures and definitions relating to sanitation. According to the International Bank for Reconstruction and Development, 79% of Morocco's population has *access to improved sanitation facilities*.⁶⁰ While this figure looks promising, the difference between urban and rural situations for sanitation collection is stark. According to ONEP, the *sewer connection rate* to urban households is 75%⁶¹, meaning that three-fourths of the population is connected to infrastructure that will collect and dispose wastewater. In rural areas, only 35% of the population is connected to a sewer network. Of these total amounts (both urban and rural combined), just over 20% of the collected wastewater goes on to be treated.⁶²

Furthermore, urban populations are growing at a faster rate than rural populations: World Bank Statistics for 2009 placed Morocco's population at 31.9 million with a growth rate of 1.2%. The percentage of those living in urban areas was 56% and the percentage living in rural areas was 44%.⁶³ Of these figures, rural populations are currently growing at a rate of 0.4% per year. In contrast, urban population growth is upwards of 3.5%.⁶⁴

Economic and Environmental Impacts

Morocco is classified as a "water-scarce" country as the average volume of water per inhabitant rests slightly below the 1000 cubic meters (m³) per inhabitant per year threshold.⁶⁵ This is particularly worrisome as poor water quality also impacts water quantity. According to UNEP, "Polluted water that cannot be used for drinking, bathing, industry or agriculture effectively reduces the amount of water available in a given area, directly impacting water quantity."⁶⁶ This limited water availability is continuously stressed by the water needs of a

growing population, (34% of the population is under the age of 15)⁶⁷, the pollution of groundwater resources by household and industrial waste, the under-valuing of water (buying toilet paper is more expensive than buying water), and the impacts of climate change (many of Morocco's lakes are shrinking).

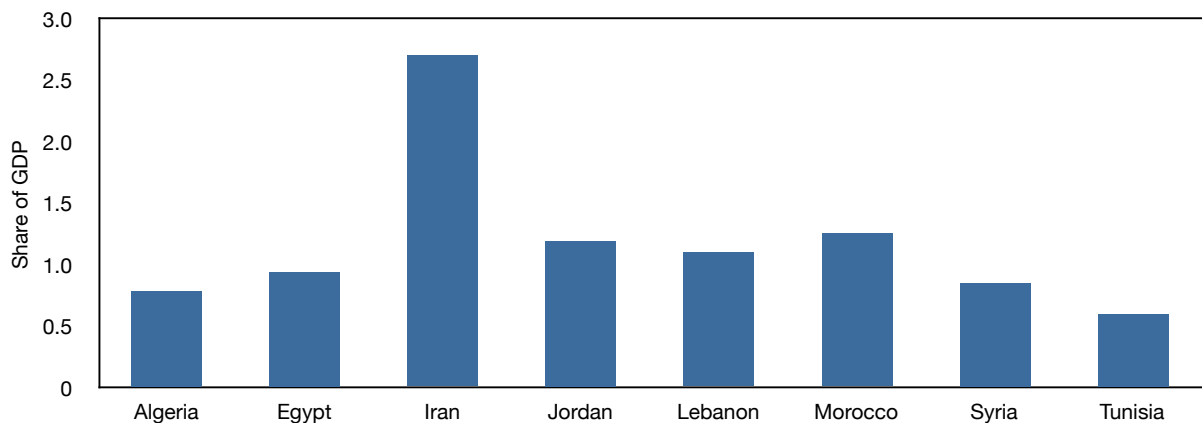
Morocco has experienced negative impacts to both the environment and economy due to an increase in population growth that has outpaced the expansion of sanitation and wastewater treatment efforts. Morocco currently has 72 wastewater treatment facilities that are primarily located in rural areas, but only 32 are operational due to elevated maintenance costs^{68,69}. Many of these plants are out of order due to rising electricity costs, the lack of equipment maintenance, and the lack of coordination between different managers of wastewater treatment plants.⁷⁰ In a report by Mr. Mostafa Biad, Chief of Distribution Services for ONEP, Biad stated that procedures such as technical and performance indicator follow-up, monthly reporting, and studying the potential for efficiency improvements were part of ONEP's strategy for operation and maintenance plans. However, no information was given in terms of addressing operations and management (O&M) costs as a longer-term strategy; instead, many of Morocco's wastewater treatment facilities eventually fall into disrepair due to lack of personnel training to run facilities and a failure to continue hiring people to oversee facilities after the initial set up and implementation.

Improper sanitation treatment and planning leads to further environmental and health problems such as water and land degradation, negative public health impacts (such as infection from parasites, bacteria or viruses causing worm disease, river blindness, dysentery, typhoid fever and others), and limited social and economic development. Appendix A outlines the impacts of insufficient sanitation collection and pollution reduction, as identified by Morocco's National Water Plan.

The inadequate handling of wastewater also impacts the economy of Morocco.

World Bank and Ministry of Environment assessments in 2003 place the overall cost of environmental degradation in Morocco at 13 billion dirham per year (\$1.6 billion USD), or 3.7% of the national GDP.⁷¹ However, other sources, such as the International Institute for Water and Sanitation, place the figure closer to 0.5% of the GDP per year.⁷² Of the World Bank and Ministry of Environment's figures, water resources degradation due to pollution is 4.3 billion dirham (\$540 million USD), or 1.2% of the GDP.⁷³ Figure 1 from the World Bank shows the annual cost of the environmental degradation of water between Morocco and other countries in the MENA region.

Figure 1: Annual Cost of Environmental Degradation of Water⁷⁴



Source: Palaniappan, et. al., 2010

Many of these costs are attributed to potable water treatment, treatment costs for harmful parasites and pathogens, and diseases causing premature death from water-related pollution.⁷⁵ Heavy metals, food-processing waste, nitrates, and pesticides originating from domestic, industrial, and agriculture sources that have been discharged into the environment also contribute to these costs.⁷⁶

Studies show that increased access to clean water and sanitation services typically results in faster economic growth. The UN World Water Assessment Program found that for

every \$1 USD invested in sanitation and drinking water, there is an estimated \$3-\$34 return.⁷⁷ These returns have been shown to be greater with the involvement of women. Projects in sub-Saharan Africa countries in the 1980s found that, in using a gender approach for water projects, women will “bring up relevant issues from their own areas of knowledge and responsibility,” and thus can be active designers and managers of water projects to add to their sustainability and success.⁷⁸

Development of Wastewater Treatment and Sanitation Policy

Recognizing the need for sound water management in a country facing increased water scarcity, Morocco created their first national water law in 1995. This law focused on the management of water resources in the country, but did not outline specific legislation for sanitation and wastewater treatment. As water policy has developed, Morocco’s sanitation and wastewater treatment policy evolved through three main initiatives: Morocco’s National Grouped Rural Drinking Water Supply Program; the National Director’s Scheme of Sanitation; and the National Sanitation Plan.

From 1995-2004, the Government of Morocco launched its National Grouped Rural Drinking Water Supply Program (PAGER) aimed at increasing water supply and sanitation access rates.⁷⁹ Following this program, ONEP and the Food and Agricultural Organization (FAO) conducted a diagnostic study on rural drinking water supply in Morocco.⁸⁰ This study quantified the improved health conditions of populations affected by the study through the prevalence of fewer waterborne diseases, including a 37% reduction of diarrheal diseases, a 13% reduction in child mortality, and a 75% reduction of colic and chronic diarrhea.⁸¹ Mme. Fatine, an employee at the Food and Agricultural Organization who worked on the PAGER project, noted that one critique of the PAGER project was that while PAGER was meant to include sanitation programs, that component remained weak compared to the amount of attention given to potable water.⁸²

In 1995, the National Director's Scheme of Sanitation (SDNAL) was launched to plan infrastructure, financing, and institutional measures for the sanitation sector. This plan identified, estimated, and prioritized the sanitation needs in the country with a goal to cover the sanitation sector by 100% by the year 2015. By recommending the creation of a National Agency of Sanitation, this program helped communities develop sanitation projects and manage their operations. However, due to lack of consensus on financial and institutional aspects, these initiatives failed to be fully implemented.⁸³

Most recently in 2008, the government of Morocco launched the National Sanitation Plan (Planification National de l'Assainissement Liquide et d'Épuration des Eaux Usées, PNA), which outlined a strategy to increase the rate of water and sanitation access in rural areas and promote public and environmental health. The PNA defined investment needs, priorities, and financial policies for the sanitation sector; evaluated global costs; and proposed an overall financial plan for this sector.⁸⁴ While this proposal provided a more comprehensive picture of the state of wastewater treatment and sanitation than many other key water agencies, it still did not explicitly explore further possibilities for women as water managers.

These three strategies highlight the importance of improving sanitation collection and wastewater treatment infrastructure, yet all three fail to address the role of women in the implementation of these measures. Literature from past decades supports the theory that infrastructure projects involving women have a positive impact on the improvement of households.⁸⁵ For example, there is typically a higher incentive to improve water supplies and infrastructure in urban areas because shortages of water and unsanitary conditions threaten the privacy and safety of women.⁸⁶ At the same time, women in both urban and rural areas tend to see incentives to participate in water supply and sanitation projects due to their integral role in family health, and recognizing opportunities for their children's

recreation, stewardship of the environment, and a general economic interest in maintaining an adequate water supply.⁸⁷

*Types of Wastewater Management and Treatment*¹

Several types of water management and treatment options exist for communities in Morocco. Both the type of water management authority and method of treatment have direct implications for communities and households. Communes (municipalities) have four options available to manage sanitation collection, wastewater treatment, and wastewater reuse. First, the commune can choose to govern water resources directly. This is most popular for smaller villages in rural areas. Second, the commune can choose to delegate any aspect of the human water cycle (water production and distribution, sanitation collection and disposal, and wastewater treatment) to either an Autonomous Authority (Régie Autonome) which is popular in many of Morocco's medium and larger cities; to ONEP, which operates in many of Morocco's smaller and medium cities; or to private companies which operate in Morocco's largest cities. For more information, see Appendix C.

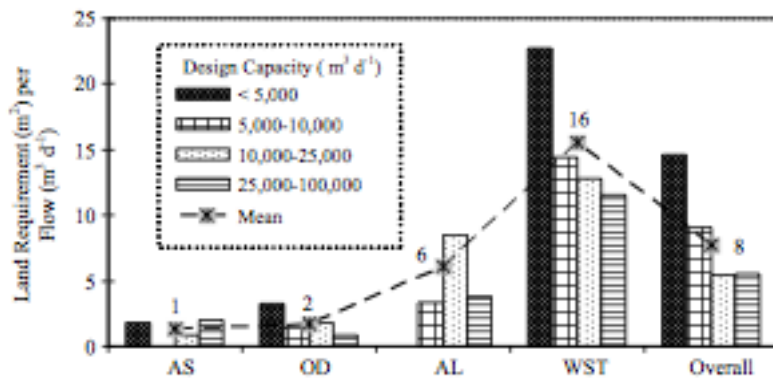
Depending on a community's needs, the extent, cost and type of treatment can differ. Typically the trade-off in wastewater treatment is between land and cost. Some types of treatment require large amounts of land, while others have large upfront costs or operations and maintenance (O&M) costs comprised of personnel, energy, equipment & chemical, and maintenance.⁸⁸ Another consideration is the level of water quality. If water will be used for drinking and irrigation, contaminants such as organic wastes and bacteria must be removed in order to be at an acceptable level for reuse.⁸⁹ Community members, men and women alike, must determine which treatment cost most adequately reflects a household's or community's

¹ A more comprehensive description of the various types of wastewater treatment can be found in Appendix B.

income and expenses, as the ability to pay is the most likely determinant of which type of treatment facility to construct.⁹⁰

A common type of treatment system used in rural areas is the Waste Stabilization Pond, a type of pond treatment system that requires large amounts of land but operates at a low cost. Another similar treatment used in rural areas is Oxidation Ditches, which requires more area. In contrast, an Activated Sludge process requires less land but is more costly to operate due to energy demands and complex O&M requirements. The presumption is that “larger plants generally require less land per unit served due to an economy of scale.” Figure 2 from the *Journal of Sustainable Environmental Resources*, illustrates the economy of scale trend for land requirements of different treatment processes by showing how the amount of land required per increase in cubic flow decreases as the size of the plant increases⁹¹:

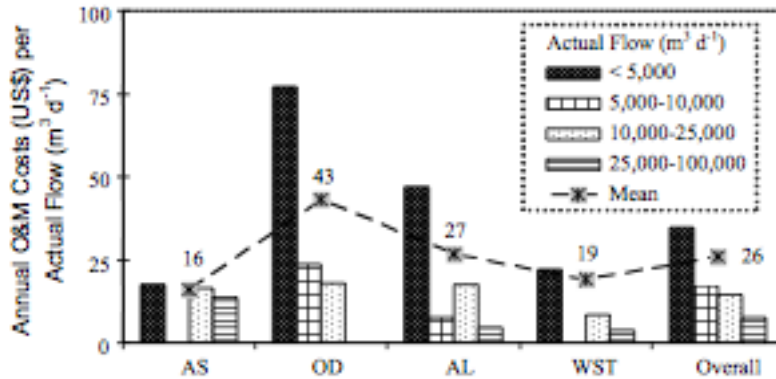
Figure 2: Land Requirements for Different Processes and Design Capabilities



Source: Singhirunnusorn, Wichitra and Michael K. Stenstrom (2010). AS: Activated Sludge; OD: Oxidation Ditches; AL: Aerated Lagoons; WST: Waste Stabilization Ponds

Similarly, the figure below depicts overall annual O&M costs for different treatment types:

Figure 3: Overall annual Operations and Maintenance costs for Different Processes and Actual Flows



Source: Singhirunusorn, Wichitra and Michael K. Stenstrom (2010). AS: Activated Sludge, OD: Oxidation Ditches, AL: Aerated Lagoons, WST: Waste Stabilization Ponds

The type of treatment applied to wastewater is determined by the nature of municipal or industrial waste, and the amount of treatment required to keep receiving bodies of water at an acceptable level of quality.⁹² For example, in some smaller communes, first-level treatment in waste stabilization ponds may be sufficient to decrease the exposure of pathogens into the environment. In larger municipalities, citizens may wish to treat water further to a “tertiary” standard (removing virtually all pollutants) if the goal is to reuse water for irrigation in agriculture. At least some degree of treatment is necessary to reduce the risk of water-borne diseases in the environment, which could be transferred to household use via waterways. However, households and communities must be involved in the decisions to determine which type of treatment will yield the lowest cost.

In the past, the global tendency to respond to wastewater management was determined by the opinions of a few elite professionals, as opposed to households’ and communities’ perceptions of actual needs. Decisions regarding the type of treatment or intervention needed (e.g. deciding between using an “extensive” or “intensive” process) have

often been made at levels removed from those being served. Therefore, to both promote ownership of services as well as matching the type of service to the community being served, decisions regarding type of wastewater treatment must be done in direct consultation with community members.⁹³ Further still, asking women at the household level for their input on community and household needs may help to ensure that projects both fit the objective of the project, and provide for equitable access.⁹⁴

Current Progress and Extent of Wastewater Treatment Systems

So what is the current progress and extent of Morocco's sanitation collection and wastewater treatment infrastructure today, and to what extent are women involved in the processes? Morocco's key water agencies have placed extensive efforts on developing wastewater treatment and infrastructure during the past few years.⁹⁵ Despite the importance of the role of women, their decision-making power is mentioned infrequently in country reports.

To understand the extent of importance that improvements in sanitation and wastewater treatment infrastructure can have on a society, the tables below outline the extent of the quantities of wastewater generated verses treated to provide a general background of the country situation. In 2009 the Ministry of Energy, Mines, Water and the Environment reported that Morocco generated close to 750 million cubic meters (Mm³) of wastewater that year. Of that amount, only 100 Mm³ was treated (roughly 13%) and a mere 10 Mm³ (1.3%) reused.⁹⁶ Furthermore, the scale of wastewater generation is increasing – in 1960 the volume of wastewater generated stood at 48 Mm³, and today that amount has increased almost 15-fold. By the year 2020, the projected amount of wastewater generated will be 900 Mm³.⁹⁷

While the volume of wastewater generated has increased, Morocco's population is also increasing at a rapid rate. Population projections for 2014 predict Morocco's population will grow to 35 million – an increase of one-third since 1998. While the rural population is

expected to remain at current population levels, the urban population is predicted to grow by 70%. Two-thirds of Morocco’s population is expected to live in urban areas by the middle of this century, when the population is expected to increase upwards of 50 million inhabitants.⁹⁸ Morocco’s water and sanitation infrastructure must keep up with this rapid pace of demand.

Table 1 shows the quantity of wastewater generated and treated per year in 1960, 1994, 2009, 2010, and the projected amount for 2020. This table was derived from a number of sources, as no one source could be found to adequately reflect the evolving state of wastewater treatment countrywide.

Table 1: Quantity of Wastewater Generated vs. Treated: 1960 – 2010⁹⁹

Year	Quantity of Wastewater Generated per Year	Quantity of Wastewater Treated per Year
1960	48 Mm3/year	N/A ¹⁰⁰
1994	500 Mm3/year	40 Mm3/year (or 8%) ¹⁰¹
2009	750 Mm3/year	100 Mm3/year (13%); and 10Mm3 or 1.3% is reused. ¹⁰²
2010	N/A	Treating 20% of all generated wastewater ¹⁰³
2020	900 Mm3 (estimated)	N/A ¹⁰⁴

Sources: Berrada Gouzi, 2007; Mountadar, 2006; Touahri, 2009; Global Water Intelligence, 2010

According to the above table, only 8% of wastewater was treated in 1994, with 52% going into the ocean, 32% discharged into tributaries and the remainder unaccounted for.¹⁰⁵ In 2010, Morocco treated 20% of its municipal effluent,¹⁰⁶ and set a new goal to recycle more than 95% of wastewater, as well as treat water to be reused for agriculture. The government also adopted a “polluter pays” principle to encourage the industrial sector to make similar ecological adjustments.¹⁰⁷ Many of these goals and adjustments have come in response to an

increase in rural to urban migration that has put pressure on the outskirts of cities and *medinas* (old city centers). No large cities are adequately equipped with wastewater treatment facilities, and the majority of effluent goes directly into the rivers, streams, and seas.¹⁰⁸

Country Goals

Morocco's National Water Plan recognizes that sanitation collection and wastewater treatment facilities play an integral role in ensuring that water resources remain clean, which in turn helps to achieve health and sanitation goals such as reducing disease, increasing hygiene and quality of living standards, and reducing inequalities. To reach these standards, the PNA identified the World Bank as a key partner to implement rural water and sanitation projects as part of a National Water Strategy.¹⁰⁹ The World Bank and the Government of Morocco have worked closely together for decades to meet water and sanitation goals for the country. In attempting to meet these goals, certain challenges – degradation and depletion of water resources, gaps in water supply and sanitation coverage, and inefficient water usage – continue to limit both economic and social development opportunities. A comparison between sanitation and health indicators between Morocco, Tunisia and Egypt provides further context to Morocco's specific situation.

In Morocco, the maternal mortality rate is 240 (deaths of women per 100,000 live births), in contrast to Egypt (130) and Tunisia (100)¹¹⁰. When comparing these rates to clean water and sanitation, the connection between health and sanitation becomes clearer: Egypt, Tunisia and Morocco all provide sustainable access to clean water to over 90% of their urban populations, but only Egypt will attain their goal of halving the proportion of people without access to safe drinking water and sanitation by 2015. This goal is out of reach for both Tunisia and Morocco. Furthermore, in Egypt, nearly 100% of the urban population has improved sanitation; in Tunisia, 96% of the urban population has improved sanitation and the

country is on target to reach its goal of upwards of 100% by 2020. Morocco currently lags behind both Egypt and Tunisia at 86% and will reach its goal of improving sanitation only if the country redoubles efforts to improve access to sanitation to the poorest segments of society.¹¹¹

Future goals for Morocco’s National Water Strategy include having 95% access to water in rural areas by 2015, water balance restored in all river basins by 2020, provide 90% of the population with access to sanitation nation-wide and decrease urban pollution by 60% by 2030. Table 2 outlines the 2006 connection rates and 2015 goals.

Table 2: Access to Sanitation Network by City Size¹¹²

City Size	Connection Rate	2015 Goal
Large Cities (Over 100,000 inhabitants)	76%	83%
Medium Cities (between 20,000 and 100,000 inhabitants)	67%	75%
Small Cities (less than 20,000 inhabitants)	40%	60%
National Urban Average	70%	80%

Source: National Water Program, 2008

These goals represent major challenges that may not be achieved. While Morocco is implementing water savings plans, water infrastructure, and environmental protection strategies, four factors constrain these efforts according to the World Bank: a shortage of water to meet current needs, weak institutional governance, inefficient agriculture use, and inadequate access to water supply and sanitation services.¹¹³ Dr. Bouabid notes that a principle challenge that must be addressed is the quality of sanitation networks. For example, in most major rain events, water managers have discovered that sanitation networks are not

up to standards. The principle examples of this include both Casablanca and Tangiers, where Lydec and Amendis are redoing the primary sanitation networks that were implemented by the previous régies.¹¹⁴

Best Practices in Wastewater Treatment and Reuse

The cities of Drarga and Ben Slimane are two model examples for wastewater treatment and reuse. One reason why wastewater treatment projects tend to get less of a focus by communities is that the benefits of treating wastewater are not always garnered directly by areas that choose to treat wastewater. Communities have an incentive to provide clean drinking water to citizens, as well as to collect and dispose of wastewater out of a city. But choosing to treat wastewater does not necessarily benefit communities directly. Benefits are often on the side of communities located downstream of treatment sites. As implementing any type of wastewater treatment system poses an initial upfront cost, communities may have an adverse incentive in treating wastewater because they do not benefit immediately from that treatment. Therefore, developing wastewater treatment infrastructure in a way that captures immediate benefits for the community treating that water is critical. The two case studies below highlight how wastewater facilities have been successful. Both of these communities directly benefit from wastewater treatment and reuse for agricultural and tourism economic activities. Table 3 further explains the treatment methods, capacities, and populations served in 1997 and 1999.

Table 3: Treatment Methods, Capacity, and Population Served in Ben Slimane (1997) and Drarga (1999)¹¹⁵

Urban Wastewater Treatment Plant (UWTP)	Treatment Method	Opening Year	Treatment Capacity	Population
Ben Slimane	Aerated Lagoon	1997	5,600 m ³ /day	37,000
Drarga	Infiltration-percolation	1999	600 m ³ /day	5,700

Source: *European Commission Euro-Mediterranean Partnership (2004)*.

In the case of Drarga, a close community to Agadir, wastewater is treated from primary to tertiary levels. For primary treatment, wastewater is filtered and transferred to anaerobic basins; at the secondary level the water is further treated in the anaerobic basins; and at the third stage wastewater is transferred to additional basins to reduce pollutants. In Drarga, treated wastewater containing fertilizing value is sold to farmers at a price competitive with other water resources. Due to this type of wastewater reuse in agriculture, land values and crop yields have increased in Drarga, thus provoking other areas to adopt similar technologies.¹¹⁶

Such technologies have the potential to impact households in a positive manner. As women are directly involved in many agriculture activities in rural areas, this is one way women in communities could work to decrease the amount of wastewater in the environment and increase the livelihood of nearby agricultural activities. Although this plant was implemented by a USAID project, it may be noted that the site of implementation did not take into consideration the rapid urban expansion of the town (a planning problem). In a few years, the plant will be surrounded by new constructions and inhabitants, which will become a source for future problems such as bad odors and mosquitoes carrying malaria.

In Ben Slimane, 80% of the city is connected to the treatment network, which includes four stages of water decontamination: pre-treatment, primary treatment, secondary treatment, and tertiary treatment. While harmful pathogens can be taken out during the first stages of treatment, an advantage of treating water at the tertiary treatment stage is the ability for water to be reused. Such uses could include irrigating golf course areas while providing important fertilizing value. This has allowed the city to expand into future touristic enterprises.¹¹⁷ As many of the recommendations below focus specifically on wastewater treatment in rural areas, this could be one model to expand to further areas of the country, perhaps with a component to include the direction from local women's groups and organizations.

RECOMMENDATIONS

Given the above analysis, I have identified five key recommendations to improve water and sanitation efforts in Morocco: empower women in local communities; increase the participation of women in commune authorities; update and centralize water and sanitation indicators; involve women in identifying appropriate treatment methods; and educate youth, utilize university partnerships and create jobs.

1. Empower Women in Local Communities

The voices of women are lacking in many of Morocco's water initiatives, as evidenced by the fact that gender is not a component explicitly addressed in Morocco's sanitation and wastewater treatment goals. Morocco's ministerial leaders have an opportunity take a lead in initiating women-led programs, particularly in rural communities. One woman to perhaps lead this change could be Morocco's current Minister of Energy, Mines, Water and the Environment, Amina Benkhadra. These initiatives could include getting women more involved in local projects, expanding their role in community decision-making circles, and improving sanitation and hygiene education.

Morocco's women leaders could take the lead in creating opportunities for women in rural areas by leading events similar to the trips taken to Dayat-Ifrah and Ain al-Khail. Other initiatives could include assisting women to establish community groups for dialogue on water-related issues; offering women-led community courses on different collection and treatment options available; and providing travel grants for women in rural communities to talk with leaders in Morocco's water agencies.

2. Increase the Participation of Women in Commune Authorities

Rural communes have the ultimate say in choosing which management authority – régies, ONEP, private companies, or the commune itself – will receive the bid to produce, distribute and treat water. To increase the efficiency and sustainability of local water and

sanitation projects, communes could establish a Water Commune Board to involve both women and men in local decisions. This board could have an elected woman representative to work as an advocate on behalf of women, or establish a women's water group with a local elected official to sit on the main water commune board.

Having a woman on this board would be beneficial for numerous reasons. First, women may feel they have a voice if they have a safe place with fellow household water managers to discuss issues relating to water resources. Second, women would likely have a vested interest in ensuring projects be implemented in a timely, efficient and sustainable manner. Finally, having an official elected representative may signal to others in the community the legitimacy of the position, and thus give women a stronger voice in the decision-making process.

3. Update and Centralize Water and Sanitation Indicators

The economic and environmental costs for Morocco have increased due to improper sanitation collection and wastewater treatment. To reduce these costs and improve water quality, water agencies must first have a complete picture as to the current state of sanitation and wastewater treatment. In 2011, much of the literature and information from water agencies is out of date, and information is scattered across numerous agencies. Reports from 2009 and 2010 continue to use early 2000 numbers despite claims that Morocco has made progress in improving sanitation and wastewater treatment infrastructure. Where are the true figures located? Which numbers tell the true story? Until this information is updated and centralized, Morocco will be unable to adequately plan for future sanitation and wastewater infrastructure needs.

I recommend that the Ministry of Energy, Mines, Water and the Environment create a centralized database to collect information across the country pertaining to potable water connection rates, sanitation collection rates, and quantities of water used and treated. This

information would be collected from ONEP, régies, communes, private companies, and other water agencies operating in the country. By centralizing this information, Morocco's water agencies will have easier access to accurate data when planning for future sanitation and wastewater projects. Furthermore, as a government organization, this ministry is not tied to private investment and profit motivations. This Ministry is already playing the role of convener of interests and collector of information in many ways. For example, their establishment of an Observatory for Environment (ONEM) aims to involve stakeholders to collect and access countrywide environmental indicators to formulate policy.¹¹⁸

Over the course of writing this paper, I considered recommending the National Organization for Potable Water (ONEP) to carry out the role that I recommend for Morocco's water ministry. ONEP has already been given significant funds to provide clean drinking water to nearly all rural and urban communities across the country, and received a mandate from the Government of Morocco to begin providing sanitation services in areas where ONEP already provides water. Because of these reasons, ONEP could be a leader for the expansion of the sanitation sector, particularly if this agency shifts its focus to larger cities as opposed to rural communes.

However, the objective of Morocco's recent water law is one of decentralization – and for the specific community needs that must be considered for water agencies, I believe decentralization is still an appropriate approach for the country to follow. While giving ONEP full leadership capabilities may appear to be an efficient solution on paper, local agencies (régies) and the private sector should also play a role in continuing this goal of decentralization. Furthermore, ONEP is a unique agency in that it is both public and private. The agency receives its directives from the government, but also looks for opportunities to make a profit. While ONEP is taking a lead on expanding sanitation and wastewater

treatment projects, ONEP may have a conflict of interest if it acts as the sole central manager of countrywide water management data.

4. Involve Women in Identifying Appropriate Treatment Methods

Determining the appropriate method for treating wastewater depends on a community's cost structure and needs. Therefore, it is important to consider the input of community members who will be directly impacted by water project decisions. Women are often best suited to provide this input based on their established societal roles of working with water on a daily basis. Their participation may help highlight issues or concerns not seen by high-level governmental authorities. In addition to choosing an extensive or an intensive treatment process, other sanitation projects may include separating wastewater generated from different sources, installing septic tanks and providing training on how to maintain them, and implementing latrines in local school buildings. The joint participation of both men and women in the decision-making process can help to identify how projects can benefit individual communities in the most efficient manner.

5. Educate Youth, Utilize University Partnerships, and Create Jobs

The youth of Morocco today are the leaders of tomorrow. Their education and awareness must be increased in order to be more sensitive to water management issues, with a true and equitable vision towards rural areas. All projects and programs related to water should include education, awareness, and empowerment aspects when targeting youth, especially those already involved in either communal (elected) or civil society activities.

Unemployment for Morocco's youth is very high, with 17.6% of the population between ages 15-24 unemployed.¹¹⁹ As 30.5% of Morocco's population is at or below the age of 14, job creation is a major government priority. Water agencies in Morocco can use the challenges relating to sanitation collection and wastewater treatment infrastructure as an opportunity to further educate, train and employ youth. For example, creating nationally

sponsored internship programs with public high schools and universities for students to participate in the work of the water sector would not only provide much-needed practical experience for many of these youth, but also serve to bring in fresh ideas for the water sector at large. In addition, these youth members would gain an invaluable education to promote ideas for the future of Morocco's sanitation and wastewater treatment sector, and be more vested in the projects themselves due to their direct involvement. Such programs could also be developed to route youth – specifically young girls – into growing jobs in the water and sanitation sectors, perhaps via apprenticeship programs.

Supporting this next generation of leaders in Morocco is crucial. A few decades ago, the University of Minnesota and the Government of Morocco had a strong partnership. Many of Morocco's citizens came to the University of Minnesota on educational exchange programs to receive higher-education degrees. Those who received further education have gone on to become prominent members of society holding leadership positions across governmental organizations, businesses and universities. Today, Morocco and Minnesota are re-examining that exchange and looking for ways to renew the partnership. One area that could benefit both Minnesota and Morocco is within the realm of water. Minnesota has strong environmental policy initiatives, and Morocco is looking for ways to educate and involve youth in national projects to boost their economy and improve the environment. Renewing this partnership would have positive impacts on all parties involved.

FUTURE RESEARCH

As Morocco continues to further its sanitation and wastewater initiatives, the impacts these projects have on women's health, education and empowerment must be examined. While many smaller-scale studies have connected sanitation and hygiene to women's empowerment, comprehensive national assessments are lacking. These macro-level studies are important because rural villages are often evaluated sporadically and many urban areas are left out of the scope of research studies. As rural to urban migration is growing at a high rate, looking into the specific effects of sanitation and wastewater treatment in urban areas will be important for Morocco as the country continues its efforts to provide clean water to all citizens.

CONCLUSIONS

Water agencies in Morocco have an opportunity to improve sanitation and wastewater treatment services by empowering women in the decision-making process. By allowing women to offer expertise and ideas pertaining to the effectiveness and sustainability of water projects, the discussions may lead to a better understanding of community needs and implementation processes.

A grassroots example of this decision-making process is already underway in the village of Dayet Ifrah in the Middle Atlas region. This community is now considering the role of women in water projects, as well as promoting small business development opportunities for women. Morocco's leading water agencies could provide assistance with: building schools with nearby latrines to encourage young girls to attend; leading workshops for women on health risks associated with pollution; and incorporating public health, environment and water conservation aspects into course curricula.

Overall, Morocco must continue to make strides to reduce the degradation of their scarce water resources. Legislation has already been enacted with goals to further treat water, increase wastewater treatment infrastructure, and reduce environmental pollution. As women are the main household managers of water, new water-related initiatives and programs will be more likely to succeed if women are included in the decision-making process, thus empowering women both across Morocco and around the world.

Appendix A: Impacts of insufficient sanitation collection and pollution reduction¹²⁰

	Impacts of Insufficient Collection	Impacts of Insufficient Pollution Reduction
1. Sanitary Impacts	<ul style="list-style-type: none"> ▪ Waterborne diseases transmitted by the flow of uncollected wastewater; ▪ Waterborne diseases transmitted by floodwater or sewage overflow 	<ul style="list-style-type: none"> ▪ Sickness caused by: ▪ Ingestion of food products contaminated by crops irrigated by untreated water ▪ Exposure to pathogens in sludge ▪ Consuming food contaminated by inorganic pollutants
2. Impacts on water resources	<ul style="list-style-type: none"> ▪ Contamination of surface and groundwater by uncollected wastewater or insufficiently collected wastewater 	<ul style="list-style-type: none"> ▪ Degradation of water quality in the natural environment by solid, organic, and inorganic pollutants such as nitrates, metals (mercury, copper and zinc), and persistent organic pollutants (POPs) which can accumulate through the food chain¹²¹ ▪ Costs accrued for potable water ▪ Inconsistent production of potable water ▪ Lowered surface water levels to dilute pollution

	Impacts of Insufficient Collection	Impacts of Insufficient Pollution Reduction
3. Environmental and Economic Impacts	<ul style="list-style-type: none"> ▪ Visual and smell nuisance ▪ Degradation of quality of life, and the potential social exclusion of populations without sanitation collection networks and wastewater treatment facilities ▪ Loss of potential tourism development ▪ Flood damage in low-lying areas ▪ Depreciation of land values 	<ul style="list-style-type: none"> ▪ Loss of water usage for irrigation ▪ Impacts on flora and fauna ▪ Loss of recreative value ▪ Pollutant insolubility ▪ Eutrophication of dams ▪ Impacts on wildlife ▪ Corrosion, inhibition of purification by untreated industrial waste

Source: National Sanitation Program, 2008.

Appendix B: Types of Treatment

The sanitation network in Morocco consists primarily of collection pipes placed underground and made of plastic or concrete. Following the collection of sewage and wastewater, treatment can consist of either intensive or extensive processes. Intensive processes are mechanical systems mainly used in medium and big cities. This type of process is typically favorable in larger cities as they require less space than extensive processes and are more adept at removing organic matter. There are a few downsides to this type of process: these systems require specific training and have higher maintenance costs; pathogens tend to be poorly removed (which can be overcome by chlorination); and due to their lack of storage capacity, releasing the large amounts of sludge (waste solids) is both difficult and expensive.¹²²

Extensive processes require a more expansive area for operation, but these natural systems are low-cost and require less formal instruction to manage and maintain. Morocco commonly uses a system of natural lagoons (ponds to separate solids from liquids, and treat the remaining liquid) when using extensive processes.¹²³ This type of treatment can include stabilization ponds, constructed wetlands, or wastewater reservoirs, to name a few. Though this type of treatment is adequate in removing pathogens, the process takes longer than intensive processes. Seasonal variations in the quality of treated water, difficulty in extracting sludge, and a reduction in nitrogen and phosphorus can complicate the process.¹²⁴ At the same time, such a treatment process tends to release little to no sludge and therefore eliminates the need for further disposal.¹²⁵ The studies of two Moroccan cities in this paper, Drarga and Ben Slimane, highlight how this type of process can be particularly beneficial in reusing wastewater.

Appendix Table 1: Type of Treatment, City, Flows, Capacity Treated, and Populations Served¹²⁶

Type of Treatment	City	Number of inhabitants served	Incoming Flow m ³ /day	Quantity of treated wastewater m ³ / y
<i>Activated Sludge</i>	<i>NADOR</i>	100 000	10 000	3 650 000
	KHOURIBGA	75 000	7 500	2 737 500
	AL HOCEIMA	84 000	8 400	3 066 000
	M'DIQ (T)	3 000	300	109 500
	CABO NEGRO (T)	22 000	2 200	803 000
	BENGUERIR - OCP	5 000	1 260	459 900
	BENI MELLAL	110 000	11 890	4 339 850
	NOUACER	Airport	550	200 750
	EL JADIDA (Nestle Company)	Industry	503	183 595
<i>Lagoons</i>	BENSLIMANE	37 000	5 600	2 044 000
	BOUJAAD	20 000	2 500	912 500
	BOUZNIKA	12 000	1 400	511 000
	OUARZAZATE 1	4 300	430	156 950
	OUARZAZATE 2	4 300	430	156 950
	MARRAKECH	3 000	380	138 700
	EL ATTAOUIA	13 500	780	284 700
	IAV- HASSAN II, Rabat	1 400	85	31 025
<i>Infiltration-Percolation</i>	BEN SERGAO	5 000	750	273 750
	DRARGA	8 000	1 000	365 000
	MARRAKECH (T)	750	225	82 125
	AGADIR	350 000	43 000	15 695 000
<i>Bacterial Bed</i>	HATTANE- OCP	3 600	375	136 875
	BOUJNIBA -OCP	3 600	225	82 125
	YOUSSOUFIA-OCP	25 000	27 500	10 037 500

Source: European Commission Euro-Mediterranean Partnership, 2004.

Activated Sludge Treatment:¹²⁷ An aerobic process where bacteria is injected into wastewater in order to separate liquid from the growth in solids. Usually the separation is done by gravity, where solids are separated from liquid and removed from the bottom. The scale of the process can range from small package plants sufficient for one family to large plants serving cities.

Lagoons: Lagoons are one of the simplest and least expensive methods for treating wastewater. This type of treatment costs less to construct and operate, but does require more land than other types of treatment systems. This type of system uses one or more pond-like bodies of water to collect, hold and treat wastewater, and are artificially lined to prevent leakage into groundwater. Wastewater is treated naturally through “physical, biological and chemical processes,” and some systems also use aeration techniques to increase the amount of oxygen and growth of bacteria to make the process more efficient. Due to the low level of treatment, additional treatment is sometimes needed to remove disease-causing organisms before returning the water to the environment.¹²⁸

Infiltration-Percolation: This type of treatment uses a process of applying sewage on buried sand filters or permeable soil. The water percolates down and is collected by a drainage system. When passing through the filter, water is treated by biological processes which mineralize organic matter.¹²⁹

Bacterial Bed: This type of treatment removes suspended solids from sewage. Treatment methods utilize are and bacteria to decompose waste that filters through sand to result in cleaner water draining from the bed.¹³⁰

Appendix C: Water Agency Descriptions by Percentage of Population Served.

The table below describes each management type available to communes and shows the percentage of the population served by each type of management authority.

Appendix Table 2: Water Agency Descriptions by Percentage of Population Served

Stakeholder	Description	Percentage of Population Served
Direct management by municipality (Régie Directe)	<p>A less specialized mode of service operated directly by the commune. More than 250 small and medium cities operate under this type of agreement.</p> <p>According to the municipal code of 1976, public services (water supply, sewerage and electricity distribution) are the responsibility of municipalities (communes).</p> <p>There are 1,547 municipalities in Morocco (249 urban and 1,298 rural). Some delegate service provision to private companies; in other municipalities the Régies Autonomes provide these services; in smaller municipalities ONEP provides services.</p>	40 municipalities (in small/rural areas) serve 3% of water consumers in Morocco. Provide sewerage services in 280 towns (WB, 2004)
Autonomous Authority (Régie Autonome). Largest cities served include Agadir, Fes, Marrakech, Meknes, and Oujda. Also exist in Chaouia, El Jadida, Kenitra, Larache, Safi, Tadla and Taza	<p>Specialized public entities; these authorities operate in 12 large cities in Morocco, along with distributing water and electricity.</p> <p>Autonomous Authorities provide sanitation services in 11 cities and electricity distribution in 7 cities.</p>	Autonomous Authorities serve 31% of water consumers in Morocco.
Private Companies (“Private concessionnaires)	Four private companies operate in Greater-Casablanca, Rabat-Salé, Tangier, and Tétouan: Lydec (SUEZ); Amendis and Redel (subsidiaries of Veolia Environnement); and a fourth, which provides bulk water to Casablanca. ¹³¹	Private companies serve 38% of water consumers in Morocco.

Stakeholder	Description	Percentage of Population Served
ONEP ¹³²	<p>Since 2000, ONEP may now offer sanitation services in areas where they distribute water. ONEP provides 80% of country's drinking water and sells much of it to the Régies and private concessionaires. ONEP distributes water directly to customers in approximately 500 small and medium areas, and provides sanitation services in over 65 of the towns where the agency also distributes drinking water. In 2009, ONEP set a goal to take over sanitation services in 191 towns by 2017.</p>	<p>ONEP serves 28% of water consumers in Morocco.</p> <p>ONEP operates 72 wastewater treatment facilities: 5 in large cities (Khouribga, Beni Mellal, Nador, Agadir and Al Hoceima); 49 in municipalities; 8 in rural communities; and 5 in centers (some communities have more than one).</p>

Sources: PNA 2006, World Bank, Wikipedia

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