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WOMEN'S WATER, WOMEN'S WORK:
EVALUATING DECENTRALIZED MANAGEMENT OF DEEP BOREHOLE WELLS FOR
IMPROVED RURAL WATER ACCESS IN TAWA FALL VILLAGE, SENEGAL

By

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Bachelor of Arts, Whitman College 2006

Professional Paper

Presented in partial fulfillment of the requirements
for the degree of

Masters of Science
Resource Conservation
International Conservation and Development

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ABSTRACT

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Resource Conservation

Chair: Dr. Steve Siebert

Throughout the developing world, countries face a number of issues regarding the health and welfare of their populations. One issue that stands out with critical and growing importance is the availability-and accessibility-of water. Across the Sahel, access to potable water for domestic use, as well as contaminant-free water for agricultural and animal husbandry purposes is of growing concern. This study evaluates Government of Senegal efforts at improving rural water access through public-private operation contracts to manage deep groundwater resources.

In West Africa, Senegal currently counts itself among the few Sahelian countries having sufficient freshwater supplies to support its population's growing domestic and industrial needs, though this is threatened by global climate change, and the Sahel's natural ecological variability. Surface water supplies the majority of urban areas in the country, while rural regions commonly draw water from groundwater systems. From 2002-2009, the Senegalese government, in cooperation with external partners, launched the *Projet d'Organisation et de Gestion Villageoise* (Village Organization and Management Project) which aimed to reduce poverty and improve quality-of-life at the village level. In 2007, the village of Tawa Fall received the technology necessary to access deep groundwater resources through this project. In a unique public-private system, the government of Senegal engaged *Associations d'Usagers de Forages* (Drilling User Associations, ASUFOR) to manage operation and maintenance contracts for these boreholes. Proceeds from the sale of water is managed by ASUFOR associations, and used both for borehole maintenance and to further village development.

This study explores the effectiveness of deep borehole wells at reducing women's workload, evaluating the wells' effects on communities from the perspective of women as primary domestic water drawers and users. The study also examines the efficiency of the ASUFOR system at maintaining decentralized management of natural resources. It examines how Tawa Fall's ASUFOR committee has used proceeds from the sale of groundwater to bring electricity to the village, and also explores how village women manage their household water needs through a combination of purchased, and well-drawn water. The data collection methods utilized include spot observation, site visits, semi-structured and unstructured interviews with key informants, and a survey of female heads of household to determine domestic water use patterns. The results suggest that, while deep borehole wells provide a fairly reliable source of water for villagers and reduce women's labor burden, the cost of water is often prohibitive, and the majority of residents continue to regularly use open wells in addition to public taps. This suggests that Senegal's management of rural water systems is still at an emerging stage, and would benefit from increased financial investment to maintain continuous access and expand the existing rural water provision network.

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I'd like to thank my mother, for her unflinching support, and for teaching me how to be a good person, and an honorable woman. I want to thank my father for his gift of intellect and writing, I couldn't have produced this paper without those skills. I'd like to thank both my parents, and all my other mothers and fathers, for their inspiration, and for their continual, unhesitating love. I could not have accomplished this project without your help.

I'd like to thank the late Don Bedunah, whose wisdom and honesty helped me to take myself, and my work, seriously. I miss your wry smile Don, your kind voice, and your gentleness. I want to especially thank Steve Siebert for stepping into the role of advisor with such grace and kindness. Great thanks also go to Sarah Halvorson and Jeffrey Gritzner for offering their time and input to this study, and also to Laurie Yung for her dedication to teaching throughout my coursework.

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PREFACE

I came to Senegal in early 2007, the first year I lived in West Africa serving as Peace Corps volunteer. Based in the city of Thiès, I worked from 2007-2009 as an urban agriculture extension agent, providing instruction to the Senegalese on a variety of agriculture-related topics. During my service as a Peace Corps volunteer, my work concerned both urban gardening and rural cereal production, and also touched upon the related subjects of integrated pest management, composting, natural fertilization, and water conservation. In Thiès I collaborated with a number of women's groups, neighborhood organizations, and individuals, and conducted trainings on urban gardening. In rural settings outside of the city I focused on the production of local cereals and improved cultivation techniques. Before beginning service as a volunteer, I participated in three months of intensive language, cultural, and technical training to prepare me for my work. Fluent in French from previous study, I was taught the local language of Wolof, which was spoken by nearly half the country. Language training was rigorous, involving frequent oral tests to gauge pronunciation and comprehension, and was taught by host country nationals fluent in English, and in the various languages of the country. Cultural training, also taught by host country nationals, involved intensive sessions outlining aspects of Senegalese culture which were different than Western norms, and may have been challenging for Americans to understand or accept. Among other aspects of Senegalese society, American volunteers were instructed on the treatment of children in Senegal, "men's work" versus "women's work," and the effects of Islam on cultural practices and gender relations. Without this cultural background, integration into African society could potentially have been much more difficult. Gaining, at a minimum, a basic understanding of the cultural reasons behind individuals' actions aided in communication and facilitated working partnerships to a great degree.

The technical aspects of Peace Corps training first introduced me to water resource issues in Senegal. Perhaps the most intensive portion of training aside from language, urban agriculture volunteers were trained in nearly every aspect of dryland agriculture. This included integrated pest management, composting, companion planting, organic fertilization and pest treatments, diseases, field crop management, and fruit tree grafting. Because of the nature of the region, technical training focused particularly on water conservation, specifically advocating local crops, and outlining best practices to prevent erosion and encourage the least possible waste of water. Through this training, I became deeply interested in the field of natural resource management, especially pertaining to dryland areas with less abundant resources. Due to more severe environmental conditions, and higher demands on potentially scant resources, these areas tend to develop highly interesting forms of management and usage of existing resources.

Throughout my work in both urban and rural settings in Senegal, a constant narrative existed concerning water. Whether the price, the access, or the quantity, it was clear that water provoked a number of issues that were invariably tied to agricultural production. Without water there was no work, and its availability in sufficient or affordable quantities contributed enormously to the success or failure of our projects. Upon completing Peace Corps service, my interest in water accessibility grew during a year of study at The University of Montana, and evolved into a desire to study aspects of water security and domestic water use in rural settings. I returned to Senegal in 2011 to Tawa Fall, a village I had previously worked with as a volunteer on cereal production. Though just a few miles outside an urban center, the village is still without electricity, and has only recently received a water tower, generator, electric pump and a borehole well dug to approximately 600 feet. These materials were given to the village as part of a poverty reduction

project launched by the Senegalese government. Whereas previously, the state would construct a borehole and abandon its management to well-intentioned, but disorganized, village associations, these boreholes are now typically managed by the ASUFOR system, rendering the process of rural water provision transparent and accountable. In Tawa Fall, proceeds from the sale of water from the borehole allowed the construction of a transformer to access high tension electric lines in the region.

Today, an interesting situation exists in the village regarding water access. Few, if any, female residents of the village understand the ASUFOR system, or are even aware of its existence. Additionally, only a small number of families can afford a private tap, while the majority of village residents access water through a combination of purchasing from public taps, and drawing free water from wells. When, why, and how households choose to access water, how public taps are managed, and the process of accessing clean, running water, are major issues that the majority of rural regions in Senegal still face today. This period of research in the fall of 2011 addressed the particular circumstances regarding rural water access in Tawa Fall village through an evaluation of the effectiveness of the decentralized ASUFOR system at providing increased rural water access, and at stimulating rural markets and economies.

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CHAPTER 1. INTRODUCTION

Chapter one introduces the study site and outlines the basic parameters of the study. It also discusses global water issues, drought patterns in the Sahel, effects of climate change on the region, and the process of decentralization in West Africa.

1.1 Tawa Fall Village: Emerging Community Based Water Resource Management

The village of Tawa Fall is very much like almost all villages in rural Senegal. Never paved, the entire village is floored with sand, which often piles as high as the ankles, and is a dusty red-brown. Depending on a village's wealth and size, these sand streets may run past a school building, or a *poste de santé* (health clinic) which more often than not is closed down, and does not provide the health services it was originally intended to. Sometimes a village boasts a small boutique which sells, among other items: onions, spices, candy, soap, bread, shampoo, butter, candles, wire, and oil from a great tin drum. The majority of village residents in rural Senegal earn less than a single dollar per day (FAO, 2013) and very often they are almost entirely dependent on farming and agriculture for the production of food and for sustaining their livelihood. A network of fields surround these villages, connected by a maze of skinny dirt pathways, beaten hard and dry by the sandaled feet of field workers.

Rural inhabitants are very close to their land; they depend on it to survive.

Tawa Fall has been the recipient of myriad development projects sponsored by nearly every country which offers aid to Africa. Mere Bougouma Gueye, a longtime resident of Thiès and originally from Tawa Fall, put it very concisely, "Tawa should be much more advanced than it is. There have been American, Japanese, and European projects there for years. They have been given chicken coops, boutiques, and farming projects, and they've all fallen apart"

(Gueye, pers. comm.,2011). In addition, the village has received attention from the Peace Corps for several years, and recently has begun hosting its own volunteer to live and work exclusively in the community. So was the situation I found in 2007 when I first began visiting Tawa Fall to extend field crop seeds, and so the situation remains today. A host of development projects have run through the village, and barely any evidence exists that any money has been spent there at all. A small grove of mango trees, planted by one aid group and originally intended to provide work and income to female residents, still stands in one corner of the village. The local boutique, built by the Japanese and meant to be managed, again, by female residents of the village, is currently run by a single male resident and his family. How these projects dissolved, and how the boutique came into the hands of a single family, are mysteries that no amount of probing or questioning seemed to be able to answer. What is clearly notable about the village though, indeed the first thing anyone can see passing by on the main road, is the enormous water tower standing 100 yards into the brush, surrounded by a low fence covered with bougainvillea.

Tied inextricably to agriculture, and to the livelihood of all people living in dry areas, is water. Water is a critical resource for all life on earth; however, for individuals living in areas of particularly low water availability, of extreme climatic conditions, or of low infrastructure for resource access, procurement of water becomes a daily struggle. While the residents of Tawa Fall fortunately do not face a dearth of water resources, their situation is similar to many other West African rural villages, specifically there is a painful lack of infrastructure for improved water access (White, 1977; Van Wijk-Sijbesma, 1985; Valfrey-Visser & Thiaw, 2010; Pimentel et al., 2004; Nyong & Kanaroglou, 1999). As recently as 2005, all

residents of Tawa Fall, no matter their vocation or relative wealth, attained water for all daily activities such as bathing, cooking, washing, and drinking, by pulling water by hand from a well (Pers. obs. 2011). This water-drawing is performed almost exclusively by women and girls, though young boys may help until they are old enough to be considered “men,” and are exempt from such toil. In order to provide for a household of six to ten people, women spent their entire day splitting time between child-rearing, cooking, chores, and drawing the water to perform those chores.

With the installation of the forage (deep boring well) in Tawa Fall significant changes occurred in both men’s and women’s work load relating to water (World Bank, 2010; PEPAM, 2004). Similar results have been seen regarding the positive effects on *forage* installation in rural areas across sub-Saharan Africa (Mehta, Fugelsnes, & Kruger, 2009; McDonald & Davies, 2000). The *forage*, which draws water from deep aquifers by means of an electric pump, provides safe and quickly accessible water for both agricultural and domestic purposes. Women are no longer absolutely required to draw water from wells, where they previously spent much of their time standing in queues. They now have a choice whether to draw water, which is monetarily free but costly in time and labor, or to pay a small fee and fill a bucket from a public tap. Agriculturally, men are gaining access to entirely new potential markets as the possibility of irrigation of vegetable crops replaces previous dependence solely on rain-fed field crops. The potential of choice, which is slowly changing the form and structure of both rural Senegalese communities, and of their management of critical natural resources, is being staged within a larger context of nationwide development processes. Though much of the change seen in rural villages

appears to be relatively organic, and directed by elected bodies of local representatives, the structure of natural resource management and water in particular, is part of a broad program of economic liberalization.

Across much of Africa, market liberalization is playing an increasingly visible role in natural resource management (Larson, 2002; Agrawal, 2001; Agrawal & Ribot, 1999; Benjaminsen, 1997; Fisher, 2000). In many ways, it seems that an older version of internationally funded, externally directed, project-based development is being replaced by a new paradigm which nestles itself in existing economic structures, and seeks to attain human and infrastructure development by way of the marketplace (Agrawal & Ribot, 1999; Brosio, 2000; Dada, 2011; Katsiaouni, 2003; Prud'homme, 1995). In Senegal, the French Development Agency has a clearly stated goal of supporting the decentralization of natural resource management.

Through their aid projects, they are openly supporting a country and government-wide movement toward decentralization practices, transferring the responsibility for management of groundwater accessing equipment to regional councils and the private sector (AFD, 2013). Through locally elected bodies, called “associations des usagers de forages” or ASUFOR, the government of Senegal has almost entirely transferred power to manage the *forages* to the local, community-based level. While many other West African countries have decentralized their natural resource management systems to a significant degree (Niang, pers. comm., 2011), Senegal’s decentralization process was only begun in 1997, and the relative success of that program has only become evident during the last five years. During the period of field research in Tawa Fall, the primary focus of my project was to understand and evaluate community reaction to the effects of the ASUFOR system in their village. Specifically, I

wished to gauge community awareness of the program, and to evaluate the efficacy of the program from both a resident's perspective, and from the broader view of rural development at large. I felt that understanding the ASUFOR project from a community perspective would be an invaluable source of evaluation for other potential forms of community capacity building and rural progress. Unlike so many other development projects, the ASUFOR system is truly self-perpetuating, and self-sustaining, due to its strong marriage of local politics and local economies. This professional paper will further explore the strengths of the ASUFOR system, as well as point out potential weaknesses which challenge, and potentially threaten, its continued success.

1.2 World Water

Of all components necessary for sustaining life on the planet, freshwater is clearly paramount for humans, ecological processes and all plants and animals. Freshwater composes only a tiny portion of the total global water pool, but is the key to all life on earth. For people, freshwater provides multiple uses, such as for drinking, agriculture, and industrial production, as well as for recreation and transportation. Recent estimates from the United Nations Population Division (UNDP) indicate that, even with a marked deceleration of population growth in the second half of the 21st century, total world population could reach 9.3 billion in 2050, and 10.1 billion in 2100 (UNDP, 2011). Increasingly, burgeoning populations and the economic draw on water for agriculture and industry are coming into conflict as the human need for freshwater is displaced by economic production (Pimentel et al., 2004; Shah et al., 2000; World Water, 2013; Postel, 2000). In addition, climate change is

beginning to have a global effect on hydrological systems, with notable changes in recorded precipitation events (Bates et al., 2008). Finding ways to provide for humanity's needs, while also protecting the earth's ecological freshwater provision systems and navigating the growing effects of climate change is fast becoming the challenge of the 21st century. The question of water is one which spans multiple fields and disciplines, and must be addressed through collusion between political, social, and scientific realms.

Calculating total water resources for the world is a complex undertaking, involving estimations of both surface and ground water resources, and quantifying the balance of extraction and replenishment of groundwater. While the planet is covered with water, the great majority of it is not available for terrestrial use. Less than 3% of the total water on earth is available for drinking, or irrigating crops, and of that amount, almost two-thirds of it is held in glaciers and ice caps (Jackson, 2001). Freshwater lakes and rivers, forms of water that are most accessible and recognizable to people, hold 100, 000 km³ globally, or less than 0.01% of all water on earth. Best estimates put total water resources on earth at $> 1 \times 10^9$ km³ of water (Jackson, 2001). In total, the earth's hydrological cycle annually provides many times more freshwater than is actually needed to sustain the current world population of approximately seven billion. This water is not always available when and where it is needed, however, and much of it is inaccessible to people, whether due to geography or prohibitively expensive extraction costs. Approximately half of the net precipitation which falls on land, an amount equal to roughly 40,700 square kilometers annually, quickly leaves land through floods. Another one fifth of this precipitation falls in areas too geographically remote to access easily, making it unavailable for human use. Therefore, approximately 31%

of this water is usable by people, an amount which increases with the construction of more dams and the development of sophisticated water storage technology. Despite best innovations, however, dam storage is projected to increase global water storage only by roughly 10%, while the world's population is expected to increase by 30-35% (Postel, 2000). In addition, Postel (2000) has estimated that humans already utilize 50% of available runoff for agriculture, urban development, industry, and other uses, a number which could rise as high as 70% by the year 2025.

While surface water is the most easily accessible of the world's water resources for human use, groundwater is of particularly critical importance for human well-being and development throughout the world. Both developed and developing countries rely heavily on groundwater, with at least one quarter of the world's population drawing their water from groundwater (Jackson, 2001). Groundwater is usually quantified as a balance between recharge and depletion, though worldwide there is a trend toward consistent depletion. Additionally, approximately 99% of all freshwater is stored in underground aquifers (World Water, 2013). Interestingly, most groundwater is not in contact or exchange with surface water resources, and instead remains as a relic of previous wetter climate conditions, of melting Pleistocene ice sheets of the past (Jackson, 2001). While it is difficult to accurately estimate the percentage of freshwater use that groundwater accounts for, Doll (2009) citing Zektser and Everett (2004) places the amount globally at 50% of domestic water supply, 40% of water withdrawals for self-supplied industry, and 20% of irrigation water supply from groundwater. It is also important to distinguish between renewable and nonrenewable groundwater resources, the former being resources which are recharged by current

precipitation, and which are therefore susceptible to climatic changes and contamination (Jackson, 2001). The benefits of groundwater for global water provision are numerous, and especially in rural areas of dry regions like the Sahel, groundwater accessibility is becoming increasingly critical for consistently providing water, both for domestic and agricultural uses, and for a source of clean drinking water. Specifically, groundwater is usually better protected against pollution and contamination than surface water, and is also often more spatially accessible considering the large expanses it may cover underground. Groundwater serves as a natural reservoir, and may provide water throughout dry seasons or periods of drought. Finally, gradual and perhaps more sustainable development of water resources is available with groundwater through the sequential installation of wells, though locating groundwater is more challenging than surface water, and the costs of drilling and maintaining wells may be prohibitively high in some cases (Doll, 2009).

While groundwater provides a consistent source of water for much of the developing world, growing populations, expanding irrigated cultivation, and further economic development are leading to an ever-increasing demand on global water resources. While globally, surface water resources are sufficient to provide for these demands, regional variability in resources is high, leading to extreme water stress in parts of the world (Wada et. al., 2010). The Sahel is one of many regions in the world which experiences chronic water stress, and which borrows from its extensive groundwater resources to provide for its needs. Broad access to mechanized, pumped wells throughout the developing world has led to a relatively recent explosion of reliance upon groundwater for agricultural and domestic purposes. Across North and West Africa, much of the Middle East, South and Central Asia, North China and

Australia, excessive groundwater depletion has been noted (Konikow & Kendy, 2005). Due to heavy reliance on groundwater, persistent groundwater depletion has led to serious environmental and ecological consequences throughout much of the world, including localized areas of North America (Hanasaki et al., 2008), and in the Sahel (Rapport sur L'Etat, 2005). These negative effects can include disruption of the water table, land collapse above over-exploited aquifers, and hyper-salinization of existing water sources (Wada et al., 2010). Increasingly, research is focusing on the appropriate management of groundwater withdrawal, and on mitigating the effects of over-exploitation.

1.3 Climate Change in West Africa

In the 21st century, the most common dialogue which accompanies any discussion of global development, ecology, natural resource management, or the environment, is the existence of anthropogenically caused climate change (Adger et al., 2003; Bates et al., 2008; Collier et al., 2008). At best a highly controversial subject, climate change has come to the fore of the majority of global policy discussions, and is rapidly becoming a critical component of any strategy for development, and economic growth. National and international corporate business, national governments, transnational governing bodies, and natural resource planning bodies are all affected by the potential for massive environmental change brought on by climate change. This chapter will discuss general, global aspects of climate change, its effects on global freshwater resources, and the implications for the health and society of the African continent at large, as well as for the Sahelian belt of West Africa.

A great number of the world's scientists observing the earth's climate believe that human activities have increased atmospheric concentrations of carbon (CO₂), which is leading to an increase in the world's temperature or "global warming" (Justus & Fletcher, 2006). Carbon levels have risen by 35% from preindustrial values of 280 parts per million (ppm) to 378 ppm over the past 150 years, which scientists believe have contributed to a 0.6 C (0.9 F) increase in global temperatures in the last 100 years, and which could rise again from as little as 1.8C to as much as 7.1C (2.7F to 10.7F) over the next 100 years (Justus & Fletcher, 2006).

Carbon dioxide is typically considered to be the primary driver of global warming; however, it is accompanied by three other active greenhouse gases which contribute to warming as well: Methane (CH₄), nitrous oxide (N₂O), and chlorofluorocarbons (CFCs). The amount of carbon cycling through the earth's biosphere from natural processes is nearly 800 billion tons, the majority of which is absorbed back into the earth through further natural processes, and leading to a fairly stable historic global climate. Human activity, however, has contributed approximately 24 billion tons of CO₂ annually since the industrial revolution (approx. 1850) mainly from the burning of fossil fuels (Justus & Fletcher, 2006).

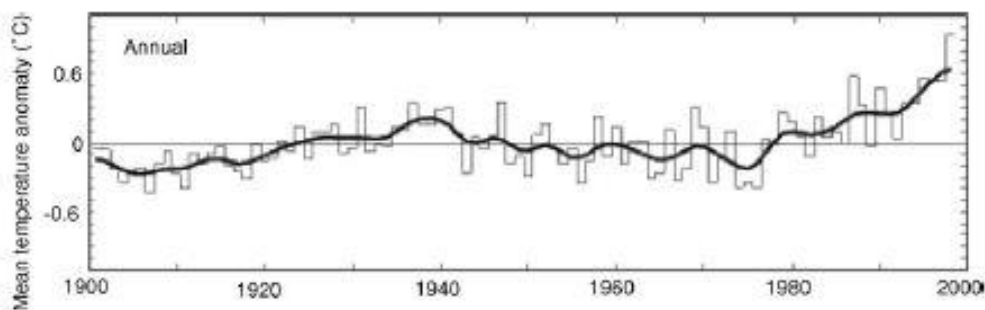
While policy-makers and much of mainstream American media frequently portray climate change as uncertain, using such rhetoric to curb efforts to reduce greenhouse gas emissions, the great majority of official scientific organizations recognize the anthropogenic effects of climate change on the environment (Oreskes, 2005). The strongest international recognition of anthropogenic climate change is through the Intergovernmental Panel on Climate Change (IPCC) formed in 1988 by the World Meteorological Organization and the United Nations Environmental Program. The stated goal of the IPCC is to, "evaluate the state of climate

science as a basis for informed policy action, primarily on the basis of peer-reviewed and published scientific literature” (Oreskes, 2005). Additional credible organizations, such as the National Academy of Sciences, the American Association for the Advancement of Science, and the American Meteorological Society, have issued similar statements to that of the IPCC, indicating broad support for theories on human-exacerbated climatic change. This united front, which runs through and across scientific borders, is a strong indication of the scientific community’s consensus on anthropogenic climate change. To date, however, a transnational policy-making board has not been created to cope with the effects of human-induced global climatic shifts. Beyond the debate over the causes behind climate change, the effects of global warming and anthropogenic changes to the atmosphere have begun to have far-reaching effects throughout the world (IPCC, 2007). Furthermore, scientists and policy makers have agreed that the area first and hardest hit in terms of human quality of life will be Africa (Collier et al., 2008). Throughout the world, the climatic changes that human society are already facing include warmer temperatures, drier soils, changes in weather extremes, and higher temperatures worldwide (Adger et al., 2003). While natural climate variation has made it difficult for scientists to state with absolute certainty that rising temperatures are due to human activities, the National Oceanic and Atmospheric Administration’s research has reported that globally the warmest 12 years on record, since historical temperature records have been kept, occurred within the past two decades (Justus & Fletcher, 2006), with 2012 recorded as the ninth hottest year globally, and the hottest year on record in the United States (NOAA, 2012). In the Intergovernmental Panel on Climate Change’s (IPCC) fourth Assessment Report (2007), findings concluded that Africa is one of the most vulnerable continents because of the, “range of projected impacts, multiple stresses, and low adaptive

capacity.” While low-lying countries throughout the world are at risk of flooding due to rising sea levels, much of the population of Africa stands to face severe threats to the sustainability of their livelihood in the near future.

Specifically, the major issues facing Africa relating to climate change are its high agricultural dependence, the exposure of its economy to climatic variation, and its limited capacity to adapt to major ecological change or events. (Collier et al.,2008). The Sahel specifically is subject to a season, monsoon climate, which is likely to exhibit more variability and extremes in weather, such as drought (Zeng, 2003). In the IPCC’s Fourth Assessment Report (2007), scientists state that, “Climate exerts a significant control on the day-to-day economic development of Africa, particularly for the agricultural and water-resources sectors, at regional, local and household scales.”

Figure 1: African annual mean temperature anomalies °C for the past 100 years



Source: Collier et al. 2008

Africa demonstrates a consistently low level of basic infrastructure across the continent, coupled with high dependence on subsistence agriculture for both economic production and survival of its population (Montgomery & Elimelech, 2007). Additionally, over the past fifty years or so, African economies have not displayed a high level of adaptability (Caffentzis, 2002). While somewhat adaptable to infrequent and short-term shocks, a sustained ability to adapt to long-term change or adopt new technologies has not been evident amongst African countries at large (Collier et al., 2008). While the economic impacts on Africa will likely be enormous due to its vulnerability, the impact of climate change on Africa is not well understood, and several climate change models predict drastically different outcomes for the continent (Baker, 1995; Doll, 2009; Hanasaki et al., 2008).

1.4 Climate Change and Drought in the Sahel

A transitional zone between the Sahara to the north, and the green tropical forests of the coast, the Sahel represents an area which runs at least 4,500 km from Cape Verde at its westernmost point, through Senegal, Mauritania, Mali, Burkina Faso, Niger and Chad. More than just an eco-climatic zone, the Sahel has become something of a geopolitical entity. In 1973, nine West African countries formed the Permanent Interstates Committee for Drought Control in the Sahel (CILSS). This committee covers over 5.7 million km², and includes a number of countries that share not only common ecology, but also common culture, traditions, and livelihoods (Kandji et al. 2006). Millet, sorghum, and cowpea are the major staple food crops of the region, while groundnuts and cotton are the most prevalent cash

crops (CIA World Factbook, 2012). Except on the borders of major river and lake systems, most farming in the region is entirely dependent on three to four months of rainfall during the year.

Figure 2: Member countries of the Permanent Interstates Committee for Drought Control

Country	Area (km ²)	Population (Million)	Per capita GNP (US\$)	HDI
Burkina Faso	274,000	12.3	240	0.320 (159e)
Cape Verde	4,030	0.43	1207	0.708 (91e)
Chad	1,284,000	8.7	210	0.359 (155e)
Gambia	11,295	1.4	498	0.398 (149e)
Guinea Bissau	36,125	1.3	160	0.339 (156e)
Mali	1,240,190	11	240	0.378 (153e)
Mauritania	1,025,520	2.7	390	0.437 (139e)
Niger	1,267,000	10.4	190	0.274 (161e)
Senegal	196,722	9.7	500	0.423 (145e)
CILSS	5, 664, 007	57. 93		

Source: Kandji et al., 2006

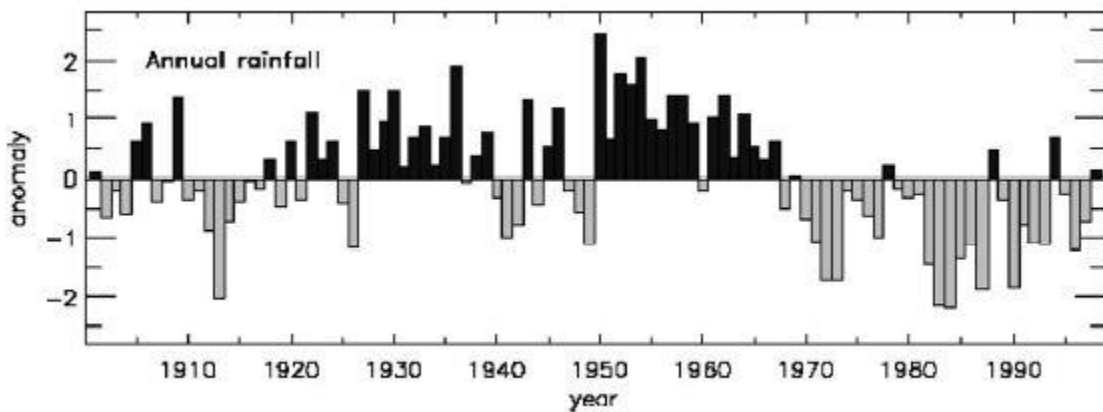
The Sahel has been subject to three major intense drought periods, the first spanning 1910-1916, 1941-1945, and what has been named the, “desiccation,” which began in 1968 and lasted throughout the 1970s and most of the 1980s, continuing with some interruptions into the 1990s (Kandji et al., 2006). The severe drought of the 1970s in the Sahel triggered global interest in the process of desertification, and its human impacts. During this drought period, a reported million people starved across the countries of the Sahel, 40%-50% of the domestic livestock population died, and millions of people migrated as refugees to more southerly areas to take refuge in camps and urban areas, which as a result became highly dependent on external food aid (Nicholson et al., 1998). The extent and continuance of drought conditions in the Sahel has been questioned by a number of scientists. Using rainfall data sets from

consistent and reliable sources, however, Dai et al., (2004) have proven that decreasing rainfall trends were evident during the 1950s through the 1980s in the Sahel, and that large, multi-year oscillations in precipitation were more frequent after the 1980s. Scientists have tried to explain the continual drought periods in the Sahel using different hypotheses. One narrative involves the process of desertification, focusing on anthropogenic factors such as overgrazing and deforestation which strip the land of vegetation (Nicholson et al., 1998). Reduced vegetation increases surface albedo (meaning less sunlight is absorbed), and therefore reduces moisture supply to the atmosphere. This then reduces precipitation, and leads to even worse conditions for vegetative growth. A second theory involves complex climatic activity of large-scale atmospheric changes due to changes in sea-surface temperatures (Zeng, 2003). Changes in sea surface temperatures can have negative effects on precipitation, as well as natural vegetation processes on land. Together, the sea temperature theory in combination with potential synergistic changes in land-use patterns by humans, offers the best explanation for continued drought in the Sahel (Zeng, 2003).

In total, the future of climate change in the Sahel is not easy to predict. Multiple climate change mapping scenarios have produced a broad spectrum of possible outcomes for the region, including both increased, and decreased precipitation potential. Groups of researchers are working to determine scenarios where temperature rises may occur, with a recent simulation exercise in Mali (assuming a temperature rise of between 1 and 2.75 degrees Celsius) suggesting that, by the year 2030, reduced precipitation will induce a decline in cereal harvest of 15-19%, causing a doubling in food prices (Butt et al., 2003). These higher prices would increase the risk of hunger in the Malian population from its baseline of 34% to

64-70% (Butt et al., 2003). While aspects of climate change in Africa are not entirely predictable, temperatures across the continent may continue to rise, and the current trend of greater variability in rainfall across the Sahelian belt could also continue. Specifically, higher temperatures will affect agriculture partly because the amount of semi-arid to arid land is expected to increase, and partly because of diminishing water resources (Collier et al., 2008). The IPCC fourth annual report (2007), predicts reductions in crop yield by as much as 50% in some countries by the year 2020.

Figure 3: Annual rainfall anomalies representing the region 10–20°N; 25°W–30°E, roughly corresponding to the Sahelian zone



Source: Brooks (2004)

Through specific climate change modeling focusing on the impacts of climate change on West Africa, scientists such as Roudier et al., (2011), have predicted a median yield loss in crop productivity around -11%. The predicted response in more northern Sudano-Sahelian countries like Senegal, however, may be as high as -18%. These negative effects on crops are due mainly to heightened temperatures, whose rise is much larger relative to precipitation. The Sahel is particularly vulnerable to increased temperatures and reduced precipitation due

both to its location at the southern edge of the Sahara desert, and to its population's high dependence on rain-fed agriculture and livestock. Rain-fed agriculture and livestock sectors for example provide nearly 40% of Senegal's gross domestic product (GDP) (Kandji et al., 2006).

1.5 Decentralization in Africa

Throughout the last century, decentralization practices have been implemented as a policy solution to the multiple issues facing countries throughout the developing world (Parker, 1995). Since the 1980s, decentralization has become a global movement, implemented in much of the developing world (Katsiaouni, 2003). Governments choose to decentralize for political, social, and economic reasons; however, in the developing world they are often pushed to do so by global financial institutions and aid agencies (Ribot, 2003). At least 60 countries now publically claim to be decentralizing some aspect of natural resource management (Agrawal, 2001), and the figure may now be even higher. Theorists and proponents of decentralization as a development strategy argue that the process increases efficiency and inclusion (Smoke, 2000), while others argue that decentralization creates stronger and more effective human development (Klugman, 1994). Additionally, decentralization has increasingly been tied to democratic political movements in countries previously governed by colonial powers (Ribot & Larson, 2004), suggesting that decentralized development efforts may increase local capacity and public participation in the management of critical resources and processes.

DEFINITIONS

Defining the term “decentralization” is critical for properly understanding the shift in power, politics, and management of valuable natural resources in Senegal and throughout Africa.

While many authors agree upon a basic definition of decentralization as, “involv[ing] the transfer of power from the central government to actors and institutions at lower levels in a political-administrative and territorial hierarchy (Ribot & Larson, 2004; Bejaminsen, 1997; Agrawal, 2001; Dickovick, 2005), there are several ways that decentralization may be realized within a political context. Rondinelli and Cheema (1983) provide a foundation for discussions of decentralization today, differentiating between four distinct types. These are:

- **Deconcentration:** the redistribution of authority from the central government to field delegations of the central government
- **Delegation:** the transfer of specific decision-making and management authority to semi-independent units
- **Devolution:** the strengthening of and transfer of governing authority to independent, autonomous local units of government, whose activities are substantially outside the direct control of the central government
- **Privatization:** the transfer of authority from the central government to nongovernment sectors

Decentralization takes on a particular character, and has specific connotations, in a sub-Saharan context. While many countries throughout the developing world are in various stages of decentralization, Africa is unique in its fluidity between management systems, with

many sub-Saharan countries attempting to rapidly diffuse political power and management of natural resources through regional governing bodies (Wunsch, 2001). Some authors (Brosio, 2000) argue that the African continent is too large as a unit of analysis to evaluate the efficacy of decentralization. The myriad countries making up the continent are at such varying stages of progress in decentralizing that finding a common characteristic can be challenging. What the majority of countries do share in Africa, however, is poverty, and nascent democratic governance.

Based on this common trait, decentralization has been a common theme throughout Africa, with some countries speeding along to a highly decentralized system of governance (e.g. Ethiopia, South Africa, Uganda), while others are still at the stage of officially announcing an intention to decentralize (Brosio, 2000). There are several reasons for developing governments to decentralize, including building political capital with citizens, reducing financial pressure on the central government, decreasing management pressure on central agencies, stimulating regional and rural economies, and strengthening fragile democracies through capacity building (Brosio, 2000; Wunsch, 2001). Others authors suggest that developing countries' governments decentralize following prescriptions of development institutions and international lenders (Dickovick, 2005; Larson & Ribot, 2004). There are essentially three theoretical aspects behind the reasoning for decentralization: politics, economics, and human health. Politically, decentralization is seen as a way for countries to extract themselves from their colonial histories and build legitimate democracy. By empowering subnational governments (SNG) with fiscal and political autonomy within a broader context of national government, the state is no longer solely a colonial master, but

can participate in governance as a legitimate actor in a balanced system (Dickovick, 2005). Ribot and Larson (2003), suggest that the best way to attain balanced decentralization is through downwardly accountable authorities who empower citizens to control their environment through decision-making and resource management.

Economically, decentralization is viewed as encouraging free enterprise through the stimulation of local markets. Proponents of decentralization for economic stimulus view development through a neoliberal, or quasi-neoliberal lens. Until fairly recently, much of the World Bank's lending policy for developing countries was influenced by neoliberal thought, which encouraged free market participation with an eye on human development (Brosio, 2000). In theory, empowering local populations to manage their own resources would stimulate a local economy to trade services and goods freely and without circumventing centralized regulation (Parker, 1995). Finally, decentralization has a humanitarian facet, which involves amplifying the local voice and allowing greater individual management of vital natural resources. Klugman (1994) notes that increased economic opportunities are critical for increasing human development, as well as greater access to resources. Ideally, the greater the power of local populations to manage their own critical resources, the better the provision of those resources and the healthier the population will be.

Natural resources are a particularly important proving ground for the decentralization process due to their power-creating position within countries. Because natural resources are important to both the elite and the poor as a source of wealth and survival (Ribot & Larson, 2004), they are inherently tied to aspects of inequality and the dynamics of power. Local

populations rely on natural resources for their livelihood, and the state and elites rely on them as a source of income (Ribot, 2003), separating the reality of necessity and benefit, and segregating a country's population through management of those resources. Additionally, the colonial state used allocation of local management as a form of control over rural populations, further dividing the centralized state from the people it ostensibly governed. Decentralization is one way of moving beyond the colonial legacy, due to the income-generating ability of natural resources, as opposed to other institutional functions such as infrastructure or social programs. As a result, natural resources can give local government power of allocation over lucrative opportunities, helping to build local legitimacy and reinforce perception of local power (Ribot, 2003).

Water is a critical vehicle for this dialectic between power, economics, and the environment, and is growing more significant as the world population expands. The countries of West Africa struggle mightily to overcome the challenges of their colonial and political history, and this challenge is played out through the successes and failures of decentralized, regional management of borehole wells for accessing deep groundwater resources in Senegal. In moving away from the centralized, state-focused policies of post-colonialism to a system of water management which focuses on public-private partnerships and private enterprise, Senegal has managed to build community capacity in rural areas (PEPAM, 2010). Questions, however, remain as to whether Senegal's system of decentralization is supported by downwardly accountable local representation (Ribot, 2003), whether sufficient mechanisms of accountability exist to regulate management (Ribot, 2003; Agrawal & Ribot, 1999), and if

Senegal's government and people are ready to embrace the neoliberal and decentralization policies pushed by external aid organizations (Caffentzis, 2002).

In any discussion regarding the decentralization of natural resource management, the incorporation and consideration of culture, as well as traditional ecological knowledge (TEK) held by local inhabitants, is critical for developing sustainable projects. Much of the previous discussion about decentralization focused on the stimulus of local economies. Natural resources cannot and should not be placed solely within an economic context however. The new processes of decentralization should, in ideal circumstances, avoid imitating previous aspects of colonialism which, in many ways, ignored local ecological and social knowledge, and imposed foreign governance systems on people and their environment. Water, as a critical natural resource, is particularly susceptible to decentralization development initiatives which may omit consideration of TEK principles of sustainable and ecologically appropriate management.

CHAPTER 2. SENEGAL COUNTRY SPECIFICS

Chapter two addresses the demographics of Senegal, as well as its surface and groundwater resources, and the state of water accessibility and sanitation in both rural and urban sectors.

2.1 Senegal Country Background and Demographics

The country of Senegal is situated in the far west of the African continent, and covers a land area of 196 720 km². It is bordered to the North and Northeast by Mauritania, to the Southwest by Mali, to the South by Guinée and Guinée Bissau, and to the West by the Atlantic Ocean. Senegal is a relatively flat country, characterized by plains and plateaus, and is tropical in climate.

Temperatures are warm throughout the year, but vary with the annual rains. Senegal's climate is classified as Sudano-Sahelian, characterized by alternation between a dry season, which lasts from November to May, and a rainy season, which begins in June and ends in October.

Maximum rainfall typically occurs in August and September, and temperatures can range from lows around 64.4 °F, to highs up to 129.2 °F in certain inland regions closer to Mali (Etude de Faisabilité).

A coastal country, Senegal has a long history of fairly rich and diversified opportunities for its inhabitants. 12.4 million people live in the country, with nearly 50% of the population concentrated in urban areas (CIA World Factbook, 2012). Dakar, the country's capital, is home to around two million inhabitants. Approximately 43% of the population is below the age of 15, and population growth is currently at 2.4% (CIA World Factbook, 2012). Nationally, primary industries are agriculture, livestock, fisheries, and forestry, with agriculture employing nearly 3.4 million Senegalese (Barron et al., 2007). Arable land in Senegal counts for only 19% of the total

land mass, and is highly unequally distributed throughout the country. As a result, cultivation for export is mainly concentrated in regions with the best land and access to water, while populations subsist on farming for consumption and pastoral herding in the rest of the country. In addition, much of Senegal's arable land is threatened by encroaching desertification (Dai et al., 2004). Inconsistent rainfall, which may be attributed to climate change, is regarded as contributing to this problem (Etude de Faisabilité). Senegal's economy depends heavily on donor assistance, and high unemployment has led to a growing number of illegal migrants leaving the country for Europe seeking better work opportunities (CIA World Factbook, 2012).

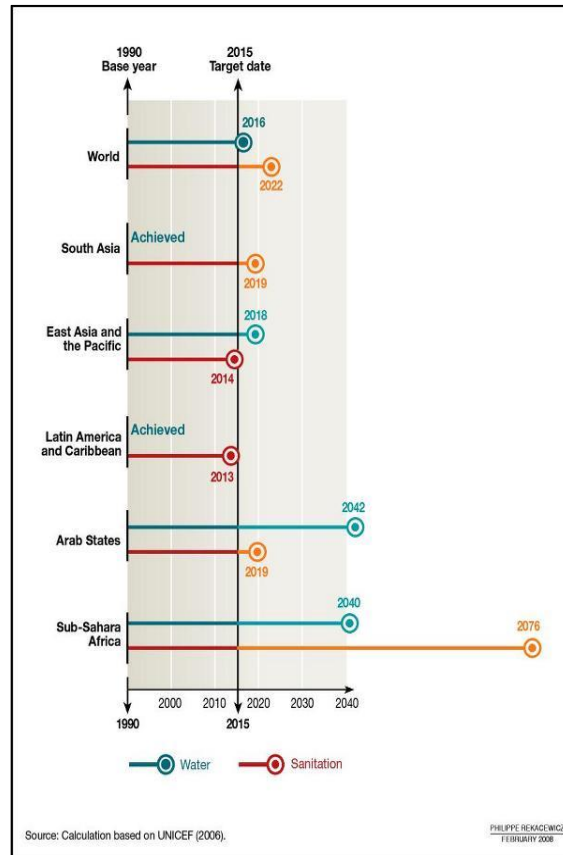
Senegal is a predominantly Islamic country, with Muslims making up approximately 95% of the population, while Christians form only 4%, and traditional animists 1% (CIA World Factbook, 2012). A former French colony, Senegal's official language is French; however, approximately 43% of the population is ethnically and linguistically Wolof, 23% are Fulani (Peulh), 15% are Serer, and the rest are made up of smaller tribes and languages (UNICEF Country Profile, 2009). According to the World Health Organization's (WHO) country profile for Senegal, average life expectancy in Senegal is around 54, and the majority of children under five who die from disease are primarily affected by malaria, pneumonia, and diarrhea (2006). In rural Senegal, where resources are scant and poverty apparent, entire families will usually live together in what are known in Senegal as compounds (Snow, pers. ob., 2011). A single family typically consists of at least one set of elderly parents, their children, and their children's families. Compounds may hold several buildings in which each family unit resides, and many resources are shared amongst siblings, such as firewood, food, water, and labor. The World Development indicators for 2005 recorded that Iraq had the highest average number of individuals in a household, at 7.7, while in

Central Africa, the average is recorded at five (World Bank). A 2001 study on household size in developing countries found that average household size in sub-Saharan Africa was around 5.3 people per household. By conducting a household survey in 43 participating countries around the world, the study also found that the average number of children in a sub-Saharan household was approximately 2.5 (Bongaarts).

2.2 Water and Sanitation in Senegal

Water has consistently stood out as a critical resource in the country, and is deeply tied to the health of the population and its economic success. The Millennium Development Goals (MDG) were established by the United Nations (UN) in order to gauge the progress of developing countries in attaining basic standards of human health and rights. While making some progress, especially in terms of basic health and malaria-related morbidity and mortality, progress for providing improved water access still consistently falls short in Senegal (Barron et al., Water Poverty and Linkages). Senegal, though typically referred to as part of the Sahel, is also considered as part of sub-Saharan Africa which, as a region, is not projected to meet MDG goals for water until 2040, and not until 2076 for sanitation (UNICEF, 2006).

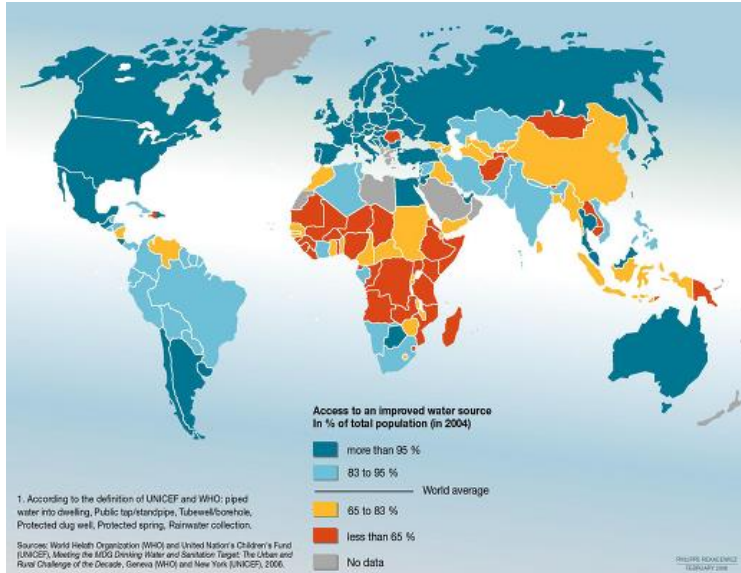
Figure 4: Target dates and actual realization of attaining MDG goals in water and sanitation by region



Source: UNICEF 2006

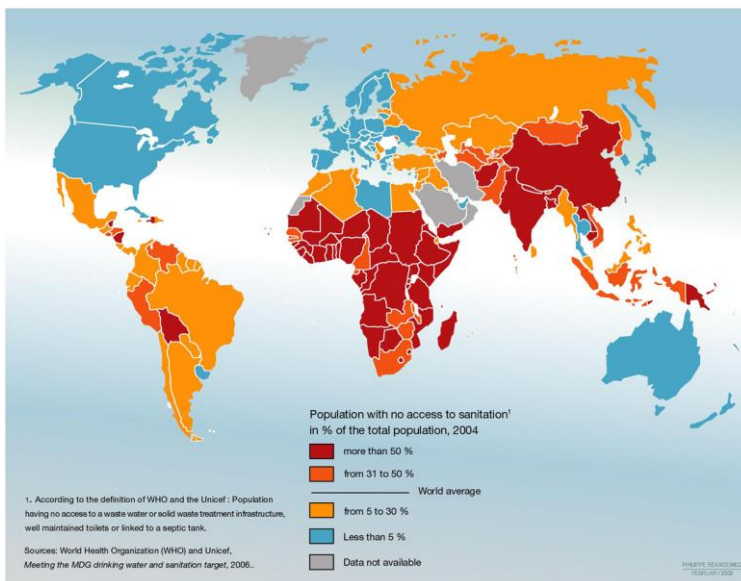
Senegal’s targets for MDG goals in water and sanitation are 100% urban coverage and 82% rural coverage. Its targets for sanitation are 78% urban coverage and 59% rural coverage (WHO, 2009). A joint report issued by WHO/UNICEF in 2006 stated that, while Senegal appeared to be on the right track for providing a greater number of improved water sources throughout the country, progress on sanitation appeared to be moving at a much slower rate. The government of Senegal, however, is committed to increasing access to improved water sources, and has specifically chosen to focus on rural provision as an area of primary need.

Figure 5: Access to an improved water source in percentage of total population, 2004



Source: WHO 2006

Figure 6: Map of population with no access to basic sanitation in percentage of total population



Source: WHO 2006

As previously stated in this paper, Senegal counts itself among countries in the Sahel fortunate to have relatively abundant surface and groundwater resources. Statistically, there is a significant amount of water available in the country accessible by people for domestic, industrial, and agricultural use. Regardless of water availability, however, an enormous gap still exists between urban and rural development regarding improved water sources and improved sanitation facilities. The challenges facing rural water development in Senegal are numerous, and mainly stem from a lack of infrastructure to build and maintain improved water sources, and to construct improved latrines for sanitation. The Senegalese government has estimated that US\$624 million will be required to finance the investment program planned for a period from 2005 to 2015 in the water supply sector, and that US\$638 million will be required for adequate investment in the sanitation sector (World Bank, 2010). Significant investment will be required in not only Senegal, but in the entire African region, considering that WHO estimates put the African regional average at approximately 61% access to improved water sources, and 34% access to basic sanitation services. Senegal stands somewhere in the middle of these statistics, hovering around 69% access to improved water sources, and 51% access to sanitation services (WHO, 2011).

A critical component in the evaluation of Senegal's total access to improved water sources and sanitation is the validity of the data reported by international monitoring organizations. These large organizations, such as the World Health Organization (WHO), and the United Nations Children's Fund (UNICEF), work jointly to report data on development progress in several areas, including access to safe drinking water. A 2012 study, however, evaluated the actual chemical and biological safety of drinking water that was reported by the Joint Monitoring

Program for Water and Sanitation. The study concluded that disparity between reported water quality and actual water quality was as high as 16% in one country, with biological contamination from coliform bacteria the primary issue (Bain et al., 2012). This study is not meant to entirely discount the value of international monitoring of water provision and safety; it does, however, imply that more rigorous evaluation of actual conditions should be performed when monitoring or implementing rural water supply projects.

In Tawa Fall village, women typically do not live more than 500 meters from some type of water source, either well or robinet (public tap). This is significant for their ability to procure water for domestic uses, considering that on average, a woman in Africa travels six kilometers (3.72 miles) for water (World Water, 2013). Despite this, village women still walk a line between balancing money, labor, and time, and make daily decisions regarding how much water they are willing, or able, to haul back to their homes for domestic use. The World Health Organization has stated that water supply for an individual person must be sufficient and continuous for personal and domestic uses. These uses usually include drinking, sanitation, washing of clothes, food preparation, personal and household hygiene, and need to be between 50 and 100 liters per person, per day, in order to ensure that the most basic needs are met (2011).

Regarding nearly any discussion of water provision in sub-Saharan Africa, a principle theme that stands out is Africans' ability to access clean water. While inhabitants typically struggle to procure enough water to meet their needs, they also struggle to find water which is clean, and free from waterborne pathogens. Articles on regional water development for sub-Saharan Africa

consistently mention access to improved water sources as a significant goal of development programs, presumably in an effort to reduce water-related morbidity and mortality among both adult and juvenile populations (Valfrey-Visser & Thiaw, 2010). Both rural and urban Senegalese regularly experience illness related to waterborne disease (Montgomery & Elimelech, 2007), indicating that cleanliness of water is a high priority for increasing general health and wellness of the region's inhabitants. More often than not, however, studies or projects involving populations of underserved individuals in developing countries tend to be removed from the actual needs or wants of the people these projects claim to be assisting. Water-related development projects tend to focus heavily on the provision of clean, or improved, drinking water sources, often without considering the lives of the very people these projects are meant to improve.

2.3 Senegal Surface and Groundwater Resources

Senegal has four major surface-water systems, including the Senegal, Gambian and Casamance rivers, and a shallow, river delta called the Sine-Saloum. In order to meet the demands of a growing population, however, the government of Senegal has increasingly turned to deep groundwater systems to provide for both urban and rural needs (Valfrey-Visser & Thiaw, 2010). To date, Senegal's combined surface and groundwater resources are adequate for supporting its needs, and the country hosts a large and plentiful aquifer system (Rapport sur L'Etat, 2005).

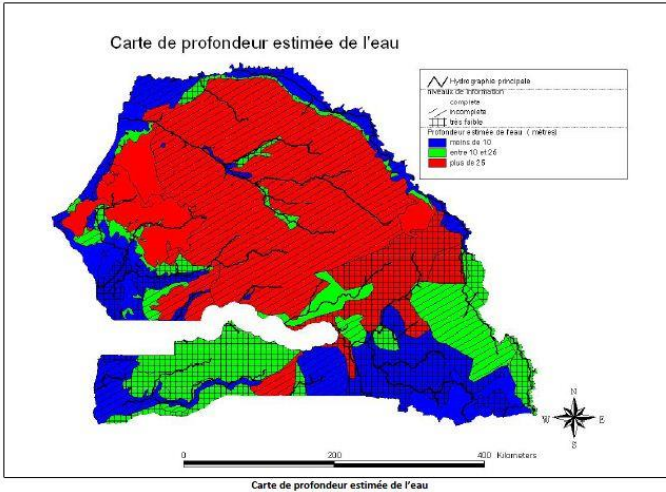


Figure 7: Map of estimated water depth throughout Senegal, indicating a significant area of depth over 25m

Source: Etude de faisabilité

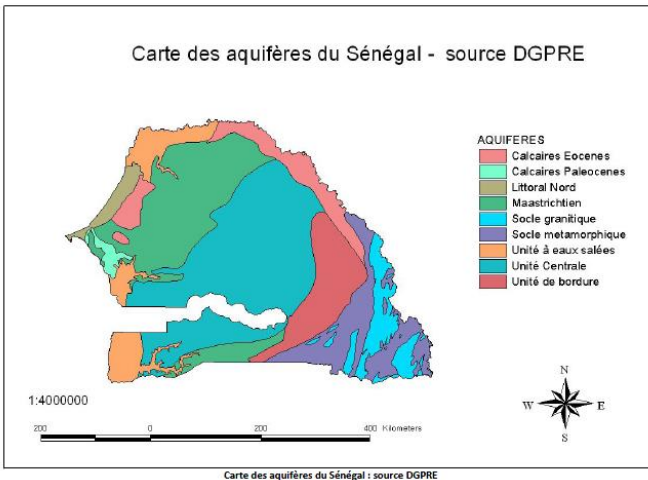


Figure 8: Map of aquifer sites in Senegal

Source: Etude de faisabilité

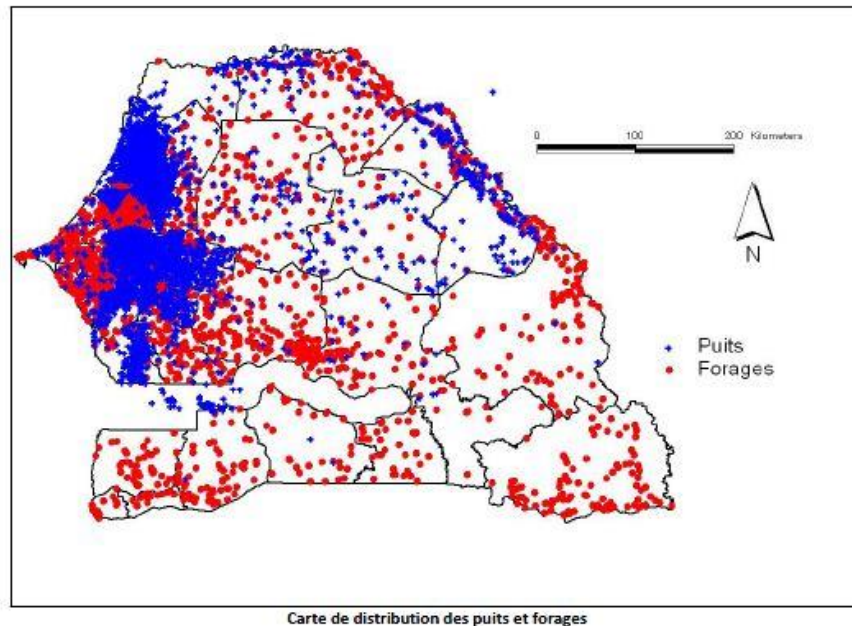
Senegal has roughly 3 billion cubic meters per year of renewable groundwater resources, excluding those groundwater resources that overlap with surface water. Groundwater reserves are estimated at approximately 7 billion cubic meters (World Resources Institute, 2003). In order to meet MDG goals for improved water source access, and to meet its own domestic needs, the government of Senegal is turning to groundwater stocks. Increasingly, surface water resources are insufficient due to inconsistent rainfall and water replenishment, as well as the contamination of surface and shallow water sources due to solid waste, salinization, and

mineralization (Rapport Sur l'Etat, 2005). While the actual quality and availability of groundwater in Senegal is poorly understood, the most exploited deep aquifer resources come from the sand and sandstone of *Maastrichtien*, which can be reached at a depth of 400m (1300 ft.) through drilling. This aquifer covers 4/5 of the country's territory with a potential abstraction of 500,000 m³/day (Rapport sur L'Etat, 2005). Even groundwater resources, though, suffer from over-exploitation along the coast, from hyper-salinization in the north and south, and from low recharge rates in the center (Barron et al., 2007).

2.4 Deep Borehole Wells in Senegal

According to the most recent available statistics, the number of both motorized and non-motorized borehole wells in Senegal is approximately 2,500, built in the 30 years since the introduction of deep-well technology to the country (PEPAM Elaboration, 2010). A borehole is defined as, "a cylindrical hole, usually greater than 20 m deep and 100 mm in diameter constructed by a drilling rig to allow groundwater to be abstracted from an aquifer" (McDonald, 2000). A motorized borehole refers to the need for some kind of motorized pump to draw water from the well.

Figure 9: Map of well (puit) and borehole (forage) distribution throughout Senegal



Source: Etude de faisabilite

Before the mid 1970s, the only available form of water for domestic or agricultural use in rural areas of Senegal was either surface water (rivers, streams, lakes) or hand-dug wells. As seen in figure nine above, it is nearly impossible to estimate the number of hand-dug wells in Senegal, as they are too numerous to count, and many regularly dry up or change location. Tawa Fall village alone likely had over twenty wells scattered throughout the village and surrounding fields, all in various stages of disrepair or age (Snow, pers. ob. 2011). Previous to decentralization reforms of the mid 1990s, nearly all motorized boreholes built with state or international aid money were managed and repaired by the centralized state. Only after the 90s, with the advent of the REGEFOR and ASUFOR systems, did management of boreholes and water towers pass to local governing bodies .

Prior to the construction of boreholes in Senegal, the only water source available in rural areas were hand-dug wells, which essentially provided all water for domestic purposes, as well as for agriculture and construction. Until fairly recently, the only way of accessing well water was through a bucket and pulley system which only allowed single buckets to be pulled at a time. While some well water is now accessed through motorized pumps, hand-dug wells are typically very traditional, and hand-pulling water remains a daily practice. The number of wells in a village depends entirely on need, means, and the reality of water availability throughout the year. An intricate network of privately and publically constructed wells exists in Tawa Fall, and in fact most villages in Senegal host wells built by a variety of funding sources. Famara Massaly, a regional development expert and assistant Peace Corps director in the country, explains:

"Usually if the water table is not too deep, there are community members, or every villager chips in money, or there is an association, who pays to dig the well. Sometimes individuals build their own wells. If the water table is high, most households will have their own wells because at 7-8m they can have water. If though, the well requires more funding, or a more elaborate well, those are reserved for projects" (See Appendix A, Interview 2). By projects, Mr. Massaly is referring to externally guided development projects, which are usually funded through the Senegalese government, with the assistance of global donors.

Due to the shifting nature of the water table in Senegal, as well as dramatic and frequent fluctuations in annual rainfall, traditional wells can extend as far as 150 feet below ground, and cannot guarantee consistent water provision throughout the year. While the rainy season typically runs from June to October, Mr. Massaly comments, "In some years where the rainy season turns out to be dry, I've seen villages where already in January or February they were

almost out of water. Drought significantly affects water availability here in Senegal.” He continues, "In every well there is water table movement. At the end of the rainy season the water level in the well will be at its maximum, and then over time it will go down, and May-June are the lowest level. Sometimes in May and June the well can actually go dry, and people need to dig the well deeper in order to have water. That increases the water capacity of the well. It's a real problem that some communities can face” (See Appendix A, Interview 2).

A single village, depending on its size, can have dozens of wells, all in various states of repair, accessibility, and water level. Landowners or farmers with the means to construct a well will almost invariably build at least one well, if not several, on their land in order to irrigate their crops. Within villages, some family compounds are actually large enough to hold their own well, although typically women access water at either a public well, or at that of a private landowner who shares water with other residents at no cost. Regardless of their location, however, there is an innate, cultural, understanding about wells that they are free for village women to access in order to provide for their domestic needs.

2.5 Decentralized Water Management in Senegal: ASUFOR System

The current situation of water resource management in Senegal has its roots in a number of overlapping and interwoven political, social, and economic concerns, and many of its challenges are based in its heavily centralized, French-style administration. Senegal is currently divided into four administrative divisions. At the top are four regions, which are subdivided into 34

departments with no independent political authority. These are then further divided into 103 arrondissements, which then split into 19 communes, roughly equal to cities. In rural areas, however, communes are called *communautés rurales*, which hold the same political structure as communes. The current system of water management and movement toward decentralization began 1972 with the creation of these *communautés rurales*, whose distance from the central governmental authority would ostensibly give them some measure of autonomy in managing regional affairs. It is important to note, however, that the *communautés rurales* are not considered by local residents to be representative of their needs. Rural councilors are selected by Deputies in the National Assembly, and are typically chosen for their political support, not their accountability to local needs (Ribot, 1998).

Following the country's independence in 1960, Senegal has struggled to emerge from a highly state-dominant form of governance which was unsustainable, both financially and socially (PEPAM Elaboration, 2010). The country made significant progress toward building local capacity for management during the mid-1990s, however, when projects like REGEFOR (*Réforme de la gestion des forages motorisés*, Motorized Borehole Management Reform) were initiated. Beginning in 1998 l'Agence Française de Développement (French Development Agency, AFD), agreed to invest 7.6 million euros into a project to rebuild and manage motorized boreholes in rural Senegal (Fiche de Performance, 2008). The project included both the construction of new boreholes through contracts with a private drilling company, EQUIPLUS, and the renovation and management of existing, though typically defunct, boreholes.

Both the French Development Agency and the Senegalese government recognized the benefits of augmenting rural water supply through boreholes, especially in regard to meeting MDG goals for access to improved water sources (AFD, 2013). The World Health Organization (WHO) defines an improved water source as water drawn from the following sources: “piped water into dwelling, plot or yard; public tap/standpipe; tube well/borehole; protected dug well; protected spring; rainwater collection” (World Health Organization, 2009). The government chose to focus on motorized boreholes due to the high potential for contamination in surface wells due to solid waste and salts. In addition, rainfall has high annual and inter-annual variability in Senegal; some surface water resources actually dry up entirely in parts of the country during the hottest times of the year (Massaly, pers. comm. 2011). Eager to avoid the over-centralized, top-down management mistakes of the past, however, the AFD and the Senegalese government collaborated to establish what the AFD termed a “hard nut” of rural management associations at the heart of the project: the ASUFOR (Associations d’Usagers de Forages, Well Users Associations; AFD, 2013). Whereas before 1998, motorized boreholes were managed by the Direction de l’Exploitation et de la Maintenance (DEM), a government agency, the creation of the ASUFOR was a huge step toward building private enterprise and community-based management of a critical natural resource. These water user associations are formed based on the rural community boards, and often include members of multiple villages, centered on the management of a single motorized borehole. While the theory behind their governance is of equal local representation and local management of groundwater, the analysis portion of this study will explore the weaknesses and strengths of the ASUFOR in terms of democratic representation and accountability.

The goals of the REGEFOR project were threefold, including elements of economic, social, and public health development (Fiche de Performance, 2008). The intention of the AFD was to develop new management principles based on the disengagement of the state to the benefit of water users and the private sector. Through reforms begun in 1995, and the REGEFOR project in 1998, an enabling environment for private sector participation (PSP) was created which fostered private enterprise regarding water and sanitation delivery. As of 2008, there were over 1,200 motorized rural water supply systems (RWSS) serving 3.6 million people in 5,000 villages or small towns, but only 10% of operational motorized boreholes were actually maintained by the private sector (World Bank, 2013). The small percentage of boreholes under private operation is evidence of what post-completion evaluation identified as challenges to the project: difficulty in mobilizing finances; absence of a central pilot committee; and weak feasibility studies, to name a few. This evaluation leads to the conclusion that, while the project was deemed generally successful, there is still a strong need to enhance professional, technical and management skills at all levels. Encouragingly, though, out of 1200 operating piped RWSS, over 95% are in good condition, a figure much higher than other neighboring countries (Fiche de Performance, 2008).

In addition to the goal of developing private sector participation, the REGEFOR project helped lay the framework for increased rural water accessibility to a consistent and improved water source. Access to water sanitation services remain a major issue in the country, and the gap between urban and rural access indicates that significant continued attention is needed to adequately assist the rural sector in attaining basic services. Senegal has been held up as a model for sub-Saharan Africa in terms of its public-private partnerships (PPP) to manage urban water access (Fall et al., 2009). Through a program called the Social Connection Program, funded

partially by the World Bank and modeled after similar efforts in Cote D'Ivoire, urban residents were guaranteed a free, or very low-cost, connection to city water networks. Since the program started in 1996, an estimated 1.7 million people have gained access to piped water in urban areas (Fall et al., 2009). While gains in the urban sector through PPP management have been significant, rural development has lagged significantly. In 2008, only 60% of the rural population had access to an improved drinking water source, and 17% had a piped home connection. Additionally, 34% of rural residents had access to basic sanitation, broadly defined, and only 2% had an in-home sewer system (World Health Organization, 2009). This disparity is stark, and while progress has been made to develop rural water accessibility, sanitation still lags far behind.

CHAPTER 3. RESEARCH SITE

Chapter three describes the study site, including demographics, well locations, and specific elements of the water tower and borehole well.

3.1 Tawa Fall Village, Senegal



Photo credit: Tenly Snow, 2011

The village of Tawa Fall lies five kilometers outside of the city of Thiès, population 250-300,000. Founded in 1889 as a regional center for Koranic teaching and culture, the village itself holds around 400 people, who live in approximately 25 family compounds. Though it is just a few miles from a large, and well-developed urban center, it still is not connected to the local power grid. One of dozens of tiny villages along the Route de Tassette (pictured above) there is a sense of timelessness that hangs over its low, tawny structures, and a silence broken only by the sound of wind moving through the grass. Without electricity, there is rarely the blare of a television or radio. Without much money, the harsh scrape of a car engine is seldom heard. The

health post in the village stands locked, hardly used, and dozens of people live in single compounds, eating what they can grab out of a single, metal bowl. In the yards, women deftly pluck the stems from bissap (hibiscus) blossoms, gossiping as they work. Men come and go from the fields for meals, rest, and a cup of cool water from an earthen pot. Dirt yards are shaded by large, green trees, and the women sit on brightly colored woven mats, sometimes napping on an outstretched arm. Idyllic in some ways, much of the peace here comes from exhaustion and hunger, the lack of work, or of any real vibrant market in which to present goods and services. With a closer look, shoes are held together by tape, and the women's colorful pagnes (wrap skirts) are threadbare. So close to a city which hosts a large population of wealthy Arabs, French, and Senegalese alike, such poverty is almost unbelievable. The urban/rural disparity in the developing world is striking.

The great majority of the residents of Tawa Fall are farmers who typically do not own their own land (Goldsmith et al., 2004). A trend is growing in Senegal of private construction and investment in the countryside, fed by wealthy individuals, both Senegalese and foreign-born, wishing to profit from Senegal's primary economic activity, agriculture (L'Enquête de Suivi, 2006). Most of the agricultural land surrounding Tawa Fall is not owned by residents of the village; instead, its owners come to visit the land more-or-less sporadically, and local men are employed to perform the daily labor (Snow, pers. ob., 2011). Their wives also frequently work on the land, scratching up a few extra cents a day by growing bissap non-irrigated patches of unused land. Additionally, Tawa Fall hosts a Peace Corps volunteer, and has been in partnership with the Peace Corps for several years. Through this relationship, the volunteer's host receives a

small amount of compensation, and the village occasionally receives farming or irrigation equipment in order to demonstrate experimental techniques (PC Senegal, 2012).

3.2 Deep Boring Well and Water Tower



Photo credit: Tenly Snow, 2011

Despite its apparent poverty, the village does have a rural water supply system that is fairly well developed, hosting a borehole that accesses groundwater at a depth of 186 m (610 feet), and which serves the domestic and agricultural needs of six separate villages. The motorized borehole in Tawa was constructed using money from the Projet d'Organisation et de Gestion Villegeoise (POGV, Project for Village Organization and Management). This project, which operated from 2002 to 2009, was conceived through collaboration between the Senegalese

government, the International Fund for Agricultural Development (IFAD), and the West African Development Bank (BOAD). The program operated in three regions of Senegal: Fatick, Kaolack, and Thies, and constructed projects in 129 villages of the Thies region, including Tawa Fall. Villages were chosen for their small size, and their high level of vulnerability due to significant poverty, and the primary object of the POGV project was poverty alleviation and village development in rural areas (Fiche de Performance, 2008).

While the borehole in Tawa Fall was not constructed through the REFEGOR project, the village does participate in the ASUFOR system, with a committee made up of village representatives and regional leaders managing the water. The maximum village distance from the water tower is approximately 3 km (1.86 miles), which stands alone in a small, fenced compound. The borehole was drilled in 2006, with final installation and production beginning in 2007. The water tower stands next to a small pump house which houses the Caprari brand generator and pump, which runs on gasoline. The tower has a maximum capacity of 100m³ (26,417 gallons), and the pump capacity is 27-28 m³/hour (7,132 gallons/hour). It takes approximately 3-3.5 hours to fill the water tower, at which point the generator and pump are shut off and water flows through a system of underground pipes to neighboring villages and fields.

One person in the village primarily manages the pump and its components, and is responsible for procuring gasoline for the generator, starting the pump, and filling the tower. This has to be done almost every day, sometimes every other day depending on the amount of water used by residents (Pers. observation, 2011). During my time in Tawa Fall it was somewhat unclear about how this individual, Ibrahim (Ibu) Jaxate, came to be responsible for managing the borehole.

Through observation and conversation, I believe that Ibu came to manage the water due to his position on the ASUFOR committee as the secretary, as well as his location in Tawa Fall, and his capacity for careful management of funds and machinery (Pers. obs, 2011).

3.3 Robinets and Wells

Through the ASUFOR system, water from the borehole is accessed by village residents at public standpipes, and is sold for just a few cents per baignoir, or plastic bucket. An extensive system of underground pipes brings water to farmers' fields, where the water is sold for less than a dollar per square meter. Throughout the village there previously existed an extensive system of *robinets*, also known as a borne fontaine (public tap). While there are five taps in the village, only two still function properly and are able to provide water; the others have been shut down for an unknown amount of time (Pers. observation, 2011). These two public taps were run by Ibu Jaxate, who unlocked the tap pictured below each morning, and another tap managed by an elderly woman who used it as her primary source of income.



Photo credit: Tenly Snow, 2011

Public taps in the village are generally controlled by a single person who holds the key to locks which prevent the water from being accessed illegally. The public tap pictured at left is unlocked from approximately 7 am to 11 am.

In addition to the public taps, there are numerous hand-dug wells throughout the village, which access shallower groundwater resources. These wells in the Thies region typically do not stretch more than 70 feet below the surface, though in certain parts of the country they can go as deep as 45m, or 147 feet (See Appendix A, Interview 2). While water from surface wells is free, there is a very real danger of the wells running dry during part of the year. Famara Massaly describes the fluctuation in shallow water sources, stating, “In every well there is water table movement. At the end of the rainy season the water level in the well will be at its maximum, and then over time it will go down, and May-June are the lowest level. Sometimes in May and June the well can actually go dry, and people need to dig the well deeper in order to have water” (2011).



Photo credit: Tenly Snow, 2011

The well pictured at left is approximately 12m (39f) deep, and was built by a wealthy landowner who allows village women to gather water there. The well, only recently constructed, is cement lined and appears very clean. It is, however, never covered, and the water never treated.

Shallow, hand-dug wells, while convenient and free, are susceptible to contamination by solid waste on the surface of the ground, the introduction of animal feces, and the potential for fecal-oral contamination. The majority of wells not only in Tawa Fall, but throughout Senegal, are never covered, leaving them open for a variety of contaminants. Disinfection is rarely, if ever, performed, leaving inhabitants of rural regions almost entirely unprotected against waterborne diseases and parasites. In Senegal, diarrhea accounts for 14% of deaths of children under five, surpassed only by malaria and pneumonia (WHO country profile, 2006), though a local health expert puts the number much higher, at close to 30% (See Appendix A, Interview 1)

3.4 Water Pricing and Funds Management

In order for Tawa Fall to continue providing groundwater to its residents and surrounding villages, and to continue paying for the gasoline, parts, and maintenance of the large pump and generator, water drawn from the ground is sold to inhabitants at a specific cost depending on their usage. The system of water sale is an integral part of the ASUFOR system, indeed it is the cornerstone for the project's goal of developing self-sustaining, vital regional economies based on private market action (World Bank, 2010). As part of the statutes of participation in the ASUFOR system, each water management committee is required to open a bank account at a decentralized financial institution, such as a local credit union. They do so under the supervision of the Senegalese government, and are required to report the status of this account, as well as request permission for any type of withdrawal (PEPAM, 2004).

The system of sale in Tawa Fall is relatively straightforward for agriculturalists, who each generally benefit from having a tap located directly next to their fields. Large-scale agriculture, which previously covered a significant portion of land in Senegal, has fallen out of favor due to unfavorable ecological and soil conditions. With these changes, small-scale agriculture has come to the fore as a more feasible and profitable form of cultivation, and the benefits of having groundwater access at the point of origin are numerous. For example, a 2002 FAO article mentions that the primary challenge of small-scale agriculture is the lack of adequate labor to water fields by hand. With the relatively recent advent of localized taps, farmers are able to both increase their production and reduce their workload.

Water from the borehole was priced at a specific, and set, scale which was determined through discussion between the national government and regional management committees. Through semi-structured interviews with regional water development experts, I understood that these prices were relatively homogenous throughout the country, and varied by only a few cents depending on the region (See Appendix A, Interview 2 & 4). The system of water sale within the village for domestic use was very basic, and was entrusted to whichever member of the village volunteered to manage a public tap. Water is dispensed through the public tap at a cost of 400 West African CFA francs (500 francs to the dollar), with an additional charge of 100 CFA for profit, per cubic meter (1000 liters). This water is sold to local women at the price of 25 CFA per two buckets, or approximately 4.5 cents. Women were typically responsible for selling the water, and during my time in Tawa Fall, the only public tap not managed by Ibu Jaxate was managed by a handicapped woman, Penda Fall, who sells water every day as her primary source of income. The water is measured by a meter, and at the end of each month, Penda is given a bill from the ASUFOR for the water dispensed from the tap. Whatever she has left over from the sale is hers to keep. From conversation with Penda, I understood that she generally sold 40 to 50 cubic meters of water per day, and could sell as much as 100-200 cubic meters in a single day.

For agriculturalists, the cost of a cubic meter of water is just 200 CFA. Presumably, water is sold cheaper to farmers because they use significantly more than nearly anyone else in the region, and to encourage more agriculture. Water trucks, which provide water to distant villages for domestic, agricultural, and construction purposes, are charged 500 CFA per cubic meter, with a 50 CFA surcharge for profit. Schools and mosques, if they have a private tap, are

charged 200 CFA, their cost reduced because they are providing a service to the community. Very few villagers had a private tap installed in their homes, due to the prohibitive installation cost of 20,000 CFA, or 40 dollars. Additionally, through semi-structured interviews I learned that villagers hesitated to install taps in their homes because they typically used more water when it was easily accessible, and thus paid more per month.

Prices for water obtained from boreholes in Senegal is determined by a number of factors, and is mainly influenced by governing national bodies which calculate operation and management (O&M) costs, as well as the potential for additional capital. In 2010, the World Bank published a report stating that, “revenue [from water sales] is largely sufficient to cover O&M costs, and some communities have even been able to build up savings for capital expenditure.” This report, however, does make clear that communities which are able to build savings are not the general trend. As Famara Massaly stated, “Water is sold almost at the actual cost to reduce stress on the people. The margin is just something that can help pay for the workers and used as funding for replacing parts. The profit margin is not that large”(2011). Tawa Fall is one of the communities mentioned in the World Bank report which has done particularly well managing its borehole, and producing funds sufficient to benefit village development. During the period of my research, Tawa Fall had spent approximately \$6,000-\$8,000 of groundwater sale funds to build a transformer and connect the village to regional electricity.

CHAPTER 4. RESEARCH METHODS

4.1 Research Methods

Senegal is at a crossroads, slowly developing capacity to manage its resources through a decentralized, and locally-focused management system. The primary goal of this study was to evaluate these changes from the perspective of rural women, who function as the primary point of care for rural families, and who utilize water for the broadest variety of uses. While men utilize both ground and surface water for agriculture purposes, women are responsible for drawing and transporting water, as well as for using water for domestic purposes. To assess the various ways that rural, Senegalese women utilize groundwater on a daily basis, and to evaluate whether groundwater meets the needs of women with their workload, I used a mixed-method data collection approach, which combined semistructured and unstructured interviews, written questionnaires, and observation. This approach is useful when data comes from various sources, as with this project (Axinn and Pearce, 2006). Data sources included the study participants (the women of Tawa Fall) and my personal notes and observations. Additionally, mixed methods can provide information from one source that is not fully explained by other methods or sources, reduce error by generating replicated information from multiple sources, and reduce the potential for bias in approach by using multiple methods (Axinn and Pearce, 2006). For this study, I conducted a survey, combined with semi-structured interviews, with women in the village who were both heads of household, and younger women not yet married. I also conducted semi-structured interviews with members of the community, as well as individuals who had a relationship with the village, but who were not currently residing there. When possible, I transformed data into quantitative categorical variables that were coded and then statistically

analyzed. In other cases, where data were not numeric, content analysis was conducted on the text (Axinn and Pearce, 2006). All data collection was performed in a combination of French, and Wolof, and then translated into English.

I conducted a survey of the majority of female heads of household in November, 2011. These women were primarily heads of household; however, if a female head of household was not present, I surveyed the eldest female in the compound. I surveyed 92% of the village compounds (n=33) through a verbal survey, since it was very likely that the majority of interviewees would have a difficult time reading questions written in French. Three families declined to participate in the survey for unexplained reasons. Additional reasoning for the verbal nature of my survey lay in the cultural character of Senegal, in which verbal communication yields far greater results than written. A large portion of female rural inhabitants have had very little formal education, and while many were able to speak and read rudimentary French, conducting verbal surveys in Wolof was a much more effective way to communicate with rural women, and to make them more comfortable with the interview process. Mere Bougouma corroborated this, suggesting that, “The women will like it much more if you just talk to them. Having them write something down makes them suspicious, even if what you’re doing is good” (Guèye, pers. comm., 2011).

Village women are quite busy performing a gamut of tasks which includes drawing and hauling water; cooking breakfast, lunch, and dinner; washing all clothing; cleaning the house; bathing and looking after children; and sometimes working in the fields. Because of their high workload, I tried to keep survey questions simple and to the point in order to avoid keeping them from their work. The first few questions were mainly to establish a baseline understanding of village demographics. I asked women their age and religion, as well as the number of people in the

household, and the number of children they had. Because this study focused mainly on the efficacy of the ASUFOR and borehole groundwater systems at tackling poverty and reducing women's heavy workload, I also wanted to find out how many children the village women had, and how many of those children were girls of school and/or working age. From a very early age, girls in Senegal begin helping their mothers with small tasks around the house, such as cleaning, childcare, and eventually, fetching water. If these girls were tasked with helping their mothers around the house, they would have less time and energy to dedicate to their education, thereby contributing to the cycle of poverty and missed opportunity.

The next set of questions I asked pertained to water usage, in order to gain a clear picture of how and where village women accessed water. A very small number of families in the village were able to afford a tap within their homes. If they were, I asked approximately how much they spent per month on their water bill, and if they still used free water from the wells. If the women didn't have a tap in their home, I determined how far their water was from the nearest well and tap, and how many times a day they visited both. I also felt it important to discover the particular uses women had for both well and tap water, due to Senegal's documented issues with mineral contamination of groundwater. I asked about the five main uses that women had for water, drinking, cooking, laundry, cleaning, and bathing, and I also inquired into women's opinions about the cost of tap water. Finally, I concluded the survey with a handful of questions that were closer in character to a semi-structured interview. These were questions like, "Do you think that using the *robinet* gives you more free time, or helps you to feel less tired during the day?" and, "Do you know where and what the money from the sale of tap water goes to?" This final question was asked to determine whether the workings of the ASUFOR was public knowledge in

the village, or if local management of groundwater was something that mainly elites and those specifically involved with the committee were privy to.

I conducted this survey with 92% (n=33) of women acting as head of household in their compound. The average age of participants was 32.5 years, with a range from 19 to 66. I explained the reason for the survey to each woman, and told them that their participation was entirely voluntary. 92% of women asked to participate in the survey agreed to the process, with three out of 36 female heads of household declining to participate for unknown reasons. As previously stated, at the end of each survey, I asked a small number of largely unstructured questions designed to supplement the information gained from the survey. While I had a handful of questions prepared, I did not hold only to this predetermined set of questions, but allowed women's answers to direct follow-up questions. This method allows greater flexibility and enables interview to pursue new directions as warranted, and thus can reveal issues that the interviewer had not initially considered (Axinn and Pearce, 2006). Additionally, gender-specific interviewing is a process which seeks to gain a specific perspective on a situation or issue. Flexible follow-up interviews with women helped to provide more detailed background, context and reflection by the participants (Lightfoot, Feldman & Abedin, 1991).

CHAPTER 5. RESULTS

5.1 Women's Water Use Survey

Section 1. Domestic Statistics

The findings in my study determined that the statistical household size and average number of children is slightly higher in the village than was reported as an average across the region. In Tawa Fall, the average household size was found to be 5.9, and the average number of children 3.24 (See Table I). A 2001 study by John Bongaarts indicates that regionally in sub-Saharan Africa, household size averaged at 5.25, and the average number of children was 2.8. Bongaarts study, however, includes surveys of urban areas, where fertility rates tend to be lower, and access to education and contraceptives is higher (Bongaarts, 2001).

Table I – Household Size, Number of Children and Working Age Girls in Tawa Fall, Senegal
(Mean Values)

Household Factors	Individuals
Household Size	5.9
Number of Children	3.24
Working Age Girls	1.9

In addition to surveying women about their household size and number of children, I also included a question about the average number of female children in the household. Because water provision is almost solely the responsibility of female members of the household, I wished to gain a perspective on how much help female heads of household had in their water provision duties. I chose to ask women about the number of female children they had of “working age.” I determined that working age was age eight or higher, based on personal observation of girls’ ages when they began seriously assisting their mothers with household work. The survey found that the average Tawa Fall village household had an average of 1.9 girls of working age.

Table II – Women’s Contribution to Family Income and Productivity

Activity	Individuals
Farming Only	5
Farming and Selling	18
Housework Only	10
Other	1

Women in Tawa Fall contribute to the well-being of the household in a number of different ways. While they are almost entirely responsible for the daily care of children, and the upkeep of the household (Snow, pers. ob., 2011), they also frequently contribute to the household economy by undertaking small farming and/or selling activities outside the home. The majority of women

in the village worked outside the home both farming and selling product in a local market. Awake and working at sunrise, 18 of the women surveyed left their homes after feeding and caring for children to take product, typically hibiscus, to sell in markets in the nearby city of Thiès (Snow, pers. ob., 2011). Table II shows that 15% (n=5) of women worked outside the home farming only, and 56% (n=19) of women worked both farming and selling small crops. An additional 30% (n=10) performed housework only, and did not work outside the home, while a single woman surveyed worked periodically outside the home as a nurse.

Section 2. Average Daily Water Consumption

Table III – Average Water Consumption by village households by number of buckets; laundry days versus non-laundry days (Mean Values)

Day	Number of Buckets
Laundry Day	11.16
Non-Laundry Day	9.06

Table III indicates that, in Tawa Fall village, average domestic water consumption was around nine buckets per household, which held an average of six people. Water usage changes on days when women must do laundry, which puts daily water consumption between 37.5 and 45.83 liters of water per day, per person. While this is not as troubling as some regions in Africa where

water consumption is between five and ten liters per person (WHO, 2011) it is still below world health recommendations for even the most basic health and sanitation. In addition, well water is significantly at risk for contamination, and even tap water which is considered an improved source, can be contaminated during its travel from the source to the home.

Table III also indicates women's responses regarding the average total number of buckets they brought back to their homes for domestic water consumption on days when they do laundry, and days when they do not. The reason for differentiating between laundry and non-laundry days is because doing laundry by hand for an entire household requires more water than on days when no washing is required. I asked women to calculate approximately how many buckets they or their children brought back from either the well, or from the *robinet*, on days when they knew they would be doing laundry, or not. On non-laundry days, the average number of buckets used was 9.06. On laundry days, the number rose to approximately 11.16.

Section 3. Well Versus Robinet



Photo credit: Tenly Snow, 2011

Table IV – Water Consumption by Well, Robinet, and Well-Laundry Days (Mean Values)

Source	Number of Buckets
Well	4.3
Robinet	4.6
Well/Laundry Day	6.5

Shown in Table IV, on average, women pulled approximately 4.3 buckets from the free wells, and purchased approximately 4.6 buckets from the *robinet*, at a total average cost of US15.45 cents. Additionally, women said that on days they needed to do laundry they would pull between one and three extra buckets from the well to complete their washing, which led to an average of

6.5 buckets. A typical bucket used to gather water from either a *robinet* or a well could be purchased in a local market, cost around US\$1, and held roughly 25 liters of liquid.

Section 4. Water Uses

Through personal observation and discussion with village women during my time as a Peace Corps volunteer, and also during the period of field research for this study, I determined that women have five primary uses of water in the home. Water is required for drinking, cooking, cleaning, laundry, and personal hygiene. In order to determine whether the borehole was making a difference in women's lives and labor, I chose to ask women specifically which type of water they preferred to use for these primary needs. While groundwater is rapidly becoming essential to domestic and economic development in Senegal, the country's principal issue with its groundwater is high levels of saline, calcium and other minerals, and contamination by surface pollutants (McDonald & Davies, 2000).

Table V – Uses of Robinet Water for Domestic Purposes

Domestic Use	Individuals
Drinking	6
Cooking	33
Laundry	0
Cleaning	33
Personal Hygiene	27

Though research had provided me an understanding of Senegal’s issues with its groundwater, I gained further insight into domestic village water usage through personal communication with a Peace Corps volunteer stationed in the neighboring village of Keur Doua Cisse. Through casual conversation about water prices and women’s usage of the public *robinets*, she informed me that women preferred *robinet* water for certain uses in the home, and well water for others. This valuable information led to a survey question differentiating between *robinet* versus well water. In Table V, it is shown that 100% (n=33) of women surveyed used *robinet* water for cooking and cleaning, while 82% (n=27) used it for personal hygiene. Only 18% (n=6) of women surveyed drank *robinet* water regularly, despite its relatively guaranteed safety from contaminants and waterborne disease. With additional questions following the survey, I understood from the majority of women surveyed that, “*robinet* water has a strange taste,” and was therefore not consumed regularly, despite its status as a protected or improved water source.

Table VI – Uses of Well Water for Domestic Purposes

Domestic Use	Individuals
Drinking	33
Cooking	0
Laundry	33
Cleaning	0
Personal Hygiene	33

Village women in Tawa Fall regularly make choices regarding their domestic water usage, choosing to use different types of water for different tasks. There are several reasons why women would choose to use well water in the village, one primary reason being that it is free, with 39% of women indicating that low-cost, or free water, is a priority . Interestingly, though, despite the cost of *robinet* water, women often chose to use it over well water for certain activities. For example, 100% (n=33) of women surveyed said that they and their families drank well water instead of *robinet* water, owing to its improved taste. Women regularly said that well water was, “sweet,” as opposed to *robinet* water which was described as having a strong mineral flavor. Additionally, 100% (n=33) of women surveyed used well water for doing laundry, owing to the high mineral content of borehole water. Rural Senegalese women hand-wash clothing using bars of laundry-specific soap. In a situation where extreme poverty describes the majority, every ounce of a resource is valuable. Hard water prevents the soap from producing active foam, leading village women to prefer “soft” well water over “hard” groundwater. In situations where

the flavor or mineral content of water didn't necessarily factor, 100% (n=33) of women preferred to save labor and energy by purchasing water for cooking and cleaning instead of hauling it from a well. Approximately 45% (n=15) of women used well water for personal hygiene, indicating a neutral preference for well water in the case of bathing.

Section 5. Water Priorities and Costs

Table VII – Women's Priorities Regarding Water for Domestic Use, and Opinion of Cost of Robinet Water

Priority	Individuals	Opinion	Individuals
Close/easy to access	20	Price high	24
Clean	0	Price OK	6
Good taste	0	Price low	0
Free/affordable	13		

In this survey, I asked women what single element was most important to them regarding water, and gave them four choices which I determined to be most relevant for quality of water relating to palatability, health, accessibility, and cost. I asked women if the cleanliness or taste of water was most important, or if it was free, or nearby and easy to access. Table VII shows that 61% (n=20) of women responded that water being close and easy to access was of primary importance to them, while 39% (n=13) of women responded that cost was the most important element to them regarding water. Not one survey participant responded that the cleanliness or taste of water

was most important to them, indicating perhaps that coping with unprotected water sources for generations had changed women's priorities in terms of water, health, or palatability

While conducting research for this study, two things struck me as an observer in the field: the striking poverty of rural Senegal, and the apparent exhaustion of village inhabitants. Whether due to heat, illness, poor nutrition, heavy labor, or a combination of all, both men and women seemed to consistently be in a state of extreme physical exhaustion. As a result of this observation, the women's responses about their priorities regarding water were not altogether surprising to me. That water was close and easy to access was of highest importance to female heads of household makes sense when considering the amount of physical labor that women are expected to perform on a daily basis. Any additional distance that women would be required to walk in order to haul water would only be a heavier burden on their already beleaguered shoulders. Additionally, although the great majority of female heads of household were married, the majority of them worked outside the home farming, or farming and selling, small crops (typically of hibiscus flowers) in local markets.

The high number of women working outside the home to supplement household income is clear evidence of the incidence of poverty in the village. By farming and selling hibiscus flowers in the market, women typically earned around US\$1 per day (BTC, 2013), money they would contribute to family expenses. In order to understand how much women were willing, or able, to spend on borehole water, I asked them whether they felt that the price of water from the *robinet* was too low, too high, or appropriate. None of the women (n=0) felt that the price of *robinet* water was too low, while only 27% (n=9) felt that the price was appropriate. 73% (n=24) felt that

the price of water from the *robinet* (US\$4.5 cents/two buckets) was too high. Despite the extremely low cost of *robinet* water which, according to Famara Massaly, is priced nearly at the cost of production in order to ease financial stress on rural inhabitants (See Appendix A, Interview 2), village women still complained that prices are too high.

CHAPTER 6. DISCUSSION AND CONCLUSION

6.1 Decentralization as Development Policy

Throughout this study on water provision for rural areas through deep borehole wells, the framework has been based on the concept of decentralized management of natural resources. Before decentralization became a reality in Senegal, water in rural regions was managed by the centralized state based in Dakar, which was anywhere from one to thirty hours away by car from the sites it was expected to manage. This centralized state, with archaic ties to its former colonizer, France, had neither the means nor the motivation to adequately manage water provision for rural regions (Dickovick, 2005). With continual international pressure to make progress in development goals for basic sanitation, health, and water provision, a more fluid, localized, and empowered system was required to both cope with the burgeoning needs of rural inhabitants, and to meet the expectations of international monitoring and lending organizations. Empowering local officials to manage resources through national legislation, enabling them to also have meaningful discretionary power, establishing both infrastructure and effective policy for management, and encouraging broad local participation in management decisions are all essential goals of decentralization (Ribot, 1998; 2003; 2012; Smoke, 2003; Wunsch, 2001;

Parker, 1995; Boone, 2003). Senegal's desire to reduce the management burden on the state and foster free enterprise at a regional level caused it to pursue decentralization beginning in 1996 when the ruling political party, the *Partie Socialiste* (PS) passed the Decentralization Laws of 1996 (Dickovick, 2005).

Through these laws passed in the mid-90s, the government created the *Fonds de Dotation de la Décentralisation* (FDD, or the Decentralization Fund), which was charged with providing funding for the sub-national government (SNG). The stated goal of the FDD was to move Senegal toward decentralized governance by providing a fund to compensate SNG for assuming increased responsibility in important sectors. Despite this, the SNG has struggled due to its minimal local tax base, and its dependence on the FDD, which also has marginal revenue.

Additionally, funds from the FDD are often extremely late in being disbursed, and are inadequate for covering basic services (Dickovick, 2005). Meanwhile, the central government still controls most social spending, owing to the fact that civil service personnel (teachers, for example) are under the purview of the central state, thereby negating the "decentralized" nature of the 1996 reforms. Finally, funds that are disbursed are often overseen by political elites, who choose to encourage members of their political party at a regional level by rewarding them with higher budgets and increased funding, indicating a high level of corruption and cronyism (Dickovick, 2005).

Analysis by regional and political experts has shown that Senegal faces severe challenges to its decentralization policies, primarily due to lack of revenue, and confused, haphazard funding

mechanisms which are still centralized and exhibit a moderate degree of corruption (Dickovick, 2003). While the country exhibited a desire to increase revenue and power in the subnational government in the mid-90s, much of the legislative action designed to accomplish this has been ineffective or insufficient. In essence, the Senegalese government has acted to increase local responsibility for public services without creating sufficient funding mechanisms, introducing a series of unfunded mandates. (Dickovick, 2003). As a result, Senegal, which is regularly touted as one of Africa's most stable and productive democracies, is languishing in a mire of checkerboard decentralization efforts without significant central leadership from either parliament or the president.

For former colonies of European powers, throwing off the yoke of previous governance and building capacity through healthy reform is a substantial challenge. In Senegal, reaching for various forms of economic and political management has characterized the country which, while peaceful, is lacking the political acumen to implement effective capacity-building (Fall et al., 2009). The great majority of funding for Senegal's development efforts have come through international donations totaling approximately US\$477 million in 2007 (CIA World Factbook), with €104.9 million alone coming from the French Development Agency in 2011 (AFD, 2013). Ideally, as countries progress in their evolution as nations and their fulfillment of UN goals for human development, they build greater capacity to generate income and manage public services. Ultimately, the goal of development is for a country to no longer need foreign aid for, "development," but to function as a healthy system, providing human services to citizens on the merit of self-supporting, vibrant economies.

One of the primary goals, or effects, of decentralization is the encouragement of local economies. Theoretically, by empowering local communities to manage their own resources through a combination of neoliberal-inspired competition, designation of power, restructuring of management mechanisms, and involvement of local residents, community needs will be expressed and addressed more efficiently, and infrastructure will be supported by localized economic activity. These are the theoretical best-outcomes of decentralization, and vary according to a state's degree of accommodation for rural elites, and the degree of intervention it chooses to display (Boone, 2003). Some negative potential outcomes of decentralization are concentration of power in the hands of rural elites, poorly trained personnel, and the lack of effective processes to involve locals (Ribot, 2002). Tawa Fall experiences all these problems with decentralization to some degree, most specifically at the level of sub-national government where state designated funding concentrates in the hands of politically affiliated and appointed local officials. Typically, what assistance rural inhabitants do receive are fringe benefits from larger political battles between elected elites (Boone, 2003). Village residents are rarely the subject of focused, participatory processes, due to their lack of influence as a tax base, and a dearth of education or ability to contribute to management decisions (Dickovick, 2005).

Much of the focus of the discussion about Senegal's decentralization practices is concentrated on economics, funding mechanisms, and the transfer of responsibility for provision of local services from the central government to the SNG. Often, theorists addressing decentralization talk about local participation and representation as a key to effectively decentralized, democratic governments (Ribot, 2005). Synthesizing the economic aspects of decentralization with its human component is usually represented by progress in human development goals, and in this

case, people's access to clean water and sanitation services (Ribot & Larson, 2004). How can a discussion about what is primarily an economic event be linked to the health of a country's citizens, or the natural resources they depend on? In Senegal, local management of-and responsibility for-groundwater has been significantly increased with the reforms of the 1990s. The provision of clean water, a basic necessity of life, is now under substantial management by locally elected authorities whose responsibility is to manage the finances and infrastructure of groundwater provision. The effects of decentralization on people's health in rural areas of Senegal has yet to be fully evaluated; however, studies like this provide a basic view of women's responses to localized natural resource management. By evaluating water usage and opinions on water provision, a link is established between theoretical statements on decentralization, and the reality of individual responses to its implementation. As Ribot (2005) states, understanding of local needs, and participation of local communities, are critical to an effectively decentralized state. Positioning ourselves analytically toward decentralization in African countries through more specialized research into its effects on individual's daily lives allows for more informed decision-making on implementing further, successful, decentralization measures. As the focus on this study, the next chapter will evaluate how well the ASUFOR system has worked to manage natural resources at a local level, and its effectiveness at encouraging local participation in management decisions.

6.2 Effectiveness of the ASUFOR

Although struggling, Senegal has made progress in meeting MDG goals for 2015, specifically in the areas of water and sanitation. Despite drought, or drought-like conditions, which have plagued the country for decades, advances have been made in water provision, specifically in the exploitation of Senegal's groundwater resources. Perhaps the most successful of these advances has been the ASUFOR system, developed in conjunction with the AFD to effectively manage motorized borehole wells scattered throughout the country. The ASUFOR system was envisioned to be an aspect of Senegal's governmental decentralization process, designed to pass management of borehole wells and their infrastructure onto local authorities, ultimately involving the villagers served by the RWSS themselves through the election of governing bodies.

Ultimately, the ASUFOR were not designed to merely be localized management groups, something which would have corresponded with relatively ineffectual efforts at community based natural resource management (CBNRM) that had previously taken place in the country (Ribot, 1998). Instead, the AFD and Senegal worked in conjunction to develop a program which would seriously focus on the economic aspects of service provision in rural areas (AFD, 2013). In effect, the REGEFOR/ASUFOR project treated rural water provision like a self-sustaining, revenue-generating system for the first time, no longer relying on "development projects," or handouts of foreign aid, to sustain an ineffectual, archaic system. Quoting the AFD in their article on modernizing motorized boreholes in Senegal, "This program envisioned developing new management principles based on the disengagement of the state for the profit of water users and the private sector" (2013). In the same article, the agency mentions that the project was a

sort-of “cultural revolution” in the country, effected by not only the state, but also the villagers themselves. In addition to passing management of motorized boreholes onto rural management associations, other strong elements of the program included a clause which legally requires all ASUFOR to sign a management contract for basic maintenance and repairs with a local outfit (PEPAM, 2004). Relating to market-building strategies of neoliberal development theory, this clause assures that the central state is not responsible for upkeep of boreholes, an issue which plagued the government and rural residents for years, and which led to almost continual breakdown of expensive equipment, and lack of continuous water service. It also guarantees that the local economy will be stimulated through maintenance fees and provision of parts and labor to upkeep generators, pumps, and water towers. This type of public-private partnership (PPP) has worked for quite some time in urban Senegal for water provision, and is being extended to rural regions through the ASUFOR system.

Much of the literature on the ASUFOR project sounds very rosy, painting a picture of a new style of management which could solve Senegal’s rural water provision issues. While Senegal still faces an enormous number of issues with the rural sector at large, the ASUFOR system has been one of the more successful undertakings of the government in its ongoing process of decentralization (AFD, 2013; Fiche de Performance, 2008). According to a 2010 World Bank report on the status of ASUFOR-managed borehole wells throughout Senegal, the average rate of functionality for rural, multi-village boreholes with motorized pumps has fluctuated around the 90% mark for several years. Multi-village boreholes are viewed by development experts and financial investors in the rural water provision sector as a fairly successful, and stable, form of access for rural inhabitants (Water Supply and Sanitation). Additionally, the ASUFOR system

functions very well in conjunction with local banking networks, where they are required to deposit funds from the sale of water, and where withdrawals can only be made with a signature from an overseeing government official. The ASUFOR system has also assisted in increasing the number of local service providers, due to the system's contractual obligation to engage the private sector in maintenance contracts (World Bank, 2013). Actual figures, listed in a post-performance evaluation document, indicate that, through €7.6 million contributed by the AFD, 180 out of 200 ASUFOR were able to support delegation of management from the state to their user associations; 80% of ASUFOR were able to successfully set up accounts with local banking networks; 63% of ASUFOR signed maintenance contracts with private operators; and 90% of existing boreholes had satisfactory equipment upgrades (Fiche de Performance, 2008).

Issues identified by post-evaluation of the initial REGEFOR project include a lack of adequate structural preparation for the complex number of management elements of the project; the necessity of instilling a very solid set of expectations at the beginning of the project in order to synthesize varying points of view; and assuring the regulation and control of contracts through legitimate judicial bodies (Fiche de Performance, 2008).

Aside from official documentation of the relative successes and struggles of the ASUFOR, this study evaluated the effectiveness of the ASUFOR from the perspective of actual inhabitants served by these rural water amelioration projects. In addition to baseline survey questions, women of Tawa Fall were asked whether they felt that the borehole well had made their lives easier in terms of procuring water. Responses were almost entirely positive on behalf of the borehole well, with all women interviewed indicating that it has helped them with their daily workload. One woman, Ndeye Ndiaye, said, “The *forage* has really helped me. When I get home

from the market, I can just get water from the *robinet*. It's much easier on us" (Pers. comm, 2011). Another, Ndjemba Fall, responded, "It's hard pulling water every day! Villagers are tired! It's tiring going every day to the fields, picking food, pulling water. The *forage* has helped to advance us, but we still want a tap in the house" (Pers. comm, 2011). This was a regular response from women interviewed: that while they appreciated the existence of public taps, they still had to fill buckets and haul them home. Having a tap inside the house would reduce their workload even further, allowing them more time, energy, and perhaps better personal and family health.

In order to further evaluate women's understanding of the ASUFOR in their village, I included a question in the survey about their knowledge of the cost of water. I asked women whether they knew where their money went when they purchased water, and whether they were familiar with the term ASUFOR. Out of 33 women interviewed, 6% (n=2) knew about the ASUFOR, and understood that their payments for tap water were going toward a village development account. The extremely low number of women who were aware of the ASUFOR, or where their money goes, coincides with a Belgian Development Agency report on women's participation in water management. "Women," the article states, "who are the first users of water, have little say in these decision-making bodies." Of the 400 ASUFOR studied in the evaluation, only four were presided over by women (2013). While ASUFOR charters stipulate that the boards must be comprised of 50% women, this is rarely respected, possibly due to gendered cultural restraints associated with Islamic society, or because women receive less education, and are therefore less likely to submit candidature for these positions. While women in Tawa Fall clearly appreciate the borehole in their village, the low incidence of village awareness about the function of the

ASUFOR indicates issues with what Ribot (2002, 2003, 2005) noted about community participation in decentralization, and downwardly accountable authority.

Despite these issues, however, Daouda Niang, a regional water management expert and sociologist, stated in a 2011 interview, “The ASUFOR works better than the old system. I wouldn't say that it is perfect, but every reform demands follow-up, and a moratorium for observing which aspects of the program must be reworked. So, since 1997 until now, nearly 13-14 years, people should now be able to evaluate the process, and see now what the new dynamics are. Always, the program had the objective of increasing water access through the lens of durability, which is a continual process. Populations grow, dynamics change, and it is always necessary to follow-up and make observations. I think ASUFOR are a very good thing, but they should be continually evaluated. In observing the ASUFOR in the field, I have seen that they have much better results than the old system before 1997" (See Appendix A, Interview 4).

6.3 The Future of Rural Senegal

There is no doubt, based on development statistics and personal experience, that rural West Africa is a difficult place to live. Families and individuals face constant challenges, not only to their daily comfort, but to their survival. Few places in the world present such few opportunities for development of natural resources, few places are more vulnerable to climatic changes, and few places are governed as inefficiently, or are as isolated. Out of 177 countries measured by the United Nations Development Program for progress in human development, Senegal ranks 158

(IFAD, 2011). Since the country gained independence in 1960, Senegal's population has steadily increased, while the majority of its self-generated economic sectors like manufacturing, or agriculture, have steadily decreased. Migration, both in-country from rural to urban areas, and emigration to mainly European countries, is commonplace among young men who find little or no opportunity within their own country to earn a living (HWWI, 2007). Additionally, the lack of adequate infrastructure for the provision of water, electricity, and health services is severely affecting rural populations' ability to live functional and productive lives.

Since 1960, when Senegal gained independence from its former colonizer, France, the country has, in many ways, been on a slow decline. Since the French retreated from Senegal, basic infrastructure and economic opportunity have declined dramatically (HWWI, 2007). Since independence, the population has nearly quadrupled, with nearly half of the population under the age of 18 (HWWI, 2007). In addition, Senegal has faced an economic crisis beginning in the 1970s, and which intensified in the 1990s. Between 1990 and 1999, GDP per head dropped by 28.1% (HWWI, 2007). Beyond the national economic crisis which affects all inhabitants of the country no matter their location, changes in the country's structure and population density also regularly occur. Between 1961 and 1993, the rural population fell from 70% of the total population to 57% (Goldsmith et al., 2004). Additionally, between 1961 and 1999, the per capita agricultural production base dropped nearly 50% (FAO, 2013). Drops in agricultural production likely coincide with the severe drought that Senegal has regularly experienced, and increases in rural-urban migration may be a consequence of falling agricultural production. Conversely, drops in agricultural output may be due to a labor shortage resulting from increased in-country emigration to urban areas (Goldsmith et al., 2004). In addition to in-country migration, a large

number of Senegalese have chosen to emigrate from their country, with European countries as their most likely destination. In 2005, approximately 463,000 Senegalese, or 4% of the population, were living abroad (HWWI, 2007).

Most often, people choose to migrate due to economic hardship, believing that greater financial opportunities may be had in areas of higher population density and economic activity (Goldsmith et al., 2004). The incidence of deep, systemic poverty in sub-Saharan Africa supports this theory behind migration. The highest incidences of what is termed, “ultra-hunger” and “ultra-poverty,” defined as people living on less than US \$1 per day, and consuming less than 1,600 calories per day, is in sub-Saharan Africa (Ahmed et al., 2007). Rural areas are particularly susceptible to ultra-poverty, due to their remoteness from urban services, a high incidence of landlessness, and a fundamental lack of education about primary health care (IFAD, 2011). Specific to the region, the incidence of rural extreme poverty hovered around 61.6% in 2008, only one in five people have access to an electricity grid, and more than three quarters of the region’s poor live in rural areas (IFAD, 2011).

If this is the state of rural, sub-Saharan Africa currently, what does the future look like for Senegal, which is facing expanding populations, decreasing economic opportunity, and potentially higher temperatures and more severe drought due to climate change? There is no doubt that suffering occurs, and will continue to occur, in rural Senegal. The rural sub-Saharan region is not expected to climb out of extreme poverty until 2045 (IFAD, 2011), indicating that hard times lie ahead for the millions of people living there. The country, however, in conjunction

with international relief agencies, is committed to improving the lives of its rural citizens, bringing them closer to the quality of life enjoyed by urban inhabitants. Small advances, like the ASUFOR program, have already saved several million dollars in operating costs for the central government (World Bank, 2013), and are improving water access for hundreds of remote villages across the region. The ASUFOR program has been a great success, especially when placed on a spectrum of development projects over the 53 years since independence. Women in particular struggle in rural areas, suffering from a lack of adequate pre and post-natal health care, as well as low access to quality education for themselves and their children, notably female children (Halvorson, 2002). While Senegal is making progress in MDG goals for education, health, water, and sanitation, attainment of those goals is decades behind the ideal, indicating that, while work is being done, enormous obstacles are still present.

Many of the issues facing rural Senegalese, specifically women, involve the cost of *robinet* water. While *robinet* water is an improved source and reduces women's labor load, the cost of this water, at US4.5 cents for two buckets, is still perceived by 73% (n=24) of women as being too high. This could indicate either: village residents are truly so poor that they cannot afford to pay for water, or having been accustomed to paying nothing for water the majority of their lives, any monetary cost associated with water is deemed, "too much." In order to evaluate the feasibility of development of boreholes for continuous, protected water provision, it is critical to understand, or at the very least, discuss, ways to mitigate village reticence to paying even a nominal fee for water. On the issue of water pricing, Douda Niang comments, "*Forages* accumulate quite a lot of money. Some have almost 25 million CFA (US \$49,500) in the account, others are at 16 million (US \$31,679). Now, the problem is that the state and the people

are asking what should be done with that money. The state is asking if the money should be loaned to the population, the state is questioning itself, asking, ‘how can this money be used?’ Populations say, ‘this is our money, it should be loaned to us.’ The hydraulic department is afraid that the whole system and project will slide back into previous problems” (See Appendix A, Interview 4).

Reducing the cost of water, which is already sold at a very small profit margin (See Appendix A, Interview 2), is not an option for most rural areas. While the *forages* do accumulate a fairly large amount of money, a decent cushion is required in order for the ASUFOR to perform adequate maintenance on pumping systems, and to purchase gasoline for the daily operation of pumps (Etude de Faisabilité). This study determined that the majority of women in Tawa Fall like the *robinet*, and purchase tap water on almost a daily basis. Most of them, however, do not know where their money is going, or what it is being used for. Greater education and transparency about the accumulation of funds, as well as fuller participation by local communities, specifically women, in determining where *robinet* money should be spent, are both potential solutions to villagers’ complaints about the price of water. Specifically, villagers’ complaints about the cost of water could be addressed through citywide, or even regional meetings, that are open to the public, and which clearly explain the function of the ASUFOR, and the accumulation of funds. Women in Senegal also frequently form local neighborhood groups which have an elected president and council. Addressing the leaders of these women’s groups, and allowing them to disseminate information to other local women is a possible culturally sensitive solution to educating local communities about the activity of the ASUFOR.

Reviewing improved rural water provision from women's perspective has intriguing implications for African countries at large, and for countries whose primary religion is Islam. Women's role in Muslim, African society, is multi-faceted, demonstrating aspects both of leadership, and of dismissal. Women, as primary domestic water users, should logically hold a position of influence in decision-making for rural water improvement projects. As found in this study, however, female representation on rural committee boards and in rural governance is very minimal, and their empowerment is confined to women's groups which, while important, are not generally consulted for key decisions. Additionally, the role of female children in domestic water provision is an important dimension of a gendered perspective on rural water. Girls are socialized from a very young age to play the role of water provider, and this "women's work," is never questioned or challenged. Culturally, there is a disconnect between water users, water providers, and representation for decision-making. When society demonstrates to young girls that their elder female role models are not relevant in decisions about resource management, they are taught to develop fringe organizations to satisfy their practical domestic needs, and are not fully empowered to participate socially in their communities (Halvorson, 2003).

The results of this study in Tawa Fall may be indicative of the region as a whole, demonstrative of gender dynamics throughout West African society. The study is replicable as an evaluation of gendered domestic water use perspectives, and may be applied to evaluate the economic and societal effects of decentralization of water resource management throughout the region. It is important to note, however, that replication of this study may not be appropriate for all areas of Senegal, or of West Africa. Tawa Fall is located near an urban center, and relatively close to the capital city. Its location has allowed for greater education of inhabitants, greater access to

infrastructure, and greater concentration of project financing. Deeply rural areas of Senegal still rely entirely on shallow wells and manual pumps for water provision, and should not be evaluated in the same manner as Tawa Fall.

6.4 Conclusion

The outlook for rural populations in Senegal is truly challenging, with a seemingly insurmountable number of issues facing development experts, central governments, and sub-national officials. Rural Senegal falls in line with the majority of statistics and predictions for the region, demonstrating a chronic lack of solid development strategies to help balance the prominent gap between urban and rural progress. Beyond the notable lack of infrastructure, or funding to promote construction and expansion of services in rural areas, additional issues include more complex problems with haphazard or uncertain systems for information sharing, and the concentration of power in the hands of a select few. While decentralization has made strides toward allocating power downward to the SNG, as one functionary in the Senegalese government stated simply, “The state has decentralized more problems than solutions” (Dickovick, 2003).

This study aimed to synthesize two key issues in Senegal today: the political and economic process of decentralization, and the management of one of the world’s most necessary resources, water. In many of the world’s developing countries, decentralization is an ongoing process which

has attained varying levels of success, especially regarding natural resource management. While superficially, the theories of decentralized natural resource management are attractive, when put into practice they can create problems without clear solutions. As Daouda Niang stated, “While the ASUFOR system is dependable and durable, the real question is, how do we manage our resources sustainably?” In other words, discussions regarding resource provision to people living in ultra-poverty usually focus on getting the maximum amount of resources to people as quickly as possible; the question of sustainable or responsible usage of resources is generally not considered. Mr. Niang continues, “We have had, with the ASUFOR, less problems than before. There are still many conflicts between actors, and we should still be looking for solutions. There are still certain aspects that the state and the political realm must consider, such as the promotion of people's rights, involving women in water management in the rural sector, the importance of community management of natural resources, and what are the social aspects which act as parameters, or which must be integrated into the program" (See Appendix A, Interview 4).

By interviewing village women, and gauging the amount of water they used per day from borehole wells, this study documented that the borehole well in Tawa Fall is an asset to not only the village, but also to several villages in surrounding areas. Of equal importance too was gaining a grounded perspective on the durability of not only the borehole infrastructure, but the management system which is now responsible for its maintenance. Ultimately, this study found that deep borehole wells in Senegal are a practical form of rural water provision, significantly increasing the number of people able to more consistently access safe water through RWSS. Additionally, this study suggests that the ASUFOR system has stimulated local markets,

generated revenue for rural development, and empowered local citizens to contribute to management decisions regarding their primary natural resources.

This study also determined that, while the ASUFOR system is a viable form of rural water provision, elements of the program still require evaluation, follow-up, and potential revision. Greater involvement of women could increase the program's vitality, and perhaps contribute to further extension of its revenue-generating ability as women might feel more comfortable purchasing water, and may even be encouraged to purchase more water, if they understood where the funds were going. With greater community involvement, ASUFOR-generated revenue could be better allocated to village development, following recommendations from village inhabitants themselves, and not only from local elites. Continual oversight of the program would assist both local and national development experts in further expanding the program into regions of the country with greater need of RWSS, and could deepen the system's durability as the primary form of rural water provision. Finally, expanding the program could continue to stimulate local economies, encouraging self-sustaining local markets which would no longer struggle to exist, or be as dependent on funding from a centralized government. Through the ASUFOR system, Senegal is moving forward toward durable, viable, and most importantly, self-sustaining, rural development.

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APPENDICES

APPENDIX A: Key Informant Interviews

Interview 1. Sanitation and Improved Water Access in Senegal *Mamadou Diaw*

Statements by Mr. Diaw:

"There is a conflict around water in many areas, people want to access water for irrigation."

"Women still devote several hours a day to getting fresh water. In most places you will find a well, but they are often very deep, sometimes up to 50-70 metres. It takes time to pull out water. Gender roles make them responsible for fetching water for the family. Getting fresh water takes time away from girls, and from all the duties they have at school. Also, there is the concept of 'pénibilité,' the difficulty, the hardship, of having to draw water. "

"Progress has been made on access to safe water, but low progress has been made on sanitation."

Question and Answer:

Q: Is water supply consistent in rural areas? Are there problems with the *forages*?

A: "Many *forages* can break, and they can rest almost three months sometimes without getting fixed. During those three months, people resort to other water sources, and it's not the best water

that they can get. A big problem is still the continuity of access. Water may be available, but in low quantity, and the effort made to get that water can be very large. People end up spending most of their time trying to access that water.”

Q: Why do *forages* break down or stop serving a community?

A: "The problem is that the committee managing *forages* usually face financial issues to replace a broken part, or buy gas for the pump engine. So, even if a village has a *forage*, there will very likely be some months where it is broken. During that time there's a very large problem. "

Q: What is the money from the sale of water used for?

A: "They use that money to maintain the *forage*. The problem is that sometimes there can be mis-management of the money. People don't pay on time, and then the committee runs out of money, or there is a serious break in the pump and they don't have the capital to repair it. "

Q: What is rural health like relating to water?

A: "People don't have the practice of treating water. Even if they know that by putting bromide in the water they can treat it, it's hard to make the change. Even in educated families, people do not treat their water. Or they don't wash their hands with soap. Or they do it in the traditional way, everyone washing their hands in the same bowl with the same water. Those practices aggravate the problem, and it's hard to segregate the factors that contribute to the prevalence of illness, whether it's personal sanitation, or that the water itself is not safe."

Interview 2. Water Access Issues at the Rural Level *Famara Massaly*

Statements by Mr. Massaly:

"Running water is the exception in villages, not the rule. Based on my personal experience, I see that maybe 10% of villages may have running water, and 10% may actually be an over-estimation."

"During the rainy season whenever it is raining, people in villages will shower in the rain, or next to the roof because it collects water. So this person has increased access to water and will spend less money on water for showering."

"It's very common during the rainy season along the roads, if there is a pond next to the road, you will see a lot of pagnes (wrap skirts) drying next to the pond because the girls and women washed them right there. "

"The wealthiest compounds (households) can sometimes pay to have a water connection in their home. They can actually extend the water line into their compound."

"In cities where people use normal showers, flushing toilets, etc., those consume a lot of water. My monthly bill every two months is 45,000CFA. I have sometimes 14 people at home, and most people shower twice a day."

"In every well there is water table movement. At the end of the rainy season the water level in the well will be at its maximum, and then over time it will go down, and May-June are the lowest level. Sometimes in May and June the well can actually go dry, and people need to dig the well deeper in order to have water. That increases the water capacity of the well. It's a real problem that some communities can face."

"Usually if the water table is not too deep, there are community members, or every villager chips in money, or there is an association, who pays to dig the well. Sometimes individuals build their own wells. If the water table is high, most households will have their own wells because at 7-8m they can have water. If though, the well requires more funding, or a more elaborate well, those are reserved for projects."

"Whenever it is very difficult to have an improved well, communities will usually request funding from either the Communauté Rurale, or from projects and organizations like Peace Corps, NGOs, etc."

"In the budget of the CR, they make priorities depending upon issues that there are in the area. It can be about expanding the water line if they have a deep boring well somewhere, or it can be about digging wells in a couple of villages."

Question and Answer:

Q: What incidence of corruption do you see in village management?

A: "The problem that I see happening is that the most powerful leaders in the CR sometimes pull the blanket toward themselves, which is toward the village they originated from, trying to push the priority of that village over the priorities of other villages."

Q: What challenges face implementation of the ASUFOR policies?

A: "When it comes to implementing, unfortunately, there is this embezzlement technique which is very common in Senegal and in most developing countries. Say I need to construct a well. In contracting an entrepreneur, I can push your offer to the committee and get you the contract, provided you give me 5-10% of the total cost. Then, the entrepreneur would include this 5-10% in the cost they quote to the committee. Say the project costs three million CFA. Knowing he would need to bribe someone in order to get the project, he would include that 5-10% in his quoted cost, then he may say that the real cost would be four million CFA."

“As far as water is concerned, another level where embezzlement can happen is at the level of management committees. I have seen a management committee that was almost in bankruptcy for a couple of months. That was in a big village where a couple of leaders were not paying their water dues and it puts the group in a difficult situation where they were not even able to pay for the gasoline fees for the forage pump.”

Q: What was water management in rural areas like in the past?

A: "In the past, the water management committees had a lot of difficulties 10-15 years ago, both at the very local and the regional level. In the past, people were not able to sustain water supply from forages. The government would come, build a forage, create a management committee and after a while, the committee can no longer supply the forage with gas or pay people. No gas, no water."

"The money got embezzled, it went to someone's pocket, then something would break in the process and there would be no money to replace that part."

"Now though I would say things are improving and they're having better management procedures. However, there are still some problems like embezzlement, or some leaders in the community not paying their dues. As they are leaders, they can be the wealthiest components of the community, and because of that they consume the most water. They know that they have to pay but they say, ok, I'll skip one month, but then next month all the problems come and their debt increases. Their debt increases, and then their debt gets transferred to the group and there is a progressive deficit. I have seen a big village that didn't have running water for a couple of months because of that."

Q: How does the management committee cope with these kinds of issues?

A: "The management committee can put pressure on those people by cutting off their water line."

Q: What about the price of *robinet* water?

A: "Water is sold almost at the actual cost to reduce stress on the people. The margin is just something that can help pay for the workers and used as funding for replacing parts. The profit margin is not that large. If people are not paying, then the profit is sometimes not able to compensate for those who aren't paying."

"If the procedure is transparent, when someone brings me money for a certain amount of water, we need to specify how many baignoirs, the individual cost and total cost. He signs, I sign and I give him a copy and keep one copy for my records. If it's not transparent, I collect the money and we just say the number of baignoirs. If one day I get money for 1,000 baignoirs, I can say that I only collected money for 700 baignoirs. If the system is not very transparent, or very thorough, embezzlement can occur that way."

"It's important to have clear and transparent procedures at every level. Everything should be documented. Also, working with the decentralized, financial systems so that they treasurer can

deposit the money in an account every day, or almost every day rather than saving the money in his hut."

"If you live in a village and I know you are the one saving the water management committee's money and I need a medical procedure, I will come and borrow money from you, depending on how close we are. Sometimes people are so connected socially that it's hard to take a person to the police, just because you lent him money for a prescription and he didn't pay it back. If that happens with 1,2, 3 people, you'll end up being in trouble."

Q: What have you seen personally regarding water provision during the dry and rainy seasons in rural villages?

A: "In some years where the rainy season turns out to be dry, I've seen villages where already in January or February they were almost out of water. Drought significantly affects water availability here in Senegal."

"If they don't have enough water to shower, sometimes people will go to ponds where the sanitation issues may happen."

Interview 3. Government Programs for Improved Water Access *Aaron Brownell*

Statements by Mr. Brownell:

"An ASUFOR is established with *forages* to help with the maintenance and the management of that infrastructure. Standardization of the ASUFOR: Revenue is generated, water is not free, and revenue is generated from the water supply. There is management of resources, different people have different roles and responsibilities within the ASUFOR."

"Now with the *forages*, the state is ultimately in charge of repairing and maintaining the forages. They are now looking to privatize, a public private partnership, PPP."

"Senegal has a vision to make PPPs a reality, they have broken the country down into three regions, central, north and south, starting with the central region to see how it works. Ultimately the relationship is that a private operator is in charge of maintenance, working with the ASUFOR, to maintain the *forage*."

"Senegalaise des Eaux (SDE) is urban sector and has had lots of success with the PPP model. The government now envisions repeating the success of the PPP in the rural sector. Rural is lagging compared to urban with water, and with sanitation both are lagging."

Question and Answer:

Q: What are the incentives to invest in water and sanitation

A:

1. "Quality of life: Women walk kms and kms to access water. Having a safe water source that is closer creates a whole plethora of co-benefits
2. Diarrheal diseases are the second leading cause of death for children under 5, after malaria. Health implications of safe and accessible water supply and sanitation facilities are incredible. The rationale to do all these investments and work."

Q: What are some new or innovative projects occurring in Senegal currently?

A: "Senegal has a lot of exciting things occurring in certain regions. The PPPs and the forages is very innovative. Nature, Wealth and Power is a program to manage natural resources, and to extend best techniques for management. Wealth is the economic growth and the incentive for people to manage their resources better, and power being the governance. All aspects combine to help populations manage their resources at the local level. USAID is working directly with local NGOs, focusing on local organizations, contracting out to NGOs. A lot of American companies are taking contracts from USAID, they then pack up and leave. Local organizations stick around."

Interview 4. Decentralized Natural Resource Management in Senegal *Daouda Niang*

Statements by Mr. Niang:

"SONES and SDE manage water in the urban area. SDE has a contract with the state to manage water in the urban sector. The management was direct previously in the rural sector, the government managed the *forages* and the wells directly, with *communautés rurales* that managed the sale of the water. They found, however, that this wasn't a very good system of management. "

"There is a president, and several people around him, the money was not held in an account, it was held by a treasurer, no one knows where he put the money, and when people paid for their water, it wasn't sold in great volumes, but in small amounts, and often there was mismanagement of the money collected."

"If the *forage* was broken, the state didn't have the means to repair it, the *communaute* didn't have the means to repair it either. Often, they didn't even have the money to buy the gasoline to run the pumps. This caused enormous problems with management, and very often, *forages* fell apart and weren't repaired."

“Before the years 1997, things were like this. In 1997 there was a reformation of management of water resources. The first *forages* in the rural sector were built around the year 1957. They were the largest, and they contributed the greatest to the development of pastoralism and water access, built under the colonial regime and using American technology. This technology helped to discover and access the Maastrichtian aquifer.”

“Around the year 1957, this technology helped contribute to deep groundwater access. All this was under the colonial administration. “

“Since then, the state has directly managed deep groundwater access through the *communautes rurales*. Before, the state didn't have enough means to manage and maintenance the *forages*. "The treasurer kept the money and was autonomous, with no oversight. If the *forage* broke down, the treasurer could say that there was no money available." The state wasn't happy, because it paid to build *forages*, and they broke down. 1997, there were great administrative reforms in the rural sector, the reform of 1997. The DEM took charge of these new reforms. Since then, there was a system of ASUFOR.

Before, a *forage* was created with a water tower which served a certain village. 5,000-7,000 inhabitants. There was a system of water sales, the head of each family could buy a water membership card which enabled them to purchase water from the *forage*. That cost between 100 and 200CFA. If there are 100 members, each member can send a delegate, those people get together, rent a bureau and form a committee of, for example, ten people, they form a bureau of ASUFOR. The state asks them to open a bank account. When they open an account, the principle is high volume sale, using a counter. If you use water, you pay a deposit. If the population doesn't have the means to install *robinets*, then there is almost always a public fountain, selling a bucket at 10-15 CFA. “

“Before the reform of 1997, people paid a fixed amount for water, regardless of how much they consumed. After 1997, the principle of "vente au volume," where people paid for the amount of water they used. 250CFA, cubic meter. “

“Generally, the population cannot afford to install private *robinets* in the homes, and the water is provided through a public fountain.”

“The ASUFOR are installed at the local level through the decentralized authority of the *sous-prefet*, and the authority of the chief of the brigade of the hydraulic department. They control the process of establishing the ASUFOR.”

Question and Answer:

Q: What changes do you see now in the ASUFOR system?

A: “More and more now, the *forages* service multiple villages instead of only one. Before, the *forages* in the rural sector serviced only one village. Now though, the *forage* is in one village, but the water can travel up to five kilometers, counting topographic considerations.”

“The number of water concessions are represented throughout the villages, for example one village may have 50 concessions, and another may have 70, they are represented through that number of concessions and then elect a board democratically. This is the ASUFOR.”

Q: Are the *forages* successful at generating revenue?

A: “*Forages* accumulate quite a lot of money. Some have almost 25 million CFA in the account, others are at 16 million. Now, the problem is that the state and the people are asking what should be done with that money. The state is asking if the money should be loaned to the population, the state is questioning itself. How can this money be used? Populations say, ‘this is our money, it should be loaned to us.’ The hydraulic department is afraid that the whole system and project will slide back into previous problems. “

“There are also problems and issues with power at the local level. People fight amongst themselves to be the president of an ASUFOR. Another aspect is that there is conflict between the people raising animals and the local populations. They are not accustomed to this new system. Before, they might have 100 head of cows, and they would pay a fixed amount. Now, with the *vente au volume*, they are asked to pay per head of cattle. There are *forages* that tried to be a part of the ASUFOR system, but because of this conflict, they still are unable to join the ASUFOR system. There are Peulth villages who don't recognize the presidents of the ASUFOR, don't recognize the groups.”

“People also say that, if the *forages* are making so much money, then the price of rural water should be lowered. Instead of buying water to give to their animals, many *eleveurs* choose to go to the free wells.

The general tendency is that almost everyone uses the *forage*.”

Q: What is your opinion of the effectiveness of the ASUFOR?

A: "Generally, this is a very good approach to development and social support because, when we change, people are habituated to their ways, and it's not always easy. The resources that have the So, that have the expertise on the social development plan, to develop a social communication plan, to bring together people in a rural milieu to create social integration to help get out of a negative situation toward a positive situation, there are actors and their interests, so more or less, the more we change from an ancient system, to a new system, all this must be considered. “

Q: What are some critical management considerations with the ASUFOR?

A: “All these aspects are important, what is critical in this new management, the ASUFOR, the hydraulic systems, is to have expertise in the social milieu, in order to integrate all the different social elements. This was not always evident at the beginning. In the beginning there were many technicians and engineers, and they didn't focus on the social aspect, and only knew how to technically construct a *forage*. But, since we have changed our strategy, we want community participation, we want a community to manage itself, in a strategy of durability of the *forage*, it's necessary that, in the beginning development and strategizing of these programs, there is an

expertise capable of understanding the social aspects, and of organizing and integrating local communities in the management of *forages*.”

Q: What problems has the ASUFOR had at different levels?

A: "At the state level, however, which didn't really understand the social aspect of the program, they had problems with it. And very often, they understood the importance of the social aspect, but it was only in the offices which studied the program, and not on the ground. They got together people who didn't entirely understand how to implement social integration into programs to address it. It requires a certain level of experience and expertise."

"In their conception of the program, if they don't have an expertise capable of seeing to what level integrating the technical aspects and the social aspects is required, that can be the weak point in the installation of the program."

“There are certain aspects that the state and the political realm must consider, such as the promotion of people's rights, involving women in water management in the rural sector, the importance of community management of natural resources, what are the social aspects which act as parameters, or which must be integrated into the program.”

"Before it was the state which had the capacity and the means to repair issues with *forages*, the state would send a technician. Now, the state wants to go toward the communities. In other countries, they have gone much farther than Senegal even, and have completely decentralized the management of water."

Q: What issues do you see with decentralization in Senegal?

A: "Here, in Senegal, we have decentralized, but there is still much left in the process. We have decentralized at the community level, but the state intervenes in the politics and does not truly allow much freedom with localized management."

"But, it would be correct to say that, in general, it is the communities which manage their water. In this strategy of community management, it is critical that we find also the competence at the local level to address maintenance issues. Before, it was the state that did maintenance. If we give power to the local populations, we must find local competence and expertise. That is why the public-private partnership is encouraged. So that, the private sector can participate more to provide local expertise which is there, which comes from resources within the community. The state encourages public-private partnerships, which then leads to the creation of a market to meet local demands. The private sector organizes itself in order to win maintenance contracts. In the logic of durability, this is the best approach. Because, if this local level of expertise didn't exist, the strategy of community management would not work. The state no longer has teams of hydraulic engineers and experts which come and repair broken equipment. So, a local market must be created."

Q: What is your opinion on public-private partnerships?

A: "This dynamic in Senegal (public-private partnerships) has begun to work, when the local market is present. When the need for a local market is there, organizations begin to form, in order to play their role. I think that, a partnership between the private sector and water management creates actors to intervene in water management in the rural sector. I think that helps to maintain a cohesive strategy."

"In creating this local expertise, it reinforces rural economies. And in creating local economies, that creates power at the local level which can then have macro-economic impact. And that plays a role in the economic growth of the entire country."

"This is why, this reform which began in 1997, requires constant supervision and follow-up, in order to understand the new parameters which must be considered. It is always a process which must be followed."

Q: In your opinion, is the ASUFOR system working for Senegal? Is it a successful program?

A: "The ASUFOR works better than the old system. I wouldn't say that it is perfect, but every reform demands follow-up, and a moratorium for observing which aspects of the program must be reworked. So, since 1997 until now, nearly 13-14 years, people should now be able to evaluate the process, and see now what the new dynamics are. Always, the program had the objective of increasing water access through the lens of durability. The durability perspective. It is a continual process. Populations grow, dynamics change, and it is always necessary to follow-up and make observations. I think ASUFOR are a very good thing, but they should be continually evaluated. In observing the ASUFOR in the field, I have seen that they have much better results than the old system before 1997."

Q: Do you believe that the ASUFOR system is durable?

A: "I think the system of ASUFOR, in terms of management, is durable. In our country, the main question is: How to manage the resources in a sustainable way? We have had, with the ASUFOR, less problems than before. I think the program could always be questioned, and could always be better. There are still many conflicts between actors, and we should still be looking for solutions. We should always see, in terms of the level of socio-economic development, is it maybe necessary to lower the price of water as some believe, or to address the issues through the state and politics. The first objective of this program was to increase access to potable water for communities. Water always has an impact on socio-economic development in a region. Agriculture plays a large role in the economic system of a place."

Q: Do you think that the majority of people served by the forage find the price acceptable, or do they think it's too expensive?

A: "They sometimes have enough money to pay for the water. The first thing is to install hydraulic and sanitation systems, and the second thing is that populations have the means to access these resources. At this level in general, I think that it doesn't work too well for the population. There is a certain instability in the rural sector. There are moments where it is very

difficult. Where populations have no options, no alternatives. They may have the means to access *forage* water, but they still go to wells. They still go to wells."

"Wells are the case which created the *forage*. The *forage* came to replace an older technology. Generally, that technology was the well. When there are difficulties with the *forage*, many go to the well while they are waiting. There is a certain instability which is tied to the rural economy. "

Q: So why not stick with the old system, which many people seem to prefer?

A: "No, because the water from the *forage* is more drinkable, and it's easier to access. There are some even who have a tap in their own homes. But, for the moment, you can be confronted by difficulties, and people return to the wells. Or, they use both at the same time. People still use wells because of the instability of the rural economy, but it's just circumstantial. "

"When I did my own research and asked questions of people, who purchased the water from the *forage*, they said that it was the head of the household who bought water. This was research by questionnaire. But when I did a questionnaire with mainly women, the head of household gave the women money to buy water, but it was the women who left the house, who actually bought the water to give to their husbands, to give the impression that it was actually their husband who bought the water. Because, in the rural sector, women always try to guard a certain image of their husband. But often, when there are difficulties, the head of the family is the woman, and groups of women, who provide the money to buy water."

Q: And women scrape together money through odd jobs?

A: "Generally, women in the rural sector work by raising and selling chickens in the market, or they sell bissap, or they may have a young daughter who works as a maid in another household who sends them money.

APPENDIX B: Women's Survey Questions

1. What is your name? No tudd?
2. How many people are there in your household? Naata nit ngay am ci sa waa ker?
3. Do you work? What do you do? Dangay liggey? Loy def?
4. Does your husband work? What does he do? Sa boroom-ker, lan lay def?
5. Do you have children? Am-nga doom?
 - a. How many? Naata baant ngay am?
 - b. How many are girls? Naata jigeen ngay am?
6. Do your daughters go to school? Say doom bu jigeen, launy jang?

7. Do they help you with housework? Say doom bu jigeen, lanuy nga japp si sa liggey u ker?
 - a. If they go to school, when do they help you with housework? Sufekke lanuy dem ecole, quand lanuy nga japp ci sa liggey u ker?
8. Do you have a robinet in your home? Ndax am-nga robinet ci sa ker?
 - i. How much water do you get from your robinet per day? Naata ndox ngay jel ci sa robinet bes-bu-nekk?
 - i. If yes, do you still get water from the wells? Ndax dangay jel sa ndox ci tenn-bi?
 - i. Why? Lootax?
 - ii. How much water do you get from the well? Naata pannes ngay jel si tenn-bi?
 - ii. If no, where do you get water? Si non, fan ngay jel sa ndox?
 - i. How much water do you get from the robinet per day? On laundry day? Naata paanes ngay jel ci robinet bes-bu-nekk? Bufekke dangay foot, naata pannes ngay soxhla?
 - ii. How much water do you get from the well per day? On laundry day? Naata paanes ngay jel ci tenn-bi bes-bu-nekk? Bufekke dangay foot, naata pannes ngay soxhla?
9. How far is your house from the nearest source of water? Lan mo distance-bi ci diggante sa ker wa ten-bi, walla robinet?
10. What do you use robinet water for? How much per activity? Ci lan ngay jefandekoo ndox u robinet-bi?
 - a. Drinking / Naan
 - b. Cooking / Togg
 - c. Clothes washing / Foot
 - d. Cleaning / Raxase
 - e. Bathing / Douche
 - f. Other / Lennen
11. What do you use well water for? How much per activity? Ci lan ngay jefandekoo ndox u tenn-bi?
 - a. Drinking / Naan
 - b. Cooking / Togg
 - c. Clothes washing / Foot
 - d. Cleaning / Raxase
 - e. Bathing / Douche
 - f. Other / Lennen
12. Which water do you prefer for drinking? Because: Ban ndox ngay mo genn begg por naan? Ngir:
 - a. It's cleaner / Mo genn set
 - b. It tastes better / Mo genn neex ci naan
 - c. It's easier to get / Do jaffe por am
 - d. It's free / Duma faay dara
13. What is most important about water to you? Lan mo genn am solo ci ndox-bi ci yow?
 - a. It's close to home and easy to get / Distance-bi, dafay petit
 - b. It's clean / Dafay set
 - c. It's cold and better for drinking / Dafay set wa dafay mo genn neex ci naan

- d. It's free / Duma faay dara
14. Is the price of robinet water: Lo xaalat ci prix u ndox u robinet?
- a. Too high / Dafay cher
 - b. Ok / Ca va
 - c. Too low / Dafay yomb
15. Do you want a robinet in your home? Begg-nga robinet ci sa ker?
- i. Why don't you have a robinet? Lutax yow do-am robinet ci sa ker?
16. Do you think the robinet makes a difference in how much free time you have, or how tired you are? Lo xaalat ci robinet-bi? Ndax robinet-bi dafa nga japp ci sa liggey? Ndax ngay mo genn am jot bes-bu-nekk?