Using Demand Side Management to Adapt to Water Scarcity and Climate Change in the Saïss Basin, Morocco

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***Abstract:** This project proceeded on three tracks, a technical approach oriented towards testing the feasibility of and dissemination of drip irrigation techniques in disadvantaged contexts in the Saïss Basin, a part of the Sebou River Basin, in Morocco. We also conducted a KAP survey and its associated qualitative work that aimed to establish what the population knows about Climate Change and how it utilizes existing state efforts to mitigate the damage of Climate Change and excessive abstraction of water resources. The expansion of the farmers' capacity to utilize the resources made available by the state through the formation of cooperatives and using the loans and grants provided for drip irrigation was the third locus of our project and it is the one that was most successful. This aspect was actualized through our Climate Change and Training workshops which directly led to the formation of the Zoubiya cooperative by local farmers. The cooperative's members pooled their resources to create a water reservoir and drip irrigation systems for its members thereby increasing the adaptive capacity of the region in response to water shortages.

***Keywords:** Climate Change, Drip irrigation, Cooperatives, KAP survey, Adaptation, Aquifer depletion

1. The Research Problem

General context

The Saïss Sub-Basin of the Sebou Basin in Northern Morocco is experiencing unsustainable levels of water overexploitation, due both to long-term decreases in precipitation and increases in water demand. Surface waters are greatly reduced, and at current exploitation rates of the aquifer will be completely depleted within 25 years.[1]

As a mean of reducing water use within the area and thereby contributing to aquifer sustainability, this project examined whether Water Demand Management (WDM, also known as Demand Side Management, DSM) could provide a solid basis for integrated water management and strengthened capacity for adaptation to climate change in the Saïss basin. This project worked with multiple stakeholders and focused on the benefits for the most vulnerable and disadvantaged communities within project sites. Since agriculture accounts for 92 percent of Morocco's water consumption,[2] it would be the focus of this effort; in the Saïss basin, which is the focus of this study, over 80 percent of the water is used for agriculture.[3] It would be the focal area of the WDM strategy.

Background and Justification

The policy position of the Moroccan State Secretariat of Water and Environment is that climate change is negatively influencing the replenishment of aquifers throughout the country. In the Sebou basin, the aquifers may have lost as much as a quarter of their water during the last 25 years.[4] Current hydrological models predict that without a substantial change in the use of water or increase in precipitation and recharge, the Saïss aquifer in Eastern Morocco will be completely dry within a span of 25 years, and the Saïss basin transformed into a high desert plateau.[5] If this were to happen there would be severe social and economic consequences, especially for those most vulnerable to changes in access to and availability of water, such as contract herders and women.[6] If the aquifer is fully depleted, the agricultural sector in the Saïss basin will be lost. This would result in the disappearance of 3 million workdays a year in the region and contribute to increased unemployment and social instability.[7]The region would also lose the 150 million Euros generated in gross revenues a

[1] Ahmed Belkheiri, Gestion intégrée des ressources en eau et protection de la ressource : Bassin du Sebou, *Revue HTE,* N°137, Juin 2007, pp. 9-22.

[2] Samir Rhaouti, Sebou Hydraulic Basin Agency, ABHS, Fes, Presentation at the International Workshop on Adapting to Water Scarcity and Climate Change in North Africa: DSM and its Implications for Social Equity and Environmental Sustainability, Al Akhawayn University, Ifrane, Morocco, 2007.

[3] State Secretariat in Charge of Water and Environment, SEEE, Rabat, Presentation at the International Workshop on Adapting to Water Scarcity and Climate Change in North Africa: DSM and its Implications for Social Equity and Environmental Sustainability, Al Akhawayn University, Ifrane, Morocco, 2007.

[4] See Ref. 3.

[5] See Ref. 3.

[6] Samir Rhaouti, Sebou Hydraulic Basin Agency, ABHS, Fes, Presentation at the International Workshop on Adapting to Water Scarcity and Climate Change in North Africa: DSM and its Implications for Social Equity and Environmental Sustainability, Al Akhawayn University, Ifrane, Morocco, 2007.

[7] See Ref. 6.

year.[8] Thus, the process of aquifer depletion must be reversed if devastating socio-economic problems are to be avoided.

Out of an annual water endowment of about 20 recoverable cubic kilometers of rainwater and surfacing groundwater, Moroccans use about 13.7 cubic kilometers of water per year.[9] While at the overall level this may appear to be sustainable, at the local level it is not, when increasing groundwater abstractions are taken into consideration.[10] Currently, one of the critical sources of water for Moroccans is the Sebou water basin, which supports 6.2 million people or about one-fifth or Morocco's population.[11] The region is part of the country's demographic and hydrological core, accounting for about one third of the national annual water endowment; including three quarters of the unused surplus. Thus, the Sebou basin is also important to many Moroccans living outside it, and its ecological decline has already influenced the country as a whole.[12]

The Saïss basin, located in the upper eastern reaches of greater Sebou Basin, represents 11 percent of Morocco's annual water endowment, providing water for 1.8 million people, and contains about a quarter of Morocco's arable land. The basin's surface covers over 2,200 square kilometers and includes about 8,000 commercial and subsistence farms. These farms represent about 37,000 hectares of irrigated land, of which the largest proportion, 45 percent, are irrigated by pumped water, 32 percent are irrigated with surface water and about 22 percent are drip irrigated.[13] Given the legal and traditional frameworks of Moroccan agriculture, the state does not compel farmers to cultivate specific crops. As a result of this liberty and the existence of export markets, the basin contains some water-intensive crops including about 4,500 hectares of apple orchards and hundreds of hectares of wine vineyards.[14] Studies are currently underway to determine the possibility of planting olives, which are less water intensive, in place of apples.[15]

The Saïss aquifer has been experiencing increasingly unsustainable levels of exploitation since 1980.[16] Coupled with decreasing precipitation, increased levels of abstraction have led to the disappearance of some small rivers and springs and significantly reduced flows in remaining rivers and springs[17]. While subjected to large pumped withdrawals, the aquifer

[8] See Ref. 7.

[9] M'hamed Belghiti and Zakariae El Yacoubi, "Tarification de l'eau d'irrigation au Maroc," *Forum sur la gestion de la demande en eau: valeur économique de l'eau*, Beirut 25-27 June 2002.

[10] See Ref. 9.

[11] Ahmed Belkheiri, Gestion intégrée des ressources en eau et protection de la ressource : Bassin du Sebou, *Revue HTE,* N°137, Juin 2007, pp. 9-22.

[12] Claudia W. Sadoff, "The Price of Dirty Water: Pollution Costs in the Sebou Basin," *World Bank Environment Department Papers,* No. 038, June 1996, p. 16.

[13] See Ref. 6. [14] Personal communication: Directors of Sefrou and El Hajeb DPAs (Département Provincial de l'Agriculture).

[14] Personal communication: Directors of Sefrou and El Hajeb DPAs (Département Provincial de l'Agriculture).

[15] See Ref. 14.

[16] Ahmed Belkheiri, Gestion intégrée des ressources en eau et protection de la ressource : Bassin du Sebou, *Revue HTE,* N°137, Juin 2007, pp. 9-22.

[17] See Ref. 16.

receives only limited seasonal recharge, making it susceptible to rapid depletion. The balance, as indicated by the data below, is a net loss of 100 Mm^3/year.[18]

- Recharge (in Mm^3/year): 241.5
- Withdrawal (in Mm^3/year): Agriculture (160), Potable Water (100), Rivers and Springs (81.5) = 341.5

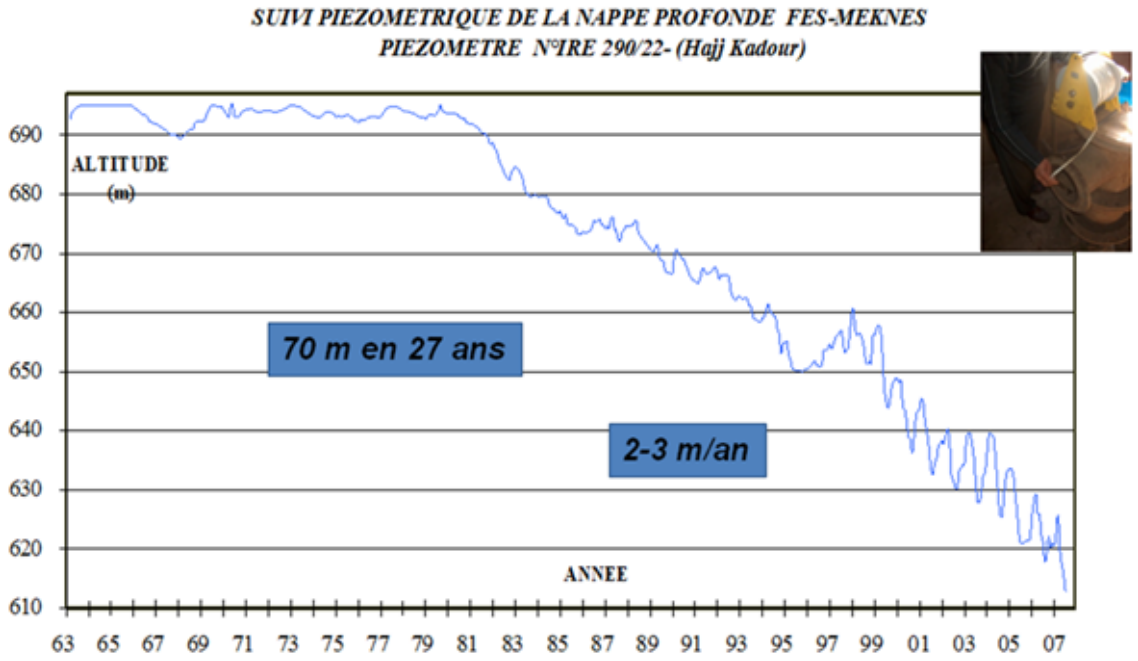


Figure 1: Evolution of the Fes-Meknes aquifer level between 1963 and 2007.

Since 1970 the overall production of water declined from 24 cubic meters per second to 15 cubic meters per second, or 45 percent. Additionally, the surface water table has declined by 70 meters over the past 27 years in Hajj Kaddour, a measuring point in the Saïss basin (see Appendix 2). Moreover, an increase in pollution levels due to economic and population growth makes many water sources unusable.[19]

The overall level of recharge in the Saïss basin has been decreasing over the last 30 years as a result of increasing average temperature and a fall in the level of precipitation. Data from Ifrane, located within the Saïss basin, one of the wettest and coolest places in the country, indicates a strong relationship between climate change and water shortfalls. According to DMN, over the last forty years the average temperature in Ifrane rose by one degree Celsius.[20] The temperature increase is predicted to occur throughout the entire country with a warming prediction to approach 3°C by 2080 for the 6 agro-ecological zones.[21] The increase in

[18] See Ref. 16.

[19] See Ref. 18.

[20] Fatima Driouech, Direction de le Météorologie Nationale, DMN, Casablanca, Presentation at the International Workshop on Adapting to Water Scarcity and Climate Change in North Africa: DSM and its Implications for Social Equity and Environmental Sustainability, Al Akhawayn University, Ifrane, Morocco, 2007.

[21] World Bank, Impact of climate change on the agricultural yields in Morocco, 2009.

temperature has been accompanied by a decline in precipitation.[22] According to a pessimistic scenario, annual rainfall will drop about 20% by 2050 and by 40% around 2080, except for the Saharan zone (16% in 2080). The overall decline in the levels of rain and snowfall has led to a decline in surface water flow. This in turn has led more and more farmers to dig deeper for water. Consequently, the number of wells has gone up from a handful to about 9,000 during the last thirty years.[23] Digging wells is expensive and extracting water costs significant amounts of money in terms of the cost of diesel fuel required, which is not as heavily subsidized in Morocco as it is in other countries; at about 9 dirhams a liter, diesel fuel is a luxury that few small farmers can afford.[24]

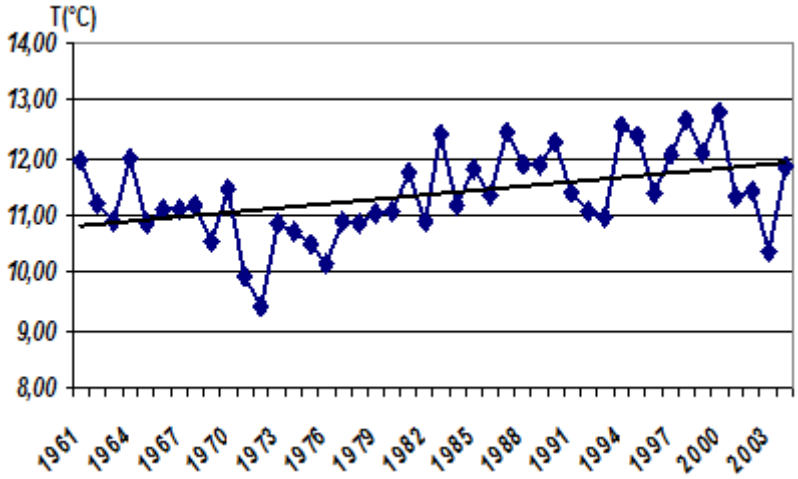
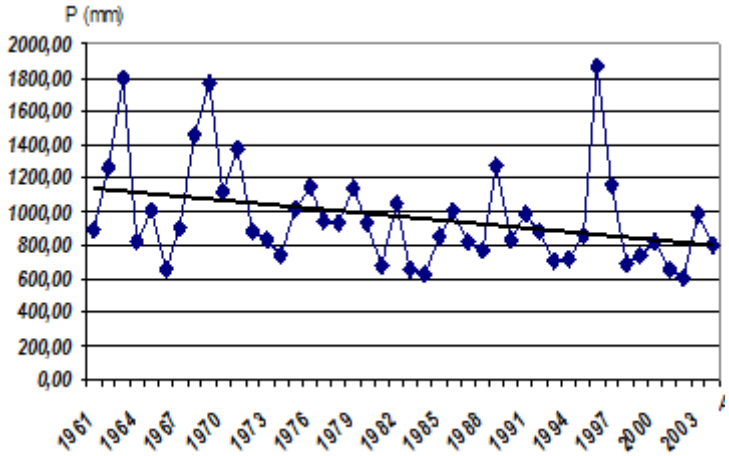


Figure 2: Indications of Climate Change in the Region: Temperature increase between 1961 and 2003 (Source: DMN, Casablanca)



[22] See Ref. 21.

[23] Samir Rhaouti, Sebou Hydraulic Basin Agency, ABHS, Fes, Presentation at the International Workshop on Adapting to Water Scarcity and Climate Change in North Africa: DSM and its Implications for Social Equity and Environmental Sustainability, Al Akhawayn University, Ifrane, Morocco, 2007.

[24] See Ref. 25.

Figure 3: Indications of Climate Change in the Region: Rainfall decrease between 1961 and 2003 (Source: DMN, Casablanca).

While Morocco has benefited from economic growth in many ways, such as industrial development and subsequent job creation, it brings with it numerous environmental and social costs. For example, industrial growth has led to increased pollution throughout the country and particularly in the Sebou basin. The Saïss basin is beginning to display the same pattern observed in the Sebou basin downstream from Fez where Chromium levels ranged between 10 to 100 times the internationally acceptable levels in the mid-1990s. The lower ranges of the Sebou basin have been hard hit with industrial effluents and urban waste, rendering the river water dangerous for human and agricultural use, including irrigation. This is leading farmers and others to rely even more heavily on the Saïss aquifer for water. The current inability to use all the water available downstream from the Saïss basin for large-scale commercial agribusiness or small scale farming has had significant welfare effects throughout the country. Farmers are forced to use less water leading to a reduction in agricultural production and, hence, an increase in food prices, which particularly hurts the poorest populations. This is both because they have less purchasing power, and because they are unable to access natural water supplies for themselves and their herds.[25] The reduced capacity to farm and herd has played a significant role in worsened overall public health and rural-urban migration, and has led to increasing pressure on urban areas to provide access to resources and employment, particularly among rural men.[26] Urban growth further depletes water supplies, leaving less for agricultural use.[27]

General population growth has also contributed to a dramatic increase in water demand. Morocco's population has been growing at an extremely high rate over the last fifty years and is anticipated to continue climbing exponentially for the next fifty. For example, in 1952 the population of Morocco was 8.9 million.[28] By 2012, the population had risen to 32.5 million, representing a nearly 400 % increase. It is anticipated to grow another 5 million, to 38 million, by 2030.[29] As a result of this growth, it is estimated that by 2020 the country per person water supply will be less than half of the current critical supply per person.[30]

Vision

[25] Najib Akesbi, Evolution et perspectives de l'agriculture marocaine, Rapport sur « 50 ans de développement humain au Maroc », 2006.

[26] See Ref. 27.

[27] For a comprehensive picture concerning the influence of pollution, see Sadoff, pp. 15-16.

[28] Démographie Marocaine : tendances passées et perspectives d'avenir, , Rapport sur « 50 ans de développement humain au Maroc », 2006.

[29] Observatoire National de Développement Humain, ONDH, Rabat, au Maroc », Population du Maroc par année civile et par milieu de 2004 à 2030. Available at http://www.ondh.ma/Pdf_doc%5CProjectionsdelapopulation.pdf.

[30] Paola Minoia and Anna Brusarosco, "Water Infrastructures Facing Sustainable Development Challenges: Integrated Evaluation of Impacts of Dams on Regional Development in Morocco," Fondazione Eni Enrico Mattei, Nota Di Lavoro 105. August 2006 Available at the Social Science Research Network Electronic Paper Collection: http://ssrn.com/abstract=927734.

The *vision* is to cope with climate change induced water stress, Morocco has a proactive, ongoing adaptation process that involves multiple stakeholders. The national strategy of maintaining equilibrium in groundwater resources is achieved and maintained, and ground water pollution is prevented. Successful policies have reduced reservoir depletion, overgrazing, and ecological degradation; legal frameworks and regulations as well as multi-stakeholder processes that support ongoing adaptation. The present research was aimed to identify new adaptation options, and new agricultural varieties and techniques that would allow for stable agricultural productivity in the face of increased water stress. Water is appropriately valued and used to its best economic efficiency to the benefit of disadvantaged and vulnerable people. Vulnerable rural people have better incomes, health care and education, and as a consequence rural-urban migration is greatly reduced. Infrastructure and land use management improves recharge of aquifers and decreases both water lost and damage done during floods. Capable, well trained staff and researchers have the resources they need to face future problems.

Mission

The *mission* the project team started with was to develop and implement a demand side management approach in the Saïss basin focusing on agriculture and irrigation, through a multi-stakeholder participatory process involving civil society, the local population, elected officials, NGOs, CSOs, ministry delegates to create behavioral change that produces eco-friendly water use and influences policy and decision makers.

Research Problem

Globally, aquifers are under significant threat of depletion and degradation.[31] In Morocco, aquifer depletion is threatening one of the hydrological cores of the country – the Saïss basin. Declining levels of precipitation in the Saïss basin, as measured by the Sebou Basin Agency over the last forty years, accompanying a 1 degree Celsius increase in average temperature, suggest that climate change, along with increased water demand from population growth and economic development have led to unsustainable levels of exploitation of the Saïss aquifer. The aquifer currently faces a recharging deficit of about 100,000 cubic meters per year and it risks being depleted should abstraction and recharge levels are not restored to sustainability[32].

This project's original research had the aim of studying and implementing Demand Side Management in the Saïss basin in order to spread adaptive capacity in response to Climate Change and aquifer depletion. Changes in the local climate were noted by work conducted by our partners at the Sebou Hydrological Basin Agency (ABHS in its French Acronym) which noted a one degree Celsius increase in average temperature over the last forty years. The question was how could we fill the recharge deficit of about 100,000 cubic meters per year? We operated off the assumption that the era of big dam and infrastructure solutions was over,

[31] S.S. D. Foster and P. J. Chilton, "Groundwater: the processes and global significance of aquifer degradation," *Philosophical Transactions: Biological Sciences*, Vol. 358, No. 1440, Freshwater and Welfare Fragility: Syndromes, Vulnerabilities and Challenges, (Dec. 29, 2003), pp. 1957-1972.

[32] Samir Rhaouti, Sebou Hydraulic Basin Agency, ABHS, Fes, Presentation at the International Workshop on Adapting to Water Scarcity and Climate Change in North Africa: DSM and its Implications for Social Equity and Environmental Sustainability, Al Akhawayn University, Ifrane, Morocco, 2007.

and that at least part of the solution lies in reduced demand use or Demand Side Management or Water Demand Management as the concept became known in later steps of the project.

The project intended to work with multiple stakeholders and focus on the benefits for the most vulnerable and disadvantaged communities within project sites. Given its paramount importance for Morocco, Agriculture was the focal area of the WDM strategy of this Project. Accordingly, the research team decided to involve the most significant institutions and actors in the region and Morocco that deal with agriculture, water and climate issues. These *participating institutions were:*

- Agence du Bassin Hydraulique du Sebou (Sebou Basin Agency), Fès
- Direction Provinciales de l'Agriculture (DPA) of Sefrou and El Hajeb
- Centres Techniques of DPAs
- Local authorities and elected councils
- Direction de la Météorologie Nationale, Casablanca
- Ecole National d'Agriculture, Meknès

As the project evolved, we came to understand that there are a lot of realities on the ground that necessitated many changes in our plans, including alterations in discourse and language as well as a dramatic lowering of the expectations of changes that we can effect. The reduction in precipitation was a problem, but it was being greatly amplified by illegal well digging, and with it all the attendant problems of aquifer depletion.

In terms of local communities, inter-tribal relations are a significant aspect of the Water Users association system. We conducted extensive interviews with Farmers and Water Users Associations (WUA) in the basin to address/understand the problems surrounding the exploitation of local water resources. In short, our initial findings on the ground forced a change in the focus of the project from a "policy" project to a more "social" and "developmental" project. The research problem shifted accordingly. As our focus shifted, our questions shifted along with our definitions of who our strategic and boundary partners are. These modifications followed field-based qualitative exercises in different areas. We also realized that the commercial farmers, or rather what passes for commercial farmers in this region, were ahead of the curve in many ways. As businesspeople, they viewed their water use as a cost, because they had to pump it with electricity or fuel. They were also far more likely to use drip irrigation and secure legal well-digging rights and licenses. While commercial farmers remained valuable in terms of information and perspectives, the focus clearly had to be on the small holders, because they did not have the access to capital and information.

2. Objectives

General Objective

To develop a WDM policy and institutional framework to support the return of aquifer management to sustainability in the face of increasing water stress, by fostering institutional and organization change within project boundary partners. The project will operationalize this by developing and implementing a demand side management approach in the Saïss basin focusing on agriculture and irrigation, using multi-stakeholder participatory processes.

As a research team, we had a lack of engagement from the ABHS that was promised. Without a champion inside ABHS to push the issue forward, we were unable to push forward an institutional and legal framework. Instead, we focused on building relationship with DPA, WUAs and farmers, and tried to bring the ABHS along with us. During the project we have seen the relationship with ABHS improve, but an institutional framework is now a long term objective.

Specific Objectives

1. To develop and test technical options for WDM in large scale irrigated agriculture

This was an un-necessary objective, because the larger the scale of the farm in the Saïss Basin, the higher the level of access to drip irrigation. This assessment is verified by visits to commercial farms where drip irrigations systems are extensively used along with computerized irrigation control

2. To demonstrate, through pilot projects, the value of WDM and economic use of water with small scale farmers.

Two small scale pilot projects in addition to the Zoubiya cooperative were in place by the end of project. For the Zoubia Cooperative, it was an unplanned product of the project. Farmers attending our workshops created it – as confirmed by its founders' statements.

3. To create two operational water-users associations in the sub-basin area, supported by training and capacity strengthening.

There were six pre-existing water users' associations in the region on the Bitit Canal. Their main problem is integrating their planning and operations as far as creating a federation is concerned. We did not need to create new ones. We included the WUAs in all our workshops and the state has been actively providing them with facilitation.

4. To strengthen local authorities, ministries, resulting in improved enforcement, policy, and management of water.

Through networking and participatory activities, we have provided different workshops in WEA, Information technology, drip irrigation and accessing the state for farmers and functionaries alike. This resulted in bridging gaps between the DPAs, ABHS, and the farmers. Generally, networking, knowledge sharing and capacity strengthening are cross cutting activities in all objectives.

Along with the research problem, our objectives changed in light of the information generated by the survey and through interactions with farmers, agricultural extension agents and ABHS employees. While largely not immediately visible, the region was a great deal richer in terms of civil society and social capital than it first appeared. Some of the objectives had to be discarded because there was no need for pursuing them as originally envisioned, others were met partially and one was met fully. In some cases, the information about various objectives was incomplete at the start of the project a more complete picture emerged after research was underway. In other instances, the information was simply not accessible because it was not written down or formalized otherwise. This information included matters related to tribes in the region and their forms of landholding and their relationship with WUAs. We can safely say that the objectives set at the beginning of the project have either been met or were superseded by new information.

3. Methodology

Conceptual Framework

In order to answer the research questions and fulfill the objectives listed above, our research team carried out a number of activities and actions. We primarily used the Participatory Action Research methodology. This is a research methodology which supports those involved in a project, including citizens, farmers, officers as well as researchers to be active contributors to the research activities at all stages. The research team fully involved and encouraged the active participation of individuals/institutions concerned and interested in this project success. The different stakeholders were fully engaged and actively participated in the different activities we organized.

In order to investigate the research questions, the team used a combination of research methods to gather and track the needed data. The underpinning reason was the fact that "each method is a different line of sight directed toward the same point, observing social and symbolic reality. By combining several lines of sight, researchers obtain a better, more substantive picture of reality; a richer, more complete array of symbols and theoretical concepts; and a means of verifying many of these elements. The use of multiple lines of sight is frequently called "triangulation". Berg (2004) provides a historical overview of Triangulation use; it "was used largely to describe multiple data-collection technologies designed to measure a single concept or construct (data triangulation).[33] However, Denzin (1978) introduced an additional metaphor, lines of action, which characterizes the use of multiple data-collection technologies, multiple theories, multiple researchers, multiple methodologies, or combinations of these four categories of research activities."[34]. Research methods include, but are not limited to:

- **"Field research strategies** under the broad umbrella of ***ethnography":*** Ethnography is widely known as the "practice [that] places researchers in the midst of whatever it is they study". Berg (2004) provides an overview of its application; it started as a method used by cultural anthropologists and evolved to new application areas leading to coining new terms, such as: "street ethnography", "urban ethnography", "ethno-nursing", "educational ethnography", "analytic ethnography" and "macroethnography"/ "microethnography." [35]
- Berg (2004) quotes Lofland (1996)[36] referring to "analytic ethnography" as "research processes and products in which, to a greater or lesser degree, an investigator
  - (a) attempts to provide generic propositional answers to questions about social life and organization;
  - (b) strives to pursue such an attempt in a spirit of unfettered or naturalistic inquiry;
  - (c) utilizes data based on deep familiarity with a social setting or situation that is gained by personal participation or an approximation of it;
  - (d) develops the generic propositional analysis over the course of doing research;
  - (e) strives to present data and analyses that are true;

[33] Berg, B. L. (2004) *Qualitative Research Methods for the Social Sciences*, 5th Edition, Pearson Education: Boston

[34] Denzin, N. K. (1978). *The research act: A theoretical introduction to sociological methods.* New York: McGraw-Hill.

[35] See Ref. 35.

[36] Lofland, J. (1996). Analytic ethnography: Features, failings, and futures. Journal of Contemporary Ethnography, 21, 30–67.

- (f) seeks to provide data and/or analyses that are new; and
- (g) presents an analysis that is developed in the senses of being conceptually elaborated, descriptively detailed, and concept-data interpenetrated".

- While "microethnography focuses on particular *incisions* at particular points in the larger setting, group, or institution", "macroethnography attempts to describe the entire way of life of a group...analytically focuses more directly on the face-to-face interactions of members of the group or institution under investigation. By examining these interactions, their implications, or as Mehan (1978)[37] suggests, their *outcomes* can be considered"
- Albeit the different terms and names, *ethnography* has evolved as a research practice "that involves extensive fieldwork of various types including participant observation, formal and informal interviewing, document collecting, filming, recording, and so on."[38] One central element of the ethnographic investigation "involves entering the setting of some group and simply watching and listening attentively…..the researchers can partition or restrict certain places where they watch and listen and increase observational capabilities through filming or videotaping the area". In practical and procedural terms, researchers practice ethnography via conducting the following:
  1. "Taking in the physical setting
  2. developing relationships with inhabitants (locating potential guides and informants)
  3. Tracking, observing, eavesdropping, and asking questions
  4. Locating subgroups and stars (central characters in various subgroups)."

- ***Interviewing***: "may be defined simply as a conversation with a purpose. Specifically, the purpose is to gather information". Interview structures vary according to research contexts:
  - *Structured interview "*uses a formally structured schedule of interview questions….designed to elicit information using a set of predetermined questions that are expected to elicit the subjects' thoughts, opinions, and attitudes about study-related issues. Standardized interviews, thus, operate from the perspective that one's thoughts are intricately related to one's actions*".*
  - *Unstandardized interviews "*operate from a different set of assumptions. First, interviewers begin with the assumption that they do not know in advance what all the necessary questions are. Consequently, they cannot predetermine fully a list of questions to ask. They also assume that not all subjects will necessarily find equal meaning in like-worded questions- in short, that subjects may possess different vocabularies*".* With theses underlying assumptions, "interviewers must develop, adapt, and generate questions and follow-up probes appropriate to each given situation and the central purpose of the investigation". Such flexible structure makes this type of interviewing a research tool "used during the course of field research to augment field observations"
  - *Semi-standardized interview "*involves the implementation of a number of predetermined questions and special topics. These questions are typically asked of each interviewee in a systematic and consistent order, but the interviewers are allowed freedom to digress; that is, the interviewers are permitted (in fact, expected) to probe far beyond the answers to their prepared standardized questions*."* This semi-rigid structure aims to allow researchers to "approach the

[37] Mehan, H. (1978). Structuring school structure. Harvard Educational Review, 48, 32-64.

[38] J. Van Maanen, J. M. Dabbs Jr., and R. Faulkner, *Varieties of Qualitative Research*, pp. 103-151, Sage Publications, USA, 1982.

world from the subjects' perspective. Researchers can accomplish this by adjusting the level of language of given scheduled questions or through unscheduled probes…that arise from the interview process itself"

- ***Focus Group Interviews***: "may be defined as an interview style designed for small groups." They are "either guided or unguided discussions addressing a particular topic of interest or relevance to the group and the researcher". It is a data-gathering technique in research contexts "where one-shot collection is necessary"

- ***Questionnaire survey or "pencil-and-paper survey":*** "involves a printed or electronic list of questions…is distributed to a predetermined group of individuals…individuals complete and return questionnaire" [39].

- ***Document Review***: defined as a process that "Involves identification of written or electronic documents containing information or issues to be explored", where "Researchers review documents and identify relevant information" and "keep track of the information retrieved from documents"[40]. We used this research method to gain insights and understanding of historical outlooks and varied perspectives associated with issues as they rise.

Within the scope of the study of the most appropriate social responses to climate change in the Saiss basin, we intended to divide the work into two distinct clusters, along methodological lines. In the first cluster, we examined the potential and impact of WDM, as an adaptation strategy, on water efficiency through surveys, case studies, profiles, participatory methods and pilot-program based experimental/focus group research. In the second cluster, we used Geographic Information Systems and explored the applicability of the Water Evaluation and Planning (WEAP) system to the Saiss basin. The work of the two clusters was be coordinated through a common commitment to participatory Monitoring and Evaluation and stakeholder ownership methods, where WEAP would be used both in the planned training and workshop sessions with the farmers participating in the pilot projects and in evaluating various policy options. We intended to use our non-profit, developing country status to secure the license to use WEAP software for free.

The coherence of the overall project was secured by using common variables and analytical factors throughout both clusters and within each data gathering exercise and stakeholder/boundary partner activity. Throughout this project, the overall dependent variable would be water efficiency, defined as agricultural output, in terms of tons of food and non-food agriculturals and in terms of the monetary value of these products per cubic meters of water used.

The *first element* of this project entailed producing a model of climate change in the Saiss basin. This part of the project was initiated by the Sebou Basin Agency in conjunction with the National Meteorological Department.

[39] Earl, L., Levin, B., Leithwood, K., Fullan, M. & Watson, N. (2001) Watching and Learning 2: OISE/UT evaluation of the implementation of the National Literacy and Numeracy Strategies in England, London, Department of Education and Employment.

[40] See Ref. 39.

The *second element* of the project consisted of a survey of the farming practices in the Saiss basin using a random sample of 500 farmers among the 5000 currently active in the region, according to a list provided by the local councils and the DPAs in the two areas within the Saïss basin where our project is concentrated.

The *third element* of the project entailed the recruitment of, dialogue with, and training of volunteer farmers. We envisioned recruiting two large farmers and two groups of small farmers, learning from them about their concerns, introducing them to WDM , and encouraging them to experiment with methods designed to enhance water efficiency. A key requirement for the success of the research was the implementation of projects based on WDM with the small farmers, in particular, and presentation of outcomes to the other farmers. Dialogue and training alone would not be sufficient to mobilize the overall population of farmers. All of the participants in this process would be invited to evaluate the training and workshop programs they attended. WEAP would be used in the training exercises and the farmers opinions of it would be used in assessing its utility. With regard to the small farmers, we planned to compensate for the small size of the two pilot projects by dramatically increasing the number of observations made at both sites so that a larger quantitative picture emerges to confirm or negate the survey's results. Given the large farmers' extensive organization, relatively small numbers and large landholdings, success in reducing water consumption while improving or retaining productivity was quickly disseminated. We planned to include farmers outside the pilot projects, both large and small, in mutual learning exercises towards the end of the overall program to insure farmer-to-farmer transmission of lessons and experience.

The *fourth element* of the project entailed conducting farm visits and developing on-going relationships of trust that would allow us to see whether the educational and participatory activities of element three have been successful.

The *fifth* and final element of the project entailed the preparation of the deliverables including a study that addressed the assessment of the utility of WDM in preserving the aquifer, case studies and profiles of the farmers (See Appendix 3) and farms involved in the pilot projects, an assessment of WEAP, a KAP inventory that combines survey results with qualitative data gathered from field work during the fourth element.

Therefore, we used a variety of methods, largely along participatory lines. These included Qualitative data gathering through field methods such as participatory observation, a formal KAP survey, and action research through the construction of two pilot projects. The data gathering instruments and tools associated with each of these is included in an appendix. We modified our instruments by consulting with local stakeholders and were able to add new categories to the survey, for example.

Emergent and indeterminate methods are often best when wading into a new field. There was a lot of work that needed to take place as constitutive research rather than explanatory work. The most effective methods were those that actually placed farmers in charge, allowing them to discuss their issues and raise their own agenda directly. As a team, we were sure that the field needed a lot more exploratory work, before we went onto it.

4. Project Activities

4.1. KAP survey

Objectives

The main purpose of conducting a KAP survey is to get to know the farmers' knowledge, attitudes and perceptions in terms of using water resources in the Saïss basin and to generate quantitative data for further analysis.

Methods

As stated above, we have conducted a survey of the farming practices in the Saiss basin using a random sample of 500 farmers among the 5000 currently active in the region, according to a list provided by the local councils and the DPAs in the two areas within the Saïss basin where our project is concentrated. We have chosen 10 percent because the total number of farmers is so large, given the time frame for the project. We have assigned numbers to each farmer's name and put them in a basket then pull 500 farmers out randomly which were sampled for the survey. We took measures to insure that there is little influence from the DPA on the data. We sent our teams to the field in pairs. One data gatherer always interviewed the randomly selected farmer while the other talked with the DPA worker and interviewed him on the issues concerning the farmer or the area – at a distance.

The survey form was validated in a workshop last two years that involved the DPA, the ABHS and a number of independent outside researchers on agriculture in Morocco. The data was gathered in cooperation with the DPA, relying on quantitative methods. Our explanatory variables included:

- Water use by month, reported and ABHS estimated.
- Land size, the ABHS already has the data on this variable.
- The number of family members who directly participate in farming.
- Farm output by hectare in dirhams and quantities.
- Type of irrigation used and water saving techniques, if any.
- Number of wells and depth.
- Farmers' level of education.
- Number of farm employees and their educational level.
- Cooperative or not: does the farmer have access to either commercial or social credit.
- Demographic variables such as the age of the primary farmer, gender, and age.
- Views about the sources of water and conservation.
- Water as a value in terms of the farmer's religious and cultural outlook.
- Knowledge of WDM , climate change, and aquifer depletion.
- Other variables should participatory approaches suggest them.

The KAP survey took an inventory of the Knowledge, Attitudes and Practices of the farmers in the region with regard to water use and WDM . We intended to develop a program of studies that use various qualitative and experimental methods such as participant observation and farming experiments using reduced water consumption. Both took place within a participatory framework where farmers, both large and small, actively worked with the

researchers to express their concerns, needs and demands, as well as share examples of best practices with each other, the ABHS and other strategic partners.

Central Results (JK: Sir, the figure numbers usually go on top)

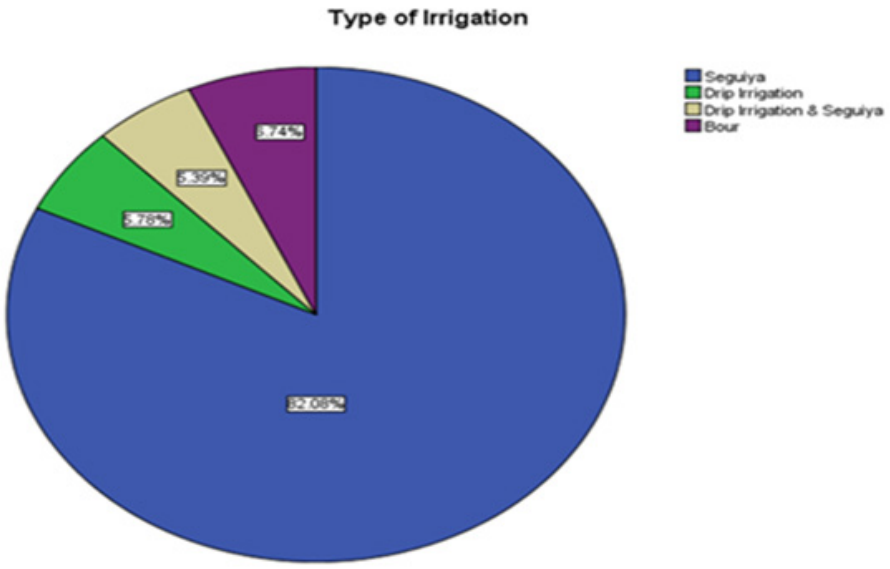


Figure 4: Irrigation in the Saïss Basin today

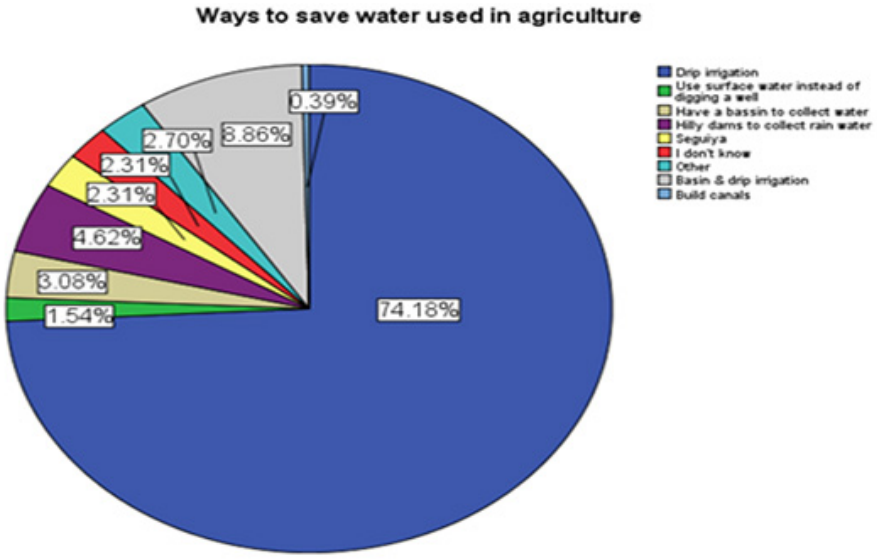


Figure 5: Farmers are aware of the need for change to Drip Irrigation

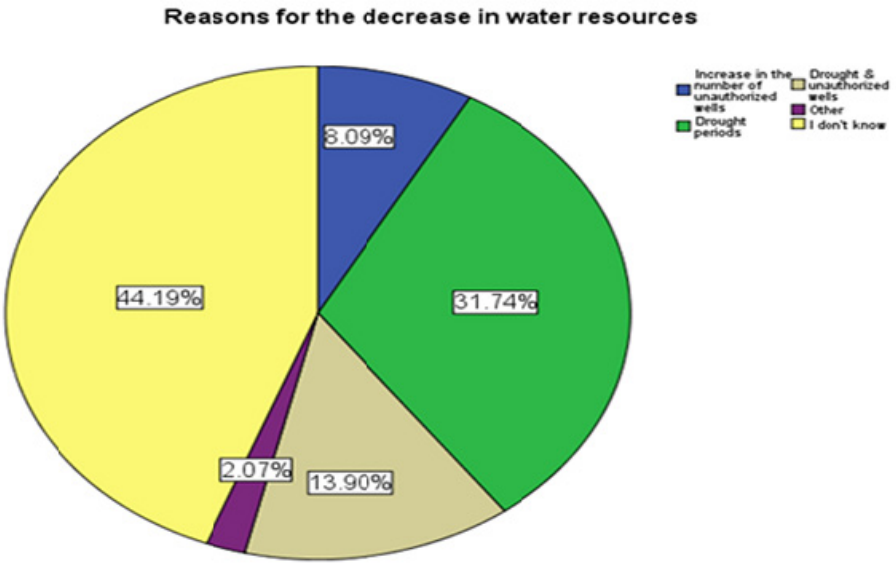


Figure 6: Many but not most Saïss farmers are also aware of Climate Change Observationally

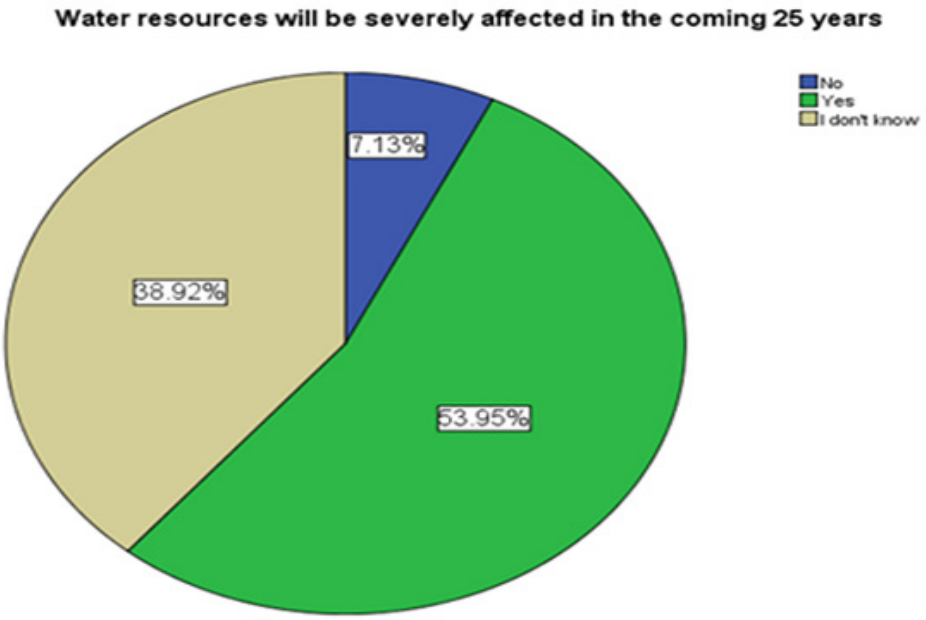


Figure 7: Some Farmers are also aware that the future will feature less water

- Drip irrigation results in water savings of about fifty percent per unit of crop yield compared to the saqiya (furrow) system for cucumbers, tomatoes, eggplant and onions, as the data from the US, Australia and the Jordan River Valley suggests. (Van Tuijil, 1993).
- With olives, the water savings per unit of output are at 57 percent per Turkish data (Cetin et al, 2004).
- Our research that there is an awareness of Climate Change in the region at some level, but it is not widespread and many farmers are not aware yet of the long term risks.

- Some farmers claimed that 70% of the workload is done by the rural woman. Her contribution is significant in terms of helping the husband in the agricultural sector.
- Some farmers during the questionnaires feel that their knowledge is useless since they are illiterate.
- The questionnaires were an opportunity for the DPA to give advice to the farmers as well as updates about the new state subsidies

A Summary of KAP Findings & Discussion

The KAP survey farmers believe that the problem of water supplies due to over-exploitation of the aquifer and climate change is solvable. They believe that they could match their current yields and exceed them while using less water should they be able to access drip irrigation technology. They have other motives for requesting drip irrigation technology, including labor and input costs.

- The data indicates that that farming community is aware of the problem of declining water resources and climate change (understood as drought and the decline of the water table) and has been articulating its needs to the Ministry of Interior through the workshops and other events organized by this project; community representatives, such as nawab al turab (tribal elders) were included in all our meetings and workshops.

- It may be possible to reduce the damage from climate change, in part through increasing the use of drip irrigation from the current 6 percent reported by the farmers to being the norm rather than the exception. For that reason, we embarked on the pilot projects. The pilot projects show a dramatic decline in water use is attainable, confirming the views of the farmers as indicated in the KAP survey

- There is widespread understanding in the region that the climate is changing and that thre are reduced water supplies in the basin. The farmers noted that: fissane (336 hour blocks of canal water) are producing about 15-18 liters per second instead of the 20-22 liters per second.

- Wells used to be 40 meters, now they are commonly 120 meters. No wells existed before 1970 and there were more than 9,000 wells by2007 the Saiss Basin.

4.2. Action Research (Pilot Projects)

Objectives

We have implemented two pilot projects with small farmers in the Saïss basin whose purposes were to demonstrate to the rest of the farmers the efficiency of drip irrigation and make them a model for other farmers to follow.

Methods

Two small farmers were chosen by the two DPAs of Sefrou and El Hajeb; the two farming families consented to participating in the study and to make what they learned available to

their neighbors and communities. . The condition is that the selected farmer will allow his land to be used for experimentation and to collaborate with the rest of farmers in the region in case they need any information regarding drip irrigation equipment in the future. Through this way, we will make sure that there is a transfer of capacity building to the local farmers. During the launching of those pilot projects, 20 farmers per each region, water user associations (WUAs), and other agricultural cooperatives attended the openings o that they can learn the benefit of drip irrigation and ask direct questions to the directors of the two DPAs and the Sebou Basin Agency representative as well as other local authorities regarding how to apply for state subsidies to get financial support to install this technique of irrigation.

Results

The launch of the two pilot projects provided us with an opportunity to bridge the gap between officials and farmers in the two regions under study. One of the easiest responses to climate change and conditions of reduce precipitation is to install drip irrigation and significantly reduce water use by farmers, whether large or small. Fortunately, drip irrigation technology is well understood by the farming community, but serious concerns remain concerning its cost and price. While there are government programs designed to help farmers with these costs, there are problems in terms of informing the farmers about their conditions, procedures and eligibility requirements.

In addition, the meeting, workshops and pilot projects as well as initial assessments of the KAP survey reveal that many farmers are not aware of the regulations concerning water use and well digging. To the extent possible, we have worked with the ABHS to increase its profile with farmers. To that end, the ABHS now makes its materials available through DPA offices rather than requiring farmers to go to Fez to secure permission for well digging. Finally, our current assessments of the knowledge, attitudes and practices of farmers in the basin suggest that they are not aware of the risks posed by climate change and the need to conserve now and alter irrigation behavior. We have also found that very deep level of skepticism towards the idea of new crops, particularly downstream in the basin, is because of the watering cycle.

The farmers downstream receive water once about every fourteen days from the Bitit Canal. Farmers without the capital for wells, storage basins and pumps and other infrastructure for water storage are forced to rely on resilient crops able to survive infrequent irrigation, such as tobacco. Those with such capital often have drip or boom irrigation systems already, but their use of the water table places further strains on the water table. Tobacco is one of the few crops that can withstand infrequent irrigation, so it is heavily grown by the more marginal and smaller farmers downstream. Unfortunately, the varieties grown are of low quality and are used primarily in cigarettes and snuff. The area lacks access to the marketing skills and connections needed to switch to more expensive cultivars of tobacco for cigars and pipes. Of course, tobacco is probably the furthest from the ideal in terms of its greater social impact. In the Canal's downstream, the shift to more regular crops is conditioned by access to technology that can "stretch" the Canal's water and thereby reduce the need for more wells, particularly un-regulated wells. In general, we fear that climate change may actually mandate and force already needed alterations in crops and means of watering in a haphazard and socially painful way.

By providing an example in the two pilot projects, we believe that we can provide the farmers with the means to make adaptation and transition easier.. By installing two low-capital drip

irrigation systems, we have offered small farmers demonstrations of effective alternatives, and other project activities have provided them with increased access to officials. They were able to articulate their concerns about funding and access to technology directly to the DPA, ABHS and Ministry of Interior officials at the local level, and in response, the local administration responded by cleaning the Bitit canal and organizing workshops that showed local farmers how to access credit and other forms of government support to procure the drip irrigation technology.

Results

Bitit Pilot Project

The first farmer has one hectare of owned land and but he is renting 4-5 hectares to do other agricultural activities. This farmer has 10 hours in total which he receives every 5 days (4 days and 18 hours); he has 2 hours of his water right from the Bitit Canal, and he rents 8 hours due the scarcity in water resources. That is important to mention here is the fact that even with these hours, the water is not enough to irrigate his land. Also, this farmer has a basin of 100 m3, which needs 2 hours to be filled with his water turn. The purpose of using the basin is to irrigate more frequently instead of waiting for the 5 day water turn.

According to the farmer, the water quantity in the basin is sufficient to irrigate half hectare using the traditional way of irrigation, Seguiac -- furrow-inundation. For crop production, he relies on vegetables (onions, potatoes, etc), corn, agricultural herbage, and olive trees. After the installment of drip irrigation in his owned one hectare through our project, the farmer has started to grow vegetables, which was not the case before so, he used to rely on the production of the rented land. Now, this one hectare takes 2 hours to be irrigated using drip irrigation while it takes about 6 hours for the same purpose.

In addition, now the farmer collects his water turns in the basin to be able to irrigate this hectare in 2.5 days instead 5 days. So, the rest of the water can be used to irrigate the rented land. After three months of using drip irrigation so far, Mr. Aamer confirmed that now they have more free time to do other activities; for instance, while the owned land is being irrigated using drip irrigation, the farmer goes to the rented land to irrigate it using Seguia. Furthermore, with drip irrigation, there is less human labor and less use of fertilizers, if compared to the traditional way of irrigation, Seguia.

Besides, crop production of potatoes and green beans is doubled this year in this one hectare with high quality, compared to previous years. Now, this farmer is preparing for this year production. Finally, Mr. Aamer said that thanks to drip irrigation, there is an increase in both the quality and quantity in production, a decrease in expenses such as fertilizers and human labor, and a saving in water (2 hours using drip irrigation Vs. 6 hours using Seguia). Data are given in Tables X and Y below.

Table 1: Bitit Pilot Project: Mr. Saïd Ziyani (Period of March 2011 to December 2011

	Before Drip Irrigation (per hectare)	*After Drip Irrigation (per hectare)*	*Generated Benefits Using Drip*
Energy (Gasoline)	120 liters/month; 1250 MAD/month	40 liters/month; 450 MAD/month	800 DH/month; 9600 MAD/year

Human Labor (season)	20 employees with 80 MAD per each; total payment is 3200 MAD/season	5 employees with 80 MAD per each; total payment is 1600 MAD/season	1600 MAD/season is saved (at least two agricultural seasons per year, depending on the farmer); 3200 MAD/year
Fertilizers	1500 MAD/season	1000 MAD/season	500 MAD/season; 1000 MAD/year
Increased Revenue	~~Less~~ Base revenue	Estimated to be doubled	It depends on the market

Aïn Cheggag Pilot Project

The farmer has 3.5 hectares of owned land in total. He relies on water from unauthorized well, which has a depth of 162 meters. For his agricultural production, he grows herbage, vegetables for self-use, and olives. The portion of land in which drip irrigation was installed is 0.8 hectare. This portion has 170 olive trees, so to be irrigated using Seguia the farmer needed 32 hours, and 300 liters was required per olive tree every 20 days. With the installment of drip irrigation, the farmer decided to grow another 170 olive trees, so that density of the trees double. The reason behind the increase in the number of trees is that now he needs to irrigate the 170 trees with only 2 hours instead of 32 hours. Therefore, there is less labor in terms of irrigation. Also, he gives 64 liters to each tree every three days. When asking the farmer the reason why he gives this water quantity to a tree, he replied by saying that he does not know the exact water quantity that should be given to an olive tree. As researchers, we have observed that even with drip irrigation, there is not water saving in the Aïn Cheggag case. An example that illustrates the latter is the fact that this farmer has 8 drippers per tree, so each dripper gives 8 liters per hour, which is in total 64 liters per hour. Knowing that this farmer uses 2 hours of drip irrigation every three days, the total number of liters is 128. When we compare between before and after drip irrigation, we have noticed that Mr. Toufahi gives more water to an olive tree than before (853 liters in 20 days using drip irrigation while he used to give 300 liters every 20 days); therefore, there is no water saving even though with the existence of drip irrigation.

Table 2: Aïn Cheggag Pilot Project: Mr. Tefahi Noureddine (Period of March 2011 to December 2011

	Before Drip Irrigation (per one hectare per three months)	*After Drip Irrigation (per one hectare)*	*Generated Benefits Using Drip*
Energy (Gas)	30 bottles; 1140 MAD	6 bottles; 228 MAD	912 MAD/year
Human Labor (season)	10 employees with 100 MAD per each; total payment is 1000 MAD	2 employees with 100 MAD per each; total payment is 200 MAD/season	800 MAD/ year
Fertilizers	Bio is used	Bio is used	
Increased Revenue	2 tons with 4000 MAD per each	4 tons with 4000 MAD per each	Approximately 10000 MAD/year

Discussion

Using data providing by the two farming families above it is clear that installing small-scale drip irrigation systems are capable of paying off within two years' time. Also, we have come up with the following observations:

- Farmers were asking direct questions to the DPA directors looking for answers on how to benefit from the state financial aids concerning drip irrigation. Before the closing of the Bitit's event, farmers expressed their positive feedback that they could fully understand how they can fill out forms for loans and licenses.

- Meeting transcripts showed that the farmers are aware of the importance of drip irrigation and that the Seguia system wastes large quantities of water.

- Also, through drip irrigation, farmers should have a basin to collect their water turns coming from the Bitit Canal. Furthermore, the DPA is encouraging farmers to work as a group instead of individuals so that farmers will share knowledge and learn from each other; especially that the Moroccan state prefers to deal with farmers as cooperatives and/or WUAs instead of individuals.

- Farmers asked for training workshops to be held in each village so that they learn about accessing drip irrigation technology and infrastructure, including government support, bank loans, and subsidies.

The primary institutional barrier remains the form of property held by the farmers. Nearly a third of the farmers in the KAP sample hold communal (tribal) titles to land and many hold their lands by custom rather than by document, so they cannot easily access credit. The governor of Ain Chegag indicated that the state is reviewing ways to formalize and equalize land holdings to address theaccess problems posed by communal title in terms of securing routine credit for drip irrigation and other improvements.

4.3. Capacity Building

Objectives

Increasing adaptive capacity in created water users associations and other key stakeholders was our main goal. We intended to evaluate this through the continued operation of the two small farmers' WUAs in the pilot project and the expansion of the model to other small farmers.

Methods and approaches – workshops & trainings

In consultation with the different stakeholders, we organized workshops and trainings for our farmers based on their needs and feedback that we usually received after each meetings with them. Also, we tried to bring the administration and the farmers together to bridge the gap between the two and try to build a good relationship based on trust. We deliberately included representatives of both communities in all future workshops; part of the approach was to include treating each farmer as an individual as well as a member of a community to allow for the emergence of trans-tribal links and channels of communication.

Course on Capacity Development for a Better Integration of Water Demand Management in Responding to Water Scarcity in Morocco, Al Akhawayn University, Ifrane, Morocco 3-5 February 2010

The program of this course, that used a participatory approach, was introduced by Prof. Ahmed Legrouri. The presentations were delivered by water experts and invited speakers followed by active contributions from participants who included 50 senior managers and professionals from government ministries, agencies, water utilities, private sector organizations, academia, and NGOs throughout Morocco. Among them were representatives of the Ministry of Interior, the Ministry of Agriculture, Rural Development, and Fisheries, UNESCO, GTZ, USAID, the Office of Water and Forests, the National Office of Potable Water, the Center for Regional Investment of Meknes- Tafilalt, the Institute of Research for Development in France, and many others. The course was an opportunity for participants to bring in their own/national experiences to share with the audience. The participants were able to evaluate this training course through a questionnaire that was circulated at the end of each day.

Awareness Workshops, Bouderbala & Aïn Cheggag: 10-11 February 2010

In this workshop, we were able to provide farmers in both regions with information about drip irrigation systems, their effects and the financing available to acquire these systems. We were assisted by the DPA. We were able to provide the farmers with a forum in which they articulated their concerns, hopes and fears. The problems facing the basin were also communicated to them and their ideas and feelings were solicited to aggregate them and present them to policy makers. For many, this was the first time they had been invited to voice their concerns publically. The contents and implications of the *Maroc Vert* plan were also discussed and communicated. A detailed report of the event is attached.

Vision, Action, Partnership Exercise: 15 March 2010

This exercise was conducted at the ABHS office and it involved the AUI research team and its partner in ABHS M. Rhaouti. The focus of the ABHS on the aquifer preservation came out very clearly in this meeting. We were able to use the exercise to introduce the ABHS to methods that it can use to have meaningful dialogue with its basin partners. The initial impression we had with the VAP is that helped bridge some of the gaps between the AUI team and the ABHS, but as subsequent interactions suggest, there is a gap that needs to be overcome at this stage still.

Awareness Workshops, Bouderbala & Aïn Cheggag: 31 March-1 April 2010

The farmers were able to articulate their problems with the ABHS. Their perspective hinged on the compulsion they feel to use Seguia water, because it does not require authorization. The Seguia wastes a great deal of water, and some of the assembled farmers clearly indicated that they would prefer getting their own wells. The differing perspectives of the DPA and the ABHS emerged into the open and there was a dialogue between the two groups, albeit in a limited way. The participants agreed that there is a need for better infrastructure in the form of small dams. They also agreed that they do need to learn more from Souss and its

experience in dealing with increased aridity. The farmers expressed satisfaction at being able to expand their networks and learn from each other. They were also pleased with the access they had to the ABHS and to higher ranking members of the DPA.

Training & Capacity Building Center: 22nd September 2011

The roles of the training & capacity building center in Aïn Cheggag are to: carry out projects on the various aspects of agricultural water conservation with an emphasis on finding innovative solutions for the needs and challenges facing local agriculture; organize and run water conservation workshops; enable consultations and technical assistance from the Agricultural Extension Agents technicians; encourage local farmers to use the information provided by the weather station in the Agricultural Extension center about which we conducted research, including the evaporation rate in irrigation to maximize the utility to the water used; and to provide farmers with information about state assistance and its associated regulations, so we have established a web site for that purpose which is the first one for a Moroccan Provincial Directorate of Agriculture to have: http://wmcc.aui.ma/dpa-sefrou/. This website has state subsidies forms that farmers can fill out without moving to different offices. Also, the computers are connected to a weather station at this center to generate evapo-transpiration values to be used for agricultural purposes.

After we have secured the cooperation of the Caïd at Ain Cheggag with regard to establishing a local training center, this latter will concentrate on the use of participatory methods that utilize the knowledge, experiences and specializations of local actors which include holistic evaluation, field research, needs analysis, and strategic planning.

We have created a website for the project in two languages: Arabic and French to be consulted by our stakeholders and farmers should they need any further information, which is http://wmcc.aui.ma/wmsb/. In addition, we have organized a national course on water management during which the participants expressed the need for a transnational network to disseminate information on WDM. The goal of this network is to achieve communication, cooperation, coordination, and collaboration on WDM issues. Al Akhawayn University took on the responsibility of establishing a network that would facilitate communication and exchange of ideas among water experts. This forum can be accessible through the following website: http://wmcc.aui.ma/forum-gde/.

Field Visit to Agadir: December 5th 2011

The idea of having a visit to the Souss region appeared during a study day that we held in September 29th, 2011. In fact, there were a number of discussions about the role of water user associations in the region and some of the farmers expressed their fear against these associations by claiming that their role is very limited. As a research team, we have decided, after getting the approval from IDRC, to schedule a visit to Souss.

The purpose of this visit is to take Saïss Basin's farmers (both small and large) to Souss to meet other farmers and Water User Associations and to learn from their experience in terms of managing water resources thanks to the high number of cooperatives that exists in Souss. Also, it will be an opportunity for our farmers to see how the weather stations can be used for irrigation purposes, which is a new technology that Moroccan large farmers in general and in the Saïss in particular are willing to adapt.

To do this visit, our team had a meeting with the DPA representatives to choose the farmers who should go to Souss. In the meantime, we have contacted Mr. Abderrahmane Aït Lhaj, Director of INRA Agadir and an IDRC-funded project holder, to see about his availability and to agree upon a program for the visit. In a participatory way, we have selected 14 farmers from the two regions with the DPA's input: 7 in Aïn Cheggag and the other 7 in Bitit. These farmers were presidents of the 6 WUAs relying on the water from the source Bitit, some of the Zoubiya's members, as well as our two pilot projects farmers. In addition, we chose some big farmers. Besides the farmers, we had DPA representatives as well as Al Akhawayn University research team to accompany the farmers during their trip to Souss.

In the morning, we had a visit to Taghfirite, a water user association for agricultural purposes in the rural commune of Oullad Aïssa in Taroudante. This association has 432 hectares. This Association manages the water of three wells. The Association's president Mr. Omar Bassite showed to the farmers a video about how the Association was created, its activities, how they manage their water resources and more importantly how they have adapted to the changes in the climate. In fact, members of this Association prior to its existence used to rely on the Souss River during the 1990s to irrigate. But because of the drought, these farmers have decided to create a water user association to dig collective wells. Another aim of the Association was to convert from Seguia to drip irrigation. So, Taghfirite has received financial help from both the Hydraulic Agency of Souss Massa Draa and the Regional Center for Agricultural Investment (RCAI). Indeed, 20% of the aid came from the Agency, 60% was received from RCAI, while the rest of the money came from the members of the Association.

The Taghfirite members received technical expertise from the Spanish in terms of using automatic drip irrigation in order to save water more efficiently. As a result, a number of problems such as the physical movement of the guardian who distributes water and water stealing were solved. Following this presentation, there were discussions between the Saïss farmers and their counterparts in Souss in which there was an exchange of information mainly related to the management of water distribution to decrease conflicts. As researchers, we could see our farmers seeking advice from the Souss farmers whom they see as their model in trying to apply their water management in the Bitit Canal. Immediately, our farmers had a tour to see the IT equipments used for irrigation and a plot of land using these techniques.

In the afternoon, were able to visit Agrotechnologies Association which has a number of weather stations in the region. Using these stations, evapotranspiration values are generated; they calculate the needed water depending on the tree, then send this information to farmers by SMS and put it in their website for public access. Every fifteen minutes, the values are updated. The members of this Association explained in details the benefits of the weather station in terms of saving water in the irrigation as well as energy. An open discussion was followed between farmers about the price of the weather stations and their types as some of the farmers expressed an interest in buying one.

Zoubiya Cooperative

The Zoubiya cooperative was created in January 2009 after its members attended our kickoff workshop. It was formed to have a common basin to collect their water turns coming from the Bitit canal. The cooperative aims to modernize irrigation techniques (mainly drip irrigation), increase vegetable and milk production, as well as to encourage women to join the cooperative to improve their financial situation. After talking to the members of this cooperative, the researchers were informed that the Zoubiya is composed of 10 families, approximately 130 people in the total; the cooperative controls 15 hectares. The poorest members prefer to grow olives rather than almonds since this latter takes time for its production. The cooperative was able to secure ABHS support for a common basin which was visited by the IDRC representative.

Results

An important change within the basin is the creation of dialogue between the ABHS and the Ministry of Agriculture's delegations in Sefrou and El Hajeb in conjuction with the Ministry of Interior. In addition, we have been able create the two groups of farmers and we were interacting with them to explore the prospects of forming Water Users' Associations and implementing experimental alterations of crops. In addition, it was thanks to those training sessions for farmers that know they came to understand several issues related to the state subsidies, mainly drip irrigation.

The most significant output of the capacity building activities was the formation of the Zoubiya cooperative as a direct result of our activities. The cooperative was able to secure the funding required to build its water storage and distribution system and is very productive. It represents both again in real capacity and in terms of institution building. Other important results for our capacity building exercises include the connections established between the Pilot Project Farmers and their neighbors as well as their knowledge of and working relationships with officials.

Analysis and discussion

The project did not anticipate until fairly late the importance of financial planning and land ownership law as inhibiters of the development of adaptive capacity. We tried to compensate for this by including representatives of Credit Agricole and the Maroc Vert government agricultural program in our later workshops. In addition, future programs should include politicians and persons involved in the creation of legal text surrounding land ownership and tenure.

The project is directly responsible for providing the context that led to the rise of the Zoubiya Cooperative which is currently working in the Bitit region. This allowed about Mr. Mohammed Abou Yaala, the Cooperative president, farming households of extremely modest size to combine their operations and to build a water reservoir and its associated drip irrigation and water works. We found water users associations already in place and provided them with forums and training workshops as well as access to local government and decision makers in order to express their concerns as well as begin a process of working out their differences and conflicts.

Table 3: Water Users Associations Sharing the Bitit Canal

WUA	Water Share Fissane	Predominant Crops	Turn and Notes
Boufadma	9	Onions, potatoes, vegetables	Shifted from 14 day turn to a 7 day turn, got rid of tobacco
Tichniwin	5	Onions, potatoes, vegetables	Shifted from 30 days to 14 day turn and then to a 7 day turn, got rid of tobacco
Khrichfa	3	Onions, potatoes, vegetables	5 day turn allowed move away from tobacco
Malouiya	5	Onions, potatoes, vegetables	7 day turn, has a well that is unused due to lack of electricity
Guellafa	9	Onions, potatoes ,vegetables	7 day turn, WUA is against wells
Al Wahda Ait Ayyach	Up to 30 never realized	Tobacco is dominant, some olives	12 days leading to tobacco's popularity. The longer turn suggests that the water actually reaching the region falls far short of the allotment.

The WUAs reflect the tribal structure of the canal area. All the upstream associations reflect the Ait Oullal and their co-residents, while Al Wahda reflects the interests of the Ait Ayyach. The two tribes are locked in disputes over water use upstream. In addition, the Ait Oullal have internal disputes surrounding the rights of some of their clans as opposed to others. The issue of water use and rights has inter-meshed with inter and intra-tribal friction, thereby reducing the potential for collective water demand management as a response to climate change. While the state deals with the tribes as a de facto reality in Morocco, they do not have legal standing. As a result, we attempted to address this problem by insuring the presence of the nuwab al turab in our events. Future projects addressing climate change or other problems related to agriculture in the region need to include a tribal dimension to their studies.

In contrast, Zoubiya stood as an excellent example of what could be done collectively by the farmers as a self-organized community. The farmers of the Zoubiya Cooperative along with the farming households of the two pilot projects have been meeting visitors and have offered to continue discussing their experiences pro-bono with any other local people interested in their experience. The main feedback confirming increased capacity was from the leadership of the Zoubiya cooperative.

Within the IDRC rubric, our research team was able to attend several trainings, both nationally and internationally to disseminate the skills and knowledge we have acquired with other experts in the water field. For instance, Dr. Ouardaoui already attended an IDRC Climate Change Workshop in Kenya to learn about methodologies used in the study of climate change as well as adaptive responses to the problem. Also, Dr. Kalpakian attended a

workshop on issues related to measuring and evaluation of climate change in Dakar, Senegal. Ms. Ejekki was able to benefit from a workshop on gender analysis and mainstreaming, which was held in Nairobi, Kenya. These events were used to build networks with colleagues conducting similar work. These ties were used as channels through which we planned to disseminate our findings, especially towards the end of the project. These workshops have been helpful in giving our team a deeper sense of the applicability of participatory approaches to climate change and the team members provided training sessions for members of the research group.

In February 2010 and as stated earlier, our research team organized a Course on Capacity Development for a Better Integration of Water Demand Management in Morocco. The course was part of a series of three courses: one regional course organized by the Arab Water Academy in Abu Dhabi and two national courses in Egypt and Morocco. The University received financial support from IDRC, Cairo for the organization of the Course.

Dr. Legrouri also attended the AWA Board Meeting in Abu Dhabi, on 2 March 2010.We have also attended several meetings and workshops where we presented our project. The list of these is given below under Project Outputs section of this report.

Our activities allowed farmers to hear about the laws governing support from the government, understand some of the administrative processes involved in securing the right to dig a well, get a loan for installing drip irrigation and accessing other forms of government support. The DPAs now carry materials from the ABHS and the farmer is increasingly served through a single point access to forms and materials.

4.4. The Bitit Canal

The canal carries water from a natural spring in the Saiss sub-basin of Morocco through the Hajeb district of the same area to Aïn Cheggag – a plain outside Fes. At the source itself, half the water is reserved for the City of Meknes. RADEEM (*Régie Autonome de Distribution Eau et Electricité Meknès*), a private monopoly water company, controls the site itself and there is a representative of the Sebou Basin Hydrological Agency (ABHS) permanently dwelling at point where the canal exists the RADEM facility. About half of the spring's 1000 liters per second output is reserved for the city of Meknes according to an agreement between the state and the stakeholders. The spring's average output has been declining over the years, and during droughts, it is significantly below its 1000 liter per second level. Once the canal leaves the RADEM facility, it carries water into an area inhabited by the *Regraga* community, traditionally a branch of the *Ait Oualal* tribe. The canal's infrastructure transfers water to the *Regraga*, enabling their farmers to water their crops daily. These arrangements date to the time of the French protectorate, which is accused by other members of the *Aït Oualal* tribe of favoring the *Regraga* as a part of a colonial divide-and-rule policy. The *Regraga* dispute this and claim to have been present at the site before the arrival of the French. The canal's waters are supposed to be shared by two tribal communities as per an independence era agreement. Water not used for Meknes is to be divided according to a 51-49 percent ration between the upland *Aït Oualal* in Hajeb and the lowland *Aït Ayyach* in Aïn Cheggag.

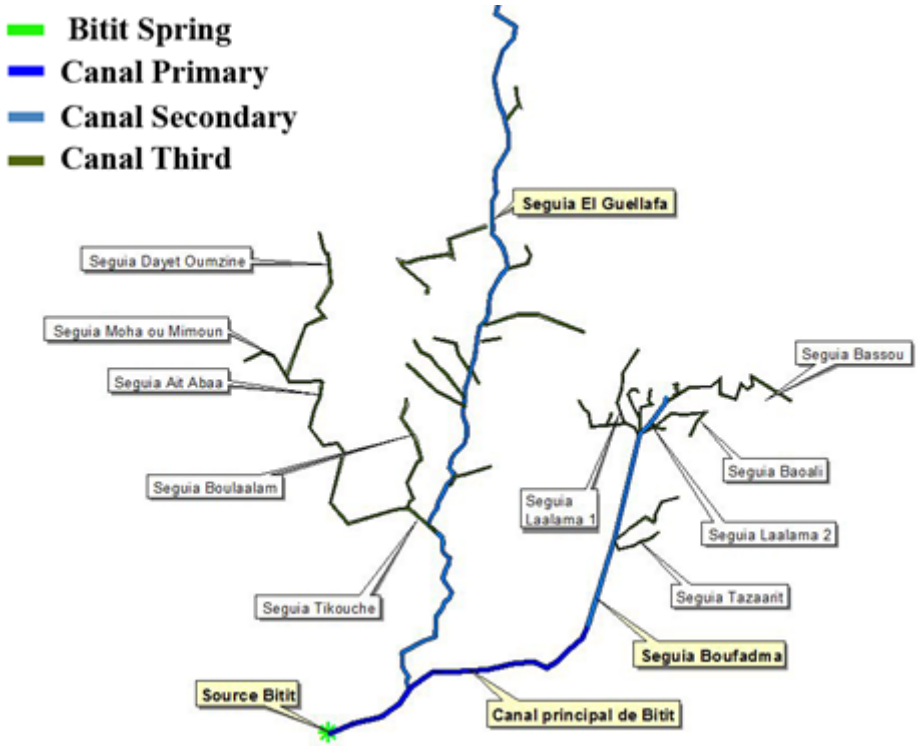


Figure 8: The Bitit Canal System

The Problem

The colonial era agreement, OB (Official Bulletin) 1940, which divides the waters between the two tribes and the city of Meknes' water company is not being applied literally with resulting water stress and aquifer depletion as lowland communities dig wells to compensate for their water shortages. The city of Meknes' water company overdraws its allotment in order to compensate for reduced flows, and this has a dramatic effect on water available particularly downstream.

Table 3**:** OB 1940 Water Allocations and Actual Use

Shares	RADEEM	Aït Oualal	Aït Ayyach
OB 1940	60 percent	24 percent	16 percent

Given the urban share and the use of the water both by the upstream tribe and *Regraga,* the canal rarely delivers water below, and the farmers in Aïn Cheggag are forced into additional well digging, which further depletes the aquifer that feeds the spring providing water to the canal. In many cases in Aïn Cheggag, farmers get canal water once every twelve days, and should they lack the financial wherewithal to store water and to use drip irrigation. The farmers of the regions literally live under the tyranny of the irrigation turn and their ability to store water is limited. As upstream farmers began using storage systems, they were able to free themselves partially from dependence on the turn and to plant more useful crops. In any case, farmers accepted half the water every 7 days instead of every fortnight, and the results were very good. We held meetings with the presidents of the water users associations and we were able to see a clear pattern in the relationship between the turn and the nature of the crop

farmed. Downstream farmers feel compelled to plant tobacco, because it is one of the few crops that can withstand a 12-day watering cycle. Each water users' association (WUA) is allocated a share of the canal water measured in units corresponding to a block of 336 hours of canal water flow, a *fas,*[41] plural *fissane*.

While there has been no direct conflict between the two large tribes and no emergence of a permanent protracted conflict dynamic, there has been violence over farm and water related issues, and in one case the victim was a government's representative was apparently assaulted in a dispute over road construction. According to local Ministry of Agriculture officials, there have been cases of assault and battery over the years, demands for separate canals, as well as sabotage of the canal and associated water works. An examination of the canal reveled leaks, poor maintenance and what appears to be intentional holes at various locations. The canal is poorly maintained because all work on it needs the approval of all three recognized stakeholders – the state and the two tribal communities.

The canal is also in desperate need of repairs. Our research team took photographs of the canal that documented damage, overgrown weeds and trees in the pathway of the water (see below).

[41] According to the farmers, One *Fasse* equals to between 15-22 liters/second.

It is noteworthy that the violence did not take place between the communities as identity groups. It occurred between individuals, and no one seriously anticipates tribal mobilization against the other communities or against the state. It also remains to be seen if water issues were critical or if there were other issues that had fed the conflict. And while there have been inter-tribal lawsuits particularly during droughts, with the tribes acting as collective bodies, the critical issue is that these were lawsuits not battles. Violence has also taken place within the tribal communities themselves due to issues that stem from politics, wealth, land rights, differing educational attainment, and disappointed marriage proposals; these events are both rare and personal. They rarely involve water rights, unless the local norm was broken by a party, which is an offense against the community as well as one's neighbors. Basin-wide policies designed to enhance adaptive capacity with regard to climate change cannot take place without including the tribal actors.

Fortunately, despite the inevitable frictions between communities, the tribes in the area have preferred resorting to the courts and not to violence concerning water allocation; this means that under the right conditions, they can be induced to cooperate. For example, the state's decision to unilaterally repair the canal could be followed by conferences over further development of the infrastructure, including exploration of issues such as enclosing the canal to save water and computerized distribution with the participation of tribal actors as represented by the Water Users Associations. Despite our active consideration of tribal factors, we should note that we did not include the tribal factor in our project as deeply as we should have. Future projects in the basin ought to start with a clear commitment to including tribal communities as units of analysis with regard to adaptation to climate change; part of the relative success of the Ait Oullal is their relative possession of more private land titles, which enables them to access bank loans for drip irrigation. In contrast, their downstream neighbors have higher levels of tribal land titles, which are more difficult to use in securing credit; in this light, it is important to note that the Zoubiya cooperative is located in Ait Oullal areas, but its membership is open to people outside the tribal community.

4.5. Use of Weather Monitoring in Agriculture

Objective

The main purpose of using the weather stations is to sensitize farmers on tools they can use in order to optimize water; fertilizers, pesticides use in agriculture. As weather forecast is an important factor in irrigation, we worked with the DPAs to operate the weather stations that were already installed in the centers but not used by the farmers.

Methodology

We conducted research about weather stations to be implemented with the collaboration of our stakeholders: DPAs and ABHS as well as the two large farmers in Aïn Chegag (Sefrou) and Aïn Taoujdat (El Hajeb). The suppliers provided us with three different types of the weather stations: IMetos, Watchdog, and Campbell. Their common features are the following:

- An acquisition unit and a solar power
- Sensor combination of T ° and relative humidity of the air
- Two sensors of wind (speed & direction)
- Pluviometer
- A sensor of the global radiation
- Evapo-transpiration is calculated automatically by the station
- Data transmission is via GPRS (Internet)

Results

In addition, the commercial weather station providers in Morocco offer fee-based training and installation packages along with the weather stations. We were able to get quotes for the price of weather stations; the firms stated that associated training and installation services can be provided. The hardware, installation, updates and training can be acquired for 42,000 MAD – excluding the tax, of which AUI is exempt.

Analysis and Discussions

The role of these weather stations was meant to help farmers, especially the large ones, optimize their water and fertilizers use and be installed in an area where an important number of large farmers are close to each other so that they can use it collectively through GPRS.

At the beginning, we met with large farmers and encouraged them to use weather station data to reduce their water consumption. But we realized that they were not ready to initiate investment in this. In fact, they wanted the project to provide all the funds to purchase modern weather stations, which are costly. Thus, we helped the Sefrou DPA establish a training and capacity building center in the Aïn Cheggag technical center and connect their weather station to computers so that farmers can retrieve data and make use of this information in their water consumption. Therefore, the access to these data can be done by anyone through the internet. Finally, we provided large farmers with ideas about weather stations and a free data center at Aïn Cheggag that can take advantage of it, which they would be well placed to use compared to small farmers. Given the late construction of the center, we do not as yet have data on use and utility of the weather station system.

4.6. WEAP

Objective

The application of the WEAP package in the Saïss basin meant to be conducted in four major steps:

1. Study definition: this includes determining the spatial boundaries of the basin, Creating GIS files of the basin (provincial layers, drainage layers, cities layer...)
2. Current overview: Retrieving information (Precipitation, agricultural water demand, urban water demand, river flows, groundwater resources, pollution loads...) necessary to be used in WEAP by both ABHS and DMN. This step is considered as an assessment in the development of the application.
3. Scenarios: Proposal of alternative assumptions on future impacts of policies, costs and climate on water demand.
4. Evaluation: The scenarios are evaluated based on the sufficiency of water.

Methods

One member of the team attended training on WEAP on 24-25 March 2011 in which representatives of the Department of Water and Land, the National Meteorological Directorate and the Chamber of Agriculture were present. The event included experts from FutureWater who presented on WEAP as well.

Results

WEAP was introduced by Dr. David Purkey in the Workshop International Workshop on Adapting to Water Scarcity and Climate Change in North Africa: Demand Side Management and its Implications for Social Equity and Environmental Sustainability that was organized with financial support from IDRC in 2007. ABHS and other stakeholders initially indicated interest in WEAP because it would provide them with a common platform for data exchange and coordination. We did hold a training workshop introducing WEAP to boundary and strategic partners, but the participating institutions had adapted other systems and could not use WEAP. Consequently, there was a very limited interest in the software despite some recognition of its utility.

4.7. Synthesis and Discussion of Results

Using data from our social survey, we have found that while the farming community in the Saïss Basin is aware of the benefits of drip irrigation in terms of water conservation and a number of other benefits, the chief problem lies in securing the financing necessary for the installation of the systems.

Preliminary examinations of survey results and their trends suggests that the ABHS needs a permanent field presence and a deeper connection to the farming community, both commercial and subsistence. While wealthier commercial farmers have generally enjoyed the resources needed to dig wells legally and process their authorizations quickly and often properly, subsistence farmers often do not even know of the ABHS and its role. One subsistence farmer touchingly told the team that he had his authorization to dig his well from the Moqadam – the local foreman. The actual procedures involve securing permission from the ABHS itself, and consequently, the farming population does not understand the role of the strategic partners in this project and in many cases, the farmers are not aware of the agency's existence, preferring to deal with the state through the local foreman or in other cases the DPA.

The project resulted in a more self-reflective state of affairs within the ABHS. We also saw that the Technical Centers (extension agencies) of the Ministry of Agriculture were uniquely placed to reach the farmers and influence behavior on a wide range of issues. Unfortunately, they viewed their role as education in terms of seeds, fertilizers, herbicides, planting conditions, harvesting and other limited and not irrigation management issues. The ABHS lacks a field presence and it has very few employees on the field, and it could benefit from cooperation with the Technical Centers -- we have seen some stages of rudimentary cooperation between the two governmental bodies, including the provision of information and forms by the ABHS to the Technical Centers.

While conducting the KAP survey and interacting with different farmers in the Saïss region, we are outlining some of the observations we have marked in the field and some portraits of the farmers are below as an appendix.

Some farmers responding to the questionnaires were illiterate; the team communicated to the farmers the idea that as people directly involved in farming and irrigation, they possess valuable knowledge that can help others including educated people. We believe that such sentiments are a consequence of the class structure and that there is a need for communications that convey respect and appreciation to rural people.

The technician in Aïn Chegag suggested that farmers in this region should visit the Zoubiya cooperative (a newly established water user association) to learn from its experience and to break the problem existing between the two tribes.We presented participants with exercises designed to enhance problem solving along trans-communal lines. We deliberately included tribal representatives from all concerned communities in every single meeting and exercise.The problem of elections is a barrier against farmers in Aïn Cheggag to work together and collaborate. Conflict over political power and elective office within each of the two tribal communities is a barrier against collaborative behavior by farmers in both regions. To some extent, the cause of the problem is the relative immaturity of democracy in Morocco. We hope that by having some these aspiring politicians participate in our workshops and in exercises that require participatory collaboration with the putative opponents, we can further in a small way participatory trends. The issue of elected office is less of an issue in the Hajeb area, so there is a greater incentive to cooperate; further, more widespread private land holding patterns give the farmers an incentive to form cooperatives.

Without taking into account the local circumstances such as tribal disputes, forms of land holding, types of irrigation systems, water distribution structures, and water rights which vary greatly in even within the two small regions within the Saiss basin covered by this project, it is not possible to formulate coherent responses to climate change – represented here with water shortages.

We discovered that there are adaptive responses already applied by the farmers, including temporary water markets and "rented" water – or water borrowed for a fee and then "returned."

Nearly three-quarters of all the farmers have domestic animals and chickens, which often forage freely; goats in particular are able to cope with dry environments, so many households already have some "insurance" against catastrophic climate change. In one of our pilot projects, the farmer told us that he partially insured his household's access to potable water to safeguard the health of his cows and their access to water, even if it was relatively expensive compared to well water.

We also learned that accessing the farming community to work can greatly be facilitated through the DPA Technical Centers, whose personnel are often personally known by the farmers. Introducing and implementing technologies and techniques that allow for adjustment for climate change requires the presence on the field of people who can work with the farmers, without them, it is not possible to implement an adaptive strategy and reduce the social and agricultural costs of climate change.

Recommendations

1. The state's capacities on the field need dramatic enhancement. The two most capable branches of the state were the DPA and the Interior Ministry, as represented by the local Caids – governors; the ABHS has no field presence, aside from a guard at the Bitit Spring. The state's meteorology service (DMN) does not have a system of communicating with farmers except through the media. This means that both of these agencies need to develop their farmers' service capacities and integrate their operations. In some ways, this was the purpose of including WEAP.

2. Future plans and policies designed to enhance climate change in the region must look at the growing urban water demand from Fez and Meknes; about forty percent of the water use in the Saiss basin is urban or suburban at this stage. Adapting to climate change in agriculture would be greatly helped with urban water economies.

3. Villages, cooperatives and tribes must be explicitly included in adaptive capacity building in response to climate change. An approach that relies extensively on the established bureaucracies cannot be expected to succeed.

4. The problem is not that of technology or knowledge of adaptive capacities. Some of the commercial farmers even know of and want to implement computerized irrigation. Water is wasted in the basin because farmers cannot access credit to purchase water saving systems. While some may enjoy ample land and no debts, they cannot secure credit commercially if their land was held in a non-private title such as the tribal and communal titles discussed. This problem can be addressed at the national level, and is actionable only insofar as donors and developers can provide Morocco with expertise and case studies about changing landing owning systems in an equitable way.

5. Alternatively, a special program to secure water saving systems can be implemented with an ability-to-pay criterion favoring farmers who would not normally be able to afford these systems; extrapolating from the expenses of the two pilot projects (about 30000 Dirhams each), equipping each farmer (8000) with a drip irrigation system in the whole Saiss basin would cost about 30 million USD, not accounting for program administration and inevitable inefficiencies.

4.8. Conclusion

In general, Ait 'Ayyach in Ain Chegag invest their energy in maintaining the partially communal form of tribal landholding, *'Arshiya,* but will not necessarily cooperate on projects that would allow them to reduce water use. Their relationship to the duly constituted state authorities is also rather positive, and the tribe as a collective entity works closely with the representatives of the Ministry of Interior and the DPA. The relative lack of a field presence

by the ABHS makes the organization appear distant and unreachable by the local farmers in Ain Cheggag – and that problem is common to El Hajeb as well. In fact, we can say that a notable number of the local farmers do not know of the agency and its role in water management.

It appears that a leading factor determining cooperation between farmers in the region is the form of the private property title -- the *joumo'a (communal), 'arshiya (male line tribal)* and *mulkiya (private)* forms of land holding. Both regions in our study are deeply influenced by tribal loyalties, but tribal identity operates in the realm of agriculture and real estate differently in each area, and the relationship to official organs such as the ABHS and DPA is very different. The implications of these differences have been elaborated in the earlier section. At present, those with private property titles are better able to adjust to climate change and decreased water resource availability compared to those with communal or traditional tribal title. There are also deep gender implications; in this particular case, private property titles appear to be emancipatory for women in farming households; under other forms of landholding, they cannot inherit land and are barred from holding it in their lifetimes.

Upstream following the Bitit canal, we can find the Ait Oualal tribe in the El Hajeb region. Given the private and non-communal form of landholding in the area, the area includes farmers who are not members of the tribe, but who are integrated into the local community and economy on an equal basis. There is a stronger tradition of cooperation between the farmers and we are working with the Zoubiya Association in the region, whose coordinator is originally from outside the region. We are currently in the process of administering the KAP survey in the region, and through the data gathering process, we have come to appreciate the very different nature of the relationship between the state, including the DPA, and the local population, because the level of cooperation with the duly constituted authorities, of all kinds, is noticeably lower. This suggests that working through the bureaucracies can be more productive in Ain Cheggag but perhaps notably less so in El Hajeb. On the other hand, it may be more effective to pursue direct-to-farmer strategies in the El Hajeb region. Disseminating information about water-conserving strategies will probably have to be conducted in a manner that directly connects the farmers to a non-state actor, preferably another farmer.

We noted that the state has become increasingly aware of the issue of gender and development. The main problem with the region of Aïn Cheggag is that land tenure there is tribal, and the local Aït Ayyach tribe's rules preclude daughters from inheriting land. The tribal title cannot be used for regular commercial loans to purchase drip irrigation systems, so there is an urgent need to negotiate away the rigidities of the exclusion of women and revise the nature of the tribal holding to allow it to be used as collateral. Given local identities, this cannot take place without negotiation and persuasion. The Governor indicated that the state has begun a program to address this issue legally and that his office is dealing with the issue of women's inheritance About 42 percent of the land is under private title, meaning that other forms of holding dominate in the region, including about 38 percent which are under tribal title. A third of the farmers in the region live in the Aït Ayyach area of Ain Chegag, suggesting.

The complexities of the region are simply not available in the literature and the problems posed by Climate Change and Water Resources Depletion cannot be addressed without the cooperation of all the stakeholders in the region. The alternative is non-cooperative behavior and that will certainly lead to the destruction of the local farming communities. There is a strong relationship between climate change and social conflict around the Bitit Canal. In this

particular case, it takes the form of lawsuits and dry years are characterized by litigation between the two main tribes. With unusually heavy rains last year, a natural spring called Agamgam came back to life and provided 260 liters per second of water. This water follows a natural stream downwards to Ain Chegag that parallels the Canal. With the unexpected dose of additional water, the farmers set their lawsuits aside and increased their farming activities. Unfortunately, the Agamgam was outside the purview of this project, but we did visit the spring and we were able to confirm the information about the reduction in legal conflict and the induction of additional lands into farming by tribes that do not normally farm and rely on herding; these were outside the two areas under study.

Water User Associations

Water use in the Canal area is co-governed by six water users associations, five serving the upstream tribe, Ait Oualal and one serving the downstream Ait Ayyach tribe in the Ain Chegag area. There are also five groups that use the Canal without the benefit of organizing in Water Users Associations. We have interviewed the presidents of some of these associations and while there have been improvements as a result of their creation; they have failed to integrate into a Water Users Association confederation due to differences on water shares and confederation membership dues.

While the WUAs have the responsibility of maintaining the Canal, inspections reveal that it is damaged and in urgent need of repair in many locations. We inspected the Canal and found obvious evidence of damage – whether intentional or not. Consequently, repairing the Canal and resolving the tribally-tinged conflict between the various WUAs is an essential part of the management of the resources of the Saiss basin and adaption to climate change.

The failure of the WUAs associated with the Canal to confederate suggests difficulties in implementing participatory forms of water demand management (WDM), as a response to climate change, in the region without the development of conflict resolution and water sharing mechanisms that reduce the litigation levels. To that end, the two pilot projects offer us hope that reducing water consumption by moving away from inundation methods towards drip irrigation may held with this problem as well.

The primary problem facing a realistic climate change adaptation policy in the region is the form of landholding, which includes many people with tribal title. Those with private title can use it to access credit for drip irrigation. They can also form cooperatives more easily than those with tribal titles due in part to the disassociation of power from land within the tribal structure. There is a fallback crop, tobacco, which creates and opens up more problems socially, so it is not a viable option on the long run. Future research should look into ways with which drip irrigation can be introduced into region so that it is within reach of all the farmers. Such a project should look at enhancing the capacity of the ABHS and the DMN to operate on the field in conjunction with the DPA and when appropriate, the Ministry of Interior.

5. Project Outputs

KAP Survey

Through interacting with farmers, we gained their trust in sharing with us their concerns regarding water management. This study was for some the first research being conducted in the field directly with the local people.

Action Research (Pilot Project)

The implementation of the two pilot projects in the Saïss basin was extremely important because we could, as a research team, made sure that there will be one farmer in each region who will be open and ready to disseminate information regarding the benefits of drip irrigation after the project is over.

Capacity Building

The idea of the training and capacity building center was really appreciated by the local authorities, the DPAs, the Technical Centers, as well as the farmers since it integrates different parties at once. The main Center's projects will be developed, carried out and evaluated in a manner that includes the farmers, field experts and officials in agriculture and water management at all levels. Also, the farmers' main issue with the administrative procedures to apply for the state's subsidies has been solved through the website that we have produced for the DPA upon its request, which has all the needed forms to apply for financial aids, both from the DPA and ABHS without moving from one office to the other.

We managed to use the project as a vehicle to encourage the Ministries of Agriculture and Interior as well as the ABHS to be more open towards working with each other at least within the context of meetings and workshops.

Bitit Canal Repair

Throughout the project, we have provided farmers from the Saïss Basin and other stakeholders with information about drip irrigation, climate change and aquifer depletion. We developed a very close working relationship with the Technical Centers of the Ministry of Agriculture on the field as well as the Ministry of Interior, as represented by the Governor (Caïd) of Aïn Cheggag. Some of these networks preceded the project but they were significantly less fluid than they are now. Also, we were able to alert the farming communities of the region of the long term decline of the annual water endowment. We were also able to inform many farmers of the loans available to install drip irrigation and other water saving systems. In addition, we were able to convey to them a sense of their own importance not only in terms of food production but also in terms of their know-how and their understanding of water management issues. Some farmers did not know of the licensing regime to dig wells, so our questions within the rubric of survey sparked curiosity about the legal framework and its impact on them. Our presence on the field was generally welcome

and it had the impact of leading some of our participants to reflect on life chances and their expectations from the state.

Our forums provided a direct opportunity for the state to receive complaints and to convey policy decisions. In fact, we have also encountered the urgent need for repairs of the Bitit Canal. It is punctured in several places and its sections are often decayed. Repairing the canal would increase the water available to all communities. Its legal regime needs to be revisited, because it does not account for the traditional allocation given the Regraga, which is reflected in its infrastructure. Encouraging upstream water conservation would reduce the need for wells downstream.

At the very short term, the repair of the canal is a very important step. Repairing the canal and perhaps enclosing it could lead to an increase in the water available to all. This will require mediation between the state, RADEEM, and the three farming communities affected by the canal. It may also help if the status of OB 1940 is legally clarified, because as it stands it is an unclear piece of law. Since the 1960 constitution abolished tribalism, the legal force of an agreement between two tribes and the state is naturally unclear. It may also be wise to help in installing water saving technologies which at present farmers do not have an incentive to install. While there are some slight shifts towards commercial farming in all three communities, the land ownership rights in the three areas are different, so it is very likely that the three communities will continue to exist as economic zones regardless of the levels of inter-marriage and the arrival of new farmers from other regions of Morocco.

As a result of communication provided by the farmers to the state at our forums, the state has decided to unilaterally repair the canal and to do so unilaterally, because reaching an agreement with the two tribes proved very difficult. The decision did not reflect any change in the allotment regime.

Weather Stations

The weather stations' feasibility was highlighted during several of our previous workshops by the Technical Center' Agents in saving water in irrigation. The technicians claimed to be ready to help the farmers interpret the data generated from these stations, especially the ones who cannot read and/or write.

Geographic Information System (GIS)

With the help of the Sebou Basin Agency, we were able to generate several maps of the aquifer that helped us a lot in getting a better idea about the Saïss basin. In fact, we benefited from some existing reports and materials that SBA had provided us. Therefore, this was achieved with the Agency instead of WEAP as there was less interest in it. Illustrations of some GIS maps are given in the appendix 4 below.

Publications and Presentations

The project has led to different conference presentations and a single publication thus far. A second publication is planned to come out in April with Springer, and the information is provided below. The first publication concerned inter-communal and trans-boundary conflicts

using the Bitit Canal and the Nile as deliberately asymmetric case studies. The second publication will provide a picture of some the preliminary findings from the project, including survey results and infrastructure issues.
We have attended several conferences in which we presented our findings. These were:

1. *Presentation title*: Using Demand Side Management to Adapt to Water Scarcity and Climate Change in the Saiss Basin, presented by Dr. Ahmed Legrouri
   Conference: Advisory Board Meeting of the 7th Climate Change Adaptation in Africa, IDRC
   Location: Agadir, Morocco
   Date: May 13, 2009

2. *Presentation title*: Using Demand Side Management to Adapt to Water Scarcity and Climate Change in the Saiss Basin, presented by Dr. Abdelkrim Ouardaoui
   Conference: CCAA workshop on Integrated Climate Risk Assessment (ICRA)
   Location: Nairobi, Kenya
   Date: November 2-6, 2009

3. *Presentation title*: Using Demand Side Management to Adapt to Water Scarcity and Climate Change: Saïss Basin as a Case Study, presented by Ms. Fatima Ejekki
   Conference: CCAA workshop on gender analysis and mainstreaming
   Location: Nairobi, Kenya
   Date: January 24-30, 2010

4. *Presentation title*: Using Demand Side Management to Adapt to Water Scarcity and Climate Change in the Saiss Basin, presented by Dr. Jack Kalpakian
   Conference : Course on Capacity Development for a Better Integration of Water Demand Management in Morocco
   Location : Al Akhawayn University, Morocco
   Date : February 3-5, 2010

5. *Presentation title*: Moroccan Women's Role in Protecting the Environment, presented by Fatima Ejekki
   Conference : International Women's Day under the Theme "Women, Environment & Citizenship"
   Location : Al Akhawayn University Azrou Center for Community Development, Morocco
   Date : March 18, 2010

6. *Presentation title*: Water Resources in Morocco, presented by Dr. Ahmed Legrouri
   Conference: The Saudi and Moroccan Cultural and Scientific Week
   Location: Al Akhawayn University, Morocco
   Date: April 12-14, 2010

7. *Presentation title*: Water Demand Management to Adapt to Climate Change in the Saiss Basin, presented by Dr. Ahmed Legrouri
   Conference: Policy Outreach Workshop for the four CCAA projects in Morocco
   Location: Rabat
   Date: April 15, 2010

8. *Presentation titles*:

a. Water and Wars: The Construction of a Myth presented by Dr. Jack Kalpakian
b. Water Demand Side Management for Adaptation to Climate Change in the Saiss Basin presented by Dr. Ahmed Legrouri

Conference: International Conference on Arid Lands: Environments and Societies at Risk
Location: Al Akhawayn University, Morocco
Date: May 19-21, 2010

9. *Presentation title*: The "Green War": The Construction of A Myth by Dr. Jack Kalpakian and an article was published in the MELIA Conference book of abstracts
Conference: MELIA Conference on Integrated Water Resource Management in the Mediterranean Region: Dialogue Towards New Strategy
Location: Agadir, Morocco
Date: 19-22 June, 2011

10. *Presentation title*: Water Demand Management to Adapt to Climate Change in the Saiss Basin, presented by Fatima Ejekki & Khalid Doudou. The project's abstract was published in the NATO book of abstracts.
Conference: A NATO Training Course on Economic Sustainability and Environmental Protection in Mediterranean Countries through Clean Manufacturing Methods
Location: Huelva, Spain
Date: 3-7 October 2011

11. *Presentation title*: Using Water Demand Management to Adapt to Water Scarcity and Climate Change in the Saiss Basin, Morocco, presented by Ahmed Legrouri.
Conference: Session on Climate Change, Aridity, Drought, and Desertification in MENA Region of the International Conference on New Prospects and Challenges for Science and Education in MENA Region
Location: Marrakech
Date: 9-11 March 2012

Participation in water events

1. Green Water Credits Conference and training on WEAP by Khalid Doudou, organized by FutureWater Wageningen Netherlands and Sebou Basin Agency, Fez, Morocco, 23-25 March 2011.

2. Course on "*Water Purification and Management in Mediterranean Countries*" by Fatima Ejekki & Khalid Doudou, supported by the NATO Science for Peace & Security Program, Oviedo, Spain, 16- 20 November 2009.

3. Conference on "*The Future of Urban Water: Solutions for Livable and Resilient Cities*" by Fatima Ejekki & Khalid Doudou, hosted by the UNESCO and the International Hydrological Program, Paris, France 24-26 January 2011.

4. Summer School: "*Water Society, Space-Time Framework for Integrated Studies*," organized by the Physics School, Les Houches, France, 8-13 May 2011.

We have two chapters planned for publication in an upcoming book by Springer. The paper originally published in the conference proceedings has been greatly altered. It will be

published under a new title and under a new name. Here is information and the schedule we intend to follow, as provided by the editor:
Book Title: Integrated Water Resource Management in the Mediterranean: Dialogue towards new strategy:
The timetable for the book will be:
Draft chapters ready: 30 December 2011
Final versions: 30 January 2012
Book to be published: End of April 2012
As always, we plan to credit IDRC with supporting the project. The data gathering and entry phase took a lot longer than anticipated due to gate-keeper access issues along with difficulties in securing the correct numbers and names of the region's farming community. In addition, we had operated on some premises that should not to be applicable at all. We believed that religious channels of communication were important for sensitization, but we found that using the Ministry of Agriculture's technical centers was a great deal more expedient and effective for that purpose. But we learned this lesson at the cost of time that could have been used in writing papers. In addition, we had under-estimated the time needed peer interview and the need to create a free responsive environment for the interviews. We also tried to pursue project goals like WEAP and have prepared and distributed materials related to it, which were rejected by the main stakeholders, including those who stood to benefit most from them. Finally, we had a goal of creating a system for integrated water demand management in the basin which proved itself not only inappropriate but perhaps contradictory to the goal of participatory development. These errors led not only to learning, but also to delays in terms of deliverables. In addition, we have generated the following maps of the Saïss basin using GIS software with the help of ABHS.

To evaluate our research project, we organized a workshop in which we gathered different stakeholders, being the DPAs, ABHS, WUAs, as well as farmers to get their feedback about what our project has brought to them. We received positive feedback from all of them, especially from the farmers as they stated that they learnt more from our trainings that we had held; it was also an opportunity for the Saïss basin farmers to have a direct dialogue with the administration while asking questions about state financial aids, which seems to be a barrier for most of the farmers. More importantly, through our project, we have been trying to influence policy-making and establish collaboration between the DPAs and ABHS for the benefit of the farmers; for instance, farmers find it hard to move from one office to the other filling out forms to benefit from the state subsidies. We were able to convince the ABHS, in our previous workshops, to make all the needed forms to get different authorizations available at the Technical Centers (e.g. our training & capacity building center) to take advantage of the good relationship between farmers and TC agents on the one hand, and to make the procedures for the farmers much easier on the other. In addition, and being an intermediary between the state (DPAs) and the farmers, the creation of the Zoubia was a remarkable result, and that happened thanks to one of the workshop that its members had attended, which opened a door for to build a collective bassin, after receiving financial supported from both the ABHS and the Agricultural Development Fund after the approval of El Hajeb DPA.

Finally, we learned about our region in a way that we would not have known about at all without the project. The complexities of the region are simply not available in the literature and the problems posed by Climate Change and Water Resources Depletion cannot be addressed without the cooperation of all the stakeholders in the region. The alternative is non-cooperative behavior and that will certainly lead to the destruction of the local farming communities.

6. Project Outcomes

As far as the project outcomes are concerned, we have observed that there have been some changes at different levels. In terms of behaviors, we have noticed that farmers generally believe in what they see and hear from their peers if compared to the local authorities or even the DPA. For instance, and after installing drip irrigation in the two pilot projects and through demonstrations, they have learnt that drip irrigation is a very effective technique in saving water. So, we heard that a number of farmers have applied for the state subsidies to install drip irrigation in their land. Also, after the visit to Agadir, our farmers, especially the ones in Aïn Cheggag, learnt about the benefits of the collective work within associations, so they were discussing the possibility of working together in trying to imitate the farmers in the Souss.

In terms of attitudes, we did not know about them at the beginning until we talked to the farmers. Initially, we had an assumption that people did not care about water due to the aquifer situation presented by the ABHS to us. However, we figured out that people do care about water both at home and in the field, but the main problem is that they do not have the sufficient knowledge about using new technologies in saving water, and that was due to the lack of awareness and trainings from the Ministry of Agriculture. That is why the majority, if not all, of farmers expressed their gratitude for the workshops and activities that we held and that were very informative to them and a way to bridge the gap between the farmers and the administration. Moreover, we have created the following website http://wmcc.aui.ma/dpa-sefrou/ that has all the needed forms for the state's aids so as to make the task for the farmers much easier since some of them had given up due to the bureaucracy.

To influence people's practices in addition to the attitudes and behaviors, we thought to work with different parties (being the DPA, Caïdat, ABHS) on the water issues, including Imams as these people are considered the most influential with local communities. But, we swiftly realized that this would not work since it would have created problems with the administration, which might see their role as being decreased/ threatened.

As a university, we played a visible role in the field with farmers during this research project. Indeed and through this IDRC-DFID funding project, Al Akhawayn University was able to achieve one of its missions, both locally and regionally, in building the local capacities and contributing to the sustainable development and reduce poverty. Due to the good relationships that our University has established with different stakeholders during this project, ABHS has recently asked the research group to carry out a study on planning and management of water resources in the Valley of Tigrigra, Province of Ifrane: *Schéma d'Aménagement et de Gestion de l'Eau SAGE au niveau de la Plaine de Tigrigra, Province d'Ifrane*. Our Institution has been intrusted with the development plan of the Ifrane Commune (*Plan Communal de Developpement*) to which members of the research tean are contributing.

It is important to consider both tangible achievements (outputs) and resulting consequences (outcomes), together with derived learning. The presentation at the MELIA conference in Agadir brought the importance of testing assumptions on the field to the view of leading water-policy makers in Morocco and throughout the MENA region. Finally, our program did encourage Bitit area farmers to carry out a very important step that they had avoided out of concern for their individual autonomies – that of forming a cooperative to benefit from state

funding programs. The Zoubiya cooperative is probably the most significant outcome of this project.

This project helped us build significant capacity in the field and we have learned all that we did not know as a university and as a research team. The area contains significant tribal areas, legal conflicts and documents dating to the 19th century with a legacy of local customary law that has served to entrench gender-based relations of power. While there are significant warrants for considering certain centrally enforced approaches like applying the Moroccan constitution's gender equality provisions, attempts to do so without securing tribal support through negotiation will almost certainly fail. An identical set of problems haunts water management, which is a combination of traditional legal systems, bureaucratically enforced regulations, traditional market system and anarchy. Attempting to replace these systems with an integrated rationalized water management system may appeal to those who want to save water at all costs, but it also risks subtle resistance and self-help that can be very damaging, as was the case with the Bitit Canal. For this area in particular, participatory approaches to water management are absolutely essential. The government is the best actor in terms of addressing larger pieces of infrastructure such as the canal and perhaps the suggested recharge dams, but its role in structuring behavior would be greatly enhanced if it included the farmers in the decision making process and encouraged the transition towards technologies like drip irrigation, cisterns and water tanks.

7. Overall Assessment and Recommendations

This research benefited immensely from initial input, commentary and evaluation by Dr. David Brooks of Canada and Dr. Peter Gleick of the United States. These individuals provided us with ways to think about the problems we faced that emphasized cooperative behavior, collaboration and participatory approaches instead of technological and administrative approaches that do not take local perspectives and conditions into account.

We identified the barriers that implementing a wealth creating and environmentally technology faces in terms of implementation such as gender inheritance issue, inability to access to capital because of illiteracy. We have also shown that the solution that is identified in the social survey as the farmers favored solution to water shortages is also economically viable. We have shown that drip irrigation is identified by farmers as a favored solution, and the social KAP survey confirms this; the pilot projects confirmed the economic viability of drip irrigation. In addition, the project has identified the role of gender-based tribal laws inheritance laws play in the underdevelopment of the lower Saïss Basin in Aïn Cheggag.

We also learned the role of the Technical Center (extension agency) system is vital and cannot be replaced. Despite their expenses, these centers are an essential interface between farmers and the authorities and provide a bridge between traditional farming with science-based agriculture. It would be very hard to introduce new technologies such ICT in farming or new seeds and crops without their active participation. Relegating the question to whether the farmers stay on the land or not to the market would result in a social and environmental catastrophe in Morocco, and these Technical Centers should be funded and promoted. The project was enabled by the cooperation of Technical Centers – they are known for and trusted by the farmers.

First, we should have allocated funds for an administrative assistant. Second, we should have focused on the cooperatives earlier on. Third, the survey should have been more implemented more hastily and earlier on. We also should have included the Ministry of Agriculture as a strategic partner from the start. Fourth, the focus should have been on sustainable resource management rather than Climate Change. While Climate Change is visible and we have documented that many farmers realize that it is taking place with negative results, it is one several factors in terms of water stress and the decline of the aquifers.

Furthermore, and as a research team, we went back to the field to seek the administration and well as the farmers' feedback about the trip to Agadir and what both of these have learnt in terms of skills and knowledge. Here are some of the observations that we marked:

- This trip was an opportunity for our farmers to interact with each other in the bus. For instance, farmers from Aïn Cheggag were asking Zoubiya about how they had formed their association and what benefits has it brought to them.
- During the presentations and dialogue that our farmers had with their counterparts in Souss, a kind of fear was felt by the Saïss farmers that if they did not manage water resources in an efficient way, they might be end up like Souss one day (The Taghfirite president was addressing the Saïss farmers that they should not do the mistake that the Souss people had done before which worsened their situation in terms of water resources).

- After seeing with their eyes the way water in the Souss is managed, Bitit WUAs presidents have decided to come back to spend some days with Taghfirite and to learn more about how they succeed in their association to be able to apply this experience in Bitit.

In this regard, we have documented the success stories from the field in a video that we have produced and that can be found in an annex. In this video, both the farmers and members of the DPA expressed their gratitude to the IDRC and DFID for supporting such projects in Morocco and to the Al Akhawayn research team for their work in the field through which they have felt that there has been a large influence in changing the farmers' behaviors in terms of managing water resources, not directly from our as academic researchers, but through learning from their neighbors and DPA administrations whom they trust and respect very well.

The project is extremely valuable and it allowed us to understand the social environment in the basin and immense challenges facing the government and the communities in the region. The project could have used a curtailment of scope – focusing either on the social or technological cones of action – or a longer time span to insure that the data is properly and deeply processed.

Managing Water Demand

As argued earlier, while drip irrigation is the best technical solution to the problem of water resources depletion, it faces social and institutional hurdles in terms of its introduction in the region. Over 80 percent of the farmers in the region have identified as part of the solution to problems with water, but they cannot access it as easily as their commercial colleagues due to the lack of capital. The state is willing to offer financial support to farmers to help them install drip irrigation systems within the framework of cooperatives. The Zoubiya Cooperative which emerged as a result of the current project has been a relative success, but problems with land title, social structures and access to capital remain. Attempts by the state to form water users associations to rationalize surface water use and to reduce the pressure for well digging have been mixed. There are currently six water users associations centered on the local irrigation canal system. Unfortunately, these associations are not coordinating policy or use with each other, and as a result the canal has become an object of additional conflict rather than a resource that can be marshaled to reduce local vulnerabilities.

We have indentified the following questions as relevant to a successful adaptation strategy in the region:

- How can we extend the Zoubiya model of cooperative formation to the whole Saiss basin?
- How can we help the Water Users Associations form a federative structure in the face of difficulties caused by local identities and histories?
- How can we improve the fluidity of communication between the bureaucratic stakeholders and the farmers?
- How can we make capital more available to the holders of tribal titles who represent about 38 percent of all farmers in the region?
- How can we reinforce the role of ICT in the training centers for a better management of water resources facing changes in the climate (information from weather station, administrative forms electronically, etc)?

Managing the Risk of Climate Change

The region does not use cisterns or other rainwater harvesting systems at present. Climate change induces dramatic variation in the weather with periods of over-supply as represented by the Agamgam Spring and periods of drought inducing further well-digging. In additions, plenty of rainwater simply evaporates or disappears. There are not catchment pools and there are no groundwater recharge dams. Additionally, weather data is not used by farmers except for the largest commercial growers. In this second phase of the project we aim to introduce cisterns and rain water storage systems into the region in a small and local pilot project that uses commonly available materials and reused resources.

We dissemenated the findings through our colleagues in the Zoubiya cooperative to other famers. In addition, the dialogue with the state concerning recharge dams will be initiated to insure that the part of society that can construct such structures is aware of the demand for them. Finally, we would like to see commercial farmers who can afford to use weather stations and pooled internet based meteorological data doing so.

Improving Debate

All of our current stakeholders admit that there is a gap between the bureaucracy and the farmers in terms of communication. They credit our current project with helping reduce it, but it still remains. We have found that the academic presence or "cover" our research provides enables farmers to make their voices clearly heard to policy makers. One early result was the acceptance and implantation of a policy recommendation concerning repairs to the canal. At present, the debate on the status of non-private forms of land holding is due to be opened up. There are proposals to transform tribal and religious foundations' lands into private properties held by those who currently work on these lands. There are of course many issues to debate and discuss regarding that transition. The central issue we kept facing was the inability of farmers to access capital for drip irrigation systems due to the tribal nature of their land holding. Given the new constitution in Morocco and the upcoming dialogue on the transformation of power relationships and the status of wealth and capital in this country, we plan to provide forums and workshops that facilitate communicate between farmers and policy makers. We have evidence that these activities are crucial to improving governance in this basin.

Appendix 1. Portraits from Aïn Chegag

➢ *First Farmer[42]:*

- He lives 7 km away from Aïn Chegag.
- He has 35 hectares (ha) of land.
- This farmer is responsible for the production while his brother is taking care of the marketing aspect of crops.
- They think that there is a lack of research from INRA.
- He has traditional almonds (patient to thirst) in a surface of 12 ha. It is both Bour (rainfall) & drip-irrigated.
- Peach trees: 7-8 tons of water per day.
- Crops are exported to other Moroccan cities such as Barkane, Tangier, Tetouan, and Casablanca. Why these cities? Because of the high demand if compared to other places.
- All of their land is drip irrigated.
- They get varieties from France.
- At the beginning, they had just olives, but after buying more land, they thought to farm fruits (peach which needs more water and gives after 3 years). However, they do not have vegetables.
- They have two sondas[43].
- 70 meters he dug and found water. He has a well of 120 meters deep.
- He and his brother do not think that they have a water problem.
- They started farming in 2000. In 2002, they started peach.
- Labor: minimum 20 people temporary & 10 permanent ones. During harvest times, 20 people usually are needed and between 8 and10 people are in the packaging.
- Trees get vaccination from bees.
- Varieties are imported for different crops at different times. They learnt this from another farmer.
- For them, they think that the aquifer has gone up.
- They have a gasoline motor, which is expensive if compared to the electricity one.
- They have rabbits for personal use.
- They prefer to have women in the packaging instead of men because women are lazy, so they cannot make them work in the land.
- The social scientist talked to four women who are working in packaging of peach. They said that they work from 5 am to 6 pm. They told the social scientist that they have a lot of work during summer times even though it is temporary linked to the harvest times.

➢ *Second farmer:*

- He has a flat land with no rocks.
- He has land separated: 1.25 ha and another half ha. He has potato, wheat, tobacco, corn, olive, green pepper.
- Both land and water are his. He shares the crop with his employees. Paying employees costs him 70 DH per day.
- He switched to the production of tobacco because of water shortage. This is an indicator of adopting to CC.

[42] Farmers' names were not provided for confidentiality reasons.

43 In farmers' jargon, a sonda is a modern well and it is deeper if compared to a traditional well.

- He said that one needs 12 days to get his turn of water Seguia.
- Before adoption, he said that he needs to experiment the aloevera and see it. Then, they can form corporate purchases to sell it.

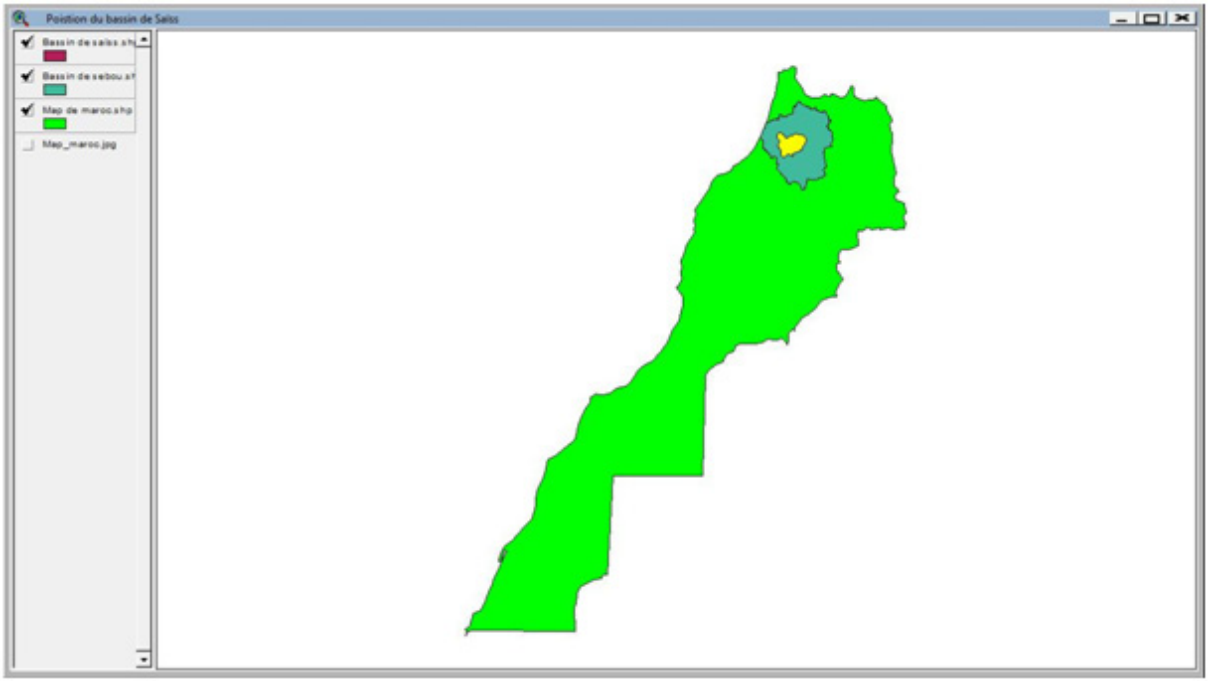
➢ ***Third farmer:***

- He is located in Ait Bouftine Karkour. He has 10 ha of land. He owns the land by heredity.
- This 10 ha is irrigated by Seguia.
- He has a well of 200 m deep which has 160 liter of water.
- His land is flat which does not have rocks. The type of soil he has is "hamri."
- His land used to be based on rainfall water for the growing of wheat.
- He sells wholesale as the harvest is weak.
- Before coming to AUI during the meeting on March 30th, he was against the idea of drip irrigation.
- He has sonda. He does not have an authorization. Generally, the ABHS provides authorizations to dig no more than 80 m.
- He has a motor to pump water from underground (bought it bonne occasion 2 millions). He has bomba integré au puit.
- He has sheep & cows. The wife is the one who supervises her husband's employees. So, her work usually starts at 4 am).
- For the moment, he cultivates merely vegetables (green and hot pepper, potato) and planning to have fruits next year.
- He has 2 women who take care of cows (came from Germany) besides a male farmer. Also, those two women take herb between trees to allow water go through.
- This farmer deals with a corporative when he gets cows.
- This farmer does not want his kids be involved in the agricultural sector. Instead, he prefers his children to go to school.
- This family used to host students from ENAM to conduct their research.
- The wife welcomes the idea of Homestay.
- According to him, the project should focus more on small farmers since the big ones already have drip-irrigation.

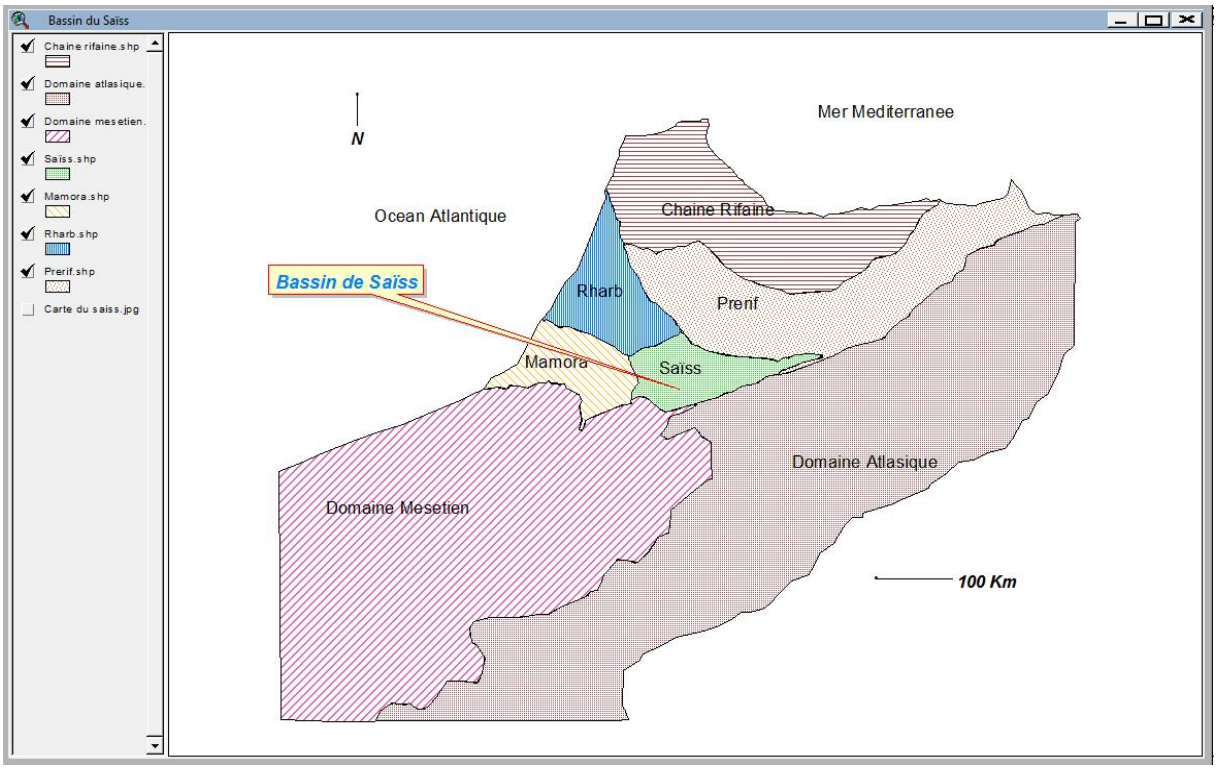
➢ ***Fourth farmer:***

- This is a woman who helps her husband who is a farmer in the field, both daytimes and at nights.
- Her tasks include fetching of water, which is usually 15 liters per day and uses the donkey.
- This woman claimed that people say that drip irrigation is a good thing since it will decrease her labor. Also, she said that Seguias are just a waste of water.
- She was aware that the aquifer will be reduced in the near future, so there should be awareness campaigns to make the people understand that.
- She thinks that the government is a key factor in protecting water resources. In this regard, she pointed out that the state should do something about making water available at home instead of traveling few kilometers to fetch it.

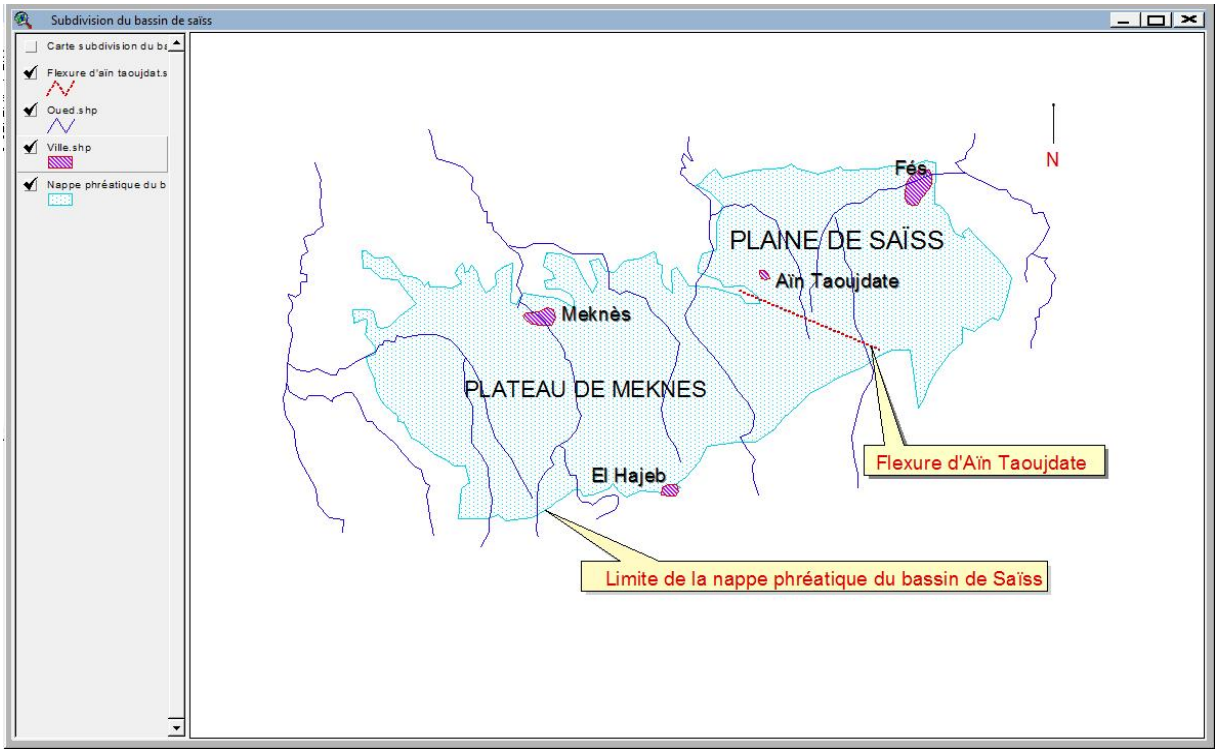
Appendix 2: Sample maps from GIS



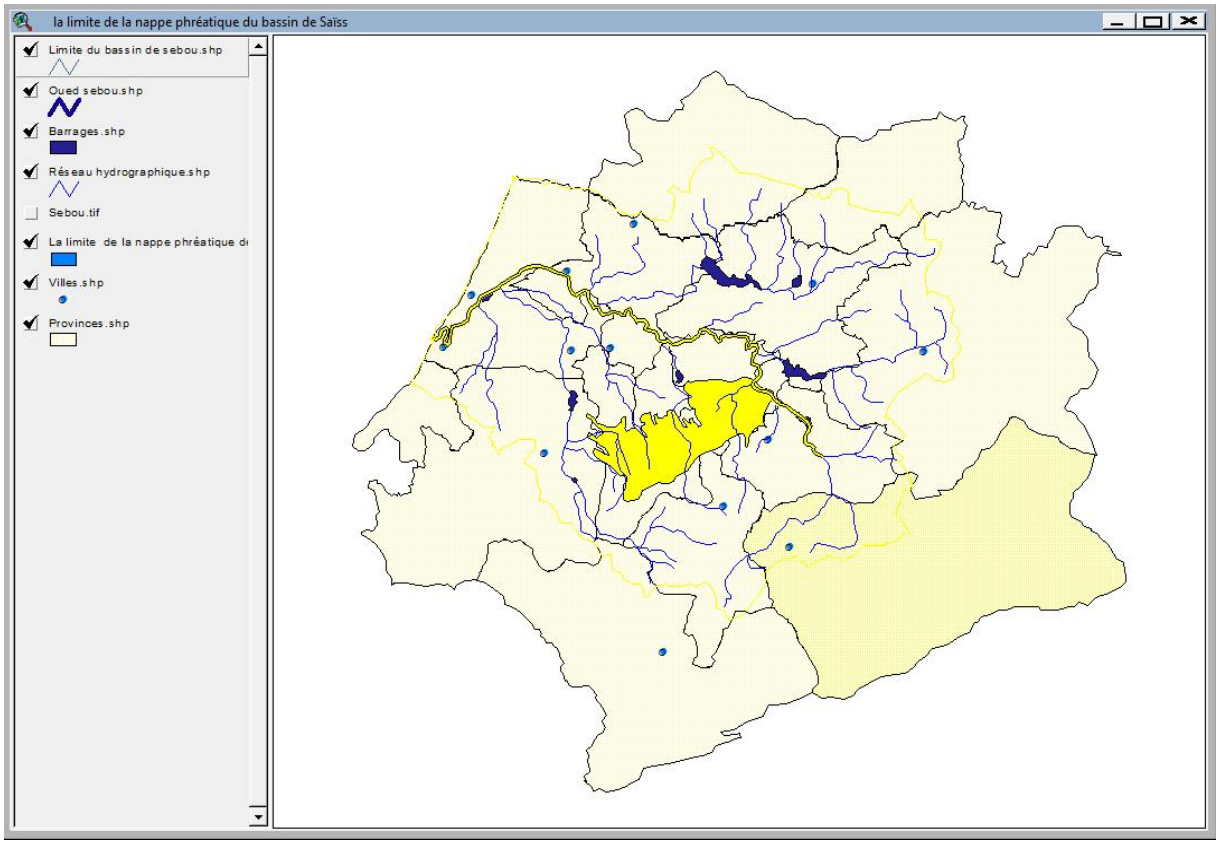
Position du bassin de Saïss au Maroc

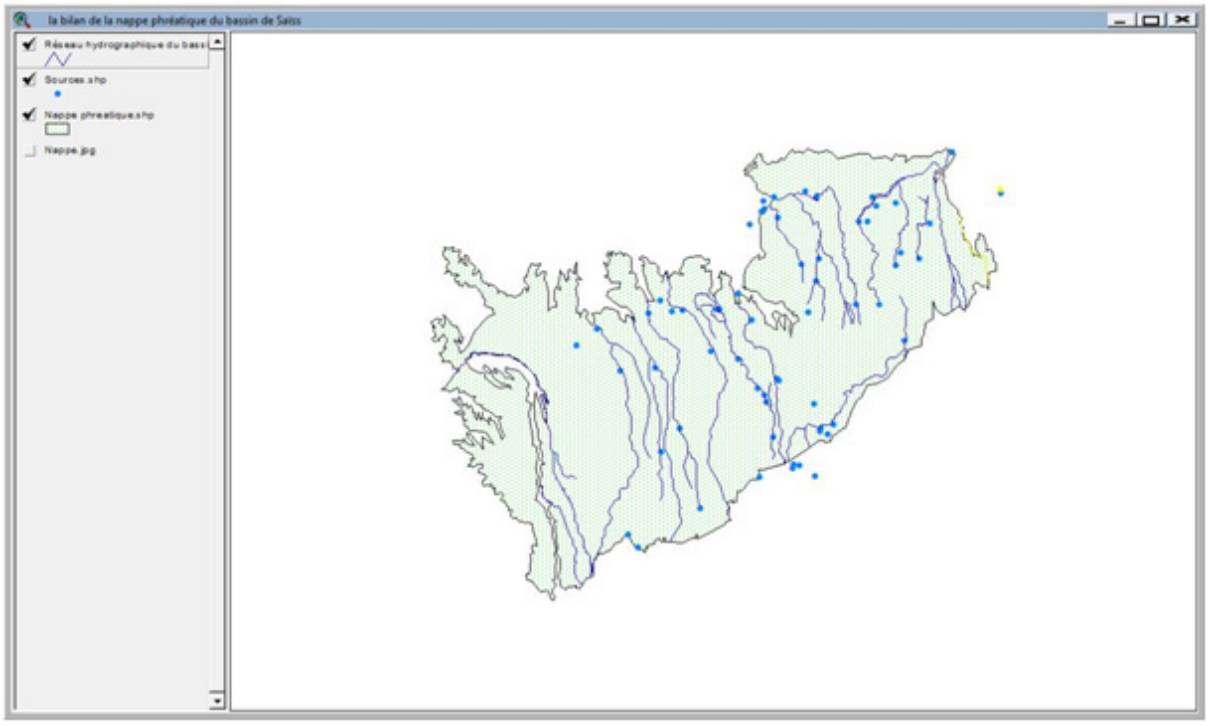


Position géographique de bassin de Saïss

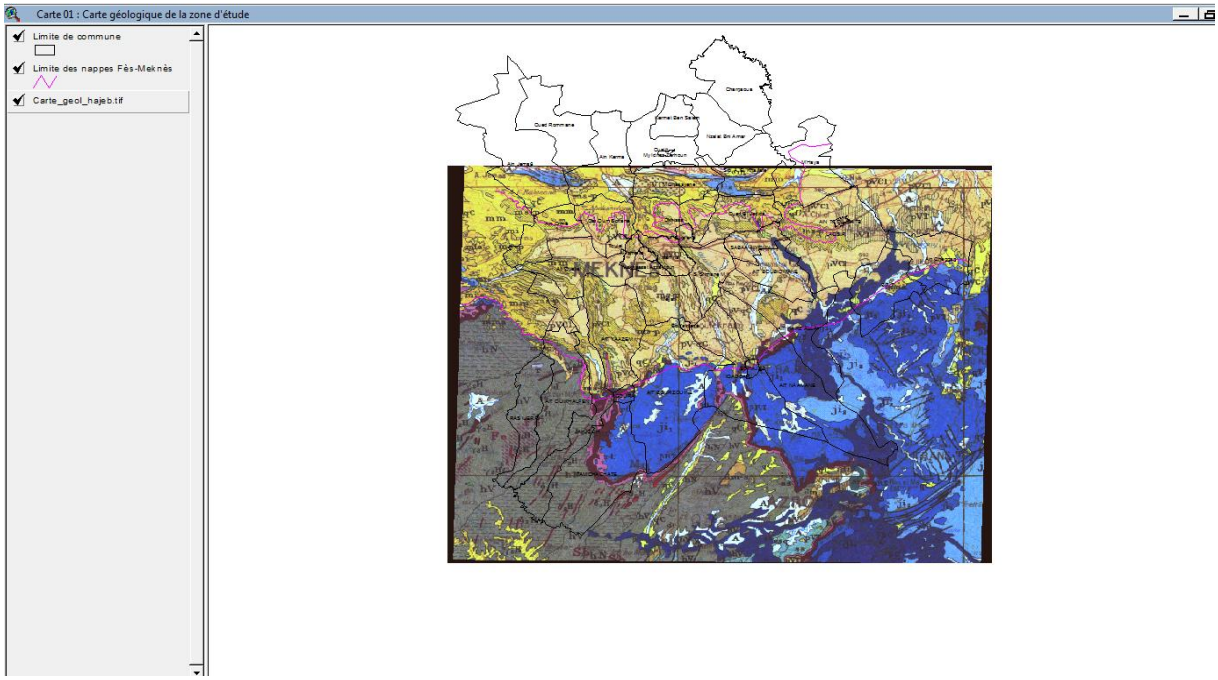


Subdivision du bassin de Saïss
La limite de la nappe phréatique du bassin de Saïss





Le bilan de la nappe phréatique du bassin de Saïss



Carte Géologique du bassin de Saïss

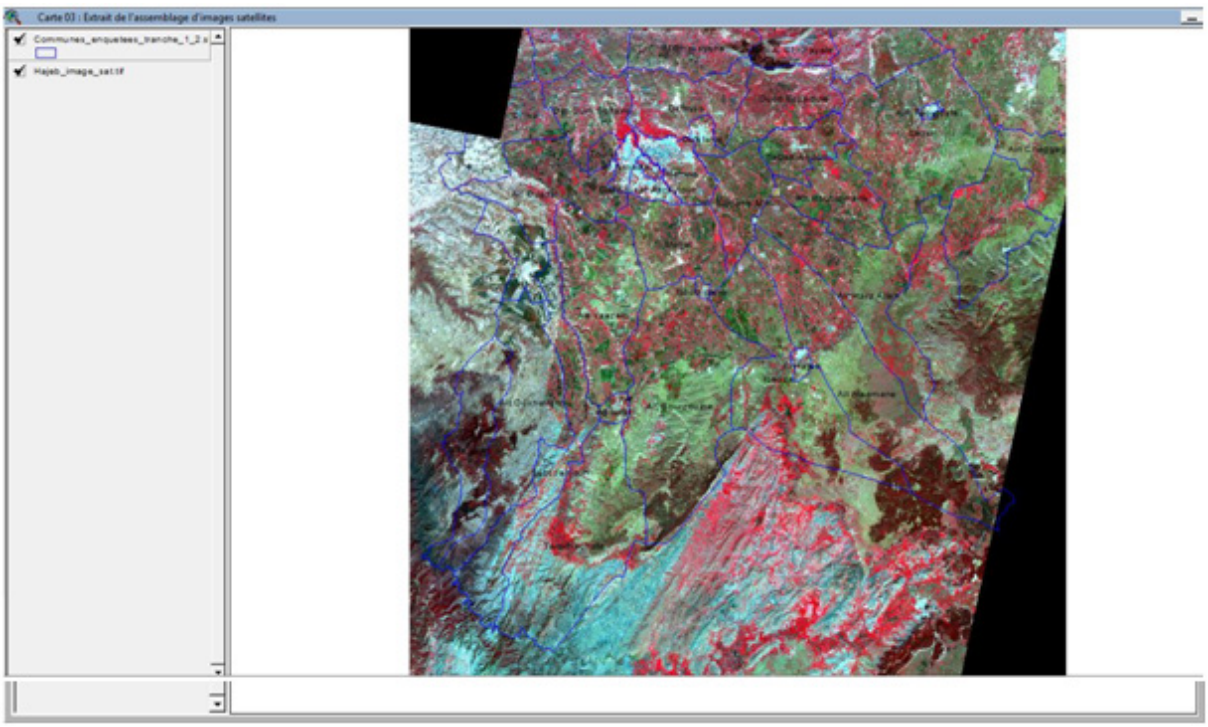
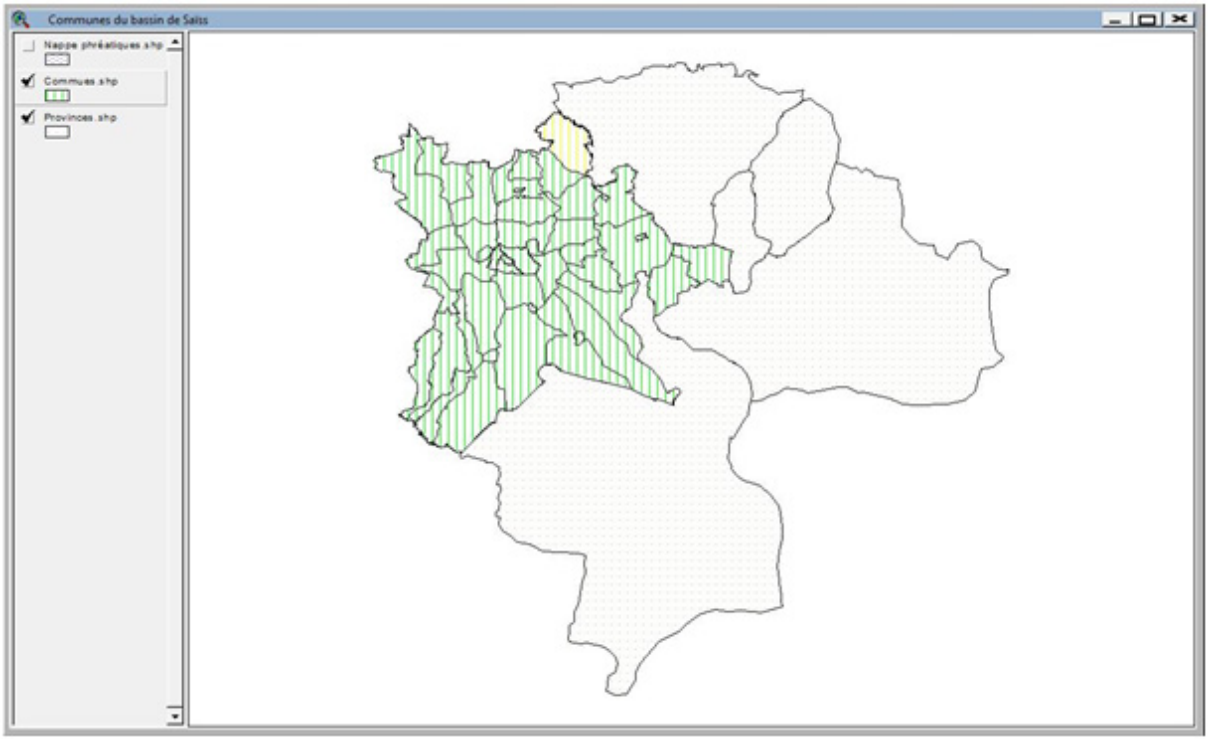
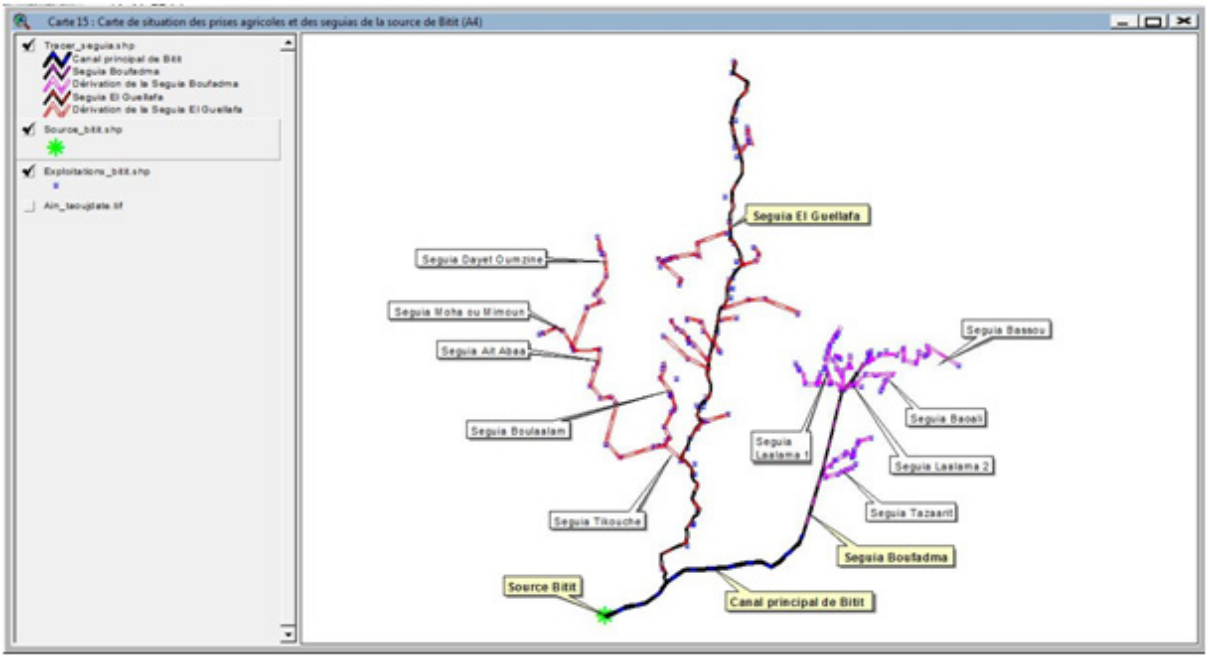


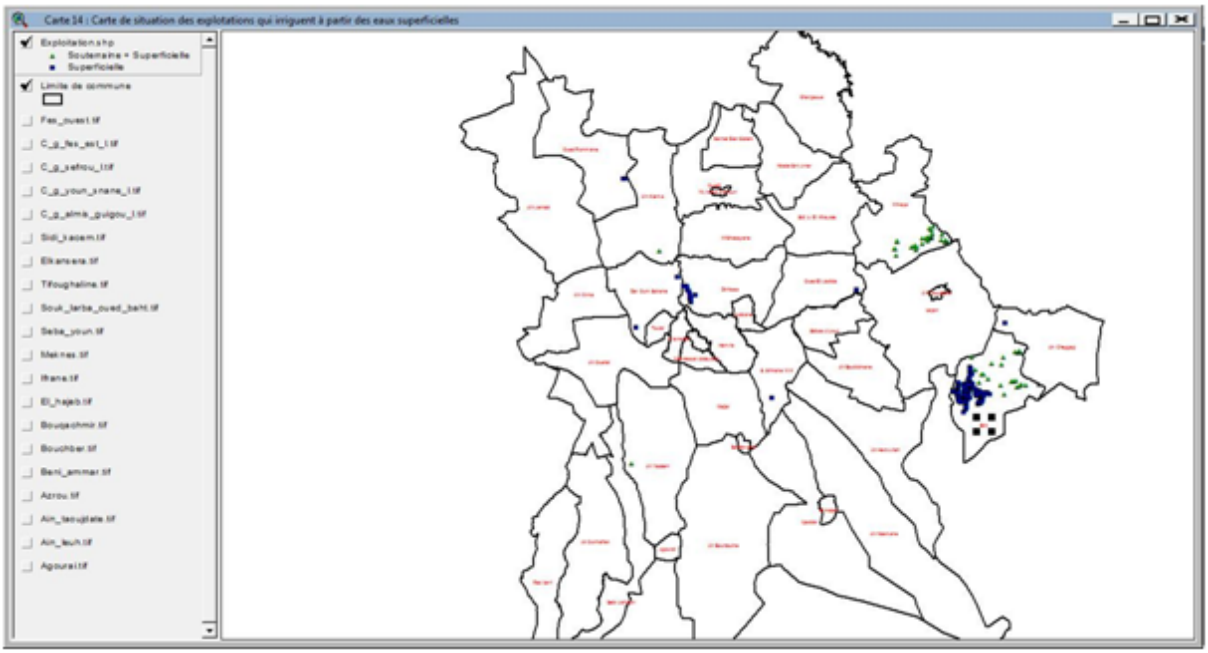
Image satellite du bassin du Saïss



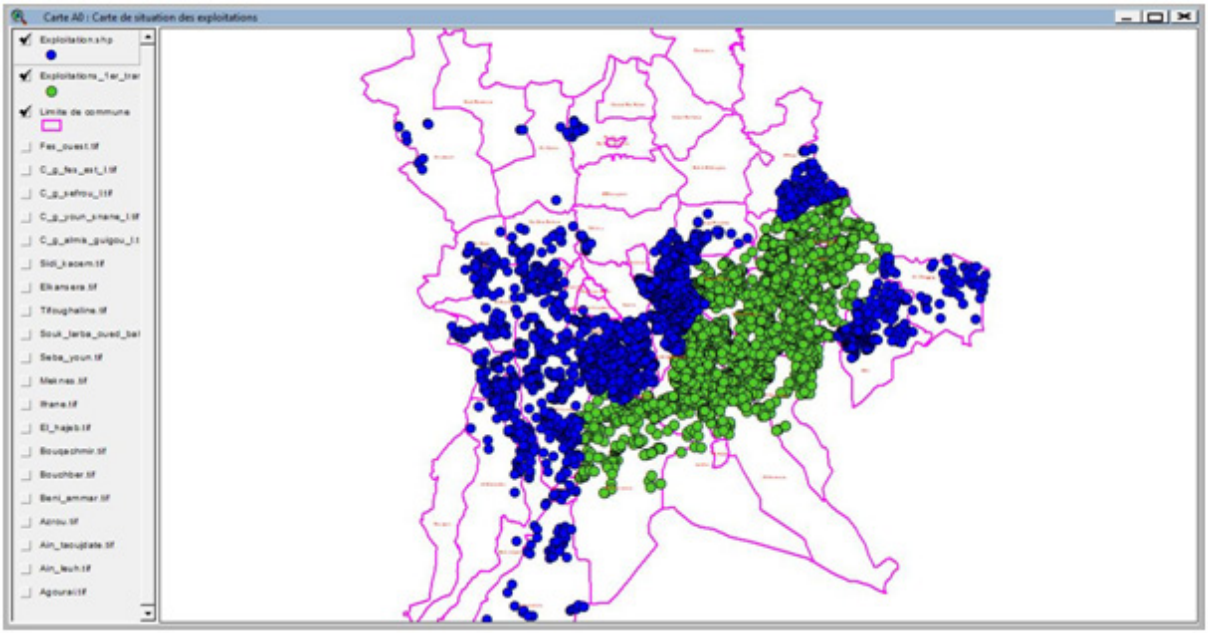
Carte des communes du bassin de Saïss



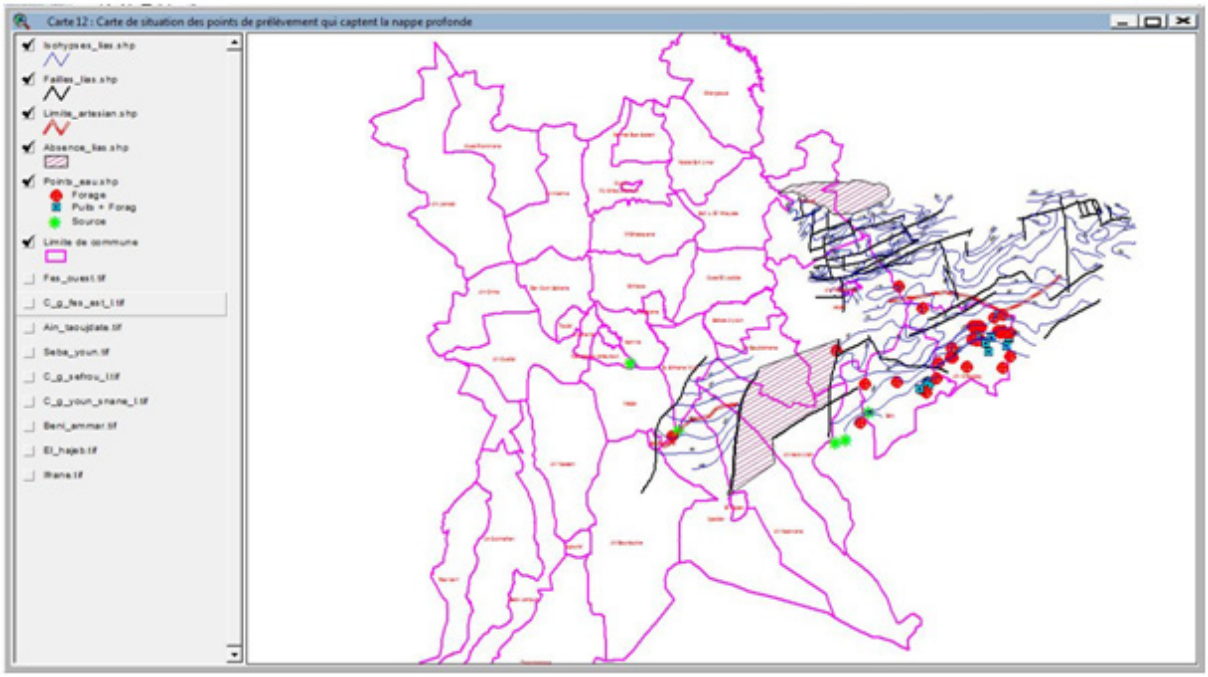
Carte de situation des prises agricoles et des seguias de la source de Bitit



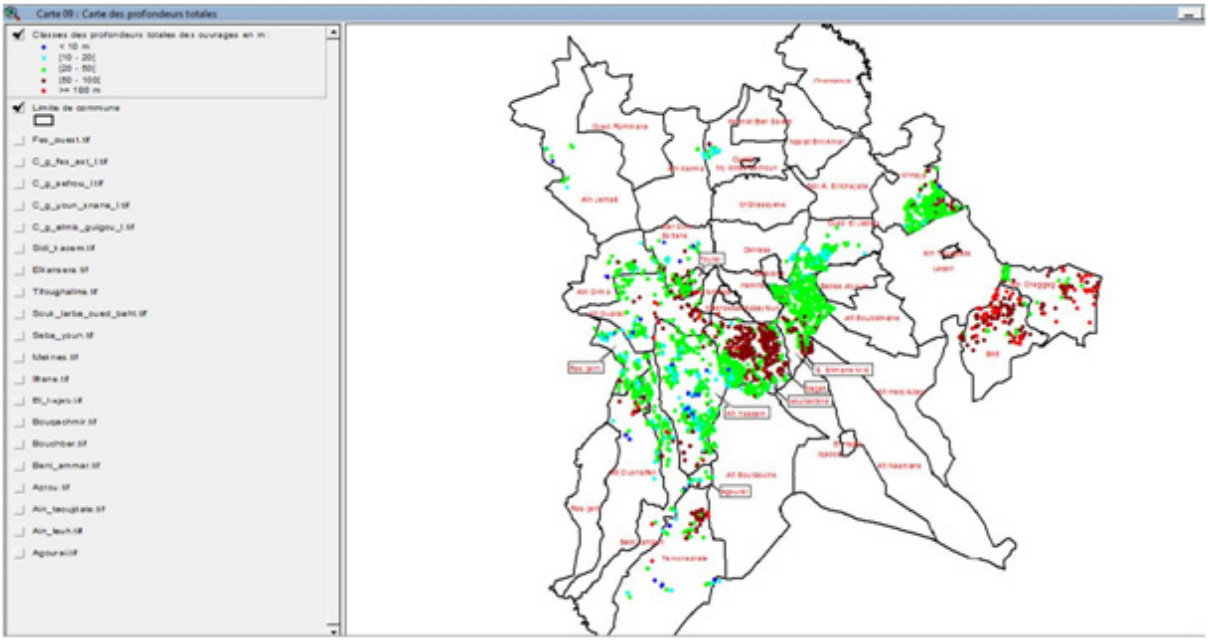
Carte de situation des exploitations qui irriguent à partir des eaux superficielles



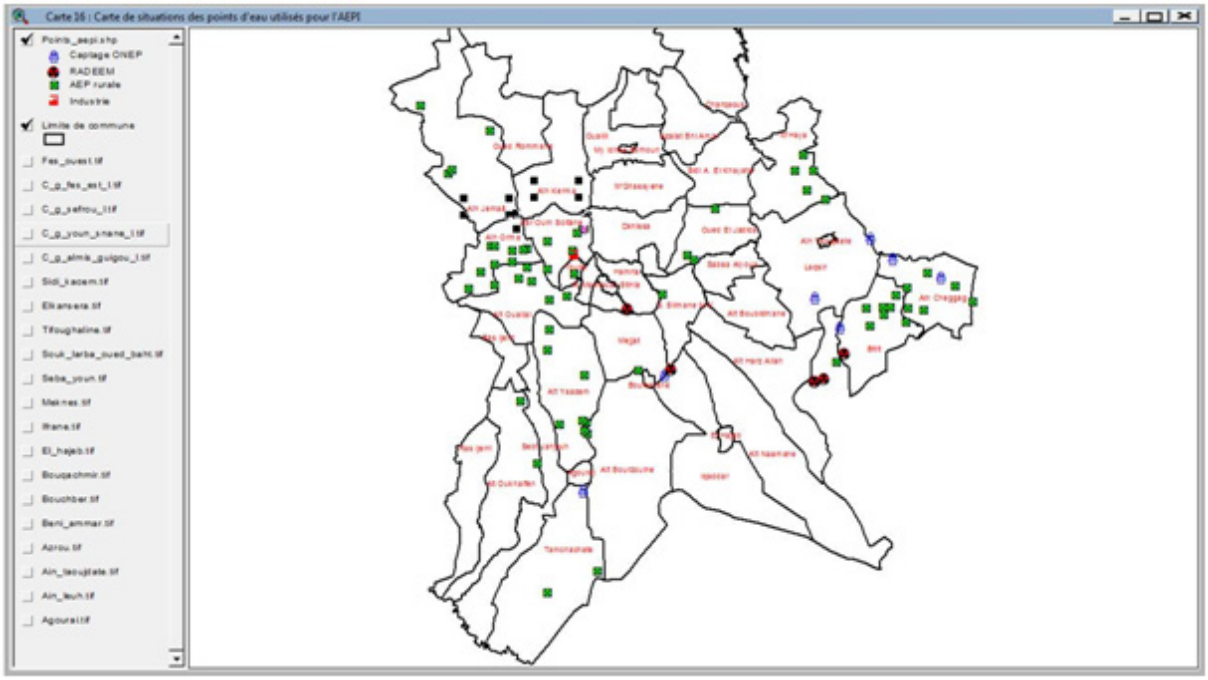
Carte de situation des exploitations



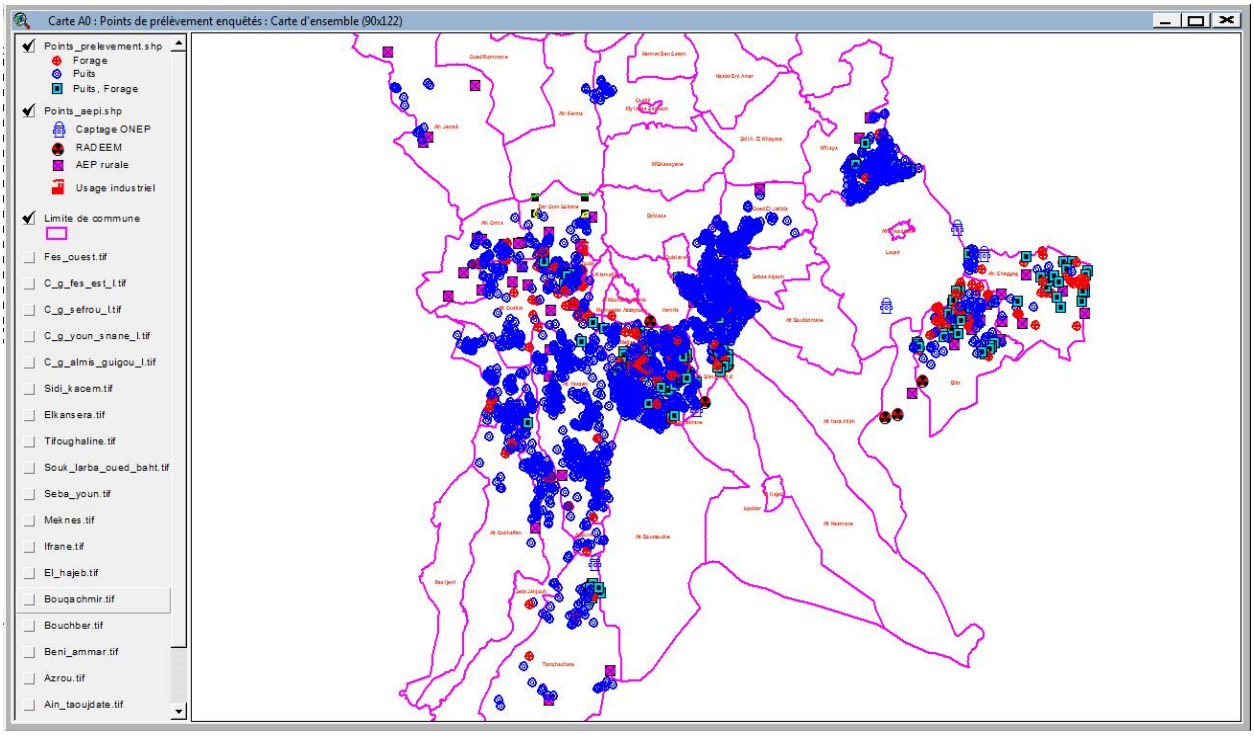
Carte de situation des points de prélèvement qui captent la nappe profonde



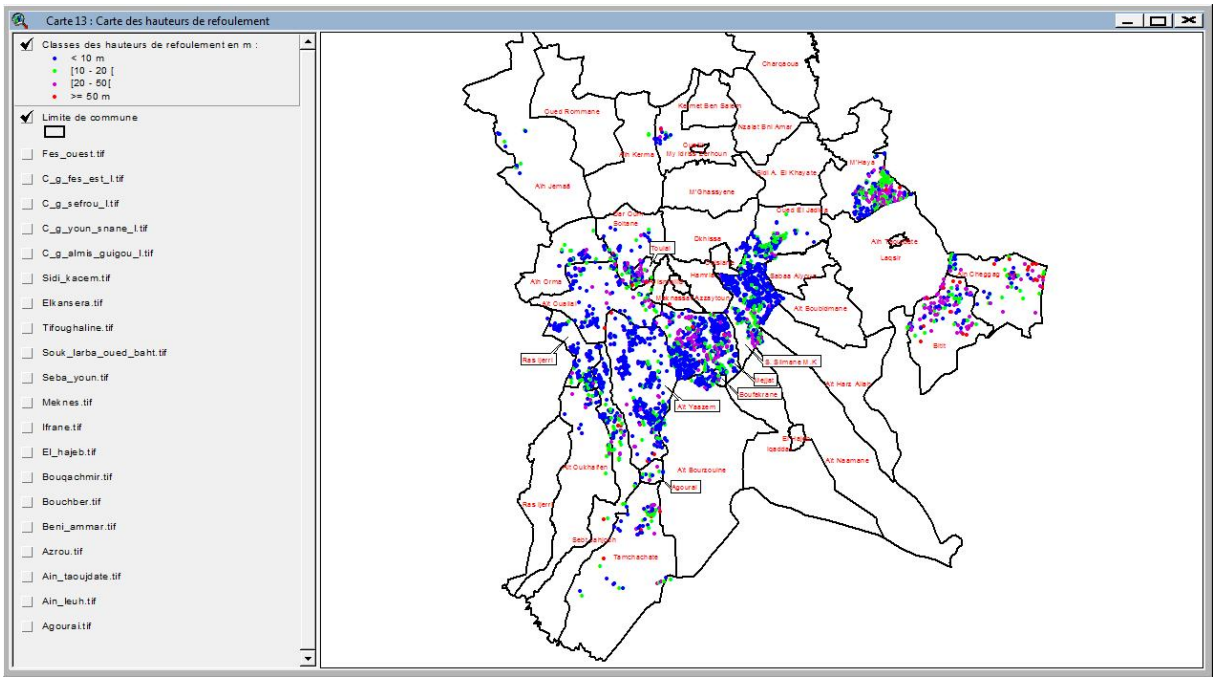
Carte des profondeurs



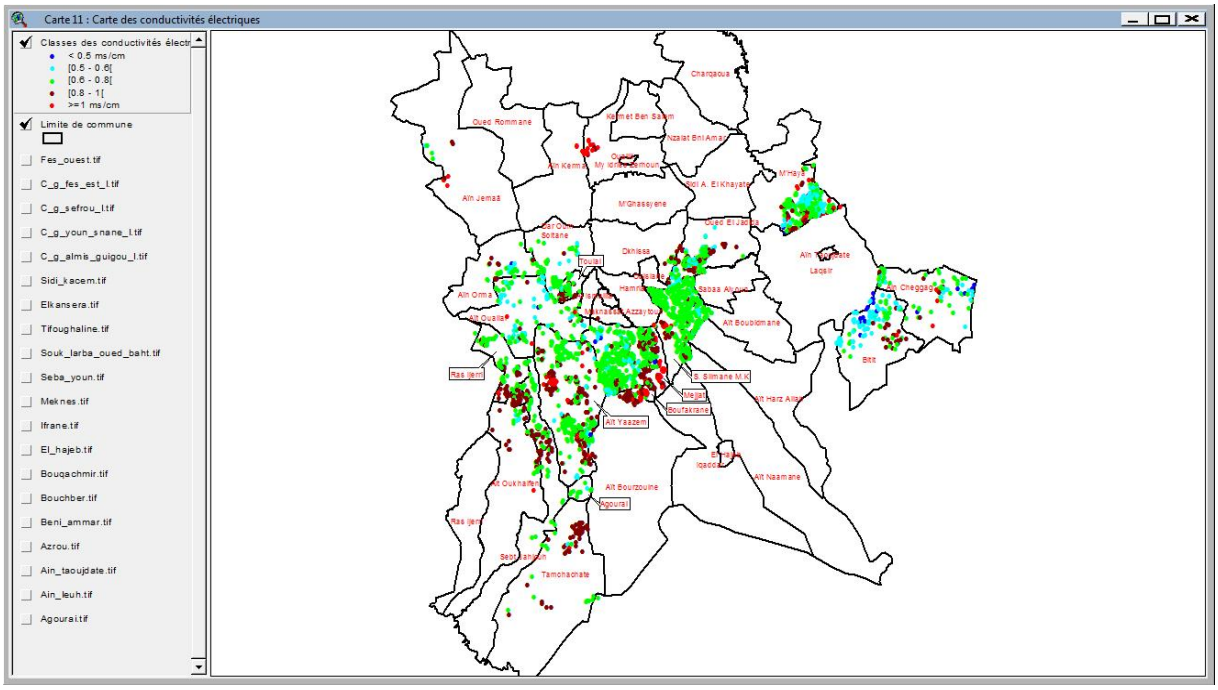
Carte de situations des points d'eau utilisés pour l'AEPI



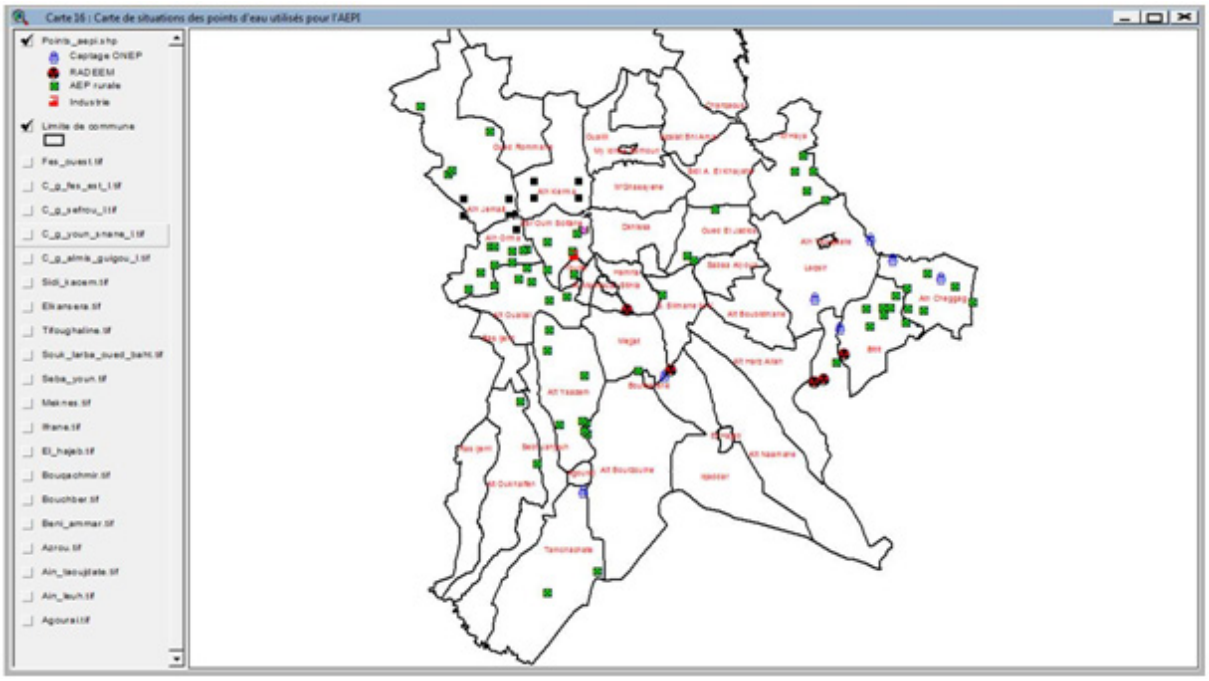
Carte des points de prélèvement d'AEPI



Carte des classes des hauteurs de refoulement en m



Carte des conductivités électriques



Carte des profondeurs de la nappe phréatique du bassin de Saïss

Supporting Documents

The following documents are available on the web:

- Abstract_NATO Huelva 2011
- AUI Morocco Presentation_NATO Huelva 2011
- CCAA Rabat Report
- Climate Change & Water Concept Note
- Climate Change, conflict & cooperation among the_Agadir MELIA Conference 19-22 June
- Data Analysis Report
- Female Farmers Instrument
- GIS Maps
- IDRC Short Report April 2011-October 2011
- IDRC Saïss Story
- Inauguration Center Media Arabic Note
- Inauguration of Training & Capacity Building Center Article
- Instrument-English
- International Women's Day_Environment
- Kick-Off Meeting Press Releases
- Kick-Off Meeting Report AR
- Kick-Off Meeting Report EN
- Kick-Off Meeting Report FR
- Male Farmers' Instrument
- Pilot Project Evaluation Report
- Pilot Project Implementation Report
- Poster_Huelva 2011
- Press-Review_WDM
- Project Note Arabic
- Project Note French
- Questions Concerning Farmers
- Report_Campaigns 10-11 February 2010
- Report_Campaigns 31March-1 April 2010
- REPORT_WDM course
- Saudi & Moroccan Cultural & Scientific Week Presentation
- Testing the Instrument
- Training & Capacity Building Center_Report
- Vision Action Partnership Exercise
- Visit to Souss_Report
- Water Presentation for CCAA for April
- WDM_Course_Article
- WEAP
- Weather Station in Aïn Cheggag
- WUA & Bitit Canal_Report
- Zoubia Report
- Stories from the Field Video
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