WAHARA - Report Series

A cross-country socio-economic comparative analysis

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WP1 Potential of water harvesting

Task: **1.4 Farm household agro-socio-economic surveys (MS2: Household survey)**

A cross-country socioeconomic comparative analysis

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List of Abbreviations

ADL	Agricultural Development Lead Industrialization
CRDA	Commissariat Régional de Développement agricole
GTP	Growth and Transformation Plan
HH	Household
IRA	Institute of Arid Regions
m	Meters
NGO	Non Governmental Organisation
NRM	Natural Resources Managements
ODS	Office de Développement du Sud
OSS	Observatoire du Sahara et du Sahel
SAP	The Structural Adjustment Plan
SLA	Sustainable Livelihood Approach
WAHARA	Water Harvesting for Rainfed Africa
WHT	Water harvesting technologies

Executive Summary

This report is prepared within the framework of Work package 1 “The potential for WH in an array of biophysical and human environmental settings in rainfed Africa” within the WAHARA project. It presents an outline of the main agro-socio-economic characteristics of the farm households of selected sites across rainfed Africa (Ethiopia, Tunisia, Burkina Faso and Zambia). The main objective of this survey was to come up with statistical and spatially based analyses of biophysical and socio-economic factors that characterize livelihood strategies, natural resources and land management practices. The contextual situation of selected sites was analysed with the objective to understand what the preconditions and limitations are for WH technology development. For all study sites included in the project, biophysical characteristics of the local environment that affect WH potential were inventoried. Stakeholder group characteristics (livelihoods, resources, farming practices) have been sampled through a farm agro-socio-economic survey among individual group members. All the above mentioned collected data have been combined to assess the local potential for WH technology development.

Results show that farm households in Ethiopia study area depend heavily on agriculture for their livelihood. More than 60% of their income is generated from agriculture which is mainly rainfed. Land, and amount and distribution of rainfall are two of the basic inputs that determine agricultural productivity and production. Land in Ethiopia is publicly owned. Farmers have a user right that authorize sale of land. They cannot accumulate or decumulate land through purchase and sale, but use rights can be inherited, rented or sharecropped for some time.

Land holdings in the area are small, approximately three quarters of a hectare to a family with average family size of five. This is small even when compared to the average land holding for Tigray as a whole which is close to one hectare per household. The small land holding coupled with deteriorating soil fertility and highly variable/erratic rainfall is a major challenge to the income of households and hence to their livelihood. For this, the regional government has since long designed and implemented conservation-based agricultural development strategies. Integrated watershed management (soil and water conservation, area closures, etc), coupled with water harvesting are the primary focuses to boost agricultural production and productivity. A wide variety of water harvesting techniques has been implemented in the Tigray region in general and in study area in particular.

WHT in the study areas was found to be important both in terms of harvesting enough water needed to meet both the domestic and the irrigation needs. A significant number of farmers in the study areas started to obtain higher yields after they adopted the technologies. According to the farmer's assessment, agricultural production has increased by about 77% after introduction of WHT. More than 90 per cent of the sample respondents confirmed that there is gradual improvement in soil

fertility and water availability as a result of the continuous work in WHT in the study area.

In the Tunisia, the study site of Oum Zessar watershed is typically an agro-pastoral interlocked area, with crop cultivation expanding rapidly in flatter areas and marginal rangelands. Desertification is an on-going phenomenon, aggravated by anthropogenic pressures, which are driven by changes in socio-economic policies and population growth. In sum, the study site has the following key biophysical and socio-economic characteristics: i) degraded dry lands ii) low rainfall iii) water scarce iv) accelerated expansion of rain-fed and irrigated agriculture for olive trees and cereals v) high demand for irrigation vi) mixed communal and private agrarian system and vii) rapid population growth and urbanization. Among other factors, these make the watershed highly vulnerable to the impacts of climate change, complicating the challenges people face, in terms of achieving balance between improving livelihoods and environmental protection.

Oum Zessar watershed has been the focus of many Natural Resources Management (NRM) interventions that started from 1980. The Structural Adjustment Plan (SAP) that started in mid 1980s tried to make a significant shift from a top down approach to NRM towards a more integrated and participatory approach, which involved a lot of partnership building. However, as mentioned by Sghaier et al. (2011) several issues constrained their success, such as i) Low or lack of intra-sectorial integration particularly in the agricultural sector as well as inter-sectorial integration with tourism, servicing and other economic sectors. This has led to inefficiency and sometimes, conflict of interest between sectors ii) Limited involvement and participation of local actors and communities leading up to weak partnerships between and amongst stakeholders (those of the State and of civil society); and iii) Low economic efficiency due to lack of cooperation and synergy between activities and sectorial interventions.

Survey results show that small farms dominate the farm count in Oum Zessar, making up 67 percent of the entire watershed. In addition, medium farms (between 10 and 20 hectare) make up more than 24 percent of the watershed's farms while farms more than 20 hectare represent only 9%. The fact that most farms are small has negative implications for mechanization and economies of scale. Further, farmland typology indicates a large variability within and between watershed compartments. 22 percent of the farmers have more than one plot, (14% have two plots, 6% have three plots and 2% have four plots). As expected, and given the arid nature of Oum Zessar watershed, the rainfed farming system has always been of crucial importance in generating much of the region's agricultural output. In fact it represents 91% of total agriculture practice in the area. The rainfed farming systems are based on the traditional and innovative water harvesting technologies. The irrigated and rangelands farming system represent respectively 5% and 4% of the total area.

To evaluate the public policies focused on NRM, households have been asked if they are satisfied from government intervention. The results showed that only 12% of the total samples are satisfied, 36% are little satisfied and more than 50% are not at all satisfied. In fact, project beneficiaries were largely in favour of the positive impacts of water harvesting techniques on ground water recharge, soil erosion control and cropping diversification. However, they were sceptical on the aspect of water yield improvement and runoff control. On the contrary, livestock breeders and irrigators tend to be negatively affected by the introduced water harvesting technique because retention of water run-off in the watershed, in turn, could negatively affect the halophytic vegetation of the Sebkhat (saline area), which is used as the main grazing area for camels during winter. The survey also revealed that overall participation in NRM conceptualization and execution is quite acceptable, around 70%. Up-stream and mid-stream farmers are more involved in NRM conceptualization and execution (figure 6). In the piedmont zones, however, the participation rate is less than 55% of the total sample. On other hand, households were asked whether or not they are member of natural resource management institutions and the reason for their involvement. More than 95% of the total sample said that are not engaged with natural resource management institution. While no one in the down-stream is member of NRM institution Moreover, results in upstream (Bénikhdeche) show more than 10% of the respondents are member of NRM institution.

Almost 100% of the respondents justified their involvement in the NRM institution in order to improve livelihood through enhancing productivity by conserving soil and water. Households were asked if they benefit from water harvesting techniques applied in their area, what type of water harvesting techniques have been implemented and who implements these techniques. The survey revealed that within the watershed gabion units are the more used technique (67%) followed by tabias and jessour (31%). The presence of recharge techniques is quite small (2%). Some difference cross location can be observed. In fact, preference given to jesours and Tabias in the upstream and midstream is higher than in the downstream. In fact, in some location checks dams represent 100% of used WHT techniques. It was clear that technologies use depend largely on plot location in the watershed. Households were also asked whether implemented WHT positively affect the crop productivity or not.

For Burkina study site, results show that the average household size is quite high compared to Tunisia and Ethiopia study site. It reaches 10.83 with a maximum of 12 household members in one household. The average age of household head for the overall simple is 55.2 with the highest being 85 years and the lowest 25 years. The illiteracy rate seems to be very high, 63.3 % of the sample size does not have any schooling, 26.66 % have some religious or traditional education, around 6% have completed primary school and only 3.33% are in the secondary school. The private tanks represent the second water source by 6.66%. The health situation seem to be better than in Tunisia and Ethiopia because the distance from the nearest public or

private health clinic or hospital does not exceed 0.8 km with a maximum of 1 km. Spending patterns of Burkina Faso study site households seems to be identical to Tunisian and Ethiopian one. Meanwhile, famers in Burkina Faso are the poorest with a total of expenditure less than 183 USA per year. The main expenditure items are food (48%) children needs (32%) and medicine (11%). Business activities contribute by 33% of total income of households. Agriculture activities keep the second rang with other incomes by 26%.

Concerning natural assets, results shows that average land holding size remains around one hectare per household (1.15 ha) and the rainfed farming system represents 100% of the total area. The main water harvesting technologies that are currently used are Zaï, half-moons, rock bunds and bouli. Bouli is a traditional water harvesting technique. It is a big hole dug in the soil that captures runoff. It has a circumference of 30 meters and a depth of 3-4 meters. These technologies are all successful in this area, although there are also constraints and challenges. The main constrains are: labour availability, lack of stones, little availability of organic matter and compost manure, lack of chemical fertilizers. The main challenges are: mechanization, using appropriate quantity of fertilizers to improve yield, sustainability, production in quantity of compost manure. According to a survey conducted in 2002, the average crop yields in Burkina study site respectively are 577 kg/ha in Somyaga and 507 kg/ha in Ziga. The first observation that can be made is that the effect of SWCT on crop yields is positive irrespectively of the village. However the scale of increase in crop yield varies depending on the type of SWCT. In 2002 zaï technique application to plots had resulted in doubling yields comparatively to plots that had no SWCT treatment in Somyaga. The same year yields on farms under zaï regime increased by 63% in Ziga.

The Zambia study site is Magoye in Mazabuka District. The area is sparsely populated and largely traditional agricultural area within Mazabuka district of Southern Province, Zambia. The population density is about 20 people per km2. The predominately rural community mostly sustain their livelihoods on smallholder farming, mainly arable and dairy farming under rain-fed conditions. Remarkably the farmers are market oriented, particularly those in the settlements. Public services (health, education, banking etc.) are to a certain extent adequate.

In terms of industrial development in the area, Mazabuka district (in which Magoye lies) hosts the largest Sugar Company in Zambia. Zambia in the last 5 years, has witnessed unprecedented maize (staple food) bumper harvest and the majority of households in Magoye are food secure nearly throughout the year

In this catchment a number of interventions have been made related to soil/water conservation, water harvesting and natural resources management efforts. Existing data on land use/land cover, hydrology, soil and natural resources management efforts have been collected. Field survey was carried out to assess the Water Harvesting Technologies (indigenous and introduced) in the study site. Moreover,

inventory of different water harvesting technologies in Zambia was made and a complete report on the watershed inventory was done and submitted. The results show the majority of the households drew water from public wells in Zambia study site (59 %). Then, the second most important source of water was a private well. The percent that indicated river as a main source was 1.3%. On the other hand 30% of participating households in water harvesting indicated that they had experienced shortage of drinking water in the last 5 years. While for non-participating households the percent was 41%.

1. Introduction

Water harvesting and irrigation development are considered critical to sustainable development and an important tool to boost rural development and sustain livelihoods in rainfed Africa. In fact, Water Harvesting (WH) presents highly adapted, flexible, easy to understand and implement, low-cost solutions to the productivity, climate adaptation and water security challenges, primarily by building water buffering capacity. WH technologies include centuries-old systems developed by local knowledge but also innovative new approaches. In order to address what the preconditions and limitations are for WH technology development, it is essential to understand the combined and context-specific effects of socio-economic, environmental and institutional factors. Indeed, the selection of optimal WH technology requires a solid understanding of the key driving forces in the area; including biophysical context, climate and land use policies and underlying factors, such as human activities, population dynamics, or economic growth that underpin the proximate causes of successful WHT implementation, such factors either operate at the local level or have an indirect impact from the national or global level. The institutional context determines whether the selected WHTs can be effectively and successfully implemented.

The methodological framework to study the potential of WH is based on:

The SLA (Sustainable Livelihood Approach) (Dearden et al., 2002) which aims to understand the factors that influence the ability of people to achieve sustainable development in a particular circumstance.

Socio-economic and biophysical survey: The questionnaire contains questions set regarding various socio economic and biophysical parameters such as household characterization size and economy, details of agricultural activities, livestock assets, soil and water conservation, agro forestry, etc. A generic questionnaire has been designed; each country adapted the model questionnaires and modules to meet their particular needs and circumstances. The questionnaire allows gathering data in the household level in order to:

- Describe the farming system
- Analyse the capita assets
- Identify and assess WHT

This document presents an outline of the main agro-socio-economic characteristics of the farm households of selected sites across rainfed Africa (Ethiopia, Tunisia, Burkina Faso and Zambia) within the WAHARA project. The household survey outcomes have been used to feed an analysis using the SLA in order to evaluate patterns and driver impacting on livelihood conditions. This results in statistical and spatially-based analyses of biophysical and socio-economic factors that characterize livelihood strategies, natural resources and land management practices. The

contextual situation of each of selected sites was analysed with the objective to know what the preconditions and limitations are for WH technology development. For all study sites included in the project, biophysical characteristics of the local environment that affect WH potential were inventoried. Specificities of the context of each study site considered (Tigray, Ethiopia, Oum Zessar, Tunisia, Yatenga, Burkina Faso and Magoye, Zambia)

2. Methodology

2.1. Questionnaire

The adopted questionnaire (see annex 2) contains questions regarding various socio economic and biophysical parameters in a modular format described below:

The farm household agro-socio-economic survey aims to characterize:

- The resource base,
- Livelihood strategies,
- Current farming practices,

The questionnaire provides the basic set of questions needed to obtain population-based estimates of a large number of indicators. The questionnaire modules are the product of a long consultative period between project partners, and the indicators estimated are largely comparable with those obtained by most other international household survey programmes.

The model questionnaire and the additional and optional modules have been designed for two reasons. First, they provide standard questions needed to estimate indicators of internationally agreed upon goals so that each country's indicators can be compared with others. These national indicators can also be compared with earlier estimated indicators. Second, the questionnaires and modules provide questions and standard methodologies that countries can use to collect data to plan and improve water harvesting technologies implementation. These questions provide data at regional level to assess household needs, advocate for new WHT, modify old ones, and collect baseline data for evaluation where WHT already exist.

Each country adapted the model questionnaire and modules to meet their particular needs and circumstances. The information in this document will help to design nationally water and soil conservation strategies. At the same time these questionnaire allows comparison of results across the study sites and allows drawing conclusions about general factors influencing the potential for WHT.

Total of five modules have been designed as follows:

A. Household Characteristics

B. Livelihood strategy

B. 1. Human Assets
B. 2. Natural Assets
B. 3. Physical assets (farm capital)
B. 4. Financial assets (farmer's income and expenditure)
B.4.1. Income
B.4.2. Expenditure
B.5. Social assets "Participation in conservation activities"

C. Farming system characteristics and Land resources
D. Water harvesting techniques
E. Natural resources assets

2.2. Sampling method

The sampling method adopted is based on the total population structure, stratified into relatively homogeneous groups and defined by the presence of different zones. Each area represents a cluster of farms that are of the same farm types. In choosing the final sample the representativeness and heterogeneity of the local population have been respected and some orientations have been followed:

a. Representativeness and heterogeneity: the interviewed sample is representative of the total sample size

b. Sample distribution: the sample size is larger than 30 (n>30) to respect the normal distribution. The sample size respects the degree of heterogeneity of the population

c. A biophysical and socio-economic zoning has been established that permits to cover the different WHT & agriculture production systems

d. Farmers and household's stratification according to the major parameters (farm size, WHT types, number of trees, number of heads of animals, etc.) have been respected.

e. The total population is defined as the entire population of the study site which benefit directly or indirectly from the public or private water harvesting unit.

f. The sample type and size for a given accuracy depends on the variability of the studied characteristics and the extent to which it is possible to eliminate the sampling error.

For example for the Tunisia case study, the total population is defined as the entire population of the Oum Zessar watershed which almost benefit directly or indirectly from the public or private water harvesting units. Administratively the study site covers from upstream to downstream three delegations (Beni khdeche, Sidi Makhlouf and Medenine North). It contains 3000 households that can be distributed over three main classes i) the beneficiaries of private and public WH unit (three sub-samples were considered in this class; Tabia, jessour and without WHT "plain") ii) the breeders and iii) irrigators (public and private irrigated perimeters)

An existing data base made within the Jeffara project, based on a survey conducted during 2002-2003, has been used as starting point. The same respondents have been interviewed within the framework of AFROMAISON and WAHARA projects where possible, and where not, a replacement sample has been used. A total of 139 households were selected as indicated in table1:

Tableau 1. Sample distribution in Oum Zessar watershed

County (Délégation)	Imadat (district)	Number of interviewed population
Bénikhdéche	Menzla	15
	Bhaïra	21
	Hmaïma	23
	Total	59
Médenine Nord	Oum ettamar ouest	5
	Oum ettamar est	7
	Koutine	21
	Total	33
Sidi Makhlouf	Sidi Makhlouf	2
	Ragouba ouest	9
	Ragouba est	2
	Gabbay	1
	Gosba	16
	Bédoui	3
	Elgrine	10
	Droj est	3
	Droj ouest	1
	Total	47
Total	Total	139

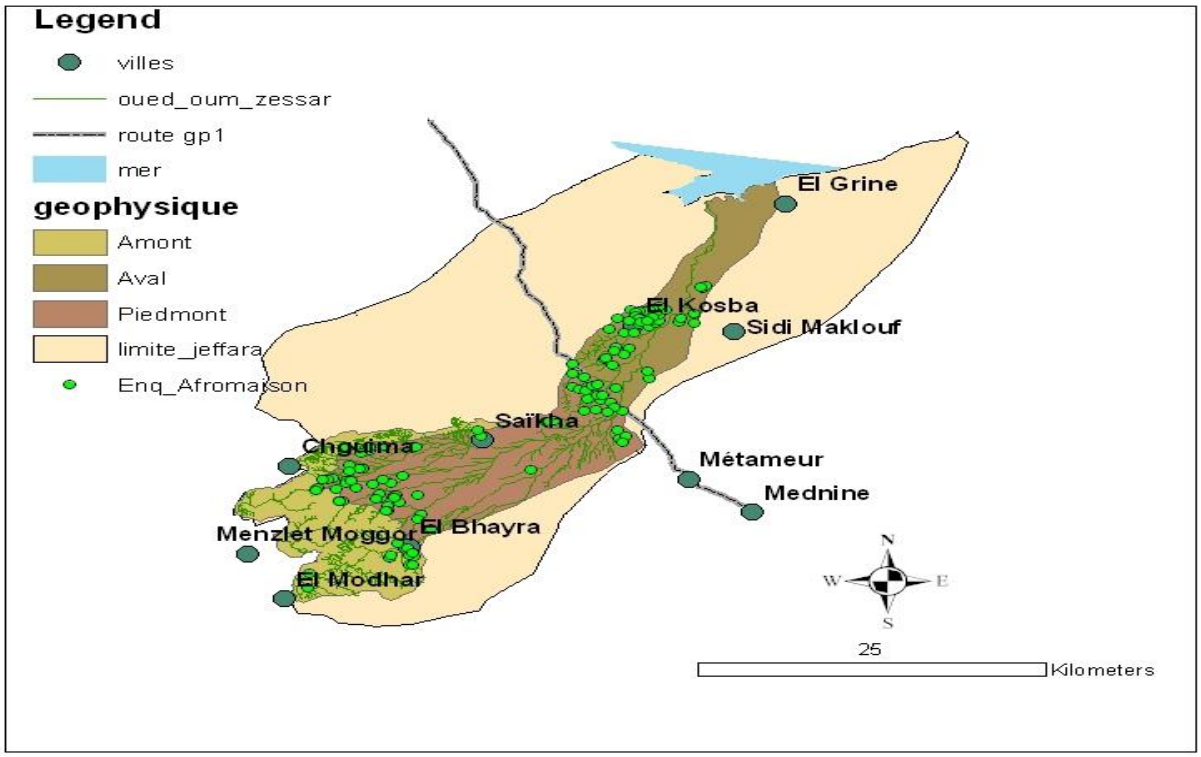

Figure 1. Interviewed population for Oum Zessar watershed

Table 2 summarize the sample characteristics and sizes by country and study site.

Tableau 2. Sampling outputs of different study sites

	Burkina	**Ethiopia**	**Zambia**	**Tunisia**
Total Population (N)	140000	236000	73000	25000
Number of households surveyed (n)	325	301	100	138
Data base format	Excel	Excel	SPSS	SPSS

2.3. Livelihood approach

The SLA approach looks into the complex range of assets and activities on which people depended for their livelihoods (Dearden et al., 2002; Karl et al., 2002; Norton and Foster, 2001). SLA is also an analytical framework that helps to understand the factors that influence the ability of people to achieve sustainable development in a particular context. The livelihood framework is based on five capital assets upon which livelihoods are built. These are natural, social, human, physical and financial capital. Indeed enhancing capital assets is a way for improving people's livelihood outcomes (Baumann, 2002).

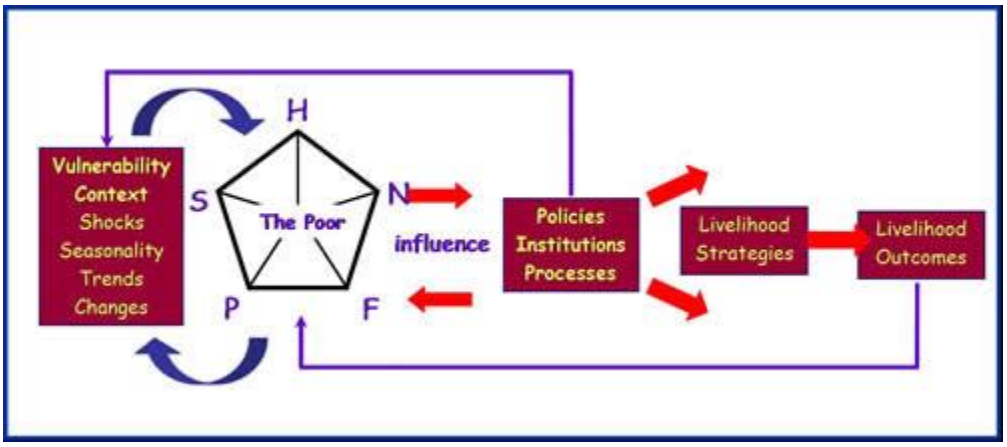

Figure 2. Sustainable Livelihoods Approach

3. Results

3.1. Comparative description of study sites

In this section, the comparative features of the study sites with respect to environmental conditions in general and the potential for agriculture production in particular are discussed (table 3). Four countries representing different rainfall conditions are considered within WAHARA project: seasonally humid in Ethiopia, sub-humid in Zambia, semi-arid in Burkina Faso and arid in Tunisia. In all 4 countries, rainfall is seasonal especially in Burkina Faso and Zambia, resulting in seasonal drought. Whereas the rainy season in Burkina Faso falls in the hot summer period, the scarce rains in Tunisia fall mostly in the cool winter period. The study sites are located in rural areas which still rely heavily on agriculture. In the poor developing countries Burkina Faso and Ethiopia more than 80 % of the population is still rural; in Zambia this figure is slightly lower at 64%, whereas in Tunisia this has now declined to 34 %. The agricultural sector in these countries is the largest water consuming sector, with 94, 86, 82 and 76 % of total water withdrawal in Ethiopia, Burkina Faso, Tunisia and Zambia respectively (FAO Aquastat, 2009)

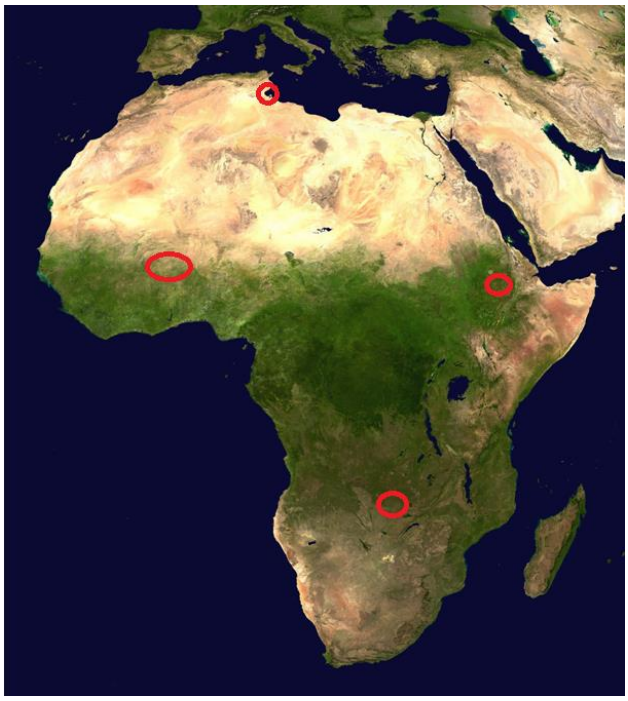

Figure 3. WAHARA study sites (to be modified)

3.1.1. Ethiopia study site

The study site is found in the Tekeze river basin in the Eastern zone Tigray. It concerns particularly the highlands watersheds of Suluh, Agulae and Genfel jointly, coveing an area of 2400 km^2 where around 236000 people are living primarily from farming activities. The climate is semi-arid to sub humid with average annual rainfall ranging between 550 and 800 mm. The farming system is based mainly on rainfed and irrigation cropping and livestock. The main crops are barley, maize, broccoli, etc. A large variety of indigenous (armo, spate diversion, ponds, terraces, trench bunds, etc.) and introduced (gabion check dams, dams, concrete diversion dams, etc.) water harvesting and soil conservation technologies are practiced. In addition to the farmers and the Mekelle University, the main stakeholders include, farmers local leaders, community organizations, development agencies (agriculture), farmer organizations, NGOs, international organizations, other research and university teams, etc. Many development projects have been implemented in the region as well as research for development projects

3.1.2. Burkina Faso study site

Located in the Northwest of the country, the watersheds of Ziga and Somyaga where around 140000 people are living, covers an area of around 5000 km2. The climate is Sahelo-Sudanian with the average annual rainfall ranging between 400

and 800 mm. The farming system is a mix of agro-pastoralism and agro-forestry. The main crops are sorghum and millet which are grown on various water harvesting systems such as: zai, half moon, bunds, etc. In addition to the farmers, the main stakeholders include, farmers, political leaders, development agencies (agriculture), farmer organizations, NGOs, and other research and university teams. Many development projects well as research for development projects have been implemented in the region. The same site is also the study area of the project WHATER (which was funded in the same call as WAHARA).

3.1.3. Tunisia study site

The watershed of wadi Hallouf, covering 1200 km2, is located in south-eastern Tunisia. With an arid climate, the annual rainfall is ranging between 150 and 220 mm. Around 25000 people are living in this site. The farming system is mainly based on rainfed agriculture and livestock. Various traditional/indigenous (jessour, tabia, cisterns, terraces, etc.) and newly introduced (gabion check dams, recharge wells, etc.) are encountered. They allow mainly olive and other fruit copping as well as occasional legumes and wheat.

In addition to the farmers and Institute of Arid Regions (IRA), the main stakeholders include local authorities, development agencies (agriculture, environment), farmer organizations, NGOs, regional organizations (CRDA, ODS), etc. Many development projects have been implemented in the region as well as research for development projects.

3.1.4. Zambia study site

The study site for Golden Valley Agricultural Research Trust (GART/Zambia) is Magoye in Mazabuka District. Magoye is located about 140 km South of Lusaka (Latitude: 16.133S; Longitude: 27.633e; altitude: 1018 m). The size of Magoye catchment area is 2,281 km2.

The area is sparsely populated and largely traditional agricultural area within Mazabuka district of Southern Province, Zambia. The population density is about 20 people per km2. The predominately rural community mostly sustain their livelihoods on smallholder farming, mainly arable and dairy farming under rain-fed conditions. Remarkably the farmers are market oriented, particularly those in the settlements. Public services (health, education, banking etc.) are to a certain extent adequate.

In terms of industrial development in the area, Mazabuka district (in which Magoye lies) hosts the largest Sugar Company in Zambia. Zambia in the last 5 years, has witnessed unprecedented maize (staple food) bumper harvest and the majority of households in Magoye are food secure nearly throughout the year

In this catchment a number of interventions have been made related to soil/water conservation, water harvesting and natural resources management efforts. Existing data on land use/land cover, hydrology, soil and natural resources management efforts have been collected. Field survey was carried out to assess the Water Harvesting Technologies (indigenous and introduced) in the study site. Moreover, inventory of different water harvesting technologies in Zambia was made and a complete report on the watershed inventory was done and submitted.

Tableau 3. Overview of study sites characteristics

	Burkina	Ethiopia	Zambia	Tunisia
Area (km2)	NE – 5000	East – 2400	South – 2300	SE – 1200
Rainfall (mm)	400-800	550-800	700-800	150-220
Bioclimate	Sahelo Sudan	Semi arid	Tropical conti	Arid
Population	140000	236000	73000	25000
Farming sys	Mixed	Mixed	Agroforestry, arable farming, dairy	Mixed
WH	Zai, ados, half moon, bund, cropping methods	Armo, diversion, spate, bunds, ponds, terraces, dams, eyebrow basins, deep trenches, cropping methods	Dams, cisterns, storage structures, quarries, cropping methods	Jessour, tabia, recharge structures, cisterns
Crops	Sorghum, millet, ..	Barely, maize, brocolli	Maize, cotton, groundnuts,	Olive, cereals
Water resources	Rain, dam, aquifer	Rain, springs, water storage,	Rain, wells, streams,	Rain, aquifer
Water use	Rainfed, irrigation, drinking	Rainfed agriculture, irrigation,	rainfed, drinking, livestock	Drinking, agriculture, industry

Source: Ouessar et al (2012)

3.2. Households identification

In different study sites, farmer communities consist of heterogeneous groups of households based on their different socio-economic status (table 4).

Tableau 4. Socio-economic characteristics

Characteristic		Ethiopia	Tunisia	Burkina Faso	Zambia
Family size (number)		5.4	6.00	10.83	6
Age of HH head (number)		50	60.35	55.2	50
Sex of household head (%)	Male	70.4	99.3	66	89.6
	female	29.6	0.7	33	10.5
Education of household head (%)	Never any schooling	56	33.33	63.33	1.3
	Religious/Traditional schooling	15	15.87	26.66	2.6
	Primary school	24.6	33.33	6.66	34.2
	Secondary school	3.7	9.5	3.33	50
	College diploma	0.7	7.9	0	11.9
Occupation of household head (%)	Farming	87.0	56.3	100	92.1
	Business	1.3	14.6	0	
	Employee (public sector)	1.3	10.4	0	6.6
	Pensioner	0.7	0	0	1.3
	Unemployed	0.3	0	0	--
	Employee (private sector)	0	18.8	0	--
	Disabled and unable to work	1.0	0	0	--
	Housewife	3.0	0	0	--
	Too old to work	5.7	0	0	--

Household size represents the number of usual members in a household. Usual members are defined as those who have lived in the household for at least 6 months in the past 12 months. Several empirical studies showed a strong negative correlation between household size and consumption (or income) per person in

developing countries. Indeed people living in larger and (generally) younger households are typically poorer. The direction of causality which is the "'cause" and which is the "effect" in this correlation, still a subject of debate (Lanjouw and Ravallion, 1995).

For the Ethiopia study site the average family size of the sample is 5.4 with a maximum of 12 household members in one household (see Table Annex 1). The average family size in the three study Tabias is comparable with the highest average family size being in Genfel with an average family size of 5.7 and the lowest being in Tsaedanaele with an average family size of 5.14. It's important to highlight that out of the total sample of 301 households, 89 households (i.e. nearly 30%) of the households are headed by female and the remaining 212 (i.e. 70%) households are male headed households (see Table Annex 1). The distribution of female headed households in the three study Tabias is comparable the highest proportion female headed households being observed in Tsaedanaele followed by Genfel and finally Mesanu.

The average household size in Oum Zessar (Tunisia study site) reaches 6.0 and remains more or less the same cross compartments as showed in Table Annex 2. Thereby household's location, urban (Medenine nord) or rural (Benikhdeche and Sidi Makhlouf) don't affect the household's size.

In Zambia study site the size of the household was found to be 5 in this sample. The number is comparable to the national figure which is around 5-6 members per household (Mulenga at el. 2011).

For the Burkina study site the average household size is quite high compared to Tunisia and Ethiopia study site. It reaches 10.83 with a maximum of 12 household members in one household.

The average age of the household head in the Ethiopia study site for the overall sample is 50 years with the highest being 90 years and the lowest 19 years. The distribution of average age in the three study sites is comparable in Genfel and Mesanu but the average household head age in Tsaedanaele is slightly higher (Table Annex 1).

The average age of the household head in the Burkina study site for the overall sample is 55.2 with the highest being 85 years and the lowest 25 years. The mean age of household for Zambia study site was around 50 years.

Compared to Ethiopia, Zambia and Burkina, farmers in Oum zessar watershed are older. The average age of household head exceed 60 years. The percentage distribution of population by age group shows that Oum Zessar population is youthful (table Annex 3). Person aged 20 to 40 represent 65% of the total population, indeed persons above 60 years represent only 5% of the total population. The proportion of young people younger than 20 years constituted 30% of the total population. Population in up-stream and down-stream parts of the watershed follow the same

age distribution pattern as the total sample, whereas in mid-stream watershed (Médenine nord) the distribution pattern is significantly different. There, the proportion of young person's under 20 years represents 57% of total population, and persons aged 20 to 40 represent only 36%.

The total dependency ratio is a commonly used measure of potential social support needs. It is based on the simple notion that all persons under 15 and those 65 or older are likely to be in some sense dependent on the population in the working ages of 15-64. Those in the working ages are assumed to provide direct or indirect support to those in the dependent ages (Kinsella and Gist, 1995). The data for Oum Zessar watershed further indicates a high age dependency ratio that exceeds 50% for the total sample. This ratio reaches 400% in Sidi Makhlouf, meaning that for every 100 persons in the working age group (20–60 years), there are 400 dependent persons (table Annex 4).

As educated farmers are more able to access information on sustainable production techniques, agricultural markets and on the effective management of water resources, knowledge of the level of education of farmers is important. Information reported in table 1 concerns the highest education level attained by the head of the household in Ethiopia, Tunisia and Burkina study sites.

Table 1 shows for Ethiopia study site that most households in the sample (56% of the sample size) do not have any schooling, close to 20% have primary school incomplete (table 4 annex 1) , around 15% have some religious or traditional education, 5% have completed primary school and only less than 5% have attended secondary school and above, the highest level of education being college diploma. The distribution of education of household head by Tabia shows the same result (table Annex 4). In all the three Tabias, the dominant level of education in order of size/percentage of the sample no formal any schooling followed by primary schooling incomplete and religious/traditional education.

For the Burkina study site the illiteracy rate seems to be very high, 63 % of the sample size does not have any schooling, 27 % have some religious or traditional education, around 6% have completed primary school and only 3% have attended secondary school.

In Oum Zessar watershed 21 persons, representing 33% of the total valid sample, do not have any formal education. The results further show that 33 % (21 persons) had attended or completed primary while 2 % (6 persons) had attended or completed secondary education. Only two percent had post-secondary education to reach university level and 16 percent (10 persons) have been enrolled in Koranic (religion) school. The education level distribution between watershed compartments (table 5 annex 1) indicates that illiteracy level seem to be higher in Sidi Makhlouf then the sample average, it reaches 46% (12 persons from 26), while Bénikhdéche presents the lowest illiteracy level, 24%. Thus we can conclude that farming is no longer an attractive option for educated young people.

Compared to Tunisia, Ethiopia and Burkina Faso, education level in Zambia study site is very high. In fact, around 50 % of the total sample reached the secondary school and 12 % have a diploma.

As expected, results indicate that agriculture remained the major sector of employment in the three rural study sites.

In the Ethiopia study site, the primary occupation is farming which constitutes for close to 87% (table annex 5), followed by the head being too old to work (6%). For the remaining (less than 10 percent) households in the sample, the primary occupation includes business, employee, pensioner, unemployed, disable/unable to work and housewife. The distribution by Tabia is similar. Farming is the main occupation of households in all study Tabias. In Burkina study site 100% of the total sample practice only farming activities.

The majority of the households in Zambia study site were involved in farming related activities. In fact 92% were involved in farming related activities, 7 percent were employed, and only 1 percent relied on pension.

In Tunisia study site 56% of the total sample are primarily farmers. The results further indicate that employment in the private sector mainly in construction/ building was the second most common occupation (19%), followed by business activities (15%) and public sector (10%). The trend has remained the same when compared with the different location except for relatively high share of public sector employment in Benikhdeche reaching 8% (Table Annex 6).

3.3. Livelihood strategies

3.3.1. Physical assets

Access to services such as safe drinking water, transportation, health facilities, energy consumption etc are not only direct indicators of welfare of society but also play a tremendous role in enhancing productivity.

- **Access to drinking water**

The survey collected information on the household's main source of water for drinking. Several principal types of water sources exist including private wells, public sources and public wells, etc.

Table 5 presents the source of drinking water for Ethiopia, Tunisia, Burkina Faso and Zambia reported by the respondents. The most important sources for the sample as a whole are: public sources which constitute 48%, 72 % , 87 % and 59 % respectively for Ethiopia, Tunisia, Burkina Faso and Zambia study sites..

Tableau 5. Source of drinking water

Source of drinking water	Ethiopia		Tunisia		Burkina Faso		Zambia	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Private source	10	3.3	9	6.5	2	6.66		39.5
Public source	145	48	99	71.7	26	86.66		59.2
Private well	4	1.3	27	19.5	0	0		
Public well	50	16.6	0	0	0	0		
Tanker	5	1.7	3	2.1	0	0		
River	74	24.6	0	0	0	0		1.3
Other	13	4.3	0	0	2	6.66		
Total	301	100%	138	100	30	100		100

For the Ethiopia case study public sources of drinking water are followed by rivers constituting close to 25% and public wells contributing for nearly 17%. However, the distribution is different when it comes to the Tabia level (Table Annex 7). Unlike households in Genfel and Mesanu, households in Tsaedanaele do not get their drinking water from rivers. This could be mainly due to the absence of a river close to the Tabia. In Tabias Genfel and Mesanu on the other hand, there are rivers close to the Tabias called Genfel and Agulae respectively that are used for both irrigation and drinking. Thus, rivers serve as source of drinking water for close to 24% and 50% of the sample in Tabias Genfle and Mesanu respectively. Access to drinking water is measured not only by availability but also by the amount of travel time it takes to fetch water or distance to reach to the water point and whether or not the water is safe for drinking. Survey results indicate that most households (close to 84%) in the sample perceive the water they use for drinking is safe and only 16% said it is not safe for drinking. Survey results further indicate that households in the sample travel on average 1.45 km to fetch water. The distance slightly varies from Tabia to Tabia. Households in Mesanu area travel relatively the longest distance, i.e., 1.8 km followed by households in Genfel (1.3 km) and the shortest average distance is observed in Tabia Tsaedanaele (1.2 km). The burden of fetching water as is true in most developing countries heavily lies on women. The table below (Table 6) summarizes the response of sample households to the question of 'who is responsible for fetching water? The table result clearly indicates that it is adult females followed by female children who are responsible for fetching water in the study area.

For Tunisia case study results show that 72 percent of households had access to water drinking from a public source (SONEDE and GDA). The National Water Distribution Utility, SONEDE (Société Nationale d'Exploitation et de Distribution des Eaux), mission is to supply all the country with potable water. The main activities are; Water production: (production, treatment and transport) , Water distribution (management and maintenance of drinking water network and equipment and management of customers) , Development (studies, works and supply). The Agricultural Development Cooperatives (GDA) is an integral part of the Water Sector Investment Programme that provides blue water for rural population and green water for agriculture sector. The second water sources are respectively private well (majel) and private tanks (fesgya) by 18% and 20% respectively. For the Burkina case study, public source represents 87%, while private tanks represent the second water source by 6.66%.

The results show the majority of the households drew water from public wells in Zambia study site (59 %). Then, the second most important source of water was a private well. The

percent that indicated river as a main source was 1.3%. The mean distance in km from the source of water was at 0.49 km. Specifically the means distances for each water source (private, public and river) were 0.32, 0.66 and 0.5 km respectively. Results show also that the both adults and children were mostly involved in fetching water. Drinking water shortage was also another issue that was assessed. Results show that 30% of participating households in water harvesting indicated that they had experienced shortage of drinking water in the last 5 years. While for non-participating households the percent was 41%. This means that there were relative terms there were more non-participating households that experienced water shortage. The majority of the households that experienced water shortage indicated that the problem was caused by natural causes such as low rainfall.

- **Energy source**

The main energy source (table 6) for cooking in Ethiopia study site is cow dung (52%) followed by firewood (41%). The other sources of energy for cooking in order of importance include charcoal (6%) and kerosene (2%). The distribution of energy sources at Tabia level also follows the same pattern (Table Annex 8). In all Tabias, the primary source of energy for cooking is cow dung followed by firewood. Kerosene as a source of energy for cooking, however, is used in Tsaedanaele Tabia only.

For the Tunisia case study the main energy source of cooking is charcoal (68%) followed by kerosene (32%). Cow dung and firewood are not used as energy sources, indicating the favourable living condition of Tunisian rural households compared with Ethiopian households.

Most of the households in Zambia study site used firewood as the main source of energy for their homes. In fact about 97 percent participating households use firewood. Only about 3 percent households using electricity.

Tableau 6. Energy source by study site

Source of energy	**Ethiopia**		**Tunisia**		**Zambia**	
	Freq	%	Freq	%	Freq	%
Firewood	123	41.2	0	0	--	97.4
Charcoal	17	5.7	89	68.4	--	--
Kerosene	6	2.0	41	31.6	--	--
Cow dung	153	51.1	0	0	--	--

3.3.2. Human assets

- **Access to health care**

Access to health is another indicator of welfare and also part of the Millennium Development Goals which developing countries in Africa have committed to achieve.

In the Ethiopia case study, although it is difficult to measure access to health, respondents were asked about type of health facilities they visit when sick and how far they live from the nearest clinic and health center. Survey results indicate that almost all respondents in the sample (more than 98%) said they visit government clinics or hospitals for their treatment. Only less than 2% said they often go to traditional or homeopathic healers and private clinics.

Although in a country like Ethiopia, where alternative modern health facilities are limited, especially in the rural area where the government is the sole modern health facility provider, the high percentage of households visiting government health facilities should not come as a surprise, the figures seem to be slightly higher than indicated by many studies.

Respondents were also asked how far they live from the nearest health clinic or hospital. Results indicate that most of the respondents (more than 93%) live within the range of 0 to 10 km distance from the nearest health clinic or hospital and only few (less than 7%) live in the range of 10 to 20 km distance from the nearest health clinic or hospital.

For the Tunisia case study, the distance from the nearest public or private health clinic or hospital does not exceed 2.9 km with a maximum of 10 km. For the Burkina case study the health situation seems to be better than Tunisia and Ethiopia because the distance from the nearest public or private health clinic or hospital does not exceed 0.8 km with a maximum of 1 km.

The majority of the households in Zambia study site accessed government clinics and hospitals. The majority of those that go to the government clinic or hospital stay within a radius of less or equal to 10km.

- **Households expenditure**

Figure 4 represents the yearly consumption expenditure per household in Ethiopia, Tunisia and Burkina Faso.

In Tunisia the results reveal that the average household's yearly consumption expenditure reaches 2145 USD. The maximum expenditure is observed in rural areas respectively 2366 USD in Sidi Makhlouf and 2278 USD in Bénikhdéche (Table Annex 9). The results further show that, overall, the share of food in total household expenditure was the highest (43%); followed by other unexpected expenditure (16%). The share of education, health and water in total household expenditure are respectively 7%, 7% and 6%.

Rural-urban variations show that there was a two percentage point increase in the share of leisure in urban areas (Médenine Nord) while that of rural areas (Sidi Makhlouf, Bénikhdeche) reduced by one percentage points. On the other hand, the share of transport and communication in total household expenditure decreased by one percentage points in urban areas, this is can be explained by the proximity of market and public and private services. In contrast the findings indicate that the urban region registered a significant reduction in the share of food expenses compared to the rural regions.

Results show that Ethiopian households spend 550 USD on average per year. An examination of spending patterns across the eight broad categories (figure 4) shows that 82 % of total expenditure was dedicated to food (72%) and children's needs (10%) - mainly related to education and health, leaving 18% to cover all other households expenses. These included communication (phone and cell phone) (5%), housing (2%), etc.

Spending patterns of Burkina Faso study site households seems to be similar to Tunisian and Ethiopian ones. Meanwhile, farmers in Burkina Faso are the poorest with a total of expenditure less than 183 USD per year. The main expenditure items are food (48%), children needs (32%) and medicine (11%).

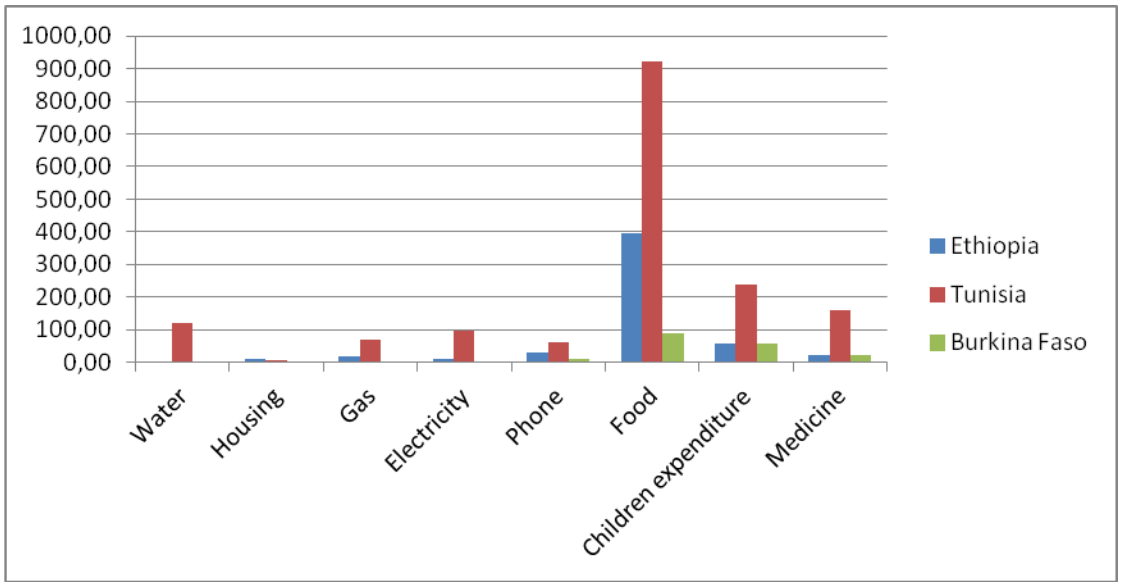

Figure 4. Household's expenditure by items (USD)

3.3.3. Financial assets

Figure 5 shows the income structure of households in Tunisia, Ethiopia and Burkina Faso. The major contributing sector to income of households in Ethiopia is farming (66%) followed by other income (21%) and business income (5%). Farmers in the sample get an average annual income of 230 USD from farming, followed by other sources with an average income of 80 USD, followed by income from livestock (24 USD), own business income (17 USD), wage/salary income (11 USD), migration income (10 USD) and finally transfer income (9.5 USD) in the form of remittance from household members living in other places.

The most important sources of finances for Zambia study site was income from agriculture crop production and sales. This was found at 41 percent, followed by income from livestock and poultry sales at 22 percent. The third important source of income for rural households is remittances from relatives and friends at 8 percent.

The income structure in Tunisia seems to be unconventional for a rural area. In fact, agriculture income represents only 2% of total income. The major contribution in income formation is coming from migration transfers (37%) followed by other incomes (19%) and business income (17%). Business activities in Burkina Faso contribute 33% of total income of households. Agriculture activities keep the second rank together with other incomes, contributing 26% each.

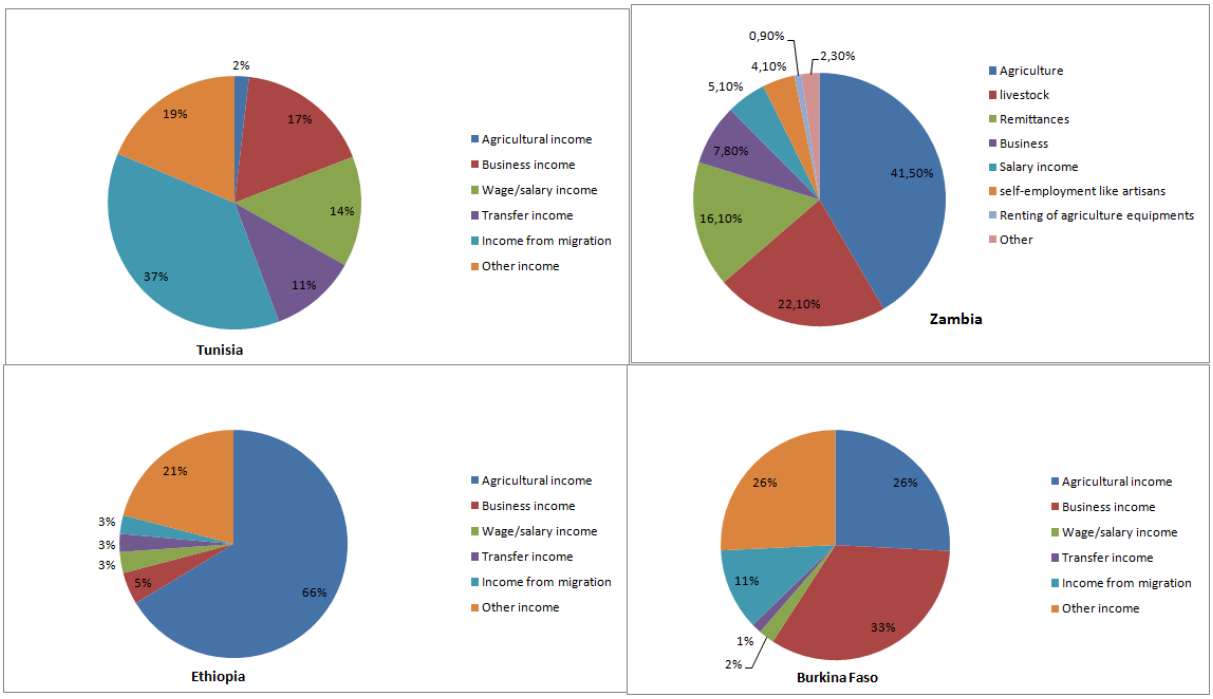

Figure 5. Income by source (%)

3.3.4. Natural assets

➢ **Land ownership and fragmentation**

Land fragmentation may exacerbate conflicts regarding labour allocation on the farm: it takes time to travel from one plot to another while the labour force could be undertaking more productive tasks. Second, production costs may be increased as land fragmentation may require additional equipment, secondary farm buildings and/or external service expenses. Third, land fragmentation may restrict the choice of production and constrain management practices, especially in terms of herd management. The principal indicator of land fragmentation is the farm size (The traditional tenure system of inheritance encourages land fragmentation) and the number of plots per farmer.

One way to address the diversity of farms is to categorize them into several homogeneous groups. The simple farm typology presented here is based on farm size given that structure of farmland ownership is considered among the most complex aspects of farming system in the region.

For the Tunisia case study, three groups are distinguished; small farm (less than 10 hectare); medium (between 10 and 20 hectare) and large farm (bigger than 20 hectare).

Results show that small farms dominate the farm count, making up 67 percent of farms sampled in the entire watershed. In addition, medium farms (between 10 and 20 hectare) make up more than 24 percent of the watershed's farms while farms with more than 20 hectare represent only 9%. Farmland structure is more or less typical cross watershed compartment except Médenine Nord where the medium and large farms represent respectively 42 and 15 %. The fact that most farms are small has negative implications for mechanization and economies of scale. Further, the farmland typology indicates a large

variability within and between watershed compartments. For example, the proportion of small farmland are ranging from 0% (Ragouba Est in Sidi makhlouf) to 100% (Bedoui, in Sidi makhlouf), while all farmland are more than 20 hectare in Gabbay, Sidi Makhlouf (table 7, for more details see table 10 annex 1).

Tableau 7. Farm size distribution per delegation in the Tunisian study site.

Délégation	Mean ha	Land structure			
		Percentage of farm between 0 and 10 ha	Percentage of farm between 10 and 20 ha	Percentage of farm above 20 ha	Total %
Bénikhdéche	9	76	17	7	100
Médenine Nord	12	42	42	15	100
Sidi Makhlouf	9	72	21	6	100
Total	10	67	24	9	100

Table 8 shows that 22 percent of the farmers have more than one plot, (14% have two plots, 6% have three plots and 2% have four plots). The results vary according to the location. For example in Ragouba Est all farmers have two plots while in Ragouba Ouest all farmers have just one plot (for more details see Table Annex 11).

Tableau 8. Number of plot per farmer

County (*Délégation*)	One plot	Two plots	Three plots	Four plots	Total
Bénikhdéche	66%	19%	10%	5%	100%
Médenine Nord	85%	12%	3%	0%	100%
Sidi Makhlouf	87%	11%	2%	0%	100%
Total	78%	14%	6%	2%	100%

In Oum Zessar watershed, the rainfed farming system has always been of crucial importance in generating much of the region's agricultural output. In fact it represents 91% of total agriculture practice in the area (table 9). The rainfed farming systems are based on the traditional and innovative water harvesting technologies. The irrigated and rangelands farming system represent respectively 5% and 4% of the total area (for more details see table Annex 12).

Tableau 9. Farm type in Oum Zessar watershed

County (*Délégation*)	Irrigated Plot	Rainfed	Rangelands	Total
Bénikhdéche	5%	86%	9%	100%
Médenine Nord	12%	88%	0%	100%
Sidi Makhlouf	2%	98%	0%	100%
Total	5%	91%	4%	100%

Farming plots owned by rural households in the Ethiopia study site are generally small and found in different locations. While this pattern may negatively affect land productivity in view of difficulties for investment, it, on the other hand, ensures some sort of equity by distributing

land ownership among different areas of soil fertility within the particular village. Taking only those households possessing land, the average number of plots per household is 2.39 (Table 10). Thus, on average, every household possesses slightly more than two plots of land.

Tableau 10. Average number of plots per household

Tabia	N	Mean	Standard deviation
Genfel	95	2.98	1.33
Mesanu	99	2.72	1.89
Tsaedanaele	95	1.46	0.63
Overall sample	289	2.39	1.28

However, if we consider all households in the sample; i.e., including those who do not own land, the average number of plots per household becomes slightly smaller and stands at 2.3 plots per household.

Perhaps more important than the number of plots is the size of holdings. Keeping other factors constant, one can safely imagine that the larger the size of land a household owns, the more output it generates. However, land holding size in Tigray has remained small because the region has seen a rapid growth in rural population accompanied by progressive dividing of land resources. One needs to note, in the meantime, that one can attain higher levels of land productivity by introducing appropriate technologies and reap higher levels of harvest even if land remains of small size.

Alike to previous studies, this survey shows that average land holding size remains below one hectare per household. In precise terms, and excluding landless households, the average land holding size is reckoned as 3.01 tsimad (or 0.75 hectares) per household (Table 11). This figure is lower than the average land holding for the Tigray region at large which stands at 0.9 hectares (Fredu et al. 2011). There exists variation in terms of Tabia distribution of land holding sizes as shown in the table below. While land holding size in Tabias Genfel and Mesanu is comparable, the land holding size in Tsaedanaele is almost half of the land holding size in the other two Tabias.

Tableau 11. Average land holding size in Ethipia study site

Tabia	Number of observations	Average land holding in tsimad*	Standard deviation
Genfel	95	3.47	2.67
Mesanu	99	3.68	2.0
Tsaedanaele	95	1.84	0.89
Overall sample	289	3.01	2.15

*Tsimad is an area of land that can be ploughed by a pair of oxen and is equivalent to one-fourth of a hectare.

As the areas sampled are the home of farming communities, the land in the sample household is mainly used to grow crops. The following pie chart shows the share of use of land (Figure 6). More than 93% of the land is used for growing crops.

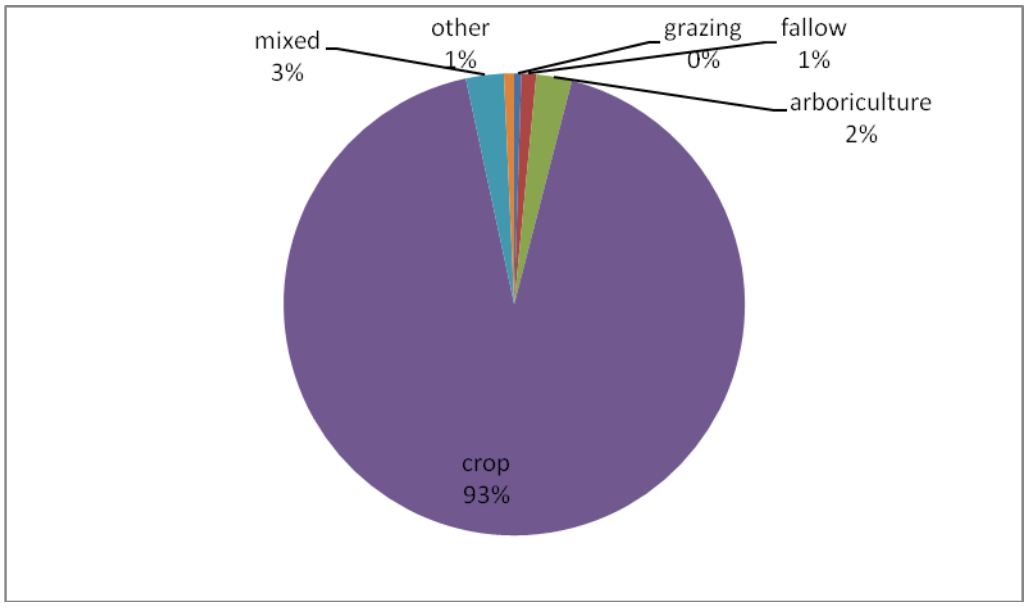

Figure 6. Share of land in the study area

For the Burkina study site, the survey results shows that average land holding size remains around one hectare per household (1.15 ha) and the rainfed farming system represents 100% of the total area.

For Zambia study site, 82 percent of asked households were participating households in water harvesting technologies and only 18 percent were non-participating households.

Tableau 12: Total area and irrigation sources

		With participation	Without participation
Total area hectares	Mean (ha)	26.94	5.38
	Median (ha)	11.00	3.00
Did you practice irrigation?	Percent	21.1%	17.6%
What was the source of irrigation water?	Public Well	18.8%	33.3%
	Private Well	50.0%	0.0%
	River/Stream	25.0%	33.3%
	Dam	6.3%	33.3%
Difficult to access irrigation water?	Percent	62.5%	66.7%

Source: WAHARA Survey Data 2014

The mean area of total area in hectares owned by all households was 23 hectares (table 12). However, the mean area for participating household was 22 hectares more than the non-participating households at 27 hectares. Irrigation practice is an important activity for crop production. Among participating households, only about 21 percent practiced irrigation while those of non-participating, only about 18 percent practiced irrigation.

Source of water for households' use is key for their wellbeing. The important sources include the following, public well, private well, river and dam. The most important source of water for participating households was private well. Half of these households indicated water as the main source of their water. Then 25 percent of the participating households indicated

river/stream as the most important source of their water. These two sources are where 75 percent of the participating households accessed their water. The reminder 25 percent of the participating households accessed their water from the public well and the dam.

On the other hand, non-participating households had no access to water from private well. The remaining three sources of water; public well, river/stream and dam were the major sources of water, the percent of non-participating households that accessed water from these sources was 33.3 percent for each source respectively.

Irrigation is an important aspect of activity especially for households that do dry season agriculture. The percentage of households that accessed irrigation among the participating households was 62 percent. While the percentage of non-participating households that accessed irrigation water was 67 percent.

The results from Table 12 shows that a higher number of participating households accessed natural resources assets compared to non-participating households.

3.3.5. Social Assets

Social capital, which can be understood as the norms and networks that enable people to act collectively (Woolcock and Narayan, 2000), is increasingly getting attention as a mechanism for understanding a range of phenomena ranging from voting patterns (DiPasquale and Glaeser, 1999) to health (Kennedy et al., 1998) to judicial efficiency (LaPorta et al., 1997) and to household welfare analysis (Putnam, 2000). In this part, the focus is more on social capital related to natural resource management.

For the Ethiopia case study, the Tigray regional state follows an Agricultural Development Lead Industrialization (ADLI) strategy based on resource conservation. Accordingly, main emphasis is given to water as the region has limited water sources. This has motivated the regional government to deploy a variety of water harvesting mechanisms to contribute to integrated watershed management. Besides government programs such as the public work program in which rural communities engage in public works (mainly in natural resource conservation activities) against payment, farmers in Tigray contribute up to 40 days of free labour to work on natural resource conservation activities through the locally operating natural resource management institutions.

Respondents were asked whether or not they are engaged with natural resource management institutions and the reason for their engagement. More than 72% of the respondents said that at least one member of the household is a member of natural resource management institutions. Moreover, except very few (only close to 13%) who considered their involvement solely as government obligation, all respondents justified their involvement in implementing watershed management activities in order to improve their livelihood through enhancing productivity by conserving soil and water.

The local natural resource management institutions in the study area and elsewhere in rural Tigray are well organized with their own structures or grouping and have many years of experience. Respondents were asked whether or not watershed communities are capable of continuing/maintaining watershed management activities on their own. Most respondents

(more than 80%) have the confidence that the local institutions are capable of undertaking watershed management activities by their own. Even more than the local institutions, almost all the respondents (more than 96%) have expressed their satisfaction on the regional government's policies on water resources.

The Oum Zessar watershed in South East Tunisia has been the focus of many Natural Resources Management (NRM) interventions that started from 1980. The Structural Adjustment Plan (SAP) that started in mid 1980s tried to make a significant shift from a top-down approach to NRM towards a more integrated and participatory approach, which involved a lot of partnership building. However, as mentioned by Sghaier et al. (2011) several issues constrained their success, such as i) Low or lack of intra-sectoral integration particularly in the agricultural sector as well as inter-sectoral integration with tourism, servicing and other economic sectors. This has led to inefficiency and sometimes, conflict of interest between sectors; ii) Limited involvement and participation of local actors and communities leading up to weak partnerships between and amongst stakeholders (those of the State and of civil society); and iii) Low economic efficiency due to lack of cooperation and synergy between activities and sectoral interventions.

To evaluate the public policies focused on NRM, households were asked if they are satisfied with government intervention. The results showed that only 12% of the total sample is satisfied, 36% are little satisfied and more than 50% are not at all satisfied (figure 5). The satisfaction degrees vary with watershed location. Households living in the down-stream (Sidi Makhlouf) seem to be not really in favour of the public intervention; indeed the satisfaction degree does not exceed 2%. Contrarily the satisfaction degree of households living in the up-stream and mid-stream sections reaches respectively 17 and 18%.

Project beneficiaries were largely in favour of the positive impacts of water harvesting techniques on ground water recharge, soil erosion control and cropping diversification. However, they were sceptical on the aspect of water yield improvement and runoff control. On the contrary, livestock breeders and irrigators tend to be negatively affected by the introduced water harvesting technique because retention of water run-off in the watershed, in turn, could negatively affect the halophytic vegetation of the Sebkhat (saline area), which is used as the main grazing area for camels during winter.

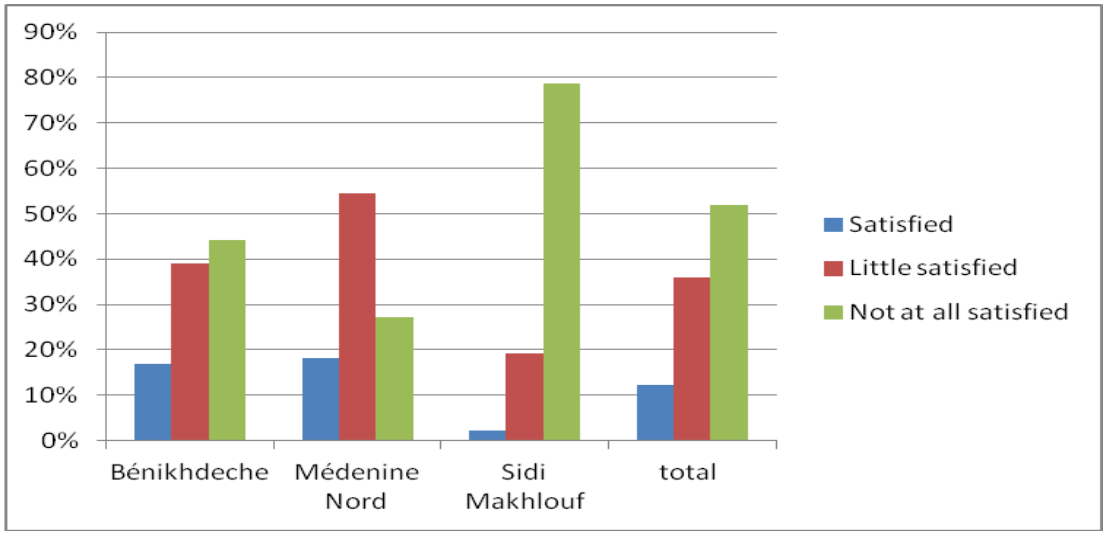

Figure 7. Satisfaction of households with government NRM intervention

The survey also revealed that overall participation in NRM conceptualization and execution is quite acceptable, around 70%. Up-stream and mid-stream farmers are more involved in NRM conceptualization and execution (figure 8). In the piedmont zones, however, the participation rate is less than 55% of the total sample.

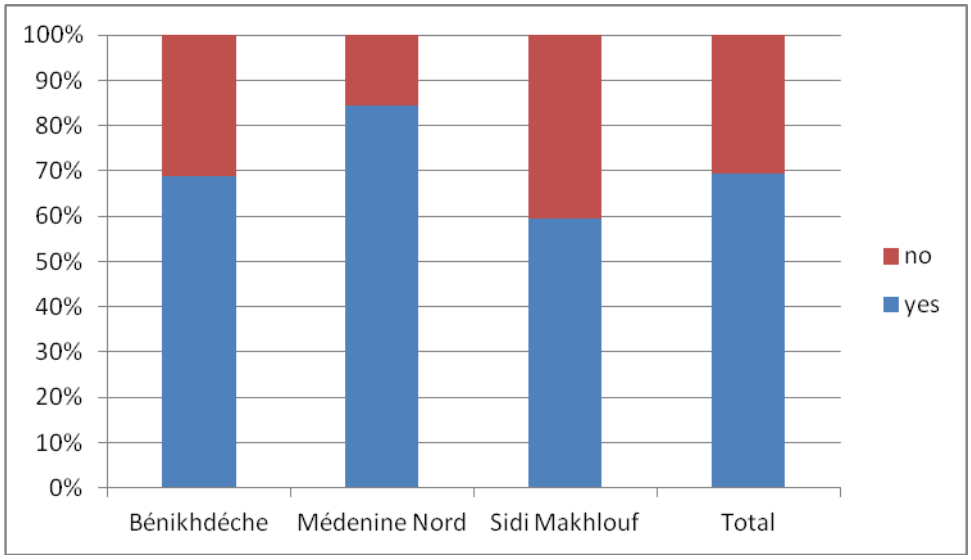

Figure 8. Participation in NRM conceptualization and execution activities

On other hand, households were asked whether or not they are member of NRM institutions and the reason for their involvement. As shown by figure 7 more than 95% of the total sample said that they are not engaged with NRM institutions. While no one in the down-stream is a member of NRM institutions, in the upstream area (Bénikhdeche) more than 10% of the respondents are a member of NRM institutions.

Almost 100% of the respondents justified their involvement in the NRM institution in order to improve livelihood through enhancing productivity by conserving soil and water.

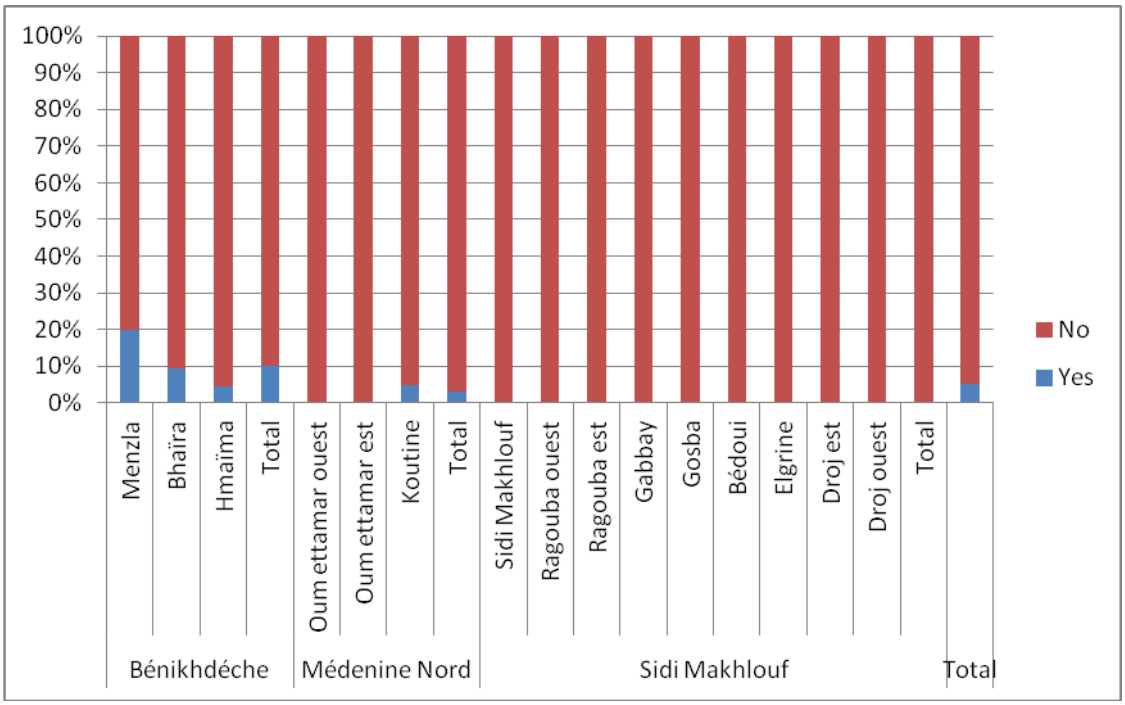

Figure 9. Engagement with NRM institution

For Zambia study site, under the social assets, the key indicators for the study included leadership natural resources governance, natural resources management governance structure both legal (formal) and informal laws, natural institutional capacity to enforce policies and the use of water harvesting technologies (WHT). However the focus in this study was the water harvesting technologies (WHT) as shown in Table 13.

Tableau 13: Table of Social Assets

		With participation	Without participation
Main motivation of land users to implement institutional water harvesting technologies (WHTs)	Reduce effects of climate change	19.7%	23.5%
	Enhance crop production	80.3%	76.5%
Communities capable of maintaining water harvesting technologies (WHTs)	Percentage (Yes)	84.2%	82.4%
Satisfied with current government policies on WHT?	Percentage (Yes)	60.5%	52.9%
Engaged in any natural resources management institution?	Percentage (Yes)	36.8%	5.9%
Satisfied with the functionality of these institutions?	Percentage (Yes)	64.3%	100.0%
How far are you to nearest school?	Mean	3.60	2.54
How far are you to the nearest market?	Mean	15.35	16.00

Source: WAHARA Survey Data 2014

Results from Table 13 shows that 80 percent of participating households and 76 percent of non-participating households who used water harvesting technologies farmers their motivation was mainly to enhance crop production respectively. This means that their main concern was how to enhance food security. The other motivation was the issue of how to reduce the effect of climate change on crop production. 20 percent of participating households indicated that the main reason for using water harvesting technologies was to reduce the effect of climate change. On the other hand, about 23 percent of the non-participating households who used water harvesting technologies indicated reducing of the effect of climate change as the main reason their use.

The study also tried to find out if farmers were satisfied with the current government policies on water harvesting technologies. About 60 percent of the participating and 53 percent of the non-participating households indicated that they were satisfied with the current government policies on water harvesting technologies. This is more than half of the sample.

Maintenance of the water harvesting technologies is critical to realize the benefits of the technologies. For example, Haggblade and Tembo 2003 found that using the same planting basins tended to reduce the amount of labor required to weed the field and it also helps

improving the fertility of the soil. The study found that over 80 percent of the participating and non-participating households indicated that their communities were capable of maintaining the water harvesting technologies.

Natural resource management institutions are important ingredients in enforcing maintenance of the water harvesting technologies. These are laws and norms that govern the use of the technologies. From the study very few households were engaged in any natural resource management institution. About 36 percent of the participating and 6 percent of the non-participating households indicated they had engaged in any of the natural resource management institution.

Despite very few households engaging in any natural resource management institutions, a lot of them were satisfied with the functionality of these institutions. About 65 percent of the participating households and 100 percent of the non-participating households indicated that there were satisfied with the functionality of these institutions.

The other indicator of social assets was the proximity of households to amenities such as the school and markets. The mean distance to the nearest school for both participating and non-participating households was less than 4 km, while the mean distance to the nearest market was 15km and 16km for participating and non-participating households respectively.

Not all indicators under the social assets were captured. However, the only indicator captured was the use of the water harvesting technologies. From the statistics, it shows that the main reason for the use of the water harvesting technologies was to enhance the crop production for both categories. Despite the majority of the farmers being aware of the functionality of the institutions, very few households were engaged in natural resources management institutions.

3.4. Farming characteristics and practices with and without WHT

3.4.1. Water harvesting techniques

- **Water harvesting in Ethiopia**

Tigray is one of the moisture stressed regions in Ethiopia. Following this fact, the regional government has given due place to water harvesting in its strategies. The government and the people have invested intensively on water harvesting mechanisms for more than two decades. It is widely believed and argued in the region that this effort has started to pay in terms of increasing productivity through improvements in soil fertility and water availability for productive purposes.

Sample households in the study areas were asked if they benefit from water harvesting techniques applied in their area, what type of water harvesting techniques have been implemented, who implements these techniques etc.

A wide variety of both traditional and introduced water harvesting and watershed management techniques have been implemented in the study area. Some of the common techniques include:

- application of organic and chemical fertilizers, Contour ploughing;

- Contour soil and stone bunds;
- Stone faced soil bunds;
- Stone/soil/stone faced soil bund with trenches, Stone faced deep trenches;
- Semi-circular bunds;
- Construction of demarcation bunds (Armo) between farm holdings or within a farm to reduce slope length and gradient;
- Application of manure to farms;
- Fallowing of farm lands;
- Crop rotation between cereals and legumes;
- Construction of diversion channels to protect farm lands from damage from upstream runoff and drainage channels to safely remove excess runoff from the farm lands;
- Construction of hand-dug wells for household and irrigation purposes;

Most of the aforementioned water harvesting technologies are implemented by the government, the community and individual farmers themselves. The government provides financial, material and technical support, and the community contributes labour.

- **Water harvesting in Tunisia**

The hydraulic history of the watershed is very ancient as evidenced by remnants of small retention dams, built during the Roman Empire near the village of Koutine and the abandoned terraces in the hills of oued Nagb (Ouessar et al., 2002). Because of chronic water deficiency, a wide variety of relatively small sized hydraulic techniques have been introduced over many centuries to make the land productive, irrespective of its geographical location. In their diversity, the indigenous practices that involve the use of runoff water to supplement rainfall deficiencies seem to be consistent with long-standing climatological features. In sub-humid environments (550-800 mm), rainfall meets the water requirements of most winter crops; therefore, water harvesting involves the collection and storage of surface water in reservoirs and ponds for a deferred use during summer. In the semi-arid regions (400-550 mm), some annual crops such as cereals and Mediterranean-type tree species are grown extensively. Sloping areas, however, are characterized by shallow soils and need specific management in order to retain runoff water. Terraces and embankments are the most common techniques used to enhance agricultural production in these areas. More sophisticated systems have been developed in the arid zone (150-400 mm). In the central and south-eastern parts of the country, where large areas are covered by sloping lands, micro-catchment techniques have been used to mitigate runoff. Spate irrigation from wadis is also commonly used in the central plains of Tunisia (Ben Mechlia & Ouessar, 2002).

Population growth and rapid development of water consuming sectors have resulted in an accelerated competition for water resources. To face the challenges of increasing food production with little allocated water, mobilization of all available water resources and improvement of water use efficiency are inevitable. There has been renewed interest in

traditional soil and water conservation techniques from various sectors (decision makers, farmers, research, private sector, ect.) during the late 1980s. As a result, the role of water harvesting has been highly recognized in all regional agricultural development plans. However, unlike in the 1960s, emphasis is now on participatory approaches. In parallel, new techniques such as gabion structures, hill lakes, check dams, etc. were introduced for watershed rehabilitation. Ambitious programs for water resources mobilization and soil conservation have been implemented. As far as watersheds are concerned, the enrichment of adopted techniques has induced multiple physical and socio-economic impacts

Terracing

Terracing is apparently the oldest adopted WHT in the study area and in the region. Like other regions of Tunisia (e.g., Raf Raf), terraces are mostly found in steep slopes, which are formed by small retaining walls made of rocks. Their remnants are commonly found in the upper extreme area of oued Nagab.

Jessour

As mentioned above, the jessour is mainly found in the mountainous area of Beni Khdache and Moggar, and is known as an ancient WHT. It is practiced in the inter mountain and hill water courses to intercept runoff and sediments. The terrace is the cropped area, formed progressively by the deposition of sediments. The dike (tabia, sed, katra) is the barrier (dam), established to trap sediments and run-off water. It is made of earth equipped with a central (masraf) and/or lateral (manfes) spillway to allow the flow of excess water.

Tabias

Tabias are situated in areas with more or less deep soils with a slope not exceeding 3%. In the Oum Zessar watershed, these are found in the area between Bhayra and Koutine. The tabia is formed by a principal bank of 50-150 m along the contour lines, and ends with lateral bunds of about 30 m. Water is stored until it reaches a height of 20 to 30 cm after which it is diverted, either by a spillway or at the upper ends of the lateral bunds. The tabia harbors water directly from the catchment or by diversion of wadi runoff by a mgoud (Alaya et al., 1993).

Cisterns

This technique, which is locally known as fesquia or majel is built to collect and store rain water for animal drinking, irrigation and domestic use. A cistern is a hole dug in the soil with a gypsic or cement coating to avoid vertical and lateral infiltration. Generally, each unit is made of three main components, the catchment, the decantation basin, and the storage and pumping reservoir. Small to large (5 to 50 m3) cisterns can be found in the entire area.

Gabion units

Gabions are made of blocks of galvanised nets (gabion) filled with rocks. They are constructed in the Oued beds and are formed like a rectangular spillway. Gabion slows down runoff, and helps to increase water infiltration to underground water tables and/or divert a portion of runoff to adjacent cultivated fields (tabias). Gabion units are common in stream beds of the main tributaries in the area.

Recharge wells

When the permeability of the underlying bedrock is too low, casting tubes are drilled to enhance infiltration of runoff water into the water table. Recharge wells are usually established behind gabion units, and are common in Koutine.

- **Water harvesting in Burkina Faso**

The population and the extending services have developed various water harvesting and moisture retention techniques such as:

Ados

- ACN (ploughing contours)
- Rock bunds or lines of stones,
- Zaï, mechanized zaï, forestry zaï
- Half moons, Digues filtrantes,
- Mulching
- Agroforestry
- Windbreaks
- Small-dams,
- Boulis,
- Wells with big circonference, etc.

The main water harvesting technologies that are currently used are Zaï, half moons, rock bunds and bouli. Bouli is a traditional water harvesting technique. It is a big hole dug in the soil that captures runoff. It has a circumference of 30 meters and a depth of 3-4 meters. These technologies are all successful in this area, although there are also constraints and challenges. The main constrains are: labor availability, lack of stones, little availability of organic matter and compost manure, lack of chemical fertilizers. The main challenges are: mechanization, using appropriate quantity of fertilizers to improve yield, sustainability, production in quantity of compost manure.

3.4.2. Benefits of WHT: Assessment by farmers

For the Ethiopia case study, respondents were asked if WHT applied on their plots have brought any changes in productivity. Although difficult to measure the changes in productivity due to WHT without a closely observed data, a rough approximation that could indicate the productivity impact of WHT was collected through recall.

Farmers were asked to recall average production before and after WHT implementation for the plots on which WHT have been implemented. Farmers were asked to recall production in this way for up to two plots. Results of the farmers' assessment on average productivity before and after WHT are summarized below (Table 12).

Tableau 14. Farmers' assessment of average productivity per plot before and after WHT in the Ethiopian study site

Tabia	Plot	Average yield per household before WHT	Average yield per household after WHT	Percentage change
Genfel	Plot1	168	369	120%
	Plot2	145	245	69%
	Overall	203	427	110%
Mesanu	Plot1	241	382	59%
	Plot2	215	326	52%
	Overall	307	482	57%
Tsaedanaele	Plot1	167	297	78%
	Plot2	71	125	76%
	Overall	174	308	77%
Overall sample	Plot1	192	347	81%
	Plot2	167	265	59%
	Overall	227	401	77%

Table 14 indicates that in all the study villages, WHT has a significant impact on productivity. In all the villages, average productivity has increased after WHT significantly. Although these observed changes may not have been solely attributed to WHT, (agriculture intensification, mechanization ect), it clearly indicated that WHT enhances agricultural production.

The sample households were further asked if they observe gradual improvements in soil fertility and water availability due to the WHT. More than 90 per cent of the sample respondents confirmed that there is gradual improvement in soil fertility and water availability as a result of the continuous work in WHT in the study area.

For the Tunisia case study, the households were asked if they benefit from water harvesting techniques applied in their area, what type of water harvesting techniques have been implemented and who implements these techniques.

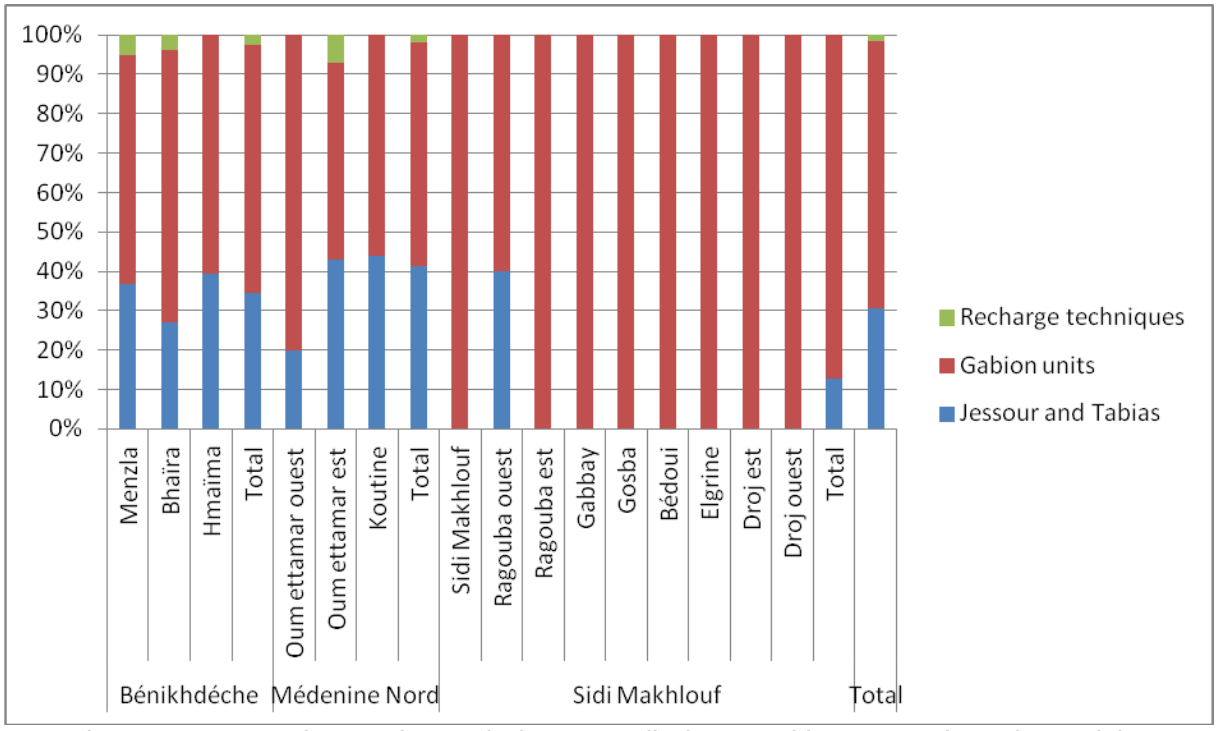

Figure 10. Water harvesting techniques applied or used by respondents in Tunisia

The survey revealed that within the watershed gabion units are the more used technique (67%) followed by tabias and jessour (31%). The presence of recharge techniques is quite small (2%). Some difference between locations can be observed. In fact, preference is given to jesours and Tabias in the upstream and midstream compared to the downstream parts of the watershed. In fact, in some downstream locations, checks dams represent 100% of used WHT techniques. It was clear that technologies use depend largely on plot location in the watershed.

Households were also asked whether implemented WHT positively affect the crop productivity or not. Table 13 reports on perceived effects of crop production with and without water harvesting technologies in dry, average and wet years. According to the responses, globally within the watershed WHT has a significant impact on crop production. We have to note that during dry years the water harvesting technologies have no significant effect on crop production.

Tableau 15. Average yield with and without WHT reported by Tunisian respondents (kg/ha/year)

Crop	location	Dry year			average year			rainfall year		
		Without WHT	with WHT	% change	Without WHT	with WHT	% change	Without WHT	with WHT	% change
Olive	Bénikhdéche	0	0	0%	0	55	100%	0	120	100%
	Médenine Nord	0	0	0%	0	28	100%	0	38	100%
	Sidi Makhlouf	0	20	100%	50	50	0%	0	75	100%
	Overall	0	20	100%	50	47	-6%	0	91	100%
Almond	Bénikhdéche	0	0	0%	0	20	100%	0	58	100%
	Médenine Nord	0	0	0%	0	20	100%	0	32	100%
	Sidi Makhlouf	0	0	0%	0	20	100%	0	50	100%
	Overall	0	0	0%	0	20	100%	0	48	100%
Fig	Bénikhdéche	0	0	0%	0	22	100%	0	45	100%
	Médenine Nord	0	0	0%	0	33	100%	0	70	100%
	Sidi Makhlouf	0	5	100%	0	16	100%	0	41	100%
	Overall	0	3	100%	0	20	100%	0	47	100%
Cereal	Bénikhdéche	0	0	0%	150	150	0%	450	380	-16%
	Médenine Nord	0	0	0%	35	29	-17%	60	65	8%
	Sidi Makhlouf	0	0	0%	0	60	100%	0	207	100%
	Overall	0	0	0%	92	67	-27%	255	226	-11%

According to a survey conducted in 2002, the average crop yields in the Burkina study site respectively are 577 kg/ha in Somyaga and 507 kg/ha in Ziga. The first observation that can be made is that the effect of WHT on crop yields is positive irrespectively of the village. However the extent of increase in crop yield varies depending on the type of SWCT. In 2002 zaï technique application to plots had resulted in doubling yields compared to plots that had no SWCT treatment in Somyaga. The same year, yields on farms under zaï regime increased by 63% in Ziga.

3.4.3. Suggestions for rural development

With the aim to conceptualize integrated and participatory management plan for Oum zessar watershed, surveyed households were asked to freely propose rural development suggestions. Figure 11 report development proposals in the upstream section of the watershed. Figure 11 show that 38% of suggestions directly concern WHT implementation and maintenance, which confirms the priority given to water and soil conservation. Providing healthy drinking water and asphalting rural roads to facilitate access to plot represent 11% of the total number of suggestions. Implementation of irrigated perimeters and subsidies for and encouragement of small farmers are cited by 10% of respondents. Encouragement of rural women to create micro-projects reaches 4% of the total suggestion.

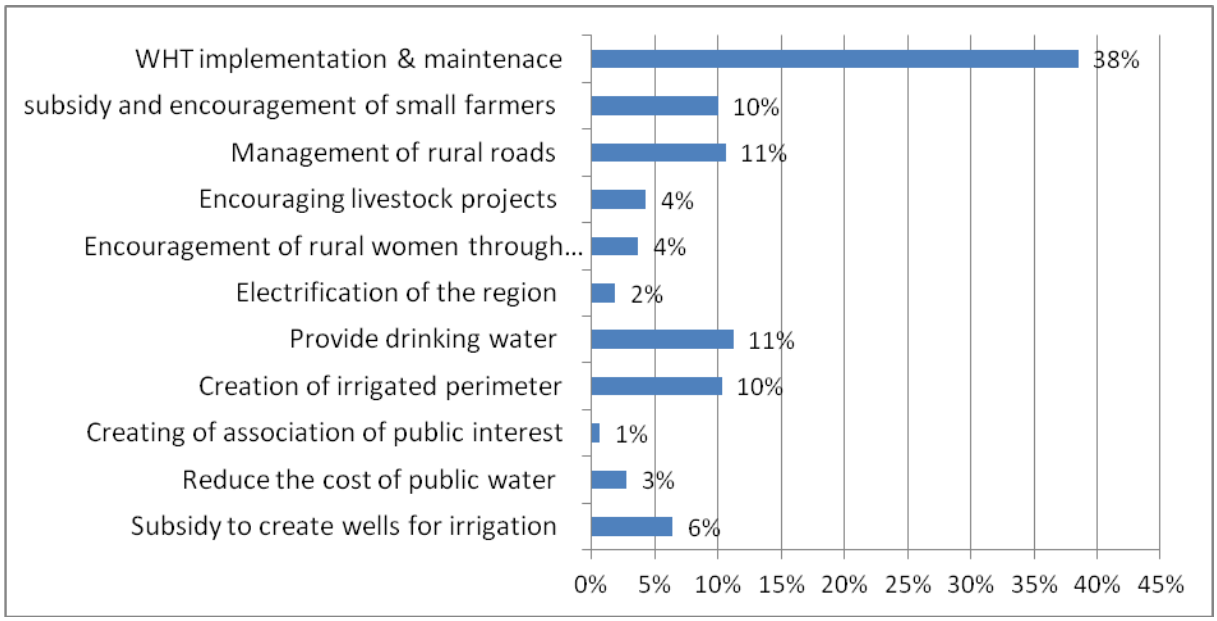

Figure 11. Suggestions for rural development in the upstream part of Oum Zessar watershed brought forward by respondents in the Tunisia study site

Conclusion

Water as a natural asset forms part of the asset range available to households and improved access to water supply plays critical role in the sustainable livelihoods of households. One way in which access to this natural resource can be increased is by increasing its availability through harvesting this natural asset. For this, wide ranges of water harvesting techniques have been used to harvest water for both drinking and productive purposes.

This study assessed the agro-socio-economic characteristics of the farm households. The assessment was done in four selected regions in Africa with different climatic and socio-economic conditions to make statistical and spatial based analyses of biophysical and socio-economic factors that characterize livelihood strategies, natural resources and land management practices.

Results in this study are useful to understand agro-socio-economic characteristics of the farm households in Africa with focus on WHT. However, the document has limitations in the sense that it does not provide ground for selective WHT as necessary elements in poverty reduction strategies. Moreover, the document also does not address the cost benefit analysis of WHTs.

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ANNEXES

ANNEX 1 : Household characteristics by Tabia (Ethiopia)

HH characteristic		Genfel			Mesanu			Tsaedanaele			Overall sample		
		Average	Max.	Min.	Average	Max.	Min.	Average	Max.	Min.	Average	Max.	Min.
Family size		5.7	12	1	5.5	12	1	5.14	12	1	5.4	12	1
Age of HH head		49	85	22	49	96	19	52	90	21	50	96	19
Sex of HH head	Male (total)	72			74			66			212		
	Female (total)	29			26			34			89		

ANNEX 2. Household's size Oum zessar watershed

County (*Délégation*)	Imadat	N Valid	Mean	Maximum	Minimum	Standard Deviation
Bénikhdéche	Menzla	15	5	8	2	2
	Bhaïra	21	7	12	3	2
	Hmaïma	23	5	9	2	2
	Total	59	**6**	**12**	**2**	**2**
Médenine Nord	Oum ettamar ouest	5	5	7	2	2
	Oum ettamar est	7	6	9	4	2
	Koutine	21	5	11	2	2
	Total	33	**6**	**11**	**2**	**2**
Sidi Makhlouf	Sidi Makhlouf	2	4	5	4	1
	Ragouba ouest	9	7	9	5	1
	Ragouba est	2	4	7	2	4
	Gabbay	1	4	4	4	.
	Gosba	16	4	7	2	1
	Bédoui	3	5	5	4	1
	Elgrine	10	6	9	3	2
	Droj est	3	5	7	2	3
	Droj ouest	1	7	7	7	.
	Total	47	**5**	**9**	**2**	**2**
Total		139	**6**	**12**	**2**	**2**

ANNEX 3 . Percentage distribution of Population by Age group and Residence (%) in OZ watershed

		[0-20]	[20-60]	> 60	Age dependency ratio
Bénikhdéche	Menzla	39%	56%	6%	80%
	Bhaïra	22%	75%	3%	33%
	Hmaïma	33%	60%	8%	67%
	Total	29%	67%	5%	50%
Médenine Nord	Oum ettamar ouest	50%	38%	13%	167%
	Oum ettamar est	67%	33%	0%	200%
	Total	57%	36%	7%	180%
Sidi Makhlouf	Sidi Makhlouf	80%	20%	0%	400%
	Ragouba ouest	0%	100%	0%	0%
	Ragouba est	0%	90%	10%	11%
	Gabbay	0%	100%	0%	0%
	Gosba	0%	80%	20%	25%
	Bédoui	33%	67%	0%	50%
	Elgrine	37%	58%	5%	73%
	Droj est	14%	86%	0%	17%
	Total	27%	68%	5%	46%
Total	Total	30%	65%	5%	53%

ANNEX 4: Educational level of household head by *Tabia (Ethiopia case study)*

Level of education	Genfel		Mesanu		Tsaedanaele		Overall sample	
	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Never any schooling	50	49.5	65	65.0	54	54.0	169	56
Religious/Traditional schooling	14	13.9	16	16.0	15	15.0	45	15
Primary school incomplete	21	20.8	14	14.0	24	24.0	59	19.6
Primary school complete	9	8.9	4	4.0	2	2.0	15	5
Secondary school incomplete	5	4.9	1	1.0	2	2.0	8	2.7
Secondary school	2	2.0	0	0.0	1	1.0	3	1

complete								
College diploma	0	0.0	0	0.0	2	2.0	2	0.7

ANNEX 5. Education level in OZ Watershed

County (*Delegation*)	Imadat	N valid	Illitreate	Koranic school (koutteb)	primary	Secondary	University	Vocational training
Bénikhdéche	Menzla	9	2	1	0	3	1	2
	Bhaïra	13	2	4	6	0	0	1
	Hmaïma	12	4	2	5	1	0	0
	Total	34	8	7	11	4	1	3
Médenine Nord	Oum ettamar ouest	1	1	0	0	0	0	0
	Oum ettamar est	2	0	0	0	1	0	1
	Koutine	0	0	0	0	0	0	0
	Total	3	1	0	0	1	0	1
Sidi Makhlouf	Sidi Makhlouf	1	0	0	1	0	0	0
	Ragouba ouest	2	0	1	0	1	0	0
	Ragouba est	2	1	1	0	0	0	0
	Gabbay	1	1	0	0	0	0	0
	Gosba	6	4	1	1	0	0	0
	Bédoui	3	1	0	2	0	0	0
	Elgrine	9	4	0	5	0	0	0
	Droj est	2	1	0	1	0	0	0
	Droj ouest	0	0	0	0	0	0	0
	Total	26	12	3	10	1	0	0
Total		63	21	10	21	6	1	4

ANNEX 5: Primary occupation of household head by *Tabia (Ethiopia case study)*

Primary Occupation	Genfel		Mesanu		Tsaedanaele		Overall sample	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Farming	89	88.1	89	89.0	83	83.0	261	87.0
Business	2	2.0	2	2.0			4	1.3
Employee	1	1.0	1	1.0	2	2.0	4	1.3
Pensioner	2	2.0					2	0.7
Unemployed					1	1.0	1	0.3

Disabled and unable to work			1	1.0	2	2.0	3	1.0
Housewife	5	4.9	1	1.0	3	3.0	9	3.0
Too old to work	2	2.0	6	6.0	9	9.0	17	5.7

ANNEX 6 . Main jobs of the households head in OZ watershed

County (*Délégation*)	imadat	Agriculture	Construction	Services	Trade	Public sector	% N valid
Bénikhdéche	Menzla	6,67	0,00	0,00	6,67	26,67	40
	Bhaïra	33,33	9,52	0,00	9,52	4,76	57
	Hmaïma	26,09	4,35	4,35	0,00	0,00	35
	Total	**23,73**	**5,08**	**1,69**	**5,08**	**8,47**	**44**
Médenine Nord	Oum ettamar ouest	0,00	0,00	0,00	0,00	0,00	0
	Oum ettamar est	0,00	0,00	0,00	0,00	0,00	0
	Koutine	0,00	0,00	0,00	0,00	0,00	0
	Total	0,00	0,00	0,00	0,00	0,00	0
Sidi Makhlouf	Sidi Makhlouf	0,00	50,00	0,00	0,00	0,00	50
	Ragouba ouest	0,00	0,00	0,00	22,22	0,00	22
	Ragouba est	100,00	0,00	0,00	0,00	0,00	100
	Gabbay	100,00	0,00	0,00	0,00	0,00	100
	Gosba	6,25	6,25	0,00	6,25	0,00	19
	Bédoui	100,00	0,00	0,00	0,00	0,00	100
	Elgrine	70,00	20,00	0,00	0,00	0,00	90
	Droj est	0,00	33,33	0,00	0,00	0,00	33
	Droj ouest	0,00	0,00	0,00	0,00	0,00	0
	Total	**29,79**	**10,64**	**0,00**	**6,38**	**0,00**	**47**
Total	Total	**20,14**	**5,76**	**0,72**	**4,32**	**3,60**	35

ANNEX 7: Source of drinking water by Tabia (Ethiopia case study)

Source of drinking water	Genfel		Mesanu		Tsaedanaele		Overall sample	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Private source	5	4.9	3	3.0	2	2.0	10	3.3
Public source	43	42.6	25	25.0	77	77.0	145	48
Private well	2	2.0	1	1.0	1	1.0	4	1.3
Public well	18	17.8	12	12.0	20	20.0	50	16.6
Tanker	4	4.0	1	1.0			5	1.7
River	24	23.8	50	50.0			74	24.6

Other	5	4.9	8	8.0			13	4.3

ANNEX 8: Energy source by Tabia (Ethiopia case study)

Source of energy	Genfel		Mesanu		Tsaedanaele		Overall sample	
	Freq	%	Freq	%	Freq	%	Freq	%
Firewood	41	41.0	43	43.4	39	39.0	123	41.2
Charcoal	3	3.0	5	5.1	9	9.0	17	5.7
Kerosene					6	6.0	6	2.0
Cow dung	56	56.0	51	51.5	46	46.0	153	51.1

ANNEX 9. Households expenditure by Residence and Item Groups (DT) in OZ watershed

County (Délégation)	Imadat	Total Dépenses (DT/an)	Water (DT/an)	Housing (DT/an)	Gaz (DT/an)	Energy (DT/an)	Phone (DT/an)	Food (DT/an)	Health (DT/an)	Education (DT/an)	leasure (DT/an)	transfert to family (solidarity) (DT/an)	Children (DT/an)	Others (DT/an)
Bénikhdéche	Menzla	4249	247	0	131	183	147	1904	320	400	73	0	190	653
	Bhaïra	4319	249	0	150	170	155	2014	342	334	164	11	169	560
	Hmaïma	4524	175	0	130	183	71	2330	382	280	72	89	114	698
	Total	4381	220	0	137	179	120	2109	352	330	105	39	153	637
Médenine Nord	Oum ettamar ouest	3233	286	0	144	140	40	1178	225	350	90	20	60	700
	Oum ettamar est	3344	200	0	110	118	81	1093	186	236	257	0	114	950
	Koutine	2929	205	0	125	156	70	976	198	164	132	17	110	776
	Total	3063	216	0	125	145	68	1032	200	208	152	14	103	802
Sidi Makhlouf	Sidi Makhlouf	4120	120	0	140	185	125	1850	200	750	50	0	250	450
	Ragouba ouest	4683	340	0	115	198	97	1500	156	589	139	0	422	1128
	Ragouba est	9072	23	0	165	245	180	4200	559	550	0	0	400	2750
	Gabbay	7130	400	0	180	210	720	1920	200	1000	1000	0	0	1500
	Gosba	3193	217	0	114	229	108	1150	241	172	9	0	191	763
	Bédoui	384	13	0	12	15	16	18	30	217	11	0	133	80

		0	0		1	0	0	00	0		7			0
	Elgrine	5522	355	200	165	253	230	2590	579	215	200	0	100	635
	Droj est	5840	320	0	133	183	137	3500	433	0	100	0	200	833
	Droj ouest	2850	300	0	100	300	0	700	0	350	0	0	400	700
	Total	4550	264	43	131	220	151	1881	318	315	110	0	224	898
Total	Total	4125	234	14	132	185	118	1776	304	296	118	20	165	764

ANNEX 10. Size Variation among Typology Groups

County (Délégation)	Imadat	Mean ha	Land structure			
			Percentage of farm between o and 10 ha	Percentage of farm between 10 and 20 ha	Percentage of farm above 20 ha	Total %
Bénikhdéche	Bhaïra	6	81	19	0	100
	Hmaïma	13	65	17	17	100
	Total	**9**	**76**	**17**	**7**	**100**
Médenine Nord	Oum ettamar ouest	16	40	20	40	100
	Oum ettamar est	13	43	29	29	100
	Koutine	11	43	52	5	100
	Total	**12**	**42**	**42**	**15**	**100**
Sidi Makhlouf	Sidi Makhlouf	12	50	50	0	100
	Ragouba ouest	7	78	22	0	100
	Ragouba est	15	0	100	0	100
	Gabbay	27	0	0	100	100
	Gosba	8	81	13	6	100
	Bédoui	4	100	0	0	100
	Elgrine	6	80	20	0	100
	Droj est	23	33	33	33	100
	Droj ouest	8	100	0	0	100
	Total	**9**	**72**	**21**	**6**	**100**
Total	Total	**10**	**67**	**24**	**9**	**100**

ANNEX 11. Number of plot per farmer

County (Délégation)	Imadat	One plot	Two plot	Three plot	Four plot	Total
Bénikhdéche	Menzla	87%	0%	13%	0%	100%
	Bhaïra	52%	33%	5%	10%	100%
	Hmaïma	65%	17%	13%	4%	100%
	Total	66%	19%	10%	5%	100%
Médenine Nord	Oum ettamar ouest	80%	0%	20%	0%	100%
	Oum ettamar est	86%	14%	0%	0%	100%
	Koutine	86%	14%	0%	0%	100%
	Total	**85%**	**12%**	**3%**	**0%**	**100%**
Sidi Makhlouf	Sidi Makhlouf	0%	50%	50%	0%	100%
	Ragouba ouest	100%	0%	0%	0%	100%
	Ragouba est	0%	100%	0%	0%	100%
	Gabbay	100%	0%	0%	0%	100%
	Gosba	100%	0%	0%	0%	100%
	Bédoui	100%	0%	0%	0%	100%
	Elgrine	90%	10%	0%	0%	100%
	Droj est	67%	33%	0%	0%	100%
	Droj ouest	100%	0%	0%	0%	100%
	Total	**87%**	**11%**	**2%**	**0%**	**100%**
Total	**Total**	**78%**	**14%**	**6%**	**2%**	**100%**

ANNEX 12. Farm type

County (*Délégation*)	Imadat	Irrigated Plot	Rainfed	Ranglands	Total
Bénikhdéche	Menzla	7%	64%	29%	100%
	Bhaïra	5%	90%	5%	100%
	Hmaïma	5%	95%	0%	100%
	Total	**5%**	**86%**	**9%**	**100%**
Médenine Nord	Oum ettamar ouest	0%	100%	0%	100%
	Oum ettamar est	17%	83%	0%	100%
	Koutine	13%	88%	0%	100%
	Total	**12%**	**88%**	**0%**	**100%**
Sidi Makhlouf	Sidi Makhlouf	0%	100%	0%	100%
	Ragouba ouest	0%	100%	0%	100%
	Ragouba est	50%	50%	0%	100%
	Gabbay	0%	100%	0%	100%
	Gosba	0%	100%	0%	100%
	Bédoui	0%	100%	0%	100%
	Elgrine	0%	100%	0%	100%
	Droj est	0%	100%	0%	100%
	Droj ouest	0%	100%	0%	100%
	Total	**2%**	**98%**	**0%**	**100%**
Total		**5%**	**91%**	**4%**	**100%**

The Households Socio-economic and biophysical survey
WAHARA project
Consent Statement

In the framework of the WAHARA project 'Water Harvesting for Rainfed Africa: investing in dryland agriculture for growth and resilience' funded by European commission 2011-2015, a study on the Socio- economic and biophysical impact of WHT will be carried out.
The farm household agro-socio-economic survey aims to characterise:
1- The resource base,
2- Livelihood strategies,
3- Current farming practices,
We would like to ask you a few questions regarding your economic and social status. However, your participation in this survey is voluntary. Even if you agree to respond to these questions, you can refuse to answer any question that you do not wish to answer. We would like to assure you that the information provided by you would only be used for the purpose of research and your identity will not be revealed to anyone either in the final report or in any other way. Through this study people will learn about WHT in their country and the well being of the people of this country but your personal information will not be divulged.
Do you agree to be interviewed? Yes /No
Name of the Interviewer:
.....

Signature of the Interviewer: .....
Date and time of interview: .....
Place of Interview (country/village): .....
Household Characteristics
Name of the household head: …….....
Address: …….....
Geographic coordinates:
GPS point latitude (UTM)…….....
GPS point longitude (UTM): …….....
Altitude (m. a.s.l): …….....
What is the highest level of education you have completed? I_I
1.No school 2.Elementary 3.High school 4.College 5.Higher education (professional or post-graduate) 6.Religious schooling only 7. Literacy classes only 8.other
Any other (Please specify)…….
Principal activity of the HH head: .....
Since when do you practice this activity? .....
Secondary activity: .....
Type of Residence? I_I *1 Apartment; 2.Townhouse; 3.House; 4. Hut 5.Other specify*
how far from the farm? …….....
How long have you lived in this area (years)? I_I
1.Less than 5 years; 2. Between 5 and 10 years; 3. More than 15 years
13. Give the main reason why you moved into this area. I_I
1.Native of the area; 2. Farming; 3.Livestock 4. Grazing; 5. Fishing; 6. Other (specify)
If other please specify: …….
How do you characterize your homestead? I_I *1. Permanent 2.Temporary*
Do any member of your HH migrate to other areas for employment? I_I *1. Yes, 2. No*
If yes, please describe

HH Member (I.D. No)	17.Where	18.Duration	19.Period	20.Type of employment

Table1.Demographic characteristics of household members

I.D. No.	Name (Optional)	21.Age (years)	22.Relationship with head	23.Sex	24.Marital status	25.Education	26.Principal occupation	27. Farm work (no of days)	28.Specify the period of farm activity (agriculture calendar/season)	29: Off-farm work (no of days)	30:Specify off farm activity
1.HH											
2											
3											
4											
5											
6											
7											
8											
9											
10											

22. Head (1);Wife/Husband/Partner (2); Son/Daughter (3);Step-Son/Daughter (4);Grandchild (5) Father/Mather (6);Sister/Brother (7);Niece/Nephew (8);Uncle/Aunt (9);Son/Daughter-In-Law (10);Father/Mother-In Law(11);Brother/Sister –In-Law(12);Grandparent (13);Other Relative To Head Or His/her Spouse (14);Servant (15);Tenant/Boarder (16);Other Unrelated Person (17). 13. Sex: (1).F (2).M

24. Single /Never Married (1);Married (2);Widowed (3);Divorced (4);Separated (5);Too Young To Marry (6)25. Never Any Schooling (1); Religious/Traditional School (2); Primary School Incomplete (3);Primary School (Complete) (4) Grade Complete (5); Grade Incomplete (6); Technical/Vocational (11); College Diploma (12); First Degree at University (13); Post Graduate (14); Other (Specify).

26. farming (1),business including employer and own account worker(2),employee (gov employees ,private, ngo, , casual workers, domestic worker)(3),pensioner(4),unemployed (unable to find work, not looking for work) (5),disabled and unable to work (6),student (at school) (7),house wife(8),unpaid family worker (9),child, helping the domestic and other family work (10),child, too young to work (11),too old to work(12)

Livelihood strategy

B.1. Human Assets

1. What is the main source of drinking water?

1. Private source 2; Public source 3. Private well; 4. Public well; 5.Tanker 6.river 7. Other

2. Any other sources (specify)……

3. How far do you have to go to fetch drinking water? (Km) if possible indicate location……..

4. Who is in charge of water fetching? .....

5. At what cost if any (cost of water fetching)? .....

6. Have you over the past 5 years experienced drinking water shortages? I_I *1. Yes; 2.No*

7. If so, when did it happen? .....

8. What do you think were the causes of the shortages? .....

9. Water quality (safe for human health yes or no?) I_I *1. Yes; 2.No*

10. Is there a separate space for cooking? I_I *1. Kitchen; 2.external to house; 3.No*

11. What type of fuel mostly used for cooking? I_I

1. Firewood 2.Coal 3.Kerosene 4.Cow dung 5.Electricity 6.Bio-gas 7.Natural/liquid gaz 8.Other

12. Any other (specify)…… ……

13. Where do you usually go if you are sick, or to treat a general health problem? I_I

1. Private clinic 2.Government clinic or hospital 3.Traditional or homeopathic healer 4.Clinic runs by a nongovernmental organization or other 5.Other

14. Any other (specify)…… ……

15. How far do you live from the nearest health clinic or hospital? I_I

1.(0-10) km; 2. (10-20) Km ; 3. more than 20 km

Table 2. Living cost

Type	Quantity (year)	Unit cost	Total cost (year)	Funding sources
16. Water				
17. Housing				
18.Gas				
19. Electricity				
20.Phone				
21.Food				
22.Children expenditure				
23.Medicine				
24. Other ……..				

B. 2. Natural Assets

1. Total area (ha/are/acre, etc): ……

2. Have you sold any land plots in the last 5 years? I_I *1. Yes, 2. No*

3. Please specify the area type……..

4. At what price? ……

5. Reasons: I_I

1. Low productivity, 2.water shortage, 3. Lack of funding, 4. Other

6. Do you rent out plots? I_I *1. Yes, 2. No*

7. At what price?

Plot 1:…….2. Plot 2:……..3. Plot 3:……

8. Reasons? I_I

1. Productivity, 2.water availability, 3.Other (please specify)……..

9.Practice of irrigation: I_I *1. Yes, 2. No*

10. For your irrigated fields, what is the source of water? .....

11.Is it sometimes difficult to access irrigation water? I_I

Yes, 2. No

12 .If so, when does this occur? .....

13. Did your family sharecrop in / rent in land during the last harvesting season? I_I

Yes (1); No (2)

14. How much land did you sharecrop/rent in? …… (In hectare)

15. If you do sharecrop in land, what are the three main reasons for sharecropping in land?

Reasons for sharecrop in land	Circle max. three
Sharecropped land is near house	1
High quality of sharecropped land	2
Sharecropped land has access to irrigation	3
Sharecropped land is close to Market/transportation Profitable to cultivate more land	4
	5
Enough manpower available to cultivate more land	6
Not enough land for our needs	7
Others specify _____	8

16. During the last harvesting season, has someone else worked as a sharecropper on your household's land?

I_I *Yes (1); No (2)*

17. If you currently sharecrop out land, what are the three main reasons for sharecropping out land?

Reasons for sharecrop out land	Circle max three
Plot too far from the house	1
Land of (very) poor quality	2
Not profitable to cultivate	3
Cannot get necessary inputs	4
Lack of oxen	5
Not enough money	6
Not enough manpower	7
Other reasons	8 Specify……

Table 3. Land characteristics

19. 1.Irrigated area; 2.Rainfed area;3. Permanent fallows area; 4.Seasonal fallow area

PLOT NO	Plot name	18.Plot localisation (GPS coordinates if possible)	19. Plot type	20. Plot Size (In hectare/tsimad)	21. When did you obtain this land? YEAR	22.Do you have land certificate	23.Use of the plot during last harvesting season? (Type of tenure (direct or indirect)	24. Land uses	25.Soil quality	26. Slope of the plot?
01										
02										
03										
04										
05										
06										
07										

22. Yes (1); No (2)

23. Own cultivated (1); Owned but cultivated by other HH (sharecropped out) (2); Owned but cultivated by other HH (Rented out) (3)

24. Grazing land (1) ; Left fallow (2); Arboriculture (3); Crops (4); Mixed (5); Other (Specify) (6)

25. Fertile (1); Less fertile (2); Marginal (3)

26. Flat (1); Steep (2); undulating (3)

B.3. Physical assets (farm capital)

Table4.Agricultural tools

Type	Initial number (5 years ago)	current number now	Purchase price	Funding source
1. Irrigation (hoses, drip hose, pump, automated. systems, rain barrel etc).				
2. Greenhouse				
3. tractors				
4. truck				
5. Ploughing tools				
6. tank				
7. Other				

Table 5. Arboriculture

Plots	8.Types	9.Initial number (5 y ago)	10.current number	11.Density	12.Number in production	13.other
1						
2						
3						
4						
5						
6						

B.4. Financial assets (farmer's income and expenditure)

B.4.1. Income

Table 7. Rural income

Activities	HH Member (I.D. No)	Amount net	Total days worked by the HH	Total hired labour used	
				Total days worked	Paid wage
1.Weaving					
2.Milling					
3.Handicraft, including pottery					
4.Hair dressing					
5.Spinning					
6.Trade in grain/general					
6.Trade in livestock					
7.Traditional healer/					
8.Religious teacher					
9.Transport by pack					
10.Selling agriculture products					
11.Selling wood and					
12.Charcoal					
13.Others (Specify)					

Table 8.Aggregated source of income

Source of Income	Amount (last year)	Trends last 5years	Reasons for trends?
14.Income from Agriculture and related activities			
15.Income from Livestock, Poultry, green houses etc			
16.Income from renting of tractors/ pump sets & other implements			
17. Income from Trade/Business/ other			
18. Income from self employment like Artisan			

19. Salary income (of all the household members who have salaried income)			
20. Income from Rent, Interest, Dividends etc			
21. Transfer Income (remittance from household members living in other places)			
22.income from migration			
23. Any other income (specify)			
24.Total Income from All Sources			

Trends: 1. Increase, 2. decrease, 3.stable (Please specify in %)

Table 9. Transfers (remittance and aid)

Type of receipt	Amount (in the last year)	sources
25.Remittance		
26.Food Aid		
27.Gift		
28.Inheritance		
29.Dowry		
30.Other		

B.4.2. Expenditure

Table 10. Human, animal and mechanical labour Expenditure by plot

		1.HH	2.Family		3.Unskilled		4.Skilled		5.Animal traction	6.mechanical traction	7.Other
			Women	Men	Women	Men	Women	Men			
Plot (1)	Number										
	Day of work per year										
	Unit cost										
	Hour per day										
	Total cost										
Plot (2)	Number										
	Day of work per year										
	Unit cost										
	Hour per day										
	Total cost										
Plot (3)	Number										
	Day of work per year										
	Unit cost										
	Hour per day										
	Total cost										
Plot (4)	Number										
	Day of work per year										
	Unit cost										
	Hour per day										
	Total cost										
Plot	Number										
	Day of work per year										
	Unit cost										

(5)	Hour per day										
	Total cost										

Table 11. Fertilizers seeds and chemical treatment

Type	Plot (1)				Plot (2)				Plot (3)				Plot (3)			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
8.Manure																
9.chemical fertilizer																
10.Insecticides																
11.Herbicides																
12.Fungicides																
13.Seeds																
14.Other ()																

(1) Quantity Kg/ha; (2) Unit cost; (3) Total cost; (4) Funding sources

Table 12. Water irrigation cost

Type	Plot (1)				Plot (2)				Plot (3)				Plot (3)			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
15. Irrigation water (m^3)																
16.Pumping cost (MU)																
17.Fuel (L)																
18.Material of maintenance (MU)																
19.other																

(1) Quantity Kg/ha; (2) Unit cost; (3) Total cost; (4) Funding sources

B.5. Social assets "Participation in conservation activities"

1. What is the main motivation of the land users to implement watershed management?

……

……

……

2. Are the watershed communities capable of continuing / maintaining watershed management activities on their own?

……

……

……

3. Are you satisfied with the current government policies on water resources?

……

……

……

4. Are you (and or any HH member) engaged in any natural resources management institution? For how many days?

……

……

……

5. Are you satisfied with the functionality of this institution?

……

……

……

6. Other social indicator

Proximity to the school (km)……

Proximity to the market (km)……

C. Farming system characteristics and Land resources

1. How do you decide on the planting dates?

……

……

2. Do the planting dates vary from one year to the next?

……

……

3. Are the crop yields stable from one year to the next?

……
……
4. What factors influence if you get good yields or not between years?
……
……
5. Before the products are sold or consumed, are they stored?
……
……

6. If so, where, how, for how long, and are there any losses?
……
……
7. For the products that you sell to the markets, how long does it take you to reach the market?
……
……
8. How do you reach the market (i.e. mode of transportation)?
……
……
9. How much does it cost you?
……
……

10. How far is the closest paved road from your home?
……
……
D. Water harvesting techniques
1. Have you benefited from WHT implementation on your farm? I_I
1. Yes 2.No
2. What are these WHT?
……
……
3. on what context? I_I
1. Government investment; 2. International cooperation; 3.NGOs; 4.Private Investment
4. What was your contribution? .
……
……
5. Do you perceive any personal benefits from these community-based WHT projects?
……
……
Table 13. WH technologies

	Plot (1)			Plot (1)			Plot (2)		
6.WHT types									
7.implementation date									
8.Who has implemented									
9.On what context									
10.Size (WH retention capacity)									
11.Source of funding									
12.Costs									
13.What was your contribution									
14.Costs of maintenance									

Table14. Associated agriculture activities

WHT types & plot	15.Without (before WHT implementation) WHT			16.With (after WHT implementation) WHT		
	Crops	trees	other	Crops	trees	other

Table 15. WHT assessment by farmers

	17WHT type	18.Crops/trees	19.Yields without WHT	20.Market price (unit)	21.Monetary value	22.Yields without WHT	23.Unit Price	24.Monetary value	25.Estimated yields variation%	26.Observations
Plot 1										
Plot 2										
Plot 3										

27. Do you feel that the fertility of the soil on your plot(s) has been gradually improved as a consequence of WHT? I_I
1. Yes 2.No

28. How do you evaluate the improvement of fertility on your plot(s)?
……
……
……

29. Is there a difference between ancient and modern WHT?
Concerning water harvesting? .....
Concerning associate agriculture activities? .....
Soil erosion? .....

30. Have you noticed any changes in the abundance of water due to the WHT installation?
……
……
……
31. If yes describe what are the impacts of these changes?
……
……
……

33. Have you noticed any impact of upstream construction of WHT on the downstream?
……
……
……

34. In your opinion, what are the suggestions and techniques that can be used for equitable distribution of water and for the minimum risk of damage or destruction?
……
……
……

35. Is the soil of your parcels more protected than before implementing WHT? I_I
1. Yes 2.No

E. Resources bases

Indicate sources of water for agriculture

1. Shallow wells:
-Depth:.....
-Flow……
-Salinity……
- Cost ……..

2.Public resources (1.functional or 2. not) I_I

If yes:
- Hours……
- Period……..
- Energy consumption……..cost :…….

3. Other water sources……

Table 16.Water resources from WHT

Plot	4.WHT type	5.Storage capacity Max (m^3)	6.Agriculture use Max (m^3)	7.Irrigation cost

8. In terms of the WHT listed earlier, who would you say benefited most from their implementation? (Big farmers, medium farmers, small farmers, women, agricultural labourers, the landless)
……

……
……
9. Do you practice supplemental irrigation with WH techniques?
……
……
……
10 .Is rainfall insurance implemented in your area, and do you use it? I_I

1. Yes 2.No

11. How much rain do you get during the rainy season?
……
……
……
12. How much rain do you get during the dry season?
……
……
……
13. Have adopted new and/or modified (improved) WH techniques. If yes who introduced them?
……
……
……
14. Do you think the WH techniques have contributed in decreasing migration in your village?
……
……
……
15. Have you noticed any changes in water availability following the adoption of WH techniques? For drinking water? For irrigation water?
……
……
……
16. Have you noticed any benefits from WHT? (e.g. Improved irrigation, improved domestic water, reduced soil erosion, improved fodder, increased livestock assets, increased area cultivated, etc
……
……
……
17. Have you experienced any crop failures in the past? If so, how often? What were the main factors that caused the crops to fail?
……
……
……
18. Where do you obtain meteorological information? What kind of information is provided, and how often do you access such information?.
……
……
……

End of the Questionnaire