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Digging, Damming or Diverting? Small-Scale Irrigation in the Blue Nile Basin, Ethiopia

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ABSTRACT: The diversity of small-scale irrigation in the Ethiopian Blue Nile basin comprises small dams, wells, ponds and river diversion. The diversity of irrigation infrastructure is partly a consequence of the topographic heterogeneity of the Fogera plains. Despite similar social-political conditions and the same administrative framework, irrigation facilities are established, used and managed differently, ranging from informal arrangements of households and 'water fathers' to water user associations, as well as from open access to irrigation schedules. Fogera belongs to Ethiopian landscapes that will soon transform as a consequence of large dams and huge irrigation schemes. Property rights to land and water are negotiated among a variety of old and new actors. This study, based on ethnographic, hydrological and survey data, synthesises four case studies to analyse the current state of small-scale irrigation. It argues that all water storage options have not only certain comparative advantages but also social constraints, and supports a policy of extending water storage 'systems' that combine and build on complementarities of different storage types instead of fully replacing diversity by large dams.

KEYWORDS: Water storage, water rights, land rights, Amhara, Fogera, Ethiopia

INTRODUCTION

Ethiopia's agricultural production is in a dynamic process of change resulting in immense transformations of landscapes covered by vast irrigation schemes nurtured by large dams. Agriculture also changes because of the land rentals by foreign investors who either use existing facilities or are in a legal position to establish their own irrigation infrastructures when permitted by Ethiopian authorities (Bossio et al., 2012). There is an initiative underway to declare areas around Lake Tana a UNESCO biosphere reservation. Actors and interests in land and water diversify under unequal distribution of bargaining power. Property rights get newly regulated to meet current conditions but not always to the benefit of local populations (Bues and Theesfeld, 2012). It is worthwhile having an analytical look at these landscapes prone to changes in economy, hydrology and social-political relations. This paper focuses on the present irrigation conditions and water management in the Fogera plains at the east shore of Lake Tana, which can be expected to be replaced by the new dam projects very soon – in an ongoing process that the local population seemed not to be aware of in 2010/2011. After introducing the study region and existing irrigation facilities, we will briefly outline the research methodology before discussing the establishment and local management of small-scale irrigation. Before concluding, we then give some idea of changes in local livelihoods and social dynamics related to irrigation.

Beyond the establishment of large reservoirs for irrigation and hydropower generation in the Blue Nile river basin, the Ethiopian government currently emphasises the development of small-scale irrigation schemes of less than 200 ha. The extension of small-scale irrigation to an additional 127,000 ha nationally is highlighted in the National Water Resources Policy (FDRE, 2002). This form of irrigation has dominated the share of irrigated land in Amhara National Regional State (ANRS), but the numerical situation is about to change dramatically with the establishment of large irrigation schemes. The canal system of the Koga scheme south of Bahir Dar will be completed, while upstream of the Fogera plains, in the wetlands on the eastern side of Lake Tana, three large dam projects are in the planning and construction phase, namely on the Ribb, Megech and Gumara rivers. Therefore, we take a closer look at the Fogera *woreda* and Dera *woreda,*[1] where there is already a diversity of small irrigation infrastructure including small dams, hand-dug wells, ponds, spring irrigation systems and river diversion systems, as well as traditional irrigation schemes (Deneke et al., 2011). These small irrigation facilities are important with regard to the size of irrigated land (no reliable figures on irrigation facilities in the area covered by irrigation were available), their impact on local livelihoods and their potential to serve as localised adaptation and water storage services in the face of anticipated climate variability. Their diversity is rooted partly in topographic heterogeneity of the plains. The rural Amhara communities face similar social conditions, follow Orthodox Christianity, are administered by the same political and bureaucratic framework and have similar access to markets, assets and infrastructure.

Nonetheless, the small-scale irrigation facilities are acquired, used and managed in various ways. Production systems, land and water rights, as well as their accompanying social dynamics, are not homogeneous. This calls for a critical inventory, especially because sources for small irrigation are already managed locally by water users. Local management is also a policy paradigm and management option envisioned for upcoming large irrigation schemes in Ethiopia by both government and donors, and is in the process of being implemented in the Koga irrigation scheme in ANRS, which will be managed by a professional operation team in cooperation with farmers.

AGRICULTURAL CHALLENGES IN THE FOGERA PLAINS

Fogera *woreda* and its 250,000 inhabitants are administered from Woreta, a small town located on the road 58 km north of Bahir Dar en route to Gondar. The *woreda* comprises 29 *kebelewotch* and covers about 117,414 ha of land. Due to its closeness to Lake Tana and the rivers Gumara, Ribb and Guanta with some other smaller perennial streams, about 21.4% of the land in the *woreda* is made up of either water bodies or wetlands, which serve as valuable habitats for birds. The general water abundance

[1] *Kebele* is the lowest administrative unit of the government system in Ethiopia. It refers to peasant associations and may contain several villages. A number of *kebelewotch* are combined into a district (singular, *woreda and kebele;* plural, *woredawotch and kebelewotch*, respectively).

should not belie seasonal variations ranging from seasonal floods with waterlogging from July to September through to the dry season from May to June, when farming is not possible except when supported by irrigation. There is one rainy season in the area that occurs from June to September, while the other 8 months are dry. The average annual rainfall is 1248 mm, with a mean maximum daily temperature of 27°C and a minimum of 12°C (Derib et al., 2011).

Fogera *woreda* is considered food-secure. However, the plain's potential for grain production is yet to be fully exploited. Irrigation plays a central role in increasing the production to an extent that helps to mitigate the short supply of food elsewhere in the country. This increase could be gained by supplementary irrigation during the two months of May and June alone; it is not an area that has to bridge long dry spells as experienced by other parts of the country. About 68% of the land in Fogera *woreda* is currently cultivated or used as pasture whereas 3.7% of the land is too steep to support agricultural production. Wetlands covering about 20% are exceptionally important (see table 1).

Table 1. Land use and land cover in Fogera *woreda.*

Land use/ land cover	Area coverage (ha)	Percentage
Land devoted to crop production	51,472	44.0
Grazing land	26,999	24.0
Wetlands	23,354	20.0
Infrastructure and settlement	7075	6.0
Unproductive land (slopes)	4375	3.7
Forest land	2190	1.8
Swamp land[a]	1698	0.2
Perennial crop	2190	1.8

Source: Fogera Woreda Planning and Monitoring Office, 2010.

[a] According to the woreda definition and report keeping, swamp lands are spots within wetlands that are marshy throughout the year. Wetlands are lands where water is found seasonally or all year-round.

Production in Fogera goes beyond grains like teff, finger millet, and maize and rice cultivation. A variety of vegetables such as tomato, onion, potato, pepper, chat, cabbage and pawpaw are produced in dispersed gardens and small irrigated fields. From October onwards, farmers have been using residual moisture to produce rough pea and chickpea (Derib et al., 2011). Most of it is cultivated at small-scale levels, but the yields add up to considerable marketable amounts.

Challenges in Fogera include floods, which can bring prosperity when regular, and used for irrigation. Extreme floods, however, may be devastating in some years, such as in 2006 which led to loss of lives and economic assets. Shortages in animal feed also occur regularly during flood periods, while the waterlogging of fields and a lack of drainage bring their own seasonal problems. In contrast, water resources seem easily exhausted in dry seasons, and soil cracking has been discussed by farmers as a serious challenge because it destroys wells, leads to the fast percolation of irrigation water and results in soil degradation and gully erosion on steep slopes. Consequently, in some parts of the plains, soil and water conservation projects are ongoing. The implementation of large dam projects upstream will pose additional challenges to agriculture in Fogera.

SMALL-SCALE IRRIGATION IN THE FOGERA PLAINS

We have selected four case studies (shown in table 2) to illustrate diverse facilities and management systems: (1) wells and ponds in Kuhar Michael Kebele, (2) Mesno traditional irrigation, (3) the Guanta Lomidor small-scale irrigation system, and (4) the Shina-Hamusit micro-earth dam project.

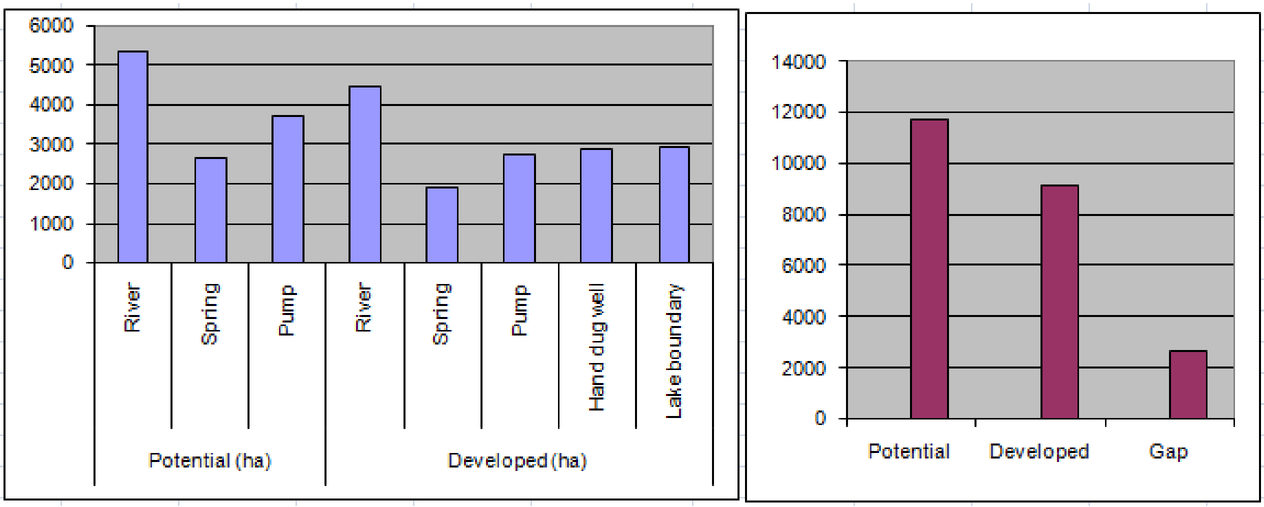
Table 2. Comparison of the case studies.

	Kuhar Michael Kebele	Mesno	Guanta Lomidur	Shina-Hamusit
Irrigation infrastructure	Ponds and wells	Traditional river diversion	Masonry river diversion structure, 1555 m lined canal, 2191 m unlined canal (in 2001), drainage basins	Dam, reservoir, main canal 2911 m, 15 tertiary canals, 10 catch drains and 11 field drains
Irrigation system	Bucket irrigation and a few diesel pumps	Gravity system	Gravity and pump irrigation	Gravity system
Size of irrigated land	No data	No data	90 ha (including 21 ha under pump irrigation)	50.24 ha
Project facilitator/ actors involved	Farmers and well-diggers supported by *woreda* administration	Farmers	Government of Ethiopia	Government of Ethiopia, FINIDA
Cost of construction	Well: 480 ETB Pond: 900 ETB (excluding local labour)	No data	No data	780,118 ETB; 7,309 ETB/ha (including local labour)
No. of users/ beneficiary households	All households for domestic uses, 30 for irrigation	Dry season 10 households, wet season 400 households	107 households, plus sharecroppers	266 households (106 landowners, 160 sharecroppers)
Management regime	Communal management, private ownership	Self-organised groups of farmers	Guanta Lomidur WUA (since 2001)	Sherk Eshet Aragewi WUA (since 2008)
Main regulations	Open access for primary usage, limited access from April to June; negotiated rights for irrigation	Open access, riparian doctrine	Water price, water allocation via schedules, joint canal maintenance	Water allocation via schedules
Social dynamics	Social tension between May and June when access to wells is restricted	No data	Conflicts over water (upstream-downstream), elite capture	Weak position of female-headed households

Note: WUA = water user association. ETB = Ethiopian Birr.

People recall that the establishment of water harvesting facilitates for irrigation in Fogera began at the end of the 1990s. Up to that point, water was provided by either natural springs, streams, hand-dug wells or community wells for livestock and domestic use. From 1995 onwards, the *Agriculture Development-Lead to Industrialization and Development* (ADLI) policy led to the increase of irrigation infrastructure. Moreover, various drinking-water development projects have been implemented. As figure 1 illustrates, the full irrigation potential of Fogera *woreda* is not yet utilised. The same holds true for other *woredawotch* in the plains.

Figure 1. Small-scale potential and developed irrigation coverage (in ha) of the Fogera *woreda* in 2009.



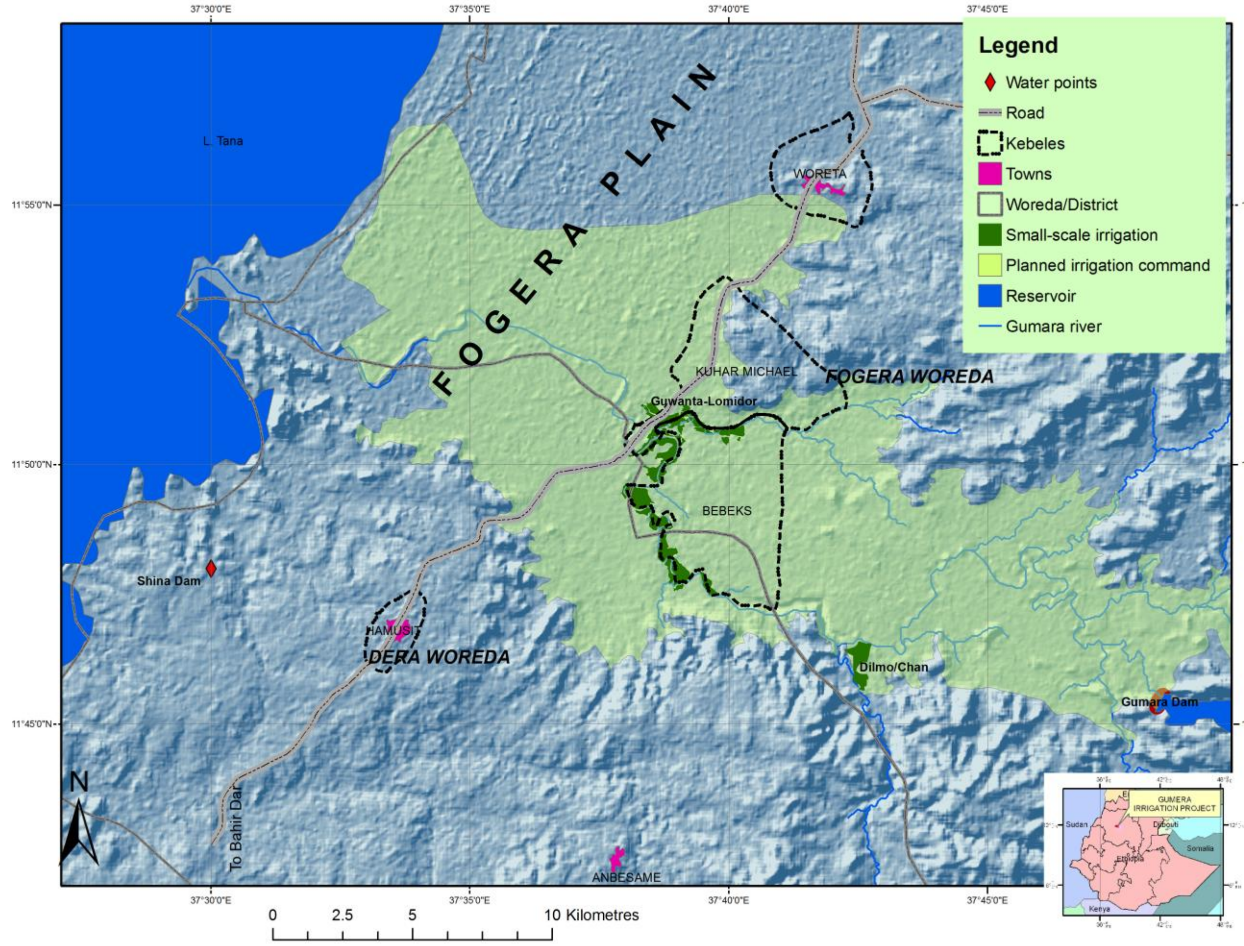
Source: Raw data from the Fogera *woreda* Rural and Agriculture Development Office, Water Resources Division. 'River' includes forms of irrigation using gravity from river water. 'Pump' includes small-scale irrigation schemes using pumped water from rivers, wells and springs. 'Spring' includes schemes using developed spring water by gravity. Lake shore potential was difficult to quantify, since lake levels differ from season to season.

Figure 2 shows the location of the case studies, as well as the location of the ongoing Ribb and the planned Gumara irrigation projects. The small-scale irrigation areas in the 2009 irrigation season show only areas supplied by river diversions, spring developments and pumps along the streams. Wells, lake shore pumping stations, undeveloped springs, traditional diversions and pumping stations are not included.

Wells and ponds

Wells and ponds show some similarities in acquisition, usage and management. Wells were first used for domestic purposes, but were converted into multi-purpose wells also serving small-scale irrigation needs when rainfall was perceived to have become unreliable. In line with findings from Rämi (2003), "the shallow well is believed to be the most efficient, sustainable and probably cheapest component of the regional water harvesting program if groundwater is available" (Otto, 2011). According to data from the Woreta Woreda Office of Water Resources, altogether 4013 wells were not functional due to high seasonal drawdown and the collapse of wells.

Figure 2. Irrigation locations in the Fogera plains.



Data: ASTER GDEM, MoWRs, Field survey, Projected Coordinate System: WGS_1984_UTM_Zone_37N, Geographic Coordinate System: GCS_WGS_1984, and Datum: D_WGS_1984

Kuhar Michael Kebele displays flat areas, as well as hilly areas in its eastern part and consists of ten hamlets, with a total population of 6700. There exists basic rural infrastructure such as electricity, a primary school and a health centre. The *kebele* is known for its production of grain and vegetables, as well as livestock. In 2010, there were 441 shallow wells, but only three standard trapezoidal water harvesting ponds in the *kebele*. The largest cluster of wells (n=149) was dug in Abate Barrage and served 124 households, whilst in Yilude, with 118 households, only one well was observed (Otto, 2011). The wells can be categorised according to different criteria such as depth, shape of the hole, technology for stabilisation and mode of management. The dominating category in the *kebele* was a round hole about 13 to 20 m deep, providing water during the 8-month dry season. At times, it was equipped with a metal tun (see figure 3) for stabilisation and to prevent children and animals from falling into the hole. This type was found in the central part of the *kebele*, where the soils are red (*Eutric Fluvisols*). Another category of wells was prevalent in lowland areas with black soils (*Vertic Fluvisols*), which tended to crack during the dry season. The tubes in these cases were V-shaped. In the lowlands, there were also shallow, round tube wells which were lined with second-hand car tyres to prevent the structure from collapsing; this can be considered the third type of well.

Figure 3. A well, stabilised with a metal tun.

Note: a wooden drinking trough is placed at ground level to enable livestock watering from the well.

River diversion

Mesno traditional irrigation refers to the small Mesno stream, as well as to the village with the same name. As the name Mesno refers literally to irrigation (*yemesno limat*), one can assume that irrigation has been practised there for a long time. In traditional irrigation, water is either diverted by a small number of farmers or applied via buckets along the river banks. Irrigation is practised with their experience and local materials, such as mud (earth), stone and wood. Farmers experiment via trial and error with the contour to divert and distribute water from rivers and springs. If any external organisation (government or NGO) contributes skill or material (like cement, metal and planning knowledge) at any part of the irrigation system, it is categorised as a modern scheme. Traditional systems are, for example, practised by a few households near Woreta. According to the Kuhar Michael Kebele Irrigation Office, there is also a traditional system irrigating an area covering 6 ha, called *Shawa*, which was not visited by the authors.

Traditional point sources in Fogera seem to be used not only for domestic and agricultural purposes but also for therapeutic purposes (Pankhurst, 1986). Based on a study in South Wello Zone, the beginning of an irrigation agriculture in the study area was determined after the mid-twentieth century: "[i]rrigation during the reign of Haile Selassie was usually introduced by external agents, particularly members of the nobility, landlords and entrepreneurs from other countries" (Kloos and Legesse, 2011). Under the socialist government Derg, small-scale irrigation declined but was put on the political agenda again in the mid-1980s. Local institutions for the management of land and water were discouraged in favour of the peasant associations (*kebelewotch*) established by the government in 1975.

Only the Guanta and Dilmo river diversions and the Lomidur and Bebekis spring development systems inaugurated in 2001 are considered modern schemes due to their size and the involvement of external donors. The Guanta river diversion system is located directly at the road site south of Woreta. The communities using the scheme are Nora upstream, Akabit in the middle and Berenguwa at the tail. Guanta used to be a traditional system of 30 ha, before it was modernised and became a scheme with 90 ha of irrigated land cultivated by 107 households and additional sharecroppers. Upstream of Guanta is a spring irrigation system known as Lomidur. The two schemes are often summarised as the Guanta Lomidur system.

Small dam

The Shina-Hamusit micro-earth dam project is situated in Metsele Kebele of Dera *woreda*, adherent to Fogera *woreda* in the south. It can be reached via the road leading to Gondar about 35 km away from Bahir Dar. From the village Hamusit, the Shina community is located about 9 km away in a north-westerly direction.

FIELD RESEARCH

The article builds on ethnographic, social-economic and hydrological field research at doctoral and master levels conducted from 2009 to 2010, as well as on the integrated data analysis of the International Water Management Institute (IWMI) projects *Re-thinking water storage for climate change adaptation in sub-Saharan Africa* and *Improved water productivity of crop-livestock systems of sub-Saharan Africa*, which were supported by household surveys and hydrological and climate modeling sub-projects in the Ethiopian Blue Nile basin. As the disciplinary background of the researchers differs, they made use of a variety of data collection and analysis methods. For the investigation of the Guanta river diversion system, one of the researchers employed observation, Participatory Rural Appraisal (PRA) methods, Global Positioning System (GPS) points, hydrological measurements, informal interviews and statistical analysis for the formulation of a land use map, as well as an estimation of biomass production and canal flow measurements. His colleague worked with focus group interviews, individual interviews and participant observation. The other two researchers also used these qualitative methods, but conducted household surveys in addition to focusing on either Kuhar Michael Kebele or the Shina – Hamusit dam. All researchers stayed in Woreta during their period of research (2-12 months) and went on regular field trips.

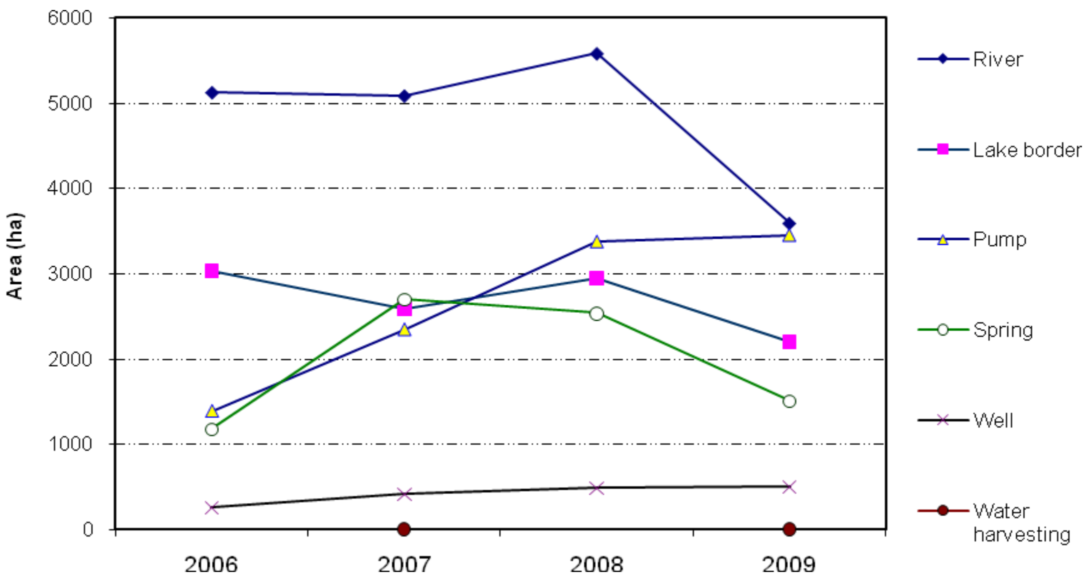
ACQUISITION OF FACILITIES FOR SMALL-SCALE IRRIGATION

As indicated in figure 4, gravity irrigation from rivers dominated small-scale irrigation, because of the low cost of water in terms of finance and skills. The use of pumps increased from 2006 to 2009 when the government provided Chinese diesel pumps, purchased through small advance payments and the participation of local investors from nearby towns, who contributed pumps and technicians while the farmers contributed farm plots and labour. Produce was shared equally among the participants. The failure of market prices for agricultural products in the 2008 irrigation season resulted in the reduction of the irrigation area in 2009 compared to the previous three years. Farmers considered market prices as 'failed' when the price was lower than cost of production. According to the farmers, much of the onion and tomato produce was not harvested because in 2008 the market price was lower than the transportation cost from the farm to the market.

Wells

The prevalence of hand-dug wells in the Ethiopian highlands is restricted to some areas such as wetlands, river beds and valley-bottom lands. Geological factors make hand-dug wells a relatively low potential option for water harvesting, even though they serve communities and even irrigation purposes in single locations. Observations of programmes in Amhara indicate that the digging of wells demands a lot of labour (10 men for one month), some masonry skill and building material. Farmers were taking up initiatives when shallow groundwater was found during excavation for other water projects. Usually, one or two households use the well for irrigation and all other purposes while their neighbours use it for domestic purposes and livestock-watering only. Lifting technologies include the Egyptian *shaduf* and bucket irrigation, as well as treadle pumps and hired diesel pumps. To prevent the over-exploitation of groundwater resources, some rules for well spacing were established in Amhara region (distances between wells) (Rämi, 2003).

Figure 4. Irrigation development trends with respect to different water sources in Fogera woreda.



Source: Raw data provided by the Fogera Woreda Rural and Agriculture Development Office, Water Resources Division, in 2009.

In Fogera, related households living together in clusters within a village pooled resources to construct a well (*gudguwad*) for domestic purposes. Cracking soil and the requirement of a V-shaped hole mean the process is more labour-intensive than when installing the round hole type of wellhead. Larger numbers of households may come together to jointly build the well, or labourers are hired by the future well-owner. The Woreda Agricultural Office encouraged the farmers to dig the V-shaped well and allocated second-hand tires to selected farmers to test them in preventing collapse of wells. Resources for building wells stem from family savings, household labour and from credits taken from the *woreda* administration. Figure 5 shows the construction of a V-shaped well.

Figure 5. Construction of a V-shaped well.

Note: the entire layer of cracking soil is removed before the actual well-digging begins.

Wells for irrigation purposes were observed to be constructed by the employment of a professional well-digger. This man was 54 years old and is known all over the *woreda*. He started to work as a well-digger around 1993, and nowadays receives 50 Ethiopian Birr (ETB) per metre of digging.[2] His employment ran from September to March, during which time he was commissioned to construct 16 shallow wells for different persons under diverse payment arrangements. The well-digger maintained a large social network all over the *kebele* and beyond, which allowed him to find out about any well-digging enterprises. The biggest concern of the farmers was the provision and cost of used car tyres for stabilising the walls of the wells. Though the local agricultural extension officer was well aware of their expectations, he could not offer them any support as the administration had financial priorities other than well-building. Farmers expressed their willingness to extend irrigation by wells. One such farmer said:

> This area is my land (…) It contains a lot of water underground that I cannot access alone. I want to go to the Woreda Agricultural Office through the Development Agent so that they can construct a community well that can irrigate a large area of land here for everybody in this gote [village]. I will give my land for a big well here (farmer quoted in Otto, 2011).

Usually, farmers started up through their own means; in this example, a larger project was envisioned.

One community well without walls in Dokmit had already existed for about 12 years (see figure 6). It was built and used by a cluster of 20 households for domestic and small productive purposes. Users cleaned the well regularly, but were still concerned with possible pollution by livestock. Private wells were therefore clearly preferred to the community well.

Figure 6. Community well in Dokmit.

Ponds

The construction of ponds has a century-old tradition in Ethiopia and was propagated by several government programmes as a policy strategy to enhance food security. Ponds can be fed with run-off harvested from catchments as well as roadside ditches. They store about 130 m^3 of water (Bewket, 2009). From 2002 to 2004 alone, about 11,414 trapezoidal plastic-lined ponds were constructed in Amhara region (Ibid; based on data from the Bureau of Rural Development in Bahir Dar). Programmes of the past years have increased in budget and number of delivered facilities even though a significant effect of these water storage facilities is not yet evident. Experience shows that ponds are not

[2] The exchange rate during the time of research (April 2010) was 0.54 Birr = 1 Euro, means 50 Birr equalled about 9.26 Euro.

everywhere the most appropriate technology. Household ponds in Tigray, for example, were rather unpopular among the population. A number of organisational and technical problems occurred when farmers were directed to construct ponds by government agents. "Most household ponds failed, despite good design and techniques, because the social, economic and management factors were inadequately integrated into the pond development system" (Lemma, 2007). The two basic pre-conditions were not fulfilled: the motivation of farmers to participate in the food-for-work programmes for pond construction, as well as their participation at the level of knowledge exchange. Farmers' priorities and concerns could not be adequately communicated to the project leaders and accounted for; therefore, they stopped investing in the ponds when the food-for-work programmes phased out or abandoned the ponds (Lemma, 2007). Farmers usually contributed to the pond under the leadership of water harvesting experts and a food-for-work arrangement. Excavating holes went rather well, but lining the ponds with plastic or compacted clay seems to have been the main problem. Many ponds could not be completed and the structures collapsed in the next rainy season, meaning that the labour input was wasted. Since 2003, farmers are expected to pay 15% of the cost for building materials. Rämi (2003) referred to farmers who discovered shallow groundwater while digging for ponds and switched to shallow wells, as well as to large ponds which successfully recharged groundwater which could be tapped by wells year-round. The implementation of rainwater harvesting ponds was "a supply driven and top-down development intervention when farmers had little to say and implementing government agents had had to struggle to reach as many households as possible, particularly during 2002/03 when each drought-prone woreda was given a certain quota to meet" (Bewket, 2009).

Kuhar Michael kebele within the Fogera plains is, however, not identified as a drought-prone area. The Woreda Agricultural Office provides an extension service to support pond-building, although the office is not able to train farmers in construction. Rainwater harvesting is much less practised than groundwater withdrawal. Pond construction has taken place only in three cases in the hilly areas of the *kebele*, where shallow wells cannot be dug. In Mesno, a 3 metre-deep pond of 8 m x 8 m was dug in the proximity of the homestead and lined with polythene. Excavations were added to both sides of the pond to allow for water collection and temporary water storage. The pond contributes to livestock watering, domestic uses and serves irrigated horticulture. Specific numbers about the benefits of ponds are not reliable in Kuhar Michael kebele as only three ponds could be observed and the number of observations is therefore limited. The study by Bewket indicated that one pond or tank may support 16 to 625 m^2 of agricultural area. The evaluation, however, was very difficult because the use pattern of households showed high variation. Ponds were used for multiple purposes including domestic activities (Bewket, 2009).

In Kuhar Michael kebele, the availability of labour within a household was identified as a constraining factor for pond construction, as hiring labour significantly increased the price of water-harvesting facilities (400-480 ETB for wells and 750 ETB for ponds). The Woreda Administrative Office stated that the last polythene was distributed among a few farmers at a cost of 150 ETB in 2008. A lack of financial support from the *woreda*, as well as a paucity of construction skills, may explain the smaller size and bad state of ponds in the study *kebele* in comparison to documented ponds in other *kebelewotch* of Amhara region or Tigray.

River diversion

As the traditional Mesno irrigation has been in place for a long time, the exact construction process can only be assumed rather than documented with empirical data. The Mesno scheme uses mainly stream diversion through diversion canals and temporary head works made of stone and mud. During the dry season, about 40 ha of land are cultivated under the scheme. In fact, the scheme has no clear boundary, as it is also used for the supplemental irrigation of rain-fed crops in October and November. During this time, the scheme covers a much larger area, and key informants indicated that as many as 400 farmers make use of it for supplemental irrigation and raising onion seedlings for dry-season irrigation farming.

The Guanta and Lomidur schemes were originally based on the local knowledge of farmers. However, with the intention of extending the irrigated areas, diverting water and gullies presented a challenge for the farmers. Therefore, the Lomidur spring development was started by a non-profit Ethiopian NGO Organisation for Rehabilitation and Development in Amhara (ORDA), and the scheme became functional in 2001. ORDA developed many nearby springs, connecting them to a common main canal to irrigate 70 ha of land for 334 households. The extension of the Guanta small stream diversion started in 2005 and was completed in 2007 by the Ethiopian government. The governmental organisation known as Co-SAERAR (Commission for Sustainable Agriculture and Environmental Rehabilitation in Amhara Region) constructed a stone masonry diversion structure and a 1555 m main canal to transport water from the diversion, both of which turned the scheme into a modern irrigation system. The management structure continued as before (see below).

Small dams

There seems to be only limited knowledge on micro dams in the Abay river basin. This term covers surface water facilities that may irrigate up to 200 ha of land, as well as small dams which do not serve irrigation. "Micro dams are permanent bodies of water between five and 50 hectares in size, located by the government and used by villagers near the dams" (Anmacher et al., 2004). Past research mainly focused on geo-hydrology and health (Gunderson et al., 1998). Social-political implications within the basin and villages have rarely been investigated, but there is some literature on micro dam projects in the Tigray outside the basin (Lemma, 2007). Most micro dams are initiated by local communities and go undocumented.

Before the Shina-Hamusit micro dam project was launched in 2008 under the *Strengthening Emergency Response Abilities* (SERA) programme, farmers had to be convinced that they would be the beneficiaries and not some large commercial farm. There was no communication with the community before the implementation of the project, so the farmers feared for their landholdings, formed vigilante groups to deal with land theft and refused to cooperate with the experts from the Ministry of Agriculture. When one farmer tried to convince his neighbours about the project's benefits, the community turned against him; however, this farmer succeeded in convincing the ministry to depend on local labour for the construction of the dam. As a result, Shina community members were called during the *sambateh* get-togethers[3] and in church to join in the construction project. People were eventually involved as daily labourers thanks to the strong incentive to earn considerable amounts of cash even though their participation was not linked to landownership in the future scheme. Through this pay-for-work arrangement, the community already started to benefit from the dam before its inauguration. Young women still talk about the money for cattle, iron sheets for roofing parental houses and marriage capital they acquired from the scheme, which was co-financed by the Ethiopian government and FINIDA at a total cost of 780,118 ETB. Participants were able to invest the money in small businesses and livestock, pay back their debts or improve their housing conditions. Thus the project directly contributed to the alleviation of poverty in the community after a short period of time, even before farmers could benefit from irrigation agriculture.

In 2010, when a project for constructing terraces was initiated in Shina,[4] the community negotiated with the *woreda* administration over adequate payments (which came to about 10 ETB per half-a-day of work). Again, more than 150 farmers, especially young men and women, found it very attractive to support the project as labourers; consequently, the entire valley changed into terraces within just three weeks.

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[3] *Sambateh* get-togethers take place to observe a day of festivity and worship dedicated to a particular patron saint. They take place on a monthly basis and on the date assigned to the saint.

[4] Soil moisture (which is conserved through construction of terraces) is conceptualised as one form of water storage (Johnson and McCartney, 2010).

ACCESS TO LAND AND WATER – LOCAL MANAGEMENT BODIES

Land use rights in Amhara region

In irrigation schemes, water rights tend to be more formalised in irrigation schedules, but there are neither water markets in place nor fees for water. The prerequisite to accessing water is access to farm plots, which was regulated in Amhara National Regional State by the Land Reform Bill of 1997 (Ademassie, 2000; Adenew and Abdi, 2005). In addition, international donor organisations such as the *Gesellschaft für Technische Zusammenarbeit* (GTZ) and the Swedish International Development Agency (SIDA) engage in securing land rights in the region.[5] Male and female household heads can register for landownership by receiving administrative land use certificates which mentioned the names of husband and wife and also had their photographs attached to it. These certificates, however, do not result in security as the land remains state property and thus can be redistributed by government order at any time. Data from other irrigation schemes in Ethiopia further show that women's certificates may be highly contested when their social status changes. When becoming a widow and female household head, for example, the relatives of the late husband may claim back the land for their patrilineage (Eguavoen and Abwoyo, 2011).

The insecurity of land use rights may be precursors to the end of irrigation farming; however, a number of institutions set up for land-sharing (*kriyit* or *kiray*) and sharecropping (*yekul*) are prevalent in the region, and allow access to irrigation, without the need for a land use certificate.[6] The pattern of land use rights in Guanta did not change with the extension of the scheme, so farmers continued cultivating their land plots received in 1997 and external actors could only gain access to the scheme through sharecropping arrangements.

In interviews conducted at Shina-Hamusit dam, more than 90% of the respondents answered that every person in Shina community could find land to farm. This is true, as the majority of households have been able to access plots in and outside the scheme based on land allocation reforms introduced by the government in 1996. Women without husbands, however, were certainly not able to access farm plots equally – and hence had limited access to irrigation water. The use rights to plots remained the same as before the irrigation project when land was redistributed following the Bill introduced in 1997. Even though Shina is a comparatively small dam project, about 36 households lost their land, 12 of which were headed by women. Eleven households were fully or partly compensated, but others have still not received compensation or refused to accept land offered in exchange. There is a tendency for women to lose out when insisting on compensation without male support. What also became apparent in 2010 was that some of the women who had received land in 1997 had lost it again due to divorce or the death of their husband. Only 12 women held land certificates under their own names. Other women had also inherited land use rights from their late husbands, but were in danger of losing them through competition with men from their late husband's family. Based on land reform bills from 1975, which declare that land can only be owned by somebody from the community, leaders of the *kebele* may claim the land for community members. As women move to their husbands' homes after marriage, they tend to inherit land in their husbands' communities, not their community of origin. As land law prohibits the sale of plots in Ethiopia, widows can neither sell nor buy land somewhere else; however,

[5] Personal conversation with Mr. H. Zerfu, GTZ office, Bahir Dar, February 2010.

[6] *Kiray* or *kiryit* is land lease lasting for more than a year in exchange for money. It is considered legal as long as it does not exceed five years. Land rental of three years and above requires registration at the Woreda Environmental Protection and Land Administration Office. *Yekul* is a sharecropping arrangement where the landowner provides the land and the sharecropper covers all labour and capital costs for crop production. In other forms of *yekul* arrangement, the landowner provides the land, labour and seed costs while the other party provides motor pump and pumping costs. In both cases, at the end of the cropping season the contracting parties share the harvest equally (for multi-layer land renting arrangements in Tigray, see Segers et al., 2010).

illegal land sales occur very occasionally.[7] Another hindrance for female-headed households in irrigation is the cultural perception that women are unable to plough (McCann, 1995), which was more dominant in Shina than in adjacent communities and actually treated as a cultural taboo. Thus, the lack of male labour in the household was another crucial hindrance to irrigation farming.

Well owners, household clusters and 'water fathers'

Local water rights follow the riparian doctrine, meaning that water from rivers and streams can be diverted to adjacent farm plots or be carried to plots in the general proximity, such as in the Mesno traditional irrigation scheme or along the banks of smaller streams. Similarly, access to groundwater is usually linked to landownership, but not formally regulated. Water is free of charge, perceived as a gift from God and a basic right for everyone – at least for household water uses (Deneke et al., 2011). The data hint to the fact that until the end of the 1990s, the usage of wells and natural springs fell under an open access regime as most of the wells were community wells; construction of private wells seems to have started afterwards.[8]

Wells and ponds are managed through minimal regulation, but maintenance has been identified as a bottleneck to sustainability. Farmers in Fogera do clean their wells regularly (on a monthly or annual basis) and take measures against water pollution. Households also apply chlorine (*uhwagar*), provided free of charge by the Kebele Health Centre. Maintenance is organised by the well owner and is based on household or communal labour arrangements. Well owners do not officially demand water users to participate in maintenance; instead water users participate, based on their own interest that the wells are kept clean and functional.

For the Mesno traditional scheme, no formal user organisation is in place (Deneke et al., 2011). Instead, the scheme is administered by the two 'water fathers' (*wuha abbat*) elected by the *kebele* leader, who own plots in the scheme and serve as overseers of the scheme. 'Water fathers' allocate water among irrigators and coordinate canal clearing activities. In Mesno 'water fathers' are appointed for one year only.

Open access to wells and ponds with seasonal limitations

From November to March, wells would be accessed freely by neighbouring households for domestic purposes and livestock watering, even though they were privately owned by particular households. From April to June, the use of the well was restricted to the household of the owner. About 70% of the respondents stated that this was a policy introduced to avoid over-exploitation that might cause low water levels in the wells: "Between April and June every year, I control the amount of water consumed per day. Like, for example, I sometimes stay without bathing, reduce the frequency of washing and also water the crops twice a week instead of three times a week" (farmer quoted in Otto, 2011). Owners of ponds started to limit open access to the pond when the dry season began, meaning that other households would have to fetch water from rivers, springs or boreholes.[9] Even though owners of wells and ponds had the right to exclude people when water was scarce, this situation often led to conflicts: "(T)here are always poor relationships in times of extreme water shortage" (Otto, 2011).

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[7] Segers et al. (2010) suggest that what is referred to in the literature as land sales are often long-term land rental arrangements.

[8] This seems to have differed in other parts of the highlands as Ramazzotti (1996) states "the variety of customs is even greater than the one for land […] Wells are used for people and for watering cattle. Consequently, wells can be strictly owned by individuals as well as by communities. Property rights over a well can be originated either by digging it or taking it over. If several individuals take part in the digging, the well will belong to them in joint ownership".

[9] Developed springs and boreholes are facilities controlled by a committee and an attendant. They are used solely for domestic purposes. The Woreda Office is in charge of larger repairs while smaller maintenance jobs are ensured by the collection of an annual user fee (8 ETB per household). Such facilities may be used by up to 100 households from different villages.

Water user associations

There is a blueprint for WUA by-laws, prepared by the Amhara Regional Bureau of Cooperatives Promotion (ARBoCP). Upon establishment, WUAs adopt these operational rules without much customisation to fit local conditions. Offices at the *woreda* level and the *kebele* administration also interfere in the day-to-day activities of WUAs, beyond giving necessary technical support. As a result, WUAs tend to be perceived as imposed governance structures with low levels of effectiveness, even in the face of trivial problems. In addition, officials of WUAs tend to lack basic knowledge, skills and experience in various aspects of managing the associations. The fact that WUAs are not formed by farmers undermines their legitimacy and local acceptance. Despite the same blueprint policy, the practical outcomes may vary significantly.

Soon after the completion of the Shina-Hamusit dam in 2008, the *Serk-Eshet Aragewi* (Evergreen) WUA was formally set up for the management of irrigation structures, following the recommendation by the Ministry of Agriculture and as a precondition for handing over the project to the Shina community. Even though the WUA was imposed on the community and regulation was set up in a top-down manner (e.g. quota for female WUA members and female executive members), farmers expressed satisfaction with the association's work, which supported its members in various other ways besides irrigation. After the payment of an entrance fee of 30 ETB and a minimum capital contribution of 120 ETB, landowners in the scheme became registered members. Farmers could take part of the money earned from dam construction to become members of the association. In March 2010, 106 households were registered including 12 female-headed households. Landowners who cannot afford the initial payments stand outside the WUA. This means they are also excluded from additional benefits that the WUA provides. The association administers a fund for seed money from capital contributions, takes investments and shares profits among the members, while agricultural products are bought and resold at better prices to members. Moreover, sales and resales are supposed to regulate market prices, as the association holds back some part of the harvest and releases it when the ratio between supply and demand allows for better prices. This has not always been successful, though. The Ministry of Agriculture uses the association to channel the provision of improved seed varieties.

The management of the scheme is organised through six committees: the executive committee, the coordinating committee, the purchasing and supply committee, the credit committee, the tertiary committee (responsible for tertiary canals) and the gender committee. Committee members need to be members of the WUA and require a basic formal education. They work for a two-year period, but can be expelled if members are not happy with their work. The most important decision-making body is the general assembly of all members headed by the executive committee and its chairman. The executive committee has seven members including one woman and deals with organising meetings, the preparation and submission of by-laws which will be approved by the general assembly, the sanction of rule-breaking and the settlement of disputes about water and occasional domestic disputes.

A WUA was also legally registered as a cooperative at the Regional Cooperatives Promotion Bureau for the management of the Guanta-Lomidur scheme. As Deneke et al. (2011) argue, the association does not work efficiently because the local abundance of water does not call for strict allocation regulations. Moreover, as a consequence of opportunistic behaviour by WUA officials and the consequent lack of trust in the WUA by farmers,[10] the WUA has disintegrated; it neither supplies seeds and sale outputs nor collects water fees and allocates water among irrigators. Interesting for the assessment of management is also the low rate of WUA membership among the users of the scheme – only 28% of all households paid the required entrance fee of 25 ETB and received decision-making

[10] A trader based in Bahir Dar supplied farmers in the WUA with poor-quality onion seeds that led to crop failure. Another trader from Addis Ababa disappeared without paying for the onions he bought from the WUA. Many farmers in Guanta-Lomidur have lost their money as well as their trust in the WUA. Lawsuits in the regional and *woreda* courts are still held up, sparking suspicions among farmers that WUA officials have negotiated with the traders and forsaken them.

rights over rules and water allocation. Farmers were discouraged to join the WUA because they found it difficult to distinguish between the purpose and potential benefits of the WUA and the government-imposed former form of cooperatives during the Derg. *Kebele* officials, being more familiar with formal management frameworks, however, took up the opportunity to have their say in local water management by becoming WUA members. Nevertheless, the incidences of water theft (taking water from outside the schedule) and bribery to obtain allocated water hint to the rather low compliance of farmers with WUA regulations. Finally, it is a matter of perspective as to which claims are acknowledged as legitimate and which are considered as water thefts.

Water allocation and irrigation schedules

There are no regular irrigation schedules in Mesno traditional irrigation. However, during the dry seasons, turns for individual fields occur on average every 21 days. The former local chief priest, however, enjoys unique water rights in the scheme which entitle him to make exclusive use of water during the weekends to irrigate his fruit trees on plots of land along a stream used for traditional irrigation by the villagers, as well as his chat field located far from the stream and irrigated with a motor pump. This institution is called Sabbath water (*yebe'al-wuha*). As the farmers pointed out, during Emperor Haile Selassie's regime (1930-1974) rights to Sabbath water used to belong to farmers or their ancestors who had played a significant role in the establishment of the local church *(bete-abenet)*. The entitlement was granted to them as a reward for their deeds. Under the Derg, these farmers lost all their lands (and water rights) during the nationalisation of land resources, based on claims that they were 'feudal landlords' (compare Ege, 2002). The chief priest of the local church by that time claimed the right to the Sabbath water for his land plots. Later, when his son had become *kebele* leader and stayed in power for more than 15 years, the former local chief priest could consolidate his claim.

The area to be irrigated by the Guanta river was planned to be about 46 ha, but farmers had extended the scheme by about 41 ha by pumping in the upper and downstream parts of the formal canal infrastructure. Whilst the upstream farmers pumped water to the upper part, which lies on a higher elevated area, water flow did not always reach those at the tail end of the scheme, resulting in conflict over the water resources between farmers upstream and downstream of the system. Incidences of violence were reported, as well as cases of water theft and bribery instigated by those at the very end of the system. Water rights were ascribed to all users of the formal scheme who did not face practical difficulties in accessing water. Claims by 'tail enders' were turned down by arguing that no water rights could be claimed outside the formal canal structures (Deneke et al., 2011). This, of course, is only half-true, as farmers in the upper part claimed such rights successfully. Their claim, however legitimate, could be turned to their favour by their location at the head of the scheme, as well as their favourable political position in the *kebele* and in Nora.

Users of the upper part were identified as *kebele* officials, who maintained sharecropping arrangements with farmers from the local community. Being officially landowners within the schemes and supporting one another politically, these *kebele* officials succeeded in becoming members of the local WUA. Members of the WUA formulated rules for water allocation (see below). As government staff, the *kebele* officials within the WUA clearly showed a preference for written-up WUA project law and by-laws for water allocation – as applied in modern irrigation schemes. Local water rights that had evolved in the plains were about to be neglected. These rights, though not codified on paper, were known to the local farmers in Nora. In water conflicts, the WUA referred to written by-laws and negated other claims that were part of local tradition.

With regard to land rights, it is important to underline that land was not redistributed in the course of the project, but farmers who owned plots in the command areas by random chance became beneficiaries of irrigation. As a result, other people were excluded from the project such as newly established farmers and household heads (Deneke et al., 2011). Figure 7 shows the Guanta-Lomidur scheme.

Figure 7. Guanta-Lomidur scheme.

Note: the picture shows high water loss for irrigable land where the lined canal ends.

Failure of WUA management in Guanta reduced the overall efficiency of the scheme. There was considerable water loss through seepage. Pumping water from the canals exacerbates conflicts over water among the head-end and tail-end farmers. Water is provided for free, but farmers from the upper part of the system closer to the source also pump water. Because they have to bear the cost of pumping, there is measurably more efficient water application in the upper part of the scheme in comparison to the downstream areas that relied on gravity flows. Farmers also constructed field canals in a way that led to the non-use of large tracts of irrigable land for some unclear reason (Derib et al., 2011). Generally, informal extensions of the scheme created more complexity in management as the number and connections between the irrigation canals increased, the area of the scheme was extended and the demand for water and number of farmers increased, too. The WUA was not able to control this development.

In Shina, there are eight tertiary canals, each managed by a committee. With at least one volunteer for each canal, committee members open gates to allow water to flow to one canal every day in order to water the adjacent fields. This rotational water allocation is based on the water requirement of the plants. All farming activities are carried out in such a way as to coincide with rotational water supply. Thus, water is let into the field of each WUA member once every other week. Farmers can ask for a supplementary water supply when the need arises, often because they are now cultivating crops which were not considered when designing the water schedule. The rotational system works well because of sufficient knowledge about the water requirements of the majority of users, so members do not often ask for additional water. There have only been a few instances when single farmers had diverted water into their fields outside the schedule, which is referred to as water theft and sanctioned by the committee.

THE CONTRIBUTION TO LOCAL LIVELIHOODS AND SOCIAL DYNAMICS

Agricultural production, nutrition and health

The ownership of wells and ponds was especially crucial for people living some distance from the river or not having agricultural plots by the riverside. Well owners and people who could not irrigate from their neighbour's well recounted that well owners are able to produce more and a larger variety of crops for sale. They mentioned health benefits due to better diets and cleaner water, and the reduction of waterborne diseases such as dysentery, typhoid and diarrhoea. There were also reported reductions in the cattle disease *gendy* (trypanosomiasis), which is associated with drinking dirty and stagnant water in the plains where cattle had to be driven in the dry season.[11] On average, well owners reported having two more head of cattle 3 years after the construction of the well, and that they started being able to afford veterinary services. Farmers with wells estimated that their household income (including crops for subsistence) had doubled after the construction of wells.

The productivity of irrigation water in Guanta was still low compared to what is given in other studies (Derib et al., 2011). Water use was efficient in pump irrigation, since it had costs associated with it. Lack of knowledge and technical skills hindered higher productivity through gravity irrigation. According to field surveys in 2009, 4 to 25% of diverted water from springs and rivers did not reach the farm plot due to problems with water storage, diversion, conveyance and application, as well as due to problems with the control of night flow in darkness (Derib et al., 2011).

Besides admiring the new green beauty of their landscape, farmers in Shina reported that their teff and potato harvest had doubled under irrigation. Significant increases were gained also in millet and pepper. Chat, onion, tomato, cabbage and pawpaw have become common local crops. By producing surplus supply, the community became more involved in Hamusit market activities, which manifested in consumption patterns as well. Desired items were clothes, mobile phones, guns, water pumps, and more cows for the production of milk. Some items were brought in to the region rather than produced locally. Before construction of the dam, women shifted from producing local cotton clothes to buying industrially produced clothes. As irrigation agriculture required more labour, men and women started spending much more time together while cultivating than before the dam, which had some impact on relationships inside the family (see below).

Conflicts over water

The studies suggest that the bigger and more complex the facility, the bigger the risk for elite capture and conflict over water allocation. They also illustrate farmers' abilities to act collectively towards a common interest. Well ownership qualifies farmers to become members in the *gimbarikadam* (farmers' first leaders) – a governmental forum which allows for easier contact with the local administration and government, enhances access to information and is also used to mobilise farmers in political campaigns. In Kuhar Michael Kebele, 106 farmers were members in the *gimbarikadam* during the time of the research.

The majority of farmers plant the same crops, usually onion or tomato, which leads to similar water demands at critical stages of crop growth. As a result, there is fierce competition over water among farmers. Water-related conflicts usually arise due to poor water management practices, opportunistic behaviours of some actors and the short supply of water due to prolonged dry seasons.

In Mesno, the old Sabbath water institution was also a source of conflict among farmers. Sabbath water rights are increasingly challenged by younger farmers, who do not give the same priority to ecclesiastical elites as their fathers and forefathers used to do.

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[11] Trypanosomiasis is caused by tsetse flies. Another cattle disease caused by drinking water infested with leaches is called simply 'leaches'. The farmers were probably referring to this particular disease.

The WUA in Guanta-Lomidur could have implemented water allocation schedules and provided a conflict resolution mechanism, but staff from the *kebele* administration held key positions in the WUA and pursued their own interests, which differed from those of most local farmers.

Gender and age relations

Gender aspects were relevant in all studies, mainly due to the gendered division of labour, limited direct access to farm plots by women and low bargaining power of women for changing water schedules. At the Guanata-Lomidure scheme, women from female headed households indicated that they preferred to sharecrop their farmlands rather than engage in irrigation, as they lacked labour and capital. One of the researchers met a woman farmer tending her wilting onion field and letting animals feed on the crop. She disclosed that she could not irrigate her field at the right time, as she was not able to bribe the water distributors. She indicated that being a woman she could neither go to the local pub to drink with the committee members nor socialise with them to get water at the right time. In addition, domestic work left her with no time for such things.

The Shina study revealed that the most common economic activities of women besides farming on family plots were the collection of cow dung and fuel wood, as well as working for a daily wage on other farmers' plots. Going out to earn money was reported to result in the better treatment of women by their husbands as women could contribute money to the household income and take care of some of their needs by themselves, such as better clothing. The majority of male respondents and one third of the women respondents said that their life had improved through spending more time together as a family, especially because the men would spend less time in Hamusit or Woreta drinking. These accounts indicate that some changes are on the way with regard to gender relations, and most of them could be linked directly to the dam project:

> Most of the women (…) think that the men have changed the way they treat them (…) The majority of the men also believed that women have the right to sell whatever amount of produce they want and that they should use the money in whatever ways they want. (…) It was noted by many women that (…) wife beating is dying out and that men no longer demand that women wash their feet (…) after a hard day's work [which used to be a common cultural practice] (Billa, 2011).

Youth factions in Kuhar Michael Kebele faced difficulties in accessing the benefits of irrigation because they had no regular access to plots of land. Young men cultivated marginal lands. The situation became a local issue, so the Kuhar Michael Church started to rent out 8 ha of land to landless youth for cultivation (Ali et al., 2011). In Guanta Lomidur, some farmers, each of whom has been allocated land under the scheme, rent out parts of their land to the landless youth. Other landless young farmers have become traders and brokers of farm products.

CONCLUSION

We wanted to shed light on the social-economic aspects of small-scale irrigation in Fogera, some of which are expected to fade away when large parts of the Fogera plains serve as the command area for the Gumara irrigation project. Expansion of irrigation is not possible without some socio-economic or environmental cost. The realistic evaluation of these costs in advance of a project, based on empirical data from existing projects, may guide the assessment of the possible future outcome. This article contributes to this effort by providing baseline information on access to land and water and existing local management options which can later be used in assessing the social-political impacts of the Gumara and Ribb dam projects.

Currently, there is great uncertainty about the likely impacts of climate change in the Blue Nile basin and in Ethiopia in general (McCartney and Menker, 2012). For the Tana lake region, Kim and Kaluarachchi (2009) have found a generally increasing trend in both precipitation and run-off in the northern part of the Blue Nile basin, but other studies have indicated a decline in rainfall and run-off into the lake (Shaka, 2008). By modifying both water availability and water demand, climate change will affect the need, performance and suitability of different water storage options. Each water storage option has different comparative advantages under specific conditions of time and place. Hence, we argue for storage 'systems' that combine and build on complementarities of different storage types and take specific local social and technical conditions into account to identify the most appropriate local source for irrigation. Such systems are likely to be most effective and socially much better reconcilable than large dam projects. Socio-economic constraints occur also in smaller projects but can be easily identified and tackled. Farmers may translate their interest in irrigation in local activities and investment that take less time than large dam projects, have less effect on existing land use rights, keep the decision-making role with the local water users and pay off earlier than large projects in terms of money for work programmes, earnings and increased agricultural produce.

With large-scale irrigation projects, land redistribution is almost always inevitable. As a consequence, the size of agricultural plots has decreased significantly per household (Tefera and Sterk, 2008; Marx, 2011; Eguavoen and Tesfai, 2012). In small irrigation projects, this is not the case, as land redistribution has rarely taken place. Access to land for young farmers and female-headed households, however, remains a challenge but has been partly dealt with by local land renting and sharecropping arrangements. Nevertheless, these local arrangements also allow influential people from outside the communities to monopolise water allocation. While avoiding land reallocation increases farmers' sense of tenure stability, it can also increase rural inequality (Deneke et al., 2011). It seems quite random as to who benefits from irrigation within a local community, as land plots and plot sizes are not adjusted to give needy community members the opportunity to benefit without becoming involved in sharecropping.

In the Fogera plains, it is important that more research is conducted to determine exactly how the planned large-scale water storage and irrigation schemes will actually impact on existing smallholder schemes that we have documented. Documentation of local property rights also gains importance in the face of competition over land and water resources between local farmers and foreign investors (Bues and Theesfeld, 2012). While the future impact of climate change in the Ethiopian highlands remains uncertain (Shaka, 2008; Kim and Kaluarachchi, 2009; Eguavoen and zur Heide, 2012), the hydrologic model projection shows that large dams will severely impact the hydrology of the plains, while social-economic assessments at the large Koga dam suggest some future social consequences (Eguavoen and Tesfai, 2012). The studies indicate the value of an approach that extends storage capacities and considers small and large schemes as complementary, instead of eradicating existing systems as a side effect of large dams – mainly out of non-consideration in planning.

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REFERENCES

Anmacher, G.S.; Ersado, L.; Grebner, D.L. and Hyde, W.F. 2004. Disease, microdams and natural resources in Tigray, Ethiopia. Impact on productivity and labour supplies. *Journal of Development Studies* 40(6): 122-145.

Adenew, B. and Abdi, F. 2005. *Land registration in Amhara region, Ethiopia*. London: International Institute for Environment and Development.

Ademassie, Y. 2000. *Twenty years to nowhere. Property rights, land management and conservation in Ethiopia*. Asmara: The Red Sea Press.

Ali, H.; Descheemaeker, K.; Steenhuis, T.S. and Pandey, S. 2011. Comparison of land use and land cover changes for a moisture sufficient and drought prone region in the Ethiopian highlands. *Experimental Agriculture* 47(1): 71-83.

Billa, S.S. 2011. Gender aspects in the use of land and water resources. Shina-Hamusit micro-earth dam project in Ethiopia. MA thesis, Culture and Environment in Africa, University of Cologne, Germany.

Bossio, D.; Erkossa, T.; Dile, Y.; McCartney, M.; Killiches, F. and Hoff, H. 2012. Water implications of foreign direct investment in Ethiopia's agricultural sector. *Water Alternatives* 5(2): 223-242.

Bewket, W. 2009. *Rainwater harvesting as a livelihood strategy in the drought-prone areas of the Amhara Region of Ethiopia.* Addis Ababa: OSSREA.

Bues, A. and Theesfeld, I. 2012. Water grabbing and the role of power: Shifting water governance in the light of agricultural investment. *Water Alternatives* 5(2): 266-283.

Deneke, T.T.; Mapedza, E. and Amede, T. 2011. Institutional implications of governance of local common pool resources on livestock water productivity in Ethiopia. *Experimental Agriculture* 47(1): 99-111.

Derib, S.D.; Descheemaeker, K.; Haileslassie, A. and Amede, T. 2011. Irrigation water productivity as affected by water management in a small-scale irrigation scheme in the Blue Nile basin, Ethiopia. *Experimental Agriculture* 47(1): 39-55.

Ege, S. 2002. Peasants' participation in land reforms. The Amhara land distribution of 1997. In Zewde, B. and Pausewang, S. (Eds), *Ethiopia. The challenge of democracy from below,* pp. 71-86. Upsalla: Nordiska Afrikainstitutet.

Eguavoen, I. and Abwoyo, C. 2011. Certificates and contestation. Land tenure security for female farmers in Ethiopia. Poster at the Annual Meeting of the American Association of Anthropologists, November, Montreal.

Eguavoen, I. and Tesfai, W. 2012. Social impact and impoverishment risks of the Koga irrigation scheme, Blue Nile basin, Ethiopia. *Afrika Focus* 25(1): 39-60.

Eguavoen, I. and zur Heide, F. 2012. Klimawandel und Anpassungsforschung in Äthiopien. *Zeitschrift für Ethnologie* 137(1): 97-118 (in press).

FDRE (Federal Democratic Republic of Ethiopia). 2002. *The national water resources policy.* Addis Ababa.

Fogera Woreda Planning and Monitoring Office. 2010. Annual report. Unpublished document.

Gundersen, S.G.; Birrie, H.; Torwik, H.P.; Medhin, G. and Mengesha, H. 1998. Delayed reinfection of Schistosoma Mansoni in the Blue Nile valley of western Ethiopia 10 years after mass chemotherapy. *Acta Tropica* 70(1): 35-42.

Johnston, R. and McCartney, M. 2010. *Inventory of water storage types in the Blue Nile and Volta river basins.* IWMI Working Paper No. 140. Colombo, Sri Lanka: International Water Management Institute.

Kim, U. and Kaluarachchi, J.J. 2009. Climate change impacts on water resources in the upper Blue Nile River basin, Ethiopia. *Journal of American Water Resources Association* 45(6): 1361-1378.

Kloos, H. and Legesse, W. 2011. Small-scale irrigation and micro-dams. In Kloos, H. and Legesse, W. (Eds), *Water resources management in Ethiopia: Implications for the Nile basin*, pp. 104-122. Amherst: Cambria Press.

Lemma, M. 2007. *The agricultural knowledge system in Tigray, Ethiopia. Recent history and actual effectiveness*. Weikersheim: Margraf Publishers.

Marx, S. 2011. The political ecology of irrigation management in the Blue Nile basin. Impacts of global environmental policies on local adaptation in the Koga irrigation project, Ethiopia. MA thesis. Cultural and Social Anthropology, University of Cologne, Germany.

McCann, J. 1995. *People of the plow: An agricultural history of Ethiopia*, *1800-1990*. Madison: The University of Wisconsin Press.

McCartney, M. and Menker, M. 2012. Evaluating the downstream implications of planned water resource development in the Ethiopian portion of the Blue Nile River. *Water International* 37(4): 362-379.

Otto, B.A. 2011. Access, acquisition and usage of shallow wells and ponds in Kuhar Michael Kebele, Gumara watershed, Ethiopia. MA thesis. Culture and Environment in Africa, University of Cologne, Germany.

Pankhurst, R. 1986. The thermal baths of traditional Ethiopia. *Journal of the History of Medicine and Allied Sciences* 41(3): 308-318.

Ramazzotti, M. 1996. *Readings in African customary water laws*. FAO Legislative Study No. 58. Rome: Food and Agriculture Organization.

Rämi, H. 2003. *Ponds filled with challenges: Water harvesting experiences in Amhara and Tigray*. Report of the United Nations – Office for the Coordination of Humanitarian Affairs assessment mission. Addis Ababa, Ethiopia.

Segers, K.; Dessein, J.; Hagberg, S.; Teklebirhan, Y.; Haile, M. and Deckers, J. 2010. Unraveling the dynamics of access to farmland in Tigray, Ethiopia. The 'emerging land market' revisited. *Land Use Policy* 27(4): 1018-1026.

Shaka, A. 2008. Assessment of climate change impacts on the hydrology of the Gilgel Abbay catchment in the Lake Tana basin, Ethiopia. MSc thesis. University of Twente, Faculty of Geo-Information Science and Earth Observation, the Netherlands.

Tefera, B. and Sterk, G. 2008. Hydropower-induced land use change in Fincha'a watershed, western Ethiopia: Analysis and impacts. *Mountain Research and Development* 28(1): 72-80.

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