ZEF

Zentrum für Entwicklungsforschung
Center for Development Research
University of Bonn

Working Paper Series 84

Irit Eguavoen, Sisay Demeku Derib, Tilaye Teklewold Deneke, Matthew McCartney, Ben Adol Otto, Saeed Seidu Billa

Digging, damming or diverting? Small-scale irrigation in the Blue Nile basin, Ethiopia

universitätbonn

ISSN 1864-6638

Bonn, December 2011

ZEF Working Paper Series, ISSN 1864-6638
Department of Political and Cultural Change
Center for Development Research, University of Bonn
Editors: Joachim von Braun, Manfred Denich, Solvay Gerke, Anna-Katharina Hornidge and Conrad Schetter

Authors' addresses

Dr. Irit Eguavoen
Center for Development Research,
University of Bonn, Germany
E-mail: eguavoen@uni-bonn.de
www.zef.de

Tilaye Teklewold Deneke
E-mail: ttddeneke@yahoo.com

Ben Adol Otto
Advocates for Research in Development
(ARiD)
Pader District, Northern Uganda
E-mail: ottobenadol@yahoo.co.uk

Sisay Demeku Derib
Center for Development Research,
University of Bonn, Germany
E-mail: sdemeku@yahoo.com
www.zef.de

Matthew McCartney, PhD
International Water Management Institute
East Africa and Nile Basin Office
Addis Ababa, Ethiopia
E-mail: m.mccartney@cgiar.org

Saeed Seidu Billa
E-mail: saebilla@yahoo.com

Digging, damming or diverting?

Small-scale irrigation in the Blue Nile basin, Ethiopia.

Irit Eguavoen, Sisay Demeku Derib, Tilaye Teklewold Deneke,
Matthew McCartney, Ben Adol Otto, Saeed Seidu Billa

Acknowledgements

We thank the German Federal Ministry for Economic Cooperation and Development for project funding, the IWMI in Addis Ababa for logistical support, our academic supervisors and the Center for Development Research in Bonn, the University of Cologne and the Humboldt University in Berlin.

Please quote as:

Eguavoen, I., Sisay Demeku Derib et al. 2011. Digging, damming or diverting? Small-scale irrigation in the Blue Nile basin, Ethiopia. ZEF Working Paper 84. Bonn.

Abstract

The diversity of small-scale irrigation on the Fogera plains, in the Ethiopian Blue Nile river basin, includes small dams, hand-dug wells, ponds and river diversion systems. These facilities, however, receive little political attention in negotiations over Nile resources, which focus primarily on large dams. Nevertheless, they are important in relation to their impact on local livelihoods, as well as their potential to contribute to adaptive capacity in the light of anticipated climate change. The diversity of irrigation infrastructure is partly a consequence of the topographic heterogeneity of the plains, as well as a range of other biophysical factors. Communities within the region cope with similar social-political conditions, the same administrative framework and similar access to markets, yet facilities are still acquired, used and managed differently. Production systems as well as the social dynamics accompanying them are far from homogeneous, though, which calls for critical evaluation, especially as small scale irrigation is managed by beneficiaries; a policy paradigm just starting to be implemented for large dams in Ethiopia. The article also discusses the impact of large dams on the hydrological regime of the plains, as well as the possible impact of anticipated climate change.

Keywords:

Amhara, Fogera, water storage, acquisition, management, climate change

1 Agricultural challenges in the Fogera plains

> "Any new legislative provision for dealing with water ownership, distribution and use should take into consideration the existing water uses and customs of the […] region concerned".[1]

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 clearly highlighted in the National Water Resources Policy (FDRE, 2002). This form of irrigation has clearly 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 schemes south of Bahir Dar will be finalised in the coming year, while upstream of the Fogera plains, wetland 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. The question is whether small-scale irrigation and large dams may co-exist and in combination constitute an adequate strategy to meet the challenges posed by anticipated climate change.

Therefore, we take a closer look at Fogera woreda and Dera woreda[2], where there is already a diversity of small irrigation infrastructure including small dams, hand-dug wells, ponds, spring irrigation systems and river diversion systems, referred to as Guanta and Dilmo modern irrigation schemes, 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 ambiguous 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 very similar social conditions, follow Orthodox Christianity, are administered by the same political and bureaucratic framework and enjoy equal 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, which calls for a critical inventory, especially because sources for small irrigation are already managed locally by beneficiaries – a policy paradigm and management option envisioned for upcoming large irrigation schemes in Ethiopia by both government and donors, and in the process of being implemented in the Koga irrigation scheme in ANRS, where about 7,000 ha of irrigated land will be managed by a professional operation team (dam, reservoir and primary to secondary canals) in cooperation with farmers in charge of infrastructure beyond secondary canals.

The Fogera plains gave the name to Fogera woreda of the South Gondar zone in ANRS. The 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 twenty-nine 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 whose beds cross the plains and drain to the lake, about 21.4 per cent 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 should not belie seasonal variations ranging

[1] Ramazzotti (1996 quoting Caponeira 1956: Report to the Imperial Government of Ethiopia on Water Control and Legislation).

[2] *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 (sing. *woreda*, pl. *woredawotch*).

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 eight months are dry. Based on measurements from Bahir Dar and Woreta, the annual rainfall has been calculated at 1248 mm, with a mean maximum daily temperature of 27 °C and a minimum of 12 °C (Derib et al. 2011).

Generally, Fogera woreda is considered food-secure. However, the plain's potential for grain production is yet to be fully exploited. Irrigation is about to play a central role in pushing the production to an extent that helps to support local livelihoods and alleviate poverty, as well as to mitigate the short supply of food elsewhere in the country. It is, however, important to stress that 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. Only 3.7% of the land is too steep to support agricultural production. Wetlands counting about 20% are exceptionally important (see Table 1). Naturally, the land share of wetlands is higher in woredawotch closer to Lake Tana.

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%
Grazing land	26,999	24%
Wetlands	23,354	20%
Infrastructure and settlement	7,075	6%
Unproductive land (slopes)	4,375	3.7%
Forest land	2,190	1.8%
Swamp land	1,698	0.2%
Perennial crop	2,190	1.8%

Source: Fogera Woreda Planning and Monitoring Office, 2010

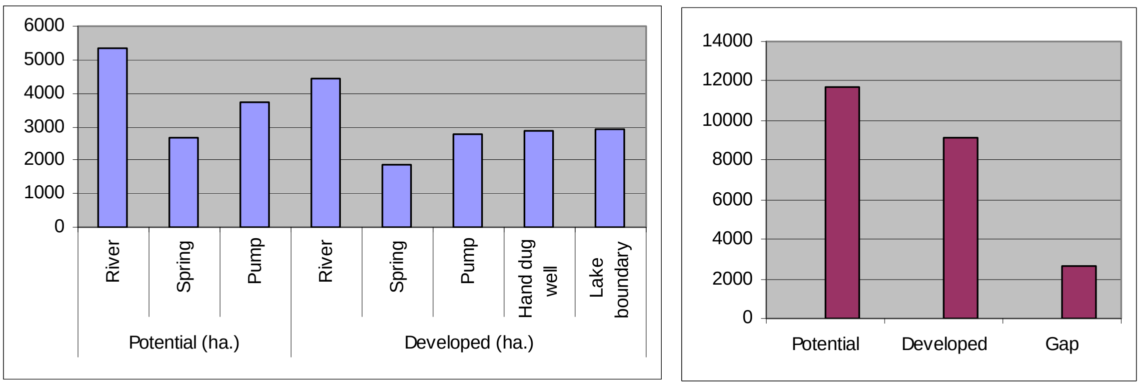
Challenges that inhabitants in Fogera face include floods, which can bring prosperity when regular and used for irrigation. Extreme floods, however, may be devastating in some years, such as in 2006 which led to loss of lives and economic assets. Animal feed shortages also occur regularly during flood 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. Soil cracking indicates low soil moisture and the low water storage capacity of the soil. Consequently, in some parts of the plains, soil and water conservation projects are ongoing. Whilst variations in water availability are caused by natural processes, anthropogenic influences also come into play, such as the extension of irrigation by drawing water from aquifers, or by river diversion.

Production in Fogera goes beyond grains like teff, finger millet, maize and recently introduced rice production. A variety of vegetables such as tomatoes, onions, potatoes, peppers, chat, cabbage and pawpaw are also produced in dispersed gardens and small irrigated fields. From October onwards, farmers use 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. The implementation of large dam projects upstream, as well as anticipated climate change, will therefore pose additional challenges to agriculture.

2 Small-scale irrigation in the Fogera Plains

We have selected four case studies 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. 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 ADLI (Agriculture Development-Lead to Industrialization and Development) policy was implemented and led, among other things, to the increase of irrigation infrastructure. Moreover, various drinking water development projects have been implemented by either the government or international NGOs, such as the Finnish International Development Assistance (FINIDA) and German Agro Action. 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.

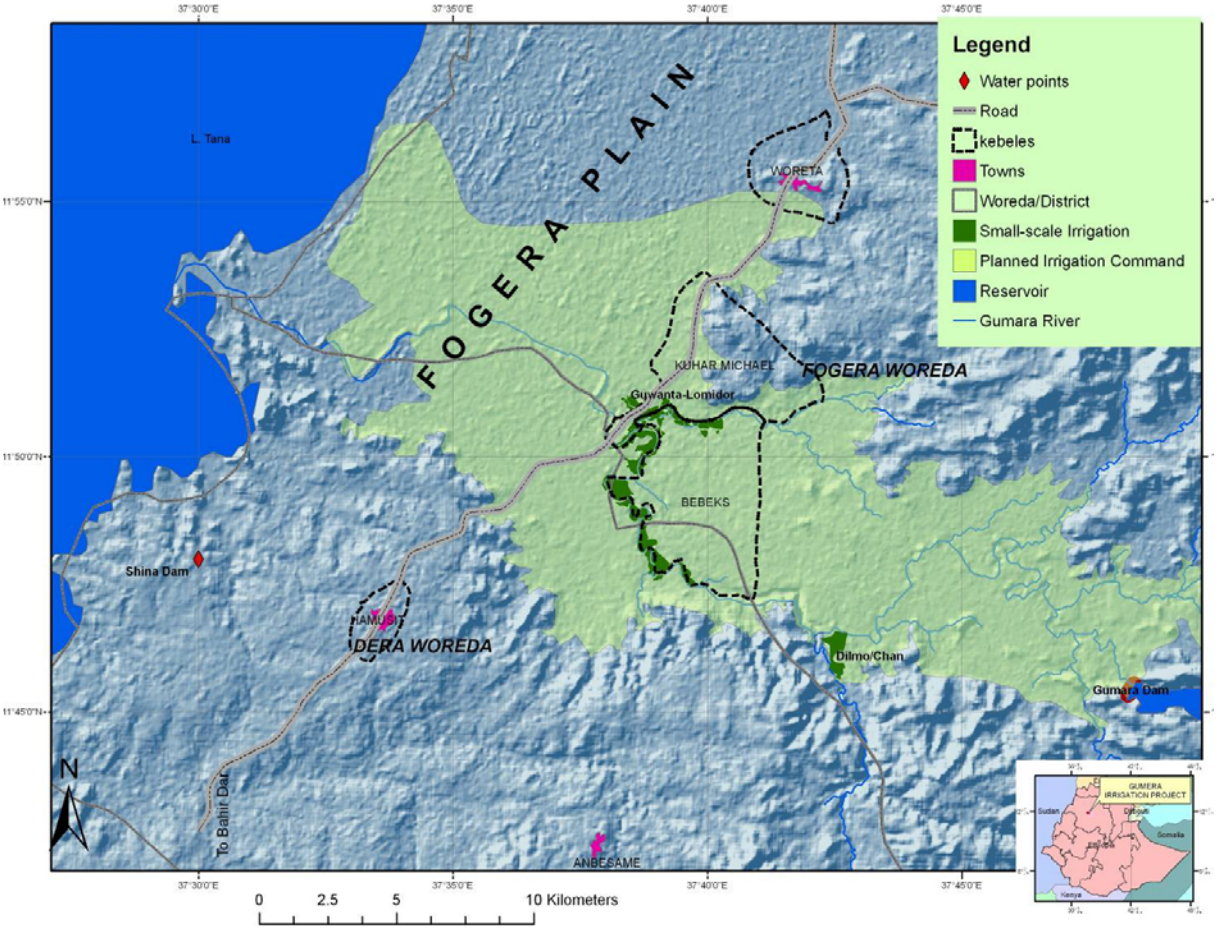
Figure 1: Small-scale potential and developed irrigation coverage (in ha) of the *woreda* in 2009



Source: Raw data from the Fogera woreda Rural and Agriculture Development Office/ Water Resources Division, where “river” includes forms of irrigation using gravity from river water and “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 2009’s irrigation season show only areas supplied by river diversions, spring developments and pumps along the streams. Hand-dug wells, lake shore pumping stations, undeveloped springs, traditional diversions and pumping stations are not illustrated here.

Figure 2: Irrigation locations in the Fogera plains



Source: 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

Wells and ponds

Wells and ponds are point sources and 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, 2010). According to data from the Woreta Woreda Office of Water Resources, a total of 4,013 wells were not functional due to high seasonal drawdown and the collapse of wells. Thus, it would be an error to assume that new water facilities have always added to the total number, because the failure of wells and ponds led to the abandonment of facilities in the same period.

Kuhar Michael Kebele is located on the road before reaching Woreta from the south. The *kebele* displays flat areas, which represent the plains, as well as hilly areas in its eastern part and consists of ten hamlets or villages, with a total population of 6,700 people. There is exists basic rural infrastructure such as electricity, 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 Barage 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 modes of management. The dominating category in the *kebele* was a round hole about 13 to 20 m deep, providing water during the eight-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 tires to prevent the structure from collapsing; this can be considered the third type of well.

Figure 3: A well, stabilised with a metal tun

A wooden drinking trough (below) has been created to enable livestock watering from the well (above).

River diversion

Mesno traditional irrigation refers to the small Mesno stream, as well as to the village with the same name. As the name refers literally to irrigation (*yemesno limat*), one can assume that irrigation has been practiced 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. Such systems are, for example, practiced 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 unknown to the authors.

Traditional schemes and point sources seem to be used for domestic, agricultural and therapeutic purposes. Some hot water springs in the area were developed into thermal baths in the eighteenth and nineteenth centuries. Wanzagay, in Fogera on the Gumara river, used to be among the most popular of these spas (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: "*Irrigation during the reign of Haile Selassie was usually introduced by external agents, particularly members of the nobility, landlords and entrepreneurs from other countries* […] *Only at the end of the 20th century, were fruits and vegetables gradually introduced, mainly in response to increasing urban demands*" (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 association (*kebelewotch*) established by the government in 1975.

With regard to irrigation, 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 the Nora at the 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. As a result of their proximity, 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 northwesterly direction.

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 few diesel pumps	Gravity system	Gravity and pump irrigation	Gravity system
Size of irrigated land	No data	No data	90 ha (incl. 21 ha under pump irrigation)	50.24 ha
Project facilitator/ actors involved	Farmers & well diggers supported by *woreda* administration	Farmers	Government of Ethiopia	Government of Ethiopia, FINIDA
Cost of construction	Well: 480 ETB Pond: 900 ETB Excl. local labour	No data	No data	780,118 ETB; 7,309 ETB per ha (incl. local labour)
No. of users/ beneficiary households	All households for domestic uses, 30 for irrigation	Dry season: 10 households, wet season 400 farmers	107 households, plus share croppers	266 households (106 land owners, 160 share croppers=
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;	Open access, riparian doctrine	Water price, water allocation via schedules, joint canal maintenance	Water allocation via schedules

	negotiated rights for irrigation			
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

3 Field research

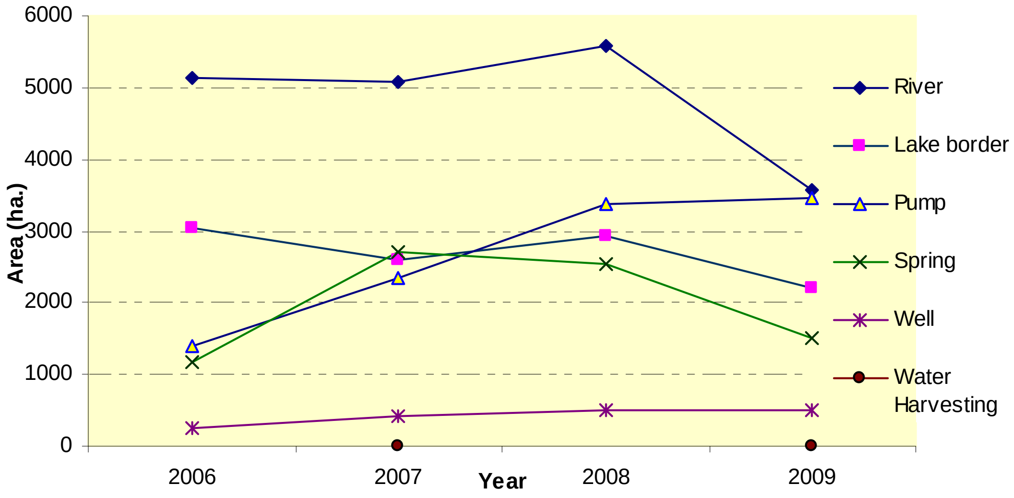
The article builds mainly on ethnographic, social-economic and hydrological field research at doctoral and master level conducted from 2009-2010, as well as on the integrated data analysis of the IWMI[3] projects "Re-thinking water storage for climate change adaptation in Sub-Saharan Africa" and "Improved water productivity of crop-livestock systems of Sub-Saharan Africa", which were supported by household surveys and hydrological and climate modelling sub-projects in other watersheds of 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, PRA methods, 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.

4 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 2008's irrigation season resulted in the reduction of the irrigation area in 2009 compared to the previous three years.

[3] International Water Management Institute.

Figure 4: Irrigation development trends with respect to different water sources



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

Wells and ponds

In most cases, 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 tube mean the process is more labour-intensive than when installing the round tube 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 as a prevention to well collapse. Resources for well building stem from family savings, household labour and from credits taken from the *woreda* administration.

Figure 5: Construction of a V-shaped well

The entire layer of cracking soil is removed before the actual well digging begins

Wells for irrigation purposes were observed to be constructed by hired labour and the employment of a professional well digger. This man was 54 years old and known all over the *woreda*. He started to work as a well digger around 1993, and nowadays receives 50 Ethiopian Birr (ETB) per metre. His employment ran from September to March, during which time he was commissioned to construct 16 shallow wells for different people under diverse payment arrangements. The well digger maintained a large social network all over the *kebele* and beyond, which allowed him find out about any well digging enterprises. The biggest concern of the farmers was the provision and cost of car tires 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: "*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*" (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 twelve years (see Figure 6). It was built and used by a cluster of twenty households for domestic and small productive purposes. Users cleaned the well regularly, but were still concerned with management challenges such as possible pollution by livestock. Private wells were therefore clearly preferred to the community well.

Figure 6: Community well in Dokmit

Pond construction in rain-scarce regions is funded by the Federal Government; Kuhar Michael Kebele is, however, not identified as such. Despite this, 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 practiced 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 three metre-deep pond of 8 m x 8 m was dug in the proximity of the homestead and lined with polythene (geo-membrane). 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.

The availability of labour within a household was identified as either an enabling or 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 geo-membrane 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 comparison to documented ponds in Tigray National Regional State.

River diversion

As the traditional Mesno irrigation has been in place for a long time, the exact acquisition process can only really be assumed rather than documented with empirical data. The Mesno stream uses mainly stream diversion through traditional 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 after the rains stop in September. 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 mainlined 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 dam

Before the Shina-Hamusit micro dam project was launched in 2008 under the SERA (Strengthening Emergency Response Abilities) 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 land holdings, formed vigilante groups to deal with land theft and refused to cooperate with the engineers and 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[4] and in church to join in the construction project. It took some time to overcome the initial scepticism, but the people were eventually involved as daily labourers thanks to the strong incentive to earn considerable amounts of cash over just a few short months. Through this pay-for-work arrangement, the community 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 amounted from the scheme, which was co-financed by the Ethiopian Government and FINIDA at a total cost of 780,118 ETB.

In 2010, when a project for constructing terraces was initiated in Shina[5], the community negotiated over adequate payments with the *woreda* administration (which came to about ten ETB per half a day of work). Again, more than 150 farmers, especially young people and women, found it very attractive to support the project as labourers; consequently, the entire valley changed into terraces within just three weeks.

[4] *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.

[5] Soil moisture is conceptualised as one form of water storage (Johnson and McCartney, 2010).

5 Access to land and water

5.1 Open access to wells and ponds with seasonal limitations

Local water rights that have evolved in the plains include the riparian doctrine, meaning that water from rivers and streams can be diverted to adherent 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 land ownership, but not formally regulated. Water is free of charge, perceived as a gift from God as well as a basic right for everyone – at least for primary and domestic uses (Deneke et al., 2011). The data hints to the fact that until the end of the 1990s, the usage of wells and natural springs fell under an open access regime; private well ownership seems to have started afterwards.[6] 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 overexploitation and 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* […] *I do this with my family until the next rainy season*" (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.[7] 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).

5.2 Land use rights

In irrigation schemes, water rights tend to be more formalised in irrigation schedules or explicit use rights, but there are neither water markets in place nor fees for water. The prerequisite to accessing water for irrigation 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 Internationale Zusammenarbeit* (GIZ, former GTZ) and the Swedish International Development Agency (SIDA) engage in securing land rights and accompanying land reallocation processes in the region.[8] Male and female household heads can register for land ownership, but insecure land ownership may result in the loss of land titles and hence agricultural production as a livelihood strategy. The lack or insecurity of land titles may be precursors to the end of irrigation farming; however, a number of institutions set up for land sharing (*kriyit* or *kiray*) and share cropping (*yekul*) are prevalent in the region, and allow access to irrigation, without the need for direct ownership of a land use title.[9] The pattern of land use rights in Guanta

---

[6] This seems to have differed in other parts of the highlands as Ramazzotti (1996, quoting Ambrosi 1941: Aspetti du diritto agrario nelle terre dell´ A.O.I.) 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*".

[7] 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.

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

[9] *Kiray* or *kiryit* is land lease lasting for more than one year in exchange for money. It is considered legal as long as it doesn't 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 land owner provides the land and the sharecropper covers all labour and capital costs for crop production. In

did not change with the modernisation and 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, 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 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 thirty-six households lost their land, twelve 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 that women 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 twelve women held land titles under their own names. Other women had also inherited land titles from their late husbands, but were in danger of losing it 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 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, illegal land sales occur very occasionally.[10] 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 adherent communities and actually treated as a cultural taboo. Thus, the lack of male labour in the household was another crucial hindrance to irrigation farming.

5.3 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 the field studies revealed that farmers had extended the scheme about 41 ha by pumping in the upper and downstream part of the formal canal infrastructure. Whilst the upstream farmers pumped water to

---

other forms of *yekul* arrangement, the land owner 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).
[10] Segers et al. (2010) suggest that what is referred to in the literature as land sales are often land-term land rental arrangements.

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 up- 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 didn't 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 favorable 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. Moreover, members of the WUA formulated rules for water allocation (see below). As government staff, they clearly showed a preference for modern water rights based on formalised rules such as written-up WUA project law and by-laws for water allocation – as applied in modern irrigation schemes. Local water rights, which had evolved in the plains, were about to be neglected. With regard to land rights, it is important to underline that land was not redistributed in the course of the project, but instead 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 Guanta Lomidur scheme

The picture shows high water loss for irrigable land where the lined canal ends

In Shina, there are eight tertiary canals – each of which is 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. Planting, weeding and all other 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 have diverted water into their fields outside the schedule, which is referred to as water theft and sanctioned by the committee. To confuse other farmers and the committees, though, these rogue farmers also flood fields next to their own.

6 Management by farmers

6.1 Well owners and household clusters

Wells and ponds are managed through minimal regulation, but maintenance has been identified as a bottleneck to sustainability. Field data reveals, however, that farmers in Fogera do clean their wells regularly (on a monthly or annual basis) and take measures against water pollution such as covering the well with metal from tuns, or placing broken jerry cans supported by stones at both ends to guard against rats and lizards contaminating the well. Households also apply the water purifier chlorine (*uhwagar*), provided free of charge by the Kebele Health Centre. Maintenance is organised by the well owner and based on household or communal labour arrangements. Well owners do not ask water users to participate in maintenance; instead, water users see their help as part of the mutual support arrangement for water provision.

For the Mesno traditional scheme, no formal user organisation is in place to facilitate the management by self-organised farmers' groups (Deneke et al., 2011). Instead, the scheme is administered by the two 'water fathers' (*wuha abbat*) elected by the *kebele* leader, who owns a plot in the scheme and serves as overseer of the scheme. 'Water fathers' allocate water among irrigators and coordinate canal clearing activities. Unlike other traditional irrigation schemes elsewhere, where these overseers have longer terms in office, in Mesno they are appointed by the *kebele* leader for one year only.

6.2 Water user associations

There is a blueprint for water user association (WUAs) 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. Besides, 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 and little viability, even in the face of trivial problems. In addition, WUA officials 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 blue policy print, the practical outcome 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, land owners in the scheme became registered members. Farmers could take part of the money earned from dam construction to buy themselves into the association. In March 2010, 106 households were registered including twelve female-headed households. Land owners who cannot afford the initial payments stand outside the WUA. 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 re-sales 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, thus extending its remit to activities usually associated with peasant cooperatives.

Leadership of the association and the management of the scheme are 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, who is very influential in the Shina community. 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 established and 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[11] by WUA officials and the consequent lack of trust in the WUA by farmers, the WUA has been disintegrated; it neither supplies seeds and sale outputs nor does it collect water fees and allocate 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/individual farmers paid the required entrance fee of 25 ETB and received decision-making rights over rules and water allocation. Farmers were discouraged to join the WUA due to their experience with cooperatives during the Derg period. The majority of farmers found it difficult to distinguish between the purpose and potential benefits of the WUA and the government-imposed former form of organisation. *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 theft.

Management issues at stake, besides the water allocation of upper and tail-enders in Guanta, include the maintenance of canals, which were neglected and resulted in the loss of water through seepage. At present, in Kuhar Michael Kebele, 39 motor pumps are used for the extraction of water from the Guanta stream and irrigation scheme canals. Pumping water from the canals creates 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 have to bear the production cost of pumping. Research revealed this as the background for more efficient water application in the upper part of the scheme in comparison to the parts which relied on the gravity system. Other interesting findings concerned farmers' rationalities in constructing field canals in a way that led to the non-use of large tracts of irrigable land (Derib et al., 2011). Generally, informal extensions of the scheme created more complexity in management, but this was balanced by the use of other potential water sources such as the night stream flow of the Guanta river, but not by the integration of springs and shallow wells into the system.

[11] 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 in vein, sparking suspicions among farmers that WUA officials have negotiated with the traders and forsaken them.

7 The contribution to local livelihoods and social dynamics

7.1 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, or were excluded during the dry season, recounted that well owners were better off, as they are able to produce more and a higher variety of crops for sale. They mentioned health benefits due to sufficient and better diets and cleaner water, and especially water-borne diseases such as dysentery, typhoid and diarrhoea were less of a problem when owning a well. Also, livestock health was reported to benefit from wells, since the prevalent cattle disease *gendy* (trypanosomiasis) was reportedly caused by drinking dirty and stagnant water in the plains where cattle had to be driven in dry season.[12] Another effect was observed in relation to livestock. On average, well owners reported having two more cattle three years after the construction of the well, one of the reasons for which was clean water, while they also started being able to afford veterinary services. Farmers with wells estimated that their household income (including crops for subsistence) had doubled in comparison to the period before the well was introduced.

Although its contribution to feed and food production for the community and Woreta market is significant, the productivity of irrigation water in Guanta was still low compared to other studies (Derib et al., 2011). Water use was efficient in pump irrigation, since every drop of water had costs associated with pump acquisition, pump maintenance and fuel. In contrast, lack of knowledge and technical skills hindered higher productivity through gravity irrigation. According to field surveys in 2009, at Kuhar Michael and Bebekse Kebelewotch, 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 (Derib et al., 2011). Nights were used in the same way as at peak times for irrigation, when flow rates during daytime were too low to satisfy demand. This practice resulted in the overflowing of the canal and waterlogging of farm plots, since it is difficult to control water flow in darkness. An alternative would be to introduce night storage to regulate water flows and irrigate during the daytime only. The natural stream bank has enough capacity to store night flow, if some check dam made of wood, concrete or iron could be created at the cross-section. This simple and relatively low-cost measure would make the fertile alluvial soil and the base flow of streams far more productive. Since the water flow at night times is used anyway, this temporal water storage would have no considerable impact on downstream flows.

Besides proudly admiring the new green beauty of their landscape, farmers in Shina reported that their teff and potato harvest had doubled under irrigation. Significant increases could be gained also for millet and pepper. Chat, onions, tomatoes, cabbage and pawpaw were hardly cultivated before the dam, but have become common local crops. By producing surplus supply, the community became more involved in Hamusit market activities, which played out in consumption patterns as well. Desired items were clothes (men and women), mobile phones, guns and water pumps (men), and more cows could be bought for the production of milk. Some items were brought in to the region rather than produced locally, e.g. clothes, which were made by women's groups. 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).

7.2 Conflicts over water

On the one hand, the studies suggest that the bigger and more complex the facility, the bigger the risk for elite capture and conflict over water allocation. On the other hand, they also illustrate

12 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.

farmers' abilities to act collectively towards a common interest. Well ownership qualifies farmers to become members in the *gimbarikadam* (farmer's 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 organised in the *gimbarikadam* during the time of the research.

The majority of farmers plant the same crops, usually onions or tomatoes, which lead to similar water demands at critical stages of crop growth when irrigation is very essential. 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 all schemes in Fogera, irrigation farming is usually supplemented by rainfall in April and May. However, these rains sometimes fail and the consequent prolonged dry spell leads to intense pressure when little water is available.

In Mesno, the old Sabbath water institution was also a source of conflict among farmers. Whilst exclusive entitlements to Sabbath water seem to have worked well so far, the increased market price for onions and tomatoes has led to a higher number of farmers becoming pump irrigators. 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.

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

7.3 Gender and age relations

With regard to gender and age relations, larger irrigation schemes produced a number of consequences. 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 female bargaining power for changing water schedules.

At the Guanata-Lomidure scheme, female farmers indicated that they preferred to sharecrop their farmlands rather than engage in irrigation, as they lacked labour and capital. In the tail-end areas of the scheme, one of the researchers met a woman farmer tending her wilting onion field and letting animals feed on the crop. She disclosed that her onions wilted because 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 and get water at the right time. In addition, domestic work left her with no time for such things.

The Shina study, which focused on gender relations, 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. The latter indicates the increased need for female labour in agriculture at community level. Going out to earn money, as well as the demands of running a household, were felt to result in the better treatment of women. About 56% of male respondents and 30% of female 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. Wife-beating also seemed to have decreased, and women felt more involved in decision-making within the household. Furthermore, the wives no longer washed the feet of their husbands, which used to be a cultural practice before the introduction of the dam. The men stated that their wives were making an effort to look more attractive (Billa, 2011). These accounts indicate that some changes in perception and practice are on the way with regard to gender relations, and most of them could be linked directly to the dam project (more labour, more income).

Youth factions in Kuhar Michael Kebele faced difficulties in accessing the benefits of the irrigation scheme because they had no regular access to plots of land. Young men seemed to have cultivated marginal lands and triggered land use change and land use cover in the *kebele*. The situation became a local issue, so the Kuhar Michael Church started to rent out eight hectares of land to landless youth for cultivation (Ali et al., 2011). The Guanta Lomidur scheme has created income generation opportunities for younger people who hold no land use rights in the community. Some farmers, each of whom has been allocated land under the scheme, face labour shortages and so rent out parts of their land to the landless youth. Other landless young farmers have become traders and brokers of farm products.

8 Impact of large dams on the Fogera small-scale irrigation scheme

As agricultural production and productivity face two main challenges – flooding during the rainy season and a long dry period – small-scale irrigation systems play their role in enabling production during the dry season. However, there is still ample fertile land on the Fogera plain which remains unproductive during the dry period, and small-scale schemes are not capable of regulating water flow to control extreme flooding and drying events by storing and releasing water. The planned Gumara and Ribb dams, which are being constructed to supply water to large scale irrigation schemes, will contribute to such regulation.

Table 3: Water demand for the Gumara and Ribb irrigation schemes

Irrigation scheme	Irrigable area (ha)	Estimated annual gross water demand $Mm^3)^+$	Estimated net water demand $(Mm^3)^+$	Large dam storage (Mm^3)	Stage of development
Gumara	14,000	115	98	59.7	Feasibility studies completed
Ribb	19,925	172 – 220	146 – 187	233.7	Dam under construction

+ demands estimated though crop water modelling and presented in feasibility study reports. Where a range of demands is presented, this reflects alternative cropping patterns. Gross minus net demand is water returned to the rivers.
Source: McCartney

The WEAP model was used to determine the impact of the large dam construction and the planned large scale irrigation schemes on the downstream flow into the lake (McCartney et al., 2010). Table 4 shows the simulated impact on flow, but with no allowance for any changes that might occur as a consequence of climate change. These results indicate:

i) The reduction in annual flow into Lake Tana for both rivers, but particularly the Ribb.
ii) The reduction of flows in all months on the Gumara river.
iii) The very significant reduction of wet season flows but higher dry season flows in the Ribb river.

These changes in the flow regimes are likely to impact heavily on small-scale irrigation schemes. It can be speculated that:

i) Reduced wet season flows, particularly in the Ribb, and other expected water resources development may reduce Lake Tana's natural level, especially during climatic extreme dry seasons.

ii) Since drainage on the Fogera is limited (MoWRs, 2008), badly managed irrigation may exacerbate existing water logging problems (Derib et al., 2011).

iii) Lower wet season flows in the Ribb may affect the farmers' (who are outside of the command area) abilities to pump water from the river, thereby reducing their ability to conduct supplementary irrigation in the wet season.

iv) Higher dry season flows on the Ribb may enhance farmers' abilities to pump water from the river and hence provide additional water for dry season irrigation.

v) Changes in flow on the Gumara are unlikely to alter smallholder farmers' abilities to pump water in the wet season, but may reduce their ability to do so in the dry season

vi) Inundation from the planned reservoir and canal network will probably reduce the size of farm plots and require land reallocation. Cultivation might stop for a few farming seasons until land is fully reallocated and practically accessible and until irrigation infrastructure in Gumara is functional.

Table 4: Comparison of mean monthly flows (Mm^3) in the Ribb and Gumara before and after the construction of the large dams and irrigation schemes

	Ribb		**Gumara**	
	Current	Future	Current	Future
Jan	1.8	12.2	3.7	2.2
Feb	1.2	8.2	2.1	1.8
Mar	1.3	4.7	1.9	1.0
Apr	2.0	6.3	1.4	0.6
May	2.1	1.8	2.2	1.2
Jun	7.6	0.6	11.5	7.9
Jul	54.6	0.0	98.1	54.5
Aug	93.3	7.5	202.3	193.9
Sep	35.6	15.5	107.9	95.3
Oct	10.4	7.6	38.1	20.4
Nov	5.4	4.5	13.5	11.8
Dec	2.6	3.3	7.0	3.2
Total	217.9	72.2	489.7	393.9

Source: McCartney

9 The role of small-scale irrigation in mitigating anticipated climate change

Currently, there is great uncertainty about the likely impacts of climate change in the Blue Nile basin and in Ethiopia in general. The Intergovernmental Panel on Climate Change (IPCC) 4th Assessment

Report (AR4) found that 18 out of 21 global climate models (GCMs) agree on increased precipitation in eastern Africa (Christansen et al., 2007). The IPCC AR4 therefore states that increased precipitation is "likely". However, a more recent study has indicated a decrease in convection and hence a reduced amount of rainfall over much of the eastern flank of the Ethiopian highlands (Williams and Funk, 2010). More specifically for the Lake Tana region, Kim et al. (2008) have found a generally increasing trend in both precipitation and runoff in the northern part of the Blue Nile basin, but other studies have indicated a decline in rainfall and runoff into the lake (Shaka, 2008).

Despite uncertainty about the likely impact of climate change on total rainfall, what seems probable is that rainfall variability will increase. Consequently, even if total amounts increase there will still be periods of more intense rainfall and longer dry periods. Prediction may also become more difficult. Under such circumstances the importance of water storage and irrigation is likely to increase. By providing a buffer, though, increased water storage will offset some of the potential negative impacts of climate change, enhancing both water security and safeguarding agricultural productivity (McCartney and Smatkhin, 2010).

By modifying both water availability and water demand, climate change will affect the need, performance and suitability of different water storage options. In some situations certain storage options will be rendered completely impracticable, whilst the viability of others may be increased. For example, groundwater recharge may be reduced if rainfall decreases or its temporal distribution changes in such a way that infiltration declines. Ponds and tanks may not fill to capacity or the frequency of filling may be reduced so that they are unable to provide sufficient water for irrigation. Changes in river flows may mean that reservoir yields and, hence, the assurance of water supplies decline. Storage in ponds, tanks and reservoirs may also be reduced more rapidly as a consequence of increased evaporation and/or greater sediment inflows. Furthermore, both large and small dams, as well as ponds and tanks, may be at increased risk of both eutrophication and flood damage. Consequently, great care needs to be taken in determining future storage options for agriculture.

Key to planning and managing water storage are determining current and future needs and making appropriate choices from the suite of storage options available (Johnston and McCartney, 2010). The details of climate change are unknown, so planning must allow for greater uncertainty, while future water storage must be more reliable and resilient and less vulnerable than in the past. All water storage options have strong comparative advantages under specific conditions of time and place. Hence, storage 'systems' that combine and build on complementarities of different storage types are likely to be most effective. 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.

10 Conclusion

We wanted to analyse whether small-scale irrigation and large dams may co-exist and in combination be an adequate strategy to meet the challenges posed by anticipated climate change. Further, 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. To water experts, researchers and politicians it is very obvious that an expansion of irrigation is not possible without some form of 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, especially in socio-economic terms. We understand this article as a contribution to this effort by providing some baseline data on access to land and water, which can later be used in assessing the social-political impacts of the Gumara and Ribb dam projects.

To summarise the first aspect, we illustrated that various water storage options have comparative advantages but may also result in social constraints. Hence, storage 'systems' that combine and build on complementarities of different storage types and are responsive to local conditions should be favoured. While the future impact of climate change remains uncertain, the WEAP model projection shows how large dams will impact on the hydrology of the plains, while social-economic assessments at Koga suggest some future social consequences. The studies indicate the value of an approach that extends storage capacities and considers small and large schemes as complementary.

The outcome of the social-economic assessment is also not clear-cut thanks to the diversity of storage options. 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; Eguavoen and Tesfai 2011). 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 benefit from local irrigation and monopolise water allocation. While avoiding land reallocation might be essential to maintain farmers' sense of tenure stability, it has its own impact by raising rural inequality and engendering a lack of cooperation for sustainable management of the scheme (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, if necessary, to give needy community members the opportunity to benefit without becoming involved in sharecropping. The Koga case illustrates a number of practical challenges such as during enumeration, land allocation and payment of compensations, as well as challenges with regard to the accessibility and usability of newly allocated plots, urbanisation and management (Eguavoen and Tesfai, 2011).

For the management of modern schemes, WUAs provide one option beside locally existing mutual support groups if they succeed in gaining local legitimacy. Regional government and non-government bodies need to assist these bodies in terms of raising the managerial and leadership capacities of their officials through relevant training, but should avoid unnecessary interference in the day-to-day activities of WUAs, which can provide many more services to farmers than water management alone – as pointed out in the example from Shina. Local authorities need to promote good governance actively in order to deal with elite capture and opportunistic behaviours. Of course, if management by farmers in the future Gumara irrigation project is intended, the scale of organisational effort is expected to reassemble more the Koga project than the conditions in small-scale irrigation projects discussed here.

11 References

Adenew, B. and Abdi, F. 2005. Land registration in Amhara region, Ethiopia. IIED.

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

Ali, H. et al. 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.

Christiansen, J.H.; Hewitson, A.; Busuioc, A. et al. 2007. Regional climate predictions, In: Solomon, S., Qin, D., Manning, M. et al. (Eds), Climate Change 2007: the physical science basis, contribution of working group 1 to the fourth assessment report of the intergovernmental panel on climate change. Cambridge: UP, pp. 849-940.

Deininger, K. et al. 2008. Rural Land Certification in Ethiopia: Process, Initial Impact, and Implications for Other African Countries. The World Bank, Elsevier Ltd.

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. et al. 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 S. Pausewang (Eds.), Ethiopia. The challenge of democracy from below. pp 71-86. Upsalla: Nordiska Afrikainstitutet.

Eguavoen, I. and W. Tesfai 2011. Rebuilding livelihoods after dam-induced relocation in Koga, Blue Nile basin, Ethiopia. ZEF Working Paper 83. Bonn.

FDRE-Federal Democratic Republic of Ethiopia 2002. The National Water Resources Policy. Addis Ababa.

Fogera Woreda Plan 2010. (unpublished document)

Johnston, R. and McCartney, M. 2010. Inventory of water storage types in the Blue Nile and Volta River basins. IWMI Working Paper 140. Colombo.

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.

Kim, U.; Kaluarachchi, J.J. and Smakhtin, V.U. 2008. Climate change impacts on hydrology and water resources of the upper Blue Nile Basin, Ethiopia. IWMI Research Report 126. Colombo, Sri Lanka: International Water Management Institute.

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.

McCann, J. 1995. People of the Plow: An Agricultural History of Ethiopia, 1800-1990. The University of Wisconsin Press.

McCartney, M. et al. 2010. Evaluation of current and future water resources development in the Lake Tana Basin, Ethiopia. IWMI Research Report 134. Colombo, Sri Lanka: International Water Management Institute.

MoWRs (Ministry of Water Resources). 2008. Gumara Irrigation Project Feasibility Study Report. Addis Ababa, Ethopia: MoWRs.

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 History and Allied Sciences 41: 308-318.

Ramazzotti, M. 1996. Readings in African customary water laws. FAO legislative study 58, Rome.

Rämi, H. 2003. Ponds filled with challenges: Water harvesting experiences in Amhara and Tigray. Report of an UN-OCHA assessment mission. Addis Ababa, Ethopia: UN-OCHA.

Segers, K. et al. 2010. Unraveling the dynamics of access to farmland in Tigray, Ethiopia. The 'emerging land market' revisited. Land Use Policy 27: 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, 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.

Teklu, A. 2005. Land registration and Women's land rights in Amhara Region, Ethiopia. IIED.

Williams, A.P. and Funk, C. 2010. A westward extension of the warm pool leads to a westward extension of the Walker circulation, drying eastern Africa. Climate Dynamics DOI: 10.1007/s00382-010-0984-y

ZEF Working Paper Series, ISSN 1864-6638
Department of Political and Cultural Change
Center for Development Research, University of Bonn
Editors: Joachim von Braun, Manfred Denich, Solvay Gerke, Anna-Katharina Hornidge and Conrad Schetter

1. Evers, Hans-Dieter and Solvay Gerke (2005). Closing the Digital Divide: Southeast Asia's Path Towards a Knowledge Society.
2. Bhuiyan, Shajahan and Hans-Dieter Evers (2005). Social Capital and Sustainable Development: Theories and Concepts.
3. Schetter, Conrad (2005). Ethnicity and the Political Reconstruction of Afghanistan.
4. Kassahun, Samson (2005). Social Capital and Community Efficacy. In Poor Localities of Addis Ababa Ethiopia.
5. Fuest, Veronika (2005). Policies, Practices and Outcomes of Demand-oriented Community Water Supply in Ghana: The National Community Water and Sanitation Programme 1994 – 2004.
6. Menkhoff, Thomas and Hans-Dieter Evers (2005). Strategic Groups in a Knowledge Society: Knowledge Elites as Drivers of Biotechnology Development in Singapore.
7. Mollinga, Peter P. (2005). The Water Resources Policy Process in India: Centralisation, Polarisation and New Demands on Governance.
8. Evers, Hans-Dieter (2005). Wissen ist Macht: Experten als Strategische Gruppe.
8.a Evers, Hans-Dieter and Solvay Gerke (2005). Knowledge is Power: Experts as Strategic Group.
9. Fuest, Veronika (2005). Partnerschaft, Patronage oder Paternalismus? Eine empirische Analyse der Praxis universitärer Forschungskooperation mit Entwicklungsländern.
10. Laube, Wolfram (2005). Promise and Perils of Water Reform: Perspectives from Northern Ghana.
11. Mollinga, Peter P. (2004). Sleeping with the Enemy: Dichotomies and Polarisation in Indian Policy Debates on the Environmental and Social Effects of Irrigation.
12. Wall, Caleb (2006). Knowledge for Development: Local and External Knowledge in Development Research.
13. Laube, Wolfram and Eva Youkhana (2006). Cultural, Socio-Economic and Political Con-straints for Virtual Water Trade: Perspectives from the Volta Basin, West Africa.
14. Hornidge, Anna-Katharina (2006). Singapore: The Knowledge-Hub in the Straits of Malacca.
15. Evers, Hans-Dieter and Caleb Wall (2006). Knowledge Loss: Managing Local Knowledge in Rural Uzbekistan.
16. Youkhana, Eva; Lautze, J. and B. Barry (2006). Changing Interfaces in Volta Basin Water Management: Customary, National and Transboundary.
17. Evers, Hans-Dieter and Solvay Gerke (2006). The Strategic Importance of the Straits of Malacca for World Trade and Regional Development.
18. Hornidge, Anna-Katharina (2006). Defining Knowledge in Germany and Singapore: Do the Country-Specific Definitions of Knowledge Converge?
19. Mollinga, Peter M. (2007). Water Policy – Water Politics: Social Engineering and Strategic Action in Water Sector Reform.
20. Evers, Hans-Dieter and Anna-Katharina Hornidge (2007). Knowledge Hubs Along the Straits of Malacca.
21. Sultana, Nayeem (2007). Trans-National Identities, Modes of Networking and Integration in a Multi-Cultural Society. A Study of Migrant Bangladeshis in Peninsular Malaysia.
22. Yalcin, Resul and Peter M. Mollinga (2007). Institutional Transformation in Uzbekistan's Agricultural and Water Resources Administration: The Creation of a New Bureaucracy.
23. Menkhoff, T.; Loh, P. H. M.; Chua, S. B.; Evers, H.-D. and Chay Yue Wah (2007). Riau Vegetables for Singapore Consumers: A Collaborative Knowledge-Transfer Project Across the Straits of Malacca.
24. Evers, Hans-Dieter and Solvay Gerke (2007). Social and Cultural Dimensions of Market Expansion.
25. Obeng, G. Y.; Evers, H.-D.; Akuffo, F. O., Braimah, I. and A. Brew-Hammond (2007). Solar PV Rural Electrification and Energy-Poverty Assessment in Ghana: A Principal Component Analysis.
26. Eguavoen, Irit; E. Youkhana (2008). Small Towns Face Big Challenge. The Management of Piped Systems after the Water Sector Reform in Ghana.
27. Evers, Hans-Dieter (2008). Knowledge Hubs and Knowledge Clusters: Designing a Knowledge Architecture for Development
28. Ampomah, Ben Y.; Adjei, B. and E. Youkhana (2008). The Transboundary Water Resources Management Regime of the Volta Basin.
29. Saravanan.V.S.; McDonald, Geoffrey T. and Peter P. Mollinga (2008). Critical Review of Integrated Water Resources Management: Moving Beyond Polarised Discourse.
30. Laube, Wolfram; Awo, Martha and Benjamin Schraven (2008). Erratic Rains and Erratic Markets: Environmental change, economic globalisation and the expansion of shallow groundwater irrigation in West Africa.

31. Mollinga, Peter P. (2008). For a Political Sociology of Water Resources Management.
32. Hauck, Jennifer; Youkhana, Eva (2008). Histories of water and fisheries management in Northern Ghana.
33. Mollinga, Peter P. (2008). The Rational Organisation of Dissent. Boundary concepts, boundary objects and boundary settings in the interdisciplinary study of natural resources management.
34. Evers, Hans-Dieter; Gerke, Solvay (2009). Strategic Group Analysis.
35. Evers, Hans-Dieter; Benedikter, Simon (2009). Strategic Group Formation in the Mekong Delta - The Development of a Modern Hydraulic Society.
36. Obeng, George Yaw; Evers, Hans-Dieter (2009). Solar PV Rural Electrification and Energy-Poverty: A Review and Conceptual Framework With Reference to Ghana.
37. Scholtes, Fabian (2009). Analysing and explaining power in a capability perspective.
38. Eguavoen, Irit (2009). The Acquisition of Water Storage Facilities in the Abay River Basin, Ethiopia.
39. Hornidge, Anna-Katharina; Mehmood Ul Hassan; Mollinga, Peter P. (2009). 'Follow the Innovation' – A joint experimentation and learning approach to transdisciplinary innovation research.
40. Scholtes, Fabian (2009). How does moral knowledge matter in development practice, and how can it be researched?
41. Laube, Wolfram (2009). Creative Bureaucracy: Balancing power in irrigation administration in northern Ghana.
42. Laube, Wolfram (2009). Changing the Course of History? Implementing water reforms in Ghana and South Africa.
43. Scholtes, Fabian (2009). Status quo and prospects of smallholders in the Brazilian sugarcane and ethanol sector: Lessons for development and poverty reduction.
44. Evers, Hans-Dieter; Genschick, Sven; Schraven, Benjamin (2009). Constructing Epistemic Landscapes: Methods of GIS-Based Mapping.
45. Saravanan V.S. (2009). Integration of Policies in Framing Water Management Problem: Analysing Policy Processes using a Bayesian Network.
46. Saravanan V.S. (2009). Dancing to the Tune of Democracy: Agents Negotiating Power to Decentralise Water Management.
47. Huu, Pham Cong; Rhlers, Eckart; Saravanan, V. Subramanian (2009). Dyke System Planing: Theory and Practice in Can Tho City, Vietnam.
48. Evers, Hans-Dieter; Bauer, Tatjana (2009). Emerging Epistemic Landscapes: Knowledge Clusters in Ho Chi Minh City and the Mekong Delta.
49. Reis, Nadine; Mollinga, Peter P. (2009). Microcredit for Rural Water Supply and Sanitation in the Mekong Delta. Policy implementation between the needs for clean water and 'beautiful latrines'.
50. Gerke, Solvay; Ehlert, Judith (2009). Local Knowledge as Strategic Resource: Fishery in the Seasonal Floodplains of the Mekong Delta, Vietnam
51. Schraven, Benjamin; Eguavoen, Irit; Manske, Günther (2009). Doctoral degrees for capacity development: Results from a survey among African BiGS-DR alumni.
52. Nguyen, Loan (2010). Legal Framework of the Water Sector in Vietnam.
53. Nguyen, Loan (2010). Problems of Law Enforcement in Vietnam. The Case of Wastewater Management in Can Tho City.
54. Oberkircher, Lisa et al. (2010). Rethinking Water Management in Khorezm, Uzbekistan. Concepts and Recommendations.
55. Waibel, Gabi (2010). State Management in Transition: Understanding Water Resources Management in Vietnam.
56. Saravanan V.S.; Mollinga, Peter P. (2010). Water Pollution and Human Health. Transdisciplinary Research on Risk Governance in a Complex Society.
57. Vormoor, Klaus (2010). Water Engineering, Agricultural Development and Socio-Economic Trends in the Mekong Delta, Vietnam.
58. Hornidge, Anna-Katharina; Kurfürst, Sandra (2010). Envisioning the Future, Conceptualising Public Space. Hanoi and Singapore Negotiating Spaces for Negotiation.
59. Mollinga, Peter P. (2010). Transdisciplinary Method for Water Pollution and Human Health Research.
60. Youkhana, Eva (2010). Gender and the development of handicraft production in rural Yucatán/Mexico.
61. Naz, Farha; Saravanan V. Subramanian (2010). Water Management across Space and Time in India.
62. Evers, Hans-Dieter; Nordin, Ramli, Nienkemoer, Pamela (2010). Knowledge Cluster Formation in Peninsular Malaysia: The Emergence of an Epistemic Landscape.
63. Mehmood Ul Hassan; Hornidge, Anna-Katharina (2010). 'Follow the Innovation' – The second year of a joint experimentation and learning approach to transdisciplinary research in Uzbekistan.
64. Mollinga, Peter P. (2010). Boundary concepts for interdisciplinary analysis of irrigation water management in South Asia.
65. Noelle-Karimi, Christine (2006). Village Institutions in the Perception of National and International Actors in Afghanistan. (Amu Darya Project Working Paper No. 1)
66. Kuzmits, Bernd (2006). Cross-bordering Water Management in Central Asia. (Amu Darya Project Working Paper No. 2)
67. Schetter, Conrad; Glassner, Rainer; Karokhail, Masood (2006). Understanding Local Violence. Security Arrangements in Kandahar, Kunduz and Paktia. (Amu Darya Project Working Paper No. 3)

68. Shah, Usman (2007). Livelihoods in the Asqalan and Sufi-Qarayateem Canal Irrigation Systems in the Kunduz River Basin. (Amu Darya Project Working Paper No. 4)
69. ter Steege, Bernie (2007). Infrastructure and Water Distribution in the Asqalan and Sufi-Qarayateem Canal Irrigation Systems in the Kunduz River Basin. (Amu Darya Project Working Paper No. 5)
70. Mielke, Katja (2007). On The Concept of 'Village' in Northeastern Afghanistan. Explorations from Kunduz Province. (Amu Darya Project Working Paper No. 6)
71. Mielke, Katja; Glassner, Rainer; Schetter, Conrad; Yarash, Nasratullah (2007). Local Governance in Warsaj and Farkhar Districts. (Amu Darya Project Working Paper No. 7)
72. Meininghaus, Esther (2007). Legal Pluralism in Afghanistan. (Amu Darya Project Working Paper No. 8)
73. Yarash, Nasratullah; Smith, Paul; Mielke, Katja (2010). The fuel economy of mountain villages in Ishkamish and Burka (Northeast Afghanistan). Rural subsistence and urban marketing patterns. (Amu Darya Project Working Paper No. 9)
74. Oberkircher, Lisa (2011). 'Stay – We Will Serve You Plov!'. Puzzles and pitfalls of water research in rural Uzbekistan.
75. Shtaltovna, Anastasiya; Hornidge, Anna-Katharina; Mollinga, Peter P. (2011). The Reinvention of Agricultural Service Organisations in Uzbekistan – a Machine-Tractor Park in the Khorezm Region.
76. Stellmacher, Till; Grote, Ulrike (2011). Forest Coffee Certification in Ethiopia: Economic Boon or Ecological Bane?
77. Gatzweiler, Franz W.; Baumüller, Heike; Ladenburger, Christine; von Braun, Joachim (2011). Marginality. Addressing the roots causes of extreme poverty.
78. Mielke, Katja; Schetter, Conrad; Wilde, Andreas (2011). Dimensions of Social Order: Empirical Fact, Analytical Framework and Boundary Concept.
79. Yarash, Nasratullah; Mielke, Katja (2011). The Social Order of the Bazaar: Socio-economic embedding of Retail and Trade in Kunduz and Imam Sahib
80. Baumüller, Heike; Ladenburger, Christine; von Braun, Joachim (2011). Innovative business approaches for the reduction of extreme poverty and marginality?
81. Ziai, Aram (2011). Some reflections on the concept of 'development'.
82. Saravanan V.S., Mollinga, Peter P. (2011). The Environment and Human Health - An Agenda for Research.
83. Eguavoen, Irit; Tesfai, Weyni (2011). Rebuilding livelihoods after dam-induced relocation in Koga, Blue Nile basin, Ethiopia.
84. Eguavoen, I., Sisay Demeku Derib et al. (2011). Digging, damming or diverting? Small-scale irrigation in the Blue Nile basin, Ethiopia.

ZEF Development Studies

edited by Solvay Gerke and Hans-Dieter Evers

Center for Development Research (ZEF), University of Bonn

Shahjahan H. Bhuiyan
Benefits of Social Capital. Urban Solid Waste Management in Bangladesh
Vol. 1, 2005, 288 p., 19.90 EUR, br. ISBN 3-8258-8382-5

Veronika Fuest
Demand-oriented Community Water Supply in Ghana. Policies, Practices and Outcomes
Vol. 2, 2006, 160 p., 19.90 EUR, br. ISBN 3-8258-9669-2

Anna-Katharina Hornidge
Knowledge Society. Vision and Social Construction of Reality in Germany and Singapore
Vol. 3, 2007, 200 p., 19.90 EUR, br. ISBN 978-3-8258-0701-6

Wolfram Laube
Changing Natural Resource Regimes in Northern Ghana. Actors, Structures and Institutions
Vol. 4, 2007, 392 p., 34.90 EUR, br. ISBN 978-3-8258-0641-5

Lirong Liu
Wirtschaftliche Freiheit und Wachstum. Eine international vergleichende Studie
Vol. 5, 2007, 200 p., 19.90 EUR, br. ISBN 978-3-8258-0701-6

Phuc Xuan To
Forest Property in the Vietnamese Uplands. An Ethnography of Forest Relations in Three Dao Villages
Vol. 6, 2007, 296 p., 29.90 EUR, br. ISBN 978-3-8258-0773-3

Caleb R.L. Wall, Peter P. Mollinga (Eds.)
Fieldwork in Difficult Environments. Methodology as Boundary Work in Development Research
Vol. 7, 2008, 192 p., 19.90 EUR, br. ISBN 978-3-8258-1383-3

Solvay Gerke, Hans-Dieter Evers, Anna-K. Hornidge (Eds.)
The Straits of Malacca. Knowledge and Diversity
Vol. 8, 2008, 240 p., 29.90 EUR, br. ISBN 978-3-8258-1383-3

Caleb Wall
Argorods of Western Uzbekistan. Knowledge Control and Agriculture in Khorezm
Vol. 9, 2008, 384 p., 29.90 EUR, br. ISBN 978-3-8258-1426-7

Irit Eguavoen
The Political Ecology of Household Water in Northern Ghana
Vol. 10, 2008, 328 p., 34.90 EUR, br. ISBN 978-3-8258-1613-1

Charlotte van der Schaaf
Institutional Change and Irrigation Management in Burkina Faso. Flowing Structures and Concrete Struggles
Vol. 11, 2009, 344 p., 34.90 EUR, br. ISBN 978-3-8258-1624-7

Nayeem Sultana
The Bangladeshi Diaspora in Peninsular Malaysia. Organizational Structure, Survival Strategies and Networks
Vol. 12, 2009, 368 p., 34.90 EUR, br. ISBN 978-3-8258-1629-2

Peter P. Mollinga, Anjali Bhat, Saravanan V.S. (Eds.)
When Policy Meets Reality. Political Dynamics and the Practice of Integration in Water Resources Management Reform
Vol. 13, 216 p., 29.90 EUR, br., ISBN 978-3-643-10672-8

Irit Eguavoen, Wolfram Laube (Eds.)
Negotiating Local Governance. Natural Resources Management at the Interface of Communities and the State.
Vol. 14, 248 p., 29.90 EUR, br., ISBN 978-3-643-10673-5

William Tsuma
Gold Mining in Ghana. Actors, Alliances and Power.
Vol. 15, 2010, 256 p., 29.90 EUR, br., ISBN 978-3-643-10811-1

Thim Ly
Planning the Lower Mekong Basin: Social Intervention in the Se San River
Vol. 16, 2010, 240 p., 29.90 EUR, br., ISBN 978-3-643-10834-0

Tatjana Bauer
The Challenge of Knowledge Sharing - Practices of the Vietnamese Science Community in Ho Chi Minh City and the Mekong Delta
Vol. 17, 2011, 304 p., 29.90 EUR, br., ISBN 978-3-643-90121-7

http://www.lit-verlag.de/reihe/zef