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Abstract

This paper provides a typology of water storage technologies in the Abay sub-basin of the Blue Nile River basin from the 1960s to the present-day. Based on a literature review and project document review, various ways of facility creation and acquisition are analysed with regard to their social dynamics, political interest and project outcome. As a result, specific research needs in the social-political domain are formulated and topics and indicators for a comparative social-political assessment of the facility acquisition processes developed.

Keywords:

Blue Nile, Ethiopia, climate change, water storage, preparation of social-political assessment

1. Introduction

"Abay, the river of the rivers. You know too much.
Abay, we blame it all to you. Our famines, our thirst, our misery: your fault!
You never answer us; don't even turn to see..."[1]

"The poor do not have the necessary technology and resources, in terms of money and so on, to be able to change and adapt. [...] The injustice of the whole issue of global warming and climate change lies in the fact that those who have contributed nothing to its genesis will suffer the most [...] However unjust it might be we have to adapt or die."[2]

In its strategy paper on Ethiopia, the World Bank recently prioritized the increase of water storage volume per capita to mitigate the country's overall economic dependency on uncertain hydrological conditions. The artificial storage capacity of Ethiopia (43 m^3/c) is relatively low in comparison with numbers from South Africa (750 m^3/c), That is why the creation of additional water storage to meet greater water variability over the year and within regions was identified as one policy target to increase national food security. The same World Bank report states that Ethiopia would have to invest fives times its annual GDP (35 billion US$) to reach South African standards, which, of course, is unaffordable (World Bank, 2006). While focussing on artificial reservoirs (either for irrigation, hydropower generation or multipurpose), the report neglects other and smaller types of water storage, as well as processes and cost of water storage creation beyond government and donor programs. These forms of water storage projects include, for example, natural surface cavities and cisterns, on-farm ponds, soil moisture conservation and agro-forestry methods, as well as forms of virtual water storage. "[T]*heir potential remains largely un-quantified and, most likely, underexploited. Each type of storage has its own niche in terms of technical feasibility, socio-economic suitability, impact on health, and environment and institutional requirements"* (IWMI, 2007). This paper presents a variety of water storage types with regard to decision-making processes, possible social dynamics, storage creation and project outcome. It will limit its regional scope to the Ethiopian Blue Nile River basin, which was identified as one research region by the project "Rethinking Water Storage for Climate Change Adaptation in Sub-Saharan Africa" under the umbrella of the International Water Management Institute (IWMI).[3]

The most comprehensive data collection within the river basin was conducted by a consultancy group for the National Ministry of Water Resources to identify suitable policies for the long-term development of the basin. From 1998 onwards, the "Abbay River Basin Integrated Development Master Plan Project" performed by the French BECOM Engineerings Consultant, started with the ambitious objectives of (1) providing a holistic inventory of natural and human resources in the entire Abay River basin; (2) outlining existing and potential natural resource systems (land, water, vegetation), as well as modes of their sustainable exploitation; and (3) designing sustainable solutions for basin management and water development. The recommendations are clearly focused on large-scale approaches, such as hydropower and irrigation development. They do not, however, pay much attention to small-scale and local approaches, which had to be reviewed with the help of other literature. Despite this bias, the project reports are a rich source of basic information. As a result, this current working paper is based on a literature and project document review.

The objective of this paper is twofold. First, it aims to provide an inventory of water harvesting and storage technologies in the basin, which will be typified. Second, it outlines the various modes of acquiring these facilities. The leading questions addressed by the paper are: How do people within the Abay River basin harvest and store water? And how do they establish the required technical artefacts?[4]

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[1] Popsong by the Ethiopian singer Gigi (2000).

[2] Mr. Meles Zenawi, Ethiopian Prime Minister, 15.01. 2009, on a national meeting on climate change.

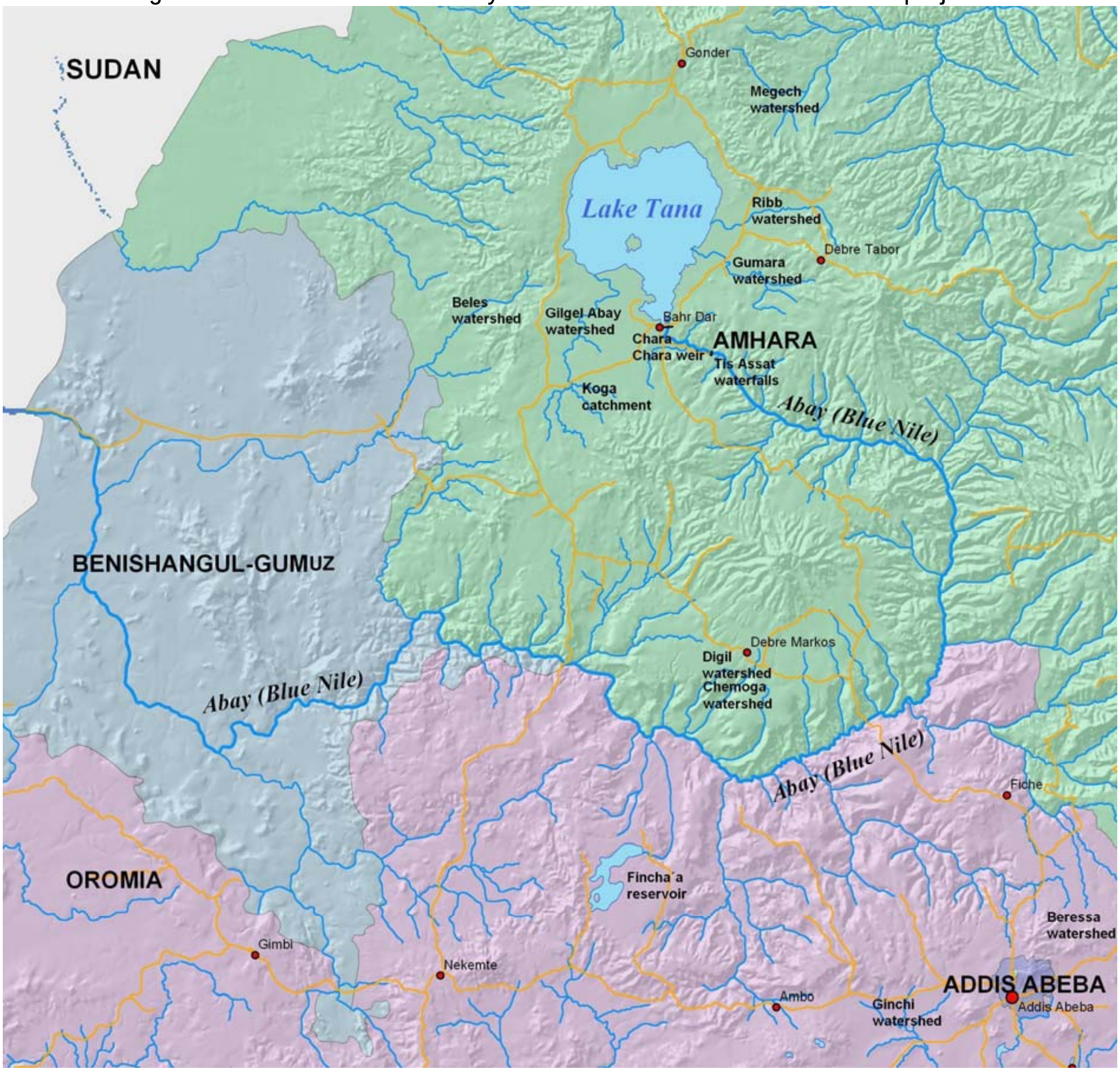
[3] The interdisciplinary research project runs from 2008 to 2011 and is concerned with water storage in the West African Volta River basin, as well as the Abay River basin. The project is funded by the German Federal Ministry of Economic Cooperation and Development (BMZ) as well as the GTZ.

[4] This is linked to the research question mentioned in the project proposal: What are the institutional implications and economic merits and cost of various storage types and creation process? It is specifically understood as a

The response drawn from the literature will include typical as well as uncommon scenarios in facility acquisition and consider local perception, political interest, social dynamics and project outcome as far as allowed by the available information.[5]

2. The Abay River basin

Figure 1 The location of the Abay River basin with documented water projects



Map design: Georg Lieth with add-ins by author

The upper part of the Blue Nile flows through the Central Highlands of Ethiopia before continuing its way to Sudan. Its two sub-basins are referred to as Abay on the Ethiopian side and as *al-Bahr al Ashraq* in Sudan. The largest river system of Ethiopia starts with the natural Lake Tana, and is joined on its 900 km long course through Ethiopia by about 50 perennial and all year tributary streams before crossing the

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preliminary contribution to Output 1: Assessment of processes of decision-making and storage creation and their impact on water entitlements and inclusion and exclusion processes.

[5] This paper serves as preparation for field visits and research in the Blue Nile basin, which will take place in 2009 and 2010.

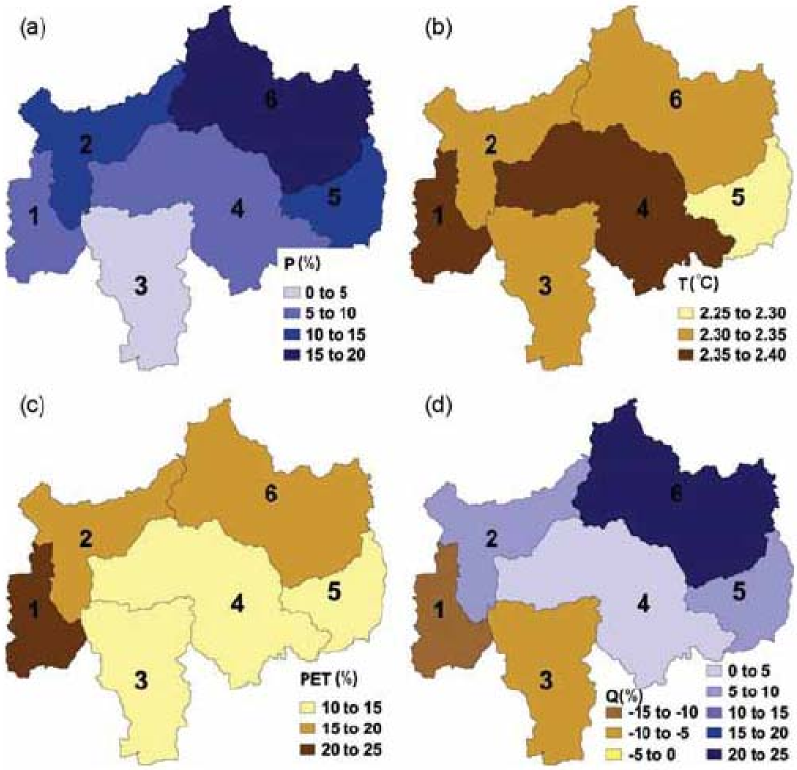
national border and entering the Nile close to Khartoum. The river basin can be subdivided into nine hydrological catchments[6], which serve as reference points for the localization of various case studies.

As the Blue Nile is the largest tributary of the Nile, sharing its water has been a sensitive issue of negotiation and political tension for many decades between the riparian countries Egypt, Sudan and Ethiopia (Ule, 1998; Karyabwite, 2000; Methawie, 2004; Arsano and Tamrat, 2005; Kagwanja, 2007; Cascao, 2008; Waterbury and Whittington (undated).

Apart from its tremendous hydrological, political and economic significance, the Abay River is associated with holiness, as it is understood by many Ethiopians to be the river flowing out of the Garden of Eden. Moreover, the Tis Assat Waterfalls about 32 km downstream of Lake Tana belong to the tourist attractions of the country enjoying international reputation.

Due to its internal differences in elevation, the Abay river basin displays variation with regard to geological and hydrological conditions, and also in regard to mean annual rainfall and temperature, which have been mapped in detail (ENTRO, 2007).[7] There are two seasonal patterns in the Ethiopian highlands: an uni-modal wet season from June to September west of the Simien mountains, as well as a bi-modal pattern with the *belg* (short wet season from mid February to mid May) and the *kiremt* (main rainy season from June to September) in regions east of the Abay. The mean annual temperature ranges from 6 to 28 degrees depending on the altitude (Ibid. 2007).

Figure 2 Spatial distributions of average annual changes in climate variables and runoff for the 2050s



(a) Precipitation; (b) temperature, (3) potential evaporation; (d) runoff
Source: Kim et al. 2008: 10

In some parts of the basin, a warming pattern has been observed (Conway, 2005). Observations of climate change in the Blue Nile basin, especially its source area, revealed rainfall anomalies in the period from 1900 to 2003. *"...a slight increasing trend occurred between 1905 and 1965 followed by a prolonged*

[6] These catchments are: Binder, Beles, Lower Abay Gorge, Dabus, Middle Abay Gorge, Didessa, Jena, Lake Tana and a small unnamed catchment at the border to Sudan (ENTRO, 2007). The categorization differs in the literature (NBI, 2007:11; Kim et al. 2008).

[7] Such maps also exist on the distribution of agro-ecological zones, administrative boundaries, farming systems, population densities, land cover etc in the basin (ENTRO, 2007).

decline which bottom out in 1984 and recovered substantially during the 1990s. [...] *mean annual Blue Nile flows are 45.9 km^3 (1961-1990) and have ranged from 20.6 km^3 (1913) to 79.0 km^3 (1909) and the lowest decade-mean flow was 37.9 km3 from 1978 to 1987"* (Conway, 2005: 102). Even though the expectation of climate change is based on various datasets and modelling exercises, the clear identification of rainfall trends has so far not been possible, meaning that the climate change scenario is merely a scenario of uncertainty. Modelling exercises also presented a picture of diverse climate trends within the basin (Figure 2). However, the current state of knowledge is that (1) the climate in the 2050s is likely to become wetter but not everywhere; (2) flows might increase and (3) mid-to long term drought might become less frequent (Kim et al. 2008).

Consequently, the required responses to regional climate change are hard to predict, plan or implement.

> "How climate change will affect the situation [in the Abay River basin] is unclear; if rainfall increases then there may be benefits for crop yields, although these may be offset by increased variability and soil erosion due to higher rainfall intensities, if rainfall decreases food security is likely to deteriorate" (Conway, 2005: 111).[8]

However, there is a tendency in the literature to assume more variability in rainfall and longer dry spells which call for specific action. One of the biggest challenge expected to be tackled by water storage is

> "to overcome rainfall availability, dry spells and drought; increase availability of per capita storage for productive and consumptive purposes and even out the availability of water in space and time; overcome soil degradation, and overcome water holding capacity and productivity problems" (Awulachew et al., 2005: 4).

The adverse scenario of increased rainfall would require intensified action towards the prevention of soil erosion. Of course, many national conservation programs tackle both, the increase of soil moisture and decrease of soil erosion (e.g. Amsalu and de Graaff, 2007; Bewket and Sterk, 2002) - thus preparing for two adverse scenarios.

Populations in northern and western Ethiopia can look back to a long tradition of water harvesting and storage; historical artefacts for domestic and ritual use can be visited in Axum (the bath of queen Sheba from ca. 560 BC), in castles of Gondar (17th century), as well as in the ancient monasteries around Lake Tana (16th/ 17th century). These water facilities were constructed for social elites, and therefore, provide clues to the history of water storage in the area. Some authors suggest that at various points in time, water development in Ethiopia has gained from Indian expertise in this field (Alem, undated; Guleid, 2002). The history of rather ´ordinary´ and rural water storage facilities and methods is still to be written. Taking the ancient culture of Amharic literacy into consideration, this could be an interesting and eye-opening task.

However, water storage has been practiced in one form or the other for a long time in several regions of Ethiopia without receiving much attention by political authorities. Water harvesting and storage started to regain attention in academic, government and development agendas in Ethiopia after the severe famines of 1983/84.

Water storage not only allows for the storage of water from rain-abundant times for dry season irrigation, it can provide other tools for hydrological regulation such as for flood control or the slowing of sedimentation flows. Moreover, storage may provide household water, create new ways of transportation, develop into habitats for fish, increase local biodiversity or may generate hydropower. Of course, these contributions are largely linked to reservoirs of different size. Other storage types are mainly established to prolong the seasonal availability of water, or to increase soil moisture. However, establishing hydropower plants as well as irrigation schemes to increase national agricultural productivity are considered the main policy targets of the present Ethiopian government. International donors, such as the World Bank, support these targets, whilst some international donors and NGOs also engage in small water storage projects for domestic uses.

With the size of 176,000 km^2, the Abay River basin is one of the largest river basin in the country with an estimated irrigation potential of 711,000 ha (Arsano and Tamrat, 2005). Despite this potential,

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[8] The Potsdam Institute for Climate Impact Research (PIK) will contribute own climate models to the project.

Ethiopian irrigation efforts have concentrated on the much smaller Awash River basin in the eastern part of the country, which holds about 71 % of the country's irrigated land (large and medium schemes only), whereby irrigated land in the Abay River basin only counted up to less than 1% ten years ago (Rahmato, 1999). The largest current irrigation scheme is the Fincha´a reservoir with a capacity of 30,000 ha irrigated land; about 23,000 ha are irrigated via smaller, partly traditional schemes.

The flow of the Abay displays dramatic variation over the year. In August, run off is 60 times more than in February. The run-off is held responsible for the annual loss of 405 million m^3 of top soil in the basin (Arsano and Tamrat, 2005); destroying the conditions for agriculture-based livelihoods in the Western Highlands.

The regular droughts, which seriously affects and damages crop and livestock productivity, the decrease in per capita food production[9], as well as the dependency on food relief even in years with regular rainfall, demand long-term strategies to mitigate rainfall variability. Thus, irrigation has been put high on the national policy agenda. This is so despite the fact that

> "even if we adopt a very optimistic scenario, irrigation will not significantly increase the volume of food production in the country. The contribution of irrigation to the country's food needs in the next twenty years will perhaps be in the range of 6 to 10 percent. The mean benefit of irrigation will thus lie in mitigating the adverse effects of drought especially in the vulnerable areas of the country." (Rahmato, 1999: 24).

Because the national food production was not always able to meet the regional demand, voluntary and enforced resettlement has regularly served as a short term political solution to mitigate acute climate change effects, severe land degradation and famine. Another way to mitigate the effect of rainfall dependency on livelihoods in the basin would be the diversification of livelihood practices towards non-farming and non-pastoral income generation, but this shift would require a long-term political strategy of investing in infrastructure, markets, education and energy supply to lift the comparatively low life standards and development indices of the entire basin. Moreover, some of the observed diversified livelihood strategies, such as the sale of dung cakes to urban fuel markets or seasonal off-farm employment, were identified as counterproductive with regard to soil and water conservation.

3. Population and livelihoods in the basin

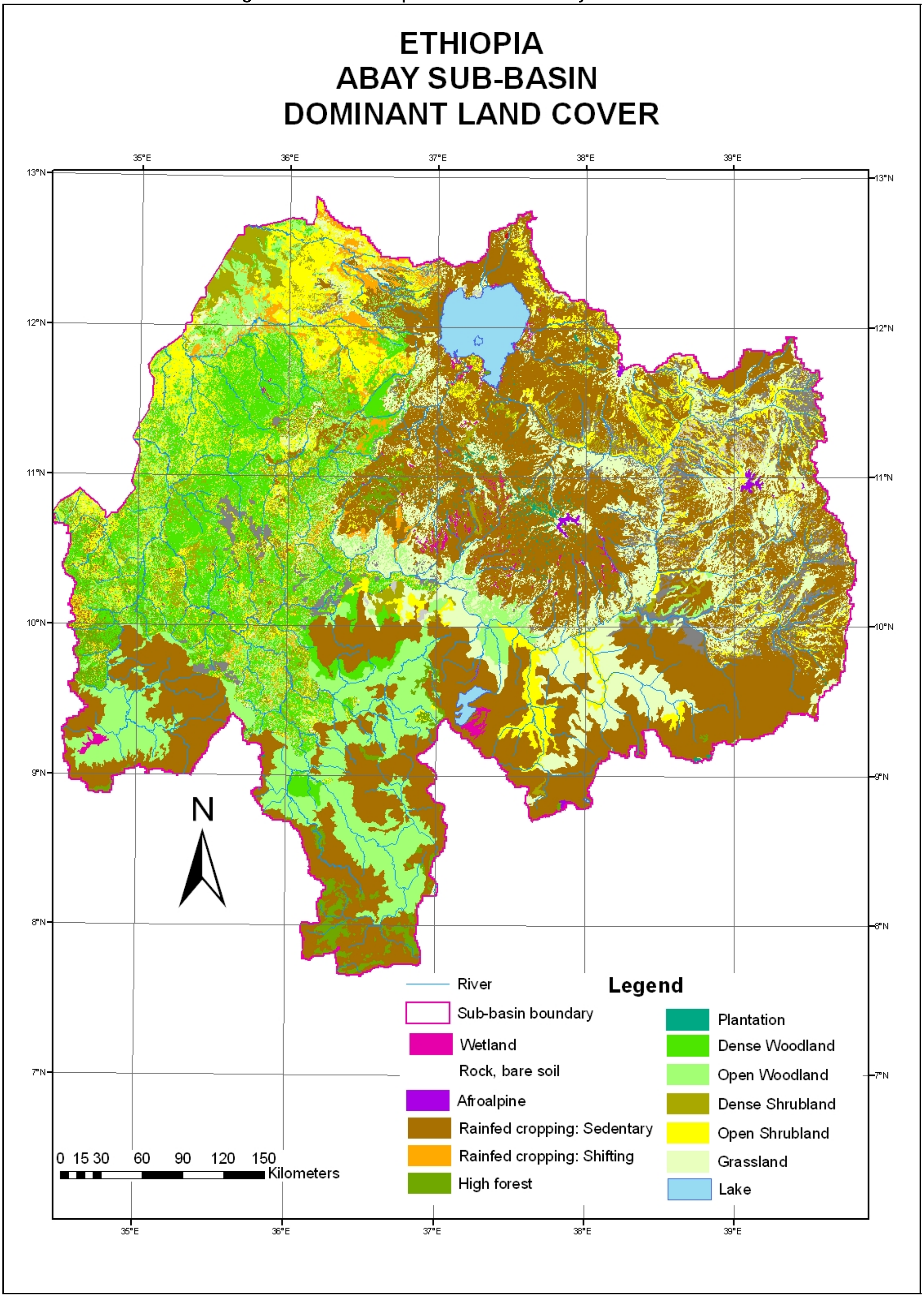
The Abay River basin of Western Ethiopia spreads over three federal states - Amhara, Oromia and Beneshangul Gumuz - with the latter comprising the largest land share. Most of the 600,000 basin inhabitants live in rural areas of the basin (90%) and depend on a strategy combining rain-fed agriculture with animal husbandry (Figure 3). The basin is marked by a trend towards the establishment of small towns. The heterogeneity of Beneshangul Gumuz population originates in part from various groups that have lived in the region for many centuries, as well as from voluntary migration movements and enforced state resettlement programs of the 1980s. These programs and migrations relocated large numbers of people from other regional states to the western part of the country, where land was perceived as abundant in comparison to the places of origin. Because settlers were not pleased with the livelihood conditions in the new settlements, many have returned to their places of origin or moved to urban centres of the country as soon as this became politically possible due to the replacement of the *Derg* in 1991. Resettlement also affected some original population groups, whose livelihood became more vulnerable as a result of the high in-migration rates and land redistribution (Gebre, 2003).

Presently, the population of Abay River basin can be distinguished in accordance with three main groups: the Amhara (64.5 %), the Oromo (29.3 %) and people who are usually referred to as autochthones of western Ethiopia, such as Jabelewis, Gumuz, Sinashas, Maos, and Koma. The characteristics of the basin population show great variation in terms of livelihood strategies (ranging mainly from nomadic to agro-pastoralist), religion (covering animist beliefs as well as the book religions), language, as well as social organization. This includes groups who were still known as hunter-gatherers or pastoralists some

[9] In 1960, Ethiopia produced about 280kg/c/y whereby present production is about 160kg/c/y (World Bank, 2006).

decades ago. Typical crops grown in the basin include wheat, barley, *teff*, sorghum, millet and various pulses; *enset* and coffee are cultivated in the southern part of the basin. Studies at local scale identified diverse and locally specific patterns of land use change over the past decades; with the main trends being the creation of surface water bodies, deforestation, the conversion from grazing into farm land, as well as the establishment of (merely) eucalyptus plantations.

Figure 3 Land use pattern in the Abay River basin



Source: ENTRO, 2007: 12

The Abay River basin can be identified as a remote and comparatively low developed region of the country in regard to socio-economic development indicators and in comparison to national average, struggling with poverty, nutrition and health challenges. This region is also associated with infrastructural underdevelopment, especially parts of the Beneshangul Gumuz regional state. One reason given for this situation is population growth, which is politically seen as responsible for deteriorating living conditions caused by natural resource degradation. One policy objective of the national government is to decrease the total fertility rate to four children per women by 2015, whereas other important policy targets include the decrease of maternal, infant and child morbidity and the regulation of population distribution.

The basin population competes for local natural resources in the river basin, such as fertile land, pastures and water. Even though, (partly violent) conflicts among the diverse groups are reported, major problems seem to be rooted in land redistribution caused by resettlement and land deprivation by the state and local authorities, rather than by conflicting livelihood systems or different lifestyles. Single water development projects aiming at water storage and river diversion were the source of social conflict at local level. These projects created competition over natural resources by resulting in land and land cover changes, as well as changes in patterns of river flows. Time-tested livelihood systems had to be adapted to the present conditions; settlements were shifted, other income-generating activities pursued, and social contracts were negotiated with new neighbours (including land use issues). Water projects usually entailed a number of beneficiaries as well as a number of people whose livelihood conditions have become more vulnerable.

Generally, water development projects are not driven by open conflict, but are instead challenged by the disinterest of the target communities, lack of transparency and communication, very long project cycles, financial and labour constraints, the balancing of positive and negative project impact, the question of how to make local participation actually happen, as well as by the struggle for (technical) sustainability.

4. Typology of water storage facilities

4.1. Large- and medium-sized dams – winners and losers

Large- and medium-sized dams designed to support irrigation are still rare in the Abay River basin compared to potential irrigable land.[10] The development of large dams falls under the responsibility of the national Ministry of Water Resources. Apart from the Fincha´a dam (460 Mio m^3 storage volume), which generates hydropower and sustains a sugar cane plantation, and the Koga dam (77 Mio m^3 storage volume) that is currently under construction, there is another dam under construction in the Upper Beles Valley with 50,000 ha irrigated land, as well as other projects in the planning phase concerning dams in the Lake Tana, Anger and Didessa watersheds (NBI, 2007).

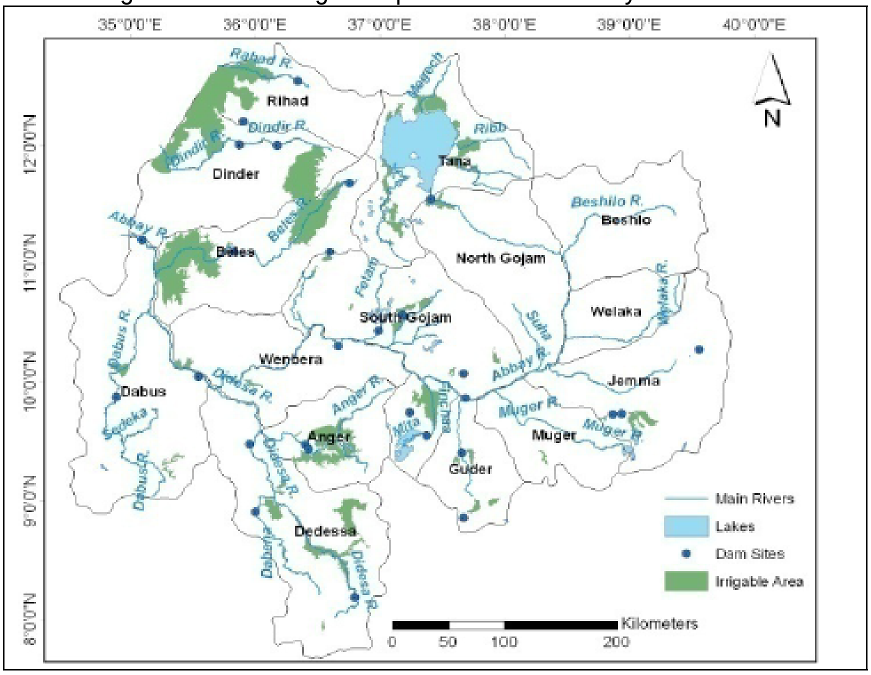
Figure 4 Existing irrigation schemes in 2005

Regional states[11]	Irrigable potential in ha	Traditional irrigation in ha (spate irrigation)	Small modern irrigation in ha (micro dams)	Large and medium irrigation in ha
Amhara	500,000	64,035	5,752	-[12]
Oromia	1,350,000	56,807	17,690	31,981
Beneshangul Gumuz	121,177	400	200	-

Source: adapted from Awulachew et al, 2005: 8

[10] Large reservoirs have a capacity of more than 3,000 ha irrigated land whilst medium reservoirs may irrigate 200-3,000 ha of land. The official definition of large, medium and small-scale reservoirs/ irrigation schemes originates from the *Derg* times.
[11] Please, note that borders of Abay sub-watersheds and regional states are not congruent.
[12] The Koga irrigation scheme is not operational yet.

Figure 5 Future irrigation potential in the Abay River basin



Source: Awulachew et al., 2008

The strategy of the Ethiopian government to increase national energy production relies almost exclusively on hydropower.[13] The Abay River basin is of strategic importance for it displays an estimated hydropower potential of 75,500 GWh/ y (Arsano and Tamrat, 2005). Within the basin, there are five operational hydropower plants.[14] But more are about to be constructed within the coming years.

Currently, two plants are under construction and seventeen others are in the study and planning phase (CEE, 2008). Already in 1964, four potential dam sites were identified, which were recently re-evaluated with the help of current models (Block 2008).[15] Downstream of the Abay confluence with the Guder River, a multi purpose Karadobi dam is projected with a planned volume of 26,480 million m^3 (Norlan Norconsult-Laymeyer, 2006).

The oldest, and largest, Fincha´a dam, is located in the state of Oromia and was planned and constructed during the 1960s-70s when stakeholder consultation, resettlement schemes or compensation was not yet part of Ethiopian water development projects.[16] The lake, which was created by storing the run off of the Fincha´a River, had a surface of 100 km^2 but increasingly extended to 149 km^2. In 1987, water from the near Amarti River was dammed up and diverted via a tunnel to the Fincha´a reservoir to boost hydropower production. Nowadays, the plant meets 27% of the national demand for power. Due to this extension, the lake's storage volume was increased from 185 to 460 Mio m^3. As a result, 431 km^2 of land were directly submerged by the water project; further 331 km^2 of grazing and agricultural lands were affected and big parts of it abandoned. Even though huge areas of cropland, swamp, grazing land and forest were inundated, an overall increase of cropland from 1957-2001 was stated. This is so because farms were created on former grazing land as well as on the steeper slopes where dislocated farmers (14 % of the people in the watershed, 3,100 families) tended to settle after their houses were flooded. Deforesting and farming steeper slopes, of course, triggered soil erosion in the watershed and contributes to the sedimentation of the reservoir. Other dislocated farmers migrated out of the watershed (Bezuagehu, 2006). The recent assessment of stakeholder perspectives and further studies indicated severe land use and livelihood changes related to the dam (see Figure 6).

[13] The 25 year national energy master plan from 2005 neglects wind and solar potential completely but marginally discusses geothermal energy sources and one coals mine.

[14] TisAbay I (commissioned in 1964, rehabilitated 1998-2000, 11.4 MW), TisAbay II (commissioned in 2001, 74 MW), Fincha´a (commissioned in 1973, extended in 1987, 128 MW), two Beles plants (commissioned in 1995).

[15] Karadobi dam, Mabil dam, Mandaia dam, and a dam at the national border.

[16] There is some hint that the project intended to compensate some landlords for the loss of trees but the revolution of 1974 when all land was nationalized seem to have balked this attempt.

Figure 6 Farmers´ perception of Fincha´a dam's impact on their livelihood

Flooded farmers	Farmers in villages near the dam/ reservoir
Loss of land, loss of home	Irrigation farming
New strategies for some people: Lumbering, honey production, wild life hunting	Swamp grazing (due to loss of grazing land) resulting in loss of livestock
Farmland of lower quality (soil erosion)	Fishing
	Health problems
	Burst of streams, habitat destruction
	Loss of human life (accidents in the swamps)
	Water shortage for people and livestock (due to sedimentation, loss of springs/ streams)
	Isolation of some communities on the islands (*cittu*), ca. 10,000 people, lack of access to infrastructure
Occurrence of famine due to loss of farmland, soil degradation, low market pieces, lack of credit facilities	
No benefit from hydropower	

Source: Bezuagehu, 2006 (summarized by author)

Farmers seem not really interested in the national level incentives for water project developments. Looking at the Fincha´a project, farmers´ mainly benefit from fishing in the reservoir and irrigation. Some found employment at the regional sugar cane factory. Many had to leave their lands and give up their farms and herds. Their households do not benefit from hydropower because there is not electrification yet. Thus, there is little interface with national level interest, such as the supply with hydropower for other regions of the country, the creation of a wetland habitat for precious birds or the increase of the national water storage.

Later large dam projects tended to accommodate the local population by offering compensations. Despite this, decision-making processes took place only at policy and water administration level without any participation of the local stakeholders. Generally, the documented large dam and other water storage projects (apart from the Fincha´a dam) are located in the Amhara regional state. This has, of course, to do with Lake Tana, but assumingly also with better road accessibility of the projects.

In the 1990s, an unsuccessful forerunner to the current Tana-Beles dam project was undertaken with the intention to link Lake Tana to the Beles River via a tunnel, where an area of 50,000 ha was planned to be brought under irrigation. The costly project design (267 Mio US$) could not be implemented. The project outcome was poor with regard to benefits but caused rather unpredicted problems. In 1995, the two hydroelectric Beles dams and some irrigation infrastructure began operation. For the hydropower plant and the irrigation system were based on run-off from the Beles River and there was no tunnel completed to supplement river run off, only 53 ha of gardens could be irrigated by pumps. Reports from the Abbay Master Plan project stated that half of the technical equipment, which was bought for the original project is already out of order because it does not serve any purpose. Even though the project to establish new reservoirs and towns was not reached, 80,000 people were enforced to resettle to provide labor for construction and draining of the Beles valley. Many of these settlers have left the region again. The settlers did not meet the promised work and irrigated land. Many of them had not even agreed to resettle to Beles region beforehand. Conflicts over resources entailed violent clashes between local people and settlers as in-migration endangered the livelihood of the original settlers (Gebre, 2003).

In 2005, the Italian construction company Salini, already responsible for the project failure in the 1990s was contracted again for the construction of dams at the Beles River. In 2008, a project report stated that the tunnel from Lake Tana was finally under construction, and also the construction of the Koga dam. The Megech and Ribb dam were reported to start soon. The same holds true for the respective irrigation schemes.[17] Lake Tana will be connected to the Beles via a 12 km long tunnel. *"The multi-purpose objective of this* [...] *transfer is to use the large elevation difference between the lake and the (underground) power house for the generation of hydropower, and to use the water downstream of the*

[17] Koga irrigation scheme: 7,000 ha; Megech irrigation scheme: 5,000 ha; Ribb irrigation scheme: 10,000 ha.

power plant for irrigation" (SMEC, 2008: 41). The Tana-Beles hydropower plant is expected to start operation in April 2009.

The social-economic factors in the pre-project assessment included fisheries, navigation, tourism and environment, which will surely be affected by changing water levels of Lake Tana. However, strategies to cope with substantial worries of the Transport and Navigation Enterprise, the Culture and Tourism Bureau in Bahir Dar and wetland ecologists were not offered. According to project documents, conflict of interest concerning the optimal technical performance and affected livelihoods of downstream users will occur but *"tradeoffs have to be made between the impacts on different demand sectors"* (SMEC; 2008: 60). Negative future impact of the Tana Beles project as outlined in the report include the decline of fish population, limited accessibility to schools, markets and health facilities, as well as income failure in times of low lake levels due to restricted boat transport, the reduction of the water flow of the Tis Assat Falls and income reduction in the tourism sector, the threat of endemic wetland bird habitats and general wetland biodiversity, the enhancement of encroaching farming, as well as a negative impact on recession farming. This list is clearly incomplete. What is recognizable is that the creation of diverse income opportunities, food production and livelihoods in the basin will be negatively affected on the basis of different water levels and river flow patterns. The increased water amounts due to the diversion will further affect biodiversity in the respective rivers and along the riverbanks; floods might occur. But no strategy to accommodate these effects seems to be in place at the planners´ level.

Generally, literature and studies on communication, negotiation and decision-making processes among diverse stakeholders in the Abay water storage projects are very rare, and more research and project documentation is desirable. Detailed studies on stakeholders, dam implementation and impact with regard to the Koga irrigation scheme as well as the Chara Chara weir clearly illustrate the need for social-political assessments.

The Chara Chara weir was constructed from 1995 to 1997 and releases the outflow of Lake Tana according to the run off requirements of the two Tis Abay power plants. A part of the outflow is diverted into canals leading to the power plants before being reunited with the natural river. The post-project assessment of stakeholders perception weir illustrates that the water level of Lake Tana is already a very sensitive issue to different livelihood systems in the region around the lake and downstream of the weir. The establishment of the weir has resulted in positive and negative changes in income security and life quality depending on the location and professional occupation of the communities. *"The various circulating misconceptions, misrepresentations and conspiracy theories concerning the weir structure are to be blamed on the failure to be transparent and participatory to the necessary extent"* (Gebre et al., 2008b). Before and during project implementation, no stakeholder consultation or environmental assessment had taken place even though crucial issues were at stake (Figure 7).

The table below gives some idea the diversity of interest and complexity of the project outcome on local livelihoods. Some local stakes are not even given appropriate attention yet. For example, the table does not consider the Negede, who live on the papyrus plant (as canoe producers, hired canoe operators, sale of papyrus trunks, and sale of household and tourist items made from papyrus). With the decline of coastal vegetation, their base of livelihood is under enormous threat. Moreover, conflict of interests has arisen between wetland cultivators and papyrus harvesters as the cultivators have begun to register the wetlands as their property with the authorities and do not allow other users. An interview partner from the Negede stated

> "The Chara Chara Weir project is a deliberate government imposed scheme. The authorities are in full knowledge of all the dimensions of the impact that the project is set to entail. Therefore, what use is telling a problem to a body or agent that has caused it in the first place?" (Gebre et al., 2008b)

The assessment supported this point of view. Authorities seemed to be well aware of most problems mentioned. Specific concerns from their side were the local preference for biofuel over electricity, the importance of biodiversity for tourism, as well as the need for more coordination between organizations/ agencies working in the Lake Tana area.

Figure 7 Project outcome and local perception of the Chara Chara weir

Farmers at Lake Tana	Farmers on the Zege Peninsula	Fishermen and fishing enterprises at Lake Tana	Farmers living between the weir and the power station	Farmers living in downstream communities, close to the power plant
CONSEQUENCES OF CHARA CHARA WEIR				
Lower water levels, increase of wetlands			Regulated outflow	
Devegetation of coastal plains, especially papyrus population, trees			Flood control	Water for irrigation available in dry season
Lost pasture areas		Silting up of Lake bed	Destruction of natural scenery (Tis Assat Waterfalls)	Accidents due to unexpected water surges
Fear of drinking water insecurity		Decrease of fishes breeding grounds		Water pollution[18]
Loss of soil moisture on farms		Decreasing fish stocks, Labeobarbus at risk of extinction[19]		
More farmland available		Fish moves to deeper waters		
		Dangers for navigation		
MAIN IMPACT ON LOCAL LIVELIHOODS/ LOCAL CONCERNS				
No benefit from hydropower plant (electricity grid)				
Promises for infrastructure to balance negative project outcome did not materialize				
Increasing wetland cultivation		More vulnerable fisheries	No more damages by floods	Increased agricultural production
More vulnerable livestock rearing and farming		Conflicts between wetland cultivators and fishermen	Negative impact on tourism (also due to lack of infrastructure)	
		Increase of boat accidents	Strong identification with Tis Assat Waterfalls (hurt feelings)	

Source: Gebre et al., 2008 (summarized by author)

It is very interesting to note that with the completion of the Tana Beles project, the operation of the Tis Abay power plants is expected to reduce its hydropower production, means that the Chara Chara weir will decreasingly regulate the outflow of Lake Tana, meaning it might allow the rather natural (former) outflow pattern. But due to the newly created tunnel outflow to the Beles River, the water level of Lake Tana will be reduced significantly (Gebre et al., 2008b). This, of course, will again impact on the outflow at the Chara Chara site. In adherent communities downstream of the weir, the current situation as presented in Figure 8 might change significantly again. In 2006, a Monitoring and Consultative Committee assembling key stakeholders of Lake Tana started its operation. It includes representatives of the Regional Bureau of Water Resources, the Meteorology Office, the North Western Region Ethiopian Electric Power Corporation, as well as the Tana Transport Enterprise but excludes non-formal interest groups, such as representatives of the local communities or professional groups. There was no data available on its work performance and political influence.

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[18] The Bahir Dar tannery is suspected to dump toxic waste into the river when the weir is opened and the waste is washed away quickly.

[19] This was not mentioned by the stakeholders themselves but seems evident from academic studies.

Stakeholder perspectives and social processes were also investigated in the Koga irrigation scheme which is part of the current Tana Beles project. The Koga water project was identified as one of the project sites for further investigations in the framework of the IWMI "Re-thinking Water Storage…" project. Project feasibility studies date back to the late 1980s; the scheme was not fully implemented yet in 2008. The study in the Koga irrigation scheme (Gebre at al., 2008a) identified four different groups of farmers, namely (a) displaced and temporarily dislocated farmers who will be moved to other areas; (b) farmers who expect displacement and relocation; (c) farmers in host communities which will accommodate (a) and (b); and (d) farmers who live adjacent to the scheme but are not directly affected. Their diverse views on the project have been summarized in Figure 8.

More than 5,000 households lost land and property due to relocation but the promised compensation in cash and kind was either coming late, did not compensate for all the losses appropriately or seems insufficient to bridge the uncertain time until the irrigated plots can be farmed. Furthermore, people suffered emotionally from the dislocation; leaving their homes behind and stepping into a long-term period of economic uncertainty. In the beginning, host communities reacted by expressing what they considered to be unfairness by the project leaders and state as they were not compensated for their loss of land holdings due to the redistribution to the arriving people, as well as distrust towards the new settlers. The four farmers groups had almost no overlap in interest even though they shared some opinion in specific aspects. The Koga study clearly illustrates that *"the project has had a significant effect on the social landscape of the Koga catchment"* (Gebre et al., 2008a: 43) even before being officially inaugurated and operational.

The assessment among government actors involved in the Koga irrigation project revealed less diverse interest and points of view. Crucial findings include the difficulty to implement the required watershed management (soil and water conservation measures) in the upstream, non-beneficiary communities, the lack of local capacity for large-scale irrigation management, the feasibility of cost-recovery, the conflicts between resettled and host communities, the insufficient effort for public participation and community consultation within the planning and implementation phase, as well as irregularities with regard to the compensations (Gebre et al., 2008a).

Figure 8 Farmers views on Koga irrigation project

<table>
<tr><th>(a) Displaced farmers</th><th>(b) Farmers expecting displacement</th><th>(c) Farmers in host communities</th><th>(d) Not directly affected farmers</th></tr>
<tr><td colspan="4">Creation of job opportunities, decrease of livestock theft and violence</td></tr>
<tr><td colspan="4">Lack of information on project, uncertainty of final project start</td></tr>
<tr><td colspan="3">Mistrust and local resistance</td><td></td></tr>
<tr><td colspan="4">Expected enforced membership in farmers associations within irrigation scheme</td></tr>
<tr><td>New ownership of urban land, problems with new farming land (land rights)</td><td>Loss of fertile land</td><td>Loss of land due to redistribution</td><td>Possible benefits through sharecropping arrangements</td></tr>
<tr><td>Gained access to health and education facilities</td><td>Loss of rather secure livelihood</td><td>Perception of injustice, mistrust towards the strange new settlers</td><td>Possible benefits through horticultural crops and market interaction</td></tr>
<tr><td>Early integration problems, hostile host communities</td><td>Enforced displacement, fear of hostile host communities</td><td rowspan="6"></td><td rowspan="7"></td></tr>
<tr><td>Delayed and insufficient compensation</td><td rowspan="2"></td></tr>
<tr><td>Loss of work for some individuals</td></tr>
<tr><td colspan="2">Loss of safe drinking water source due to the of the Koga River</td></tr>
<tr><td colspan="2">Loss of farmland due to water cover</td></tr>
<tr><td colspan="2">Inconvenient timing of relocation</td></tr>
<tr><td colspan="3">No responsive authorities, no say for affected farmers</td></tr>
</table>

Source: Gebre et al., 2008 (summarized by author)

To summarize, the projects in the basin displayed typical challenges and problems for large dams having enormous impact on diverse livelihood, social and ecological systems and a number of trade-offs in project implementation, and produced diverse social dynamics at local level.

4.2. Micro dams – balancing cost and benefits

Unlike large and medium dams, small-scale irrigation and water storage are tasks of development and implementation under the leadership of the Ministry of Agriculture and Rural Development at the level of the regional states. But specific organizational set-ups may vary from region to region.[20] There seems to be only limited knowledge and specific studies on micro dams in the Abay River basin. Under this term, surface water facilities are summarized which may irrigate up to 200 ha of land, as well as small dams which do not serve irrigation. *"Micro dams are permanent bodies of water between five and 50 hectares in size, located by the government and used by villagers near the dams" (*Anmacher et.al. 2004: 123). The "Re-thinking Water Storage…" project intends to provide a detailed interdisciplinary study on a community reservoir in Gomit (90ha, 360 beneficiary households), located in the Este *woreda* of South Gondar zone.

Past research mainly focused on geo-hydrological characteristics of small reservoirs, as well as on the consequences of micro dams for the health in the adhered villages as they may act as vectors for various insects. Social-political implications within the basin and villages have rarely been investigated, but there is some literature on micro dam projects in the Tigray outside the basin (e.g. Ersado and Anmacher, 2002; Lemma, 2007). The lack of empirical studies of local processes might be due to the fact that most micro dams are initiated by local communities, meaning they are usually not embedded in international donor or government programs but instead build on local skills, resources and labour. This implies that there are no project documents. If government, international donors or NGOs were involved in dam construction, the experience is usually documented in detail and can be accessed in the respective regional offices, such as OIDA in Oromia.

Even though there are many sites in the Western highlands, which could be developed towards micro dams and irrigated agriculture, the establishment of micro dams were included in the government strategy for the region. The Oromia regional government, for example, intended to increase the number of water storage facilities significantly by implementing small-scale irrigation by river diversion and dams (for 7, 856 ha of land), 90 hand-dug wells, and 638,500 ponds, as well as irrigation by traditional irrigation (for 8,500 ha) and harvesting of rain and flood water (for 370,000 ha) from 2004 to 2007 (Awulachew et al, 2005).

Even though, it seems evident that irrigated agriculture is not the way out to solve Ethiopia's food security challenge, micro dam development seems very attractive to the regional governments. The most compelling impact of dry season irrigation is, of course, the increase of agricultural productivity. Further, micro dams may entail additional income generating opportunities and benefits, such as fruit tree cultivation, handicraft, fishing, livestock watering, as well as provide water for domestic uses. Moreover, small reservoirs may contribute to the increase of biodiversity and the decrease of land degradation.

It was argued that micro dam development is also an attractive policy because it would be independent from international funding and hence not impact on Ethiopian interest and decision-making. Further, the downstream impact of hundreds of micro dams is much more difficult to estimate and quantify than of large dam projects. Decentralized infrastructure is rather invulnerable to military action – a security factor of importance in case the Nile conflict between Egypt and Ethiopia should escalate in future years (Waterbury and Whittington, undated).

Apart from the indisputable benefits for agricultural production, there are also a number of studies which indicate that cost and benefits of micro dams have to be carefully balanced in water projects. A number of studies stated a significant increase of the risk and spread of malaria, schistosomiasis and other water vector diseases due to the creation of new insect habitats in the form of small reservoirs

[20] Amhara: Bureau for small-scale irrigation development under Co-SEARAR; Oromia: OIDA with own extension; Beneshangul Gumuz: no data

(Gunderson and Birrie, 1998; Gundersen et al., 1988; Brewster, 1999; Anmacher et al., 2004a, Ibid, 2004b). With the help of econometrics, the economic benefits were counted against the cost of health hazards (less labour days, expenses for treatment, cost for hired labourers etc.). From an economic, but also social point of view, it is noteworthy that non-farm income generation activities were significantly reduced as one outcome of higher infection rates.

> "…households in microdam villages have become more vulnerable due not only to deteriorating health but also to shrinking income from nonagricultural sources. [...] on average, the marginal gains in terms of farm profit are significantly lower than the marginal loss from nonfarm activities" (Ersado, 2005: 22).

If non-farm activities cannot be pursued, it also means that one possible rural livelihood strategy to gain more independence from weather events, erratic rains and climate change is opted out of the possible set of adaptive strategies. Farmers, even when practicing irrigation are still more vulnerable to rainfall variability than farmers with a diversified income portfolio partly based on non-farm income sources. Such effect may be absorbed by creating additional direct or indirect income sources from the reservoir, but sickness acted as a serious constraint to implement technical innovations, especially when requiring intensive labour input. A diversity of preventive means could be applied to minimize health hazards ranging from the strict use of bednets and landscape measures to proper siting and construction of micro dams. With this regard, the advantage of micro dams come into play as prevention depends highly on the understanding, willingness and cooperation of the local population. *"In practice, it may be easier in small dam projects such as the one in Ethiopia to make the trade offs (as) part of an integrated community development project"* (Brewster, 1999: 651).

Other typical technical problems associated with micro dams include the siltation of reservoirs and hydrological effects on downstream flows. But as most micro dams are the result of local, donor-independent initiatives, not all future consequences may be foreseen or their negative impact be mitigated by preventive measures. So far, no detailed field study is available focusing on local social – political processes during the acquisition of micro dams. But possible, regional offices responsible for micro dams keep valuable information and unpublished reports.

4.3. Run off farming and in-situ water conservation – missing farmers´ priorities

In Ethiopia, on-farm water storage technologies to increase soil moisture are usually referred to under the umbrella term of soil and water conservation (SWC) with an emphasis on soil conservation and the prevention of erosion. In the "Re-thinking Water Storage…" project, the term soil and moisture conservation is used. Research will be conducted in Anjeni (Gojam zone), where SWC programmes were implemented and documented since the 1980s.

Farmers in the highlands practiced different kinds of traditional conservation methods; government SWC programs set in during the 1970s and 1980s, propagating especially *fanya juu* (earthen bund/ terrace structures) and stone walls. Local peasant organizations mobilized farmers who contributed construction labour against the payment in food, which was financed by international donors. The long-term impact of these top-down programs on conservation were rather insignificant because farmers did not maintain or even destroyed the structures after the particular program ended (Bewket and Sterk, 2002; Bewket, 2007). Similar observations were recorded for follow-up SWC programs during the 1990s that were based on agricultural extension officers instead of peasant organizations.[21]

In the Dilge watershed, farmers were hesitant and resistant to participate in the project in the first place and only changed their mind after influential farmers had reported from a trip to pilot plots in another water catchment. SIDA funded the project implementation, which was carried out by development agents and local development committees which monitored the labour contribution of the farmers and sanctioned absent farmers financially. The SWC measures in this particular project were multiple and labour intensive, including different kind of earthen bunds, a tree nursery, cut-off drains, artificial

[21] SWC programs: (a) 1999-2004, Digil watershed, funded by SIDA; (b) 1999-2000, five year PADETES program, Chemoga watershed, funded by the government; (c) Beressa watershed; no data

waterways, and agroforestry components. While the implementation was going relatively well, the project was obviously not sustainable despite the fact that farmers observed a positive impact on biodiversity and their crops. Reasons for the project failure as identified by the study included missing the priorities of the farmers, perceiving the work as too hard and the technologies too difficult, complaints about lost land due to SWC, difficulty of oxen ploughing, insecure land tenure, as well as the fading out of SIDA funding for men who guarded the structures against roaming livestock (Bewket, 2007).

A comparison with SWC outcome in the Chemoga and Beressa watersheds hints to the fact that local variables for project failure may be very context specific; but also in these two watersheds, half of the farmers expressed that their participation was enforced by agricultural extension offices, rather than caused by their own motivation and the suggested technologies were not sufficiently adapted to local conditions (Bewket and Sterk, 2002; Amsalu and de Graaff, 2007; Amsalu et al. 2007). Further, interviews with farmers revealed the importance of local perceptions, as well as their ways of observing and explaining trends in rainfall and erosion. A share of the farmers had observed trends different to the scientific data sets, while others reported what had been measured. There were diverse opinions on the impact of livestock on soil quality, the ´age of the land´ or the reason for increased crop yields after SWC programs. With regard to rainfall trends, for example, some farmers´ *"suspicion was that, either there were some people in their village* [sorcerers] *who wanted to get money from the villagers by regulating the rain, or that the Ethiopian Roads Authority* [...] *was controlling the rain until the* [nearby] *construction would be finished."* (Bewket and Sterk, 2002). With regard to water storage, it is interesting to mention that farmers did not consider increased soil moisture in their responses when talking about project outcome (Bewket, 2007).

Projects which aim at the recharge of groundwater seem to be rather exceptional even though the technology using ditches, trenches, unsealed ponds and semicircles was considered to be a promising technology (Rämi, 2003). GTZ and German Agro Action have worked in this field.

4.4. Spate irrigation/ flood spreading – knowledge gap

Ancient systems for spate irrigation and flood spreading can be found in the areas of north Shoa, north Wollo and east Gojam. The systems consist of long furrows and earthen and brushwood head works, which require regular maintenance. The numbers of schemes are inconsistent; 540 small schemes irrigating 65,000 ha are reported for Amhara regional state and in Oromia, about 180 schemes with an irrigated land of 19,000 ha were assumed (Ramato, 1999). Awulachew (2005) writes about 56,807 ha of spate irrigation in Oromia. As traditional spate irrigation systems are local initiatives, they may not all be documented in the respective regional office.

These systems make use of stream/ flood diversion or perennial springs and display a number of advantages in comparison with micro dams, such as low investment cost, no land tenure implications, no resettlement or displacement, no serious adverse environmental effect, more diffusion of irrigation benefits among farmers, and increase of local knowledge dissemination (Ramato, 1999). As the structures demand for very high labour input, there is usually a social structure on the ground, which regulates the work and access to water. Ramato mentions water fathers and water judges who originate from an elected group of elders of the communities and lead the collective efforts. The *Derg* had almost destroyed these arrangements by implementing farmers´ cooperatives instead. Typical schemes comprise 200 water users. Members of the cooperative are reported to enjoy equal rights to water. But, no empirical field study on spate irrigation systems in the Abay River basin seems available. But such studies have been conducted in Eritrea, eastern Ethiopia and the Baro-Akobo River basin (Haile, 2007; Haile, undated; Woube, 1999).

4.5. Ponds – trying to meet quota but failing the target

The construction of ponds has a century old tradition in Ethiopia and was propagated by several government programs and propagated by extension services. *"Ponds are simple to construct and the* *community can manage it. The most common type of pond is the excavated type."* (Alem, undated). Ponds can be fed with run off harvested from catchments as well as roadside ditches. Their average size is about $60m^3$ (Awulachew, 2005). The creation of household and on-farm ponds was propagated in the national media and among government agents. It is used as a large-scale strategy to fight for food security. In 2002 alone, about 70,000 ponds and underground tanks were constructed in Amhara and Tigray regional states (Rämi, 2003). Programs of the past years have increased in budget and number of delivered facilities even though a significant effect of these water storage facilities and increased food security is not yet evident. This is so due to technical failures as well as lack of water which could be stored in dry years. In addition, experience shows that ponds and tanks are not everywhere the most appropriate and cheapest technology.

Despite the fact that ponds seem to offer a rather easy to obtain water harvesting option, some authors state severe difficulties in the implementation of ponds while other sources report successful pond initiatives. CARE observed in their projects that people had no stake or interest in ponds and therefore excluded them in its water harvesting projects at an early stage (Haile and Merga, 2002).

Studies in Tigray, located outside the Abay River basin, indicated that household ponds were rather unpopular among the rural population. A number of organizational and technical problems occurred when farmers were directed to construct ponds by government agents. *"Most household ponds failed, despite good design and techniques, because the social, economic and management factors were inadequately integrated into the pond development system"* (Lemma, 2007: 83). The two basic pre-conditions were not fulfilled: the motivation and willingness of farmers to participate in the food-for-work programmes for pond construction, as well as their participation at the level of knowledge exchange. Farmers' priorities and concerns could not adequately be communicated to the project leaders and accounted for; therefore, they stopped investing in the ponds when the food-for-work programmes phased out or abandoned the ponds (Lemma, 2007).

The UN OCHA fact finding mission to the Tigray and Amhara regional states observed a number of challenges and difficulties in the implementation of ponds. Despite training thousands of people at the regional and *woreda* level, the lack of basic masonry skills and local experience in construction proved to be a problem. In addition, regional authorities had given out design and construction manuals with technical mistakes. These factors, as well as time pressure and hurry to meet construction quota, led to the wrong location of ponds. In the selection process of the water projects, the target group gained more attention than the technical feasibility of the site. Certainly, a number of wrong project sites were selected. Further, there were a lack of tools at the local level and a shortage of building material due to lack of funding and dependency from Asian imports (plastic lining).

Usually, farmers contributed to the project under the leadership of water harvesting experts and a food-for-work arrangement. Excavating holes went rather well, but lining the ponds with plastic or compacted clay seems to have been the main problem. Many ponds could not be completed and the structures collapsed in the next rainy season, meaning that the large labour input was wasted. Since 2003, farmers are expected to pay 15% of the cost for building materials. Ponds can be either communal or privately owned by single households or groups of households. Other challenges mentioned were health problems caused by the use of pond water for domestic uses and the spread of malaria, drowning accidents, and loss of land due to excavated soil. Other observations referred to farmers who discovered shallow groundwater while digging for ponds and switched to shallow wells, as well as to large ponds which successfully recharged groundwater which could be tapped by wells year-round (Rämi, 2003).

A study in Ginchi watershed illustrated the adequate potential of on-farm ponds and showed the feasibility of pond on farms of one hectare size, which could be used for additional irrigation and a second crop during the post-rainy season (Kidamu, 2004). However, social processes and farmers´ perceptions and reaction to pond development projects in the watershed were not investigated.

In some context, farmers´ participation in pond projects was enforced by the setting up of sanctions by project staff and local project committees, such as fees for non-participation. Based on studies in other regions of Ethiopia, it was concluded that government programs tend to create a bi-polar leadership structure, with a formal local team-leader, who is equipped with rules on paper (e.g. sanction against non-participation in water project) on the one hand and the local elders on the other hand. As local people clearly prioritize enduring customary rules, the enforcement of project law may suffer drawbacks (Beyene and Korf, 2008).

4.6. Underground water cisterns – technical problems and elite capture

During the Mekelle workshop on water harvesting, CARE reported its experience with the construction of 350-450m^2 water harvesting ground catchments and cisterns for domestic use. These facilities were reported to be a low cost option in comparison to boreholes[22]. Furthermore, the cisterns could be filled by water tankers in case of rainfall failure. They were well received and eagerly adopted by the population. Only minor technical problems occurred (Haile and Merga, 2002). There is no information on social processes or impact of these projects.

The construction of low cost tanks was experimented with in the Amhara region at Nazreth/ Adama. The trials identified four technologies to store 60m^3 of water each: hemispheric concrete tanks of ca. 3,500 Birr, bottleneck structures with an underground construction of ca. 5,000 Birr, domes shapes of ca. 5,000 Birr and cylindrical shapes of 5,000 Birr (Hune and Kimeu, 2002). The trials were used by the Ministry of Agriculture to write a construction manual, which was technically adapted to local circumstances at the regional and *woreda* levels. The hemispheric tank was the most implemented technology. Despite this local contextualization, the soil and water conditions were so diverse that the manuals could not accommodate specific technical requirements leading to the leakage or total failure of a large number of the tanks. Moreover, the required masonry skills were often not available, resulting in further construction mistakes (Rämi, 2003).

A study in Oromia and Somali Region (outside the Abay basin) revealed how local social dynamics may counteract the establishment of new *birkouch* (a specific kind of tank). Private *birka* owners took advantage of the fact that the labour intensive maintenance of other communal water facilities (cisterns and wells) was neglected when they sold cistern water for a low price. Once the communal facilities became dysfunctional, the *birkouch* owners increased the prices and prevented new communal or private *birkouch* from being established. This was possible due to their leadership status based on wealth, their withdrawal from communal duties of maintenance, as well as their elite position within the clan structure. It seems that rule-making of not allowing new cisterns had had some domino effect over the entire region (Beyene and Korf, 2008). Of course, such dynamics do not only constrain local initiatives but also donor-funded cistern building programs.

In addition, there also exists a market for pre-fabricated Chinese underground cisterns (Alem, undated). But no further information on this technical option was available.

4.7. Hand-dug wells – limited potential

The prevalence of hand-dug wells is restricted to some areas in the highlands due to high elevation, such as wetlands, riverbeds and valley bottom lands. These geological factors make hand-dug wells a relatively low potential option for water harvesting, even though they serve communities and even irrigation purposes in single locations.

Observations of programs in Amhara and Tigray indicate that wells demand a lot of labour (10 men, one month), some masonry skill and building material. Farmers were taking up initiatives when shallow groundwater was found during excavation for other water projects. Usually, one or two households use the well for irrigation and all other purposes whereby their neighbours use it for domestic purposes and livestock watering only. Lifting technologies were the Egyptian *shaduf* and bucket irrigation, as well as traddle pumps and hired diesel pumps. To prevent the overexploitation of groundwater resources, some regulation was established in Amhara region (distances between wells) (Rämi, 2003).

[22] Cost in 2002: ground catchment and cistern = 25,000 – 30,000 Birr; boreholes = 500,000-900,000 Birr

4.8. Virtual water – early thoughts

Virtual water storage describes the hidden water volume within an agricultural product. Even though the virtual water concept is usually describes the transfer of virtual water from a production region to a consumer's region, one could also think of it in local, but seasonal terms, indicating the water storage potential of plants and animals which one could benefit from in a dry season. So far, this idea has nor yet been systematically thought out and implemented in the Abay River basin as a strategy to mitigate dry spells. Of course, large volumes of virtual water are already transferred to the basin in the form of grain import as food relief.

Local drought-tolerant plants may serve as water storage. For example, sheep can survive up to 500 days without additional water intake by eating cactus cladodes, this could be strategically utilized for conservation measures and adaptation to rainfall variability and dry spells. It

> "may reduce wastage of energy animals spend to reach watering points and allow animals to graze and browse away from the watering points thereby reducing overgrazing, land degradation and the utilization of forages in areas further from waters. This role of cactus pear is not limited to pastoral areas" (Tegegne et al., 2007: 162).

The local highly productive cactus (*Opuntia ficus-indica*) grows in Tigray, as well as other regions of Ethiopia, and was found suitable for replacing or substituting sheep water intake (Ibid, 2007). Further, it is a multi-purpose plant, which contributes to local livelihoods as food (fruits), fodder, bee fodder and fuel. However, what seems to be problematic is the plant's tendency to grow in an uncontrolled manner. Implementing cactus plantation as water and soil conservation method in the Abay river basin would, of course, require further agricultural, economic and social-cultural investigations to see whether it could serve as a suitable adaptation strategy.[23]

More thought is given to virtual water storage in the form of livestock, which is used in the region as food item as well as storage for wealth, which can be turned to cash during an economic crisis. Of course, livestock is also vulnerable to drought, water and fodder shortage. Therefore, the World Bank suggested the exploration of ´drought proof´ forms of storing wealth, such as credits or weather insurance (WB, 2006). But in reality, replacing livestock with credits as forms of wealth storage might not succeed, for livestock are used not only as a ´walking account´; people also attach meaning and social status to the ownership of livestock or even centre their livelihood and social organization on the herds.

5. Conclusion

Generally, investigations concerning water storage were dominated by natural sciences, especially hydrology and hydrological modelling. Economic studies provided the entry point for research on farmers' motivation to participate in SWC and irrigation programs but failed to explain local social dynamics. In recent years, social-economic project evaluation and stakeholder analysis have been conducted in some watersheds, whilst the processes in others are yet to be documented. Stakeholder analysis before project planning and implementation seems rather to be exceptional due to capacity problems. *"It was claimed that virtually no feasibility studies* [on water projects in Oromia region] *were done by most of the agencies constructing the schemes except those of OIDA, because most of the NGOs were not skilled in it."* (Awulachew et al. 2005: 20). Data gaps exist, especially on (rather small-scale) water harvesting and storage projects in the Beneshangul Gumuz regional state. There seems to be also little or no scientific analysis of policy and decision-making processes within the water administration. Water rights and their change due to water storage projects, have not yet been of academic interest.

Summarizing the social-political lessons from water storage and development in the Abay River basin, one can identify the following main characteristics:

[23] The cactus also grows in the Abay River basin but it is less prevalent and popular among the population there (informal conversation with L. Tamene).

1. The participation of local stakeholders and target communities in planning was either non-existent or they were only marginally involved. But here are also water projects which are initiated and implemented by local communities alone and without external support.
2. There was a general lack of transparency and communication gaps from the side of the government, donor, and project leader to the local stakeholders and target communities.
3. Food-for-work programs were widely used to tap local labour and involve target communities in the projects. Many measures seem to have been enforced rather then implemented based on farmers´ motivation.
4. It is very difficult to make statements about the appropriate water harvesting and storage technology because the same type of facility proved to be a success in one location but failed in another due to the diversity of geological, hydrological and social conditions within the basin.
5. Farmers resisted a number of projects. If the interest of target communities was under threat or not met by the project, the water harvest facilities/ methods were abruptly abandoned if this was possible. Thus, the technical sustainability was not given.
6. Some water harvesting projects resulted in economic and social dynamics which were stirring conflicts of interest as well as open conflict between groups.

The above review and discussion also revealed that a knowledge gap exists on small-scale, especially locally initiated water projects and processes of facility acquisition. Available studies did not document local water rights and the changes which might result from the water harvesting and storage project. Thus, a need for research can be stated for social dynamics, water entitlements, decision-making processes and local funding mechanism. From our perspective, the following research needs were identified:

- Discourse analysis on the official launching of the Tana Beles project in April 2009 based on observation, media analysis and interviews
- Administrative responsibilities, actors and programs in the Beneshangul Gumuz regional state[24]
- Decision-making and policy processes at national/ regional state level (map of actors and programs, water administration in regional capitals)
- Social-political assessment in the Ribb and Megech dam project
- Social-political assessment of several household and on-farm pond development projects in the Abay River basin
- Social-political assessment of cistern development projects in the Abay River basin
- Social-political assessment of micro- dam acquisition, construction and management in the Abay River basin
- Social-political assessment of spate irrigation systems and programs for their rehabilitation in the Abay River basin

The challenges of the comparative social-political assessment are manifold. The water storage projects are of different spatial and financial scales, under a wide variety of programs with diverse regulations. The project periods include projects from the 1970s to on-going projects. Every technology entails a specific social-political scenario. As a result, the research comparison has to cover appropriate as well as relevant information within two river basins. In the Volta River basin, water storage refers mainly to reservoirs of different size whereby the facilities in the Abay River basin are more differentiated. A number of case studies conducted by several MA and Diploma students require some guideline for data collection to ensure comparative standards. Finally, the output should be presentable in illustrations and

[24] According to information by the German Foreign Office, the regional state is considered as politically instable. Therefore, conducting long-term field research seems rather impossible.

diagrams besides written project reports and some selected output should also be quantitative, to be used in other sub-projects.

The project study sites selected by IWMI in the Abay River basin will cover most of the identified research needs, such as studies on a large dam (Koga reservoir), a small community dam (Gomit reservoir), on SWC and water harvesting ponds (Anjeni site). Further, research will be conducted on deep groundwater in the Kobo Girana Valley (boreholes) as well as on issues of shallow groundwater and natural wetlands flooded by the rivers Ribb and Gumara. So far, the subjects of water cisterns and virtual water have not been accommodated in the IWMI research plan.

Based on the available information about the selected sites in the Abay River basin, as well as the West African Volta River basin, the ZEF sub-project developed eight topics and respective indicators for the qualitative but quantifiable assessment of social-political processes in the acquisition of water harvesting and storage facilities (Figure 10 and details in appendix). In a first step, eight topics were identified which contribute to the characterization and comparison on project level. Secondly, a number of indicators were selected, which inform about the respective topic. In a third step, the indicators are operationalized into data requirements and research questions (some might be added to the social-economic survey conducted in the field sites by another sub-project). These topics, indicators and research questions of the assessment will be used by the project researchers to guide their field investigations and analyze their data and evaluate field reports. The aim is to provide a matrix comparing diverse water harvesting and storage projects in the Abay and Volta River basins. Each topic of the assessment will be accompanied by a descriptive ethnographic section, which elaborates the local context and provides more detailed information.

Figure 9 Topics for social-political assessment

	Topics	Research Questions
1	Technical innovativeness	Is the water harvesting/ storage facility an innovation to the local community?
2	Involvement of external development agents	How big is the involvement of external development agents (extension officers, donors, other supporting agencies) in the water harvesting / storage project?
3	Organizational capacity	What capacity did the project implementers (community, development agents) have in organizing the water harvesting/ storage project?
4	Local Participation in project design	Did the water harvesting/ storage project respond to concerns of the local population?
5	Communicative capacity	What capacity did the project implementers (community, development agents) have in communicating the water harvesting/ storage project?
6	Social dynamics	Did social stratification change within the local communities in comparison to the pre-project situation?
7	Economic dynamics	Did economic stratification change within the local communities in comparison to the pre-project situation?
8	Technical maintenance	If possible, what can be stated on the sustainability of the water harvesting/ storage project?

Abbreviations

ADF	African Development Fund
AMAREW-USAID	Agricultural Research, Extension and Water Management - United States Agency for International Development
CIDA	Canadian International Development Agency
Co-SAERAR	Commission for Sustainable Agricultural and Environmental Rehabilitation in Amhara
ERHA	Ethiopian Rainwater Harvesting Association
ESRDF	Ethiopian Social Rehabilitation and Development Fund
EWWCA	Ethiopian Water Works Construction Agency
GoE	Government of Ethiopia
GTZ	German Development Cooperation
IWMI	International Water management Institute
IDD	Irrigation Development Department
IFAD	International Fund for Agricultural Development
JICA	Japan International Cooperation Agency
MoARD	Ministry of Agriculture and Rural Development
MoWR	(national) Ministry of Water Resources
OCHA	(United Nations) Office for the Coordination of Human Affairs
OIDA	Oromia Irrigation Development Authority
ORDA	Organization for Rehabilitation & Development an Amhara
SSI	Small-scale irrigation
SIDA	Southern Irrigation Development Authority
Swedish-SIDA	Swedish International Development Cooperation Agency
SWC	Soil and Water Conservation
ZEF	Center for Development Studies Bonn/ Germany

Appendix

Topics and indicators for social-political assessment

This assessment will be used by the project researchers to guide their field investigations and analyze their data and evaluate field reports. The aim is to provide a matrix comparing diverse water harvesting projects in the Abay and Volta River basins. Each topic of the assessment will be accompanied by a descriptive section, which elaborates the specific local context and provides more detailed information.

Topic 1: Technical innovativeness

Is the water harvesting/ storage facility an innovation to the local community?

NO TECHNICAL INNOVATION			TECHNICAL INNOVATION
The water harvest facility was rehabilitated.	The water harvest facility was newly established but others already existed in the community.	The water harvest facility was known to the community due to its prevalence in the region.	The water harvest facility was entirely new to the local community.
0/1	0/1	0/1	0/1

Indicator:

- The (non-)existence of the same type of facility before the project in the community or region.

Topic 2: Involvement of external development agents

How big is the involvement of external development agents (extension officers, donors, other supporting agencies) in the water harvesting / storage project?

NO INVOLVEMENT			INVOLVEMENT
Local community organized project completely without external support	Local community organized project with minor external support (technical advice, support in funding)	Local community organized project with major external support (technical advice, funding)	External agents organized project completely without the local community
0/1	0/1	0/1	0/1

Indicators:

- The source(s) of funding for project planning and implementation.
- The source(s) of technical expertise in planning and implementation.
- The source(s) of labour for project implementation.

Topic 3: Organizational capacity

What capacity did the project implementers (community, development agents) have in organizing the water harvesting/ storage project?

BAD ORGANIZATIONAL CAPACITY			GOOD ORGANIZATIONAL CAPACITY		
The project failed due to technical, financial and organizational problems.	The project delayed due to financial and organizational problems.	The project delayed due to technical, financial and organizational problems.	The project delayed due to technical and financial problems.	The project was implemented in time despite technical and/ or financial problems.	The project went according to its plan.
0/1	0/1	0/1	0/1	0/1	0/1

Indicators:

- Project planning documents and chronology of the project implementation
- Budget and money allocation
- Inventory of technical challenges and technical solutions

Topic 4: Local participation in project design

Did the water harvesting/ storage project respond to concerns of the local population?

NO PARTICIPATION			PARTICIPATION		
Local population concern were of no interest	Local population concern were minor interest	Local population concern were investigated after project implementation	Local population concern were investigated in the planning phase	Local population concern were negotiated with stakeholders	Local population concern were fully integrated in project design
0/1	0/1	0/1	0/1	0/1	0/1

Indicators:

- The discussion of concerns of the target community and/or other affected communities in project documents.
- The conduct of meetings with representatives of the target community.
- The integration of community concerns in the project planning and implementation.
- The perception of the project within the target community/ affected community.

Topic 5: Communicative capacity

What capacity did the project implementers (community, development agents) have in communicating the water harvesting/ storage project?

BAD COMMUNICATIVE CAPACITY			GOOD COMMUNICATIVE CAPACITY		
The project was neither transparent to most of the involved actors stakeholders, nor to the public.	Information on the project was systematically channelled and actors/ stakeholders excluded from it.	Most project components were transparent to the involved actors.	Most project components were transparent to involved actors and stakeholders.	The project was transparent to the involved actors and stakeholders.	The project was transparent to the involved actors, stakeholders and the public.
0/1	0/1	0/1	0/1	0/1	0/1

Indicators:

- Meetings, correspondence, official announcements
- Media coverage, public awareness
- Occurrence of misinformation, misconception, misunderstandings, discourses
- Local perception, perception of program organizers/ implementers, external observers

Topic 6: Social dynamics

Did social stratification change within the local communities in comparison to the pre-project situation?

NO CHANGE	LITTLE CHANGE			MAJOR CHANGE	
The project had no impact on social stratification	The project had impact on the social stratification of single individuals.	The project had impact on the social stratification of single households.		The project had impact on the social stratification of entire social groups.	The project had impact on the social stratification of all social groups.
0/1	0/1	0/1		0/1	0/1

Indicators:

- Change of social networks
- Change of relationships between poor and better off
- Change of relationships between men and women
- Change of relationship between older and younger adult generation
- Change of relationship between segments of community
- Change of leadership structure
- Change of decision-making processes
- Change of organizations and decision-making fora
- Local perception on social changes

Topic 7: Economic dynamics

Did economic stratification change within the local communities in comparison to the pre-project situation?

NO CHANGE	LITTLE CHANGE			MAJOR CHANGE	
The project had no impact on economic stratification	The project had impact on the economic stratification of single individuals.	The project had impact on the economic stratification of single households.		The project had impact on the economic stratification of entire social groups.	The project had impact on the economic stratification of all social groups.
0/1	0/1	0/1		0/1	0/1

Indicators:
- o Change of livelihood strategy*
- o Change of settlement*
- o Change of land plots*
- o Change of economic risk*
- o Change of male occupation*
- o Change of female occupation*
- o Change of young adults occupation*
- o Local perception of livelihood changes
- o Change in land rights
- o Change in water rights
- o Change in labour arrangements (cooperative groups)

* = Input by socio-economic sub-project (common sampling frame household survey)

Topic 8: Technical maintenance

If possible, what can be stated on the sustainability of the water harvesting/ storage project?

TECHNICAL MAINTENANCE			LITTLE TECHNICAL MAINTENANCE	
The project has shown an enduring impact and is maintained.	Most of the project has been maintained.	No answer possible (yet).	Parts of the project have been abandoned/ not maintained.	The project has been completely abandoned.
0/1	0/1	0/1	0/1	0/1

Indicators:
- o Existence or/ technical state of facility after end of project
- o Local perception, accounts
- o Accounts in project documents, views by implementing agency

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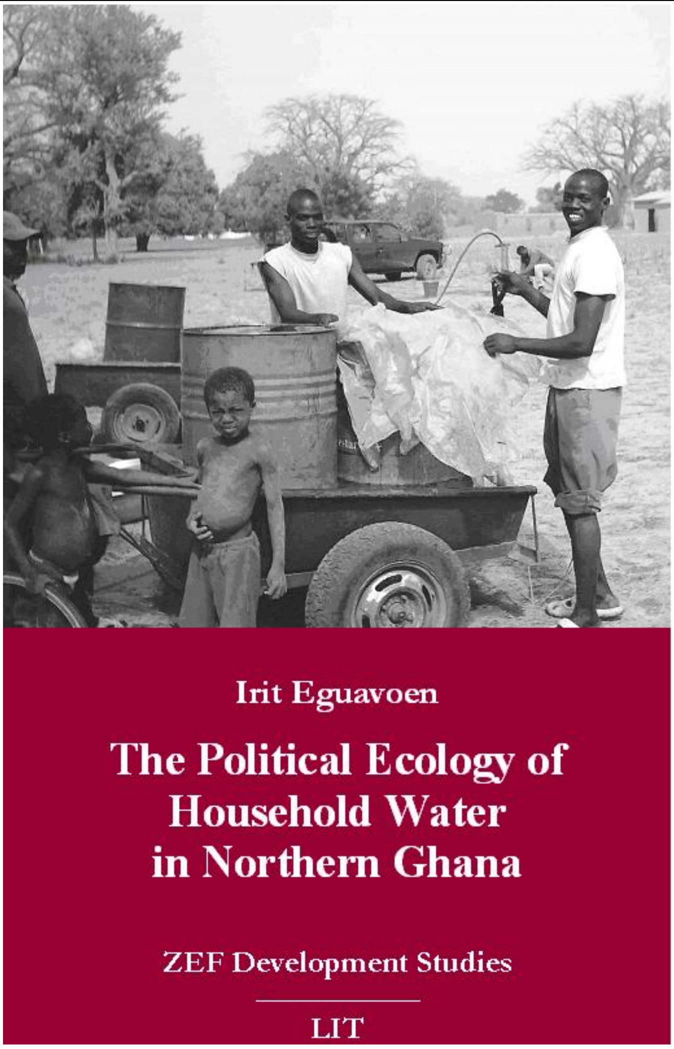

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