The ADAPTS programme in Ethiopia

Synthesis report

AFD Action for Development

IVM Institute for Environmental Studies

Both ENDS
Environment and Development Service

Acacia Water
Solutions in Groundwater

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Colophon
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CONTENTS

1 INTRODUCTION

Climate change is not only expected to result in gradual changes in temperature, rainfall patterns and sea level rise, but also to increased climate variability and extreme events which will threaten water availability and food security for millions of poor people. Local communities and national governments both urgently need adaptation strategies to deal with these impacts.

In 2008, the Institute for Environmental Studies, ACACIA Water, and Both ENDS started the ADAPTS project, funded by the Dutch Ministry of Foreign Affairs. The overall aim of ADAPTS was to increase developing countries' adaptive capacities by including considerations about climate change and options for adaptation within water policies, local planning and investment decisions.

ADAPTS has worked with local communities, civil society organisations, local and national governments, scientific institutes and the private sector. It has shown that adaption is already taking place at the local level. ADAPTS sought to combine local and global knowledge on water management and to empower vulnerable communities to design and implement cost-effective and sustainable adaptation measures. Through dialogues with local and national governments it sought to ensure the inclusion of the knowledge and visions of local people in the development of climate-proof water policies and investments.

To increase adaptive capacities in developing countries, ADAPTS focused on:
1. **Knowledge development:** developing information about climate change and studying how local water management can be made climate proof.
2. **Local action:** the identification, support, documentation, analysis and dissemination of innovative, locally-based interventions to ensure that local knowledge and visions are included within dialogues about basin-level and national policy.
3. **Dialogue:** establishing policy dialogues between local and national stakeholders on the issues of sustainable water management and adaptation to climate change to ensure up-scaling and outreach.

The project took place in six countries between November 2007 and December 2011. This report summarises the main activities, results and insights of the Ethiopia case. Similar reports for Peru, Ghana and Vietnam can be found at www.adapts.nl.

1.1 ADAPTS in Ethiopia

In Ethiopia the ADAPTS project focused on the Borana zone, located in the southern part of Ethiopia, bordering Kenya (see figure 2.1). The area has a semi arid savannah landscape with most of the 960,000 inhabitants dependent upon livestock herding and following traditional pastoralist systems. During the dry seasons, access to safe drinking water is limited, compelling both women and children to walk up to 10 or 20km in search of suitable sources. In general, poor quality drinking water results in serious health problems for the population. The project team, consisting of a local NGO, Action for Development (AfD), the Borana Zone Water Office, Acacia Water, BOTH Ends and the Institute for Environmental Studies (IVM), focused on the potential of a small-scale water harvesting technique (sand dams, see Figure 1.1) to help the local communities cope with the expected impacts of climate change. The technique had proven its functionality under similar circumstances in Kitui, Kenya, and this project supported its introduction and adoption in Ethiopia. The main goals of the project were to:

1. Improve local people's knowledge and management of water harvesting systems under current and future circumstances;
2. Replicate water harvesting techniques to other areas in the region, through pilot projects;
3. Ensure that water harvesting is included as a serious alternative to conventional resources, such as groundwater development and surface water dams, in future policy papers (at different governmental levels).

To meet these goals, the project (1) set up dialogues with relevant stakeholders (various levels of government, NGOs, knowledge institutes, etc) (2) gathered and developed information about climate change at the field and basin scale, and data about the local hydrology and socio-economic conditions (3) trained Action for Development (AfD) staff on the topic of climate change and adaptation, and (4) disseminated the results through meetings and manuals.

This report is structured as follows; Chapter 2 describes the Borana zone, where the work was carried out. Chapter 3 describes the climatic and hydrological changes that have already taken place and are expected to occur in the future. Chapter 4 discusses the impacts (on a field scale and basin scale) of constructing sand dams in more detail. Chapter 5 summarises the various dialogues and communications with outside stakeholders and the outcomes of these. The report concludes with a summary of achievements and some possibilities for continuing this work.

Figure 1-1 Example of a sand dam

2 AREA DESCRIPTION

Borana is one of the 16 Administrative Zones of the Oromia National Regional State. It occupies the southern part of Ethiopia bordering the Somali National Regional State to the Southeast, Kenya to the South, Gudji zone to the East, and the Southern Nations, Nationalities and Peoples National Regional State to the North and West. The Borana zone is divided into 13 'woredas' or districts, which are in turn divided into 265 'kebeles' (the lowest administration structure). The area of Borana is estimated to be about 56,000 km2, of which 70% is lowland, 10% highland and 20% mid-highland. The altitude ranges between 500-2,500 meters above sea level.

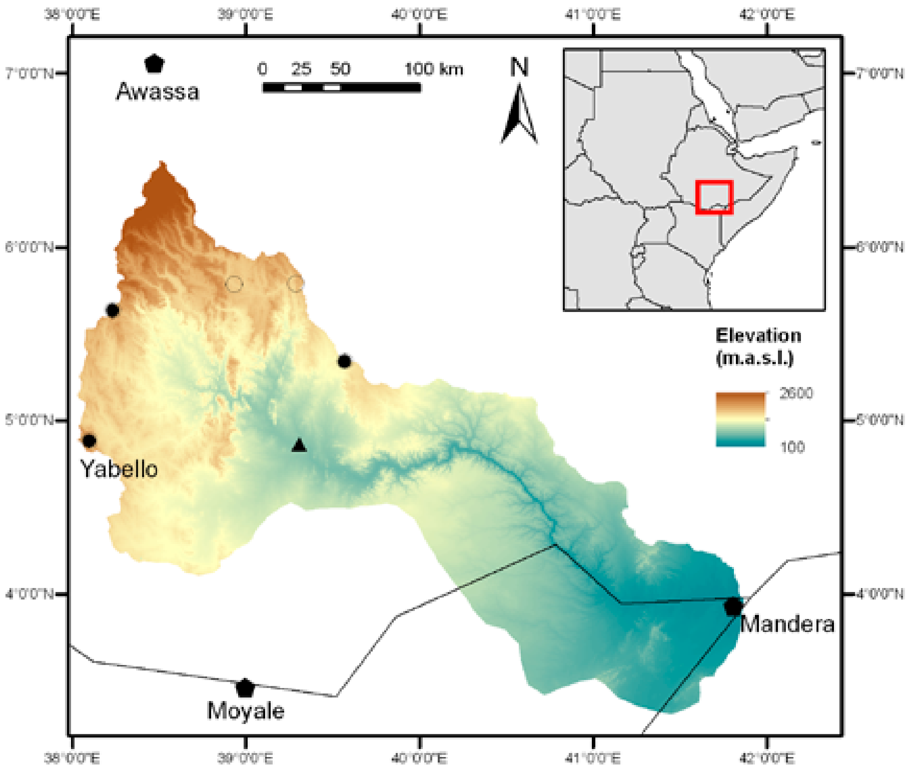

Figure 2-1 Location of Borana in Ethiopia (after Lasage et al, 2010)

The population of the Borana is estimated at slightly under one million people, with the Boran, Gudgi and Gabra Oromos peoples making up the majority, alongside small pockets of other ethnic groups such as the Burji and Konso. About 90% of the population lives in rural areas, and 49% are female. The zone has a relatively low population density of about 18 people/km^2.

2.1 Climate and seasons

Borana traditionally has a long rainy season that usually lasts for about six weeks in March and April and a shorter one, that lasts for about four weeks in September and October. The temperature of the zone ranges from 18-28 degrees Celsius.

A major climatic feature of the zone, particularly in the lowlands, is the recurrence of drought and the erratic nature of rainfall. On average, the rainy seasons fail once every five years. This has been one of the major constraints on livestock and crop production, often causing food insecurity and resulting in large-scale human and livestock mortalities.

Pastoralists are most active in the months December-February and part of March, which constitute the dry and hotter season, the 'Bona'. For those practising agriculture, the active months are March-May, the farming period, and January-February, the harvesting season.

2.2 Water

In most of the semi-arid Borana zone there are no permanent rivers and the existing wadis only contain water during the rainy seasons. In the south-east, the Dawa River contains water the entire year (see figure 3), except in years when there is no precipitation. On average the discharge of the river at Melka Guba, the most eastern part of Borana, is 6m^3/sec in the dry season and up to 50m^3/sec in the second rainy season (figure 2-2). Most local communities rely on precipitation and some scattered groundwater points as their only sources of water. These existing water sources can be divided into traditional and modern water sources. The traditional water sources are mainly shallow ponds, although there are also some deep Tulla wells. Most modern water sources are rain harvesting constructions, such as sand dams and cisterns. Other modern water sources depend on deep ground water, for example boreholes (Lasage et al., 2010). Most of the modern sources of water were introduced in the early 1970s either by NGOs or governmental water bureaus (Coppock, 1994).

2.3 Natural resource management

The Borana Zone has a high biodiversity in terms of both flora and fauna. The natural resources such as pasture, water wells, vegetation, salt lakes, etc., that sustain local pastoral livelihoods are managed through intricate

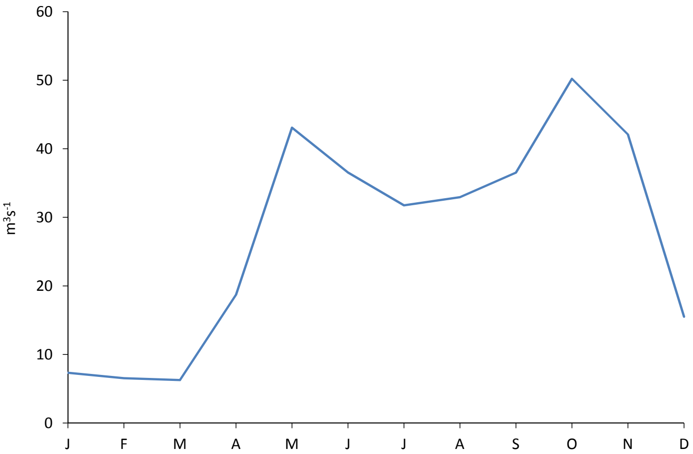

Figure 2-2 Average monthly runoff of the Dawa River at the Melka Guba Station for the periods 1972-1976 and 1987-2006 (after Lasage & Andela, 2011)

systems and regulations developed by traditional pastoral institutions. However, various natural and man-made factors are increasingly eroding the potential and role of these traditional institutions, leading to the depletion and degradation of natural resources. These factors include recurrent drought; human and livestock population pressure; bush encroachment; expansion of farming onto grazing lands; poor policies; the decreasing influence of pastoral institutions and restrictions on pastoral mobility. A balanced and sustainable use of the natural resources in the zone requires a combination of indigenous natural resource management practices complemented by modern technology. This in turn requires the strengthening of pastoral institutions and for them to be more strongly represented in governance bodies.

2.4 Livelihoods

Borana is a rural community where pastoralism is the principal mode of life. About 70-80% of the population are pastoralists and agro-pastoralists and agriculture is also practiced in isolated areas. Climatic variability, especially unreliability of the rains, is leading a growing number of pastoralist households to engage in agriculture and off-farm activities as a means of diversifying their incomes. The expansion of agriculture in an ecologically fragile environment runs the risk of doing more harm than good as farming is invading prime grazing land.

The pastoralists in Borana keep cattle, camels, donkeys, mules and some chickens. Repeated droughts and conflicts have drastically reduced the per capita livestock holding. The Boran split their livestock into two categories: the 'dry herds' (Forra) which are herded far away, close to traditional wells (Ellas) during the dry season, and the 'wet herds' (Warra) consisting of lactating cows and small calves which are normally kept closer to the homesteads or villages (Ollas). The latter are taken care of by women and children (Lasage et al., 2010).

Seasonal mobility is one of the main strategies of animal husbandry in Borana. However, the migration of herds is declining. The most common factors behind this are population increase, conflicts, stricter enforcement of national and regional borders, and the promotion of agriculture (Angassa et al., 2003). New agricultural policies have led to a decrease in mobility by restricting access to dry season grazing areas. As a result pastoral institutions see the need to have a stronger influence on policy making. In spite of the decline of migration, many households still participate in temporal migration, in order to have access to water and fodder throughout the year.

2.5 Social organisation

The Boran have a territorial political and socio-economic organisation, the Gadda system. This system regulates the social, economic, political and ritual activities of the people. It also provides a potentially useful structure for arranging future development interventions. Currently, a Boran household is answerable to both the Gadda system and the modern government administrative system. The two are not necessarily compatible. The indigenous pastoral governance institutions ensure community participation in governance. However, the pervasive influence of the modern state is increasingly eroding their potency.

2.6 Services and infrastructure

Even by regional standards, the Borana zone is underdeveloped in terms of the provision of services and the development of infrastructure. Less than 50% of the population has access to basic services such as health, education, and water supply. Basic physical and economic infrastructure such as roads, electricity, telephones, and banks are underdeveloped or non-existent in rural areas.

The services and facilities that are available are often inadequate and of poor quality. Efforts to improve them are constrained by a weak economic base, low productivity and incomes, poor institutional capacity, underinvestment in human resources, environmental degradation, and the low levels of participation by the local community in development issues and the matters that affect their lives and livelihoods. NGOs play an important role in implementing projects to improve access to water, markets, and information.

2.7 Governance

As in all other parts of the country, the system and style of governance in Borana is weak. There is limited transparency and accountability, corruption, inefficiency, a disregard for traditional institutions, violations of rights, delays in the delivery of justice and male domination. These are significant obstacles limiting the participation of local communities in the affairs that should concern them, including adaptation to climate change and water management. The ongoing programme of governance reform is envisaged to create some space for citizen participation in development.

3 CHANGES IN CLIMATE AND THEIR IMPACTS ON HOUSEHOLDS

3.1 Climate change

The ADAPTS project developed a dataset for the Dawa basin, showing the projected changes in climate that might occur during the 21st Century under two Global Climate Change Models (GCMs). These models were chosen from a list of 21 GCMs, since they perform well for this region (see Cai et al., 2009). This dataset can be used with and by regional and local stakeholders to assess their adaptation requirements and possible adaptation strategies. The project provided maps and graphs showing the possible short, medium, and long-term changes in annual and monthly precipitation and temperature in the study region under different SRES scenarios. These scenarios, which are described in the IPCC Special Report on Emission Scenarios (SRES) (IPCC, 2000) consist of different socio-economic development trajectories s for the world (until 2100) that will lead to different levels of greenhouse gas concentrations in the atmosphere. The B1, A1B, and A2 scenarios lie in the lower, middle, and upper ranges of the full spectrum of temperature change scenarios (by the end of the 21st Century) developed by the IPCC (2000). It also provided an assessment of the possible impacts of different levels of climate change on the discharge of the Dawa River. This information was then used to explore the effects of the introduction of sand dams as an adaptive measure.

The ECHAM5 model (see Figures 3-1 a & b) projects an increase in precipitation for February, July and October, and a decrease for April, May and June, with slight variations between the different SRES scenarios. This means that more rain will fall in the second rainy season and less in the first. All the scenarios project a rise in temperature (of up to two degrees) by 2050. The months of June and July will become notably warmer due to climate change. The HADCM3 model (see figures 3-2 a & b) projects an increase in precipitation from February until April, (in line with the ECHAM model) and a decrease in May, June, September and October. This means that the first rainy season will become wetter while less rain will fall in the second rainy season. The temperature is projected to rise between one and two degrees C (depending on the scenario) by 2020, and up to three degrees by 2050. The general projections are comparable for both GCMs. The figures below are from the report of Lasage and Andela (2011), which contains more details.

3.2 Impacts of projected climate change on hydrology

Figures 3-3 a &b show the impacts of projected climate change according to the two GCMs on the

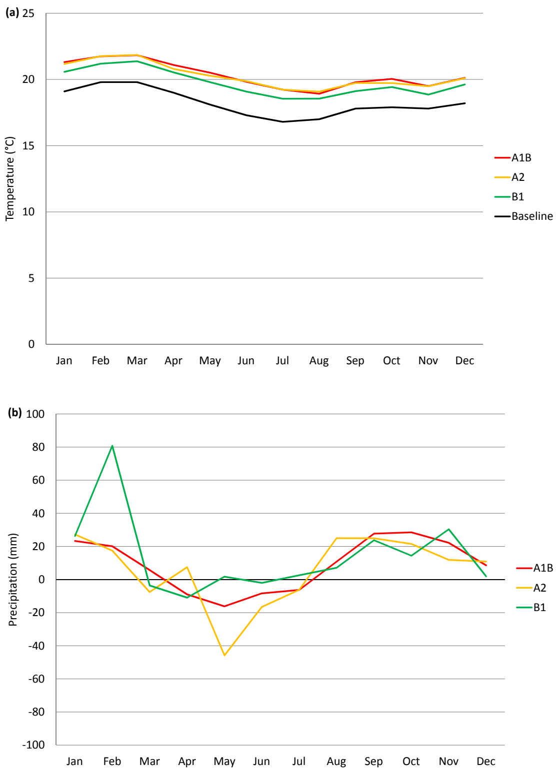

Figure 3-1 a & b, projected mean monthly temperature (2050) and projected precipitation anomaly (2050-baseline) for downscaled ECHAM data

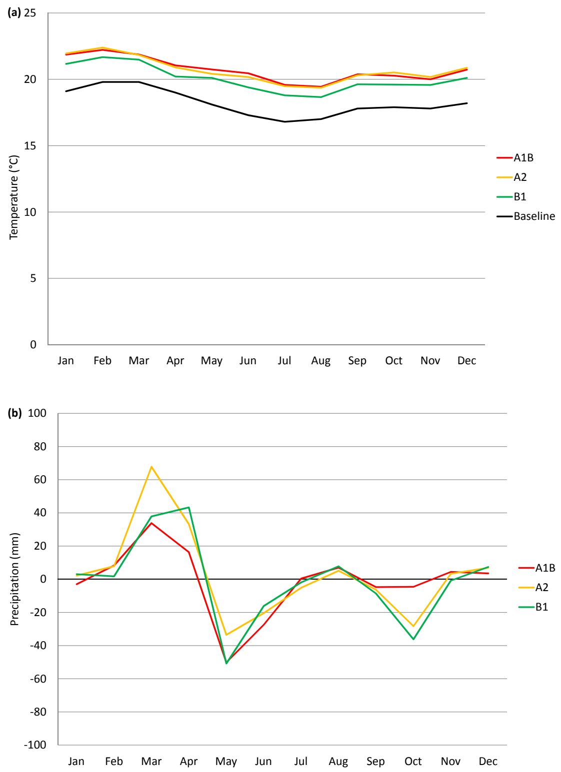

Figure 3-2 a & b projected mean monthly temperature (2050) and projected precipitation anomaly (2050-baseline), for downscaled Hadley Data

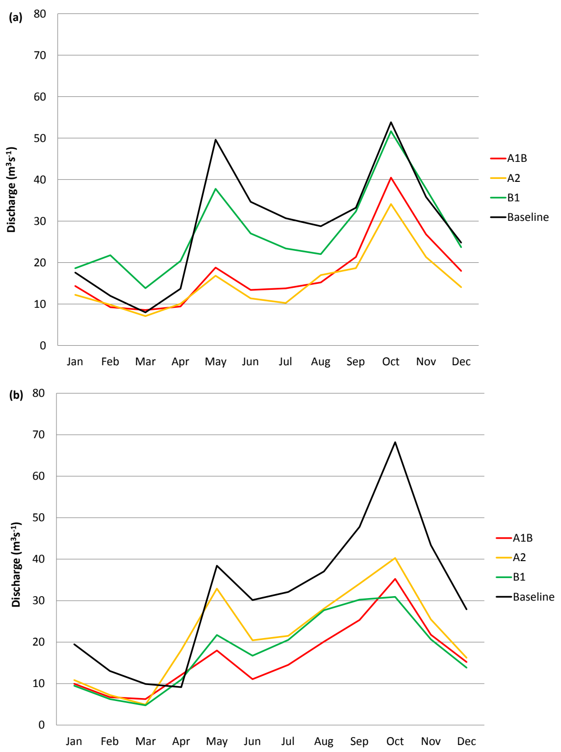

Figure 3-3 a & b projected discharges for the Dawa River at Melka Guba for 2050, using data from the ECHAM model (a) and the Hadley model (b)

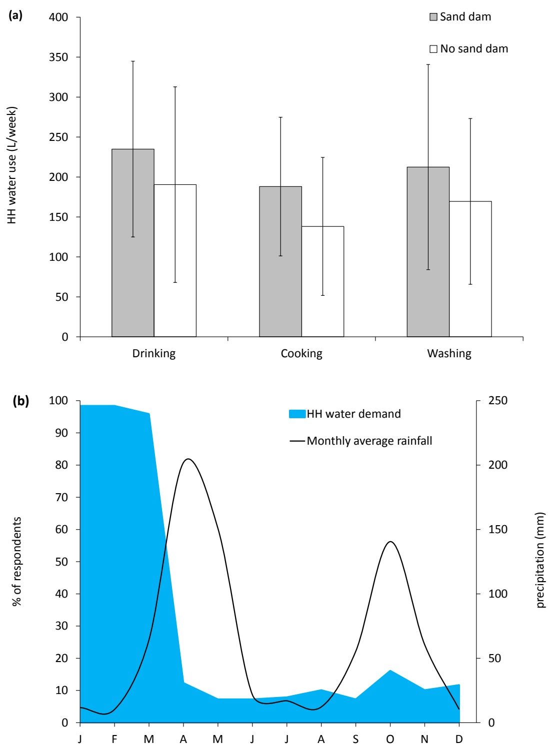

Figure 3-4a Water use by households at sites with and without sand dams

Figure 3-4b Percentage of households that indicate they need more water in a month and the monthly average rainfall

(Lasage and Verburg, 2012)

monthly runoff at Melka Guba (Lasage & Andela, 2011). For both models, the runoff decreases significantly. This is mainly due to rising temperatures which lead to higher evaporation. This reduction in water availability shows that there will be a need for improved ways of making water available in the dry seasons, for example through water harvesting.

3.3Households and climate change

In order to study how (and which) households will be the most affected by climate change, a base line survey was implemented in 2010 to assess water use in the Borana zone and to see if household vulnerability to droughts was related to other household characteristics. Households making use of recently constructed sand dams were interviewed as well as households that did not have access to sand dams, or other improved water sources. The main results are discussed below, and are discussed in more detail in Kleene (2011) and Plug (2011).

Households without a sand dam have to travel further to a water source and spend more time on agricultural activities. Households with access to a sand dam spend relatively more time on livestock keeping. Households with sand dams spend less time gathering water in the dry season than those without such access (on average 16 hours per household per day, compared to 23 - see Figure 3-4).

Household decisions about buying new animals are strongly influenced by the availability of water and fodder. Water availability is more important for households further away from water sources, and fodder availability is more important for households closer to water sources. The need for cash is the primary reason for selling animals, a far more important reason than the availability of water and fodder (Plug, 2011).

For households with access to sand dams, vulnerability to droughts appeared to be significantly correlated to demographic pressure (the number of people above 65 and below 15, divided by people between these ages). The vulnerability of households without sand dams was significantly correlated to the number of meals consumed per day, number of cows and household size (Kleene, 2011). The information gathered using the questionnaires may not be comprehensive as some people were hesitant or unable to say how many animals they owned, what their income was, or their allocation of time to different activities. This hampered the analysis of household vulnerability to droughts, and will make it harder to assess the impact of sand dams on households in the short term.

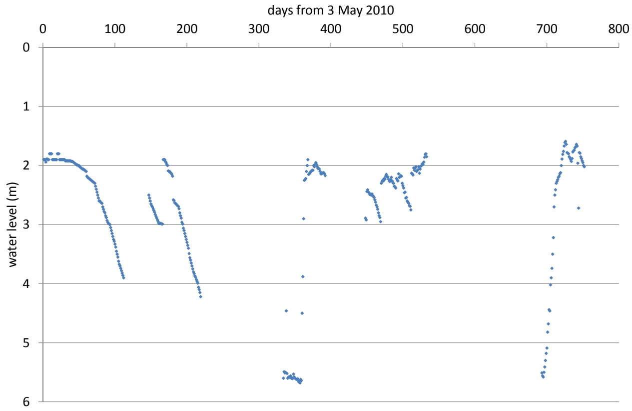

Figure 3-5 Measured water levels behind the Ougelle sand dam

Figure 3-5 shows the water levels in the well at the sand dam at Ougelle. The graph shows that the water levels rise and fall over time, indicating recharge moments and periods when water use exceeeds the recharge.

4 INTERVENTIONS

4.1 Sand dams

The main purpose of a sand dam is to store and retain water. It does this by restricting groundwater flow within the impermeable riverbed. Before the sand dam can store water which is protected from the air and sun, it needs to be filled with sediment. This process occurs naturally. After heavy rainfalls, high river discharges transport large quantities of sediments downstream. High silt and sand loads occur at the start of the rainy season, when most of the land is bare and the soils are poorly protected against soil erosion. The sedimentation process behind the dam occurs when the flow velocity of the river decreases – and the coarse particles being transported are deposited. Continuous repetition of this process causes a ridge of sand and sediment to move towards the dam, eventually filling the area behind the dam.

This process will continue until the level of sediments reaches the top of the dam. The dam is then completely full with coarse sand and is said to be mature. It can take several wet seasons to fill the dam with sediment, depending on the availability of coarse sediment, the height of the dam, river discharge, catchment slope and rainfall intensity.

The ADAPTS project oversaw the construction of two sand dams in Surupha and Haro Beke Kebeles, in Yabello Woreda. They installed water abstraction wells fitted with Afridev hand pumps. After construction in 2009 and 2010 there was a lengthy drought. From September 2011, heavy rains fell in the region, leading to large flooding events. Besides these two sand dams, several other sand dams have been built in the region over the past years, in cooperation with the RAIN foundation. These dams were also included in the evaluation and improvement of design and management in the Borana zone.

4.2 The effects of sand dams on local hydrology

4.2.1 Hydrological functioning

To better understand the functioning of sand dams, and to be able to make better assumptions about their storage capacity, we developed a simple hydrological model. To describe the hydrological performance and capacity of a sand dam it is easiest to conceptualise the system in simple components. As such, a sand dam is modelled as one single bar-shaped reservoir, the length, width and depth of which are defined by the user. The sand dam system includes two river banks that help retain the flood waters (figure 4-1). Groundwater levels within the sand dam are controlled by the topography and are largely determined by the flow of river water following a rainy period.

The effective storage capacity of the dam is influenced by the physical characteristics of the system and the exchanges between them. It is a direct function of the soil's permeability, the local topography and evapotranspiration. The dam is not a closed system and leakages may take place through subsurface flows, with water by-passing the dam.

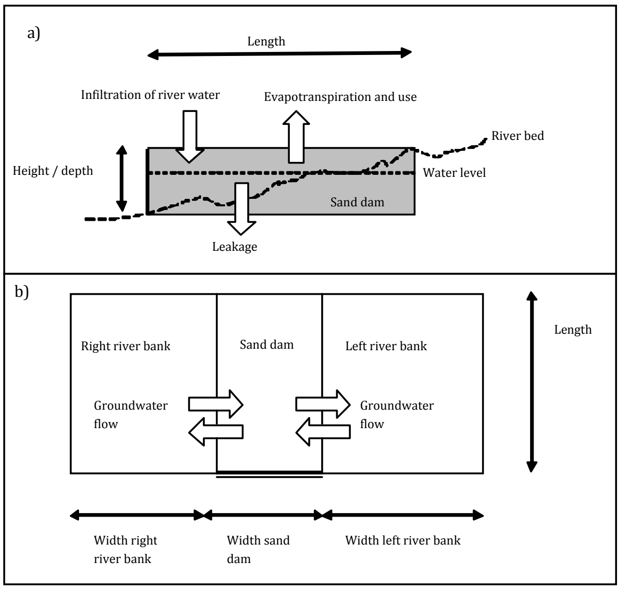

Figure 4-1 Schematic model of a sand dam and adjacent river banks.
a) Longitudinal cross-section through a sand dam
b) Cross-section through a sand dam and adjacent river banks (van Loon et al., 2011)

4.2.2 Hydrological assessment

The ADAPTS team studied the functioning of the sand dams and their hydro(geo)logical aspects. Although information is already available about similar dams elsewhere, (e.g. Kenya), the factors that optimise storage capacity and minimise siltation and downstream impacts are very site specific.

Long-term data is needed to establish the total storage capacity. For that purpose a generic monitoring programme has been set up for sand dam systems. Such monitoring will give insights into the responses of the dams to rainfall events and their total water storage capacity. The monitoring is comprehensive and provides high-quality data. After gathering data on filling and depletion of the sand dam we will gain a better understanding of the hydro(geo)logical processes associated with sand dams. The detailed results will then be used to design a simple, effective monitoring system that can be easily set up for other dams, in contrast to the more expensive monitoring system currently in place at the two ADAPTS sand dams. Figure 4-2 gives an overview of the monitoring network that has been installed at the Ougelle sand dam.

4.2.3 The sand dam infiltration tool (SAND-IT)

It is important to be able to quantify the amount of water that a sand dam can supply to a local community. The storage capacity depends on both the sand dam's dimensions and hydrological processes, including water exchange with the adjacent river banks. This is complicated since river banks adjacent to a sand dam often contribute to the retention of extra water during the rainy season and consequently supply a dam with water during the dry season. Designing sand dams is not a straightforward activity but one that requires at least some basic knowledge of the hydrology of the area. The 3R Sand Dam Infiltration Tool (SAND-IT) has been developed by ADAPTS and Aqua4all to combine this knowledge and use it to quntify the approximate storage capacity based on basic hydrologic calculations (Loon et al., 2011). The tool will be tested and improved using the monitoring data from the two sand dams. Factors that determine the suitability of different

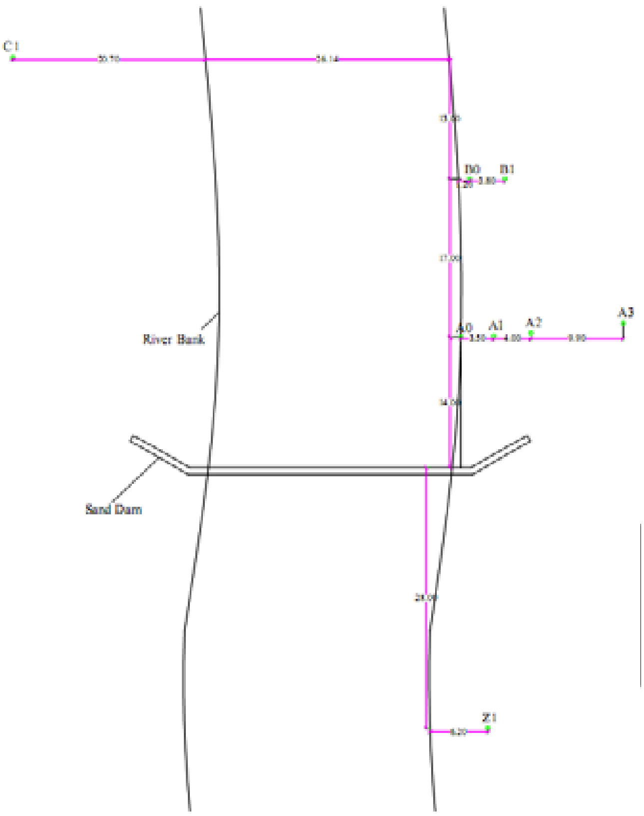

Figure 4-2 Layout of site to measure water levels at the Ougelle sand dam

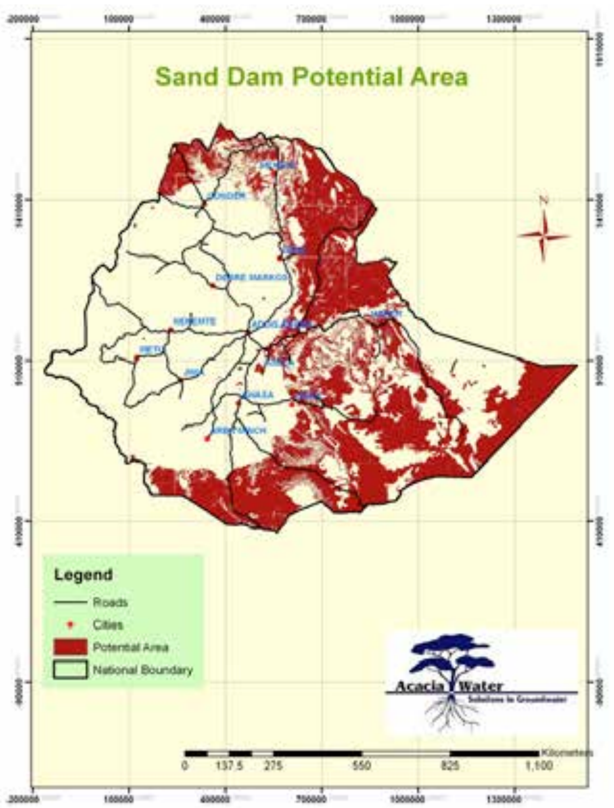

Figure 4-3 Map with locations where general circumstances are fit for water harvesting, based on GIS information (after de Vries, 2010).

areas for constructing sand dams were used to make a map indicating the regions in Ethiopia where they can probably be built (Figure 4-3). This map provides a first indicator for areas where sand dams can potentially be built, although it will be neccessary to do field inspections to check the suitabilty of specific areas and locations.

4.3 The effects of sand dams on livelihoods

Sand dams are not only relatively cheap compared to other structures for storing surface water, they also provide many other benefits. They offer the potential for high levels of community involvement; they have negligible evaporation rates; are a source of clean water (water is filtered as it flows through the sand); are free of mosquitoes and other insects; they raise the ground water table and thus assist with natural re-vegetation and are suitable for small-scale irrigation (Lasage et al., 2008).

One evaluation of community water harvesting systems in the Borana Zone (Asana, 2011), found that most sand dams were located in areas where there were no other alternative water supply sources. These sand dams meet the water needs of the communities for both domestic and livestock uses, and they now enjoy sustainable access to safe water.

The establishment of sand dams has had significant impacts on the livelihoods of the local communities. They now have year round access to clean water, leading to an increase in domestic, livestock and agricultural water uses. Livestock productivity has increased and some communities are cultivating vegetables around the dams using traditional irrigation techniques. This helps to diversify their livelihoods from livestock rearing to mixed farming. The distance travelled to the water source has decreased, along with the time spent on collecting water for domestic use. The time saved is now spent on other activities such as farming, social activities and schooling. Local inhabitants also say that the dams recharge the moisture of the surrounding soil which improves the availability of pasture and helps to protect the environment (Asana, 2011; Kleene, 2011; Plug, 2011).

4.4 An evaluation of the impacts of dams on basin hydrology under different climate change scenarios

But what is the effect of sand dams on users and the environment downstream? A hydrological model (STREAM) was used to assess these impacts. This assumed two different management strategies. In one strategy 200 sand dams would be constructed upstream from Mormora, (a sub-catchment of the Dawa River), capturing 1% of peak discharge. In the second strategy 3% of peak discharge would be stored by 600 sand dams. (Lasage & Andela, 2011),

Besides assessing the percentage of the total water stored by the dams under current climatic circumstances, these strategies were also evaluated for different climatic futures. Three different climate change scenarios were used in this assessment (B1, A1B and A2). Figure 4-4 shows the example for the A1B scenario, where 0.25m^3/sec represents the 1% strategy, and 0.75m^3/sec represents the 3% strategy. From this assessment we conclude that the percentage of total runoff stored will increase under the climate change scenarios by 8% to 13% for the 600 dam strategy and by 2% to 5% under the 200 dam strategy. This is due to the higher temperatures in the projections. It is up to local stakeholders and the government to decide what percentage of storage is desirable and acceptable. The 600 dam strategy will provide 90,000 people with access to water (average 150 people per sand dam), showing the large potential for this type of measure. See Lasage & Andela (2011) for more details of this assessment.

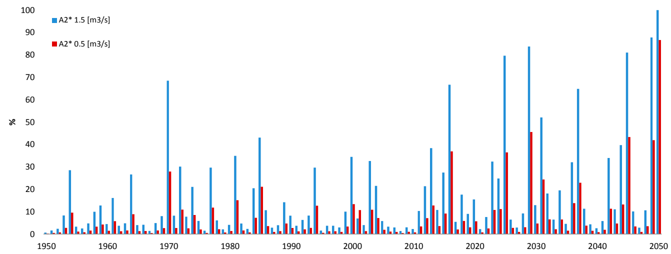

Figure 4-4 Percentage of yearly river discharge used under the low and high storage strategies and ECHAM5 A1B climate scenario (climate data between 1950 and 2000 is from the 20C3M scenario)

5 DIALOGUE

A strategy was developed for building dialogues with national, regional and local levels of government with the objective of including Community Based Water Harvesting (CB WH) into official water policy at the national and regional level. The strategy also attempted to make policy makers aware of the potential impacts of climate change on Ethiopia. A series of workshops, trainings and site visits was organised to raise awareness of these issues. The main target audience were relevant departments at the regional and district level, government officials and NGOs were also invited to participate.

Securing a major policy change, such as getting CB WH measures included in policy papers at the national level is a long-term process that cannot be achieved overnight.

But positive progress can already be observed as different governmental and non-governmental organisations (GO and NGOs) are starting to recognise the potential of establishing CB WH structures, especially in the dry land parts of the country. Further awareness-raising efforts are still underway. Several meetings, field visits, and training sessions have been organised, in close cooperation with other organisations active in water harvesting (including ERHA, Ripple and RAIN). The most important ones organised so far are listed below.

- Two workshops on CB WH and climate change were organised and conducted in 2009; one at the national level in Addis Ababa and one at the regional level in Yabello. Representatives of both GOs and NGOs participated in these. The workshops increased the awareness of these stakeholders about CB WH, climate change and adaptation. The workshops were followed by a field visit to CB WH structures.
- In 2010, a workshop was organised in Addis Ababa which was again attended by representatives of GOs and NGOs. This was followed by a field training in eastern Ethiopia.
- Other field visits and trainings were organised for staff at Dilla University, representatives of NGOs, and zone officials. Participants in the adaptation workshop were able to expand their knowledge about climate change and adaptation.
- During the project several meetings were arranged with relevant government departments and institutes to discuss the relevance of CB WH in the context of the MDGs and climate change.
- During the project, AfD and a group of other NGOs founded the Ethiopian Civil Society Network on Climate Change. This provides a knowledge network in Ethiopia, and also assists NGO staff to attend international meetings on climate change (e.g. COPs).

These meetings and workshops have put the issue of CB WH, climate change and adaptation higher on the political agenda in Ethiopia. The on-the-ground experiences have provided empirical data and visible examples to support these dialogues and trainings. AfD will continue to advocate the use of small-scale measures to improve water availability in Ethiopia while also time lobbying for the inclusion of climate change and adaptation concerns into policy documents at all levels. Plans are afoot for further activities to increase stakeholder awareness and conduct further assessment studies that can feed into policy development.

During the ADAPTS project, AfD initiated the Ethiopian Civil Society Network on Adaptation, together with several other Ethiopian NGOs. The results and insights of the ADAPTS project are being shared through this network. Finally, the ADAPTS project has also given AfD the chance to attend various international workshops that have enabled them to share their experiences with other organisations and countries.

CONCLUSIONS

Local actions

Two projects (ADAPTS and the MFS project, run by RAIN) have been involved in constructing sand dams in the Borana Zone, in the southern part of Ethiopia. The hydrological and socio-economic impacts of these dams were extensively studied, providing detailed insights on how to implement dams this area, which has a complex physical and social structure. The dams were based on designs used in nearby Kitui (Kenya) but were adjusted to better align them to the specific circumstances in Borana. The preliminary results of these improved schemes has led us to conclude that sand dams can be successfully introduced in Ethiopia and adapted to the country's circumstances. The coming years will show their precise effect on water availability and their impact on livelihoods.

The preliminary experiences in Borana also show that more attention needs to be paid to getting the community more involved in maintaining and operating the dams. Being pastoralists, the communities move around the region in search of grazing grounds and have a limited sense of ownership over the dams. This restricts their sense of obligation to maintain them. In addition, simple guidelines and an allocation plan for more optimal water use need to be developed. There is also the need to increase knowledge on how to include the extra water into yearly water management and use plans if possible, based on the water balance. ADAPTS has developed a simple tool to support this work.

The basin scale analysis shows that a large number of dams can be constructed without significant downstream impacts. Even under the most extreme climate change scenario, 600 dams could be built in the upper Dawa, with little impact on downstream water availability. It is expected that climate change will lead to the dry season being longer and precipitation taking place in shorter periods at a higher intensity Sand dams provide an effective and sustainable adaptation measure to this change, and they are already proving to be beneficial under current circumstances. If more dams were built it would be necessary to monitor the downstream effects to prevent negative impacts and conflicts in the long run.

Knowledge development

ADAPTS has carried out several surveys in the field and installed a monitoring network at two different sand dam sites. The initial information from these activities has improved insights into the functioning and impacts of sand dams on the local hydrology. However, the time series are still too short (due to the project duration and the lack of rain for two seasons), and a household level impact assessment should be carried out in a few years' time, when the communities have included the water from the dams into their water management activities.

To promote sand dams in the future, training materials have been developed and are freely available. The sand dam tool and the field surveys will support further knowledge development on this water harvesting technique. An Ethiopian knowledge centre on water harvesting has been created with support from RAIN and Ripple

Dialogue, upscaling and replication

A central aspect of the ADAPTS approach has been to bring together government agencies, NGOs, water users and knowledge institutes. In Ethiopia, many meetings and workshops were held where these diverse stakeholders were represented. It has been difficult, however, to build sustainable partnerships with these stakeholders due to the high turnover of personnel in both the government and NGOs. This reduced continuity hampered cooperation within the project. It also meant that the capacities that were strengthened during meetings in Ethiopia, and during the international ADAPTS meetings (where they met with peers from other countries), were lost to the partner institutes. They will, however, bring this knowledge to the institutes that they have moved to.

The workshops and field trainings on water harvesting and climate change were attended by some 60 people, inside and outside government. They led to the adoption of water harvesting by several NGOs who are now implementing sand dams and cisterns, (e.g. in RAIN's MFS programme).

National decision makers, including the Oromia Water Bureau, and the Ministry of Water Resources have given positive feedback about the potential of small-scale water harvesting to improve water supply in the country's semi-arid regions, and as a measure for adapting to the expected impacts of climate change. However, this has not yet been explicitly translated into national policies, as the policy process is rather slow. However, The Borana Zone Water Resource Office has incorporated water harvesting in its five year development plan for improving access to water. This will give actors in the Borana Zone the opportunity to continue and develop their work on water harvesting projects.

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