

Study on  
Community  
Groundwater  
Recharge  
And  
Community  
Groundwater  
Management  
In Butajira-  
Ziway

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EWTEC



# COMMUNITY GROUNDWATER RECHARGE AND MANAGEMENT

## 1. Introduction

This report discusses the possibilities for piloting community groundwater management, community groundwater recharge and improved rain water harvesting in Butajira-Ziway area.

The background of this study is to explore the possibility for a capacity building program in this field under the Ethiopian Water Technology Centre which would be supported by field tests and trials in Butajira-Ziway. (annex 1 for scope of works).

This report documents the findings and conclusions of a mission, that took place from 8-22 December (itinary in annex 2) and describes subsequently:

- summary of the rain water harvesting and groundwater recharge activities in Ethiopia
- scope for introducing community groundwater management, community groundwater recharge and rain water harvesting in Butajira-Ziway area
- proposed support activities

## 2. Water and runoff harvesting in Ethiopia

### 2.1 Soil water conservation, rain water harvesting and groundwater recharge

The importance of rain water harvesting and ground water recharge in Ethiopia is emphasized on many occasions. In spite of Ethiopia’s reputation as ‘Water Tower,’ large areas of the country have no nearby access to surface water or groundwater and depend on rainfall and runoff for farming but also in several areas for drinking water supply<sup>1</sup>. Humidity and rainfall varies enormously within the country, but there are large areas where annual precipitation is substantial, i.e. upward of 600 mm. Overall however rainfall is erratic, with most of the rain coming in a four month period from July-October, leaving long drought periods. Moreover, annual rainfall varies considerably from year to year.

There are three main categories of capturing rainfall and runoff (see table 1), – storing it either in the soil/ farm land (soil water conservation); in reservoirs/ receptacles (rain water harvesting) or in the shallow aquifer (groundwater recharge).

Table 1:

	Description	Conditions
Soil water conservation (SWC)	Collecting and storing rainfall and runoff in farm field soil moisture	Sloping land
Rainwater harvesting (RWH)	Collecting and storing rainfall and runoff in reservoirs	No other source available
Groundwater recharge (GWR)	Collecting rainfall and runoff to infiltrate in shallow aquifers	Shallow aquifers Intense use of groundwater No groundwater quality problems

<sup>1</sup> The Universal Action Plan suggests that the ambitious targets on nearly full access to drinking water will be met almost exclusively from groundwater sources but in several areas this may be difficult.

Soil water conservation is the most direct way and it consists of reducing the slope of the farmland and increasing the soil moisture holding capacity. There is a range of techniques such as: eyebrow terraces, trenches/ deep furrows, contour soil/ stone bunds, contour bund terraces, semi circular bunds, trapezoidal bunds, vegetative measures (vertiver strips), pits, inter row systems, contour ridges, tied furrows, negarim micro-catchments, . To improve soil moisture holding capacity ploughing, mulching and composting are practised too.

In rainwater harvesting rain and run-off is collected in receptacles. These can be community surface ponds, micro ponds, cisterns, shallow wells, roof top harvesting tanks. The size of the receptacle sets the limits to the amount of water that can be harvested. In comparison to SWC and GWR the cost of water per cubic meter stored in RWH is high. The big advantage of rainwater harvesting, however, is that it can be done almost everywhere, provided there is rain, and hence it is often a lifeline source of water.

In groundwater recharge shallow aquifers serve to store groundwater. In principle large volumes of water can be stored. The volumes of water stored through groundwater recharge are in principle larger than in RWH and even in SWC. The locations for groundwater recharge are limited, however. They are confined too:

- shallow aquifer area
- good quality groundwater
- intensive use of groundwater.

There are several techniques that can be used at community level, such as percolation ponds, contour trenches, infiltration/ recharge wells, recharge dams, flood water spreading, hafirs, road runoff, sand dams, subsurface dams, gully plugs. Community groundwater recharge needs to be complemented by community groundwater management. If not – more intensive use will take place, new wells will develop and even with increased recharge groundwater use will still be out of balance. Under community groundwater management groundwater users set and enforce rules on the use of groundwater in order to balance recharge and discharge. The process of promoting community groundwater management is not difficult if it is done in a systematic and compact way and will make use of PRA (participatory rapid appraisal) tools – such as timeline, resource mapping, transect walks and participatory water budgeting to raise awareness and do agenda setting. This is then to be followed by the identification of measures to improve recharge, improve use efficiency and regulate groundwater consumption. The latter are usually clear rules the implementation of which is easy to verify, such as distances between wells, no well zones, bans on certain crops, etc.

The different methods of storing rainfall and run off may be complemented by catchment treatment. There is macro catchment treatment, whereby soil erosion measures and revegetation measures in the upper catchment moderate runoff, improve water storage and reduce sedimentation. There are also mini catchment treatment measures – rock catchment and ground catchment, soil compacting or using road run-off. These serve to point run off toward the point of RWH or GWR. In addition, RWH and GWR may include measures to avoid heavy sedimentation (such as silt traps) – because sedimentation reduces the capacity of RWH structures and brings down effective infiltration.

## **2.2 Recent experience in Ethiopia**

Over the years several water harvesting and soil conservation programs have been implemented in Ethiopia. Groundwater recharge programs on the other hand has received so far almost no attention and the knowledge and experience on groundwater recharge is limited. In this section some of the experiences in RWH, SWC and GWR are summarized.

The water harvesting programs have come in two main categories:

- Large scale programs often related to food for work (FFW) programmes
- Intensive sometimes area-based, sometimes technology based programs implemented by NGOs or bilateral projects.

In addition a number of support mechanisms have developed to serve in particular rain water harvesting activities, among other the Ethiopian Rainwater Harvesting Network, Saskawa Global 2000. Modules on rain water harvesting are introduced in the universities of Arbo Minch, Awassa and Jimma as well as in courses on the topic in 25 vocational schools.

The single largest program in the country has been the introduction of household rainwater harvesting ponds. These measure between 6x6 to 13x13 meter and are lined either with clay, cement or geo-textiles. The implementation of these RWH programme has been large scale and target-driven, with quotas set for the different areas. As was to be expected the quality of implementation suffered commensurately: site selection was often inappropriate, designs selected were sometimes out of step with local conditions. Quality of implementation could not be ensured by the overstretched junior staff and there was a general shortage of experienced masons or geo-textile technicians. Sometimes the supply of cement and geotextile was delayed, entailed extra costs and failures, as excavation were done but construction was delayed (Rami 2003).

The costs of the tanks was high – estimated at 225000 ETB/ ha effectively irrigated. Where irrigation from surface or groundwater sources was available, this was considerably cheaper – in the order of 15000 ETB/ha irrigated.

In spite of these shortfalls, the RWH program also brought positive experiences, especially in areas where there is no alternative water source locally. The RWH program, as supported by the EU in Tigray was extensively reviewed. Major findings from this evaluation were:

- RWH Ponds can contribute significantly to household incomes and enable best farmers to purchase between 30% and 100% of their food needs by the end of year five and the average farmers from between 20% and 55%. This assumes that farmers are willing to continue to use the backyard stored pond water to grow HVH crops in times of drought and that they are able to sell up to 80% of their harvested HVH crops onto the local markets.
- Seepage from clay ponds was the main limiting factor for the sustainability of the ponds in Tigray. Performance of geo-textile lined ponds was better, but maintenance of geo-textile ponds on the other hand involves external resources and currency and cannot easily be repaired on site
- The RWH were assumed to irrigate cereals but this did not happen – instead irrigation from the RWHs is exclusively for HVH. There is a risk of market congestion
- Greater attention is needed for alternative water abstraction and application methods as well as making low cost water lifting techniques available for lifting water from the tanks.
- RWH has an important role in the overall development of watersheds especially when other sources of water are limited. Its potential extends beyond just agricultural production, but concerns livestock production as well. It is important that a holistic approach to RWH is developed. Watershed planning approach to water harvesting is an extremely important exercise to ensure that the most appropriate water resource developments are undertaken and that other water harvesting technologies, such as soil storage, irrigation and groundwater recharge are not overlooked.

In Tigray another program was the construction of micro dams. They were constructed by COSAERT – an agency, specially tasked for this purpose. The original plan was to construct 500 of these dams, but in the end 46 were built, of which 37 are still operational. The dams have a

storage capacity of 0.5 to 2.0 million m<sup>3</sup>. They are usually constructed at narrow gorges, with enough catchment upstream to ensure the reservoirs are filled. Other site selection criteria are the presence of enough spillway capacity and the location of land to be irrigated (typically 200 ha). While these microdams had an important impact on improving local food security and helped in several locations to recharge water tables and feed wells, they also caused an increase in malaria. A bed-net program was started to remedy this problem.

In Somali Region micro dams have been constructed too, but they served drinking water supply. In Harshin, Aware and Gashamo districts groundwater is deeper than 500 meter and water harvesting structures are essential to provide domestic water. So-called haffir dams consisting of large semi-circular bunds were constructed, based on traditional Somalian designs. These earth dams have generally been well managed. Sediment is removed; the reservoir area is fenced off against cattle and silt traps are in place. Water is collected from shallow wells – some 50 meters from the haffir dam – that are supplied through culverts from the reservoir. Transferring the water to these wells prevents its pollution and reduces evaporation.

In Somali Region family owned and constructed rectangular cisterns are also common. These are called 'birka'. The size of these cisterns varies according to family need and size. The walls and floor are made of stone and mortar lined with non-porous concrete. Recently sediment traps have been added to the birka cisterns.

Cisterns, using rainwater for drinking water, have also been introduced in the Rift Valley. CARE has developed ground catchment cisterns in two woredas in East Shoa (Adama and Boset). Especially in the Boset woreda there is no alternative source of water, as even deep boreholes are often not successful in the volcanic geological formation of the Rift Valley and when they are fluoride levels are usually high. The circular cisterns with capacity of 100m<sup>3</sup> are supplied by ground catchments. Costs of the ground catchments – consisting of a 350-450 m<sup>2</sup> masonry surface are ETB 30,000. The combined systems typically provide 'lifeline' water to 140 people. The quality of water depends on the sanitation around the ground catchment but is generally better than in the traditional surface ponds. A secondary benefit of the cisterns are that in case of emergency they can also be filled by a water tanker. Of 59 systems constructed 53 functioned well. Unfortunately in spite of the encouraging experience this program was not scaled up.

CARE – as well as for that matter other NGOs such as Norwegian Christian Aid Ethiopia introduced also a number of other rain water harvesting techniques for providing drinking water, such as the excavation of earthen ponds. These traditional ponds store water for 3-6 months. The earthen ponds are important supplements for local water supply, but their water quality does not match official norms of 'safe drinking water'.

Rooftop water harvesting has also been extensively piloted by NGO's. This is introduced on public building and on private buildings, that are provided with corrugated iron sheets. Recently the construction of roof top water harvesting is made compulsory for new school buildings and rural clinics in several states.

In comparison to the intense interest in RWH, SWC has received much less attention in recent years. This is partly the backlash of the forced SWC programs of the eighties, that caused considerable resentment. SWC is not systematically incorporated in the extension program and is mainly promoted through special watershed program in certain regions. An example is the Gonder Soil and Water Conservation Project (GTZ). In this project a number of SWC measures were introduced, in particular vegetative measures. These are preferred to stone bunds, which are unpopular as they attract rodents. In fact a large proportion of the stone bunds constructed earlier in the area were removed because of this reason. The Gonder Soil and Water Conservation Project introduced a number of measures:

- Vertiver strips, which even on steep hillsides (75%) establish well. Vertiver strips effectively trap the soil. Vertiver has a number of other advantages, which is that is not effected by open grazing unlike other biological measures and that it does not dry out in the dry season.
- Hedge rows of sesbania
- Vegetation planted on cut-off drains – to provide animal feed
- Hillside terracing
- Trenches in water stressed area to increase soil moisture
- Gully plugging using locally produced gabions – the design being very crucial to success. Using gabions is strongly preferred over stone check-dams. In general gully reshaping and check-dams have shown fast rehabilitation,

As mentioned, in comparison to SWC and RWH, GWR programs are still exceptional. This is also related to the fact that intense groundwater use is the exception rather than the rule in Ethiopia. Yet there are a number of areas, where competition for groundwater is emerging: in parts of Hararghe, Amhara and Tigray. In Amhara the NGO REST together with the Bureau of Agriculture and the Bureau of Water have tried to introduce community groundwater management by setting up local rules, i.e. a minimum distance between wells of 70 meters (if the recharge is good) or 150 meter (if the recharge is not so good). In addition experimental work on groundwater recharge is done by GTZ/ German AgroAction – introducing infiltration trenches, percolation ponds and demi-circles.

A general lesson that emerges from these different case studies is that rather than focussing physical measures only, the social process is more important – engaging communities in planning, implementation and management and securing land ownership. The Ministry of Agriculture and Rural Development has prepared an excellent manual documenting the required process of Community Based Participatory Watershed Development in this regard.

Another element of good process management is ensuring the interventions are embedded in a local service sector – trying to trigger local investment and maintenance, provide back up services and ensure local material production (gabions) and availability

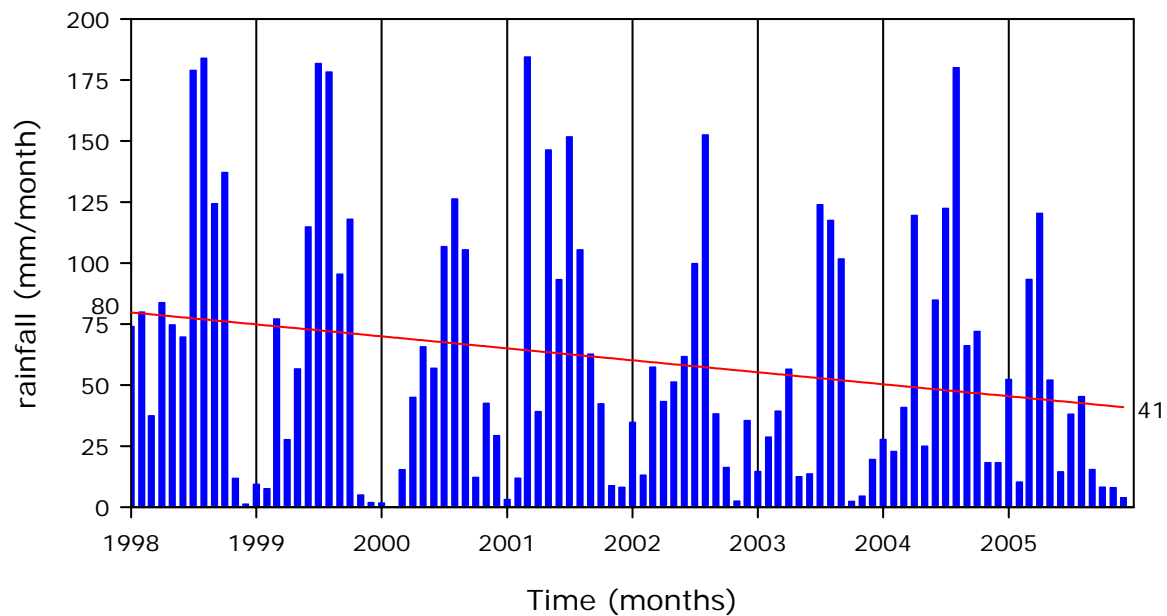
### 3. Butajira-Ziway

#### 3.1 Introduction

The Butajira-Ziway area covers the western part of the Ziway-Abyata Basin. Because of past volcanic actions and tectonics, the area is characterized by a number of different geological formations, each having specific topography and (geo)hydrology. Some of these formation have flat topography and high groundwater tables, whereas others are steep and have deep groundwater resources.

Rainfall varied between 462 mm (2005) and 1057 mm (1998), most of this falling in July-September. There is a considerable difference, typical of the erratic rainfall pattern in the Central Rift Valley. The dry period is from October to June, intercepted by the moderate rainfall of March-April. The rainfall fluctuations, based on the measurements of the TMSS satellite, are shown in diagram 1/ table 1.

**Diagram 1/ Table 1**



	1998	1999	2000	2001	2002	2003	2004	2005
January	74	9	2	3	35	15	28	52
February	80	8	0	12	13	29	23	10
March	37	77	15	184	57	39	41	93
April	84	28	45	39	43	56	120	120
May	75	57	66	146	51	12	25	52
June	70	115	57	93	62	14	85	14
July	179	182	107	152	100	124	122	38
August	184	178	126	105	152	117	180	45
September	124	95	105	63	38	102	66	15
October	137	118	12	42	16	2	72	8
November	12	5	43	9	2	5	18	8
December	1	2	29	8	35	20	18	4
Total	1057	873	607	857	606	535	798	462

Source: TMSS

Agriculture is mainly rainfed – with modest yields of sorghum (700 kg/ha) and wheat (550 kg/ha). Irrigation concerns mainly surface irrigation from the few perennial rivers in the area – the Meki, Katar and Bulbela (that connect Ziway with Abyata Lake). The only substantial groundwater irrigation in the area is the rapidly expanding small holder horticulture on the northern shore of Lake Ziway, fed by groundwater. Elsewhere in the area groundwater irrigation is limited to small home plots supplied by courtyard wells or rain water harvesting ponds.. These home-gardens consists of a mixture of horticultural trees (coffee, mango, qat, papaya), cabbage and pepper seedlings. Butajira has national fame for the quality and colour of its pepper.

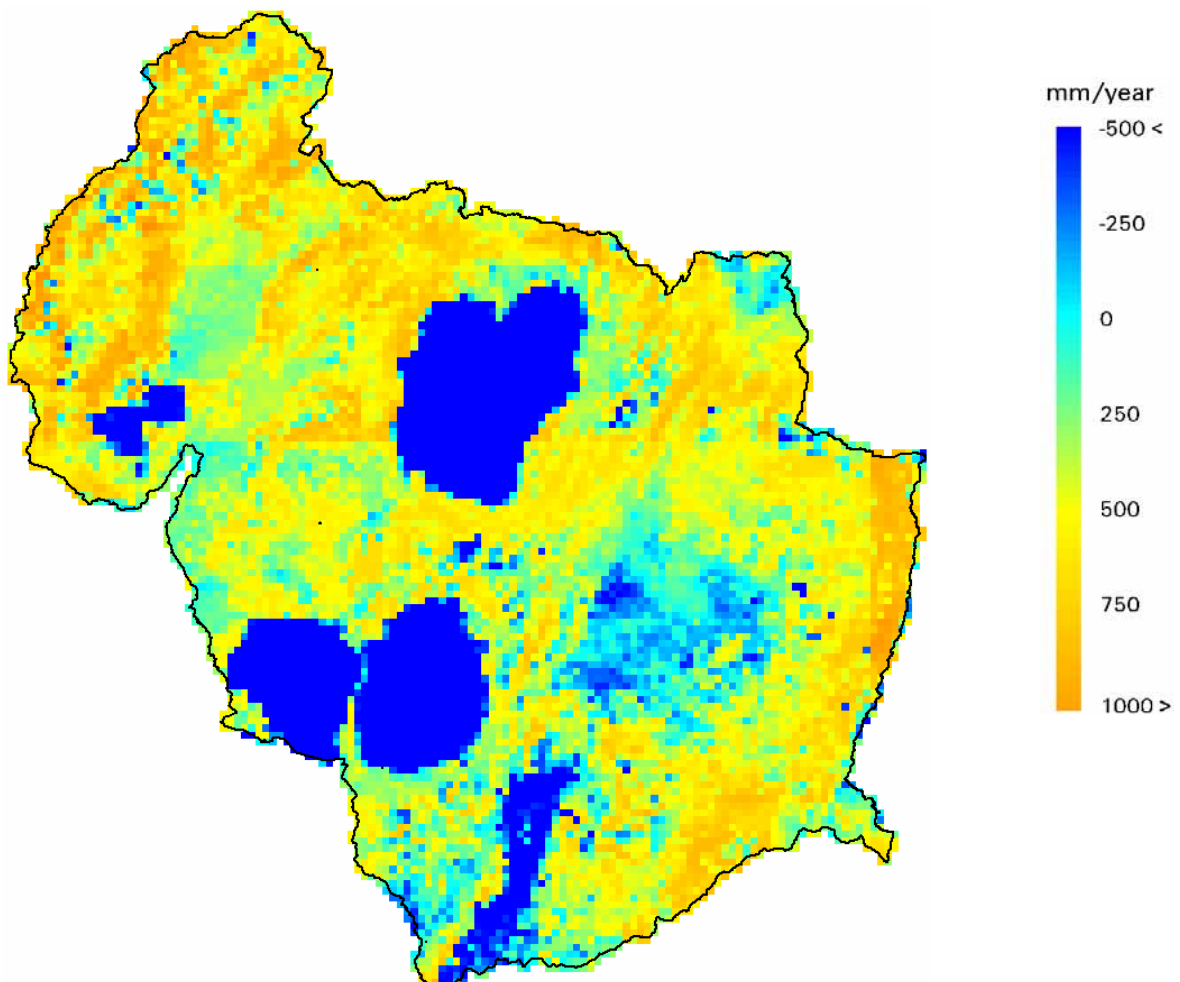
Water supply in large part of Butajira-Ziway is problematic. In large part of the area groundwater is deep. In the area with deep groundwater tables water supply comes from boreholes, local water ponds and rivers. In several places an effort at drilling a borehole was made but with no success. In addition, a substantial portion of the successful boreholes are out of order – apparently mainly because of mechanical defects. Where this does occur people depend on ponds (that usually dry out in November and December) and local streams. Especially towards the end of the dry season very long journeys (+ 15 hours) are required to the few perennial sources, such as Meki River and Ziway Lake.

In the areas with high water tables water supply comes from private wells as well as community handpumps (Afridev). These private courtyard wells are not protected and get contaminated from waste water flowing back into wells..

### 3.2 Description of opportunities and constraints for improved water harvesting and recharge

In this section we discuss the opportunities for groundwater recharge, water harvesting and soil and water conservation in the main geological formations of the Butajira-Ziway area. Picture 2 gives an overview of the potential for capturing runoff and recharge in the area, being the difference between local rainfall and evaporation. This image was generated by using TMSS and MODIS satellite images over a number of years, processed with the SEBAL algorithm.

Figure 2: Potential recharge/ water harvesting in Butajira-Ziway

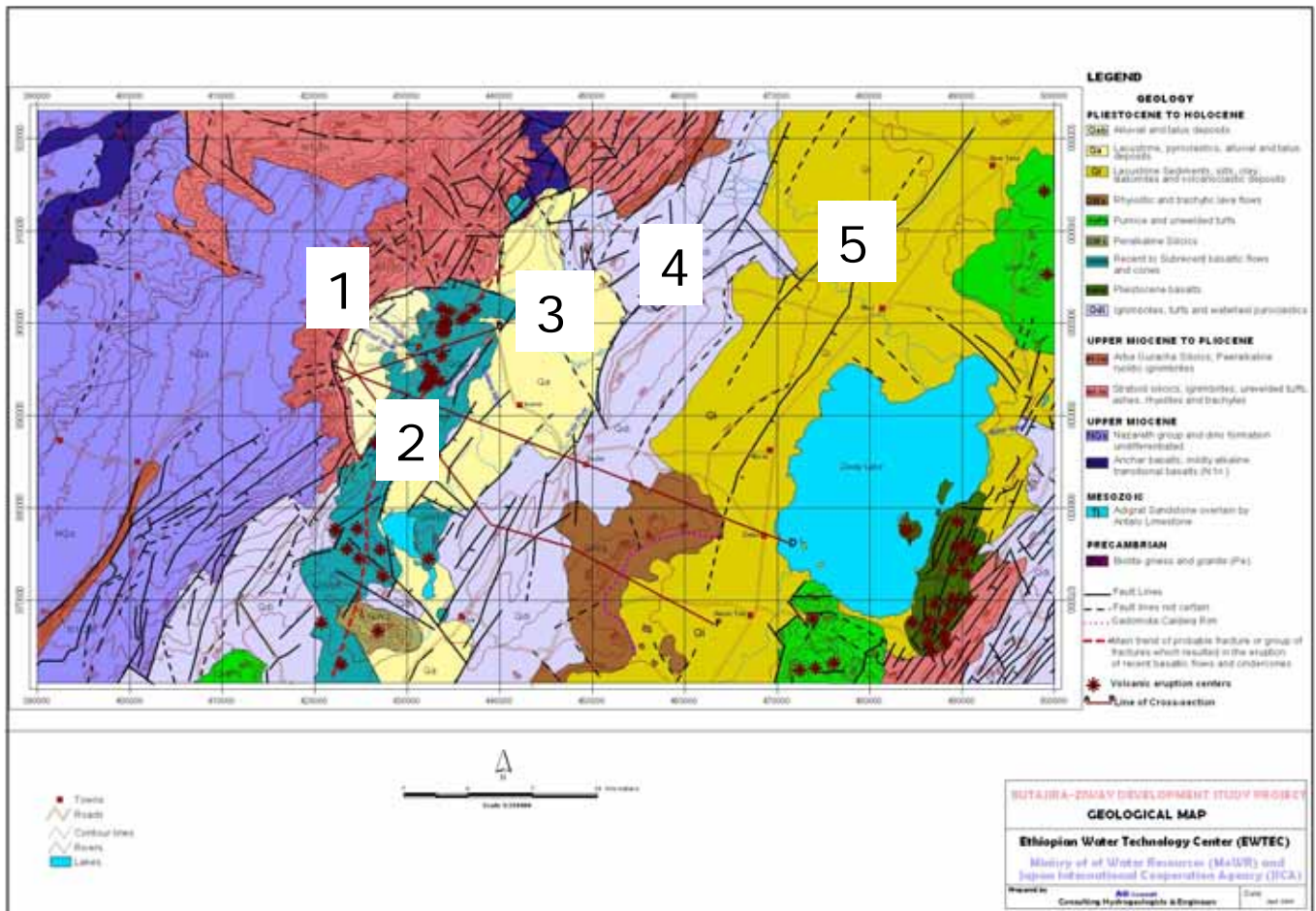


Source: WaterWatch

The potential for capturing recharge and run-off is considerable, especially in the Western extreme of the area and in the area immediately west of Lake Ziway, where the average potential

is upward of 500 mm. The actual possibilities for groundwater recharge, soil water conservation and rain water harvesting is determined by the local conditions in the different geological formations. Leaving aside mountain formations there are five separate formations in the area– as shown on the map below (figure 3). Water tables, farming system and water supply systems differ for the five areas. An overview of the main parameters for the five areas is given in table 2. A description of the opportunities and constraints in water harvesting and recharge for agriculture and drinking water supply is given next.

Figure 3: Geological formations in Butajira-Ziway



Source: AG Consult

Table 3: Main characteristics of geological formation in Butajira-Ziway area

	Formation	Geology	Slope	Water table	Estimated well density <sup>2</sup>	Water quality issues	Surface hydrology
1	Butajira Crescent (QaB)	Alluvial and talus deposits	Flat to gentle slope	0-20 meter	5/km <sup>2</sup>	Low fluoride (<0.5mg/ltr)	Springs and surface streams
2	Cinder cone areas (Qwbh)	Recent/ subrecent basalt cones and flows	Steep slope (>10%),	> 50 meter	0.1/km <sup>2</sup>	Low fluoride (<0.5mg/ltr)	Sheetflow and shallow gullies, High run-off
3	Kuntane-Ensen-Kale Plain (Qa)	Lacustrine/ pyroclastic/ alluvial deposits	Flat	0-30 meter	13/ km <sup>2</sup>	Moderate fluoride (<2.0 mg/ltr)	Springs and streams
4	Tora-Koshe-Dugda Ridge(Qda)	Ignimbrites, tuffs and waterlaid pyroclastics	Gentle slope	> 130 meter	0.5/ km <sup>2</sup>	High fluoride (>3.0 mg/ltr)	Shallow gullies
5	Ziway Plain – Gademotta Caldera (Qi)	Lacustrine sediments, silts, clays, diatomites and volcanoclastic deposits	Flat to gentle slope	Vary variable – close to Lake Side < 10 meter; elsewhere > 70 meters	Not known	High fluoride (>3.0 mg/ltr)	Rivers, lake

<sup>2</sup> Based on preliminary data from well inventory

### 3.2.1 Butajira Crescent

The Butajira Crescent is a semi-circular area enclosed by the mountain and the Cinder Cone formation. Water tables are high in this area (0-20 mtr) and potential recharge is very high too. The topography is flat and the area is made of alluvial and talus deposits..

The formation has a number of large springs, some of which are improved, but not necessarily well managed or fenced. Water supply is from community handpumps (Afridev) or even more common from small private wells in the courtyards. These hand dug wells are small diameter (<50 cm) with the top section reinforced against collapse. The hand dug wells are used for domestic water supply, livestock water supply and the irrigation of small home gardens, planted with a mix of enset, mango, coffee, qat, advocado trees, interspersed with some cabbage. Water is bailed from the small wells with a cut inner tyre tube. There is no protection of the wells against waste water or rainwater washing back into the well. Also because livestock defecates near the well, water will easily contaminate. A small top ring and a drain taking splashed water away from the well might make a useful improvement in water quality.

Apart from the home gardens there is no irrigation in the Butajira Crescent area. This comes as a surprise, because of the shallow groundwater, the location along the main road and the reportedly enterprising nature of the Ghurarghe ethnic group, residing in this part of Butajira-Ziway. Field irrigation instead is the rain-fed cultivation of maize and wheat. Because of the earlier reasons one may expect that at sometime in the future irrigated farming – of horticultural or fodder crops or supplementary to the rain-fed cereals – may take off.

There is no scope for RWH in the area (better to make use of shallow groundwater) or for SWC (topography is flat). If irrigated farming in this area would go to scale then GWC, through percolation ponds or recharge wells for instance, complemented by promoting community groundwater management. For the time being however this is not opportune.

### 3.2.2 Cinder Cone Area

The Cinder Cone area consists of basalt cones and lava flows. The topography is steep and groundwater is deep (>50 meter).

Given the difficult terrain it is surprising that a large part of the cinder cone area is developed for rainfed farming of teff, maize and wheat. A number of RWH tanks were constructed in this area, for instance in Dobobedero (430347 887475). Initially there was skepsis as to the usefulness of the tanks, but now there is enthusiasm, based on the experience of a number of successful RWHs<sup>3</sup>. Several farmers have excavating ponds and approached the Agricultural Department for the geo-textile. Excavating the tanks costs around ETB 2000. The geo-textile lining is relatively cheap at ETB 400 per pond – compared to concrete lining costing ETB 3000 and often suffering from poor workmanship. If the ponds would not be lined, water would disappear within five days. No pumps or lifting devices are used on the tanks. Instead water is bailed from the pond by a cut inner tube. The tanks collect direct rainfall and some runoff immediately adjacent to the pond. The ponds are fenced to avoid accidents and damage by livestock. They irrigate small home gardens, similar to the ones described for the Butajira Crescent.

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<sup>3</sup> The success rate of RWHs in Butajira-Ziway has been low – according to an estimate only 3 out of 10 RWH household tanks was successful. Reasons for failure were technical (cracked cement, torn plastic) and wrong targeting (lack of interest by recipient farmers; tanks unnecessarily being constructed in shallow groundwater zones).

Water supply in the area is problematic. It depends on boreholes but borings have often failed. In several areas water is collected at large distance from springs or rivers.

In the Cinder Cone area the promotion of more RWH tanks is useful, but requires the back up supply of geo-textile. For drinking water the development of cisterns with ground catchments is recommended, also because the building material for this is available. There is no scope for larger water harvesting systems. In addition the promotion of SWC measures is useful. Reportedly there is only part of one kebbele where water retention measures and mulching is practiced. Groundwater recharge in the Cinder Cone area is not feasible.

### 3.2.3 Kuntane-Ensen-Kale Plain

The Kuntane-Ensen-Kale Plain is in many ways similar to the Butajira Crescent. The topography is flat and water tables shallow (0-30 meter). The formation consists of lacustrine/pyroclastic and alluvial deposits. Well density is 13 per km<sup>2</sup>, which is even higher than the Butajira Crescent (5 per km<sup>2</sup>).

Part of the area consist of a wetland which is surrounded by locally protected<sup>4</sup> springs. The surface flows from the springs and the high water tables (<5 meters) sustain a diversified irrigated area with among others paddy, banana, sugarcane, chat, mango, tomatoes. Due to the remoteness marketing is a problem.

In other parts of the Kuntane-Ensen-Kale Plain irrigation is limited to home gardens. It was observed that a substantial number of these appear very unkept – with no levelling and with excessive weed growth.

Water supply comes from springs, community hand tubewells (afridev) and the private wells on the home gardens. Similar well contamination issues as in the Butajira Crescent occur in this area. Fluoride levels are moderate (< 2.0 mg/ltr).

As long as irrigation development remains limited, there is no need to recharge groundwater in this area. Similarly RWH and SWC are not required. The emphasis should be on gradually promoting and expanding small holder irrigation in this part of Butajira-Ziway. It comes as a surprise that in spite of the promotion of several low cost micro irrigation techniques, none of this seems to have reached farmers in this area, although spring pumps (shadouf), treadle pumps and rope pumps could make a large difference.

### 3.2.4 Tora-Koshe-Dugda Ridge

The Tora-Koshe-Dugda Ridge formation consists of ignimbrites, tuffs and waterlaid pyroclastics. In principle this aquifer has good characteristics - only the water table is very deep (>130 meter). Fluoride levels in this area are high (>3.0 mg/ltr). The topography is gently sloping.

Drinking water supply is highly problematic in this area. Safe drinking water comes from groundwater, which currently is only accessed though deep boreholes.. However the number of functioning boreholes is small. In some kebbeles a boring was tried at substantial cost but without success, in other areas the borehole is not operational because of mechanical

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<sup>4</sup> Protection consists of fencing so as to prevent tress passing livestock. There is no source protection of the springs.

problems. In fact the majority of the boreholes visited (6/8) were out of order. There is an obvious need to rethink the system of operation and maintenance, as relying on overstretched and ill-equipped woreda water desks has its limitations. Either centralized systems with pipelines or the promotion of local mechanics may address the disappointing performance. The value of drinking water is recognized in the area and up to ETB 20 is paid per jerrycan of water by local restaurant owners.

The alternative drinking water source in the June-November/ December period are communal drinking water ponds, both small and large size. These ponds are locally managed by special organizations or by funeral societies, Management consist of fencing and desilting. This desilting is done manually and this limits the capacity of the pond. In Sama Gotte kebbelle for instance ETB 6000/yr is collected to pay for a guard and to clean part of the pond, The pond is cleaned using stretchers, which is very time consuming and only part of the pond area is cleared.

The ponds vary in size – from small ponds supplying 4-5 families to community ponds. The ponds are located next to drainage lines or along the road, being supplied by the road runoff. In Galo there is one large pond in the area, that at this moment is being upgraded under EU-financing. Next to the traditional pond a large new pond has been excavated – including two small silt traps. The pond is excavated into permeable strata, however (volcanic glass and sandy loam) and may initially leak heavily. The new pond has two small silt traps too. In the same area there is closure of the pasture area to allow the rehabilitation of the area.

Not all ponds are well maintained. Where a functioning borehole, as in Koshe, is in place, the ponds are neglected. In Judasse communities have not been able to repair breaches in the bund on their own – relying on FFW to do so previously. In the same area long journey have to be made to collect water from local temporary streams (5 hrs) or when this dry up Meki River (15 hrs) or the Koshe water supply system.

Roof top water harvesting is also introduced in the area The school in Galo has two roof top water harvesting structure. These were made three years ago but do not work because the concrete tanks are not water tight.

Groundwater recharge is not possible in the area. Rainwater harvesting for agriculture is through plastic lined ponds and in some places semicircular concrete ponds. Some of these are abandoned, others are intensively used. The targetting is important. It is not possible for farmers to develop this technology themselves as plastic sheeting are not available locally.

There is scope for more intensive SWC in the area, at the minimum by field bunding. At present no SWC takes place.

### 3.2.5 Ziway Plain – Gademotta Caldera

This area consists of lacustrine sediments, silts, clays, diatomites and volcanoclastic deposits. The slope is flat to gentle. Groundwater depth varies from 10 meters close to Lake Ziway to more than 70 meters elsewhere. Fluoride is high (> 3mg/ltr).

Water supply in the area comes in many shapes – boreholes, community handtubewells, ponds and the urban water supply of the towns in this area (Meki, Ziway) that provide water to a large area. Along the lake there are individual wells – some of them rather deep (35 meters) and fitted with winches. Intriguingly the winches were not equipped with a winding mechanism making their use time consuming.

In the area close to the Gademotto Caldera there a number of large community ponds. The Soma Pond is one of the largest of these, attracting people from more than 10 kebele. The pond consists of two parts – a large pond of 100 by 50 meters that serves as a silt trap and provides water to livestock. Whereas this pond dries out by September/ October, a second pond (50 by 40 meters) continues to provide water for 2-3 months more. This pond is well managed with a committee charging ETB 60 to families and issuing receipts. The pond is fenced with a guard who control who enters the pond area through the door. The two ponds were constructed by previous governments. Improving this pond would make a sea-saw difference.

Agriculture in the area is likewise varied – consisting of high tech floriculture farms, commercial small holder irrigation on the Ziway lake banks, rainfed farming on farmer fields and on the state farm and surface irrigation from Meki and Bulbela rivers.

There is scope for more SWC and the introduction of RWH tanks in the deep groundwater part of this formation. In areas that are far from boreholes and where boreholes are not feasible ground catchment cisterns can be considered. If one wants to experiment with GWR, there is also an area close to small holder horticulture farms on the lake bank that is suitable.

A tabular overview of the main issues and possible activities in these five formations is given in table 4.



Table 4: Issues in drinking water and irrigation and options for RWH/ SWC and GWR in Butajira-Ziwaj

Formation	Drinking water position	Agricultural system	Drinking water issues	Irrigation issues	Recommendation SWC/RWH/GWR	Recommendations General
Butajira Crescent (QaB)	Individual shallow wells Community handpumps Springs	Home garden irrigation, enset Road side forestry Mixed rainfed agriculture (wheat, maize)	No drains around private well – may cause some contamination Spring needs to be better managed	Unused agricultural potential – irrigation for home plots only No use of low cost pump technology	No need for GWR unless groundwater use intensifies No need for RWH or SWC	Promote off season irrigation Strengthen water supply committees Improve drains around wells Explore STW technology
Cinder cone areas (Qwbh)	Boreholes River	Maize, sorghum, wheat, very limited home garden irrigation,	Water supply problematic	Increased demand for RWH	Introduce SWC measures Support further promotion of plastic lined RWH No scope for micro dams GWR not feasible	Better management of existing WSS systems Additional WSS systems Low cost pumps on RWH
Kuntane-Ensenakale Plain (Qa)	Individual shallow wells Community handpumps Springs	Home garden irrigation, Mixed rainfed agriculture, Wheat, maize,	No drains around private well – may cause some contamination	Unused agricultural potential – irrigation for home plots only Even these are badly developed No use of low cost pump technology	No need for GWR unless groundwater use intensifies No need for RWH or SWC	Well protection Low cost lifting technology (shadoof/ treadle pump/ ropepump appropriate for different depth of groundwater Explore STW technology

Formation	Drinking water position	Agricultural system	Drinking water issues	Irrigation issues	Recommendation SWC/RWH/GWR	Recommendations General
Tora-Koshe-Dugda Ridge(Qda)	Boreholes Ponds River	Mixed rainfed agriculture Livestock Few homegardens from RWH	Majority of boreholes not functioning Some ponds not maintained New pond near Galo excavated too deep	Urgent need for SWC No low cost pumps for RWH	Support and promote RWH Improved maintenance of ponds SWC measures GWR not feasible Improved runoff and cisterns	Introduce private maintenance on boreholes Low cost lifting technology on RWH Consider centralized systems taking water from Kuntane-Ensena-Kale Plain
Ziway Plain – Gademotta Caldera (Qi)	Boreholes Windpumps Ponds Lake Meki River	Mixed rainfed agriculture Livestock Commercial horticulture (near lake)	Low coverage of boreholes Traditional ponds are shallow – dry up in Nov-Dec	No SWC	Improved maintenance of ponds (scraper boards) Promote more RWH SWC measures Possibly GWR experiments near Ziway-Meki Road GWR if groundwater use intensifies Improved runoff and cisterns <i>Improved hafir</i>	Increase WSS systems Promote low cost lifting technology (improved winch)

## **4. Proposals for support under EWTEC**

A range of activities can be undertaken:

- Introduce improved community water harvesting, especially in the Tora-Koshe-Dugda Ridge, the Ziway-Gademotta Caldera and the Cinder Cone Area
- Introduce experimental groundwater recharge in part of the Ziway Plain and other parts of Ethiopia, supported by training
- Promote local Smart Water Centre, i.e. local private sector involvement in the promotion of water technology, in particular in household RWH, micro irrigation and servicing of community hand pumps
- Introduce on an experimental basis private sector maintenance of boreholes and community handpumps
- Promote groundwater-based irrigation development in the Butajira Crescent and Kuntane-Ensen-Kale Plain
- Promote Soil Conservation Measures, especially in the Cinder Cone Area and the Tora-Kushe-Dugda Ridge

The last two of these activities fall outside the ambit of EWTEC. The first four may be considered by EWTEC. Proposal for these activities are developed below.

### **4.1 Introduce improved community water harvesting**

Though boreholes are by far the preferred source of drinking water, in several parts of the Butajira-Ziway borings have not been successful and in other cases boreholes are not functioning. As long as this persists, community water harvesting structures will be an important source of water for humans as well as livestock.<sup>5</sup>

There are several improvements that may be introduced under EWTEC to improve community rain water harvesting for drinking water:

- Introduce animal traction in maintenance
- Add well storage to community water ponds
- Introduce ground catchment cisterns

#### **4.1.1 Introduce animal traction in maintenance of drinking water ponds**

As maintenance on the community ponds is done manually, it is not possible – especially for the larger ponds – to maintain the required capacity. The immediate effect is that the water stored lasts for a limited number of months only. A larger and deeper pond would make it possible to extend the period in which water would be available.

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<sup>5</sup> As part of this assignment a water harvesting project in Mojo was visited which suggested that water productivity for livestock was higher than for horticulture.

It is proposed to introduce animal traction in maintenance of the ponds, with the use of 'scraper boards', as been used in spate irrigation systems in Eritrea (see illustration in the accompanying powerpoint presentations). These scraper boards transport soil to a bund and are used to make strong bunds. They would facilitate sediment removal from the bund and apart from preparing a strong bund around the pond the animal action in the pond would compact the floor of the pond. In this way infiltration losses will be reduced.

Activities
Obtain scraper board and/ or have technical drawing made (MetaMeta can assist)
Obtain video material on the use of scraper boards for training (MetaMeta can assist)
Farmer trials and adjustments
Training of local workshop
Popularization (field days)

#### **4.1.2 Adding well storage to community ponds**

Investigations should be undertaken on one of the community ponds to transform them into an 'improved hafir', similarly to the designs used successfully in the Somali Region. This would consist of adding well storage to the pond including an overflow structure. Storing water in the wells would have a number of advantages in terms of improved water quality and reduced evaporation losses. To avoid that a failed experiment would deprive a community of a vital water supply the currently unused water ponds in Juddasse (slightly damaged) or Kohle (not used because of borewell) could be used.

Activities
Review improved hafir designs
Discussion with local water users committee
Site investigation Investigate soil permeability
Design and costing
Implementation and testing

#### **4.1.3 Introduce ground catchment cisterns**

Ground catchment plus cisterns were successfully introduced in two woreda's in the CRV, i.e. Adama and Boset, at reasonable cost. These models appear very appropriate for the deep groundwater areas of Butajira-Ziway, especially where there is availability of rocks, as in the Cinder Cone area. The ground catchment cisterns may also be tried in the other deep groundwater areas in the Butajira-Ziway area. They will make it possible to store lifeline supplies of water (100 m<sup>3</sup>) in areas where borehole development is very difficult.

Activities
Review improved hafir designs
Discussion with local water users committee/ visit Adama and Boret
Site identification
Design and costing
Community to agree on maintenance (incl sanitation around the catchment) and usage rules
Implementation and testing (water quality

## 4.2 Experimental community groundwater recharge and training

At present groundwater recharge in Ethiopia is not widespread but its importance may increase especially in areas where there is intense groundwater use from shallow aquifers. There is one area in Butajira-Ziway which fits this description, but there are other areas in Hararghe, Amhara and Tigray.

What is proposed is to undertake a number of local groundwater recharge experiments in the area adjacent to the intensely used horticultural area on the northwest bank of Lake Ziway. This area is promising to undertake recharge experiments for a number of reasons:

- High recharge potential
- Floodplain area during summer rainfall period
- Close to Meki-Ziway road
- Close to intensively used agricultural area
- High water table 20-25 meters (to be verified)
- Alluvial and lacustrine deposits

The recharge experiments could consist of the introduction of contour trenches and contour bunds, as well as mixed contour bunds/ trenches and percolation ponds. The siting of the experimental structures would need to be done with care; the contour trenches and contour bunds should not be in the lower part of the flood plain as they might be damaged, but more along a higher contour, so as to guide water along and allow it to infiltrate. The contour bunds should be provided with stone armoured spillways. The percolation ponds may be sited off-the-flow-course in such a way that one avoids that they get filled with sediment rapidly.

To prepare for the recharge experiment a detailed toposurvey of the area would be required as well as requesting farmers to dig wells that can be used to test depth and fluctuations in depth and water quality and changes therein. The design of the experimental recharge should be discussed with local land users, including the commercial small holders close to the test area – to start a process of awareness building and stimulating local management..

At the same time a course in local/ community groundwater recharge should be set up that should consist of:

- Promoting community groundwater management
- Community/ local groundwater recharge techniques

- Local area design
- Maximizing natural recharge (protect sand/gravel mining in river beds, use of roads as bunds, use of irish bridges}
- Participatory hydrological monitoring
- Practical field investigations

To prepare for this activities the profile of other areas with scope for groundwater recharge should be prepared (Hararghe, Amhara, Tigray, and others possibly).

Activities
Field investigation Ziway
Community discussions
Design of recharge structures (if required can engage specialist from India)
Implementation and measurement of impact
Inventory of potential areas for GWR in Ethiopia
Design and implement course (consider Acacia Institute)

### 4.3 Local Smart Water Centre

A number of water technologies have been developed and partially introduced in the area, but there is no local service provider for this vital equipment. As a result the popularisation of useful tools and technologies, such as rain water harvesting ponds, rope pumps, treadle pumps is unlikely to take off and dependency on government or NGO distribution channels will persist.

To break out of this it is proposed to develop as a private sector entity a Smart Water Centre (name may be changed) that will sell 'good products' to farmers and can give specialist advice. This will also counter the introduction of inferior products (such as for example the Selam rope pump) as the Smart Water Centre may provide discriminatory advice. This Centre will serve as a local distribution points and information centre but will ultimately have to operate on a profit basis. The Centre is not necessarily a new and independent company but can be a franchise to existing local businesses. The product that can be made available are:

- Rope pumps
- Treadle pumps
- Improved winches
- Geo-textile sheets
- Real low costs drip systems
- Spare parts – also spare parts for Afridev pump
- Quality agri-inputs

This proposal resembles the idea of Oromia Water Resources Bureau to set up Community Shops to source spare parts for the community handpumps.

Activities
Prepare business model for Smart Water Centre
Explore private sector entrepreneurs and local agents network
Set up Smart Water Centre
Promotion campaign
Review and phasing out of support

#### **4.4 Private sector maintenance of boreholes and community handpumps**

The huge fallout of boreholes in the deep groundwater areas is a major issue – the consequence is that women have to spend huge amounts of time to collect what is often inferior quality water. The high number of defect boreholes also does not auger well for the ambitious programs for drinking water coverage, as one may expect the O&M burden to only increase, whereas woreda water desks are thinly staffed and lack adequate means of transport etc.

As an alternative it is proposed to start on an experimental basis the private maintenance of the boreholes by identifying mechanics who could service the systems on demand or on service contract. These mechanics would need to be trained and certified by the water desks and probably equipped with tools too. Such private sector maintenance is taking place in other countries, for instance Burkina Faso and Mozambique.

Activities
Prepare business model for private sector mechanics
Identify candidates
Provide training, certification by Water Desk
Introduction to communities/ customer groups
Operations
Review and phasing out of support

## Annex 1: Scope of work

Over the years a number of groundwater recharge and water harvesting techniques have been introduced in Ethiopia, including in the Butajira area in several cases as a part of food for work programmes. The experience with these systems in Butajira is mixed and at present there appears to be no local farmer investment in recharge nor any protection or regulation – though this may become necessary in the future, once groundwater use intensifies.

During the assignment the scope for community groundwater recharge and local groundwater management will be reviewed and the outline for a program for capacity building and support will be developed.

The following activities shall be undertaken:

- Desk study of earlier and ongoing groundwater recharge programs, including the work of the EU Food Security Programs, experiences and documentation of the Dryland Coordination Group and the Ethiopian Rain Water Harvesting Association and others as relevant.
- a participatory review of earlier water harvesting and groundwater recharge in four representative locations in Butajira – assessing local experiences and perceptions with a range of recharge options as well current knowledge on hydrology and groundwater behaviour
- an assessment of scope for groundwater recharge – including moisture conservation measures – look at a broad range of options, such as infiltration wells, infiltration trenches, checkdams, dew ponds, and road recharge
- look at scope, necessity and approach to promoting local groundwater management – consisting of supply and demand options -
- Develop proposal for support – such as pilot activities and capacity building activities
- Prepare a powerpoint presentation with main experiences and options, in addition to report documenting the findings and conclusions.

Annex 2: Itinary

Day	Acitivities
8/12	Travel
9/12	Review literature
10/12	Review literature
11/12	Discussion EWTEC, AG Consult and travel to Butajira
12/12	Field visit
13/12	Field visit
14/12	Field visit
15/12	Field visit, discussion with Mr Ikemoto
16/12	Review literature, report preparation
17/12	Review literature, report preparation
18/12	Meeting ERHA, discussion, preparation Powerpoint presentation
19/12	Discussion, report preparation
20/12	Workshop
21/12	Report completion, departure
22/12	Travel and arrival

The important assistance of Mr Shifaruw Lalu (AG Consult) is happily acknowledged.