Summarized Final Report

External Project Evaluation

Soil and Water Conservation in the Irob Woreda, Tigray, Northern Ethiopia

Conduced by
Fabienne-Alexia Müller

Submitted to
Caritas Switzerland Lucerne
and
Institute for Environmental Sinces, University of Zurich

Zurich, 30th October 2003

Table of Contents:

I. Executive Summary

Caritas Switzerland and the local organization ADCS (Adigrat Dioceasan Catholic Secretariat) are supporting for 30 years projects to improve the living conditions in Northern Ethiopia. One of the main focuses of the project called ADDA (Adigrat Diocesan Development Action) is the building of "check dams" in the rural areas of the Tigrinian Highland of the so called Irob district. In cooperation with the local population, water barriers are constructed on the slopes to retain the watercourses during the rain season. The dry stone masonry constructions prevent the landscape from soil erosion, are used for agricultural land reclamation and water conservation. As reward for the local people's effort, ADDA pays the local people a little salary. These so called "cash-for-work" activities are often the only way for the Ethiopian farmers to generate money. The reclaimed land is shared by the community of the village. The crops predominantly maize, barley and sorghum contribute to the farmer's self-sufficiency.

During a stage in Adigrat and Alitena from 16th July until 17th September my task was, to analyse and assess the set-up, functioning and impact of the check dams within the Irob Woreda, constructed under ADDA.

The investigation was concentrated on 10 check dam sites. To evaluate the impact of the check dam projects it was useful to investigate the three components defined under sustainability: Ecology, economy and social issues. Therefore interviews with 35 local farmers were made as well as with the staff of ADDA.

In most of the investigated sites ADDA could increase the availability of water by the construction of check dams. This is leading to an increase of biodiversity. In once dry stream courses an impressive revitalization of flora and fauna can be observed. The reclaimed soil is fertile and in rich rain seasons as well fruitful. It is farmed in community work by the local peasants. Ethiopian male and females farmers assess the check dams as a good method to enhance their living standard. Therefore they started to construct on their private land small check dams on their own. Due to this copying effect a multiplicity of private check dams boarder the slopes of the Irobinian Mountains.

But at some check dam sites the community work and land tenure within the Irob population failed. The reclaimed soil lied fallow while the private check dam fields were cultivated with crops. Further interviews with the farmers emerged that traditional and socio-economic factors such as gender effects or war traumas influence the success of the check dam projects dramatically. As well, the feeling of ownership could not be transferred successfully by ADDA to the local population. Therefore some villages fail to maintain the check dams and to repair damaged check dam systems, still shifting the responsibility for the maintenance to ADDA.

The following report has the aim to point out the positive as well as the negative effects of ADDA's check dams on environment, rural economy and social community. The complexity of the issue is reflected by numerous cross-references.

1. Introduction

1.1 General situation

The Irob Woreda ("woreda" = district) is situated in the north-eastern part of the so-called region of Tigray, Northern Ethiopia. There the Tigrinya Highland drops away to the Danakil-Desert and the Red Sea (Caritas, 2002: p. 1). Its average altitude is app. 2000m asl (Strebel, 1979: p. 8) where the vegetation of succulent Euphorbia cops prospers. This includes plant species of Acacia abyssinica, Acacia etbaica, Euphorbia abyssinica, Euphorbia nubica, Euphorbia polyacantha, Aloe camperi, Cadia purpurea, sorts of Ficus trees along the riverbeds and scarce herbs and grass species (Strebel, 1979: p. 31). The cactus Opuntia ficus-indica Mill is widely distributed. Its cactus fruits play an important role for the nourishment of the local population (Strebel, 1979: p. 65).

The Alitena village (1850m asl) was the starting-point of the following research. With an average temperature of 19.2 °C and precipitates of app. 400 mm per year (Strebel, 1979: p. 20 - 21), it lies in the middle of the Irob Woreda. The indigenous population distinguishes three rain seasons: From March until May the so-called "Sugum" - rain falls. The main rain season "Karma", which has highest importance for the agriculture, is lasting from end of June until beginning of September. Sometimes in November the "Barit" - rain falls, which often leads to the damage of the stored harvest (Strebel, 1979: p. 21).

The Irob region is situated in the rainshadow of the highland. It is further characterized by a high density of population and low resource occurrence (Caritas, 2002: p. 1). Apart from few families, who have a modest additional income, all rural Irob people are farmers and herdsmen (Strebel, 1979: p. 55). The for centuries lasting demographic pressure, the demand for firewood and grazing livestock caused an extreme land overuse. The intense soil erosion is one of the area's main problems. Characterized by chronic famine, due to the lack of rain, the land suffers further from land migration. In addition, because of the close situation to Eritrea, the Irob Woreda was heavily attacked by the boarder-conflict from 1998 – 2000.

ADDA (Adigrat Diocesan Development Action) supports this politically forgotten region to promote a sustainable development in the area. One of its main projects is the construction of "check dam sequences" for soil and water conservation, known as well as "Limat Systems" (check dam cum flood irrigation scheme). The development and functioning of these check dams will be described in the following chapter.

1.2 Development of the check dam project

The idea of building check dams was developed about 50 years ago by indigenous farmers. One of them was Ghebray Hawku from Daya. He piled stones and earth across the stream's path to catch the soil and water that rushed down the slopes. The concept of collecting the eroded soil behind a stonewall was later more developed by another Irob man, called Kahsay Waldu. After he had seen traditional soil and water conservation schemes near Tripoli, he constructed a small dam. Zigta Gebre Medhin, a man about 80 years old from Awo village, observed this work with interest and decided to experiment with the idea himself.

In 1957, after having fixed a large stone at the bottom of a seasonal watercourse beside his house, he collected enough silt behind this barrier to sow and let grow an armful of maize. Over four decades he built a series of check dams and raised and lengthened the walls each year. He created new farmland, where there had been only rock before. As a further result well-filtered water could be collected from the foot of the lowest dam during most of the year. In the Irob language this technique is known today as “daldal”.

Zigta advised his neighbours, who had similar seasonal watercourses near their houses, how they could build their own dams. As some of these farmers were motivated by the results they had seen from Zigta, they started to copy this technique. Even though many farmers recognized the potential of check dams, it was not easy to build them because no handtools were available. It took several years before enough land could be created to cultivate sufficient cereals.

Over the time, the technique of building the “daldal” had been more and more refined, for example by changing the shape of the dams to reinforcing them. Almost all Irob farmers who live near seasonal waterflows, such as shown by illustration 1, are using now the “daldal” technique.

After the Catholic Church financed a small project, to make metal tools available, a rapid increase in the building of such dams began. This project started in 1975 and is known today as ADDA’s “Limat Systems”. In the case of this project, there were important interactions between indigenous innovation and an externally supported project that helped to give recognition to and spread the new ideas, and to make the tools and funds available to implement them.
(Reij and Waters-Bayer, 2001: p. 146 - 150).

Today ADDA is funded mainly by Caritas Switzerland and Misereor Achen/Germany. Through “cash-for-work” activities it provides job opportunities for the local people. Beside the check dams ADDA supports as well terrace building, irrigation systems, forestry, water wells, street building and organizes trainings for farmers and staff. ADDA is located in Adigrat/Tigray, within the ADCS (Adigrat Diocesan Catholic Secretariat).

Nowadays the “daldal” system is found all over the Irob Woreda. Beside the big check dams, built under ADDA, there are innumerable private check dams, which characterize the landscape of Irob (see illustration 2).

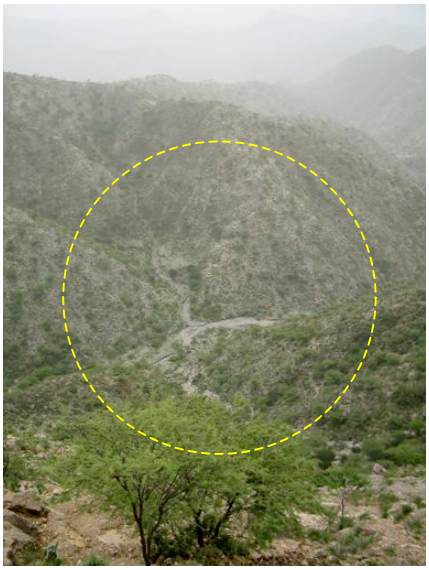
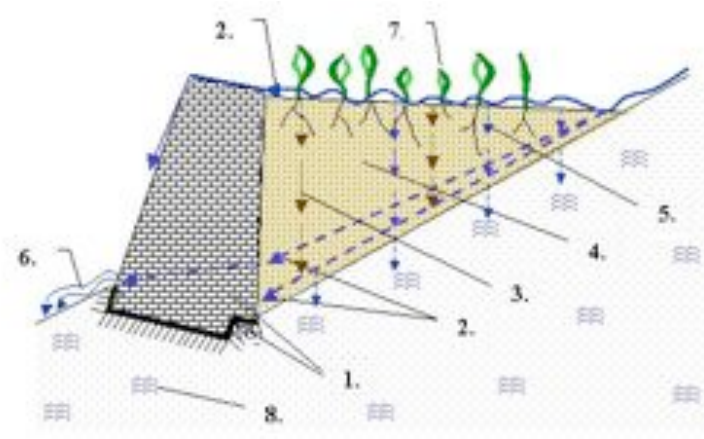


Illustration 1: The encircled zone indicates a potential area for the construction of check dams, photo

Illustration 2: Check dam sequence constructed by local farmers with cultivated maize fields in



1. construction of foundation and check dam wall
2. dam up of the watercourse and diminishing of the flood energy
3. sedimentation of soil particles
4. up-silting behind the check dam and soil reclamation
5. water infiltration
6. spring at the check dam's bottom
7. crop cultivation
8. aquifer in sediments and nearby rock faces

Illustration 3: Scheme of check dam function (cross section)

ADDA defines the functioning of check dams as follows (Soil and Water Conservation Manual for ADDA, 1986: p. I.8.10):

Check dams are cross constructions in watercourses constructed with different building materials (masonry, concrete, gabion, timber). Check dams have the task to

- reduce the gradient (slope) of the torrent thus diminishing the energy of the water flow and therefore reducing water erosion;
- to lift the riverbed, and with it to safeguard the foot of adjacent embankments, slopes or other structures;
- to guide the water course by the provision of spillways and lead the water away from endangered side portions.

1.3 Task description

The field researches in Adigrat and Alitena from 16th July until 17th September aimed to analyse and assess the set-up, functioning and impact of the "Limat Systems" within the Irob Woreda, constructed under ADDA.

The following main questions had to be answered:

a) What kind of impact have the "Limat systems" on economical, ecological and social issues in the Irob Woreda?
b) Do check dams cause an increase in life quality of the Irob farmers?

To understand the general significance and functioning of the "Limat systems", the chapters 1.2 explained the local situation and the development of the check dam projects in Irob. Chapter 2 describes the used methods, the investigation background and after revision work. The main findings about the visited check dams are described in chapter 3. Chapter 4 presents the general impact on economic, ecologic and social issues. These results are mainly based on statements, given by local farmers. The main findings and recommendations with reference to the above main questions are presented in chapter 5.

Numerous photos and sketches underline and support the statements of this report. All illustrations were made by Fabienne-Alexia Müller during the period from July until September 2003.

2. Methods

2.1 Evaluation of the study cases

After the arrival in Adigrat on the 16th July, general information about ADCS and ADDA were collected, especially about the check dam projects. Based on project documentations from ADDA, 10 study cases of check dams should be chosen, according to rational criteria. But the dam systems were not completely documented and no map was available to get an overview about the realized check dams. Finally the study cases were selected, based on the experience and know-how from ADDA Senior Technicians, according to following criteria:

- Check dams have to be in Irob Woreda
- Study cases have to include old and new check dam systems
- Evaluation should include well functioning and problematic systems
- Check dam sequences have to be reachable by foot from Alitena within few hours

After having evaluated several examples, Bruno Strebel, added further experience-based information about interesting check dam sites around Alitena.

2.2. Preparation of the investigation

For the evaluation, expressive indicators had been worked out. The following main issues and formulation of questions were specified:

Economical indicators:

- Foodstuff sources: Which are the most important resources for local foodstuff and how are they linked with the check dam system?
- Productivity of the check dam fields: How many harvests do the check dam fields produce?
- Cost-benefit consideration: Is the benefit from the check dams able to amortize its expenses? (Balance between check dam expenses and benefits)

Ecological indicators:

- Soil fertility and quality: How is the status quo of the reclaimed soils? (Inferring of the soil mineralization from collected soil data)
- Biodiversity: Do check dam systems influence the biodiversity of fauna and vegetation on and around the check dam area?
- Water occurrence: Has water quality and quantity increased or decreased since the check dams have been built?
- Use of fertilizers, pesticides etc.: Is there any impact on the environment by using such substances?

Social indicators:

- Land use: Who profits from the check dam field?
- Responsibility: Who feels responsible for the check dam maintenance?
- Participation: Were local people involved in the decisions about the project?
- Gender issue: Have women and men the same rights on the gained land? Have check dams gender related advantages/disadvantages?

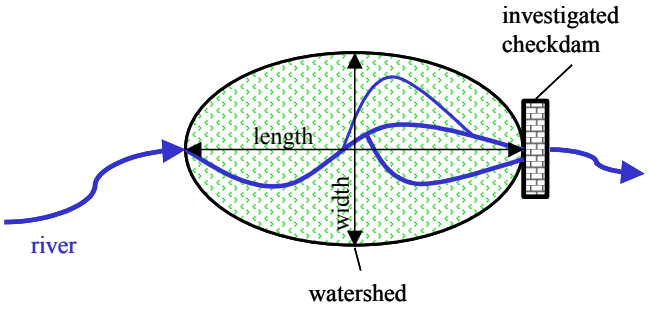
Beside getting technical and physical data, the analysis shall be based mainly on the local know-how from male and female farmers, having practical experience with the check dam systems. A detailed questionnaire, which is aimed at the above mentioned economical, social and ecological indicators, served for collecting data from the Irob population. To figure out especially an increase or decrease of local life quality, questions about the situation before and after the check dam's constructions were asked. The remarks in blue colour rend the intention of the questions more precisely and indicate necessary adjustments during the fieldwork.

2.3 Methodology

2.3.1 Estimation of the sub-catchments' size:

The length and distance (width) of the two slopes was approximated due to a reference object, which's size was easily to estimate (e.g. trees, huts, check dams etc.). The resulted eclipse could be calculated by the following term:

$$\frac{\text{length (m) x width (m) x 3.14}}{\text{40'000}} = \text{Area in ha}$$



Sketch according to Hans Hurni, 1986

2.3.2 Collecting of soil data

On most of the check dam field, we dug a whole of about 1 meter depth. To get a representative location for the soil profile investigation, it was considered, that there was no unusual object in the nearest surroundings of about 3m (such as unknown and big stones, the check dam itself, no other plants except crops etc.). When the farmers allowed, we dug right in the middle of the field.

Illustration 4: Digging for the soil profile, always with the farmer's kind help, here in Dogogola, Upper Daya; July 2003.

The soil texture respectively the texture classes were identified due to the "Guidelines for Development Agents on Soil Conservation in Ethiopia", from Hans Hurni (1986). This method can also be found in the "Soil and Water Conservation Manual for the ADDA" from Bruno Strebel et al. (1986).

The measuring of the pH-value could be done due to a pH-meter and a soil-indicator-substance. It is important to indicate the availability of minerals for plants and the biotic activity in the soil. Further, with a hydrochloric acid solution of 10%, the soil was checked for its calcareous content. Calc occurrence is important to avoid the increase of soil acidity. Samples from the soil profile have been taken at different depth levels. If there were several sedimentation layers observed, the investigation was done on each of them. As these soil profiles were more complex than homogenous samples, they will be illustrated by a specific profile sketch.

To get data about the soil's water absorption capacity, soil samples from the investigated fields were collected (see illustration 5). After letting them dry during at least 3 days, 0.5 litre of soil from each sample was irrigated with 0.5 litre of water. To avoid evaporation, the samples stayed covered during one day. The quantity of absorbed water was measured by the difference between 0.5 litres and the non-absorbed water which remained at the samples' surface.

Illustration 5: Soil samples from the check dam fields; each container is filled up with 0.5 litre of soil; Alitena, August 2003

2.3.3 Crops per square meter

The counting of crops per square meter gave an impression about the check dam "productivity". To get a representative area for the investigation of the crop quantity, the location was chosen according to the same criteria as for the digging of the soil profile. Afterwards the place of most crop density was selected. On every check dam, except the ones who were still under construction or without any cultivation, an area of 1 square meter was fenced off by a string as illustration 6 shows.

Illustration 6: Crop counting on Natiita's check dam Dasamo Gade, July 2003.

2.3.4 Check dam size

The dimensions of the surveyed check dams will be indicated in the following next to the titles under chapter 3 by **length x width x height**. The length includes the measures at the barrier's top. If the length on the bottom was delimited clearly from the rest of the check dam, its measure is indicated in brackets. It has to be considered, that the measures don't include the underground foundation.

2.3.5 Collecting of vegetation and fauna data

Beside own observations about biodiversity, the local people were asked, if they observe increasing wild animal and plant species in the check dam areas, since the barrier's construction. If possible, the Irobinyan name of the species is written in brackets between quotation marks. In case the plants and animals could not be clearly identified and translated into English, they stay indicated in Irobinya.

2.4 Working in Alitena

Working according to a rigid concept did often not succeed. Long-term planning was some times not possible because of unforeseen weather condition, changes in program, representative persons were not available etc. It was important to stay flexible and make use of the possibilities, offered at the place. At the end, several mosaic stones were put together to a whole picture.

A female translator was recruited for the work in the field and briefed by the Senior Field Technician.

After arriving the check dam fields, first the physical investigations (measuring of the dam, soil profile, crop quantity) were done, lasting app. two hours. As the questionnaire was quite detailed and some of the questions complex, it took several hours to finish it. And between and after the questions, the kind Ethiopian hospitality had to be celebrated. Because of this background, only one questionnaire a day was completed. As the local people were very interested in the work, the conversations resulted sometimes in group interviews and answers

from different persons were collected at once. The numbers of farmers answering the questions are illustrated in table 1.

Arriving at the check dam sequences, the dam to be investigated was selected according to the following criteria, from those as many as possible should be fulfilled:

1. Check dam field cultivated with crops
2. Topmost or biggest check dam
2. Availability of the farmer of the field, to complete the questionnaire

In chapter 3 the indicated number of the selected check dam is determined by counting the sequence uphill.

2.4.1 Time schedule in Alitena

23/07/03	Arrival in Alitena and accommodation at the parish Bari Are
24/07/03	Dogogola check dam in Upper Daya
25/07/03	Tikibta check dam in Dawn Daya
26/07/03	Daamoita check dam in Alitena village
27/07/03	Because farmers don't work on Sunday, only an interview about the Tikibta check dam was completed.
28/07/03	Dasamo Gade checkdam in Dawhan village
29/07/03	Masanu check dam in Aiga village
30/07/03	Intigade check dam in Bobo village
31/07/03	Alakalo check dam in Awo village
01/08/03	Questionnaire in Tikibta
02/08/03	Belguba and Magaira check dam in Upper Daya, with interview in Tikibta
03/08/03	Because of Sunday, we completed one questionnaire about Tikibta again
04/08/03	Ubuktole Ela check dam in Adaga village
05/08/03	Completing of the investigations on soil's water saturation
06/08/03	Waiting whole day for the car, which should bring us back to Adigrat
07/08/03	Car finally arrived and we returned to Adigrat

Table 1: Number of persons, answering the questionnaires:

Date	Check dam site	N° of men	N° of women	Total N° of persons
24.07.03	Dogogola	4	1	5
25.07.03	Tikibta	3	1	4
26.07.03	Daamoita	1	0	1
27.07.03	Tikibta	1	0	1
28.07.03	Dasamo Gade	2	0	2
29.07.03	Masanu	0	2	2
30.07.03	Intigade	3	0	3
31.07.03	Alakalo	2	2	5
01.08.03	Tikibta	1	1	2
02.08.03	Tikibta	1	0	1
03.08.03	Tikibta	0	3	3
04.08.03	Ubuktole Ela	2	0	2
03.09.03	Tikibta	0	1	1
04.09.03	Bobo	2	0	2
04.09.03	Daamoita	1	0	1
Total people participating in the interviews				**35**

As high rain season started three days after our first arrival in Alitena, unfortunately some of the streets were not passable. According to the information of local people, it would have been dangerous to visit some check dams (e.g. in Magauma) while the paths could have been unforeseen flooded. As the schedule demonstrates, the investigation was therefore concentrated on the well reachable check dam systems around Alitena village, often in Daya. This has the advantage, that it became possible, to compare the results within one area. The dams of Magaira and Belguba, both in Daya too, gave important impression about the work on a check dam building site.

2.5 After revision and data completion

2.5.1 Interviews with ADDA staff

After the first journey in Alitena, interviews with the ADDA staff helped to collect additional information and to complete the fieldwork data.

An interview with the responsible from the ADCS WID office delivered important information about gender related issues in Irob.

The ADDA Assistant Coordinator and chief Senior Technician reported details about the dam histories as well as occurring problems and eases during the check dam constructions.

After the conversations with specialists from ADDA, a second visit to some of the sites became necessary and was done from 3rd until 5th of September.

2.5.2 Check dam costs

The costs of the investigated check dams were calculated on the basis of the documentations at the ADDA office. The number of workforces indicates how many workers would be needed to build the check dam in one day. The total construction costs (rounded) in Birr were determined according to the following scheme:

1.)	N° of workforces working for ~9 Birr/day = Total salary costs
2.)	+ Material costs for tools/cement/gabion
3.)	**Total check dam costs within ADDA**
4.)	+ 20 % overhead-costs on 1.) for project coordination/administration
5.)	**Total check dam expenditures**
6.)	Estimated costs
7.)	Cost difference between 3.) and 6.)
8.)	Cost difference 7.) in % of the estimated costs 6.)

Depending on the size and conditions for constructions (necessary materials, number of available work forces etc.), the building of a check dam costs between 10'000 and 40'000 Ethiopian Birr (~1000 – 4400 USD).

3. Examples of the visited check dams

In the following the examined check dam will be presented including the check dam's history, soil data, field cultivation, vegetation and fauna data and water conservation.

3.1 Dogogola - Upper Daya / dry stone masonry check dam: 26m x 3.2m x 6.5m

3.1.1 Check dam data and history

In this area a sequence of 3 check dams was realized, including one big dam in the upper and two in the lower part of the watershed. The topmost, biggest and cultivated check dam was selected for our research (see illustration 7 and 8). The sub-catchment covers an area of about 14 ha, which is flooded by the river called “Gaugau”.
The construction started in February 1987 and was completed the same year in July. As the needed stones were near the building site, the construction could be completed within a short time. Field technicians mentioned that in particular a well-known local peasant technician was acting as a very hard and motivated worker. He was given the nick name “Tuntug” what means “being very active and fast”. The building period was completed without any occurring problems.

Illustration 7: Topmost check dam of the Dogogola sequence, with soil stabilizing stone embankment at the right side

Illustration 8: Maize on the Dogogola check dam in September 2003 with an average height of 1.2 m.

3.1.2 Soil data

The profile (Illustration 9) of the ploughed soil reached a depth of about 65cm. The homogenous silt loam texture showed an increasing moistness until the bottom. The pH-value varied between 6 and 7. Tests with HCL shows occurrence of calc. Roots find their way until the holes' bottom. The soil volume of 0.5 litres absorbs 1.25 dl of water.

Illustration 9: homogenous silt loam texture in Dogogola, July 2003

3.1.3 Cultivation of the check dam field

The cultivated field size is about 7'500 m^2. At the time of investigation, the area was cultivated with maize with an average density of 27 plants per square meter and an average height of 10 cm per plant. Beside the check dam area, where the flood doesn't damage the plants, the farmers cultivated the weaker barley crops. Following the check dam sequence downhill, no more fields were cultivated.

3.1.4 Vegetation and fauna data

The rest of the watershed area is covered with wild and indigenous vegetation from which a high occurrence of Aloe ("ure"), Eucalyptus, Acacia trees, Datura ("malaflaf") and other indigenous herbs could be observed.
Following the check dam sequence, Acacia trees and plants of ruderal vegetation are growing. As the cultivators reported, the prospering of the plants in this area started after the check dam construction and they are an important source for feeding their animals. As well some herbs are used as medicine for example the Aloe or the in Irobinia called "udgahara" plant.

Except several bird species, tadpoles and frogs were found in the lower part of the check dam area living in the moist soil. Farmers told us, they observed as well an increasing population of rats, monkeys, porcupines ("ladina") and a ground-squirrel species ("oros"), which affect the crops during the vegetation period.

3.1.5 Water availability

At the time of first survey, the spring at the bottom of the check dam did not run, but the surrounding was kept very moist. Visiting the site in September, water was collected in paddles. The farmers reported that in a good rain season, the spring is running during the whole year. They mentioned a good water quality due to a good infiltration rate. Before the construction of the check dam, they could only fetch water from Alitena.

3.2 Tikibta –Down Daya / dry stone masonry check dam: 83m x 3.2m x 9m

3.2.1 Check dam data and history

The sequence consists of one big check dam and six smaller ones downhill. The topmost was part of the survey. They are integrated into the same river system like Dogogola. The surrounding wathershed covers an area of about 10 ha while the field is irrigated mainly by the "Gaugau" river. The water running down the slopes sometimes does not reach the check dam field.
Before the check dam construction, there were growing big trees in the site, but the flood had washed some of them away. As the quite green area became more and more dry every year, ADDA decided to protect the area by a check dam, to reclaim land and save the vegetation.

The construction of the water barrier lasted from April 1986 up to December in 1988. The long building period had several reasons. Since it is a quite big building, it needed a lot of stones. After ladling out all near stone sources, the material had to be carried over a distance of 2 km to the building site. Additionally, there were not many workforces available due to the little community, living in the area at that time. But the main problem was the political background, which hindered the project. The site was occupied by the Guerrilla movement TPLF (Tigrinyan People's Liberation Front). The government, leaded by the DERG (Committee, overtaking the power after the fall of the emperor in 1974), did not allow access to the guerrilla site by car. All hand tools and other materials had to be carried by the people over a distance of about 30 km from Zalambessa to Alitena. Further, the construction had to be stopped during the summer period while the river flooded the building site.

Illustration 10: Tikibta's topmost check dam with part of its foundation; September 2003

3.2.2 Soil data

The soil profile of one metre's depth (Illustration 11) shows a homogenous clay loam texture. Although the same river irrigates the system, the soil is much dryer than in Dogogola. The matrix shows a finer structure and 0.5 litre of soil are absorbing 0.25 litre of water. Plant roots are reaching a depth of 80 cm. The pH-value of the calc containing soil was determined at the surface with 7. 50 cm, deeper it was assessed between 7 and 8 and at the bottom a value of 8 was measured.

Illustration 11: Soil profile in Tikibta; July 2003

3.2.3 Cultivation of the check dam field

The whole field with a size of about 12'000 m^2 is mixed up with maize and weeds. After ploughing and sowing crops in spring, the rainfall stopped suddenly and the crop cultivating could not proceed. Surprisingly the little private check dams near the slopes were cultivated successfully. One explanation for this phenomenon is given in chapter 4.1.3.

One day after our first visit, a big flood irrigated the field and rain fell as well during the following week.

On the second visit of the field in September, the field was still not cultivated efficiently, only a plot of about nine square meters was covered with maize. The reason for this insufficient cultivation even after precipitations will be explained in chapter 4.3.2. paragraph 2 and 4.3.3. paragraph 3.

Illustration 12: Tikibta check dam field, covered with weeds (mostly Datura stramonium) in September 2003

3.2.4 Vegetation and fauna data

Beside and on the check dam a little wood of acacia trees grows, confirming that the trees, growing before the check dam, could be protected. Following the system downhill, where the fields are not silted up yet, a typical example for plant succession can be observed: In the upper sequences Acacia and Eucalyptus trees prosper, the middle sequences show bushes and shrubs while the last check dam field is covered with herbs and weeds. In the surrounding area the common indigenous vegetation is growing as well as Aloe. These plants are mainly used for animal food as well as the vegetation on the lower check dam fields. Again the "udgahara" herb, used against headache, was mentioned in the interview.

In the little Acacia wood many bird species are living. As well different butterflies could be observed. Beside the check dam field domestic animals such as cows, donkeys and goats are grazing. The farmers reported an increasing population of mice, porcupines and ground-squirrels, who damage the crops.

3.2.5 Water availability

Because of the lack of rainfall, the check dam spring at the time of the first survey did not exist but some puddles and little pools kept the area moist. In September the rocky hollows from which a woman fetched water were filled up more. Farmers said, that in good years the water from the spring could be used all over the year, as well as drinking water, although the water tastes salty. If only little rain falls, water can be fetched for about 4 months. Before the waterbarrier not any water could be fetched.

3.3 Daamoita – Alitena village / cement masonry check dam: 15m x 2.5m x 5m

3.3.1 Check dam data and history

The sequence within the system of the "Bokalemako" river, shows three little check dams in the upper part. The 4th and big check dam at the end of the sequence was examined. It was in 1990, when the first construction, a dry stone masonry check dam, broke down. It had been built too high and could not stand the flood firm. The barrier was rebuilt in a period lasting from March 1992 up to Mai 1993, this time with cement and less high (5 m). The sub-catchment, including the three small check dams, has a size of about 13 ha.

Illustration 13: Relics of the broken check dam; July 2003

Illustration 14: Rebuilt cement check dam; July 2003

3.3.2 Soil data

This unploughed check dam field shows an interesting soil profile with sequences of different sedimentation, as the sketch in illustration 16 demonstrates. Remarkable was a layer of silver shimmering light clay (illustration 17), only discovered on this check field. The soil density is very high except at the sandy part. Plant roots come through until a depth of 50 cm. Collecting in total 0.5 litre of the soil in a container, imitating the sequence of sediments, the sample absorbed 1.8 dl of water.

Illustration 15: Daamoita's soil profile from above; July 2003

Illustration 16: sketch of the soil profile in Daamoita

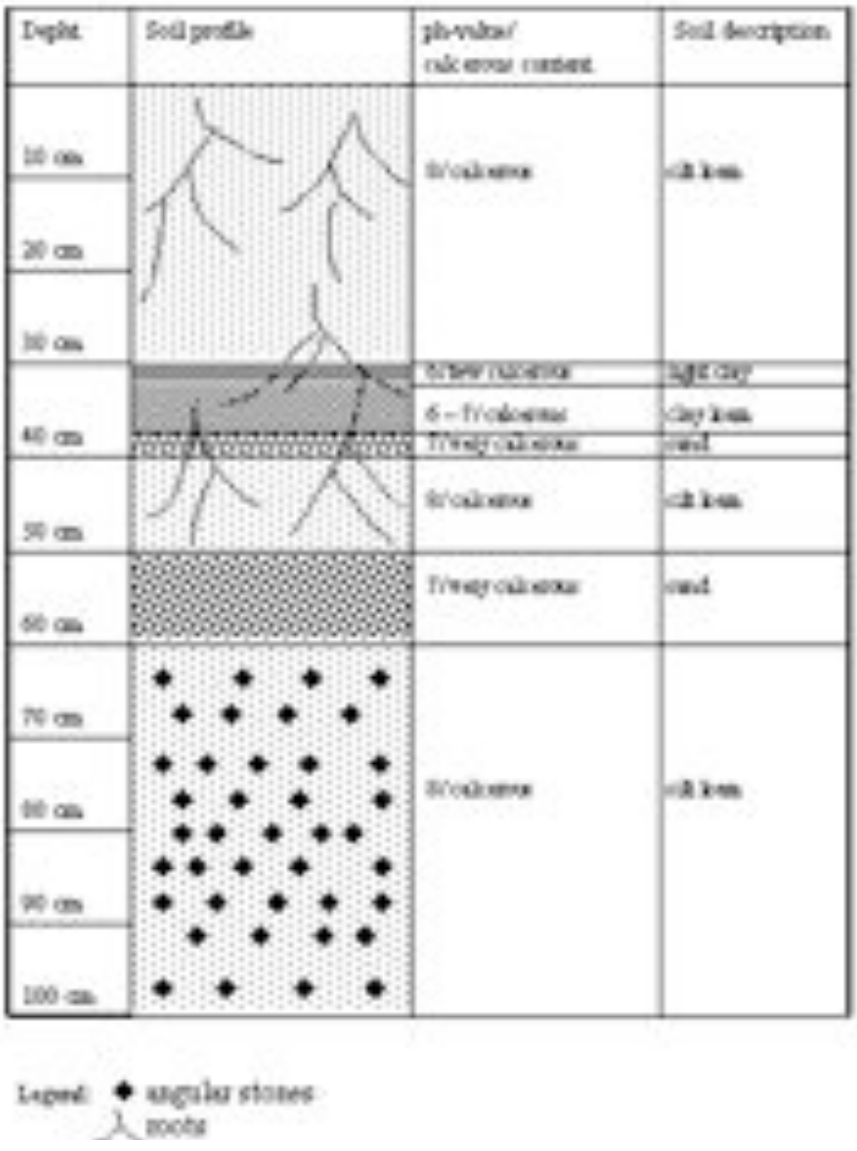


Illustration 17: shimmery clay layer in Daamoita, July 2003

3.3.3 Cultivation of the check dam field

The actually up-silted field has a size of about 460 m^2. Interviewed farmers reported at the second visit of the area, that before the breaking of the old dam, the check dam field had been cultivated regularly. In winter they used to plant tobacco on the reclaimed soil. The fields situated next to the check dam field, were irrigated during the rain season too. That's why in summer the cultivation of barley and vegetables (tomato, pepper, cabbage, onions) beside the check dam field became possible. But today, nothing is cultivated anymore. The new cement barrier is much smaller, and therefore the streaming of the watercourse changed. Today's water level is much lower and sediments are washed away. The water level of the flood does not reach the ancient vegetable gardens anymore. Local people tried to cultivate instead the fields of the upper part of the check dam sequence, but the soil erosion and power of the watercourse are too high there. There would be the need of building more check dams in the upper part, to reduce the energy of the flood. But since the community perceive the building as uncompleted, the gully "belongs" still to ADDA and the local farmers don't start building check dams on their own.

Bruno Strebel stated later in Switzerland, that because of static reasons the cement check dam cannot be constructed higher. Therefore ADDA planned to rebuild the water barrier especially for water conservation. However, after the big flood in 1990 three check dams upstream were not reconstructed.

3.3.4 Vegetation and fauna data

The growing weeds are used for animal feeding. Around the field, the indigenous vegetation covers the landscape and the farmer showed us a plant they call "einuta", which produces an eatable starch-containing root. Medical herbs such as Aloe and "udgahara" are utilised against headache, Datura stramonium ("malaflaf") cures wounds. The fields below the three small check dams are covered with trees, bushes and several herbs.

During the first visit, puddles and pools kept the area after the check dam moist and converted into biotopes, habitats for numerous tadpoles, frogs and water insects. The farmer informed us as well about an increasing population of ground-squirrels, rabbits and monkeys.

3.3.5 Water availability

As already mentioned in the previous chapter, at the time of first survey puddles and pools could be found at the bottom of the check dam. During the second visit, the field was irrigated with water and a water-fall rushed down the dam. Before the construction of the check dam, the people could fetch water from the river only for 3 months. Since the building, there is enough water during 9 months in bad rain seasons and for 12 months in good rain seasons. It is of good quality and used as drinking water.

Illustration 18: Irrigated field and waterfall on Daamoita's check dam in September 2003

Dasamo Gade – Dawhan village / dry stone masonry check dam: 50m (24m) x 2.5m x 5m

3.4.1 Check dam data and history

The upper one of the two check dams was built in 1987 from February up to December. As the stone were nearby and the people were working very actively, the construction could be completed within a short time. The sub-catchment, integrated in a seasonal river system, covers an area of about 5 ha. Mainly the people living in Dawhan village, lying opposite the check dam sequence, cultivate it. The village had been built within a short time, among other things by USAID activities, and causes the loose of valuable farming land, due to its high growing rate.

Illustration 19: check dam of Dasamo Gade/Natiita in July 2003

3.4.2 Soil data

The one meter deep profile in the ploughed silt loam shows a homogenous fine structure (illustration 20). Plant roots reach till the bottom. Although rain fell the night before and in the morning of survey, the soil was surprisingly dry. The pH-value was continuously 7. A sample of 0.5 litre of soil absorbed 0.25 litre of water.

Illustration 20: Soil profile Dasamo Gade, July 2003

3.4.3 Cultivation of the check dam

On the field with a size of 2'500 m^2 we counted 16 maize plants per square meter. The crops were in a good condition and had an average height of 20 cm at the time of first survey. Passing the site on the way to Alitena in September, the crops had grown up to an average height of 1.2 metres.

3.4.4 Vegetation and fauna data

In the surrounding area the indigenous vegetation prospers. Acacia trees and other shrub plants as well as herbs and grazes are growing at the foot of the first check dam.

Remarkable were the digging traces from ground-squirrels, spread over the whole field. According to the farmer's information, as well the increasing population of porcupines represents a big problem in the area, because they affect the harvest every year.

3.4.5 Water availability

Although the spring at the bottom of the dam did not exist, the area after the check dam was moist and little pools were filled up with water. Farmers reported in the interview, that in a year of good rain season, the little brook is running over the whole year. But due to the big river passing Dawhan, the area does not suffer from water scarcity and the check dam spring is only used for animals.

3.5 Masanu – Aiga village / dry stone masonry check dam: 23m (8m) x 7m x 7m

3.5.1 Check dam data and history

Within a sub-catchment of about 5 ha land, ADDA constructed three check dams. The topmost is a gabion check dam, while the biggest and first one of the sequence is a dry stone masonry construction. The latter was built in 1993 during February till June. It was silted up with soil within a short time. Within the site, local people realized their private check dams.

Illustration 21: The big check dam of Masanu in July 2003

Illustration 22: Masanu check dam area (big check dam taking place at the bottom of the picture's left side)

3.5.2 Soil data

The unploughed soil was very hard and after a depth of 80 cm, we hit the rocky subsoil. As the following picture and sketch of the soil profile show, it contents several sedimentation levels in which the pH-value is varying. Imitating the sedimentation sequence in a container, half a litre of soil soaks up 1.25 dl of water.

Illustration 23: Sedimentation layer in Masanu; July 2003

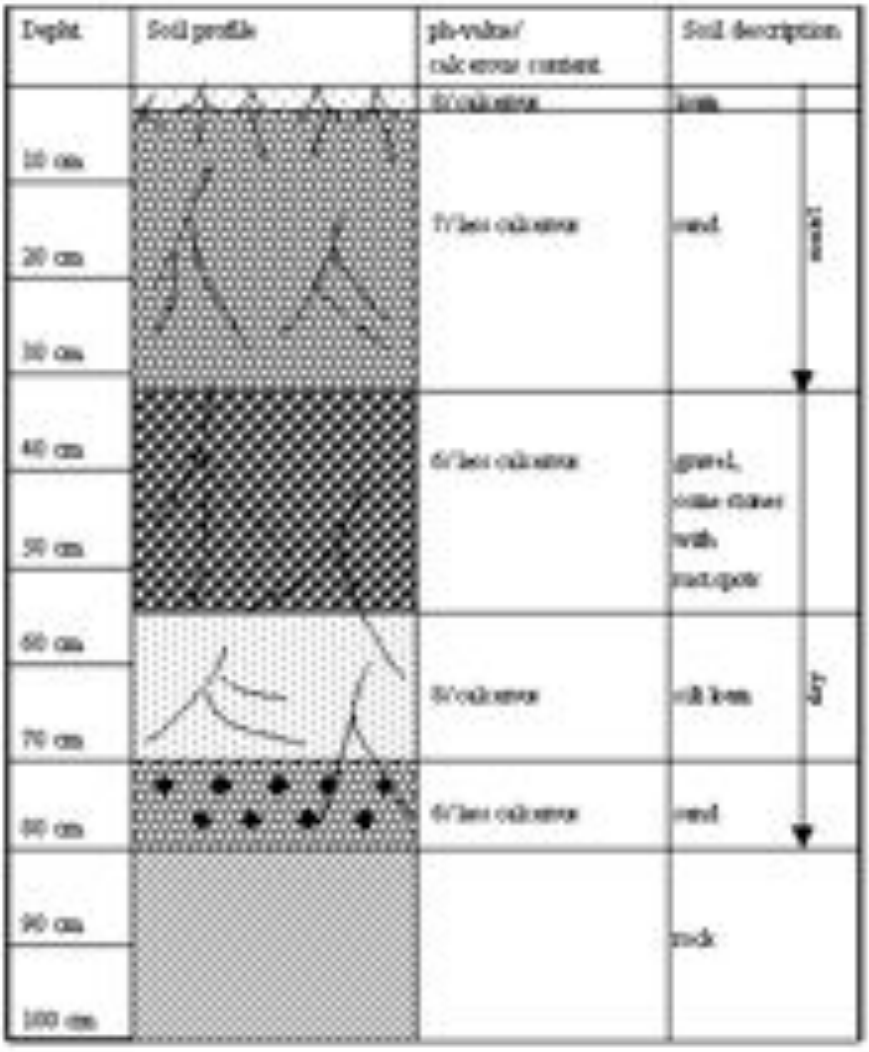


Illustration 24: sketch of soil profile found in Masanu

3.5.3 Cultivation of the check dam

There was only maize on a little private check dam field. The big check dam fields are not cultivated since the site was always used deliberately as traditional grazing ground, because there is no other possibility in the surrounding area.

3.5.4 Vegetation and fauna data

As the picture 22 illustrates, during the rain season the area is very green and shows a high biodiversity of plants. Following the riverbed downhill, wild vegetation covers the slopes and the bank. Before the check dam had been built, it was a rocky and dry site. Datura stramonium , Aloe and the "udgahara"-plant are used for medicine. Herbs called "hamla" in Irobinya are utilized for spicing the meals.

In the green landscape various birds were observed. Once more an increasing population of porcupine, ground-squirrel and monkeys was reported. Further a worm specie called "rimmita" is occurring in the field, and in some years it damages the harvest heavily.

3.5.5 Water availability

At the time of survey, a little river was running over the rocky riverbed. The check dam spring is feeding it with water during the whole year, as well as in dry seasons. People are telling, that since the barrier is silted up, they always have water in the area. Although the water tastes salty, they use it for drinking.

3.6 Intigade – Bobo village / dry stone masonry check dam: 25m x 2.5m x 4.5m

3.6.1 Check dam data and history

In Bobo, ADDA constructed a sequence of 15 check dams within a sub-catchment extension of about 20 ha. Since there were only two cultivated fields (on check dam 8 and 9), we investigated the 8th one, on which it was allowed to dig for the soil profile. The construction period lasted from March 1994 until December 1995. The workers were very active and wise in managing the project themselves and stone material could be found nearby the building site. The former owner of the land section between the 8th and 10th check dam, handed it over to the community, to make the check dam building possible. In return for his generosity, in some years he will be allowed to use the two reclaimed fields for his own (further information about check dam field ownership in chapter 4.3.2.). Beside ADDA's check dams, the local people built their little private barriers on the slopes.

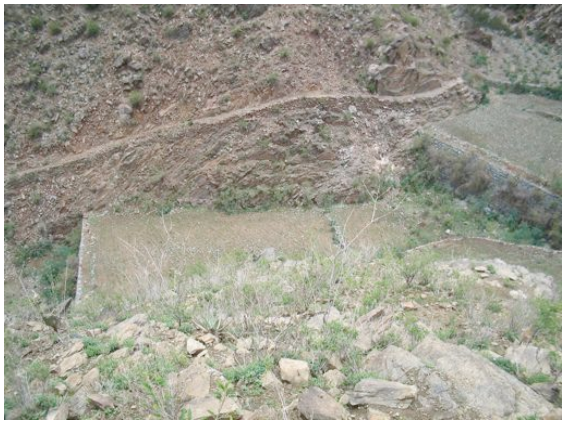


Illustration 25: Surveyed check dam and field in Bobo, July 2003

3.6.2 Soil data

As the farmer did not allow to dig in the middle of his field, a soil profile beside the crops was surveyed. For this reason the soil quality was not very high and showed a loose texture of loamy sand, mixed up with rounded stones. At a depth of 50 cm we hit the hard subsoil and it was not possible to go deeper (see illustration 26). The pH-value was 6 at the surface and 8 at the bottom, containing few calc. During the water absorption experiment the matrix got compressed by soaking 0.7 dl of the added liquid.

Illustration 26: Soil profile beside the Intigade check dam field; July 2003

3.6.3 Cultivation of the check dam field

Within the sequence only the 8th and 9th field were cultivated, each with a size of about 750m^2. At the time of first survey the wheat plants had an average height of 20 cm and 200 crops were counted within one square metre. The field was well cared-for with no growing weeds.
On the second time of survey, we asked the farmers, why not more check dam fields are cultivated. An old farmer told us, that this year for the first time 15 people share the fields, while in other years only 8 cultivated on them and produced a good harvest. He meant that due to this high number of farmers, the community organization did not work well. But one of these 15 farmers answered, that in spring there was not enough rain to sow maize (maize needs a high quantity of water and minerals). And at the time for barley cultivation (June – July), the flood was too high. Now they plan to cultivate the check dam fields during September.
Following the sequence uphill during the second visit in September, the first three fields were filled up with water. Crop cultivation seems not possible but the fields show high quantity of animal food (see illustration 27). In the upper part of the sequence, the power of the flood may be too high for weak cereals. But especially the 7th showed good conditions to be cultivated (see illustration 28). Since the cultivation of wheat in the middle part of the sequence was possible, a failed organization between the 15 farmers may have impacted the field cultivation. For further statements and conclusions see as well chapter 4.3.2.

Illustration 27: 2nd Intigade check dam field with obviously bad conditions for crop cultivating in September 2003

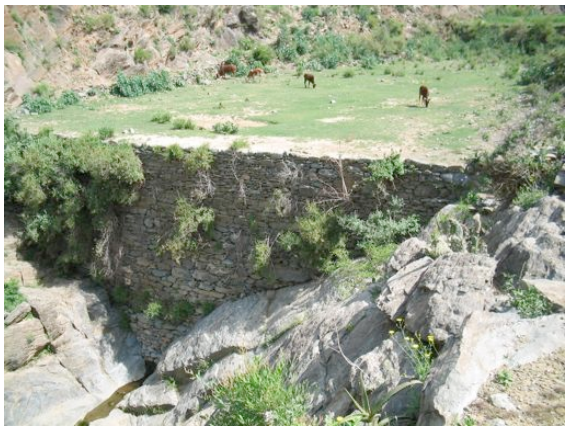


Illustration 28: 7th check dam field in Intigade shows potential for crop cultivation; September 2003

3.6.4 Vegetation and fauna data

Bushes and herbs hemmed the fields, where many birds were living in. Following the sequence, a high diversity of bushes and wild vegetation could be observed, used for animal feeding, as medicine ("udgahara") and as well as human foodstuff ("hamla"). On the first and second irrigated fields, innumerable little frogs jumped around the pools. After the construction of the check dam, the people observed increasing populations of ground-squirrels, porcupines, and monkeys.

3.6.5 Water availability

As the farmers reported, there was no water available before the check dam construction. Now the dam's spring brings water during 12 months in a good rain season or half a year when few rain is falling. The spring at the check dam's bottom was running well (illustration 28). The drinking water was judged to be of a high quality.

3.7 Alakalo – Awo village / dry stone masonry check dam: 58m x 5m x 10m

3.7.1 Check dam data and history

The interesting site in Awo is flooded by two rivers, lying in a sub-catchment of about 40 ha. Within the sequence of 10 check dams, we investigated the first and biggest one. It was constructed in 1976 and extended from April 1986 until July 1987. During its construction, an old man passed by the building site saying: "You are crazy to build a barrier here! It will break because here passes the way of god!". But up to now, the check dam stood the flood firm.

Illustration 29: Front view of the Alakalo check dam; July 2003

Illustration 30: Alakalo check dam with maize crops promising rich harvest, July 2003

3.7.2 Soil data

The 1 m deep soil profile within the ploughed field had a light clay texture. Plant roots reached till the ground. The soil was very moist and dense. Half a litre of soil example absorbed 1.24 dl of water. The pH-value varied from 7 at the bottom until 7 - 8 at the surface and experiments with hydrochloric solution detected few calc. Over the upper 50 cm of the profile, black spots were distributed. In combination with the high moistness and soil density, indicating a low aeration of the soil, they are obviously the result of chemical reduction of manganese. Other signals for the lack of oxygen were found mainly within a layer at 60 - 80 cm depth. The soil was drawn through with thin channels having diameters of needles, framed by red coloured soil. This is apparently the matter of iron, shifted from the pores to the matrix, converted into iron-oxide.

Both phenomena are often found in soils with alternating conditions of built up water and soil aeration. In the with water saturated pores, the Fe^{3+} and Mn^{3+} ions are reduced to the water transportable forms of Fe^{2+} and Mn^{2+}. The shift takes part firstly along the gross soil pores and root channels and is later spread to the fine matrix. In the following, when the soil became aired during the dry season, the elements get oxidised to Fe^{3+} and Mn^{3+} again with resulting rusty traces and black spots, characterizing the fine soil.

Regular periods of stagnant water within the layer of plant roots can hinder or slow down the growth of the crops. An indication for this process could be the uncovered plot in the field, obvious in illustration N° 30.

Illustration 31: Soil profile of Alakalo; July 2003

Illustration 32: Detail of the soil profile, showing black and red coloured traces, results of chemical reduction-oxidation processes; July 2003

3.7.3 Cultivation of the check dam field

Despite of the described soil processes, the round 3'500 m^2 large field is cultivated with high maize crops with an average height of 2m (illustration 33). The other check dam fields could not be cultivated because of the damaging flood in the upper part of the river system.

Illustration 33: Maize in Alakalo; July 2003

3.7.4 Vegetation and fauna data

After the check dam, trees, bushes and herbs cover the area (illustration 34). Farmers reported that the plants were not growing until the check dam had been built. These plants are used as animal food, medicine (Aloe and "udgahara") as well as for cooking ("hamla"). Birds find there their habitat as well as in the maize field. Increasing populations of porcupines, ground-squirrels and monkeys were reported and in some seasons "remmita" worms damage the harvest.

Illustration 34: Growing acacia trees after the check dam; July 2003

3.7.5 Water availability

At the bottom of the check dam a beautiful spring flows (illustration 35). The water of good quality is used for drinking. It is running during the whole year, in good and in bad rain seasons.

Illustration 35: spring at the check dam's bottom; July 2003

3.8 Belguba – Upper Daya / dry stone masonry check dam: 55m x 3m x 7m

3.8.1 Check dam data and history

The check dam was visited on the last day of its construction, which started in February 2003. As the building material was not available near the site, people carried the stones over a distance of approximately 1 km. The field will be silted up by the "Gaugau" river, since the check dam lies between Dogogola and Tikibta. The collecting sub-catchment measures approximately 10 ha.

Illustration 36: Working on the check dam of Belguba in August 2003

Illustration 37: Woman carrying stones to the Belguba building site; August 2003

3.8.2 Vegetation and fauna data

As the field was not silted up at the time of survey, only indigenous vegetation covers the field. Worth mentioning are especially the Acacia trees, which's continuance should be secured due to the check dam, the same way as it succeeded already in Tikibta (s. chapter 3.2.1).

3.8.3 Soil data and water availability

As the check dam was still under construction, no data about soil were collected. The area was dry since no other measures for water conservation were taken.

3.9 Magaira – Upper Daya / gabion check dam: 27m x 2m x 3m

3.9.1 Check dam data and history

The sequence of three little gabion check dams was built for gully reclamation. The first one was under construction since Mai 2003 to get finished at the day of visit. For its building it was very difficult to find good stone material, at the end it had to be brought over several kilometres distance to the building site. As the gully has an average height of about 6 m, in a first step the 3 m high gabion dam has to be silted up and stabilized, before it can be made higher.

Illustration 38: Gully reclamation by a gabion check dam; August 2003

Illustration 39: Filling up the gabion with stones; August 2003

3.9.2 Vegetation and fauna data

Although the gully was not silted up, between the second and third gabion dam sorghum with an actual average height of 20 cm was growing. In the field below wild vegetation of different bushes and herbs covered the area. As picture 38 shows, the gully is surrounded by grassland.

3.9.3 Soil data and water availability

As the check dam was still under construction, soil couldn't be collected yet. The green grassland in the surrounding indicates that the area is rain fed.

3.10 Ubuktole Ela – Adaga village / dry stone masonry check dam: 13.5m x 2m x 3.5m

3.10.1 Check dam data and history

This sequence of 4 check dams is the topmost within the "Gaugau" river system from which the first was selected. When the construction started in March 1994, a good rock foundation was found. No extra excavation was needed, saving a lot of costs. The building could be completed three months later. The check dam's special characteristics are described in the following.

Illustration 40: Up view on the Ubuktole Ela check dam, showing the running brook coming out of the check dam's bottom; August 2003

3.10.2 Soil data

The check dam field of about 340 m^2 can be divided into two parts: Within a streak along the wall, app. 2.5 m broad, the soil has a silt loam structure. The other part is silted up with a lot of chopped up organic material (see illustration 41), totally saturated with water. Digging for a soil profile in this site was not possible since it was too swampy. Footprints were filled up with water very fast and the farmers warned us to enter the field. Nevertheless the pH-value was measured right under the surface and determined with 7 – 8 within the marsh and 8 on the calcareous silt loam. Under the layer of plant rests, with a thickness of about 20cm, the soil matrix gets mixed up with loamy sand. The water absorption experiment could not be done, since there was not enough time left in Alitena, to let the samples dry.

Illustration 41: Close look on the organic material from about 0.5 – 1cm length in average, covering app. 2/3 of the swampy check dam field in August 2003

3.10.3 Vegetation and fauna data

As the picture 42 shows, the swampy area is covered with a shrub layer, mainly containing a plant species imported from Australia. Young Eucalyptus trees were found as well. They seem preferably let grow leafs near the silt loam, containing obviously more minerals. Herbs and grasses are rather poorly developed.

Following the check dam uphill until the topmost of the four barriers, there are growing plenty of herbs and bushes as well as trees, mainly used for the feeding of the cattle. Again the Datura stramonium-medicine for wound carrying was mentioned. The farmers reported, that this flora prospers, since the building of the check dam system, except some big old trees, which are now well protected due to the water barriers. Nowadays birds and butterflies liven up the new growing vegetation as well as tadpoles and frogs, living in pools between the barriers.
Further, the farmers told us, that they observe increasing populations of ground-squirrels, porcupines, monkeys and snakes.

Illustration 42: vegetation of the swampy field; August 2003

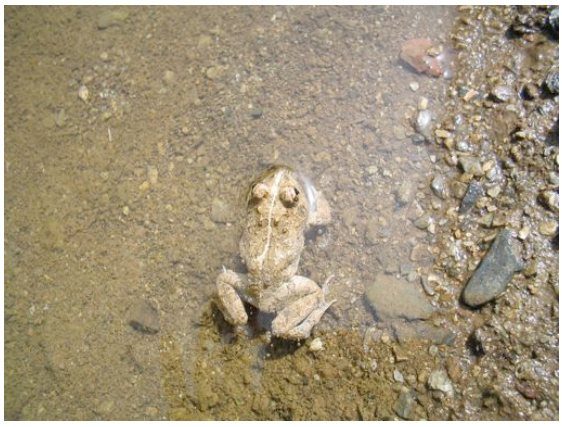


Illustration 43: A frog found in one of the water pools in the upper part of the sequence; August 2003

3.10.4 Water availability

As already described and illustrated in the chapters before, the check dams are conserving the water really good and provide the site with plenty of running water, where before only dry rocks could be found. Now along the whole sequence, a brook is rushing down the river bed, collected in many puddles and pools, reaching finally the area beyond the lowest dam. In the upper part of the check dam, water can be fetched all over the year, while the spring at the lowest check dam is running for 12 months in a good year and for 3 months in bad rain seasons. The farmers judged the water to be of very high quality and compared it even with the "Highland mineral water".

Illustration 43:

Following the check dam uphill, the proof for an effective water conservation due to the check dam system is found. Between the second and the third check dam a little paradise was discovered, where a small waterfall rushes into a pool; August 2003

4. Main findings from the interviews

In the following, the collected data will be interpreted with reference to the indicators from chapter 2.2. The main findings are based on the measured data and on the interviews with local farmers. As well the main question N^{o} 1 (see chapter 1.1) "What kind of impact have the "Limat systems" on economical, ecological and social issues in the Irob Woreda?" shall be answered.

4.1 Economic issues

4.1.1 Foodstuff sources and their relation with the check dam productivity

Preferably maize and sorghum are cultivated on the check dam fields, because both crops need high water and mineral availability. Undemanding and weaker crop sorts like barley and wheat are planted at the edge of ADDA's fields or on private check dam fields, where the power of the watercourses is less strong. The fields at the farmer's disposal are expanding between 20 and 50 m^2 (check dam fields excluded), whereas cultivators of a younger generation often don't possess any land.

Beside the crops people live from the products of their animals such as eggs, some times milk, liquid butter and meat on special occasions. Most of the questioned farmers have to feed between 100 and 200 animals (hens, cows, sheep and goats), two farmers reported an amount of 1000. The cultivators let graze their cattle on uncultivated check dam fields or in their surrounding.
In bad rain seasons the cactus fruits from Opuntia ficus-indica Mill. represent the most important food resource for months, if there is no external relief. Other goods like palm oil, and the main part of the cereals are delivered by the governmental and external aid programs like the World Food Program and USAID.

The families told us that the crops they harvest from the reclaimed soil make them independent from external relief for 1 up to 3 months. This statement depends on the rain season, field size as well as from the number of family members.

Before the check dam, the farmers gathered in one harvest a year. Since ADDA has built the waterbarriers, in some sites the production of two harvests became possible (reported for Dogogola, Tikibta and Awo). The first cultivation results in a higher crop quantity because it was fed by the high summer rain season. If no crops are cultivated, the growing vegetation is very important for animal feeding.

However, the quantity of harvest is strongly dependent on the rain season. Without rain, there can't be harvested any crop. But if there is a good rain season, farmers appreciate to have more soil available to cultivate foodstuff. And this is the main reason why they want to build more big check dams.

4.1.2 Cost-benefit consideration:

The harvest is always used to cover the own need for food and is not sold on markets. However, since every own cultivated foodstuff relieves external aid campaigns and therefore national and global economy, it makes sense, to look at the balance between check dam expenditure and the monetary value of its harvest.

Table 2: Average construction costs and harvest in a good rain season (according to the farmer's information) on check dams, used 2003 for maize cultivation:

Average expenditures per check dam (in Birr)	Average quantity of harvested maize per check dam field (in kg)
27'000.00	**17 bags à 100 kg => 1'700 kg**

Average price per kg maize is 2 Birr, hence an average harvest of 1'700 kg has a value of 3'400.00 Birr. In comparison with the average check dam costs this means:
27'000.00 Birr / 3'400.00 Birr = 7.95 harvests.

Average ROI per check dam: 7.95 times the investment

This rough calculation shows that **check dam expenditures can be amortized after 8 good maize harvests.**

Question N° 8 "Which of the past 10 years were good and bad harvest years" was asked, to get information about the field productivity. The indications between different sites are varying strongly. The locally differing quantities of precipitation could be the explanation for these contradictory answers. Yet the farmers could not give a prognosis about the harvest of this year, since the crops are still dependent on precipitations.

In Tikibta five interviews with different farmers were made. As illustrated in table 3, the answers were not always the same. However, the interview partners agreed in a good harvest three years ago. The most positive answer from 2nd August came from a former timekeeper at the check dam construction site. As ADDA's workforce, he is maybe interested in judging the check dam project as positive as possible.
As a further reason for the dissimilar answers about Tikibta I suppose, that the question was not specified sufficiently, since the valuation for "good" and "bad" years depends on many personal aspects e.g. how many family members had to be fed with the check dam harvest, was the answer related to the check dam field only (although it was asked in that sense) etc.. To work out expressive statistics about the numbers of productive or less productive years, would need a special research, spending more time and being supported by an experienced translator. Nevertheless table 3 shows an overview about the answers given to question 9.

Because of this background, it was more significant to ask the cultivators about the concrete amounts they gain from the check dam fields. In table 4 the quantity of maize harvested in a "good" year, is compared with the one in "bad" years. For Tikibta an average amount was calculated. This allows getting better information about the meaning of fertile and less fertile years.

Table 3: Years of good and bad harvests of the check dams, used for crop cultivating for the last 10 years (according to the information of local farmers given on the indicated date):

Years ago	Dogogola 24.7.03	Tikibta 25.7.03	Tikibta 27.7.03	Natiita 28.7.03	Intigade 30.7.03	Alakala 31.7.03	Tikibta 1.8.03	Tikibta 2.8.03	Tikibta 3.8.03
1	bad	good	bad	good	good	bad	medium	bad	bad
2	bad	good	bad	bad	bad	good	bad	bad	bad
3	bad	good	good	medium	medium	bad	good	good	good
4	good	bad	bad	bad	bad	good	bad	bad	bad
5	good	bad	bad	bad	medium	bad	bad	good	bad
6	bad	bad	good	bad	bad	good	bad	bad	good
7	bad	bad	bad	bad	medium	bad	bad	good	bad
8	bad	bad	bad	bad	bad	bad	bad	bad	bad
9	bad	bad	bad	bad	bad	good	bad	good	bad
10	bad	good	bad	bad	good	good	bad	good	bad

Table 4: Harvest quantity in kilograms for "good" and "bad" years on the cultivated dam fields (according to the interviewed farmers):

surveyed check dam	**village**	**"good" years**	**"bad" years**	**crop sort**	**estimated field size in m^2**
Alakalo	Awo	1'000	0	maize	3'500
Dasamo Gade	Dawhan	1'400	200	maize	2'500
Dogogola	Upper-Daya	3'000	0	maize	7'500
Intigade	Bobo	200	0	maize	750
Tikibta	Dawn-Daya	1'500	0	maize	12'000

Most farmers judge the year as "bad", if not any crop is harvested, while in Dasamo Gade 200 kg of maize means a poor year. This shows again, that the indications depend on subjectivity. As the cultivators reported, the reason for years with bad harvest was always the lack of rain and not misconstructions of the check dams.

4.1.3 Reasons for not cultivating the check dam fields

In some sites, the check dam fields were not cultivated but on the private check dams grew maize and barley. Several reasons for this phenomenon were found:

In Tikibta and Intigade the farmers explained this preference with the fact, that in spring the quantity of rain was too low to moisten the reclaimed land sufficiently, while the precipitations were enough to irrigate the small private fields, built on the slopes. In other words, in spring 2003, the watercourses reached only the small private check dam systems, while the big fields from ADDA check dams were not flooded since the river in the middle of the watershed did not run enough water. During the high rain season crop cultivating again was not possible because the energy of the flood was too high and would have damaged the seedlings. But the phenomena on both sites are as well linked to social factors. These are explained for Intigade in chapter 3.6.4 and for Tikibta in chapters 4.3.2 and 4.3.4. Additionally, the farmers in Tikibta live too far away from the check dam and prefer therefore to cultivate their own and near fields.

At the site of Daamoita, the new cement check dam is too low to prevent the important soil minerals from being washed away (for further information go back to chapter 3.3.4).

Sometimes the energy of the flood is too high and damages the seedlings. Check dams in the upper part of the sequences are therefore mainly used to decrease the river's power (e.g. Daamoita, Alakalo, Intigade).

The check dam site in Masanu is deliberately used for animal food, since there is no other opportunity, to feed the cattle in the area efficiently.

At other sites, the barriers are not enough silted up yet with good soil particles, such as the downer sequences in Dogogola and Dasamo Gade, the Ubuktole Ela sequence and of course on the latest built barriers of Magaira and Belguba.

4.2 Ecological issues

4.2.1 Soil fertility and quality:

The up-silted check dams contain relatively "young" soils, which are not (yet) influenced by the tropic climate such as high weathering processes.

Measured pH-values are varying from 6 to 8 which are typical values for semi-arid climates. Amounts between 5 and 7.5 are within the optimal interval for the growing of plants, characterized with good availability of minerals, nutrients and biotic activity (Fitze, 2003: p. 20). Hence it follows that the chemical soil conditions are good for agriculture. Fertilizers are not used because on the one hand they are not available, and on the other hand the soils are irrigated regularly that minerals and water are added every year. Although farmers reported a decreasing soil quality due to the lack of rain in the past years.
Fields with high irrigation rate, may contain stagnant water, what can result in chemical reduction-oxidation processes, such as on the Alakalo dam in Awo-village, which is irrigated by two river systems (s. chapter 3.7.3). This process should stay under control since future it might impact the prospering of the crops due to the high water saturation within the root layer.

Farmers said, that the soil on the check dam is softer than on their private land and therefore easier to cultivate. Further, it contains more minerals and conserves more water than their own fields, another reason why cultivation of maize and sorghum is preferably made on check dam fields. Since the reclamation of land, the areas could be transmitted from being rain fed to the more efficient flood irrigation.

The soil is only washed up by the flood. Only in Dogogola, the cultivators told us that at the beginning, they broke up the earth at the slopes to ease the soil erosion and fasten the reclaim of minerals behind the barrier. Since the check dam is silted up totally, people gave this technique up.

As the interview partners reported further, due to the check dam, the loose of soil could be interrupted. Only the Daamoita check dam (see chapter 3.3.4) doesn't prevent the loss of important soil particles efficiently.

4.2.2 Biodiversity

All visited sites show a high increase in biodiversity. Since the check dams were constructed, vegetation is growing in sites where before only rocky area was found. As well the fauna is livening up and even amphibians find now habitats, to live within a dry climate. With reference to the findings illustrated in chapter 3 ff., this is a very positive effect due to the check dam system. In many places it seems, that the nature has revived.

All farmers reported increasing animal populations of ground-squirrels ("oros"), porcupines ("ladina") and monkeys and complained that they damage their crops. Although during the research no porcupine and only few "oros" were observed, in the Dasamo Gade site, the impact of ground-squirrels was obvious (see chapter 3.4.5). Therefore some of the cultivators want to fence in the fields more efficiently. Up to now the harvest is protected only by cactuses, Aloe and other thorny plants, framing the fields. The farmers are asking ADDA for help, to provide them with the necessary materials. Pesticides and other chemical substances against damaging animals are not in use, since the substances are not available.

At that time a direct impact on the environment due to domestic animals (such as damages caused by over-grazing, cattle steps etc.) could not be observed, because the substantial rain falls provided the sites with high quantity of animal food.

A short term effect of increasing vegetation is the better availability of animal food, of herbs used for medicine (Aloe, Datura stramonium and the "udgahara"-plant) and of some plants used as vegetables ("hamla" and "einuta"). Even the plants growing on the check dam wall, are used for animal food, since they have no bad impact on the barrier. Finally there is not to forget the impact of the shadow donating and water conserving vegetation. As a long term impact many sites will be roused to fresh live, bringing the ecosystem into new balance.

4.2.3 Water availability

As reported in the chapters before, on every check dam system, without exception, the water quality and quantity increased. Asking the local people, what is better since the check dams had been built, the better water availability was mentioned always, combined with the increasing plant growing. Although at the time of surveys the spring at the bottom of the water barrier did not exist in every place, the area is kept moist and is covered with new vegetation.

In general it can be said, that the spring is running in average for 5 months in bad rain seasons, while in some places even under these conditions it is possible to fetch water during 12 months. Sometimes the water is salty and above all in low rain seasons the quality is low. When the rain falls are substantial, the check dam spring provides the population during the whole year with water.

4.3 Social issues:

4.3.1 Participation of the indigenous population

When we asked the local farmers "Who made the decision to built the check dam?" (s. questionnaire question 19), the answer came promptly and was always the same: "Bruno" (Bruno Strebel) and "ADDA". Every interview partner was involved as stone carrier during the check dams' construction, except one, who acted as timekeeper (Hagos Kahsay "Tuntug"). The farmers felt well involved in the making of decisions during the planning and realization of the project.

To let the farmers still participate in the project, question N^{o} 17 was asked, to figure out, if ADDA could improve their living conditions. The big majority of the cultivators answered, that they need more big check dams. Further, they want to increase the size of the existing barriers, to reclaim as much soil as possible. The farmers in Dogogola switched over to another ADDA project in the area, saying, that they need a water container for the field irrigation. And in Tikibta the water well is near to break down and needs to be repaired urgently.

4.3.2 Land tenure and community work on the check dam fields

To understand the organization of the land holding behind the check dams, it is necessary, to explain in a first step the hierarchical structure of the governmental organization in Ethiopia:

The highest administrative unit is the regional government of Tigray. Further, the region is divided into zonal governmental divisions, which include several "woredas" (= districts). Each "woreda", such as the "Irob Woreda", has again its own "woreda government". One "woreda" covers several Peasant Associations (PA's) or so-called "tabeas", e.g. the "Alitena tabea". Finally, the "tabeas" are devided into different village areas. Within this research check dams from the villages Aiga, Daya-Alitena and Dawhan-Awo (belonging to the "Alitena tabea") as well as Bobo-Village and Adaga-Village (belonging to "Weratele tabea") were visited. The village areas are represented by a member of the government on village- or PA-level. Sometimes this representative person is responsible for more than one local site.

In a second step, it has to be explained how ADDA has to proceed to build check dams:

ADDA and the local people make together the agreement to construct the check dam. Then the representative person of the community gets in touch with the village government or, if necessary, with the PA/Tabea instance, depending on the local situation. The village government respectively the PA decides, if the check dam will be constructed or not. After having finished the check dam, the village government or the PA is entitled to determine every year the land tenure on the check dam fields. In the following, two examples illustrate how this determination takes place:

a.) Tikibta:
The village government in Tikibta developed a lottery system, to select the farmers, who will cultivate the check dam fields during the coming season. In April of this year, especially the

female-headed and other very poor families from Upper- and Down-Daya were chosen, to draw the lottery tickets. Six of the 16 selected farmers are female headed.

b.) Bobo:
In early spring the PA determined 15 people to cultivate the check dam sequence while in the years before only 8 farmers were selected. The chosen 15 farmers were selected due to following criteria: 1. farmers with family; 2. farmers having no private land; 3. duration of marriage (priority given to longer lasting marriages). Finally 5 female-headed and 10 male-headed "young" families were chosen.

The selecting system and number of chosen farmers differs from site to site. Every year other people are determined. In general all people from a site have the right to cultivate the new fields. Asking them "To whom belongs the reclaimed land?" (1st questionnaire, No 24) they answer: "To all people!". As they reported in the interviews, ADDA always wanted to build the check dams for the whole population of an area. The fetching of water from the check dam spring is allowed to everybody in every year. The following table 5 shows the number of farmers on the cultivated check dams:

Table 5: Numbers of farmers sharing the cultivated check dam fields in 2003:

visited check dam	**village**	**N° of female-headed families**	**N° of male-headed families**	**Total N° of people**
Alakalo	Awo	10	27	37
Dasamo Gade	Dawhan	3	13	16
Dogogola	Upper-Daya	3	5	8
Intigade	Bobo	5	10	15
Tikibta	Down-Daya	6	10	16

To the Masanu site, used for animal feeding (s. 3.5.4), about 200 people bring their cattle to the site.

Cultivating the field in community work, the farmers share the harvest at the end of the season. In some of the interviews, the peasants complained the problematic side of the common land use, for example in Tikibta. Since the harvest has to be shared between 16 people, the single farmer doesn't profit from a high crop quantity. Further, the waiting period for crop cultivation on the check dam field lasts several years. That's why some of the farmers prefer to build their own private check dams (like this year in Tikibta) and want to build more big check dams.

In some sites the selected number of farmers seems to have high impact on the quantity of the produced harvest. For instance on the Intigade and Tikibta check dam, the community work did not function well and the fields are not used efficiently. In these cases, the productivity is higher, if one farmer takes responsibility for one field. The farmers of Intigade reported a good harvest for years, in which only 8 farmers cultivated in the sequence, while every farmer cultivated app. one field by his own. This year, the generous farmer mentioned in chapter 3.6.1, is producing a good wheat harvest because he was able to decide alone over two fields.
Other villages show a well functioning organization between numerous farmers (e.g. Alakalo and Dasamo Gade).

4.3.3 Ownership feeling on check dams

Asking the local people, "Who is responsible for the maintenance of the check dam?" they answered "ADDA". Only timekeeper Hagos Kahsay and the farmers in Bobo said, that small reparations are made by their own. But mostly people don't overtake the responsibility for the water barriers. This fact indicates the risk, that the project won't be sustainable without ADDA's support.

Why do the farmers not build check dams independently from ADDA in community work (see question N^{o} 6, second questionnaire)? One important reason is, that since the boarder conflict ended, everybody is working for the reconstruction of his own infrastructure, to find back into an ordered life. At that time the organization within the society is very difficult. And to build big check dams, there is the need of professional technical support.

4.3.4 Gender issues

Women and men do separate jobs on the field. While men are responsible for the ploughing and sowing of the crops, women (and children) weed and remove stones from the soil. Beside the wives manage the household. Men's housework is concentrated on the building and reparation of the houses and its infrastructures. The gather in of the harvest is done by both genders. Due to an old tradition, the ploughing of the fields and sowing of the crops by women is tabooed. The tradition says that if women sow crops, the plants won't grow. Therefore women are always dependent on male workforces. Furthermore in Ethiopia women have no right or access to private land use. Sharing check dam fields is often the only possibility for female-headed families to cultivate crops.

On the Tikibta check dam, these gender traditions show its negative effects. From the 16 families sharing the field six are female-headed. The ten male-peasants having more possibilities for crop cultivation prefer to cultivate their own fields (see chapter 4.1.3 and 4.3.2). Hadas Abraha, female head of a family with six children, has no private land and no ox. Although the six women once agreed to cultivate the field all together, Hadas was finally left alone to cultivate the check dam field. Fortunately three male-farmers helped her by ploughing and sowing crops on at least nine square metres of the check dam field. On this little plot, maize is growing between the weeds. According to Hadas' conclusion, every male farmer would have been able, to manage the whole field by himself, because they are not dependent on other workforces.

The responsible from the ADCS WID gender office concluded, that due to the numerous wars and conflicts, about 36% of the families in the Irob Woreda are female-headed. The strict traditional job sharing between men and women indicates a big problem for these families. The mother often has to employ and pay male farmers, who plough her fields or she has to share the harvest (in case of Tikibta the farmers helped Hadas Abraha for free). Often they have not enough money to hold oxen, what makes them even more dependent on other farmers. As a consequence, female-headed households are hit harder by poverty. To interrupt this vicious circle, it is important to provide women with cattle and to train them how to plough. Although it is difficult to break old traditions, the WID succeeded in another woreda in training one young woman, who is now able to cultivate her field independently. Another problem for single

women with children is, that their children often are left alone while they are working at the building sites or on the field.

As in chapter 4.3.2 illustrated, male- as well as female - headed families are considered for the land tenure. Female and male interview partners reported that men and women have the equal right to land tenure. But as table 5 shows, there are always more male farmers than female ones.

Within ADDA, concrete gender related work is still at its beginning. Up to now women are not trained for technical issues. As a consequence, the programs and projects within ADDA always laid stress upon male strategies. Although women reported to be well supported by men to manage the hard work on the check dam building sites (e.g. men helped to burden her with the stones she carried to the building site) ADDA should make further steps to figure out female capacities and assign adequate work to women. For example it is necessary to sensitize project leaders, timekeepers etc. for specific female needs and to include gender related concepts in the project planning. As well the creating of discussing platforms for women would help, to assist them in organizing each other, e.g. to manage the female cultivation of the check dam fields.

Due to their physical conditions, women are often not able to build private check dams. According to ADDA office there were first discussions made for a project implementation, to provide female-headed families with their own water barriers.

From 2003 – 2008 the WID of ADCS is launching a study under DAP (Development Assistance Program from CRS/USAID). Carrying out interviews with female-headed families' gender data, this action will cover at least two PA's of the Irob Woreda. In co-operation with this project, ADDA could integrate resulting gender data in their project planning too.

5. Conclusions

5.1 Research background

Every site shows its specific characteristics and needs to be observed in a broad context. Overlaying the check dam projects with a rigid black-or-white-raster, results in the loss of important detail information. The numerous cross-references within this report shall represent the complexity of the issues and connections between the single elements.

Due to the limited time of my stage, linked with the high spread of the topics, I had to restrict the report to its main issues, focussing strictly on the check dam projects. Because of the mainly on local know-how based report, the collecting of data was extremely dependent on the availability of experienced farmers, which was not guaranteed in every site. Therefore some of the mentioned subjects, especially in relation to the social network, still could be examined more profoundly (e.g. why the organization between women in Tikibta did not succeed, which factors impact the community work at most, working out the perception of "good" and "bad" harvest years etc.).

Against this background, I formed my personal opinion about ADDA's "Limat Systems", which I would like to present in the following chapter.

5.2 Main findings and recommendations

The constructed check dams are used for different purposes: For agriculture, for water conservation and as a water source or to increase the biodiversity what provides food for the cattle and brings the ecosystem into a new balance. **In the best case a check dam accomplishes all of these purposes, but often they achieve only one or two of their aims. In any case, a check dam results in a value added for the environment. However, the check dam projects should target to benefit from the entire range of positive impacts. Hence, the project design and activities have to be adapted accordingly (incl. social work with the communities, gender issues etc.).**

The most frequent positive impact of the Limat Systems is the much better **availability of water**. This has obviously a positive impact on the environment. The increasing biodiversity is impressive, areas become covered with plants, where before was a rocky and dry area. In other words: **Barren landscapes become fertile**. Hence, in the long-term Limat System improve people's livelihood and therefore contributes to prevent migration from the rural areas.

In some sites not all check dam fields within a sequence were cultivated or the fields were cultivated insufficiently. In the following, I want to give some suggestions on how to face the this phenomenon based on the difficulties as presented in chapter 4.1.3:

The Daamoita check dam should be examined, if additional water barriers upstream could improve its capacity. Above all, ADDA has to get in touch with local people to discuss, if they are allowed to **build small check dams** on their own in the upper part. As in the past several agricultural products were cultivated, it would be a pity, not to enhance its potential.

The **inspection of the fields by an agriculture expert considering organic cultivation practices** is highly recommended. In some sites (e.g. Intigade) farmers could produce more harvest by applying more efficient agricultural practices.

The sharing of the harvest and damaging floods decrease the revenue from the check dams. Hence, there is little incentive for the communities to cultivate the check dam fields. **Constructing more check dams** can solve this problem. At the one hand, more check dams lower the damaging power of the flood; at the other hand the more check dam fields the more crops can be harvested. Furthermore, the waiting queues on the big check dam fields become shorter.

As the example in Tikibta shows, it is very important to **adapt the check dam projects to gender related issues**. It is important to collect gender data, to train female technicians, timekeepers and other staff, to sensitize ADDA's workforces for gender specific needs.

As illustrated in chapter 4.3.2., the check dams built under ADDA depend very much on **governmental decisions**. They influence the local community network and can directly impact the field productivity (e.g. by giving the field responsibility to too many farmers at once). Therefore, it is important that ADDA **maintains** regular **contacts to Peasant Associations** as well as **representatives of the local governments**. They have to be involved during decision-making processes and the check dam construction.

It is obvious, that the **people hand over the responsibility to maintain the check dams** still **to ADDA**. It is important to implement activities (e.g. technical trainings with peasants, involvement of the local government etc.) that people become aware of their responsibility for the water barriers.

The project is criticized by external evaluators that ADDA creates **dependency of the local population from the project** and that coping mechanisms are increasingly lost, as the community expects ADDA to provide them with work. However, based on observations in the field and literary researches, the idea to build check dams is coming from the local people themselves (s. chapter 1.2). There are several private check dams in the area, built by the farmers themselves. As the interviews showed, farmers even prefer to cultivate their own check dams instead of sharing the fields of the big check dams with the whole community. Hence, based on my field researches I cannot confirm the reproach that the project creates dependency. According to my observations, the problem is not that people do not build their own check dams but that the big check dams built by the project are not used efficiently by the communities.

Another evidence that dependency due to "cash-for-work" activities is not a central issue is based on the question No. 4 of the 2nd questionnaire "What is the main reason for the building of more check dams?". Answering this question "money" was never mentioned. People rather concluded that more check dams provide more crops, water, animal food and prevent the soil erosion. However, it is important **not to over-pay the cash-for-work activities**, to avoid that money becomes the first priority.

Drawing a conclusion based on the collected data and looking at the achievements of the last 30 years, the project in any case has to be continued. At the same time ADDA's "Limat systems" activities have to be improved to exploit the full potential of the check dam systems.

6. Index of Literature:

CARITAS Switzerland (2002): Nord-Aethiopien, Region Tigray, Projekt 20000926.03 - Beschäftigungswirksames Programm für Bodenschutz und Wassererhaltung.

FITZE Peter (2002): Bodengeographie – Skript zur Vorlesung. Zürich

HURNI Hans (1986): Guidelines For Development Agents On Soil Conservation In Ethiopia. Community Forests Conservation and Development Department, Ethiopia

MARTINS Christine et al. (2002) : Evaluation of Adigrat Diocesan Development Action (ADDA). Adigrat and Berlin

NIEDERER Ivan S., POZZI Andrea R., STREBEL Bruno (1986): Soil and Water Conservation Manual For The Adigrat Diocesan Development Action. Zürich and Willisau

REIJ Chris, WATERS-BAYER Ann (2001): Farmer Innovation In Africa. Earthscan Publications Ltd, London.

STREBEL Bruno (1979): Kakteenbauern und Ziegenhirten in der Buknaiti Are (Nordethiopien) - Ein Planungsbeitrag zur Agrarentwicklung in semiariden Berggebieten. Inaugural-Dissertation an der Universität Zürich.

STREBEL Bruno (2002): Brief Comments On The ADDA Evaluation Draft Report.