# Monitoring Report 2013-2016

## Carbon Offset Project Exclosure (COPE) Reforestation and afforestation in Ambober, North Gondar

Dr. Abrham Abiyu, DI Florian Peloschek, Prof. Georg Gratzer

University of Natural Resources and Life Sciences, Vienna
Centre for Development Research

Transportation of Seedlings, 2015 © Yonas Worku

## Key project facts

| | |
|---|---|
| Project title: | Carbon Offset Project Exclosure-North Gondar (COPE) |
| Project start: | Planning in 2012, implementation 2013 |
| Duration of the project (in years): | 2013-2018, 5 years (inception phase)<br>2018-2043, 25 years (continuation phase) |
| Monitoring on the site: | December 2016 and January 2017 |
| **Sequestered carbon 2013-2016: (incl. 6 tons in 2012)** | **1.320 $tCO_2$ during monitoring period** |
| Annual increment estimated: | 8$m^3$ per ha/yr |
| Coordinating organisation: | Centre for Development Research (CDR) at the University of Natural Resources and Life Sciences, Vienna (BOKU) |
| Postal address: | Peter Jordan Strasse 82, 1190 Vienna |
| Scientific partner institutes at BOKU: | Centre for Development Research (CDR), Institute for Forest Ecology (IFE) |
| Partner organisation: | Amhara Region Agricultural Research Insitute (ARARI), Gondar Agricultural Research Centre (GARC), Gondar |
| Estimation of carbon offsets in 2012: | 5.310 t cumulative bound $CO_2$ (AGB+BGB minus Extraction) over 30 years upgrowth |
| Estimated of carbon offsets in 2017: | 18.338 t (AGB+BGB) cumulative bound $CO_2$ on 79,5 ha based on inventory data, over 30 years |
| Contact person & project leader: | DI Florian Peloschek florian.peloschek@boku.ac.at |
| Current Team members: | Dr. Abrham Abiyu, Yonas Worku MSc, Prof. Georg Gratzer, Dr. Birgit Habermann, Dr. Andras Darabant |

# Table of Contents

# 1. Monitoring Report Information

## 1.1 General Information

The core of the BOKU $CO_2$ compensation system are long term, innovative and participatory climate mitigation projects which are planned, funded, implemented and supported in host countries. BOKU staff had been involved in the area through joint research projects already prior to project intervention. The goal of BOKU $CO_2$ mitigation projects is not only climate protection, but also the structural and sustainable change in the area through the cooperation of science and local population to develop comprehensive climate programs and which have varied positive benefits such as biodiversity, water and soil protection, gender equality, participation, education and training as well as entrepreneurship opportunities for the local economy.

The COPE project started in 2012 where suitable areas and tree species for afforestation had been selected in a participatory process with the local land users. This participatory process lasted more than a year and a joint Community Use Plan for the sustainable management had been agreed on. The permanence of the afforestation, the first 10.000 seedlings were planted in June 2015, can now be secured by a broad acceptance of the project by the land users. During the 4 years monitoring period (2013/2016) 1320 tons of $CO_2$ had been sequestered.

## 1.2 Description of baseline scenario and context in Ethiopia

Ethiopia is a land locked country situated in the greater horn of Africa. The size of the country is ca. 1.123 million square kilometere, population is close to 95 million people with an annual growth rate of 3%. Agriculture contributes about 56% of the country's Gross-Domestic Product (GDP) and employs more than 84% of the labour force. The production system is smallholder dominated agriculture practiced under rain fed condition.

In the Amhara Region, agriculture takes place mostly on small-scale farms with less than one ha land holding. These farms are extremely diverse, one farm usually incorporates a variety of agricultural practices. Farmers combine crop and livestock production, farm forestry as well as homestead horticulture and provide ecosystem services such as soil and water conservation services.

**Land degradation** impairs land productivity in the Ethiopian Highlands. This has severe consequences on the productivity and production process of the rural population. The most important counter-measures to halt this process have been **plantations of trees and assisted natural regeneration**, mainly in areas where access of livestock is reduced or excluded. Plantations of fast growing exotic tree species are good options for increased biomass productivity per given time and area. However, in terms of restoration of degraded lands, this option may fail to address concerns of productivity and diversity. It may not be feasible and compatible with the specific local socio-economic and environmental, technological realities and may corroborate the acute land shortage of small holder farmers. These realities create a need for a paradigm shift in designing restoration processes towards true participation of land users. Additionally, there is often a lack of direct benefits of exclosures for the local community (Yami *et al.* 2006, Descheemaekter *et al.* 2006a, Mekuria *et al.* 2007 and 2009, Mekura 2010, Abiyu *et al*. 2011 and 2012).

A number of studies identified lack or poor access to seeds, lack of information, poor information transfer mechanisms[1] and liquidity constraints as the most important factors constraining improvements in productivity and adoption (see for example Techane et al. 2006; Million and Belay, 2006; Amsalu and Graaf; 2006; Yirga and Hassan, 2008; Kassie et al., 2008; Yigezu and Sanders, 2012; IFPRI, 2013; Teklewold et al., 2013; Gebremedhin et al., 2013; Shiferaw et al., 2014; Tiruneh et al., 2015). The current advisory and financial service system is also found to be biased against resource poor and women headed households calling for better approaches that close the gender gap and at the same time expand in both coverage and quality of extension service delivery (IFPRI, 2013).

The COPE project and the carbon offset mechanism of BOKU was designed to overcome some of those constraints. This has been realized by means of facilitating communication through village wide meeting, and training of farmers in tree nursery techniques, forest resource assessment, and enterpreneurship skills.

## 1.3 Description of the project activity and workplan

The COPE project facilitated a participatory process in order to enable farmers and researchers to engage in the establishment of an exclosure area in Ambober, North Gondar. This approach carried out in parallel with research activities is novel in the context of carbon compensation schemes.

The course of action is split in two phases:

**1) Inception phase.** The COPE project started in 2012 with the design of the participatory process, that in essence tried to accommodate as much as possible local traditions and debating cultures, however due to the authoritarian tendencies in those traditions, some amendments have been made. The following key actions were performed:

- Develop a participatory framework for a carbon compensation scheme in a community-based exclosure management system supported by research. Status: ongoing, long term goal
- Identify community priorities, potentials and constraints for management of exclosures in the study area including priority tree species across different land use, tenure and ownership regimes. Status:reported, participatory process reported to BOKU $CO_2$-Compensation system in 2015.
- Establish community based sustainable management schemes including communal benefit sharing. Status:ongoing, year 2017 & 2018
- Characterise carbon sequestration and plant biodiversity in the exclosure. Status: reported, Monitoring Report to BOKU $CO_2$-Compensationsystem
- Characterise community benefits of the exclosure management through monitoring. Status:ongoing, year 2017 & 2018

Beside the interaction with the communities, the 2008 established 3ha exclosure in Woiyinie is since 2013 under close supervision and control by the COPE project and hence the local guards. The biomass upgwroth in this 3 ha took place with some disturbances but was never completely interrupted between 2008 and 2013.

1 National, regional and international agricultural research organizations have made sizeable investments in the development and adaptation of new and improved agricultural technologies in Ethiopia. As a result, numerous crop varieties, livestock breeds, and natural resource management (NRM) technologies have been released, demonstrated and popularized. The government has also invested substantially in the national agricultural extension system with the deployment of extension personnel at levels of 16 per 10 thousand farmers (the largest in Africa and equivalent to that of China). While recent developments in the country show encouraging results where the agricultural sector has rebounded since 2005 registering an average annual growth rate of 11% (MOFED, 2010), numerous studies showed low average cereal productivity of 1.68 tons/ha and low adoption of improved agricultural technologies (CSA, 2011). A sustainable agricultural system is an information-intensive rather than input-intensive system (Roling, 1994). Therefore, continuous flow of information, new technologies, and innovations are necessary for farmers to engage in sustainable agriculture (World Bank, 2006; Rao and Rogers, 2006).

**2) Project phase.** The project phase started in 2013 with the participatory process. In 2014 as subsequent success the expansion of the first exclosure and the establishement of the other exclosures in Ambo Ber were decided. In this regard the tree plantings took place in the project phase in 2015 and 2016. Both Woyineye and Woglo communities had made great labor contribution in terms of transporting the seedlings from Ambo-ber to Woyineye and Woglo, at the same time they dug pits and planted the seedlings inside the exclosure of both villages. The local institution Organization for Rehabilitation and Development in Amhara (ORDA) made a payment about ETB 1.20 (EUR 0,05) per pit preparation and per planted tree. The Gondar Zuria District Office of Agriculture provided tree seedlings freely without demanding financial contribution from the project.

In the rainy season of 2015, a total of 18 680 trees were planted, 63% of which were *Eucalyptus camaldulensis,* the rest was composed of *Grevillea robusta* (24%), *Olea africana* (5%) and the rest *Melia azedarach, see table below*. The majority or close to 86 % of the trees were planted at Woglo.

Table 1 Number of trees planted in 2015

| Species | Number of seedlings | Percentage |
|---|---|---|
| *Eucalyptus camaldulensis* | 11680 | 63 |
| *Grevillea rubusta* | 4500 | 24 |
| *Olea africana* | 1000 | 5 |
| *Melia azedarach* | 500 | 3 |

For 2016, pits have been prepared and 4860 seedlings have been planted, with the exception of *Grevillea robusta* and *Jacaranda mimosifolia*, indigenous trees species were selected by the local people.

Table 2 Number of seedlings planted in 2016 in the two villages

| Woyineye | | | Woglo | |
|---|---|---|---|---|
| Species | Number of seedlings | Percentage | Number of seedlings | Percentage |
| *Grevillea robusta* | 1500 | 51 | 600 | 31 |
| *Cordia africana* | 720 | 25 | 480 | 25 |
| *Acacia saligna* | 480 | 16 | 360 | 19 |
| *Acacia decurrens* | - | - | 240 | 13 |
| *Jacaranda mimosifolia* | 240 | 8 | 240 | 13 |

In the scope of project, following activities are planned to be accomplished in 2018:

- Establish a management scheme for the exclosures as Community Participatory Forest Monitoring incl. a participatory process to define, objectives, indicators and monitoring tools and characterise community benefits of the exclosure management. Support and specific training for additional plantings of indigenous trees, especially at homestead and difficult habitat with development of a nursery scheme on farm level to grow seedlings of indigenous species, and also provision of seedlings and saplings from Gondar Zuria Administration. Characterise carbon sequestration and plant biodiversity in the exclosure sites with a follow-up inventory (baseline of site *Terarye* in Woglo, Ambo Ber).
- COPE will organise business plan training and provide seed-money to start cooperative business (e.g. seeds and saplings of indigenous trees), and also arrange farmer to farmer visit for experience sharing across sites in Amhara region.

The first carbon reductions were monitored in 2017 and are subject to this report.

### 1.4 Project participants and coordination

The project coordination at CDR is in charge to oversee all activities. In Ethipia ARARI management and the forestry research directorate team from Bahir Dar (GARC team at Gondar) including the forestry and socio-economics and research extension research directorates (Bureau of Agriculture in Gondar and district office of agriculture at Maksegnit Woreda) are implementing the project. Development agents in Ambo Ber, Watershed committee in AmboBer, forest committee at AmboBer and beneficiery farmers at Ambo Ber and further important stakeholders.

The project coordinators in Vienna and Bahir Dar, DI Florian Peloschek and Dr. Abrham Abiyu, are jointly overseeing the work plan. The project team at BOKU Prof. Georg Gratzer, Dr. Birgit Habermann and Dr. András Darabant are contributing with scientific backstopping and support as steering committee crucial decision making.

Periodical communication between the project leader, the project team and the consortium members will ensure that all partners are informed in good time about the status of the project. The progress reports and financial reports submitted to CDR ensure project controlling. Report formats successfully developed in previous partnerships with ARARI have been adapted for this project. These reporting formats include problem identification, steps towards problem solving and reporting on progress on problem solving in the next report. Crucial for a successful project implementation is a well developed communication structure, therefore great emphasis is on a continuous communication between the partners. This will be guaranteed through clear communication pathways that are defined mutually in the ToR. In addition, workshops of the coordination team guarantee the exchange of information and facilitate the decision making process.

### 1.5 Location of the project activity and system boundaries

The project 'Carbon offset project Exclosure North Gondar, Ethiopia' Is located in North Gondar Adminstrative Zone, in the villages **Woglo** and **Woyineye** in **Ambo Ber Kebele**[2] in **Gondar Zuria Woreda**[3]. Ambo Ber Kebele is located north of Lake Tana (12°31'2.87"N and 37°31'24.37"E), ca. 30 km south of Gondar (zonal adminstrative capital) in the Amhara National Regional State (ANRS).

[2] Kebele is the lowest adminstraive unit in the government structure of Ethiopia
[3] Woreda is the next higher administrative unit to Kebele

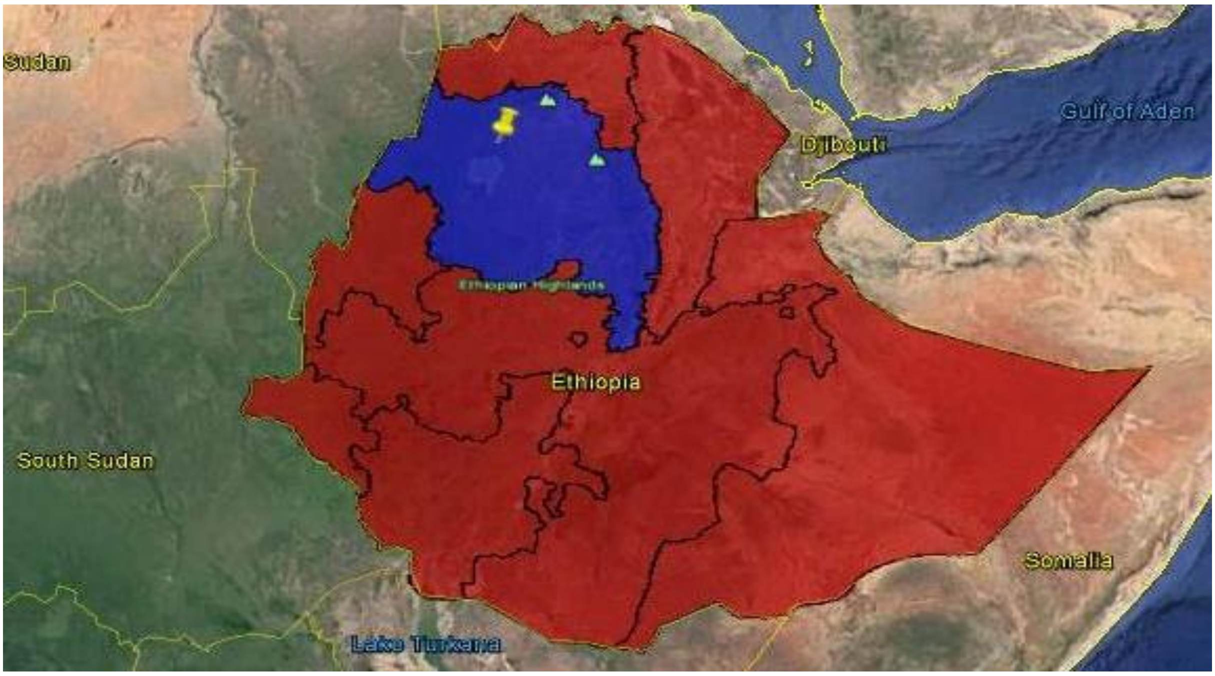



**Figure 1 Map of study area**

Red shade is denoting Ethiopia, blue shade is marking the Amhara Regional State of Ethiopia, yellow pointer shows the location of COPE

Ambo Ber is connected to the main highway with a 10 km dry weather road, both villages Woglo and Woyineye are accesible by car since 2016. The villages are connected to the main highway that runs between the regional capital Bahir Dar and Gondar. The farming system is mixed crop livestock system where trees also form valuable components. The area is a transition zone between low production potential cereal-livestock zone in the east and high production potential cereal-livestock zone in the west and south. The average size of land holdings is 0.56 ha. A typical household is entitled to manage three parcels of land. Grazing land  and forests are common property managed by different committees.

The **1st block** consists of the Woyiniye exclosure and its extension. The Woyineye exclosure was established in the end of 2008 and beginning of 2009 on 3ha. The aims of this exclosure were to improve livelihoods of the local people by increasing landscape biodiversity. The targets were to (1) provide tree fodder, (2) fire wood from shrubs and (3) grass from patches without tree growth. Hence, trees were planted in low density and much space was left for natural successional processes. The permanence of this excluse could only be established with the COPE project.

In 2012, through intervention of COPE the farmers included the surrounding area of the exclosure by excluding human and animal intrusion. The original exclosure and its extension are under close supervision and control by the local guard against any tresspassers. The total area of **Ambo Ber Deldal** is **14 ha**.

The **2nd block** is **Abay Dur** shrub land inside the Woglo village. It was included as an exclosure recently as a result of the intensive participative process of the COPE project. This thick shrub land has a size of **60 ha**. The **3rd block** in Woglo (**Terarye**) is the site where a plantation between the church and the settlement has recently been established. No growth information was collected from the third block yet. Exclosures implemented and planned in the participatory process:

Table 3 Project boundaries and size of project area

| Village | Local name | Size | Establishment | Status | no |
|---|---|---|---|---|---|
| Woyineye | *1st exclosure* | 3 ha | 2008 | established | Block 1 |
| Woyineye | *Ambo Ber Deldal (Gedelu Ser)* | 14 ha | 2013 | established | |
| Woglo | *Abayedur* | 60 ha | 2014 | established | Block 2 |
| Woglo | *Terarye* | 2,5 ha | 2014 | established | Block 3 |
| Woglo | *Fiyelwuha* | possible expansion | | | |
| Woyineye | *Workamba* | possible expansion | | | |

Picture 1 View 1st exclosure, Ambo Ber Deldal (Block 1,2), Abayedur (Block 3) and Terarye (2016)

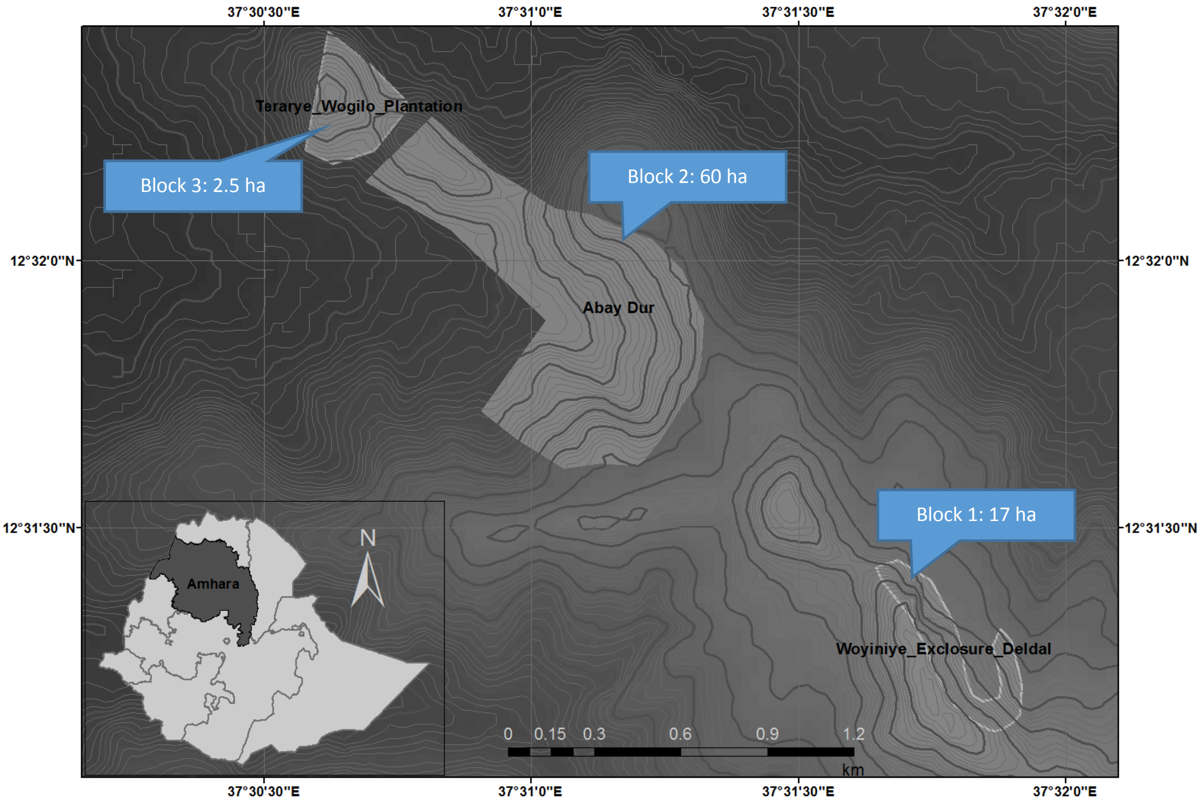



Figure 2: Contour map of the COPE implementation locating the three blocks in Ambo Ber (map prepared by Ato Beyene)

Institutional/political boundaries can be described as follows:

- To develop effective forest management institutions for reducing environmental and human pressures on forest land, it is necessary to work within larger boundaries that encompass the source of the problem, as well as the problem itself on a meta level. The administrative boundaries of our intervention are the district boundaries . Certain land use policies which are influencing implementation are also effected by national laws and land use policicies.

- The constitution of Ethiopia declares that the right to ownership of rural and urban land is exclusively vested in the State and the peoples of Ethiopia. Land is a common property of the Nations, Nationalities and peoples of Ethiopia and shall not subject to sale or to other means of exchange. However, rural people are guaranteed with lifetime holding right that gives holding right except sale and mortgage. The political and administrative boundaries are matter of continuous support, monitoring and also counselling by the project team.

Social aspects have been identified within the participatory process as a main requirement to analyse and understand the existing socio-cultural context before implementing. Different actors form a social reality across institutional and disciplinary boundaries, thus including the civil society is crucial for our success.

## 2. Monitoring Methodology and Data

### 2.1 Monitoring of baseline situation

In Ethiopia, little or no institutionalized land use rights coupled with population growth - both humans and livestock - lead to an altered, more intensive land use, soil degradation and deforestation. Thus, in Ethiopia the forest area has decreased below 3%, while 2017 figures show forest cover of around 10%, due to the plantations established. Severe consequences are soil erosion, long-term loss of vegetation and degradation of soil chemistry and biology. In addition, the shortage of woody biomass, has led to the use of manure and crop residues as fuel. This results in a drastic nutrient depletion in agricultural soils and a strong decrease of productivity. Due to the fact that inorganic fertilizers for the rural population are too expensive, there is a strong need of measures promoting the improvement of soil fertility and the income situation of the rural population.

**Picture 2 Baseline situtation and biomass measurement (c) Jonas Worku**

The main measures to increase forest and soil nutrients, are animal exclosure and reforestation. For a succesful project intervention a participatory decision need to be taken to transform the land area.

### 2.2 Description of Monitoring schedule

The monitoring of above ground biomass will be carried out in three to five year intervals. The first inventory was done in 2008 during a PhD thesis, the second in 2014 and the third in 2016. The contact person at ARARI, Dr. Abrham Abiyu,is responsible in leading the inventory. The forestry research team at GARC participates in measurement of trees and shrubs at the PSP and set up the design and maintenance plan. The PSPs are established for recording baseline carbon stocks and changes in carbon stocks as well as for monitoring biodiversity change throughout the time.

### 2.3 Description of Monitoring method

A CDM (Clean Development Mechanism), VCM (Voluntary Carbon Market) or Gold Standard carbon offset project must use registered and recognized calculation methodologies. The basis of the methodolgies are accuracy, transparenty, comparability, consitancy which are mostly based on standards and parameters of the Intergovernmental Panel on Climate Change (IPCC). COPE project is based on IPCC and CDM methods, but is not can not apply them stricly as the project is comparably small and has a low budget.

To determine carbon sequestration of a forest the growth of the forested area is being analysed and total biomass increment is modelled. In such a forest inventory several representative Permanent sample plots (PSP) were established, on which each tree (which is larger than 5cm diameter) is measured. These inventories are repeated every 5 to 10 years, whereby the newly added grown biomass is determined in the sample plot area. The inventory takes also into account the removal of the timber.

Relevant parameters for the monitoring of the project. The UNFCC methods for estimation of carbon stocks is based on measurement of biomass of trees and shrubs. For ex ante estimation of tree biomass it applies tree/stand growth models and for ex post estimation of tree biomass it uses field measurement of data from sample plots. Biomass of shrubs is estimated from field measurement of the shrub crown cover.

### 2.4. Biomass Inventory for Monitoring $CO_2$ sequestration in the Period 2013-2016

The most important parameters to be measured inside the PSP are: Tree/shrub species, height, diameter, the number of stems per tree (for shrubs), health of the tree (state of beign infected by insects or pathogens, crown condition, stem straightness etc), vigor (genetic capacity to resist strain or stress), vitality (capacity to grow, to reproduce, and to adapt in a given condition), coordinates of the trees  and PSPs (see Annex for example of PSP).

From the measured variables, above ground biomass and carbon stocks are calculated, including previous stocks, and changes in carbon stocks. Carbon stocks of trees and shrubs are calculated using biomass expansion factors (BEF) and allometric equations. For this report, allometric equations were used since BEF over estimated the biomass.

The most important tree parameters measured inthe sampling plots are: stem height, height above 20 cm from ground, height above 30 cm  from ground, height above 50 cm from ground, crown width (average of the broadest part of the crowns), crown depth, total tree height.

For the monitoring of above ground biomass and carbon stock, the area of the exclosures was stratified into three blocks. As pointed out above, the aims of the exclosure in Block 1 had a stronger focus on biodiversity enrichment combined with plantation of fodder trees. The participative process for Blocks 2, 3 and the further extensions resulted in specific aims of the local people more geared towards fast growing tree species and tree plantations with higher tree density.

Hence, the assessment of the aboveground biomass (AGB) for Block 1 and Blocks 2 and 3 will result in different growth rates per ha and are calculated separately.

Permanent sample plots inside the first Block were established in 2014. The sampling plots were 5 m radius or diameter circular plots. The total number of plots was 37. Five allometric models were compared to estimate above ground biomass (Hadera 2015).

(1) Y=(-bo*DSH)+ (b1*(DSH exp(b2)), Parent 2000
(2) Y=(b0*DSH)+ (b1*(DSH exp(b2)) , Parent 2000
(3) Y=(-bo*DSH)+ (b1*(DSH exp(b2)) , Parent 2000
(4) Y= b1 D40^2, b1= (0.147) , Negash 2013
(5) lnTDW= b0 + b1 ln DSH, b0= -3.514, b1=2.827 . Giday 2013
(6) Y = bo * (D30 ^ b1), Cleemput et al 2013

Note: Dry weight mass(Y), Number of stem (N), Diameter at stump Height (DSH), Diameter at 30 cm above ground (D30), Diameter square at 40 cm (D40^2),total dry weight (TDW), bo, b1, & b2 are coefficients

The first three models were obtained from the chapter of A manual for woody biomass inventory (Parent 2000), which was part of the Woody Biomass Inventory and Strategic Planning Project (WBISP) which run between 1990-2004 in Ethiopia. The parametes values for plant families for the Parent (2000) models can be found in the Appendix.

## 4. Monitoring Results

Table 4 Overview Project Result and sequestered carbon

| Project Results | |
|---|---|
| Carbon Sequestration of COPE Project in 2013-2016 | 1,320 $tCO_2$ |
| Carbon Sequestration per year | 681 $tCO_2e$ |
| Carbon Sequestration per month | 56.7 $tCO_2e$ |
| Anticipated Carbon Sequestration of COPE in 30 years | 18,338 $tCO_2e$ |

Carbon Sequestration calculation in the monitoring period 2013-2016

The first three models (described in Chapter 2) over estimated the AGB. For instance the AGB in 2014 was 10 ton/ha, 7.22 ton/ha and 3.85 ton/ha for model 1, model 2 and model 5 respectvely. In 2016, the estimation was 11.3 ton/ha, 6.87 ton/ha and 5.68 ton/ha for model 1, model 2 and model 5 respectvely. Therefore, we used the most conservative one, that is Giday et al (2013). The estimation from this model was found to be similar from the estimation made by the model developed by Rejou-Mechain et al (2017). The BIOMASS package in R developed by Rejou-Mechain et al (2017) (1) allows to retrieve and correct taxonomic data, (2) estimate wood density and its uncertainty (3) construct height diameter models which are important in extrapolating missing height measurements and (4) estimate above ground biomass and carbon at the stand level with the associated uncertainty. This function also has a built in error propagating function to correct measurement errors. Therefore, this model has been used for estimation of AGB and carbon for the reporting purpose.

Table 5 Values for Input Parameters

| Parameter | Value and justification |
|---|---|
| **Number of trees/ ha** | In the 1st block, there are **5632** trees/ha. In the 2nd block, there are **1090** trees/ha. The 3rd block has **2500** trees/ha. |
| **Growth (m3) per ha/a and net biomass growth (above ground)** | The growth rate per ha/a was estimated to be 2 $m^3$ in the first year and 2, 3, 5, 7 and 8 $m^3$ in the subsequent years. From year 6 onwards, the annual increment was estimated to stabilize at 8 $m^3$. Hence, the average annual increment was estimated to be 3.8 $m^3$ for the first 5 years.<br><br>The calculations presented for Block 1 *Ambo-ber Deldal (Gedelu Ser*) - the pilot exclosure - have a different setup: less fast growing trees, more natural regeneration, more bushes. Thus, most biomass increment from natural regeneration differs from Blocks 2 *Abayedur* and 3 *Terarye* were fast growing tree species and higher tree densities are present.<br><br>Since the allometric functions directly calculate biomass from shrub and tree sizes, biomass values are presented here.<br>Based on the most conservative models, the mean AGB in 2009 was 0.007±0.01 ton/ha. Mean above ground biomass was 3.85±3.5 ton/ha in 2014. The mean AGB in 2016 was 5.68 ± 5.03. ton/ha. The mean biomass increment in five years time was estimated to be 5.6 ton/ha. The mean annual increment of above ground biomass was 1.12 ton/ha.<br><br>In order to evaluate the assumptions in terms of annual increment made in the project proposal, the volume is calculated back from the AGB values.<br>Assuming a wood density of 0.46, this would result in an average annual increment of 1.7 $m^3$ per ha for the first five years and 3.98 $m^3$ for the subsequent two years. For the whole period of seven years, the average estimated annual increment was considerably higher (5.57 $m^3$) than the measured increment (0.8 $m^3$). The increase of increment of the last two years was exponential however and a further increase in annual increments is expected. In total, the lower annual increment is outweighed by the fact that larger areas were afforested than anticipated. These calculations are valid for Block 1 *Ambo-ber Deldal (Gedelu Ser*) which had few trees planted and most biomass increment from shrubs from natural regeneration. Blocks 2 *Abayedur* and 3 *Terarye* are more geared towards fast growing tree species and higher tree densities. For these blocks, the annual growth which was assumed in the beginning of the project can be maintained.<br><br>If only the data of the total area on which trees were planted from 2015 onward, Block 2 and 3, is used, we do not have monitoring data since the time was too short. Yet for these blocks, the annual growth which was assumed in the beginning of the project can be maintained: 8$m^3$ per ha/yr increment for future carbon storage.<br>The 8$m^3$ per ha increment will therefore be used as a working calculation until we have more precise estimates from plantations of 2015 and onwards. A nearby Eucalyptus plantation from the Amhara Forest Enterprise has reported a similar productivity of 8-11 $m^3$ perha.<br>After some years, during the next inventory we will have better estimates from all three exclosures of known age. |
| **Harvest($m^3$)** | Up to now there is no timber harvest from the exclosure |

| | |
|---|---|
| **timber/ ha** | |
| **Risk buffer (below ground biomass)** | The mean below ground carbon accumulation was estimated based on the assumption that 19-23% C is found in the roots, 16 - 31% in the soil organic layer (Kristensen et al. 2015). Therefore, we assumed the below ground biomass (BGB) contribution would be 50% of the AGB. |
| **Leakage** | No leakage is assumed in the project scenario |

**Table 6 Carbon sequestration calculation**

| Year | Project year | ha | No of trees | Increment m³ per ha/a | Increment in m³ total project | Removal of wood in m³ | Brushes and additional trees | Density | t wood for 79,5 ha less wood removal | Total tons of wood (AGB+ BGB) | **Total tons CO2 for 79,5 ha** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2012 | 1 | 3 | 400 | 2 | 6 | 0 | **not** | 0,46 | 3 | 4 | **6** |
| 2013 | 2 | 17 | 400 | 2 | 34 | 0 | **acounted** | 0,46 | 16 | 23 | **43** |
| 2014 | 3 | 79,5 | 400 | 3 | 239 | 0 | **in 8 m3** | 0,46 | 110 | 163 | **298** |
| 2015 | 4 | 79,5 | 400 | 5 | 398 | 0 | | 0,46 | 183 | 395 | **724** |
| 2016 | 5 | 79,5 | 400 | 7 | 557 | 0 | | 0,46 | 256 | 720 | **1.320** |
| 2017 | 6 | 79,5 | 400 | 8 | 636 | 0 | | 0,46 | 293 | 1.092 | **2.001** |
| 2018 | 7 | 79,5 | 400 | 8 | 636 | 0,3 | | 0,46 | 292 | 1.463 | **2.682** |
| 2019 | 8 | 79,5 | 400 | 8 | 636 | 0,3 | | 0,46 | 292 | 1.834 | **3.363** |
| 2020 | 9 | 79,5 | 400 | 8 | 636 | 0,3 | | 0,46 | 292 | 2.206 | **4.044** |
| 2021 | 10 | 79,5 | 400 | 8 | 636 | 0,3 | | 0,46 | 292 | 2.577 | **4.725** |
| 2022 | 11 | 79,5 | 400 | 8 | 636 | 0,3 | | 0,46 | 292 | 2.949 | **5.406** |
| 2023 | 12 | 79,5 | 400 | 8 | 636 | 0,3 | | 0,46 | 292 | 3.320 | **6.087** |
| 2024 | 13 | 79,5 | 400 | 8 | 636 | 0,3 | | 0,46 | 292 | 3.691 | **6.768** |
| 2025 | 14 | 79,5 | 400 | 8 | 636 | ***0,7*** | | 0,46 | 292 | 4.063 | **7.448** |
| 2026 | 15 | 79,5 | 400 | 8 | 636 | 0,7 | | 0,46 | 292 | 4.434 | **8.129** |
| 2027 | 16 | 79,5 | 400 | 8 | 636 | 0,7 | | 0,46 | 292 | 4.805 | **8.810** |
| 2028 | 17 | 79,5 | 400 | 8 | 636 | 0,7 | | 0,46 | 292 | 5.176 | **9.490** |
| 2029 | 18 | 79,5 | 400 | 8 | 636 | 0,7 | | 0,46 | 292 | 5.548 | **10.171** |
| 2030 | 19 | 79,5 | 400 | 8 | 636 | 0,7 | | 0,46 | 292 | 5.919 | **10.851** |
| 2031 | 20 | 79,5 | 400 | 8 | 636 | 0,7 | | 0,46 | 292 | 6.290 | **11.532** |
| 2032 | 21 | 79,5 | 400 | 8 | 636 | 0,7 | | 0,46 | 292 | 6.661 | **12.213** |
| 2033 | 22 | 79,5 | 400 | 8 | 636 | 0,7 | | 0,46 | 292 | 7.033 | **12.893** |
| 2034 | 23 | 79,5 | 400 | 8 | 636 | 0,7 | | 0,46 | 292 | 7.404 | **13.574** |
| 2035 | 24 | 79,5 | 400 | 8 | 636 | 0,7 | | 0,46 | 292 | 7.775 | **14.254** |
| 2036 | 25 | 79,5 | 400 | 8 | 636 | 0,7 | | 0,46 | 292 | 8.146 | **14.935** |
| 2037 | 26 | 79,5 | 400 | 8 | 636 | 0,7 | | 0,46 | 292 | 8.517 | **15.615** |
| 2038 | 27 | 79,5 | 400 | 8 | 636 | 0,7 | | 0,46 | 292 | 8.889 | **16.296** |
| 2039 | 28 | 79,5 | 400 | 8 | 636 | 0,7 | | 0,46 | 292 | 9.260 | **16.977** |
| 2040 | 29 | 79,5 | 400 | 8 | 636 | 0,7 | | 0,46 | 292 | 9.631 | **17.657** |
| 2041 | 30 | 79,5 | 400 | 8 | 636 | 0,7 | | 0,46 | 292 | 10.002 | **18.338** |
| **Total** | | | | | | | | | | **10.002** | **18.338** |

The calculation has been jointly developed with Centre for global Change and Sustainability at BOKU. The brown indicated cells are showing the monitored period. A soft copy of the monitoring Excel file can be downloaded from the site of the BOKU CO2 Compensation System.

## 5. Project impacts on Sustainable Development Goals

| | |
|---|---|
| 1 NO POVERTY | COPE project reduces poverty through creation of additional income and safer livelihoods. |
| 2 NO HUNGER | In 2017 Farmers in Woyiniye (63 farmers) and Woglo (57 farmers) have received for free 4,522 coffee plants, 1,296 Mangotrees and 598 Papayatrees. |
| 3 GOOD HEALTH AND WELL-BEING | COPE project support to diversify the nutrition basis of local farmers through bee keeping and other non timber forest products such as herbs. |
| 4 QUALITY EDUCATION | COPE project provided training on forest management for both villages forest in 2016. The training intends to help the committee to manage the exclosure by themselves. |
| 5 GENDER EQUALITY | According to local farmers, the current advisory and financial service system was found to be biased against resource poor and women headed households calling for better approaches that close the gender gap. In COPE project all farmers have an equal right to obtain support and trainings, without gender discrimination. |
| 6 CLEAN WATER AND SANITATION | Increasing forest cover has posivite effects on cleaning drinking water of springs and rivers. |
| 7 AFFORDABLE AND CLEAN ENERGY | After 5 years of the exclosure a share of the annual wood increment can be used for firewood. Hence the project supplies an affordable renewable energy. |
| 8 DECENT WORK AND ECONOMIC GROWTH | COPE project farmers were able to inrease income from selling grass as fodder for livestock through cut and carry arrangement. Farmers were also producing seedlings for sale within the community outside the community. |
| 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE | COPE project provided training on entrepreneurship skill and forest management for both villages forest committee in 2016. |

| | |
|---|---|
| 10 REDUCED INEQUALITIES | The first farmer meeting in Ambober took place on May 19 2013[4]. Stakeholder groups contributing to the participatory process comprise of model farmer, Kebele administrator and watershed committee, landless youths, elders, church people, married women, female household head and youth women, middle income farmer and land owner youth.<br>  <br>Pictures above: Birgit Habermann explaining the suggested procedures for the participatory process; Participants of village meetings at Woyineye, Woglo.<br>The objective of the meeting was an assessment of the current situation as well as a discussion of previous experiences with research projects and development programs. The main output of the meeting was an agreement to hold village wide meetings to discuss the feasibility of the project among all villagers. |
| 11 SUSTAINABLE CITIES AND COMMUNITIES | Overall the COPE project makes the communities more sustainable through reduction of soil erosion, creation of additional income, sustainable use of forest resources and many other factors. The participatory decisions making process is making communities more sustainable in a social manner, through transparency and fairness. |
| 13 CLIMATE ACTION | Carbon sequestration involves taking $CO_2$ out of the atmosphere for shorter or longer time period in order to decrease the effects of carbon emissions on climate change. In COPE we follow a concept for carbon sinks in exclosures. During monitoring period 1413 tCO2 had been sequestered. The overall project activity will sequester more than 15.000 tCO2. |
| 15 LIFE ON LAND | Land degradation impairs land productivity in the Ethiopian Highlands. This has severe consequences on the productivity and production process of the rural population. The most important counter-measures to halt this process have been plantations of trees and assisted natural regeneration, mainly in areas where access of livestock is reduced or excluded. |
| 17 PARTNERSHIPS FOR THE GOALS | COPE project is strengthening partnerships for SDGs both within Ethiopia but also worldwide. A constant exchange about project results and the permance of interdisciplinary research on the site and about the project disseminates the project results to a large number of stakeholders.<br>  |

[4] Details of the PRA findings are available as field report on the methods, for further information please contact the corresponding author.

**Other results of participatory process**

*"Inclusive development rests on the voluntary decisions of smallholders themselves to learn, innovate and influence change processes. They will only do so if they perceive that there are benefits to be gained"* (Francis et al, 2016, p.13).

There have been (and continuously shall be) village wide meetings that will discuss different steps of decision-making. Particular emphasis throughout the process is on conflict resolution and social mitigation. A smooth transition from the participatory process to a participatory forest management is necessary. At an informal meeting in Woynie in January 2015, the members of the forest management committee emphasised the importance of participation – they felt truly empowered by the process that led them to the decision on the exclosure. It was essential to them that they had the possibility to decide themselves, and that the researchers – in spite of some reservations – eventually accepted their decisions. This is also an important prerequisite for the development of ownership and sustainable management of the exclosures. The more salient it is to continue involving farmers to the same extent – the exclosures are set, trees have been planted, in the last years ownership on "their forest" come into being. In order to survive the next 25 years, participation is the key to success. The degradation of forests, their catchment and watershed areas, adjacent grazing and agricultural land due to human induced impacts affect the quality of the ecosystem thereby depleting the livelihoods of local communities and touch the social structures those are built on.



**Picture 3 : Farmer field workshop on forest management, Business plan and entrepreneurship workshop at GARC 2016**

Managing ecosystem services is evidence based on facts, indicators and deliverables. Each initiative starts with a plan and preconfigured priorities, often but not always based on the consolidation with beneficiaries or past achievements. Management priorities can be identified by multi-stakeholder interaction. Thus, getting the management priorities in line with (1) biodiversity conservation, (2) cultural and socio-economic values, and (3) sustainability of ecological processes to ensure a balance between conservation of natural resources and improvement of livelihood depends on participation of the concerned villagers.

Smallholder farmers, like all other entrepreneurs, need to be at the center of any intervention or project and be empowered so that they can participate actively as well as benefit from the process. In the COPE project, the benefits have been identified by the farmers themselves in the participatory process: Better living conditions through lasting, self-proponent development is based on participation. The role of interaction and learning among individuals and organizations is key for successful interventions. Thus, inclusion of all forest users and stakeholders in Ambo Ber lead to overcome the challenges of dialogic and emancipatory communication and ensure full engagement of all stakeholders.

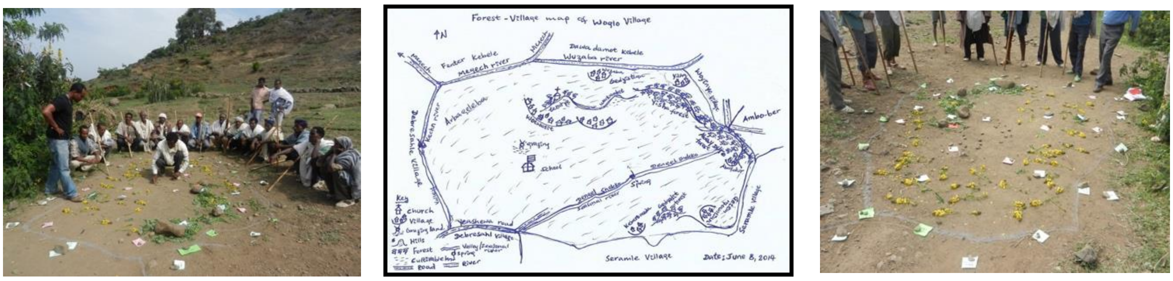
**Species preferences**

The main aim of this activity was to assess tree species preferences of the community and of current users of the communal land that was proposed to be exclosed by the community. The participants were farmers who represented different social groups. Free list and pair-wise ranking were the methods used to assess the tree preference of the community. The tree species were listed without considering their existence in the exclosure. After the completion of the species diversity research and the description of the species' availability in the exclosure, we understand which seedlings will be needed for planting. The justifications for the different species involve animal fodder, wild fruit, improving soil fertility, timber production, firewood and subjective perceptions such as attractiveness. The rankings by the participants at both sites were different due to differences in altitude and thus also in microclimate and growing conditions.

**Table 7 Short-listed tree species preferences for Woynie and Woglo**

| Rank | Woyineye | Woglo |
|---|---|---|
| **1** | Bahir Zaf (*Eucalyptus camaldulensis* ) | Wanza (*Cordia africana*) |
| **2** | Wanza (*Cordia africana*) | Weira (*Olea europaea subsp. cuspidata*) |
| **3** | Chibaha (*Ficus thoningii*) | Bahir Zaf (*Eucalyptus camaldulensis*) |
| **4** | Weira (*Olea europaea subsp. cuspidata*) | Chibaha (*Ficus thoningii*) |
| **5** | Bazira Grar (*Acacia abyssinica subsp. abyssinca*) | Bazira Grar (*Acacia abyssinica subsp. abyssinca*) |

The five shortlisted species in table above already provide a clue on the communities' needs and their species' preferences. *Bahir Zaf* (Eucalyptus) can be used as income to administer the exclosure, as it is a fast growing construction material. *Wanza* (*Cordia africana*) and *Bazira Grar* (*Acacia abyssinica*) also provide animal fodder for cattle, sheep and bees; additionally, fruits for human consumption are available.




**Picture 4: Forest social map discussion at Woglo and outcome. The facilitator thereafter drew the clear picture on a flipchart and presented it to the participants.**

### Forest social map

A range of actors are involved directly and/or indirectly in agriculture in the Ambo Ber area with different land use rights. For this reason, the community members identified the borders of village, the settlement patterns and the potential exclosure area in a facilitated process. The purpose of this activity was to enable a discussion on the scale and location of the exclosure among all stakeholders. Regarding the long term vision COPE has, the scale of the exclosure and possible new locations for additional exclosures were thoroughly discussed. Participatory mapping integrates people's knowledge and spatial information to address issues bound to a territory. As a first step, a map is drawn on the ground to demarcate the borders, in the next step different land coverages are identified and marked with rocks, pieces of paper, leafs, flowers etc.

## 6. Discussion – risks regarding permanence of carbon storage

| Risks | Mitigation strategies |
|---|---|
| Staff turn over | Ensure good communication to leading officials and both senior and junior staff members. |
| Time limitations of staff, Time conflicts for farmers | Planning of time allocation in close collaboration with farmenrs and project team members, Timely |
| Institutional administration regulations hamper implementation of activities | Combined steering committee / project team approach guarantees flexibility. |
| Active participation of the institutions through out the project | The project was planned and will be run and critically revised throughout the project with the active |
| Political change in Ethiopia | Adaption in consultation with policy makers is carried out |
| Low national acceptance of intervention logic | Embedding of the activities into national policies is assured; cooperation of concerned Ministries and |
| BOKU Carbon Offset System discontiuned | Longstanding cooperation on institutional and personal level can avoid an abrupt project collapse. |
| Woglo and Woyineye communities quit the COPE project partnership | Maintain the good relationship, consultation actual needs and report research findings |

# 7. Further reading

Weblinks:

- IPCC (2007) IPCC Fourth Assessment Report: Climate Change 2007, http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml
- CDM Methodologie AR-AM0003, http://cdm.unfccc.int/methodologies/DB/U3WW9YEC2X333WW8CPVQ6CGVY6IBPJ/view.html
- Climate, Community & Biodiversity Alliance (CCBA) Standard http://www.climate-standards.org/standards/index.html
- CDM Projekt 2712: Humbo Ethiopia Assisted Natural Regeneration Project, http://cdm.unfccc.int/Projects/DB/JACO1245724331.7/view
- CCBA Projekt: Abote Community-Managed Reforestation Project http://www.climate-standards.org/projects/
- Website of CO2 Compensation System: http://short.boku.ac.at/co2-kompensation.html

Literature:

Abiyu Hailu, A. (2012). The role of seed dispersal, exclosures, nurse shrubs and trees around churches and farms for restoration of ecosystem diversity and productivity in the Ethiopian Highlands. Institute of Forest Ecology,. Vienna, University of Natural Resources and Sciences.

Bell, S., S. Morse, et al. (2012). "Understanding stakeholder participation in research as part of sustainable development." Journal of Environmental Management 101: 13-22.

Cornwall, A. (2008). Unpacking ‘Participation’: models, meanings and practices. Community Development Journal 43(3):269-283.

Habermann, B. U. Felt, C. R. Vogl, K. Bekele and K. Mekonnen (2012) .Encounters and places: project negotiations in Galessa, Ethiopia. Multicultural Education & Technology Journal 6:4, 218-234

Habermann, B. (2014) .Ways of Knowing of Farmers and Scientists. Tree and Soil Management in the Ethiopian Highlands. PhD thesis, Sussex University, Institute of Development Studies.

Mekuria, W., Veldkamp, E., Haile, M., Nyssen, J., Muys, B., Gebrehiwot, K., (2007). Effectiveness of exclosures to restore degraded soils as a result of overgrazing in

Tigray, Ethiopia. Journal of Arid Environments 69, 270-284.

PROLINNOVA - Promoting Local innovations. (2009). Local Innovation and Participatory Innovation Development: some frequently asked questions. PROLINNOVA Working Paper 30.

Reynolds, TW. (2011). Institutional determinants of success among forestry-based carbon sequestration projects in sub-Saharan Africa. World Development, 40(3):542-554.

Roling, N. (1994). Creating human platforms to manage natural resources: first results of a research program. Montpellier, France, International Symposium on Systems-Oriented Research in Agriculture and Rural Development.

Scheuermeier, U., E. Katz and S. Heiland, (2004). Finding new things and ways that work. A Manual for Introducing Participatory Innovation Development (PID). LBL, Swiss Center for Agricultural Extension, 2004. 244 pp.

## 8. List of tables, figures and pictures

# 9. Appendix

**Appendix 1 - List of trees species in Ambo-ber watershed**

| Scientific Name | Family | Amharic Name | Life Form |
|---|---|---|---|
| *Acacia abyssinica* | Fabaceae | BazraGirar | Tree |
| *Acalypha fruticosa* | Euphorbiaceae | Nacha | Shrub/Tree |
| *Acanthus pubescens* | Acanthaceae | Kosheshile | Shrub |
| *Acokanthra schimperi* | Apocynaceae | Merenz | Tree |
| *Albizia amara* | Fabaceae | Sibkana | Tree/Shrub |
| *Albizia schimperiana* | Fabaceae | Sesa | Tree |
| *Allophylus abyssinica* | Sapindaceae | Embis | Tree |
| *Apodytes dimidiata* | Icacinaceae | Donga | Tree |
| *Bersama abyssinica* | Melianthaceae | Azamir | Tree |
| *Bridelia micrantha* | Euphorbiaceae | YenebirTifer | Tree |
| *Brucea antidysenterica* | Simaroubaceae | Abalo | Shrub |
| *Buddleja polystachya* | Loganiaceae | Atquar/Anfar | Tree |
| *Calpurnia aurea* | Fabaceae | Zigtta/Digtta | Shrub/Tree |
| *Canthium oligocarpum* | Rubiaceae | Dingayseber | Shrub/Tree |
| *Capparis tomentosa* | Capparidaceae | Gemero | Climber/Shrub |
| *Carissa edulis* | Apocynaceae | Agam | Shrub/Tree |
| *Celtis africana* | Ulmaceae | Kawoot | Tree |
| *Clausena anisata* | Rutaceae | Limich/Limbich | Shrub |
| *Clerodendron myricoides (Hoechst) R.Br.ex.Vatke* | Verbenaceae | Misirich | Shrub/Tree |
| *Clutia abyssinica* | Euphorbiaceae | Feyelefeji | Shrub |
| *Combretum mollie* | Combretaceae | Kollaabalo | Tree |
| *Cordia Africana* | Cordia | Wanza | Tree |
| *Croton macrostachyus* | Euphorbiaceae | Bisana | Tree/Shrub |
| *Dodonaea anguistifolia* | Sapindaceae | Kitkita | Shrub/Tree |
| *Dombeya torrida* | Sterculiaceae | Wulkifa | Tree |
| *Entada abyssinica* | Fabaceae | Ambelta | Tree |
| *Eucalyptus camaldulensis* | Myrtaceae | BahirZaf | Tree |
| *Euphorbia abyssinica* | Euphorbiaceae | Kulkual | Tree |
| *Ficus thonningi* | Moraceae | Chebaha | Tree |
| *Gardenia volkensii* | Rubiaceae | Gambilo | Tree |
| *Grewia bicolour* | Tiliaceae | Sumaya/Sefa | Tree/Shrub |
| *Grewia ferruginea* | Tiliaceae | Lenkuata | Tree/Shrub |
| *Jasminum grandiflorum* | Oleaceae | Tembelel | Climber/Shrub |
| *Juniperus procera* | Cupressaceae | YeabeshaTsid | Tree |
| *Justicia schimperiana* | Acanthaceae | Simiza/Sensel | Shrub |
| *Maesa lanceolata* | Myrsinaceae | Kurava/Kelawa | Tree/Shrub |
| *Maytenus arbutifalia* | Celastraceae | Atat | Shrub |

| | | | |
|---|---|---|---|
| *Nuxia congesta* | Loganiaceae | Anfar | Tree |
| *Olea europaea* | Oleaceae | Woyra | Tree |
| *Osyris quadripartita* | Santalaceae | Keret | Tree/Shrub |
| *Otostegia tomentosa* | Lamiaceae | Tinjut | Shrub |
| *Pittosporum viridiflorum* | Pittosporaceae | Ahot | Tree |
| *Podocarpus falcatus* | Podocarpaceae | Zigba | Tree |
| *Prunus africana* | Rosaceae | Homa | Tree |
| *Psydrax schimperiana* | Rubiaceae | Seged | Tree |
| *Pterollobium stellatum* | Fabaceae | Kentefa | Climber/Shrub |
| *Rhamnus staddo* | Rhamnaceae | Tedo | Shrub/Tree |
| *Rhus retinorrhoea* | Anacardiaceae | Talo/Tilem | Tree |
| *Rhus glutinosa* | Anacardiaceae | Embis | Tree |
| *Rhus vulgaris* | Anacardiaceae | Kamo | Tree |
| *Ricinus communis* | Euphorbiaceae | Chaqima | Shrub/Tree |
| *Rosa abyssinica* | Rosaceae | Kega | Shrub/Small Tree |
| *Rubusapetalus* | Rosaceae | Enjory | Shrub/Tree |
| *Rumex nervosus* | Polygonaceae | Embacho | Shrub |
| *Salix subserrata* | Salicaceae | Ahaya | Tree |
| *Schefflera abyssinica (Hochst.ex.A.Rich.) Harms* | Araliaceae | Getem | Tree |

**Appendix 2 - Inventory raw data, example pf PSP 13**

| Plot | xGPS | yGPS | Elevation | localname | dbh(cm) | H(m) |
|---|---|---|---|---|---|---|
| 13 | 339298 | 1386167 | 2064 | embes | 4,4 | 5,7 |
| | | | | embes | 4,2 | 5,1 |
| | | | | embes | 3,9 | 4,5 |
| | | | | embes | 3,5 | 3 |
| | | | | embes | 4,9 | 6,8 |
| | | | | embes | 4,6 | 5,9 |
| | | | | embes | 2,8 | 3,4 |
| | | | | embes | 3,1 | 3,5 |
| | | | | nechgirar | 8 | 6,4 |
| | | | | nechgirar | 6,3 | 5,8 |
| | | | | nechgirar | 7,5 | 6,4 |
| | | | | ketketa | 4,3 | 3,2 |
| | | | | ketketa | 2,8 | 3,2 |
| | | | | checho | 3,8 | 3,6 |
| | | | | woira | 10,5 | 6,6 |
| | | | | dedeho | 4,3 | 4,5 |
| | | | | dedeho | 3,8 | 4,3 |
| | | | | dedeho | 3,2 | 3,3 |

**Appendix 3:** Parameter values for plant families for the Parent (2000) models

| Family | Model | Parameters | | | Remark |
|---|---|---|---|---|---|
| | | bo | b1 | b2 | |
| *Fabaceae* | 1 | -0.5385 | 0.5341 | 1.6 | |
| | 2 | 0.9511 | 0.0295 | 2.4 | |
| | 3 | 230.98 | 1.47 | - | Cleemput et al 2013 |
| *Apocynaceae* | 1 | 0.0345 | 0.0377 | 3.3 | |
| | 2 | 0.1788 | 0.0319 | 2.6 | |
| | 3 | 0.3658 | 0.1144 | 2.2 | |
| *Euphorbiacea* | 1 | 0.3658 | 0.1144 | 2.2 | |
| | 2 | 0.2972 | 0.1588 | 2.2 | |
| | 3 | 0.3679 | 0.0459 | 2.5 | |
| *Sapindaceae* | 1 | 0.3989 | 0.0126 | 2.9 | |
| | 2 | 0.3197 | 0.0383 | 2.6 | |
| | 3 | 0.2313 | 0.1073 | 2 | |
| *Lamiaceae* | 1 | 0.3989 | 0.0126 | 2.9 | |
| | 2 | 0.1317 | 0.1075 | 2.4 | |
| | 3 | 45.8 | 2.26 | - | Cleemput et al 2013 |
| *Anacardiaceae* | 1 | 0.0281 | 0.1505 | 2.3 | |
| | 2 | 0.0038 | 0.6092 | 1.5 | |
| | 3 | 0.0884 | 0.0331 | 2.8 | |
| *Rosaceae* | 1 | 0.0038 | 0.6092 | 1.5 | |
| | 2 | 0.3658 | 0.1144 | 2.2 | |
| | 3 | 0.0281 | 0.1505 | 2.3 | |
| *Astreaceae* | 1 | 0.3197 | 0.0383 | 2.6 | |
| | 2 | 0.3658 | 0.1144 | 2.2 | |
| | 3 | 0.1317 | 0.1075 | 2.4 | |
| *Celastraceae* | 1 | 0.2685 | 0.0492 | 2.3 | |
| | 2 | 0.1317 | 0.1075 | 2.4 | |
| | 3 | 0.2451 | 0.0271 | 2.6 | |
| *Oleaceae* | 1 | 0.6806 | 0.0422 | 2.7 | |
| | 2 | 0.1517 | 0.1518 | 2.3 | |
| | 3 | 0.3197 | 0.0383 | 2.6 | |
| *Primulaceae* | 1 | 0.3658 | 0.1144 | 2.2 | |
| | 2 | 0.3197 | 0.0383 | 2.6 | |
| | 3 | 0.1517 | 0.1518 | 2.3 | |
| *Polygonaceae* | 1 | 0.3658 | 0.1144 | 2.2 | |
| | 2 | 0.0038 | 0.6092 | 1.5 | |
| | 3 | 0.3197 | 0.0383 | 2.6 | |
| *Malvaceae* | 1 | 0.5983 | 0.0017 | 3.7 | |
| | 2 | 0.1532 | 0.2018 | 1.9 | |
| | 3 | 0.3658 | 0.1144 | 2.2 | |
| *Combretaceae* | 1 | 0.0922 | 0.1540 | 2.2 | |
| | 2 | 0.1135 | 0.1140 | 2.3 | |
| | 3 | 0.3658 | 0.1144 | 2.2 | |
| *Melianthacea* | 1 | 0.3197 | 0.0383 | 2.6 | |
| | 2 | 0.3658 | 0.1144 | 2.2 | |
| | 3 | 0.1189 | 0.0011 | 4 | |
| *Hypericaceae* | 1 | 0.3197 | 0.0383 | 2.6 | |
| | 2 | 0.0038 | 0.6092 | 1.5 | |
| | 3 | 0.0281 | 0.1505 | 2.3 | |

**Appendix 4: Financial plan and expenditures of the project**

| | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | Total |
|---|---|---|---|---|---|---|---|
| Budget plan ARARI | € 40,00 | € 6.728,00 | € 6.163,00 | € 3.653,00 | € 3.653,00 | € 3.653,00 | |
| Budget plan CDR | € 1.769,04 | € 5.694,00 | € 9.473,10 | € 9.306,70 | € 4.307,10 | € 2.957,50 | |
| Received from gWN | | € 14.463,04 | € 14.473,10 | 12.959,70 € | 7.960,10 € | € 6.610,50 | € 56.466,44 |
| Funds transfered to ARARI | | € 7.000,00 | € 5.000,00 | € 2.559,86 | € 3.000,00 | € 3.000,00 | € 20.559,86 |
| Financial reports by ARARI | | € 3.639,78 | € 5.026,83 | € 7.653,59 | € 1.947,27 | | € 18.267,47 |
| Funds used by CDR | € 1.769,04 | € 5.694,00 | € 9.473,10 | € 9.306,70 | € 4.307,10 | | € 30.549,94 |

**Appendix 5 Work plan for the participatory process**

Activities have been accomplished within 16 months. The groups are repeatedly visited by project team members, who also apply Participatory Rural Appraisal (PRA) methods[5] such as resource mapping with time lines (before, now and future scenarios).

| No. | Activities | Participants |
|---|---|---|
| 1 | Free list: What is tree, What is forest (to know farmer's perception) | All groups |
| 2 | Visionary map (before, now and future with new exclosures (time lines) – temporal and spatial) | Elders |
| 3 | Trend analysis (trends, visions, scenarios) | Elders |
| 4 | Root causes identification for forest degradation | All groups |
| 5 | Suggested solutions for forest degradation | All groups |
| 6 | Identification of user group (How each group affected, their role in the future and befitted from the project) | All groups |
| 7 | Resource mapping (border demarcation and to know the potential exclosure areas) | Selected farmers from all groups |
| 8 | Decision on extent and location of the exclosure | All groups |
| 9 | Second village wide meeting | Community |