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Community-based forest monitoring using mobile devices in Kafa, Ethiopia

A study on the potential of smart phones for forest monitoring in Kafa

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Foreword

This minor thesis is written for the Master Geo-Information Science at the Wageningen University. The master study focuses on the application of geo-information for environmental problems. This research topic, mobile based community forest monitoring, falls directly within the scope of the master study. The research investigates the overall potential of mobile devices for community-based forest monitoring. This includes the technical aspects of the monitoring as well as the socio-economic aspects.

After preparations in Wageningen, I conducted research from September till December 2013 in Kafa, Ethiopia. These months in Ethiopia were instructive and interesting. This was my first research, where a technical concept was applied in the real world. I have gained a lot of insight in the difficulties which might occur when trying to implement the smart phone based monitoring in the real world. The concept seems rather simple when designed on paper; however in the real world practical issues arise.

I would like to thank several persons for their help during my research in Kafa. First of all, I want to thank Muluken Mekuria for his help during the field research. Without his help, this study would not have been possible. Mulukens experience within this working field and his connections were really valuable. Secondly, I would like to thank the German Nature and Biodiversity Conservation Union (NABU) and in particular Mesfin Tekle, Bekele Haile, Svane Bender and Daniela Tunger for facilitating this research. Thirdly, I would like to show my gratitude to the Kafa Development Association and Christian Sefrin for hosting me in the guesthouse. Next to this I want to thank my two supervisors, Arun Pratihast and Benjamin Devries, who gave me the opportunity and trust to conduct this study in Kafa.

Stefan Arts

Abstract

Ethiopia has set its goals on becoming a middle age income country in 2025 via the Climate Resilient Green Economy (CRGE) strategy. One of the four main pillars of the CRGE is to protect and re-establish forests for their economic and environmental value. This is established by applying the Reduced Emissions from Deforestation and Forest Degradation in Developing Countries (REDD+) framework. Next to Remote Sensed forest monitoring, field monitoring is required for the REDD+ framework.

This thesis evaluates the potential for mobile based forest monitoring by local Participatory Forest Management (PFM) members in the Kafa Biosphere reserve for the REDD+ framework applied by the Ethiopian government as part of the Climate Resilient Green Economy (CRGE). The potential of mobile device for community-based forest monitoring is relatively unexplored within scientific research. On local level, mobile based monitoring raises the motivation of PFM members to conduct monitoring and it can make monitoring easier compared to conventional monitoring. On institutional level, mobile based monitoring has the potential to improve two important shortcomings of community-based monitoring (CBM). By applying a standard data collection procedure, the data credibility can be raised. Secondly, sharing of acquired data becomes easier.

Several research methods are used to evaluate the potential for mobile based forest monitoring. Firstly, interviews are conducted with local experts and questionnaires are held amongst local community members and rangers to get insight in the study area and Participatory Forest Management (PFM) communities. Data triangulation is applied by conducting participatory observations throughout the whole research. Afterwards training on operating a mobile device for forest monitoring is conducted with 12 selected PFM members from one community. For this purpose a manual is created in Amharic and the Amharic language is enabled for the used mobile devices for reading and writing within the used Forest Disturbance Monitoring Form (FDMF). After the first day of training four persons are selected for another day of training followed by monitoring by the PFM members. Acquired data by PFM members is compared with expert data who validated all monitored plots after the monitoring.

After two days of training the selected community members are capable of conducting mobile based forest monitoring autonomously. During the monitoring sessions they monitored 41 locations, for which they captured the vast majority of the possible media. This indicates that the community members are technically capable of conducting forest monitoring. However, the forest monitoring results are low. Three reasons are indicated as the potential cause for the low forest monitoring results. First, training is conducted on operating the mobile devices. No designated training on forest monitoring is conducted. Secondly the high extrinsic motivation could have affected the forest monitoring results. Thirdly, the results are most likely affected by the subjectiveness of the forest monitoring process.

The low forest monitoring results are the main challenge for implementation of mobile based community forest monitoring for the national REDD+ framework. Furthermore, the expected cost reduction compared to expert monitoring is predicted to be lower than initially indicated, due to high expected payments by the community members. On local scale, the data usage is foreseen as the main bottleneck for implementation. The data infrastructure for and knowledge on data usage is lacking. Implementing the infrastructure on national level is relatively easy, since it is only required on several locations. However, on local level multiple locations require the knowledge and infrastructure.

Key words

Community-based Monitoring, PFM, Kafa, mobile device

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1. Introduction

Currently Ethiopia is amongst the world's lowest ten countries with respect to their Gross Domestic Product (GDP) per capita (CIA 2013, WorldBank 2013). The GDP per capita is estimated around 300 euro per year (Geiger 2013). However, Ethiopia's economy is one of the fastest growing economies in the world (Geiger 2013). About 43% of the population was still under the age of 15 years in 2012 (UN 2013), who will generate a boost for the economy in the coming years. It is expected that Ethiopia reaches a middle income status by 2025, for which agricultural and industrial growth are needed (FDRE 2011, Geiger 2013). Ethiopia wants to achieve that status by creating a Climate-Resilient Green Economy (CRGE), meaning that they want to achieve economic growth in a sustainable way (FDRE 2011).

The Climate-Resilient Green Economy strategy is based upon four main pillars, by which the expected greenhouse gas emissions due to the economic growth can be reduced. These four pillars focus on increasing the efficiency in agriculture and land use, developing renewable energy sources, applying modern technologies in industry and transport and increasing carbon sequestration in forestry.

1.1 REDD+

Currently, forest degradation and deforestation are accountable for about 30 per cent of the greenhouse gas emissions in Ethiopia (FDRE 2011). The forest cover in Ethiopia has decreased from 40% to approximately 3% in the last decades (Cheng, Hiwatashi et al. 1998). One of the four main pillars from the CRGE strategy focuses on increasing the carbon sequestration by protecting and recovering forest areas. For this purpose, Ethiopia is in the process to implement the Reduced Emissions from Deforestation and Forest Degradation in developing counties framework (REDD+) to create a climate resilient green economy since 2011 as part of the CRGE (FDRE 2011, Sima 2011). At this moment Ethiopia is in the second phase of the implementation. The REDD+ framework is intended to reduce emissions from deforestation and forest degradation by creating sustainable management, forest conservation and enhancement of carbon stocks.

Part of the REDD+ framework is the Measurement, Reporting and Verifications (MRV) component, in which field and remote sensed data are combined to produce up to date carbon stocks and emission levels. Deforestation and forest degradation monitoring can be conducted in several ways. Remote Sensing (RS) is one of them. RS is a suitable for deforestation monitoring, however it has difficulties to detect forest degradation (Danielsen, Skutsch et al. 2011) or changes on small scale. MRV is required for the REDD+ framework on a national, sub-national and local level. Furthermore, it is required that local communities are involved in forest monitoring activities. Community-based monitoring (CBM) of forests reduces the costs of MRV for the government and can generate income for local communities. Using local experts instead of the local community, doubles the costs for measuring (Pratihast, Herold et al. 2012). A second advantage of this method is the usage of local knowledge of the forests.

Currently there are three REDD+ projects running in Ethiopia in the Oromia, Bale and Kafa region. The oldest implemented REDD+ projects in Ethiopia is in the UNESCO Kafa Biosphere reserve in the Southern Nations, Nationalities, and Peoples' Regional State (SNNPRS). This

project is implemented since 2009 by the German Nature and Biodiversity Conservation Union (NABU) in cooperation with the local and regional government (NABU 2013).

The main goal of a UNESCO biosphere reserve coincides with the CRGE strategy. The goal is to generate sustainable development by using the effort of local communities in combination with science. Each biosphere reserve has as role to conserve plant and animal genetic resources. Furthermore, it allows ecosystem management, conservation and monitoring of change. A Biosphere Reserves is created by a country and recognized and supported by UNESCO (Batisse 1982).

1.2 Community-based monitoring

Five types of monitoring can be distinguished based upon the external professional input. The range goes from completely externally driven to a full autonomous local monitoring system (Danielsen, Burgess et al. 2009). When the monitoring process is completely based upon professional input, the system is not classified as CBM. CBM is monitoring on local scale conducted by local people, where the local government is most often directly involved.

When training is conducted with community members, the community data can be used as reliable data source of which the data quality is comparable with expert data (Danielsen, Skutsch et al. 2011, Palmer Fry 2011, See, Comber et al. 2013). Furthermore, community-based monitoring creates an increase in the relevance of the monitored locations (Palmer Fry 2011, Pratihast, Herold et al. 2012).

CBM is applied in several countries in the world on different monitoring topics. As example: community wildlife monitoring is conducted in China, fish populations are monitored by community members in Zambia and wetland degradation is monitored in Madagascar (Danielsen, Burgess et al. 2009). Next to this CBM is applied in several locations for measuring in the REDD+ MRV component. Several studies have been conducted about the potential for CBM for the REDD+ framework and have shown that community members are capable of conducting forest monitoring (Danielsen, Skutsch et al. 2011, Palmer Fry 2011, Pratihast, Herold et al. 2013).

1.3 CBM for REDD+

CBM has two main benefits compared to expert monitoring. CBM monitoring is seen as a more cost efficient method of monitoring compared to expert monitoring (Palmer Fry 2011). It is estimated that expert monitoring is twice as expensive as community monitoring (Pratihast, Herold et al. 2012). Local and recent knowledge about changes within the forest are used to conduct forest monitoring (Lotsch 2012, Pratihast, Herold et al. 2013).

Two main challenges for implementation of CBM is the lack of confidence in the data collection procedures, undermining the data credibility, and data sharing between local community members and governmental or international institutions (Palmer Fry 2011, Pratihast, Herold et al. 2013). Mobile devices may facilitate data collection procedure, data sharing and might increase the data credibility of national use (Pratihast, Herold et al. 2012). These devices can contain a user-friendly digital field form and provide direct central saving and analysis of the data. This might reduce data entry error, save data processing time, facilitate easy sharing and it can raise the motivation of local community members.

For current community-based forest monitoring permanent plots are established and mapped. Afterwards forest parameters consisting of the tree Diameter at Breast Height (DBH), tree height, forest strata, number of cut trees and vegetation species are captured out of which the carbon stocks can be computed (Larrazábal and Skutch 2011, Larrazábal, McCall et al. 2012). Required equipment to conduct CBM are a GPS, camera, compass and measuring tape, together with a clipboard, pen and paper to note down each measurement (Verplanke 2009, Walker 2011).

Currently phones are introduced within the community-based monitoring field. One study proposes using the SMS function of cell phones for easy data transfer using frontline forms (Brewster, Bradley et al. 2013). A different approach for community-based monitoring is proposed in two papers, which both use Google Open Data Kit (ODK) for data collection (Calo 2012, Pratihast, Herold et al. 2012, Pratihast, Souza Jr et al. 2012). Both propose an integrated system for forest monitoring using a smart phone with GPS and camera function, which makes the system suitable for forest monitoring. Both monitoring mobility and monitoring of recent disturbances gain benefit from the usage of mobile device (Pratihast, Herold et al. 2012). The proposed systems are tested in Vietnam and Mexico, where it showed that community members can collect data of which the quality is comparable with expert data (Calo 2012). Furthermore the system was more effective in detecting small scale disturbances than via remote sensing (Pratihast, Herold et al. 2012).

1.4 Forest monitoring in Kafa

NABU rangers are conducting mobile based forest monitoring using the data collection method as described in (Pratihast, Souza Jr et al. 2012) since the beginning of 2013. The NABU rangers are former Development Agents from the Department of Agriculture and Development (DoAD) and already have experience with forestry. The current monitoring system is best described according to the external professional input as “Collaborative monitoring with external data interpretation” (Danielsen, Burgess et al. 2009).

One method introduced in the Kafa reserve to promote sustainable development is Participatory Forest Management (PFM). The first PFM location in Ethiopia was introduced in the Kafa region in October 2003 by Farm Africa and SOS Sahel (Adugma 2003). Currently NABU is the main NGO initiating and supporting PFM locations in the Kafa region. The PFM method enables forest stakeholders to have a voice in the management of a forest and allow them to use specific forest products. The PFM structure is meant to protect the forests by sustainable usage of it and to support the livelihood of the communities who have benefit of this process (Winberg 2010). The Kafa reserve currently houses 76 PFM locations, of which 53 mapped PFM locations can be found in Figure 2.

Next to monitoring by rangers, forest monitoring is conducted by PFM members on a continuous basis. PFM monitoring is based upon the idea that the local communities have more knowledge of the local forests than experts. Next to this, local communities have a greater interest in sustainable forest management than governmental organizations, because they are dependent of the forest. Monitoring the forest change is an important aspect of forest management. When the change is not monitored, it is not possible to adapt

policy towards the current problems. Forest monitoring makes it possible to review the policy.

1.5 PFM assessment

Five aspects are important for the functioning of a PFM (Fröde and Masara 2007, Danielsen, Burgess et al. 2009, Stickler, Nepstad et al. 2009, Skutsch, Torres et al. 2011); all of these aspects influence the monitoring proficiency of a local community. Insight in these aspects is required before involving a community in monitoring. When one or more levels are insufficient, training on these aspects is required before involving the communities in monitoring. Otherwise, the PFM community cannot conduct monitoring as desired. The five aspects are:

1. Benefit

Benefit is the financial aspect of monitoring. Monitoring takes time and therefore costs money for the experts. On the other hand, PFM is seen as an effective way to reduce costs and increase reliability of forest monitoring data on a large scale and generates income for local communities (Skutsch, McCall et al. 2009, Danielsen, Skutsch et al. 2011, Palmer Fry 2011).

2. Technology

Technology helps local people to acquire data in an easy and effective way (Pratihast, Herold et al. 2012). The intended technology should be available or made available to enable monitoring. When a new technology is introduced it is important that the local community has proficient skills in using the technology.

3. Capacity

Capacity consists of the skills which are needed next to technological skills in order to conduct the monitoring. This includes literacy, language and knowledge on forest monitoring. When they are different than anticipated on, monitoring becomes impossible. As example; when a measurement form is in English, but the local community can only read Kafinoono, the form is redundant.

4. Motivation

Motivation is the willingness to conduct monitoring. Motivation directly influences the monitoring results. A low motivation results in a low amount of measurements with a lower reliability. A high motivation will result in more measurements with a higher accuracy. Furthermore a high motivation raises the willingness to increase the level of the other aspects.

5. Awareness

This addresses the awareness within the communities about the state of the forest, the use of the forest, their need for the forest and the economic value of the forest. Awareness is based upon the reasons why monitoring is needed. Motivation will be lower when there is no awareness.

1.6 Problem Description

Currently, NABU rangers are conducting forest monitoring on the ground in the Kafa reserve. Acquisition of field data throughout the whole Kafa region by experts is expensive. The PFM structure can act as a cost effective method to acquire ground truth data for local level MRV within the whole of Kafa. However, at this moment it is not yet known if the PFM communities in Kafa are ready to conduct the monitoring for the REDD+ legislation. The communities might be unable to monitor, because of shortcomings in one of the five aspects (Benefit, Technology, Awareness, Capacity, and Motivation).

Introducing mobile devices for PFM members in the Kafa biosphere reserve might encounter several difficulties such as lower technical infrastructure and lower technical capacity among the people. This study investigates the use of mobile devices for participatory forest monitoring in the Kafa region in Ethiopia. It includes an analysis of the possible problems with introducing mobile devices. The overall objective of this study is to test the use of mobile devices for participatory forest monitoring in Kafa, Ethiopia. The main research question within this research is as followed:

Can the use of mobile device by PFM communities improve the forest monitoring in the Kafa Biosphere Reserve?

This research question will be answered by the usage of the following five sub question:

1. How does the PFM structure function in Kafa?
2. What activities regarding forest monitoring can the local community do and not do?
3. What can be the benefits and challenges of using mobile devices for forest monitoring?
4. What assistance do local communities need to carry out mobile device based forest monitoring?
5. Can the local communities gather valid forest monitoring data?

The report continues with a description of the methods, describing the study area, data collection methods and the data analysis. Acquired results are described in the results section, followed by the discussion and conclusion. The chapter describing the recommendations for future research finalizes the report.

2. Methodology

This section describes the methods used in this study to answer the research questions. First the study area is described in section 2.1, followed by a description research strategy in section 2.2. This section first describes the data collection methods including the used mobile device, followed by the data analysis section.

The study can be roughly divided into two parts. A schematic overview of the research setup can be found in Figure 1. Within the first part information about the PFM in the Kafa Biosphere Reserve is gathered to answer the first four sub questions, represented by the blue box in Figure 1. Afterwards the research focuses on enabling the PFM to use a smart phone to conduct forest monitoring by using the knowledge and insight gained in the first part of the study to answer the fifth sub question, represented in the green box in Figure 1. The training needs for the PFM members are based upon information gathered about the PFM.

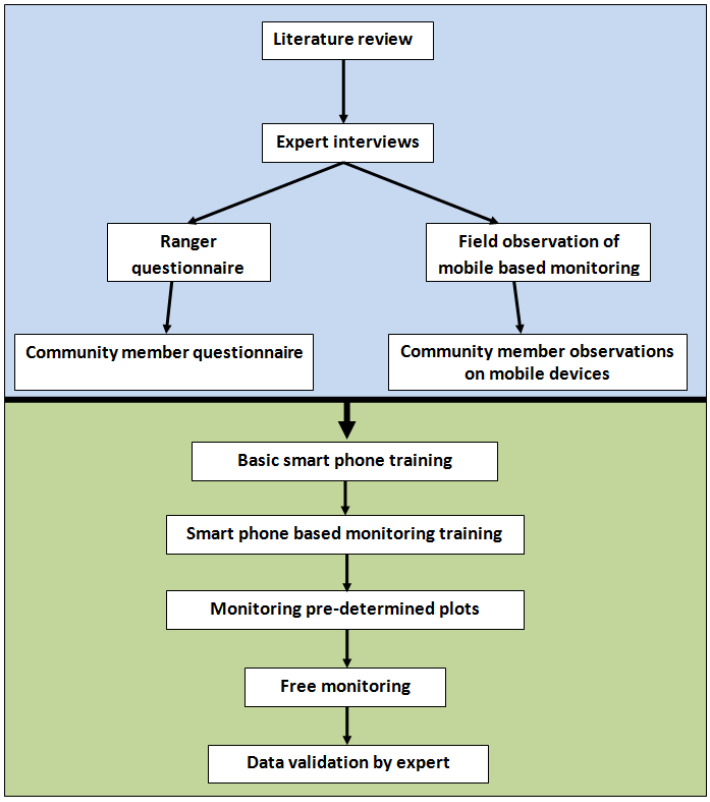

Figure 1: Schematic overview of the methodology. The blue box represents steps gathering information on PFM monitoring in Kafa. Within the green box, steps conducted to review the monitoring capacity of the PFM members are shown.

2.1 Study area

This section describes the study area. The study is conducted in two PFM locations within the Kafa Biosphere reserve. First general information is given about the Kafa reserve overall, secondly the main deforestation drivers will be explained. Finally the two PFM locations will be clarified.

The Kafa Biosphere reserve

The Kafa region in the Southern Nations, Nationalities, and Peoples' Region (SNNPR) province in Ethiopia is entitled as a biosphere reserve in 2010 (UNESCO 2010). The Kafa biosphere consists of four main zones; the Core zone, the Buffer zone, the Transition zone and Candidate Core zone. The four zones are seen in Figure 2. The total area of the Kafa biosphere reserve is 760.114 ha, the core zone consists of 41.391 ha, the buffer zone is 161.427 ha, the Transition zone is 337.885 ha and the Candidate Core zone is 219411 ha. About 56% of the total reserve is covered with forest. The main ecosystem in the Kafa region is Sub-afro alpine with moist evergreen mountain cloud forest. The altitude ranges from 500 meters to 3350 meters above sea level. The core zone of the Kafa biosphere reserve consists of 11 protected forest areas spread over the biosphere reserve.

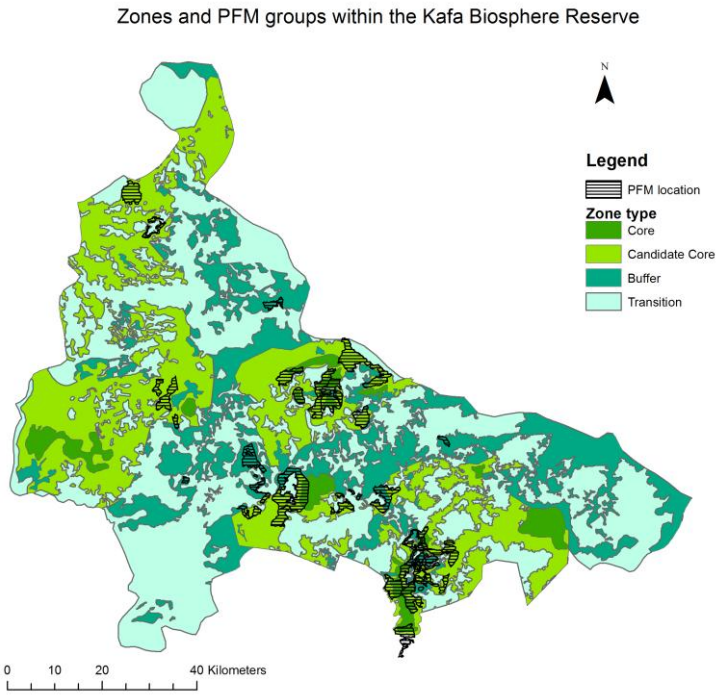

Figure 2: The four zone types and the PFM locations within the Kafa Biosphere reserve.

A lot of natural biodiversity can be found within this area. About 300 different faunal species live in the reserve of which approximately 60 are mammals and about 200 are bird species(Berhan 2008). Several species of monkeys, two different species of jackals and leopards are abundant in the reserve. Even lions and hippopotamus are seen in the area. Next to this, 8 snake types have been found in the reserve (Berhan 2008). Due to large altitude differences a complex vegetation structures is abundant in the region. Evergreen

mountain forests and grassland can be found on the higher altitudes, while on lower altitudes Afromontane moist evergreen broadleaf forests can be found.

Another name for the Afromontane forests in the Kafa region is Ethiopia's green lungs. This name emphasizes the importance for Ethiopia. Because of evapotranspiration by vegetation and the altitude, they ensure rainfall in the region which provides water for several rivers. Therefore deforestation of this area can change the water household of Ethiopia (NABU 2013).

Coffee is an important export product of Ethiopia. Ethiopia is globally the fifth large coffee exporter of the world. Nineteen percent of the Ethiopia's export consists of coffee export. For comparison this is only two percent less than the main export product gold (CIA 2013, TradingEconomics 2013). The well known Coffea Arabica coffee species has its origin in the Kafa forests (Schmitt and Grote 2006). It is estimated that the Kafa region produces about 5000 different coffee species (NABU 2013) and are part of the Kafa forest ecosystem. The current coffee industry is based upon only two coffee species (Coffea Arabica and Coffea Robusta). The international coffee market is looking for coffee plants which are capable of being grown outside the current optimal conditions. Breeding these plants is difficult, because at this moment only two species are grown. The coffee variety within Kafa can have a big contribution to this demand, because of the large genetic diversity (Schmitt 2006).

Forest Change Process in Kafa Biosphere Reserve

Despite the biodiversity and importance of the forest, the forest cover has decreased dramatically over the last decades in Ethiopia. Within the last decades the total forest area in Ethiopia decreased from about 40% to about 2% nowadays (Cheng, Hiwatashi et al. 1998).

This decrease in forest area stands in connection with the population growth in Ethiopia (Reusing 2000, Dresen 2011). Currently about 660 thousand people live in the Kafa region of which 92% live in rural areas. In the 1980's a resettlement of Ethiopia's inhabitants was conducted (Reusing 2000). About 50 thousands households were moved to the former Kafa region which include parts of Jimma and Maji zone (Stellmacher and Wannseeforum 2005), which further increased the population pressure.

The resettlement and the population growth can be seen as the main indirect factor for the forest cover decrease. Three deforestation drivers can be distinguished based upon the population increase. Firstly, more agricultural and housing land is needed. This often goes along with overgrazing of agricultural land and forests by livestock (Lemenih 2008, Dresen 2011). Secondly, more wood is needed to support the fuel wood demands. (Reusing 2000). It is estimated 70% of Ethiopia's energy demands comes from fuel wood (Lemenih 2008).Thirdly, wood is needed for construction material. Currently illegal cutting of trees and exporting of their stems for construction demands forms a threat to the forest. This is remains possible because of improper policies (Reusing 2000).

Two other reasons can be addressed next to the ones caused by the population increase. First the governmental support for coffee investment areas decreases the forest biodiversity. The coffee plant requires that the understory of the forest is removed and the upper story is thinned, which decreases the biodiversity. The coffee investments areas are

possible due to the land ownership regulations in Ethiopia. According to legislation the state owns all the land. This creates the second problem, which is that agriculture is a more attractive method for land usage than forestry.

Selected PFM

Although this study tries to establish the potential use of mobile device for PFM monitoring in the Kafa region, only two PFM locations are used during this research. Due to time limitations and transportation difficulties it is not possible to incorporate more PFM sites.

Table 1: Basic information about the selected PFM sites

	Kahin	Baka
Woreda	Decha	Gimbo
Kebele	Gedam	Michiti
PFM members	104	110
PFM area (Ha)	256	760
Year of establishment	2006	2005

A purposive sampling scheme is used to select two PFM, based upon experts information (Russel Bernard 2006). The selected PFM are the Kahin and Baka PFM of which the Kahin PFM is the least technical developed. Both PFM are located on approximately half an hour drive from Bonga and can both be described as rural areas. The Baka PFM is located further from the main road, but is easier to reach because of better transportation. Basic information about the selected PFM sites can be found in Table 1, the locations of both PFM locations can be found in Figure 3.

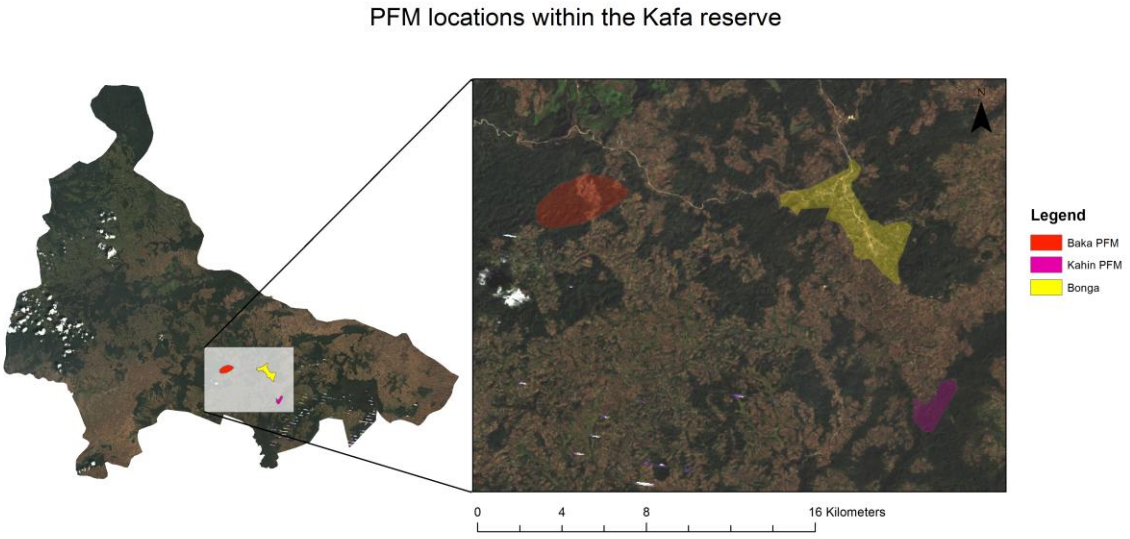

Figure 3: Locations of the city Bonga and the two PFM locations used for this study.

2.2 Research Strategy

For data acquisition about the PFM an ethnographic research design with a top down approach is applied (Moore 2013). This is combined with different research techniques to create data triangulation to ensure the internal validity of the research. Information and gained knowledge from each step is applied in the next research step. Throughout the whole research direct observations and participatory observations are used to get better understanding on smart phone possibilities within the Kafa Biosphere reserve.
Training is conducted with 12 PFM members on smart phone monitoring followed by real monitoring by 4 selected PFM members to achieve insight in the monitoring capacity of the PFM members. The conducted research methods are described in the section below, followed by the data analysis section which explains where the acquired data is used for.

Data collection methods

Several different research methods are applied for this study as can be seen in Figure 1. All applied research methods are described below. It includes a description of the used mobile device and collection form. The data usage and analysis of the different research methods is described in the next section.

a. Interviews

Semi-structured interviews, interviews following a topic list but leaving space for other questions (Russel Bernard 2006), are conducted with experts on the PFMs in Kafa to get an initial insight on the research topic and study area. The interviews are conducted at interviewees working office, to ensure that they can talk freely. A semi-structured approach is adopted to ensure that all topics are addressed, but also to leave room for other topics (Russel Bernard 2006). Appendix 1 shows the list of interviewees. The topics covered during the interviews can be found in appendix 2. The interviews are conducted to provide information about the first four sub questions.

b. Participatory Observations

Throughout the whole study observations are conducted about the usage of mobile devices within the study area, the observations are an important tool to validate and interpret the acquired information during other research techniques. Furthermore they provide information for the third and fourth research question. Observations are carried out with NABU rangers, PFM members and other inhabitants of the Kafa region.

c. Questionnaires

Two questionnaires are conducted for this study. First a questionnaire with open-ended questions is held amongst the NABU rangers, to establish their experiences with the usage of smart phones for deforestation monitoring. This qualitative method is used to get all experiences from the rangers with smart phone based monitoring and not limit them to given options (Russel Bernard 2006). The questionnaire gives insight in the third and fourth sub question. The questionnaire can be found in Appendix 3.

Afterwards a closed-end questionnaire is designed, based upon information from the interviews with experts and questionnaires with the rangers, and distributed amongst 43

PFM members of the selected PFM sites. A closed end questionnaire is chosen to enable quantitative analysis on the gathered data from the PFM (Russel Bernard 2006). The questionnaire design is based upon (Taylor-Powell and Marshall 1996, Field 2003). All questionnaires are translated to Amharic, which is the most read language in Kafa (Interview 2,3,4). Both the English and Amharic version of the questionnaire can be seen in Appendix 4. The closed-end questionnaire will provide information for the second, third and fourth sub question.

d. Training set up

Twelve members are selected from the Kahin PFM, the PFM with the least phone usage, and trained to work with the smart phones. The twelve selected PFM community members receive one full day of interactive training from one trainer at their PFM location about basic smart phone operations. During the training a user friendly manual is used, which describes the skills needed for operating the smart phone and difficulties within the ODK form. Three pictures from the first day of the training can be seen in Figure 4. At the end of the first day, four persons are selected based upon their achievements and capabilities shown during the day. Basic information about the four selected persons can be found in Table 2.

Table 2: Basic details of selected PFM members

Name	Age	Education Level	Phone Owner
Participant 1	48	Prepatory	No
Participant 2	30	Primary	No
Participant 3	25	Secondary	Yes
Participant 4	42	Prepatory	Yes

The four selected participants have a second full day of training designated to smart phone monitoring. During the training, the trainees will monitor several different locations. On the day directly after the training, the test starts with monitoring 3 pre-determined plots.

Figure 4: Three pictures showing the training. The most left image shows the general introduction. The second image shows three PFM members working with the mobile device following by the manual. The right picture shows two PFM members capturing a GPS location during the training.

e. Monitoring

To acquire insight in the monitoring capacity of PFM members, mobile based monitoring is conducted by 4 PFM members. First they monitor three pre-determined plots, which have been selected and monitored by an expert and ranger. These plots are all within walking distance and have a clear boundary. The locations of the plots can be found in Figure 5, the description in Table 3. Monitoring these 3 pre-determined plots allow direct observations of monitoring, which gives first insights in the monitoring capacities of the community members.

Table 3: Basic information about the pre-determined plots

	Topography	Distance to core forest	Land use type
Plot 1	Flat	Less than 1 km	Forest with emergents
Plot 2	Medium slope	Less than 1 km	Coffee Investment
Plot 3	medium slope	Less than 1 km	Grassland / Grazing land

After the monitoring of the pre-determined plots, the smart phones are lend to three PFM members to conduct two times five days of free monitoring. No rules are applied to the free monitoring, except that the mobile devices will be collected after the five days. This gives the PFM members the opportunity to conduct monitoring to their own insight, which will provide information on the spatial and temporal monitoring behavior. All monitored plots are validated by a local expert. Information from both monitoring set ups will be used to address sub question five.

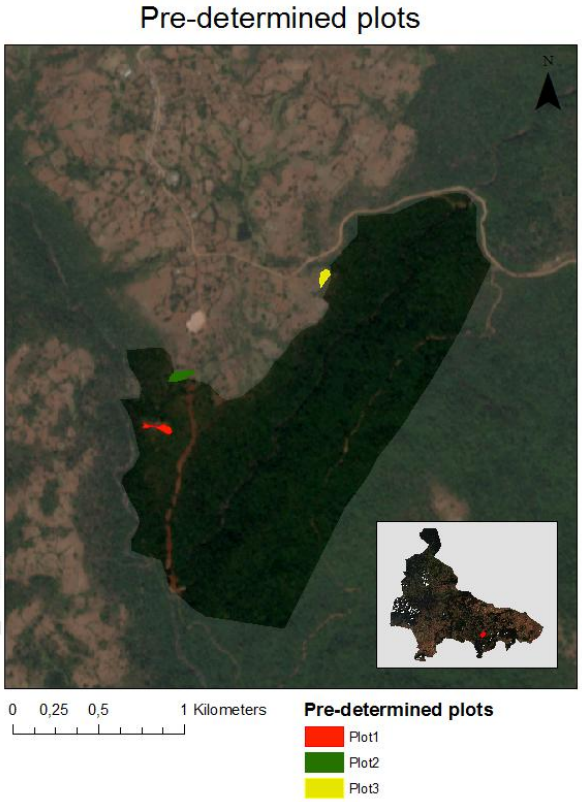

Figure 5: Location of the pre-determined plots

f. Mobile device

Within this research four Samsung GT-S7500 smart phones are used. The Samsung GT-s7500 is suitable since it is an Android phone which incorporates a GPS and camera function, which makes it possible to install Google Open Data Kit, to capture GPS locations and pictures. The smart phones are rooted and an Amharic font is installed along with the "MulitiLing Keyboard" application with the Amharic input plug-in to enable typing and writing in Amharic Ge'ez script (Figure 6). The same data collection method as described in (Pratihast, Herold et al. 2012, Pratihast, Souza Jr et al. 2012) is used.

The Forest Disturbance Monitoring Form (FDMF) is translated to Amharic, which is the official language in Ethiopia and the most read and written language in Kafa. Furthermore open end questions are removed, because these cannot be translated and interpreted due to time limitations. An overview of the questions in the FDMF can be found in Appendix 5. The questions can be divided into four groups: Basic details, Geographic Information, Area Classification and Multimedia.

Figure 6: Samsung smart phone showing the translated FDMF and Amharic keyboard.

g. Secondary data

Secondary data about the study location, like geographic information about the PFM locations and basic numbers, are acquired via the local experts, official documentation and geographical information.

Data Analysis

This section describes the conducted data analysis. The same structure as in the previous section is applied. Described steps which do not directly gather data are not described below.

a. Interviews

During each interview notes are made with pen on a normal notebook. After the interview the notes are elaborated and coded according the topic of the question and answer and stored into one Word document. The interview is not directly transcribed into a Word document, because this could create a barrier for the interviewee to give answers. The information gathered via interviews is used to answer the first four sub questions and to create the questions and answers for the questionnaires. Within the report, references to the list in appendix 1 are made if a statement from an interviewee is used.

b. Observations

Observations are, like the interviews, documented in a Word file and directly coded according to the same coding tree as the interviews. Observations are mainly used to back up or interpret interview and questionnaire data and by this providing insight in the third and fourth sub question.

c. Questionnaires

Due to the different type of questionnaires both questionnaires are analyzed differently. The questionnaire held with the NABU rangers is translated and transcribed into an Excel file. Afterwards the answers are categorized into groups, which are determined during analyzing the questions. Quantitative analysis of this questionnaire is not possible, because it contains only open end questions.
The closed-end questionnaire conducted amongst the PFM members of the Baka and Kahin PFM is processed in SPSS. Quantitative analysis is possible, because only closed-end questions are used. Descriptive statistics are conducted on the acquired data to answer the second, third and fourth sub question. Data regarding smart phone usage in both PFM is split up over the two PFM by means of a custom table.

d. Monitoring

All monitored plots are verified by a local expert. After monitoring the data is uploaded to ODK Collect, downloaded and imported into Excel. The data structure in which the monitoring results are stored can be seen in Appendix 6. Monitoring data from PFM and validation data are combined according to the Location and Form ID numbers.

Categorization of the Area Classification entries is conducted to make judgment of the classification as a whole possible. Entries from the Area Classification group are automatically categorized according to Table 4. The categorization over five categories is based upon the number of correct and false main and sub questions compared to the expert measurements. The sub questions written in Italic in appendix 5 (Date of disturbance, Calendar and Total number of trees within the Boundary questions) are not used in the categorization. Two examples of the categorization are shown in Appendix 8.

Monitored Geographic Information is validated using available geo-data from the study area. The model is shown in Appendix 7. The road network and core forest are directly available. For the villages, a mask is created using a RapidEye image and field observations. Buffers are created around all three datasets which allow discrete distance classification.

Area estimations of monitored plot are compared with the computed area, based upon recorded GPS points during validation. The area estimation is classified as correct when the difference with the real values is less than 0.5 hectare. The estimated slope and number of trees within the area are compared with expert data separate from the previous mentioned analysis. Furthermore, the captured multimedia is counted and visually checked.

Table 4: Categorization table for Area Classification.

	Score	Main Question	Sub questions
Totally Correct	5	Both correct	All correct
Correct	4	Both correct	2 or less incorrect
Partly correct	3	Both correct	2 or more incorrect
Incorrect	2	One correct	-
Totally incorrect	1	Both incorrect	-

3. Results

This chapter consists of six sub chapters describing the results acquired during the study. In the first five sub chapters results gathered by interviews, questionnaires and observations are shown. Sub chapter six shows the results achieved with the monitoring by the selected PFM members. The first sub chapter describes the functional structure of the PFM in Kafa. This sub chapter is followed by the chapter showing the reasons why local community members participate in a PFM. The third sub chapter describes the current monitoring conducted by PFM members and is followed by a section about the usage of mobile device including results about the advantages and challenges of implementing mobile device for community-based forest monitoring. The fifth sub chapter focuses on the capacity building required for carrying out mobile device based forest monitoring, followed by a sub chapter consisting of the actual monitoring results.

3.1 The PFM structure in Kafa

A PFM can be best described as an association of forest users who have achieved the rights to manage and utilize a specific part of a forest. The PFM status is based upon an agreement between the Department of Agriculture and Development (DoAD) and the participating forest users. The PFM becomes a legal entity after signing the agreement between the DoAD and the PFM. The roles and responsibilities of the PFM and DoAD are described in the PFM plan and agreement. The goal of a PFM is to create a sustainable livelihood for the forest dependent communities and by this enable future generations to continue with this livelihood (Temesgen 2012) and (Interview 1). Next to the DoAD, NABU is actively supporting existing and facilitating the establishment of new PFM locations.

Before the establishment of the PFM an elaborate PFM Management Plan (PMP) is created. The PMP consists of an elaborate resource assessment describing the initial state of the forest and its biodiversity, the exact boundaries of the PFM area, the actions which the PFM needs to undertake to protect, monitor and develop the forest and how they are allowed to use the forest. Furthermore the PMP defines which rights and benefits both the community and the DoAD have (Adugma 2003, Temesgen 2012) and (Interview 1, 4, 5,6). After establishment the PFM locations are supported by Development Agents (DA) of the DoAD and NABU rangers by conducting monitoring and conducting capacity raising activities. An overview of the structure between the three main parties is shown in Figure 7.

A PFM consists of six committees. The main committee is the implementation committee, this committee arranges the other 5 committees. The remaining five committees are the protection, utilization, development, monitoring and control committee. Members for the committees are elected by the PFM members. It is obliged to have at least one woman in the implementation as well as one member of a minority group if one is present in the PFM (Interview 2, 4). The PFM is self regulating via these committees.

Currently there are 76 PFM areas in the Kafa region (Interview 6), which can be distinguished into two different statuses. The most evolved status is the Cooperative status; the most common status is the Forest User Group status (Interview 7). The difference between the two statuses is the legal right which they have. The 14 PFM which have the cooperative status are legally seen as a cooperation and can therefore act as one body. They can for instance lent credit and start lawsuits as PFM. This strengthens their market position

(Interview 4, 7). The Forest User Group status only allows the members to use the forest according to their PMP.

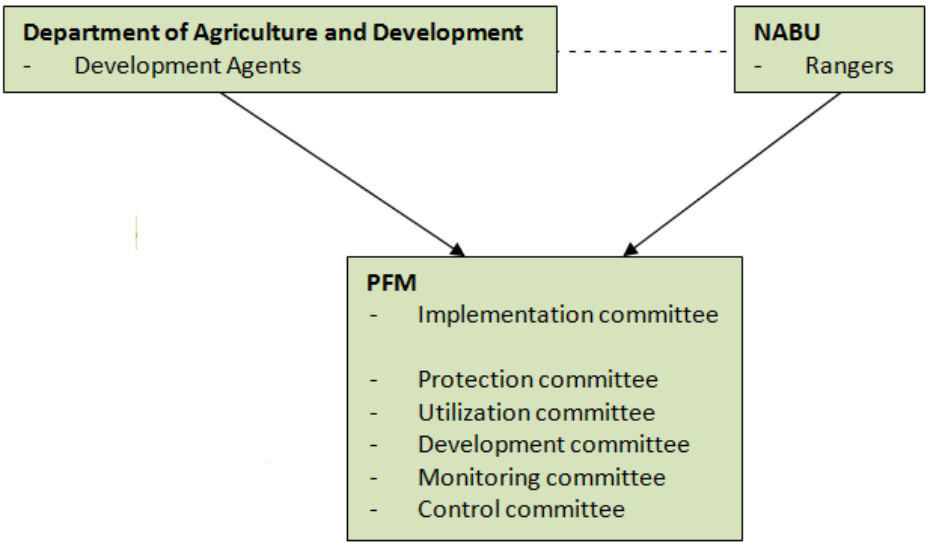

Figure 7: Structural overview of the three main involved parties in PFM in Kafa for this research. NABU is collaborating closely with the DoAD to establish and support PFM locations. Communication between the PFM and the DoAD or NABU is conducted via respectively Development Agents and Rangers.

3.2 Reasons to participate in a PFM

There are several reasons why the local forest users participate in a PFM. The reasons can be split up into two segments; the benefit of being in a PFM and the awareness about the forest amongst the forest users (FU). The combination of both determines the high motivation of the PFM members. This motivation is further raised by the open setting of a PFM. A forest user not obliged to join a PFM, they can decide if they want to participate or not. It seems that the high awareness about the state of the forest, the direct benefits as well as the indirect benefits by participating in a PFM play an important role for participation.

Benefits

Participating in a PFM has several benefits of which most are indirect. Before the establishment of the PFM in Kafa, nobody was officially allowed to use the forest. It was illegal to collect firewood or non timber forest products (NTFP) from the forest, nor was it allowed to let livestock graze. The forests were state property. Now the PFM have the right to use their designated piece of forest according to their PMP. This means that they are allowed to collect some firewood, let livestock graze and collect NTFP (Temesgen 2012) and (Interview 5,6,7). Now, the PFM even have the right so sell their products and can get support by making a business plan and promotion of their products (Interview 5). Furthermore they can now protect their forest from illegal activities by monitoring and reporting it.

Within the PMP the assigned forest location and boundaries are stated. Therefore the PFM can claim their right on the forest if this is needed. This gives the PFM members more certainty about the future of their forest. In this way they are ensured of forest conservation and the associated livelihood conservation (Interview 4, 7). As example: Currently private investors want to create large coffee plantations in the Kafa region. This is not possible in PFM areas because the forest area is officially assigned to the PFM.

Next to the indirect benefits, the direct benefits seem to play an important role as well. The PFM communities get paid to conduct forest monitoring and to participate in trainings or meetings. NABU, the main NGO operating in the Kafa Biosphere reserve initiating and supporting the PFM communities, organizes trainings and meetings for PFM communities on regular basis. To ensure participation, the participants are paid a Per Diem to cover their daily costs for participation in the sessions. A fix amount of 150 birr, approximately 6 euro, per day is paid, which does not yet include the compensation for travel expenses. Within this study a lower Per Diem than the NABU standard is paid. For the full training days a Per Diem of 50 birr, 2 euro, per day was agreed upon beforehand and paid afterwards. For the two times 5 days of free monitoring a Per Diem of 200 birr, 8 euro, was agreed upon.

The estimated per capita income of Ethiopia is about 300 euro's (Geiger 2013), which makes the average income about 0,82 eurocents per day. An import/export manager in Addis Ababa, having a master's degree earns 2500 ETB a month, 3 euro per day (SalaryExplorer 2012). Comparing these payments indicate that the standard Per Diem received by PFM members is high. The NABU Per Diem is higher than the daily salary of an import/export manager with a master's degree, while the Per Diem paid for this study is still twice the average daily wage.

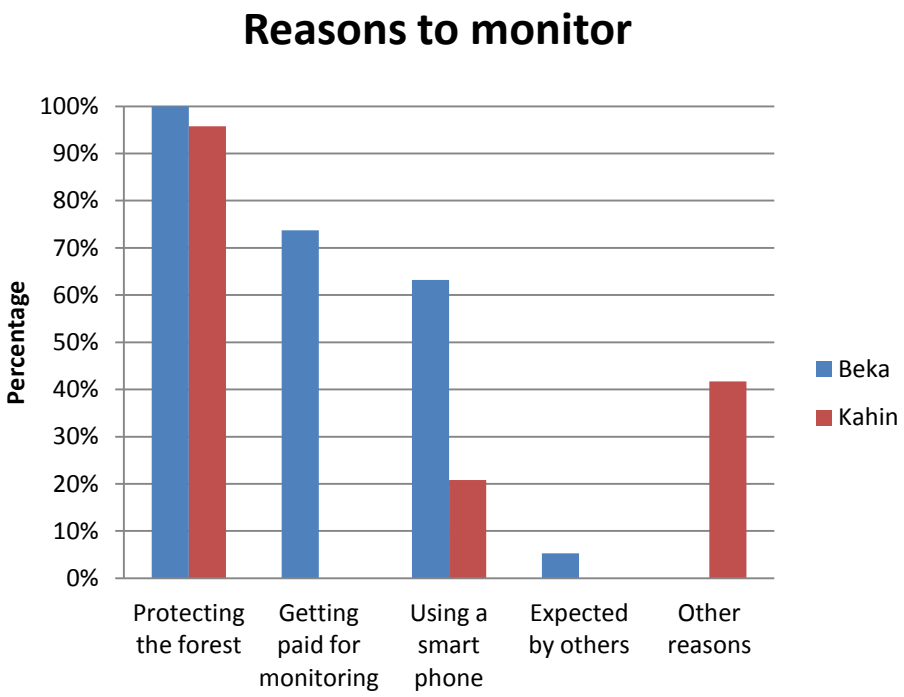

Figure 8: Reasons indicated by PFM members to monitor the forest. The main reason is protecting the forest. Other reasons for monitoring are indicated by the Kahin PFM members as well, however nobody answered what other reason they meant.

Although 72 per cent from the Beka PFM and nobody from the Kahin PFM state that direct benefits are their driver to monitor (Figure 8) and 92 per cent of the Kahin PFM members state they do not want to get paid for monitoring, the actual importance seems to be higher. Each payment resulted in elaborate discussions that the payments were not sufficient. The initial payment for the free monitoring is similar to the average per capita daily income; however two out of four participants did not want to monitor for that salary, although they can plan the free monitoring totally by themselves. One of them did not attend; the other participant was only willing to participate after the payment was increased to 300 birr, 12 euro.

Awareness

The second reason to participate in a PFM is the awareness about the state of the forest. Part of the PFM establishment is to raise awareness amongst the communities (Temesgen 2012). After establishment, the awareness raising is continued by the rangers and Development Agents from the DoAD (Interview 3, 5). 86% of the PFM members who filled in the questionnaire have the assumption that the forest cover increased in the last 20 years in Ethiopia of which 42% thinks the total amount of forest cover has doubled. 72% thinks that the forest cover in the Kafa Biosphere Reserve slightly increased in the last 20 years. This seems to contradict the awareness about the state of the forest in Ethiopia, but these opinions are due to the successive governmental campaign on reforestation which shows that deforested areas are reforested. Everybody is of opinion that the thought forest cover increase is positive.

The importance of the forest on a broader scale is well known, everybody states that the forest is important for the economy, environment and livelihood. The three most indicated reasons for the importance of the forest are that it contains and preserves unique animal and plant species, it generates rain throughout the area and that it can generate tourism. All responses are shown in Table 5. The high awareness is supported by the most indicated reason why the PFM members are willing to conduct monitoring; 97 per cent of the people indicated that they want to monitor to help keeping the forest intact (Figure 8).

Table 5: Indications given by PFM members why the forest is important

Reason	Per cent
Biodiversity preservation	76.7%
Rain generation	74.4%
Tourism	74.4%
Carbon emission reduction	55.8%
Construction material	44.2%
Effect on rain	37.2%
Income by timber	34.9%
Fuel wood collection	32.6%
Food supply	25.6%

3.3 PFM monitoring activities

The PMP describes that the PFM and the DoAD need to monitor the forest regularly. The time schedule can be different for each PFM and is according to the PMP. Currently the PFM conduct border patrols and follow tracks into the forest looking for new tracks or illegal logging. Found disturbances are registered using a paper form (Interview 4, 5, 7). Next to this, the PMP describes the official reporting from the PFM to the DoAD, normally this is done once or twice a year (Interview 5). However, unofficially the reporting is not conducted regularly and the DoAD sends Development Agents to conduct monitoring when reporting is needed. A PFM receives weekly supervision with monitoring and monthly discussions about problems from the rangers (Interview 3).

3.4 Use of mobile device and their functionalities

Smart phones are rare in Bonga, but they can be bought in Bonga and especially the wealthier people already use them. Almost everybody of the younger generation has a cell phone nowadays (Interview 1). Everybody who does not have a smart phone and who sees one is interested in it. Currently, at least 27 out of 43 PFM members have a phone of which 14 indicate to have a smart phone. None of the rangers had used, nor seen a smart phone before the project; therefore the smart phone usage of the PFM members is relatively high. The total number of phones might be as high as 40 phones out of 43 PFM members, however the exact number cannot be retrieved due to incongruence between answers.

The phone usage is lower in the Kahin PFM; only 42 per cent of the questioned PFM members have a phone, while about 90 per cent has a phone in the Beka PFM. The three most uses of the phone are calling, making pictures and sending text messages. An overview of the all uses can be found in Figure 9. Phone usage is about equal between the two PFM. There is only a big difference between the amount of persons who downloads applications; this can be explained by the higher amount of smart phones in the Beka PFM, which allow downloading applications. 20 PFM members use their phone more than 15 times a day.

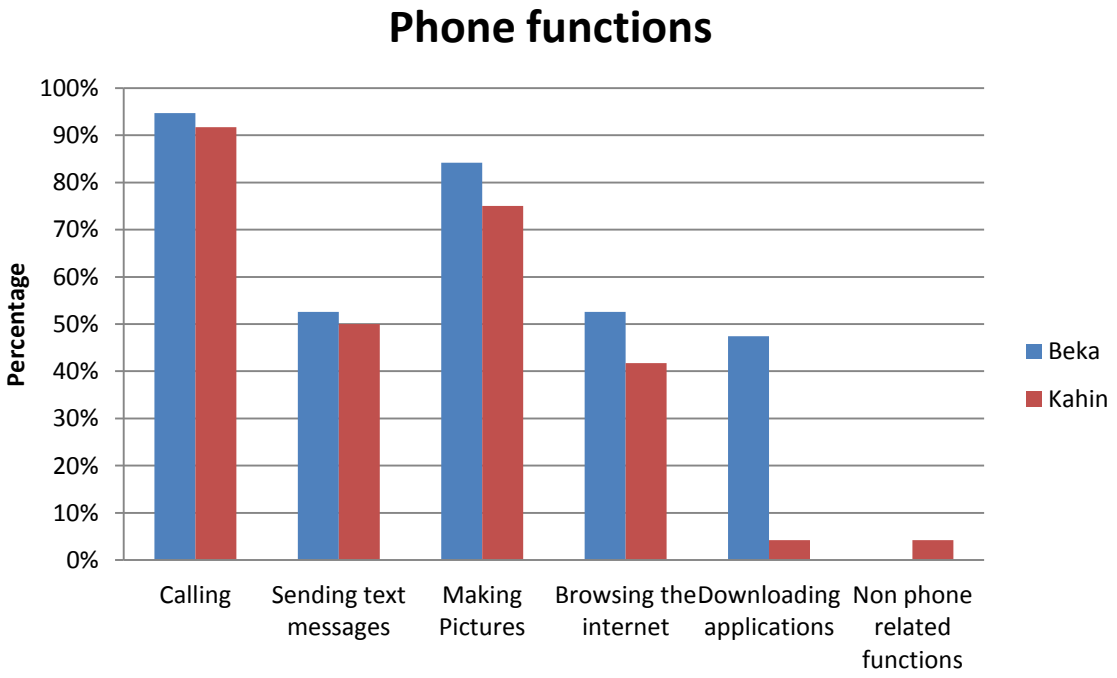

Figure 9: Phone functionalities used by the PFM members split over the two PFM locations.

Advantages of mobile device for CBM

The use of smart phones for monitoring, make the monitoring process easy and less time is consumed (Interview 3,4,7). The smart phone incorporates all needed devices for forest monitoring into one small device. The incorporation of media like pictures and audio makes it easy to collect data and the media can provide as evidence (Interview 2,5). When the monitoring becomes easier, more data can be collected (interview 2, 5). Furthermore, the collected data is more precise, because of the GPS function. Gathered data can easily be stored and shared amongst interested persons and institutes, especially when a central database is created for the storage (Interview 2). A continuous and automatically incoming data stream has the potential to activate institutions which are currently inactive (interview 2). The general opinion from the rangers supports the statements of the interviewee's. The GPS support is appreciated, they like the fact that the data can be transferred and used directly and the supported media input is seen as useful. Next to these benefits, 39 out of 42 respondents of the questionnaire state that they are more motivated to conduct forest monitoring with smart phone than monitoring without smart phone.

Challenges of mobile device for CBM

The benefits of the smart phone usage come with challenges for the implementation. The current ODK form is in English, while hardly anybody from the communities is capable of reading this (Interview 4, 7). Furthermore, nobody has ever used a smart phone before, which creates a knowledge gap concerning smart phone usage (Interview 2,3,5,6). However, about half of the rangers stated that they got accustomed to the smart phone in a couple of days. At this moment they require training every couple of weeks. Currently they are used to the smart phones and do not have problems with it anymore concerning monitoring. The most important problems the smart phone usage faces are the GPS connectivity, the battery duration and the network coverage when using it in the forests (Interview 3, 5, 7). This is supported by the rangers. Currently it is on average not possible to use a phone due to no power, which could mean low battery or no network, 5 or 6 times a week.

One big challenges of applying the smart phones for community-based monitoring (CBM) is the data usage. It is foreseen by 3 interviewees (interview 2, 3, 4) and the rangers, that no or improper use of the data by the DoAD can cause the monitoring to backfire. Once the data will be collected and is not or improper used, the communities might stop monitoring with smart phones. Furthermore, it remains unclear who of the stakeholders is willing to invest money in purchasing and enabling local communities to monitor with smart phones.

3.5 Capacity building

For this study it is not necessary to enable the community members to fully operate the phone on each possibility. They only need to know how to work with ODK, conduct the monitoring and solve the problems which they might encounter by doing so.

Although some community members indicate that they already have smart phones, observations during this research showed that most people are not yet familiar with smart phones. Basic actions to operate the smart phone, like touching on or swiping over the screen, are not yet known. People still tend to look for physical buttons to operate the phone, because most of them are used to work with normal cell phones. The rangers

indicate that they encountered difficulties with the screen lock and screen brightness and general operations like opening an application.

General skills for the phone usage like recharging the phone, turning the phone on and off, removing the screen lock, adjusting the screen brightness and screen timeout and opening and closing an application need to be explained during training. Once the basics are explained, more advanced operations needed for the usage of ODK collect can be taught. The training will focus on opening the FDMF, going to the next or previous screen, typing, changing keyboard type, record GPS locations, voice commands and taking pictures. The forest disturbance monitoring form needs to be explained elaborately and practiced with the community members by going through it step by step and letting the community members fill in the form themselves.

3.6 Monitoring Results

On the first day after the training all four trained PFM members monitored three predetermined plots, which allowed observations on their achievements during the training. For each plot participant one and two, who do not own a phone, required the most monitoring time. Furthermore, they were the most insecure with handling the phone. Participant 2 failed in saving the completed monitoring form once. All four PFM members were able to capture four GPS points per plot and were able to capture pictures and audio messages. Afterwards the smart phones were handed over two times for five days to the trained PFM members to conduct monitoring at their own insight. Their motivation was shown clearly on the first day; only two persons were willing to cooperate for the agreed Per Diem. One person found willing to monitor after an increase in Per Diem, participant 4 was still not willing to cooperate

Spatial and temporal distribution

Figure 10 shows the 33 monitored locations during the two weeks of monitoring. Not all 33 measurements are visible in the figure, because sometimes the same location is monitored more than once. The monitored locations are distributed along the two main roads in the area. More locations and locations further away, were monitored in the second monitoring week

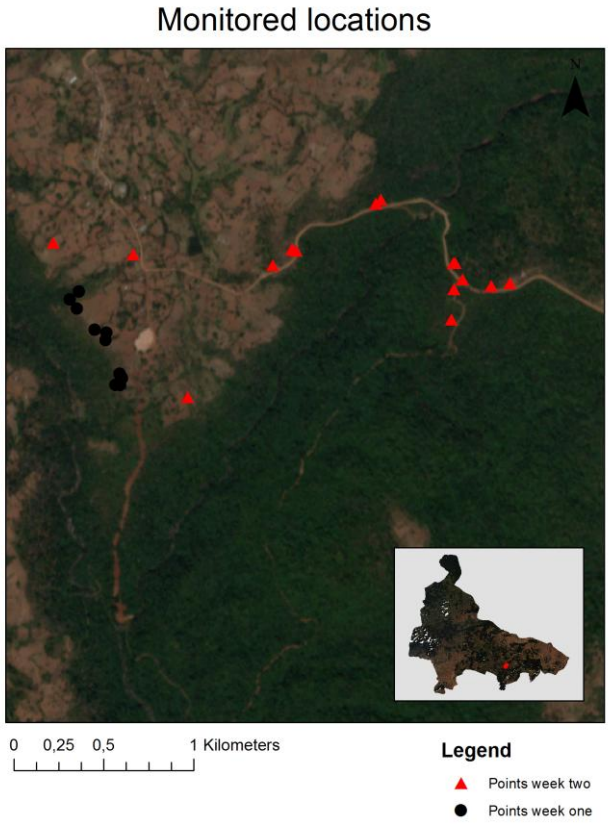

Figure 10: Monitored locations during two weeks of free monitoring

Both weeks the three PFM members monitored twice a week, all on the same day and around the same time, which indicates that they monitored together. Although there were no rules set on how often or when to monitor, they filled in the FDMF form as if they monitored on daily basis and stated that they did not go together.

Distance estimation

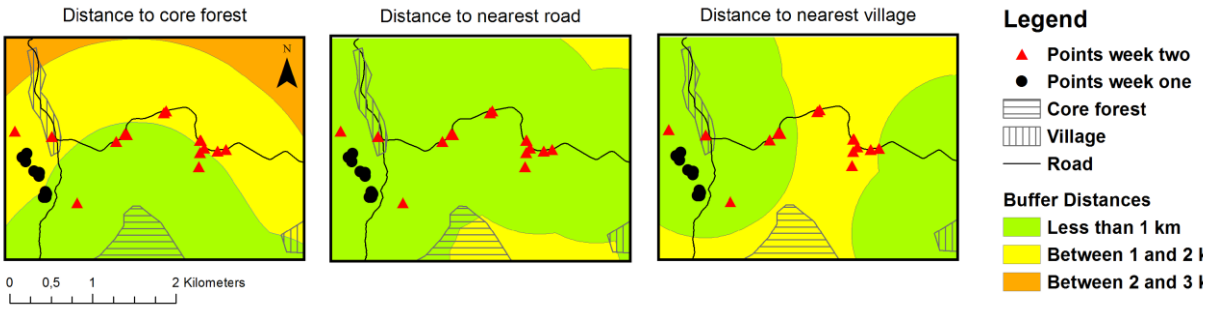

Figure 11: Monitored locations displayed on the buffers showing the distances to the village, road and core forest

Within the FDMF form the community members are asked to indicate the distance to the nearest road, the nearest village and core forests to the road, village and core forest. Figure 11 shows the monitored locations on the created buffers to retrieve the correct distances. It shows that all monitored locations are closer than one kilometre to the road, while the distances to the nearest village and core forests are divided over the first two categories, less than one km and between one and two kilometres. Table 6 shows how often these distances are indicated correctly. The distance to the road is indicated correct most often, since the monitored results are close to the road. Although each point is monitored in the vicinity of the road it is on average indicated incorrectly in 15 per cent of all cases. Secondly, the distance to the nearest village is estimated correctly most often. The distance to the nearest village is on average indicated correctly in 63 per cent of all cases. The distance to the core forest is only indicated correctly in 15% of all cases.

Table 6: Percentage of correctly indicated distances

	Road	Village	Core forest
Participant 1	64%	55%	18%
Participant 2	83%	58%	8%
Participant 3	100%	72%	17%
Average	85%	63%	15%

Area classification

Table 7 shows the overall monitoring results, which consist of the pre-determined plots and two weeks of free monitoring. In total 41 measurements have been conducted, the average area classification score is between Partly Correct and Incorrect. The variation between the trainees is low, although observations during the pre-plots showed difference in confidence between the participants. This indicates that there is no direct correlation between the overall monitoring results and education level or experience with a phone.

Table 7: Overall monitoring results, indicating the captured points per PFM member, the average score and the percentage of captured pictures and audio messages.

	Points monitored	Average Score	Photo capture	Audio Captured
Participant 1	11	2.5	82%	91%
Participant 3	12	2.0	100%	100%
Participant 3	18	2.4	100%	100%
Average	41	2.3	95%	98%

The contribution of the two main questions on the outcome of the categorization of the monitoring results is high. The percentages of combinations of correct and incorrect answers on the main questions, is given in Table 8. Both main questions are answered correctly in 34 per cent of all cases, while one of both main questions is answered incorrectly in 51 per cent of all cases. Both main questions are answered by PFM members almost as often. In only 14.6 per cent of the 41 measurements both main questions are answered incorrectly.

Table 8: Percentage of correct and incorrect answers for the combination of the first and second main question.

		1st	
		Correct	Incorrect
2nd	Correct	34.1%	24.4%
	Incorrect	26.8%	14.6%

Table 9 shows the confusion matrices for the first and second main question ("Is this forest?" and "Is there disturbance in the last ten years?"). The first main question is answered correctly in 61 per cent of all cases. The PFM members have indicated 32 out of 41 monitored locations as forest, while only 18 locations are classified as forest by the expert. It seems that there is a tendency amongst the PFM members to classify an area as forest instead of no forest. Only 53 per cent of the areas indicated by PFM members as forest are actually forest. However, when PFM members indicate an area as no forest it correct eight out of nine times.

The second main question is answered correctly 58 per cent of all cases, which is comparable with the first main question. Here the division between the answers of the PFM members and expert is less. The expert indicated disturbance in the area 33 times, while the PFM member indicated the area as disturbed 28 times. When an area is indicated as disturbed in the last ten years by the PFM members this is supported by the expert opinion in 78 per cent of the cases. When an area is classified by the PFM members as not disturbed, it only shows to be correct in 15 per cent of the cases.

Table 9: Confusion matrices for the first and second main question ("Is this forest?" and "Is there disturbance in the last ten years?"), comparing the answers of the PFM members with the expert answer. Both matrices show the true positives and negatives and false positives and negatives.

1st main question

		PFM: Yes	PFM: No
Expert	Yes	17	1
	No	15	8

2nd main question

		PFM: Yes	PFM: No
Expert	Yes	22	11
	No	6	2

Although it seems that difficulties occur for the forest monitoring perspective, Table 7 also indicates that the all trainees are technically capable to work with the smart phones after two days of training on which they are most elaborately trained. In total they successfully monitored 41 locations. 95% of all possible photos were captured. One image is of bad quality and in 13 images a finger appears covering less than 15 per cent of the image. Only once no audio was captured during the monitoring. In total 166 GPS points have been taken for all 41 monitored locations. Only for nine locations the trained four values where unique GPS recordings. For all other locations at least one GPS recording was a replication of other GPS recordings on the same location. The amounts are equally distributed over the Pre-Plots, free monitored locations and the participants.

Summarizing it can be said that the PFM members are capable of conducting forest monitoring, however the overall monitoring score is low. Both main questions are answered correctly in only one third of all monitored locations. When the first main question is answered as yes by the PFM members, the answer is unreliable. However when it is indicated as no, the answer is reliable. For the second main question the opposite can be assumed. When an area is indicated as undisturbed the answer is not reliable. When the area is indicated as disturbed this can be assumed reliable.

Slope and area estimation

The slope is indicated correctly in 45% of all cases, while the area estimation is only indicated correctly in 10% of the monitored locations. Figure 12 shows the PFM area estimates and the real values. The comparison is made between the estimated area by PFM members in the FDMF and GPS recordings captured during the validation. It shows that the PFM members only indicated whole hectares. Since no monitored location is larger than one hectare, errors occur due to rounding. In general the PFM members overestimate the total area. The figure shows the difficulty of estimating the area of a specific location. Two

reasons could explain this. Firstly, the free interpretation of the boundaries can give a difference between multiple measurements. Secondly, estimating an area in hectare, especially for irregular shaped areas can be challenging.

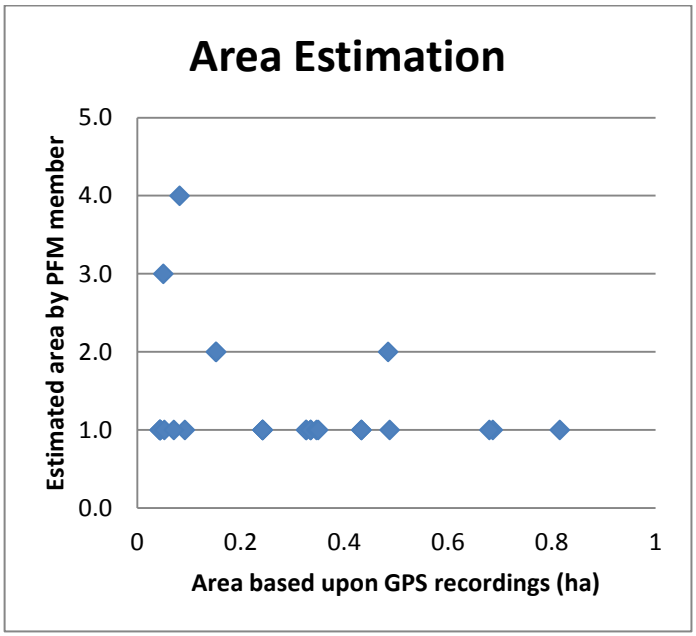

Figure 12: Graph showing the area estimation of the PFM members and the actual area. It can be seen that all PFM members only indicated whole hectares.

Tree count

Figure 13 shows the estimated amount of trees within a plot by experts and local community members. Note that the Y-axis ranges from 0 to 100, while the x-axis goes from 0 to 1000. The correlation between expert and local estimates is low, the R^2 is only 0.017. This low r^2 can be explained by the subjectiveness of monitoring in the next section as well as tree classification itself.

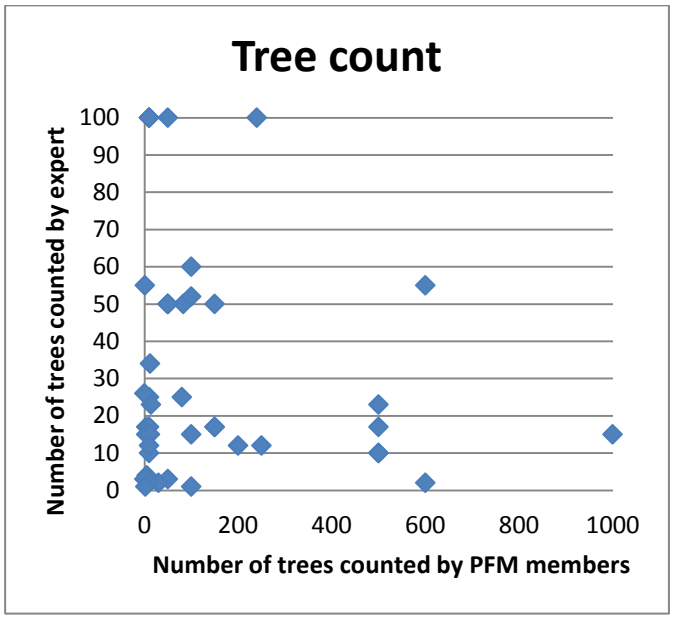

Figure 13: Scatter plot of the counted amounts of trees within a plot by an expert and the community members.

Within the grass in Figure 14 a lot of new emergent vegetation is abundant of which a lot could be trees, one person could count these already as threes, while others might not do this. Monitoring results of pre-determined plot 1 in Table 10 supports the assumption that conception of what is monitored as a tree and what not differs. The estimated amount of trees varies between 4 and 500. Persons who indicate the area as grass count a low amount of trees, while the persons who see the area as forest have a high tree count. The persons who classified the area as grass did not take the emergent trees into account and therefore only indicated four trees. The expert who classified the area as forest with emergents did take the emergents into account and therefore indicated 500 trees.

Subjectiveness of monitoring

The low area classification score and area estimation can be explained by the nature of the forest monitoring process. Figure 14 shows one of the three pre-determined plots and is used as example. The classification results from this area are shown in Table 10. The area consists of grass with some small and bigger vegetation on it, surrounded by bigger bushes and trees, rapidly evolving in dense forest. Classifying this location is more difficult than describing the area. One might see it as a grass field, so not as forest, while another person could see the wider view and see this as an open spot within the forest and therefore classify it as forest. If somebody would monitor this location when an ox, goat or sheep passes by, he could interpret this area as grazing field. Table 10 shows indications of a varying tree count with land use type. Areas classified as forest have a high tree count, while the same location classified as grass has a low tree count. The area estimation, as well as the tree count, is highly dependent on the location of the boundaries. When only the grass field is taken into account, the area is smaller than when the bigger bushes growing on the grass are also taken within the boundary.

Figure 14: One of the pre-determined plots, showing an open location within the forest.

The subjective process of forest monitoring is supported by the difference between the results of the ranger who monitored the predetermined plot beforehand and the expert who validated the data. Both had a different interpretation of the location visible in Figure 14, as well as a total different tree count (Table 10). The subjectiveness of the area classification can cause differences during the validation, since communication between community members and the expert is not allowed to prevent data corruption.

Table 10: Monitoring results of Pre-determined Plot 1. Shown are the indicated land use type, whether the area is disturbed and the tree count for the monitored location. Variety between all five monitoring entries can be seen.

	Land use type	Disturbance	Number of trees
Community member1	Grass	No	4
Community member 2	Grass	Grazing	12
Community member 3	Multi-layered forest with grass understory	Grazing	100
Ranger	Grass	No	15
Expert	Forest with emergents	Grazing	500

4. Discussion

To achieve broad insight in the study domain interviews are conducted with local experts, questionnaires are distributed amongst NABU rangers and the members of two PFM sites. Furthermore, actual training and monitoring is conducted with several PFM members. Due to time limitations, this study only uses a small test group which makes statistical analysis of the acquired data not possible. The internal validity of this study is ensured by data triangulation of the data sources. Although statistical analysis is not possible, the results from this research can be used as starting point for further research. Recommendations for further research will be addressed in chapter 6.

The discussion consists of three sections. The first section describes the challenges within the research. The second section assesses the PFM according to the five aspects (Motivation, Awareness, Benefit, Technology and Capacity) mentioned in the introduction. Afterwards, possible problems concerning implementation of smart phone based CBM in the Kafa region and on national scale will be discussed.

4.1 Challenges within the research

Several processes can have effect on the internal validity within the research. These are the response effects, the payment of PFM members and the translations. All three will be shortly addressed below. To minimize the effect of these processes, different research techniques are used to create data triangulation. Therefore, the effect on the internal validity is assumed to be relatively small.

The first part of the research depends upon information gathered via interviews, questionnaires and observations. Bias of the gathered data can be caused due to three response effects. These are the defense, social desirability and third party effect. All can cause the interviewees or respondents to give different answers than the real answer. The results of these three effects could explain the differences between answers from several interviewees and inconsistency within a couple of questionnaire answers. Therefore, reflection on the gathered information and especially on the conducted interviews, where subjectivity might occur, is essential in this study.

The PFM members were paid for the data acquisition. More than once, payment ended up in elaborate discussions. There were also discussions for the payment for the free monitoring, which could be fully planned by the selected PFM members. These discussions about the payments show that payments are one of the driving factors for the PFM members. Furthermore, these payments can also have an effect on the quantity and quality of the acquired data. This effect remains unknown after this study and further research should be conducted concerning this topic.

One of the main challenges within this study was the language barrier. Since English is not well spoken amongst the PFM members all communication had to be translated into Amharic. Communicating via a translator makes the communication less direct and errors can occur due to translating. For instance, discussions about the payment cannot be held properly as they are not conducted directly, but with the translator and therefore become even more complicated. To prevent any miscommunication, the translator was elaborately informed beforehand and evaluated at the end of the day the day.

The need of translation can also have an effect on the questionnaire and the conducted training. For questionnaires this could mean that questions might not be fully or differently understood. For the training this could mean that the training is not as elaborate as intended to. Miscommunication due to translation of the questionnaires could again explain the inconsistency between some questionnaire answers. Complications within the training have been prevented by, again, elaborately instructing the translator beforehand and by the usage of a manual, explaining the required smart phone operations on paper.

4.2 PFM Assessment

As mentioned in the introduction a PFM can be assessed according to five aspects. In the following two sub sections they will be described. For this, Capacity and Technology as well as Benefit, Motivation and Awareness are grouped.

Capacity and Technology

Observations during the research showed that the knowledge gap concerning smart phones is ample. Smart phones are rare in the investigated area, however after two days of training even the participants who do not own a normal cell phone, are technically capable of working with the phone. On average 95% of the pictures which can be taken in the FDMF form are taken and only once no audio was recorded, which both indicate that the participants can operate the smart phone.

Although forest monitoring is one of the tasks of a PFM community, forest monitoring results are lacking. The average classification result is between Partly Correct and Incorrect. This result can be explained by three reasons. First of all, the uncertainty coming with this type of forest monitoring, as explained in the results, explains part of the low score. Secondly, the PFM members did not have training dedicated to forest monitoring because forest monitoring is one of the PFM activities and therefore assumed as known capacity. Thirdly, the results can be affected by the effect of the extrinsic motivation as explained in the next section. Based upon the results from this research it is not possible to further specify the effects of the three influencing factors.

Next to the overall classification result, two other results are influenced by the subjectivity of the forest monitoring process. These are the tree count and area estimation. The results show a low correlation between the expert tree count and the PFM tree count. One of the problems for the tree count is that there is no specification about the definition of a tree. Each participant can have his own interpretation of what is a tree and what is not. A benchmark on what is counted as a tree and what not can improve the tree count. A benchmark could be specified according to the trunk width or minimum height. Furthermore, the estimated area by PFM members showed to be inaccurate. In general the PFM members overestimate the monitored area. The area indication can be improved by removing the area estimation question in the data collection form and determine the area by the captured GPS points. For this approach it is important that the PFM members capture multiple GPS points per plot, which showed to be difficult during this research.

Two technical concerns which are raised by multiple interviewees and the NABU rangers are the battery duration and GPS connectivity of the smart phone. Within the two weeks of free

monitoring the battery duration was not a problem, although results from the questionnaire indicate that phones cannot be used five or six times a week because of no electricity. This does include being unable to recharge the phone as well as no network availability due to no electricity. Since the participants only monitored twice a week, the battery duration was sufficient. Furthermore, the monitoring does not use the phone network.

The main problem with the GPS function is not the expected satellite cover but the GPS usage. Only 9 out of 41 monitored locations contained more than one unique GPS recording. For other locations, four times the same location is recorded. This is not due to a GPS problem, but due to the usage of the GPS. When four points are recorded directly after each other without changing position, the exact same location is recorded again. This replication of points might again be an effect of the motivation on the quality of the data.

Benefits, Motivation and Awareness

Participating in a PFM has several direct and indirect benefits. The main indirect benefit is the allowance to use the forest according to the PMP as well as security about the future state of the forest. Although the PFM members themselves indicate that the awareness about the state of the forest and importance of the forest is the main reason to participate, results indicate that the direct benefits for participation in a PFM has large influence. The direct benefits seem to play a big role in the participation within a PFM.

The influence of the direct benefits is supported by two examples. First, PFM members are paid by NABU to participate in arranged meetings, indicating the influence of the high extrinsic motivation. Secondly, the high extrinsic motivation was shown by all PFM members who participated in the training. Although nobody from the Kahin PFM indicated in the questionnaires that they want to get paid for monitoring, which is part of their PFM duty, each day the discussion about a too low Per Diem rate was started. The low intrinsic motivation can form a threat for the quantity and quality of the collected data. The effect of the motivation on the data quality might already be visible in the current data as the low classification result and replication of GPS points.

However, direct payments for community-based forest management area common practice. Examples can be found in Tanzania (Topp-Jørgensen, Poulsen et al. 2005), Costa Rica (Pagiola 2008, Porras 2013), Cambodia (Clements, John et al. 2010) and Mexico (García-Amado, Pérez et al. 2011). In Tanzania and Costa Rica the community members are paid 1 US dollar (Topp-Jørgensen, Poulsen et al. 2005, Pagiola 2008), while in Cambodia the participating community members are paid 2 US dollars for a full day (Clements, John et al. 2010). In the Mexican project community members are paid about 0,5 US dollars per day for monitoring (García-Amado, Pérez et al. 2011). This is lower than the payments for this study and the Per Diem rate paid by NABU and the highest percentage of the GDP per capita. Although payments for community-based monitoring are relatively normal, it has two main disadvantages. The first disadvantage is the possible effect on the data quality. Secondly, when payments for monitoring are initiated and afterward stopped, the monitoring itself will stop too. Therefore sustainable finance is required (Wunder 2007).

In general four types of payments methods can be distinguished under a national REDD+ frameworks. These four options are output based, input based, opportunity cost based or

payment for monitoring (Skutsch 2012). For implementation of solely mobile based forest monitoring the Payment for Monitoring mechanism, where people are paid for their monitoring activities, seems to be the most straightforward payment mechanism. However, the payments paid for monitoring should be incorporated with the benefits gained via the PFM structure in order to prevent negative reaction on mobile based monitoring by other community members and therefore to stimulate monitoring.

4.3 Implementation challenges

Ethiopia is applying the REDD+ framework as part of the CRGE strategy (FDRE 2011). Two of the main challenges for implementation of CBM into the national REDD+ framework is the data quality and data sharing (Palmer Fry 2011, Pratihast, Herold et al. 2013). One advantage is the expected cost reduction compared to expert monitoring. The usage of mobile device for monitoring facilitates the PFM members with a standard data collection procedure and an easy method to share the collected data.

Currently, the by PFM gathered forest data is hardly used by the DoAD. Implementing mobile based forest monitoring has the potential to make data sharing more easily. However, at this point of time the data infrastructure is not available. The basic requirement for data sharing, a mobile network, is already available. Therefore, implementing a national scale data infrastructure is relatively easy since the required data infrastructure is only required on one location. Data usage on local scale becomes more difficult because it has to be arranged for multiple locations. Furthermore, knowledge on how to work with the data is locally not available. Therefore, data usage on local scale is becoming more difficult by implementing mobile device for community-based forest monitoring.

Mobile based forest monitoring has the potential to raise the data credibility. Using mobile device containing a standard FDMF provides the local community members with a standard data collection format (Pratihast, Herold et al. 2012). During this research the community members have shown to be capable of working with the standard FDMF. However, the data quality is low and forms the biggest challenge for implementation of community data in the national REDD+ framework. The subjectiveness of the forest monitoring process can be seen as one of the causes of the low data quality. Secondly, the high extrinsic motivation shown by the PFM members can have an effect on the data quality as well. Thirdly, no training on forest monitoring was conducted, which could have been one of the causes.

One of the expected benefits of CBM for the MRV component in the REDD+ framework is the expected cost reduction for data collection. The high extrinsic motivation and therefore expected high payments form the last challenge for implementing mobile based forest monitoring in the Kafa region. Currently 29 NABU rangers are conducting forest monitoring in the Kafa region. If assumed that for each PFM one person is assigned to conduct monitoring, a minimum of 76 PFM members is needed to monitor all current PFM areas, which does not cover the whole of Kafa. This increase in persons combined with the expected relatively high Per Diem rate, might make the cost reduction by CBM for the MRV component less than expected. When taking high start up cost for training and the required mobile device into account it is questionable if CBM is a more cost efficient method for forest monitoring in the REDD+ framework compared to expert monitoring.

Overall it can be said that implementing mobile devices for community-based monitoring has two main challenges for implementation in the national REDD+ framework. Although a standard collection procedure is facilitated by the mobile device, the data quality is low. Secondly, due to the relatively high expected payments by the PFM members the expected cost reduction might be less than expected. On local level the data usability and data quality might form a challenge for implementation of this system. Implementation of the data infrastructure on national level is relatively easy; implementation on local level is more difficult since multiple locations need to be provided with the required data infrastructure.

5. Conclusion

The goal of the research is to investigate the opportunities for smart phone based forest monitoring by PFM community members in the Kafa Biosphere reserve. For this purpose local experts have been interviewed, questionnaires are distributed amongst NABU rangers and amongst community members of two PFM sites and training of several selected PFM members is conducted. In this section the findings are summarized and structured according to the research questions.

Main question: **Can the use of mobile device by PFM communities improve the forest monitoring in the Kafa Biosphere Reserve?**

Mobile based community forest has the potential to improve the forest monitoring in the Kafa region. Nevertheless, it is not possible to draw a firm conclusion concerning the main research question with the results gathered during this research. All stakeholders, including the PFM members, are interested in mobile based forest monitoring. Monitoring by PFM members is already part of the PFM structure, which makes introducing mobile based monitoring more easily. Conducting forest monitoring with mobile device raises the motivation of the community members. They have shown that they are technically capable of conducting forest monitoring with mobile device.

At this moment three problems occur for using mobile devices for community-based monitoring in the Kafa biosphere reserve. The first problem is the quality of the acquired data by community members. The community members were not capable of collecting qualitative good forest monitoring data during this research. This could have been caused by the lack of designated training on forest monitoring, by the high extrinsic motivation causing the data quality to drop or the subjectiveness of the monitoring process. Secondly, the high extrinsic motivation, and thus high expected Per Diem, might make mobile based CBM not more cost efficient than forest monitoring conducted by NABU rangers. The third complication for mobile based forest monitoring is the data usage. Currently data collected by PFM members is hardly used by the DoAD. Although data collection with mobile device has the potential of facilitating data sharing, data usage becomes more complicated. Currently the required technical infrastructure to store and use the data is lacking at the local scale.

Sub question 1: **How does the PFM structure function in Kafa?**
Sub question 2: **What activities regarding forest monitoring can the local community do and not do?**

A PFM can be best described as an autonomous group of forest users who have received the legal rights of the DoAD to use a designated part of the forest according to their PMP. Within the PMP and PFM agreement the rights and responsibilities of both the DoAD and the PFM are described. One of the duties described in the PMP is the forest monitoring by the PFM members. Monitoring is done by tracking trails back into the forest and reporting disturbances on a paper form. However, one of the problems with this system is the data usage. Collected data is currently not or barely used by the DoAD. The same problem forms a big challenge for implementation of CBM in the Kafa region.

Sub question 3: What can be the benefits and challenges of using mobile devices for forest monitoring?

Smart phone based monitoring motivates the people to monitor the forest and makes monitoring more easy because it incorporates pictures, audio and GPS points in one devise. Therefore, a larger amount of data can be acquired. However, there is currently no capacity to use the data amongst the stakeholders. Handing over the data or uploading it in the more remote areas of the Kafa region might become difficult, since these locations are hard to reach and the phone network coverage is unknown.

Sub question 4: What assistance do local communities need to carry out mobile device based forest monitoring?

Two full days of training on operating a mobile device are sufficient to allow the community members to conduct forest monitoring. Next to training on operating a mobile device for forest monitoring, actual training on forest monitoring is required in order to ensure that data with good quality is captured.

Sub question 5: Can the local communities gather valid forest monitoring data?

The monitoring conducted after the training indicates that local community members are technically capable of conducting forest monitoring with a smart phone. The technical result is independent of the education level or their experiences with a phone. Most images and audio messages were captured during the monitoring. However, after two days of training the community members are not capable of gathering qualitative sound forest monitoring data. Two adjustments in the FDMF need to be made to improve the data quality.

6. Future research

The main challenge for implementation of mobile based forest monitoring by community members is the data quality. During this research the quality of the monitored plots was low. When a full scale monitoring system is implemented for MRV in the REDD+ framework data with good quality is required. Further research needs to be conducted to see whether the data quality is only the effect of no designated training on forest monitoring or whether this is also influenced by the extrinsic motivation or the subjectivity of the monitoring process. Before continuation research is conducted, two adjustments should be made in the FDMF. A benchmark needs to be set for what is and what is not a tree. Secondly, the area estimation questions should be removed. The area estimation can be done automatically by the GPS recording.

To test the effect of the extrinsic motivation on the acquired data and estimate the effect of the subjectivity, the second part of this research, the training of and monitoring by PFM members, needs to be repeated with several comparable PFM communities. Designated training on forest monitoring is required to eliminate this factor. By paying different rates of Per Diem per PFM location, the effect of the intrinsic motivation on the data quality can be retrieved. Once the effect of the motivation is know the effect of the subjectivity of the monitoring can be estimated.

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Appendices

1. Interview list

This list shows the interviews conducted for the first part of the research. The names of the persons are given to allow other researchers to contact these persons and further elaborate on this research. The numbers can be used to trace back the statements to the interviewees.

1. Interview with Bekele Haile in Addis Ababa at the NABU Ethiopia office
2. Interview with Mesfin Tekle in the NABU office in Bonga
3. Interview with Muluken Mekuria, WUR consultant in the Kafa region
4. Interview with Frehiwet Getahun, general manager of the Kafa Forest Coffee Farmers'Cooperative Union
5. Interview with Terefe WoldeGebriel, Kafa Zone Bureau of Agriculture
6. Interview with Asaye Alemayho, Team leader NABU initiated PFM at Kafa Coffee Farmers'Union
7. Interview with Solomon Hailu, Farm Africa/SOS Sahel

2. Topics interviews with experts

The list below describes the topic guideline, which is used during the interviews with local experts.

- PFM structure in Kafa
    A. Rangers
    B. Reporting Mechanism
    C. Stakeholders and Initiators
    D. Who is in charge
    E. Local support
    F. PFM areas and no PFM areas

- Forest monitoring activities of local communities
    A. Current activities
    B. Motivation, Awareness, Capacity, Benefits

- Smart phone benefits and challenges
    A. Costs
    B. Internet
    C. Power
    D. Phone network
    E. Local knowledge
    F. Others

- PFM selection

- Feasibility if study successful

3. Ranger questionnaire

The questionnaire for the Rangers mainly consists of open ended questions to achieve qualitative data about their experiences with the smart phones. The questionnaire is translated to Amharic to ensure the rangers will understand each question correctly. During a test of the questionnaire it was clear that the English level could be a problem. The Amharic questionnaire is distributed amongst all 29 rangers, of who 22 returned it. The original English version can be found on the next page.

ይህ ቃለ ማዠቅ የተዘጋጀው ዘማዊ የስልክ ቀፎ ለደን ወድመት ከትትል ስራ ላይ ጥቅማ አና ችግሮችን ለማወቅ ነው፡ የ ቃለ ማዠቁ ውጠቤ በቀጥይ የአሳ ታፌ ደን አስተዳደር ማህበር ዘማዊ የስልክ ቀፎን በማጠቃም ደን ላይ ክትትል አንዲታደርጉ ነው፡ አርሶ ዘማዊ ቀፎን በማጠቃም የደን ወድመት ላይ የሰሩት ስራ ለፕሮጀክቱ ትልቅ አስተዋፆ አለው፤ ምክንያቱም አርሶ ዘማዊ የስልክ ቀፎን በማጠቃም ስራ ሠርተዋል ። ስለዚህ ይህ ቃለ ማዠቅ ትልቅ አስተዋፆ አለው፡

❖ የቅጥር ዘመ _____ ዕድሜ_____ ፆታ_____

1. ዘማዊ ቀፎ ከማጠቱ በፊት ሞባይል ስልክ ነበሮት? አዎ/ አይደለም
2. ቀድሞ ዘማዊ ቀፎ ተጠቅመው ወይም ለክትትል ተጠቅመዉ ያዉቃሉ? አዎ/ አይደለም
3. መጀመርያ ስለ ዘማዊ ስልክ ያሎት አስተያየት ? _____
   _____
4. በመጀመርያ ዘማዊ ቀፎ ሲጠቃሙ ቀለል ብሎት ነበር? _____
   _____
5. ከዘማዊ የስልክ ቀፎ ጋር በደንብ ለመላባባት/ ለማጠቃም ምን ያህል ጊዜ ወሰደ ?_____
   _____
   _____
6. በመጀመሪያ ዘማዊ ስልክ ሲጠቃሙ ምን ችግር ገጠምዎት?_____
   _____
   _____
7. አሰካሁን ድረስ ስልክ/አጠቃቃሙ ላይ ያሉ ችግሮች ምንድናቸዉ?_____
   _____
   _____
8. ምን ያክል ጊዜ በዘማዊ ስልክ ላይ አርዳታ ይፈልጋሉ? _____
   _____
   _____
9. ዘማዊ ስልክ በማጠቃም የደን ክትትል ላይ ጥቅሙ ምንድነው? ሊሸሻል ማባው? _____
   _____
   _____
10. ዘማዊ ቀፎ በማጠቃም የደን ክትትል ላይ ችግር /ጋፊጣ ምንድነው ? _____
    _____
    _____
11. ዘማዊ ስልክ ላይ ተፅፅዔ ስልጠና በምን በምን ላይ ይፈልጋሉ? _____
    _____
    _____

«አናመሰግናለን »

This questionnaire is created to get insight in the possibilities and difficulties of using smart phones for forest monitoring. The results from this questionnaire will be used to determine the training needs of PFM members to enable them to conduct forest monitoring with smart phones for protection of the forest. Your experiences with the smart phone can be of great value for this project, because you already work with the smart phones. The information from this questionnaire will be used anonymously.

Ranger since: Age: Sex: Male/Female

1: Did you have a (cell) phone before you started using the smart phone for monitoring? Yes/No
2: Did you ever see or used a smart phone before using it for monitoring? Yes/no
3: What was your first opinion about the smart phone?

4: Was the usage of the smart phone easy for you in the beginning?

5: How long did it take to get used to the smart phone?

6: What difficulties/problems did you have in the beginning?

7: What difficulties/problems do you currently have with the smart phone?

8: How often do you currently need help with the smart phone?

9: What do you see as the benefits of using a smart phone for forest monitoring, what improvements did it bring?

10: What do you see as difficulties/problems of using the smart phone for monitoring?

11: What additional training for the smart phone would you like to have?

4. Community member questionnaire

Below the Amharic and English version of the questionnaires amongst the community members are shown. First the Amharic version is shown, followed by the original English version. The questionnaire consists of closed ended questions, to allow quantitative analysis

ስለ አሳታፊ የማህበረሰብ ደን አስተዳደር ለካፋ ዞን ማህበረሰቦች የተዘጋጀ ቃለ መጠይቅ

ይህ ቃለመጠይቅ የተዘጋጀው ዘመናዊ የስልክ ቀፎን በመጠቀም የአሳታፍ ደን አስተዳደር አባላት በደን ጥበቃና ቁጥጥር ላይ ለሚደረገው ጥናት ነው :: ይህ ቃለ መጠይቅ በደን ላይ ግንዛቤ በመፍጠር ፤ለማነቃቃት እና የአሳታፊ ደን አስተዳደር አባላቶች ሙያዊ ክህሎታቸውን በመጨመር በቁጥጥሩ ተጠቃሚዎች ለማድረግ ነው:: ውጤቱም አባላቱ ዘመናዊ ስልክን በመጠቀም የደን ቁጥጥር እና ክትትል ለማድረግ ምን አይነት ስልጠና እንደሚያስፈልጋቸው ለማወቅ ይረዳል::

በቃለመጠይቁ የሚሰጡት መረጃ በታላፍነት ትልቅ ዋጋ አለው :: ስለዚህ ለጥያቄው ከተዘጋጁ መልሶች በማከበብ ምልክት በማድረግ ይሙሉ ::

i. ለግንዛቤ

1. ላለፉት 20 ዓመታት ውስጥ የደን መጠን በኢትዮጵያ
   - 1.1 በእጥፍ ጨምሯል
   - 1.2 በመጠኑ ጨምሯል
   - 1.3 የለውም
   - 1.4 ቀንሷል
   - 1.5 በግማሽ ቀንሷል

2. ባለፉት 20 ዓመታት ውስጥ የደን መጠን በካፋ ውስጥ
   - 2.1 በእጥፍ ጨምሯል
   - 2.2 በመጠኑ ጨምሯል
   - 2.3 የለውም
   - 2.4 በመጠኑ ቀንሷል
   - 2.5 በግማሽ ቀንሷል

3. እንደሚመስለኝ የደን ሽፋን ለውጡ
   - 3.1 በጣም ጥሩ
   - 3.2 ጥሩ
   - 3.3 አጥጋቢ
   - 3.4 መጥፎ
   - 3.5 በጣም መጥፎ

4. ደንን በአግባቡ መጠቀም ለኢኮኖም ጥቅም አለው
   - 4.1 አዉ
   - 4.2 አይደለም
   - 4.3 አላዉቅም

5. ደንን በአግባቡ መጠበቅ ለአካባቢ ጥቅም አለው
   - 5.1 አዉ
   - 5.2 አይደለም
   - 5.3 አላዉቅም

6. የደን መመናመን በአካባቢ እና በኑሮ ላይ የሚያደርሰው ጉዳት ወይም ተፅዕኖ አለ?
   - 6.1 አዉ
   - 6.2 አይደለም
   - 6.3 አላዉቅም

7. እንደሚመስለኝ ደን አስፈላጊ ነው ምክንያቱም ..... /ከአንድ በላይ መልስ ይቻላል /
   - 7.1 ጠቃሚ መስሎ አይታየኝም
   - 7.2 ለማገዶ ብቻ ያገለግላል
   - 7.3 ለተለያዩ ግንባታዎች ያገግላል
   - 7.4 ለሽያጭ ያገለግላል
   - 7.5 ለአደን ያገለግላል
   - 7.6 ብርቅዬ እንስሶችን እና እፅዋቶችን ይጠብቃል
   - 7.7 ዝናብ ያመጣል
   - 7.8 የዝናብ ወቅቶችን ያዛባል
   - 7.9 ቱሪዝምን ያበረታታል
   - 7.10 የካርቦን ልቀትን ይቀንሳል
   - 7.11 ጥቅሙ አልገባኝም
   - 7.12 ሌሎች_____

ii. ቴክኖሎጂ

8. ሞባይል ስልክ አሎት ?
   - 8.1 አዉ
   - 8.2 የለኝም

9. ዘመናዊ የስልክ ቀፎ አሎት ?
   - 9.1 አይደለም
   - 9.2 አላዉቅም

10. በቀን ስልክ ምን ያህል/ስንት ጊዜ ይጠቀማሉ?
    - 10.1 ስልክ አልጠቀምም
    - 10.2 ከ1 – 5 ጊዜ
    - 10.3 6 – 10 ጊዜ
    - 10.4 ከ10 – 15
    - 10.5 ከ16 – 20
    - 10.6 አብዛኛው ጊዜ

11. በስልኮ ላይ ኢንተርኔት አለ?
    - 11.1 አዉ
    - 11.2 የለም
    - 11.3 አላዉቅም

12. ስልክ ለምን አገልግሎት ይጠቀማሉ? /ከአንድ በላይ መልሶች ይቻላል/
    - 12.1 ለመደወል
    - 12.2 አጭር የጽሑፍ መልእክቶች
    - 12.3 ፎቶ ለማንሳት
    - 12.4 እንተርኔት ለመጠቀም
    - 12.5 ከድህረ ገጽ የተለያዩ አገልግሎቶችን ለማውረድ
    - 12.6 ስልክ የለኝም
    - 12.7 ለሌላ አገልግሎት_____

13. በመብራት ወይም ኔትወርክ ችግር ምን ያህል ይቸገራሉ ?
    - 13.1 ከ 1- 2 ጊዜ
    - 13.2 ከ 3- 4 ጊዜ
    - 13.4 ከ 5- 6 ጊዜ
    - 13.5 ከ 9 እና ከዚህ በላይ

iii. በጐ ፈቃደኝነት

14. በደን ክትትል ስራላይ ፈቃደኛ ነኝ ምክንያቱም ...../ከአንድ በላይ አማራጮች መልሶች /
    - 14.1 ደኑ ሳይጐዳ እንዲቀጥል ስለምፈለግ
    - 14.2 በክትትል ስራ ላይ ክፍያ ስለምፈልግ
    - 14.3 ዘመናዊ የስልክ ቀፎ መጠቀም ስለምፈልግ
    - 14.4 ሌሎች ሰዎች እኔ እንድሰራ ስለሚጠብቁ
    - 14.5 ክትትል ማድረግ አልፈልግም
    - 14.6 ሌላ ምክንያት_____

15. መረጃን ከሌሎች ጋር መጋርት
    - 15.1 ከማንም ጋር አልፈልግም
    - 15.2 ከእኔ አሣታፊ የደን አባላት ጋር ብቻ
    - 15.3 ከሌሎች አሳታፊ ደን አባላት ጋር
    - 15.4 ከመንግስት ድርጅት ጋር
    - 15.5 መንግስታዊ ካልሆኑ ድርጅቶች ጋር
    - 15.6 ሌላ_____

16. የደን ክትትል መረጃዎች ማየት /መቃኘት/
    - 16.1 ከኔ አሣታፊ ደን አባላት ጋር
    - 16.2 ከአጐራባች የአሳታፊ ደን ማህበራት አካባቢ
    - 16.3 በአጠቃላይ ካፋ ዞን ውስጥ
    - 16.4 የሌሎችን መረጃ ማየት አልፈልግም

17. ዘመናዊ ስልክ ተጠቅሜ የደን ክትትል ለማድረግ
    - 17.1 አልፈልግም
    - 17.2 በሣምንት አንድ ጊዜ
    - 17.3 በሣምንት ሁለት ጊዜ
    - 17.4 በሁለት ቀን አንድ ጊዜ
    - 17.5 በየቀኑ

18. ዘመናዊ የስልክ ቀፎን ሣልጠቀም ከፍተኛው የደን ክትትል በሣምንት
    - 18.1 ከአንድ ሰዓት ላነሰ ጊዜ
    - 18.2 ከ2 ወይም 3 ሰዓት
    - 18.3 ከ4 ወይም 5 ሰዓት
    - 18.4 ከ5ወይም 6 ሰዓት
    - 18.5 ከ7ወይም ከዚያም በላይ ሰዓታት

19. ዘመናዊነት የስልክ ቀፎን በመጠቀም የደን ክትትል ለማድረግ
    - 19.1 ፈቃደኛ አይደለሁም
    - 19.2 በሣምንት አንድ ጊዜ
    - 19.3 በሣምንት ሁለት ጊዜ
    - 19.4 በሁለት ቀን አንድ ጊዜ
    - 19.5 በየቀኑ

20. በአማካይ ዘመናዊ ስልክን በመጠቀም የደን ክትትል ጊዜ
    - 20.1 ከ1ሰዓት ላነሰ ጊዜ
    - 20.2 2 ወይም 3 ሰዓት
    - 20.3 4 ወይም 5 ሰዓታት
    - 20.4 5 ወይም 6 ሰዓት
    - 20.5 7 ወይም ከዚያ በላይ ሰዓታት መስራት

21. የደን ክትትል ሥራን በዘመናዊ ስልክ መስራት ያለዘመናዊ ስልክ የመስራት ፍላጐት
    - 21.1 ፍላጐት አለኝ
    - 21.2 ፍላጐት የለኝም
    - 21.3 አላውቅም

iv. ጥቅሞች

22 .በደን ክትትል ላይ ክፍያ ቢከፈለኝ ብዙ ጊዜ ሠራለሁ
    - 22.1 አው
    - 22.2 አይደለም
    - 22.3 አላውቅም

23. ለደን ክትትሉ_____ብር በወር ቢከፈለኝ
    - 23.1 ክፍያ አልፈልግም
    - 23.2 0- 33 ብር
    - 23.3 34- 67 ብር
    - 23.4 68- 100 ብር
    - 23.5 ከ100 ብር በላይ

v. Ⅴ. መረጃዎች

ቀበሌ_____

ወረዳ _____

የደን ማህበሩ /PFM/ ስም_____

ዕድሜ

1. 10 ወይም
2. 11 - 20
3. 21 - 30
4. 41- 50
5. 51- 60

«በቃለ መጠይቁ ስለተሣተፉ እጅግ በጣም አመሰግናለው !!!»

Questionnaire about PFM communities in the Kaffa Region

This questionnaire is part of a research project about forest monitoring with smart phones by PFM members. This questionnaire tries to establish the awareness about the forest, the motivation and benefits of monitoring and the technical capabilities of the PFM members. The results will be used to determine the training needs of PFM members, to be able to conduct forest monitoring with smart phones. The information of this questionnaire will be used anonymously.
Please put a circle around the number of the preferred answers. For some questions multiple answers are possible, this is indicated after the question.

Awareness

The forest cover in Ethiopia has ..... in the last 20 years

1. Doubled
2. Slightly increased
3. Remained about the same
4. Slightly decreased
5. Halved

The forest cover in Kaffa has ..... in the last 20 years

1. Doubled
2. Slightly increased
3. Remained about the same
4. Slightly decreased
5. Halved

I think this forest cover change is:

1. Very good
2. Good
3. Acceptable
4. Bad
5. Very bad

Keeping the forest intact is important for the economy:

1. Yes
2. No
3. I do not know

Keeping the forest intact is important for the environment:

1. Yes
2. No
3. I do not know

A decrease of the forest can have negative effects on the livelihood of your area:

1. Yes
2. No
3. I do not know

I think the forest is important because (multiple answers possible):

1. I do not think it is important
2. It can be used for fuel wood
3. The wood can be used as construction material
4. The wood can be sold
5. It can be used for hunting
6. It preserves unique animal and plant species
7. It generates rain throughout the area
8. It can affect the rain season
9. It can stimulate tourism
10. It reduces carbon emissions
11. I do not think it is important
12. I don't know
13. Other: _____
    _____

Technology

Do you have a cell phone?

1. Yes
2. No

Do you have a smart phone?

1. Yes
2. No

How often do you use your phone per day?

1. I do not use a phone
2. 1-5 times
3. 6-10 times
4. 10-15 times
5. 16-20 times
6. more often

Do you have internet connection on your phone?

1. Yes
2. No
3. I do not know

What do you use your phone for (multiple answers possible)?

1. Calling
2. Sending text messages
3. Making pictures
4. Browsing internet
5. Downloading applications
6. I do not have a phone
7. Other: _____

_____

How often you cannot use your phone because of a network or power error per week?

1. 1-2 times
2. 3-4 times
3. 5-6 times
4. 7-8 times
5. 9 or more times

Motivation

I am willing to conduct forest monitoring, because (multiple answers possible):

1. I want to help keeping the forest intact
2. I want to get paid for monitoring
3. I want to use a smart phone
4. Other people expect me to do it
5. I do not want to conduct monitoring
6. Other: _____

_____

I would like to share my data with:

1. Nobody
2. My PFM members
3. Members from other PFM
4. Governmental Organizations
5. Non-Governmental Organizations:
6. Other: _____

_____

I would like to see the monitoring data from:

1. Only my PFM
2. Neighboring PFM areas
3. The whole Kaffa region
4. I do not want see the data of others

I am willing to conduct forest monitoring **without** a smart phone

1. I am not
2. Once a week
3. Twice a week
4. Each two days
5. Daily

The maximum monitoring time per week for me **without** a smart phone is

1. 1 hour or less
2. 2 or 3 hours
3. 4 or 5 hours
4. 5 or 6 hours
5. 7 or more hours

I am willing to conduct forest monitoring **with** a smart phone

1. I am not
2. Once a week
3. Twice a week
4. Each two days
5. Daily

The maximum monitoring time per week for me **with** a smart phone is

1. 1 hour or less
2. 2 or 3 hours
3. 4 or 5 hours
4. 5 or 6 hours
5. 7 or more hours

I am more willing to conduct forest monitoring with a smart phone than without a smart phone

1. Yes
2. No
3. I do not know

Benefit

I would monitor more often if I get paid for monitoring

1. Yes
2. No
3. I do not know

I would like to get paid ..... birr per month to conduct forest monitoring

1. I do not want to get paid
2. 0-33 birr
3. 34-67 birr
4. 68-100 birr
5. More than 100 birr, namely: _____

Personal information

Kebele: _____

Woreda: _____

PFM: _____

My age is

1. 10 or younger
2. 11-20
3. 21-30
4. 31-40
5. 41-50
6. 51-60
7. 61 or older

My highest education is:

1. None
2. Primary school
3. Secondary school
4. University

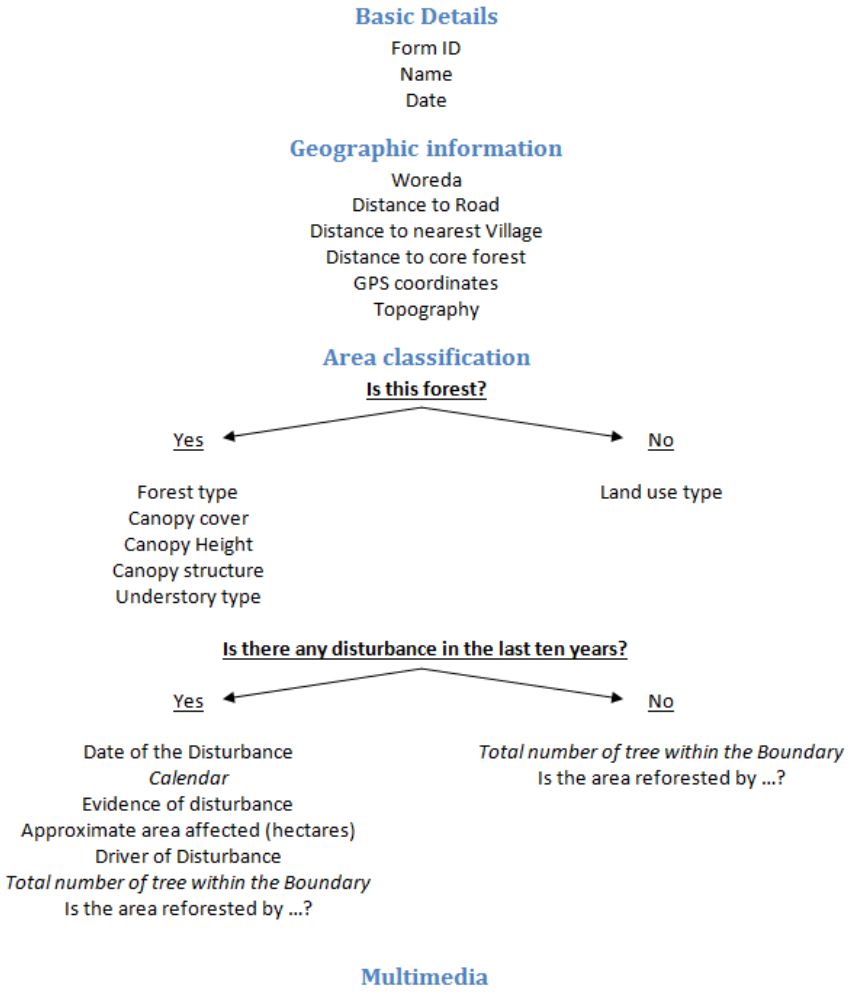
I am a

1. Male
2. Female

Thank you for your participation in this questionnaire.

5. Monitoring form overview

The figure below shows a schematic overview of the monitoring form. All questions are closed end questions, except for the Form ID. In blue the different groups of questions within the form are shown. Normal questions are not underlined, main questions are underlined. The answer on the main questions, determines the following sub question. Other questions can be seen as sub-questions. At the end of the form five pictures and one audio recording can be saved, within the group multimedia.



6. Data structure

The tables below represent the data of one monitored location. Normally one entry is displayed on one row; here they are split up for visualization. Validation measurements by the local expert and PFM measurements are combined according to the Location and form ID number (Table 11). Information about the geography can be seen in Table 12, entries belonging to the Area Classification group are shown in Table 13 and Table 14. After the Validation and PFM measurements are combined, the Classification results are automatically computed.

Table 11: Basic details entries

Location	meta:instanceID	FormID	Type	What	When	BasicDetails:Name	BasicDetails:Date
2	uuid:134cfd9d-f07a-4e11-8abf-0a6367552632	2	PFM	FreeMonitoring	Week1	Endale Belay	25-11-2013

Table 12: Geographic information entries

Woreda	DistanceToRoad	DistanceToVillage	DistanceToCore	Latitude	Longitude	Altitude	Accuracy	LargerPlot	Topography
Decha	1	1	1	7.1936395	36.267921	1602.5	3	SCOMP5062.wur	MSLP

Table 13: First Area Classification entries, consisting of the first Main Question and following sub questions.

is_forest	is_forest_yes	CanopyCover	CanopyHeight	CanopyStructure	UnderstoryType	is_forest_no	is_Disturbance
no	null	null	null	null	null	COF	yes

Table 14: Second Area Classification entries, consisting of the second Main Question and following sub questions.

is_Disturbance_yes	Date	Calendar	Evidence	AreaAffected	Driver	is_Disturbance_No	counttree	reforestation
null	00:00.0	ETHIOPIAN	SEL	1	CFIR	null	12	NO

7. Distance computation model

Below the model is displayed which is used to create the buffers around the Roads, Core Forest and Villages. The model looks elaborate at first sight, but the same steps are repeated for all three distances. The final result gives the three distances in the original input file. First a buffer is created around the object, which is afterwards intersected with the monitored locations. Thereafter the distance values are copied to a new field with unique name and redundant field are deleted, before the next intersect is conducted. These steps are necessary to prevent confusion between distance values, since the intersect operation gives each field the same name.

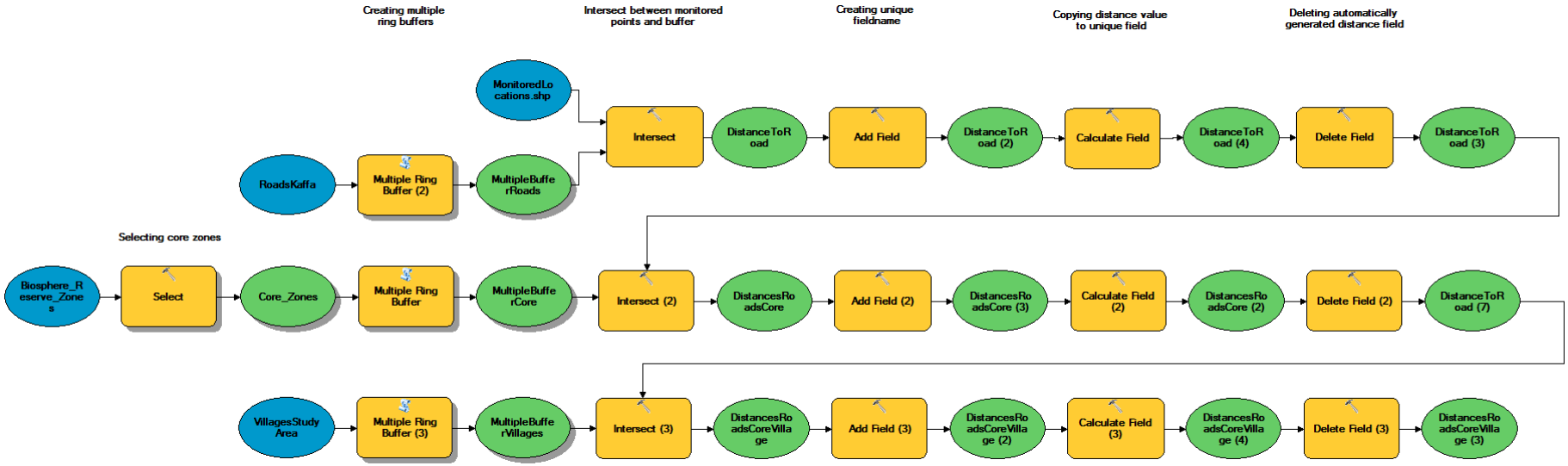


Figure 15: Model to compute actual distance from monitored location to nearest road, village and core forest.

8. Example of Categorization

This appendix illustrates the categorization of the monitored results according to the categorization table (Table 4). The two tables below show the monitoring results of two locations by the PFM members and the expert who validated the data. The first table shows the answers of main question one, the second shows the second main question. Although both monitoring results contain two errors, the categorization results are different. Location one is indicated as incorrect (2) since the first main question is answered incorrectly. The second result is indicated as partly correct (3); both main questions are answered correctly, however two sub questions are answered incorrectly.

Table 15: Monitoring results of two locations for the first main question. In green correct answers are shown, in red incorrect answer. Entries in grey show questions which are not asked during monitoring, because they belong to the other main question. The question in bold is the main question.

Number	Result	Who	**Is this forest**	Forest type	Canopy Cover	Canopy Height	Canopy Structure	Understory Type	Land use type
1	Incorrect	PFM	yes	DEG	1	1	MULTI	GRASS	null
		Expert	no	null	null	null	null	null	CROP
2	Partly correct	PFM	no	null	null	null	null	null	COF
		Expert	no	null	null	null	null	null	COF

Table 16: Monitoring results of two locations for the second main question. In green correct answers are shown, in red incorrect answer. Entries in grey show questions which are not asked during monitoring, because they belong to the other main question. The question in bold is the main question.

Number	Result		**Is there disturbance**	Evidence Of Disturbance	Approximate Area Affected	Driver Of Disturbance	Reforestation
1	Incorrect	PFM	yes	SEL GRA	1	OTH	NO
		Expert	yes	GRA	1	OTH	NO
2	Partly correct	PFM	yes	SEL	1	CFIR	NO
		Expert	yes	SEL GRA	0.5	ICOFF CFIR	NO