Social and Environmental Impact Assessment of the Form Ghana reforestation of Afrensu Brohuma Forest Reserve, Ghana

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The environmental part was based on the biodiversity analysis executed by Mr. A. Prosper Manu. His report 'Biodiversity monitoring in Asubima and Afrensu Brohuma Forest Reserves, Ghana' was the basis for this SEIA report. Other calculations were based on internal monitoring measurements performed by Form Ghana for VCS baseline calculations.

The social assessment was executed by Ms. M. Tollenaar in cooperation with Mr. F. Ogoe, Plantation Manager of Form Ghana and Mr. J. Leonie, Plantation Foreman of Form Ghana. The assessment was facilitated by Mr. W. Fourie, Managing Director of Form Ghana. We thank the contact persons at the Offinso District Forestry Office, the District Assembly in Akumadan, the District Education Center in Akumadan, the District Fire Office in Nkenkasu and the Akumadan Health Center for their assistance. Special thanks goes out to the Akumadan Hene and the Nkenkasu Hene for giving us their time and sharing their knowledge with us. Also, we are grateful to the chiefs, focal persons and respondents of the fringing communities for their cooperation in the field.

SUMMARY

Form Ghana has commissioned Form international to conduct a Social and Environmental Impact Assessment (SEIA) to contribute to the sustainable implementation of the company's reforestation activities in the Afrensu Brohuma Forest Reserve.

Figure 1: View of Asubima and Afrenso Brohuma Forest Reserves

Literature was consulted and field work was executed in the proposed project area to collect baseline information. Socio-economic studies identified social, economic and cultural factors and processes that can have an impact on the project. Interviews were held with local communities around the project site, key informants and officials of the FSD as well as Form Project staff. Environmental auditing and flora and fauna inventory studies were carried out to determine present stocking levels in the reserve. A hydrological survey was also conducted to determine the potential for the project's impact on water bodies and its environmental and social benefits for those living near the forest. These sources of data were presented in a social and environmental impact matrix to highlight sources of major concern for the project management.

Form Ghana intends to plant at least 90% of the area with teak (*Tectona grandis*). Approximately 10% of the total amount of trees planted will be indigenous. These indigenous trees will be planted throughout the plantation and in the buffer zones bordering the waterways. Considering the highly degraded current state of the forest reserve, the consultants and relevant stakeholders concluded that these efforts are likely to have a positive impact on the environment as well as on the local society. The intended forest cover has the potential to enhance water, soil, forest and general ecological integrity (biodiversity), and provide a sustainable source of income and other goods and services for local communities. The issues of benefit sharing and land access are key issues that the project management has to deal with.

CONTENTS

1. INTRODUCTION

Form Ghana has commissioned Form international to conduct a Social and Environmental Impact Assessment (SEIA) to contribute to the sustainable implementation of the company's reforestation activities in the Afrensu Brohuma Forest Reserve (Appendix D).

Form Ghana is a reforestation company established in Ghana in 2007, which aims at large-scale reforestation of degraded Forest Reserves in Ghana while conserving and restoring natural, riparian forest. Their vision is to operate in a sustainable environment and to contribute significantly to the quality of people's life related to or affected by the company, to environmental protection and to the Ghanaian economy. Form Ghana is therefore committed to operate in compliance with the Principles and Criteria of the Forest Stewardship Council™ (FSC-C044035) (see box below).

FSC™ Principles - 10 rules for responsible forest management

Principle 1: Compliance with laws and FSC™ (FSC-C044035) Principles
Comply with all laws, regulations, treaties, conventions and agreements, together with all FSC™ (FSC-C044035) Principles and Criteria.

Principle 2: Tenure and use rights and responsibilities
Define, document and legally establish long-term tenure and use rights.

Principle 3: Indigenous peoples' rights
Identify and uphold indigenous peoples' rights of ownership and use of land and resources.

Principle 4: Community relations and worker's rights
Maintain or enhance forest workers' and local communities' social and economic well-being.

Principle 5: Benefits from the forest
Maintain or enhance long term economic, social and environmental benefits from the forest.

Principle 6: Environmental impact
Maintain or restore the ecosystem, its biodiversity, resources and landscapes.

Principle 7: Management plan
Have a management plan, implemented, monitored and documented.

Principle 8: Monitoring and assessment
Demonstrate progress towards management objectives.

Principle 9: Maintenance of high conservation value forests
Maintain or enhance the attributes which define such forests.

Principle 10: Plantations
Plan and manage plantations in accordance with FSC™ (FSC-C044035) Principles and Criteria.

Source: *www.FSC.org*

An FSC™ (FSC-C044035) certificate ensures an improved social standard and employment for the local population, the enhancement of the local economy and a guaranteed timber supply for the forest industry. The following objectives have been stated by Form Ghana regarding this commitment:

- Both teak and indigenous tree species (>10%) are planted on the lease area;
- Degraded riparian zones will be actively restored and conserved;
- The project will be executed in close collaboration with local communities and other stakeholders;
- There will be transparent benefit sharing with relevant stakeholders;
- Job opportunities will be created for local people in several plantation activities;
- Farmers are offered the opportunity for intercropping in the first two years of planting.

Employees are offered a safe and healthy working environment, with good employment terms, favourable insurance policy conditions and pension build-up. Local communities benefit directly or indirectly from Form Ghana through employment opportunities, revenue sharing, community services and technical assistance. Farmers are offered the opportunity to intercrop within the plantation, with respect for the terms and conditions that apply under FSC™ (FSC-CO044035) certification and Form Ghana policy. Examples of these conditions are the prohibition of; the use of fertilizers, pesticides and herbicides, the burning of fallow land and the storage of harvested products on the land.

Biological diversity, water sources, and fragile ecosystems found in or near the plantations will be conserved or restored where possible. This includes the riparian buffer zones; 30 meters on each side of the waterway. The carbon storage function of the plantation forests contributes to climate change mitigation. Trees planted on the plantations consist for a maximum of 90% teak and at least 10% mixed local species.

The unique sustainability concept of Form

Social	Ecological	Economical
• Landlease instead of purchase • Intercropping by local farmers • High standard working conditions • Trainings for employees • Revenues partly return to local community • Stimulate outgrowing	• Reforestation of degraded land • FSC certified • > 10% of the planted seedlings are local species • Conservation of bufferzones along waterways	• Yield much higher than from natural forest • Shorter harvesting cycle compared to natural forest • Respond to declining supply and growing demand for sustainable timber • Contribute to 260 miljoen ha extra forest needed to meet global demand for timber

Form Ghana has signed a land lease agreement with traditional land owners and the Government of Ghana for the reforestation of the project area to restore productive forest in the degraded forest reserves. This lease construction and benefit sharing are part of the national policy to restore degraded forest reserves in Ghana, which is a strong policy instrument showing the commitment of the Government of Ghana to conserve, restore and promote the sustainable use of forest resources in the country.

The degraded forest reserves are of major concern to the Government of Ghana because approximately 94% is in a deplorable condition as a result of unsustainable harvesting and encroachment. Restoring these areas is therefore a key component of Ghana's 1994 Forest and Wildlife Policy and the 1996-2020 Forestry Development Master Plan as well as other related sector policies including the Ghana Poverty Reduction Strategy (GPRS) paper. The reforestation project initiated by Form Ghana in Afrensu Brohuma Forest Reserve fits well within this policy. The reserve has been declared degraded by the Forestry Commission and has suffered from ongoing degradation since then. From the satellite image below (figure 2, Image from 24-02-2011, RapidEye 5m resolution), it can be deduced that in 2011, the largest part of the FR was deforested.

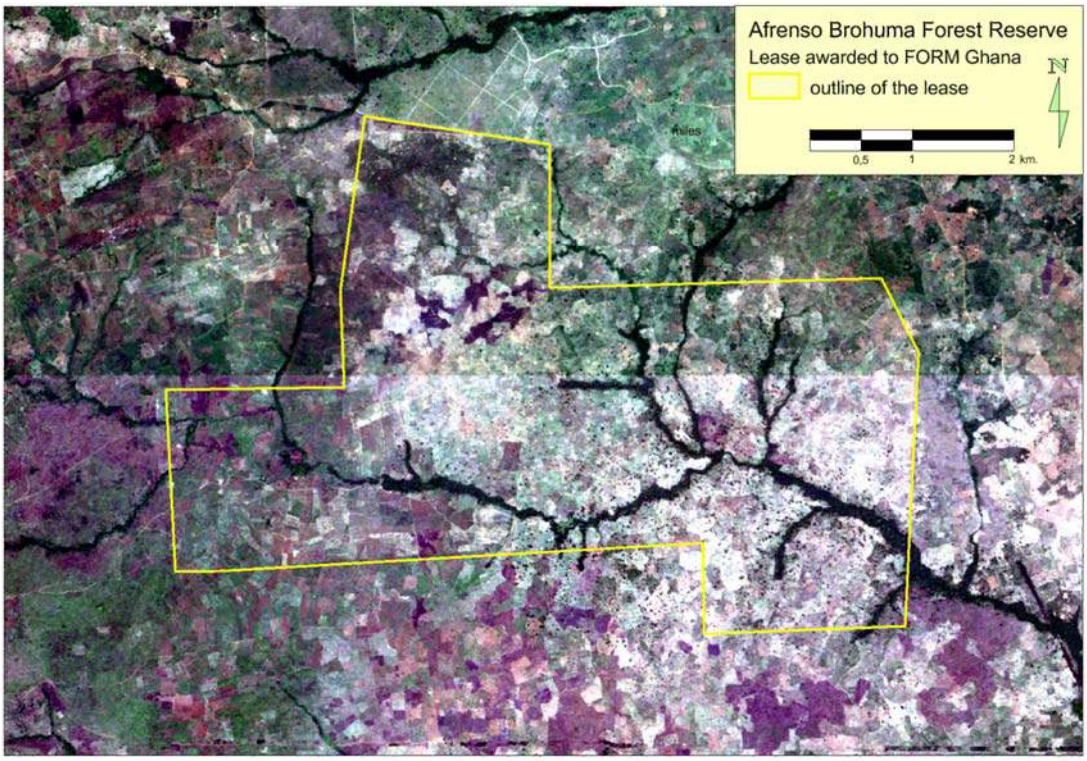

Figure 2. Satellite image of part of Afrensu Brohuma forest reserve

Form Ghana is currently active in the north of the Ashanti Region, near Akumadan, where the company had started to reforest the degraded Asubima Forest Reserve in 2008. Reforestation of parts of the highly degraded Afrensu Brohuma Forest Reserve, which is directly adjacent to Asubima Forest Reserve, has just commenced. The Forestry Commission has already given permission to Form Ghana to establish a plantation in the Forest Reserve in 2010 and the first 869ha of teak have been planted there in 2011.

Form Ghana has commissioned Form international to perform a Social and Environmental Impact Assessment in Afrensu Brohuma Forest Reserve. Form international has acquired ample experience in providing technical assistance to forest plantation companies on the subjects of tree species selection, nursery establishment and management, planting techniques, thinning regimes, FSC™ (FSC-C044035) certification, and more. In this document the methodology, results and conclusions of the com-missioned SEIA are presented. Recommendations are made for the sustainable implementation of the reforestation activities.

2. STUDY OBJECTIVES

The main purpose of the SEIA is to evaluate the impact of the reforestation project activities planned in Afrensu Brohuma Forest Reserve on the welfare of adjacent communities and the environment, from socio-economic and ecological perspectives. This will inform and guide the project management team in making sound decisions on project design and implementation, in line with sustainable forest management. The general objectives for the study are:

- To undertake baseline socio-economic and environmental studies in the project area.
- To assess social and environmental impacts of proposed project by means of SWOT (strengths, weaknesses, opportunities and threats) and impact analyses.
- To make recommendations for enhancement of positive impacts and mitigation of negative effects

The SEIA can be used to:

- Integrate environmental and socio-economical components in management decisions at the earliest stages of program investments.
- Develop plans to mitigate negative effects and enhance positive effects on existing conditions.
- Promote participation by local communities, project proponents, private and government agencies in the assessment and review of proposed actions.

3. METHODOLOGY

3.1 Site description

The plantation is located within the Afrensu Brohuma Forest Reserve (ABFR) in Offinso North District near Akumadan, in the Ashanti region. The ABFR lies within a grid reference of 7N22, 2W53. It became a forest reserve in 1934. Last logging was recorded in 1991. The reserve is managed along with Asubima, Mankrang, Afram Headwaters, Gianima, Kwamisa Group, Asufu Shelterbelt East and Opro River. Altogether these reserves constitute Forest Management Unit (FMU) 33. The Afrensu Brohuma Forest Reserve covers a total area of 73 km^2. Approximately 1250 ha of this reserve constitute the area allocated to Form Ghana Limited for commercial plantation development (Appendix D). More land compartments will be attained in the following years. The entire reserve is located within the dry semi-deciduous forest zone (DSFZ) (Hall and Swaine, 1981). The terrain is undulating and covered with a very open canopy alternating with sandy- rock patches.
Originally, the main vegetation type in the reserve used to be the dry semi-deciduous forest, which generally contains valuable timber trees such as Wawa, Odum, Sapele and Krokodua (Amponsa-kwatiah, 1993). Today however, large areas of the reserve are covered by savannah, resulting from human induced land degradation (see satellite image). Due to intensive farming and reported annual fires very little of the original forest remains and what is left is secondary forest and grassland. In the past, farmers protected the large trees on their farms but most of them have been logged eventually so that very few still remain today.

3.2 Data collection

The main survey was sectioned into three parts:

Socio Economic Situation	Ecology	Physical Environment
Interviews with community members Discussion with traditional landowners Discussion with institutions	Flora study Small Mammal Survey Bird Survey Butterfly Survey Medium Mammal Survey	Hydrological Survey Soil Research Topography

The different parts of the assessment will be discussed in the sections below.

3.2.1 Socio - economic study

The social and environmental impact assessment was based on structured field data and informal interviews with stakeholders. Stakeholders were defined as parties that are likely to be affected by the proposed project, such as farmers, service providers and government agencies. Interviews were held about their perception on the impact of the proposed project.

Seven communities were selected for this assessment; Libya, Meta, Joe-Nkwanta, Nkubem, Dompuase, Amponsankrom and Nsukusua (figure 3). In each of the communities, a group discussion was held to acquire general information on the village and 8 households were asked to fill out a questionnaire (Appendix A). In Libya, only 7 households were present at the time of visitation, so only 7 questionnaires were completed. The villages of Joe-Nkwanta and Nkubem were considered as one village in this assessment because they are located very close to each other.

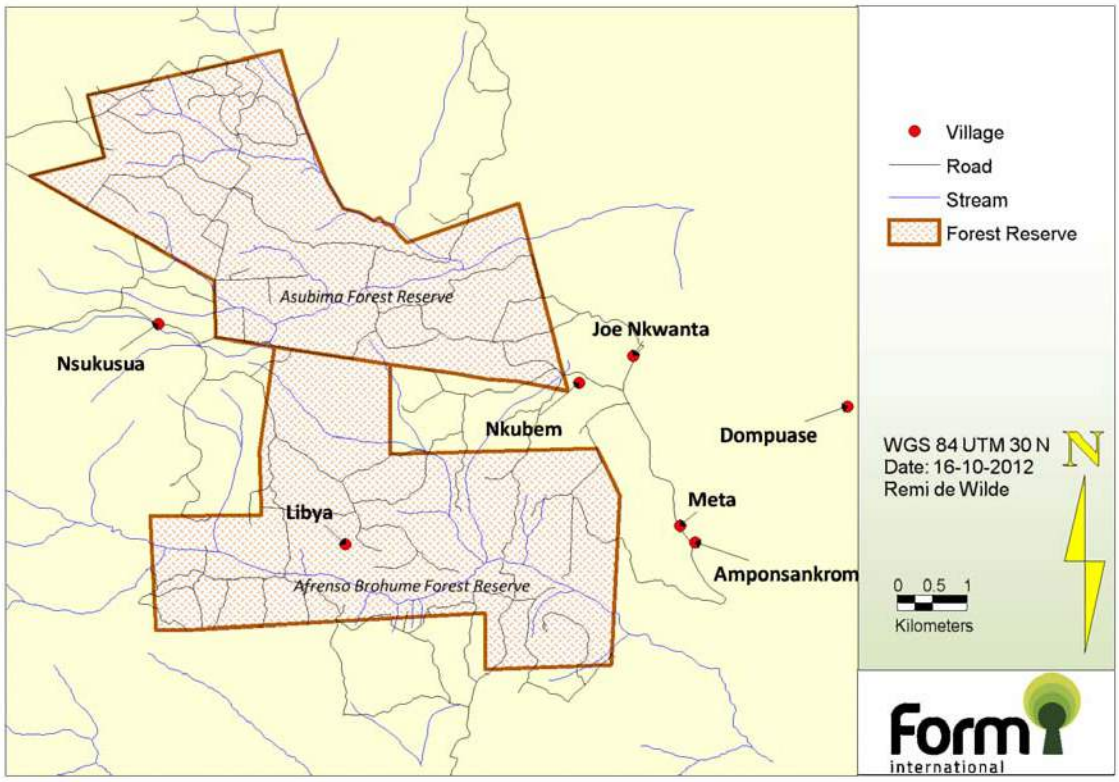

Figure 3: Selected villages for interviews and questionnaires.

3.2.2 Ecological survey

Flora survey

No measurements were taken before reforestation activities started in Afrensu Brohuma Forest Reserve. In order to make a relevant analysis of the impact of the project on the vegetation, a reconstruction of the baseline vegetation was made. Data on the clearing of the hindering tree vegetation york (*Broussonetia papyfera*) and teak (*Tectona grandis*)) and average numbers of remnant indigenous trees per plot were obtained from the VCS project description report. Also, interviews conducted with farmers and observations from areas adjacent to the planted forest reserve areas were taken into account.

A biodiversity assessment was conducted by A. Prosper Manu in 2011, but only in the riparian buffer zones of Afrensu Brohuma Forest Reserve. Using a Map Info function, 18 GPS points were randomly selected. These points marked the centre of the circle-shaped permanent plots, sized 200m^2 (radius=7.98 m), that were established in the reserve. The centre of the plots was indicated with a wooden stick. A qualified botanist helped identifying the flora, mainly the woody species. For trees, shrubs and grasses, a guide-book was used (e.g. Hawthorn and Jongkind, 2006). The measurements of vegetation within these plots are described below.

To measure *shrubs, herbs, grass and seedling* cover, 5 temporary subplots of 1 m^2 were made within each plot. Species name, height and cover in percentage of the subplot were recorded. Coverage was only documented if it exceeded 15-20% of the subplot.
For each *tree*, the following characteristics were recorded: species (scientific name and local name), number of individuals per species (> 1.30m). If *lianas* were present in a plot, the species name was recorded. The presence of *standing and lying dead wood* was included.

Figure 4. Biodiversity in Ghana: Slender Snouted Crocodile (Crocodylus cataphractus)

Small mammals

Mammals were considered 'small' in this study if they weighed less than 1kg, as described by Stuart and Stuart (2006). Examples of small mammals are shrews, rodents and bats. The populations of small mammals have a significant relationship to habitat, vegetation cover and flora diversity. Higher vegetation cover and diverse flora habitat have proved to result in higher abundance and diversity of small mammals (Blouin-Demers et al., 2003). Reasons for this relationship are their short lifespan, rapid population dynamics and low hunting pressure in comparison to larger mammals. Shrews, for instance, are never hunted because of the strong, unpleasant smell of their flank glands. They are also good bio-indicators because of the high diversity in terms of species and habitat preferences, in tropical Africa (Barrière et al. 2000). Small mammals are therefore considered as good bio-indicators of habitat.

Terrestrial small mammals (shrews and small rodents) were sampled mainly with Sherman live traps, and bats were sampled based on observations. Two sizes of Sherman live traps were used: large folding and small folding aluminum. Peanut butter and fishmeal were used for bait. A pre-baiting period preceded actual trap-

ping (Sutherland, 1996). At the evening of the last pre-baiting day, traps were set and checked twice daily, in the morning and evenings. Trapping lasted for 5 or 6 nights and the traps were collected on 288 'trap-nights'. Captured animals were identified using Stuart and Stuart (2006). The bat species were observed at their abode.

Avifauna

Birds are good indicators of spatial biodiversity and sustainability because they are high in the food chain and occupy a broad range of ecosystems Compared to other taxa, a wealth of data has been (or can be) collected by volunteers and professionals. Bird population sizes, trends and conservation status are often well known and they appeal to a wide audience. Therefore, an increasing interest in the use of ornithology data can be observed. Habitat indicators can be used to assess macro level changes, but also to identify more subtle changes in biodiversity within habitats. By highlighting these changes, bird indicators can point to the need for more detailed research to identify the causes of changes in population of different species. As West-African forests are rapidly disappearing, the survival of the birds is becoming increasingly dependent on ever fewer areas. Despite of a number of field studies conducted in the region in recent years (e.g. Demey and Rainey 2004, 2005; Rainey and Asamoah 2005; De Laat 2011), the avifauna in the majority of these forests remains largely unknown. No ornithological studies have been conducted previously in Afrensu Brohuma.

Six days of field work have been carried out. The main method used in this study consisted of observing birds by walking slowly along ten transects, laid out on existing trails, quadrant lines or, when necessary, a path was cut through dense vegetation.

Notes were taken on both visual observations and bird vocalizations. Some recordings were made for archiving purposes. Field work was carried out in the morning, from dawn (usually 6:30GMT) until noon, and in the afternoon from 15:00GMT until sunset (18:00GMT). For each field day, a list was compiled of all the species that were recorded. Numbers of individuals or flocks were noted, as well as basic information on the habitat in which the birds were observed. For the purposes of standardization, we followed the nomenclature, taxonomy and sequence of Sinclair and Ryan (2003).

Butterflies

Tropical forest ecosystems are under enormous pressure all over the world. Although the magnitude of biodiversity present on Earth is largely unknown (Dobson 1995) and its estimates remain highly controversial (May, 1990), it is generally accepted that much of the global diversity in terms of numbers of species is repre-

sented by arthropods inhabiting tropical rainforests (Wilson 1988). The data about the effects of forest disturbance on these arthropods is limited (Eggleton et al., 1995). However, several studies of butterflies (Hill et al. 1995; De Vries et al. 1997; Wood and Gillman 1998; Bakowski and Doku-Marfo,2006) showed that low disturbance levels have a positive effect on diversity and abundance of rainforest butterflies (Wood and Gillman 1998). These results are in accordance with the intermediate disturbance theory of Connell (1978) and have parallels in temperate forest habitats, where forest management providing a large range of shade levels has been found to increase the number of habitats suitable for different butterfly species (Warren 1985). Although deforestation rates are highest in several West African regions, little is known about the effects of forest disturbance on Afro-tropical butterflies (Larsen 1995a).
Butterflies are excellent model organisms for evaluating the status of natural communities in degraded landscapes. Because of the ease of collecting and close ties of individual *Lepidoptera* species to host plants and their habitats, butterflies are excellent bio-indicators and provide a wealth of information about habitats, associated host plants, and nectar sources (Smith et al., 1994; Debrot et al., 1999). Butterflies also serve as important plant pollinators in the local environment, and help pollinate many economically important plant species. A contemporary discourse regarding butterfly conservation and its importance is however lacking among the public. The study done in 201, mainly documented abundance and diversity of butterflies in Afrensu Brohuma Forest Reserve in Ghana.

Transects of 1 km in length were selected within the forest, along trails, on the edges of the forest, and at selected locations in the indigenous riparian forest and teak plantations. Most specimens were physically collected with hand-held nets, except in a few cases when easily recognizable members of the family *Papilionidae* were identified in flight. Collecting was done daily, between 9:00GMT and 12:00GMT. Butterflies observed two meters on either side of the transect and up to five meters in front were trapped and released after identification (Hill et al. 1995).
Traps were used as described by Mühlenberg (1993) and baited with fermented bananas. This method yielded a number of species of the *Nymphalidae*, which are otherwise rather difficult to catch using the nets, especially members of the genus *Charaxes*. Three baited traps were set out, two located in the indigenous forest, one within the teak plantation. The traps were installed one meter above the ground within the study site. Bait was refreshed every 24 hours. The traps were regularly moved to cover most of the collection area.
Collected butterflies were identified using ‘Butterflies of West Africa’ (Larsen 2005). Butterfly diversity was estimated using the Shannon-Weiner (H’) diversity index (Magurran 1988).

Medium-sized mammals

Mammals were classified as 'medium-sized' when the average weight was 5-45kg (Estes, 1991; Stuart and Stuart, 2006). Many medium-sized mammal species have been exploited locally and are likely to have been driven to local extinction during the past century (eg. Wilson, 1988). The IUCN Red List noted that many animals found in Ghana are threatened, endangered or extinct (IUCN 2010). Indiscriminate hunting and clearing of forest for agricultural purposes have played a major role in the decline and extinction of wildlife species in the area. In Ghana, however, there are few records that show the loss of wildlife species in the country.
Mammals assist the maintenance and regeneration of tropical forest by predation, seed dispersion, grazing, and frugivory (Cuaron, 2000).

Line transects were established and interviews were conducted in nearby villages to survey the medium-sized mammals. Transects were walked daily and mammal species were recorded using both direct observation and indirect observation through identification of footprints and tracks, dung/pellets, feed and feeding sites, and calls of animals. Sighted animals species and geographic location were recorded. Perpendicular distance from the transect line to the sign of the animal was recorded for determining estimated densities of medium-sized mammals. Old shotgun shells were recorded to assess local hunting pressure. Species identification was based on Stuart and Stuart (2006).

3.2.3 Hydrological survey

Data for the hydrological survey are obtained form the hydrological assessment of Asubima Forest Reserve, executed in 2011. Samples were taken at strategic points at outlets and inlets of waterways and analyzed in a laboratory. The following parameters were measured and the values compared to the maximum values for safe drinking water according to the WHO: pH, Turbidity (FAU), Dissolved Oxygen/(m/l), Conductivity (µs/cm), Dissolved solids, Alkalinity, Hardness, Calcium Hardness, Magnesium Hardness, Calcium, Magnesium, Chloride, Nitrate, Phosphate, Iron. It can be assumed that the results for the water in Asubima Forest Reserve are representative for Afrensu Brohuma Forest Reserve.

3.2.4 Soil survey

Data for the soil survey are obtained form the soil reconnaissance assessment in Asubima Forest Reserve, executed in 2012 by Mr. J.H.M. Scholten and Mr. A. Augustine.

During two days of field work, 18 auger hole observations were made, distributed over the entire area. Special attention was paid to areas where young teak plants showed stunted growth; it needed to be clarified whether soil related factors were the cause or other factors.

Figure 5. Young teak trees in Asubima Forest Reserve

4. RESULTS

4.1 Socio-economic study

4.1.1 Village facilities

From the group discussions held in the fringing communities, the facilities in each village were deducted. Below is a short description of the facilities, as summarized in table 4.1.

Table 4.1. Facilities per village

Facility	Village where facility is present	Remark
Roads	All villages	Dirt roads only
Electricity	None of the villages	No electricity or generator
Clinic	None of the villages	Nearest: Akumadan, Nkenkasu
Primary school	Dompuase and Meta	Other villages go to Dompuase, Meta or Akumadan
JHS	None of the villages	Nearest: Akumadan, Akuma, Makyemabre, Nkoranza
Market	None of the villages	Nearest: Akumadan, Nkoranza, Techiman, Abofour
Water (borehole)	Meta, Dompuase*, Joe-Nkwanta/ Nkubem* and Amponsankrom*	Only Meta has a functioning bore-hole, the other villages use water from the river.

Roads

Roads were generally of poor quality. None of the communities included in this assessment were connected to paved roads and the dirt roads were not well maintained. Many communities complained about poor connection to the towns/markets during the rainy season because trucks could not drive on the roads. Farmers were often forced to walk long distances to sell their products.

Electricity

There is no electricity or generator present in any of the villages. Phones are charged with batteries that they can buy and charge in town. Government official have promised to bring electricity to some of the villages, but so far haven't managed to construct it yet.

Hospital

None of the communities has a clinic. Nearest hospitals are the Akumadan Health Centre and the District Hospital in Nkenkasu, on average 12km away.

School

Primary schools are present in Dompuase and in Meta. Children from Libya, Nkubem and Joe-Nkwanta go to school in Dompuase, children from Amponsankrom go to Meta. For Nsukusua, the nearest primary school is located in Akumadan, 11 km away. For Junior High School, students travel to Akumadan, Akuma, Makyemabre or Nkoranza, max. 25km away. Many students attending JHS live in the town where they attend school and return to the village in weekends and/or for holidays.

Market

Farmers sell their products on the markets of Akumadan, Nkoranza, Techiman and Abofour. Market days are; Tuesday, Friday and Thursday respectively. On these days, market trucks come to pick up the farmers unless the rains make it impossible for the trucks to pass.

Water

Only the village of Meta has a functioning borehole where people can get their water from. The rest of the communities make use of water from nearby streams. Boreholes were constructed in Dompuase, Joe-Nkwanta/Nkubem and Amponsankrom but they all failed to work properly. The first was dug but couldn't reach the water, so they gave up. For Joe-Nkwanta/Nkubem, a borehole exists but the water that comes out is too turbid to use. In Amponsankrom, there is hardly any water coming out of the borehole so the people prefer to use the river.

4.1.2 Occupation and age of the people

The information for these paragraphs was gathered from questionnaires filled out by household heads in the selected communities (figure 4.13). The vast majority of the respondents above 12 years of age was farmer (71%). The next largest group was student (13%) and trader (4%). Other professions were tailor, shop-owner, hairdresser, mason, nurse, midwife, pastor and security.

The average age of the respondents was 25, but the most frequently occurring age is 5. It should be noted that most community members were not sure of their age or the age of their children. These numbers are based on their estimates and the author's observations.

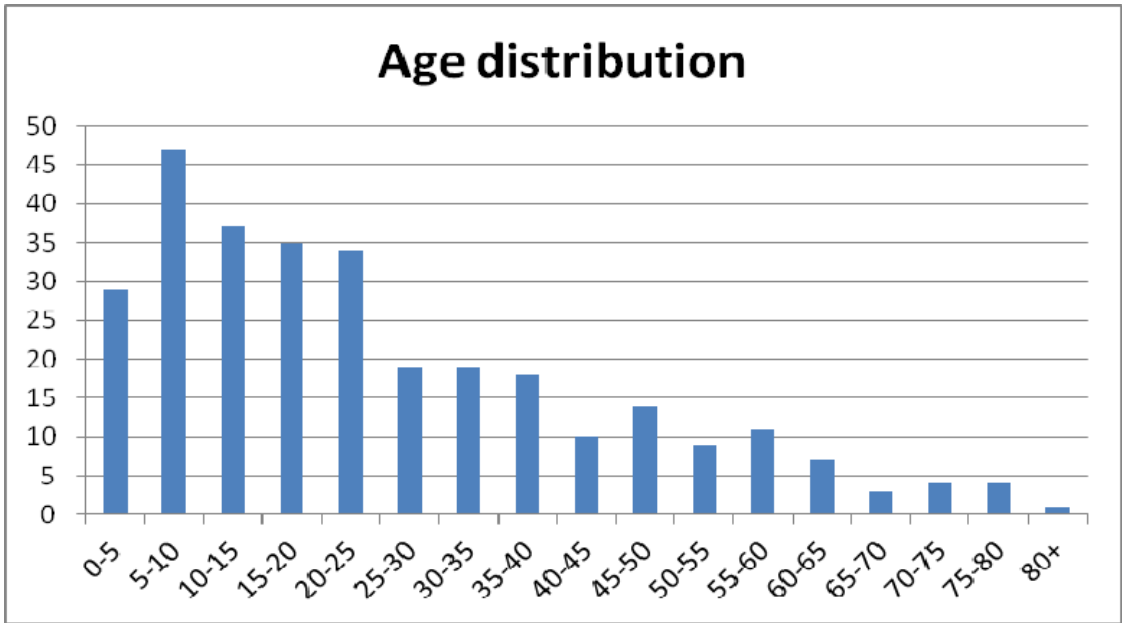

Figure 6:. Age distribution of respondents to the SEIA.

From the distribution in age classes (figure 4.1) it can be concluded that the majority of the respondents were between 5 and 25. Two gaps stand out in this graph; one between age classes 5-10 and 10-15 and one between age class 20-25 and 25-30. The first gap might be caused by the fact that many children who finished primary school were sent to Junior High School (JHS) in the city, or sent to work at farms of other relatives. The second gap can probably be explained by the migration of people that get married outside of the village or find jobs elsewhere.

Another remarkable gap is the increase between 0-5 and 5-10. This seems to confirm the field observation that children that were born outside of the village, were sent there at a later age to assist in the farm-work.

4.1.3 Marital status and household size

Average household size is 6.4, usually consisting of the household head, his wife and their children (5 on average). Some of the household heads (HH) were married twice, so that the average amount of children per person differs between men and women: 5.3 for men and 4.8 for women. Most households were reduced in size because part of their children had moved out of the village, either temporarily or permanently. The largest household consisted of 18 people. There were often other relatives included in the household, such as parents of the HH, brother/sisters, uncles/aunts or family in law.

The respondents were equally distributed in men and women (50/50).

4.1.4 Literacy/ level of education

A large percentage of the respondents above the age of 3 had not received education (42%).

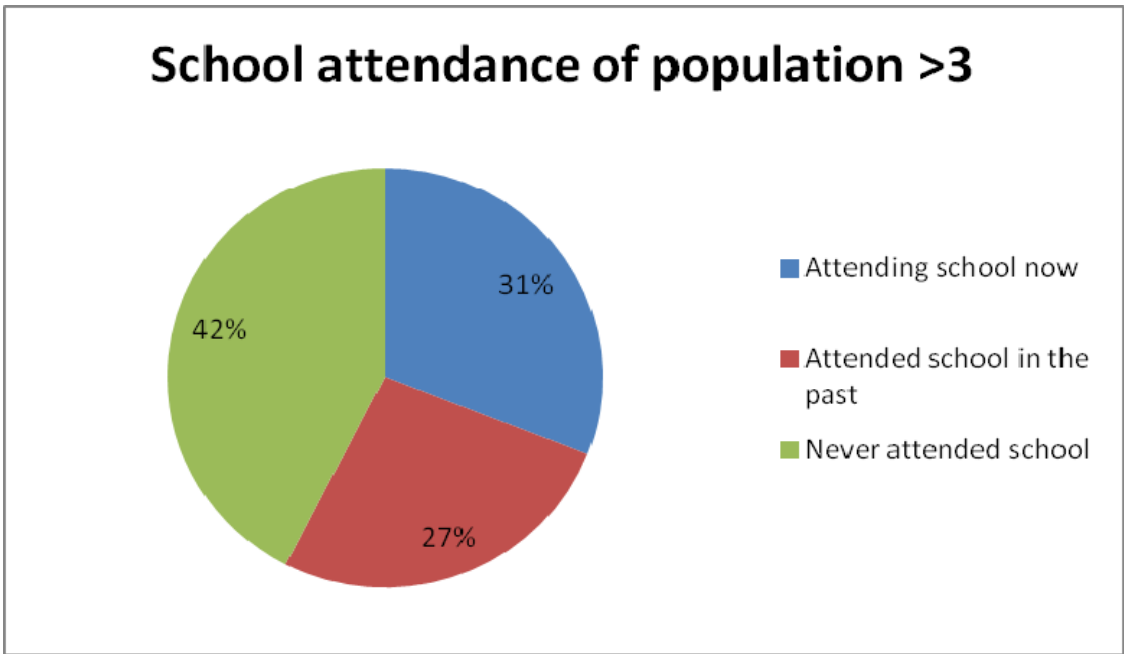

Figure 7:. School attendance of respondents above 3 years of age.

This number is considerably higher than the number presented in the national census report for the rural areas of Ashanti Region (21%).The number found in this SEIA lies closer to the number found in Upper East (48%) and Upper West (51%). This may be a result of the migration form these regions. The ratio of people that currently attended school (31%) and had attended school in the past (27%) did reflect the census data (figure 7).

The people that never attended school are considered illiterate. Illiteracy amongst the population >11 years of age at the national level is 26%, according to the national census report. In Ashanti region this percentage is lower: 17%. The 42% illiteracy amongst the respondents of this assessment is hence above the national as well as the regional average.

Education in Ghana is divided in several levels, based on the British school system. Primary school lasts six years and is preceded by nursery and kindergarten. The latter have been left out of this survey because they are usually not provided in the villages. After primary school, children can go to Junior High School (JHS).

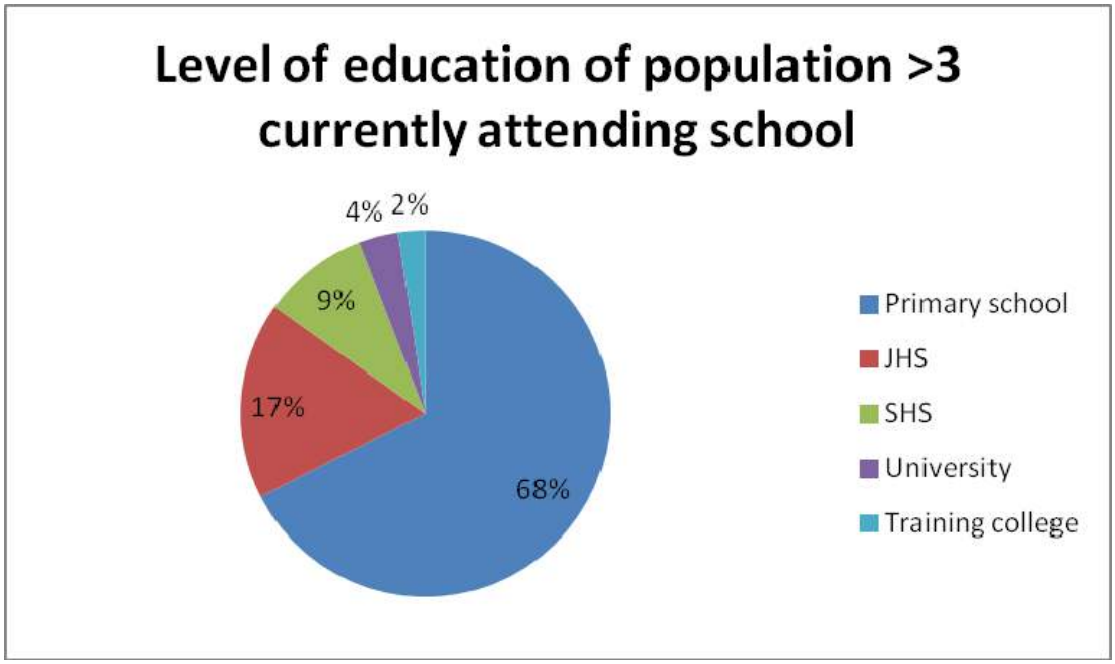

Figure 8: Level of education of school going respondents above 3 years of age

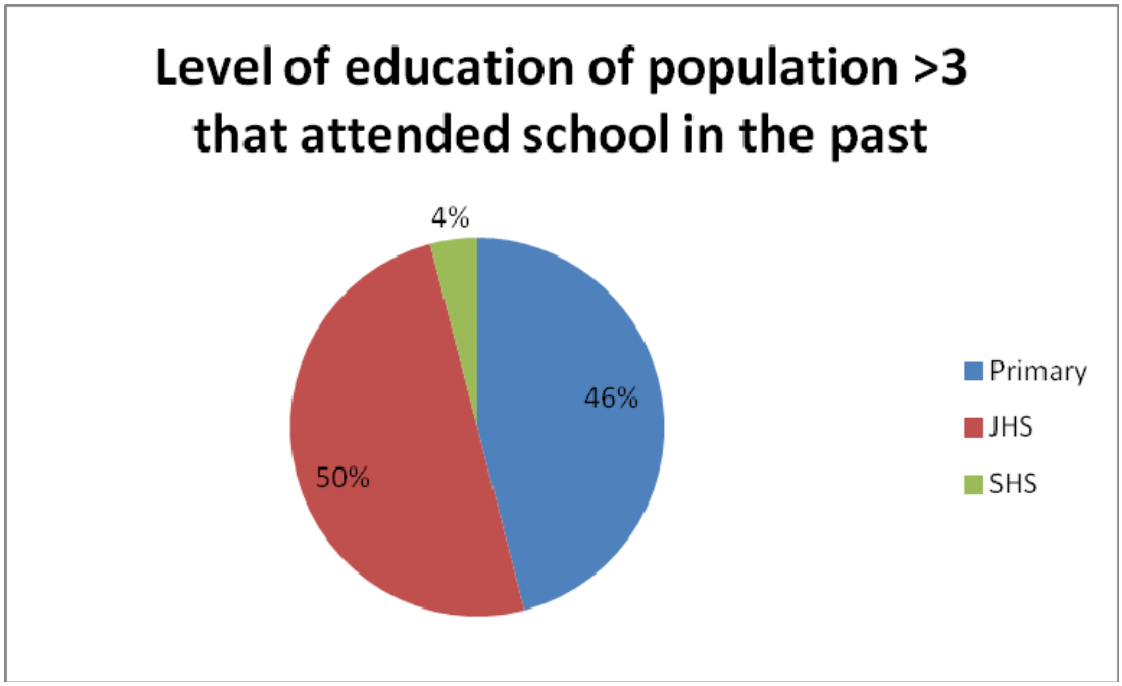

Figure 9: Level of education of non-school going respondents above 3 years of age

This school type has recently been revised as part of a cost reduction policy at the national level; instead of 4 years it now takes 3 years to complete JHS. JHS is followed by Senior High School (SHS), which takes another 3 years, after which students are allowed to go to teacher's training college or university. The distribution of education level within the population above 3 years of age is displayed in figure 8.

No distinction was made between people completing their education and people dropping out before completion.

The education level of people that attended school in the past is different from the people currently attending school (figure 9). None of the respondants in the villages had attended higher education than SHS, indicating that highly educated people move out of the villages.

4.1.5 Social status

Most respondents were not born in the village that they currently lived in (53%).

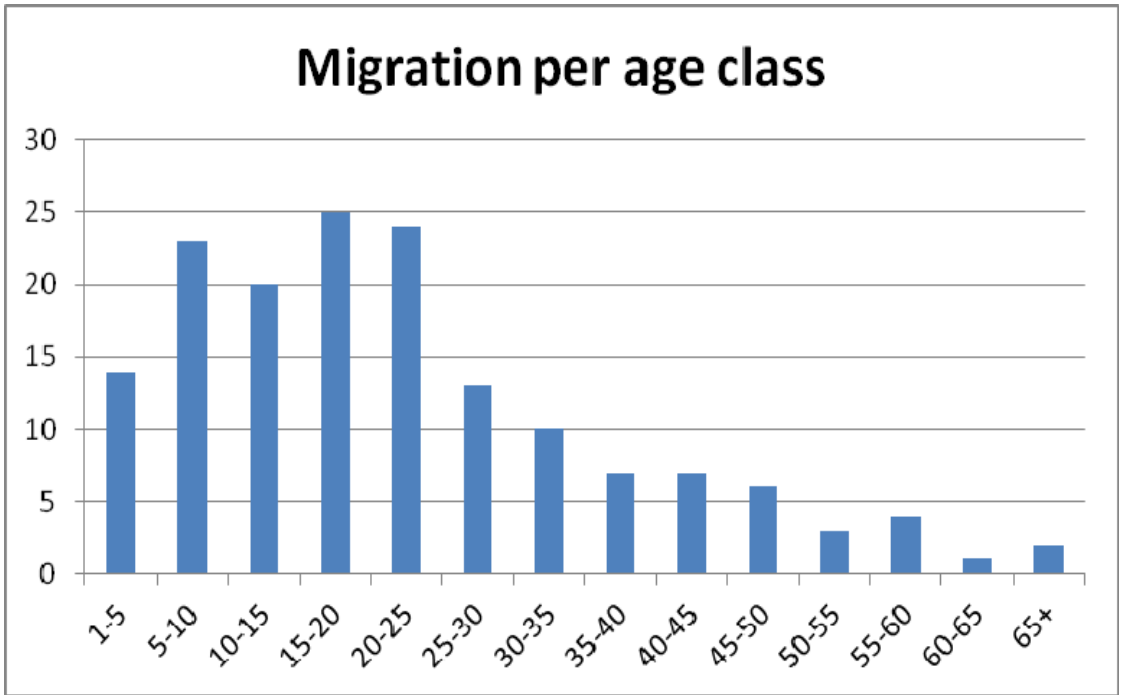

Figure 10: Age at migration of respondents per age class.

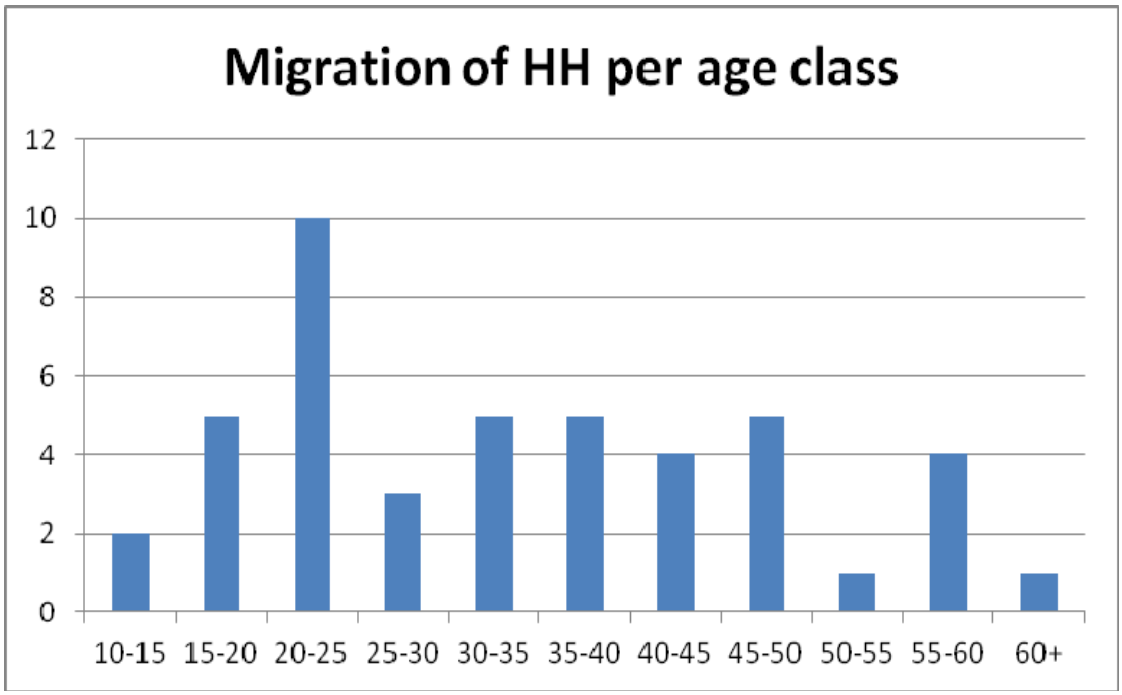

Figure 11: Migration of the respondent household heads per age class.

The age of respondents at the moment of migration showed peaks between ages 5 and 25 (figure 10), with average age at 22. The average age of household heads to migrate is 33, with a peak at age class 20 – 25 (figure 11). This difference can be explained by the fact that when a HH migrates, he brings along his (younger) wife and children, which lowers the average.The common migration peak in Ghana is in the 1980's, especially 1983/84, because of the drought that occurred throughout the Sahel countries. Harvests were unsuccessfull and to escape famines, mass migration was directed to the southern regions. This peak is visible in figure 12, but is considerably smaller than the peak in the 2000's. This may be explained by people migrating back to the north after the drought, and by the large share of children and youth in the village population. Also, the village of Libya was founded around that time, indicating that farmland became available within reserve boundaries around that time.

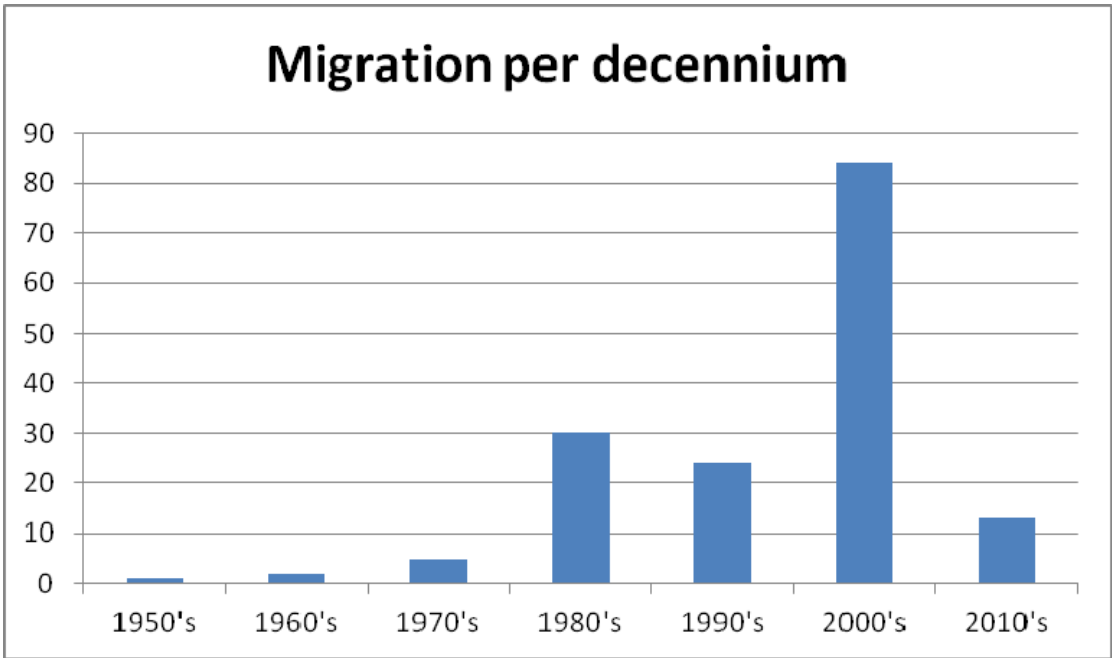

Figure 12: Migration of respondents per decennium.

Many of the respondents (57%) were born in another region and migrated to Ashanti Region. Upper West and Brong Ahafo are the most frequently encountered regions of origin in this assessment; 20% and 19% of the respondents respectively (figure 13). A large part of the population originated from the Northern part of Ghana; Upper West, Upper East and Northern region (36%). It is common that people from the north migrate to the south because of the favorable climatic conditions for farming: more rains and more fertile soils (less sandy). Many of the Northerners return to their homeland a few times per year and marry in the north.

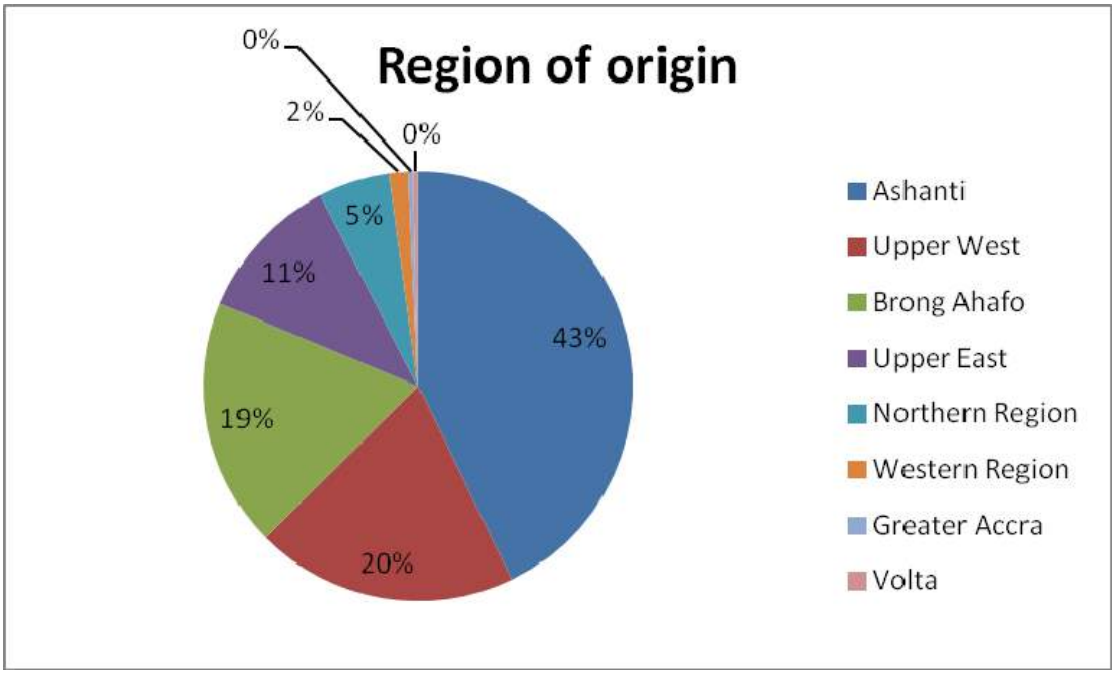

Figure 13:. Respondents' region of origin.

In total, 13 different ethnicities were interviewed in this assessment. The largest ethnic group are the Dagari: 43% (figure 14). Dagari (also spelled Dagaare or Dagarti) actually refers to the language spoken by the Dagaaba, a people from the northwest of Ghana and southwest of Burkina Faso.

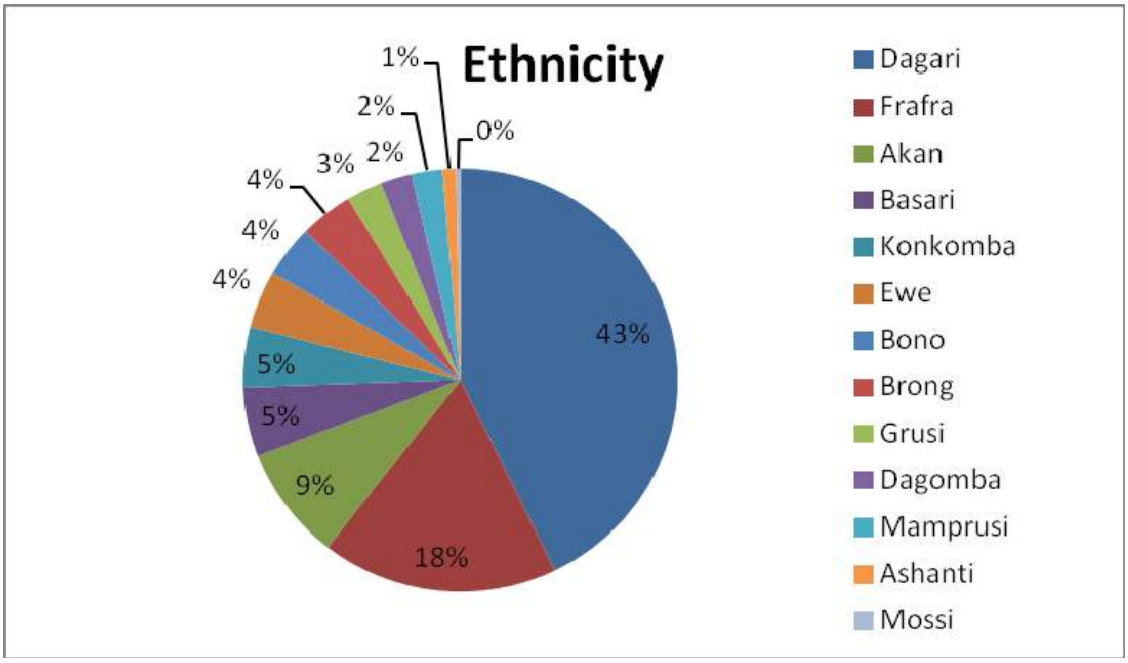

Figure 14:. Respondents' ethnic background.

The second largest ethnic group is the Frafra (18%), also from the north of Ghana. This indicates that an even larger part of the population has roots in the Northern regions than those said to have been born there.

4.1.6 Main agricultural crops cultivated + location

The main crops that are cultivated in the area, calculated by the average number of acres of farmland, are maize, watermelon and yam (figure 15).

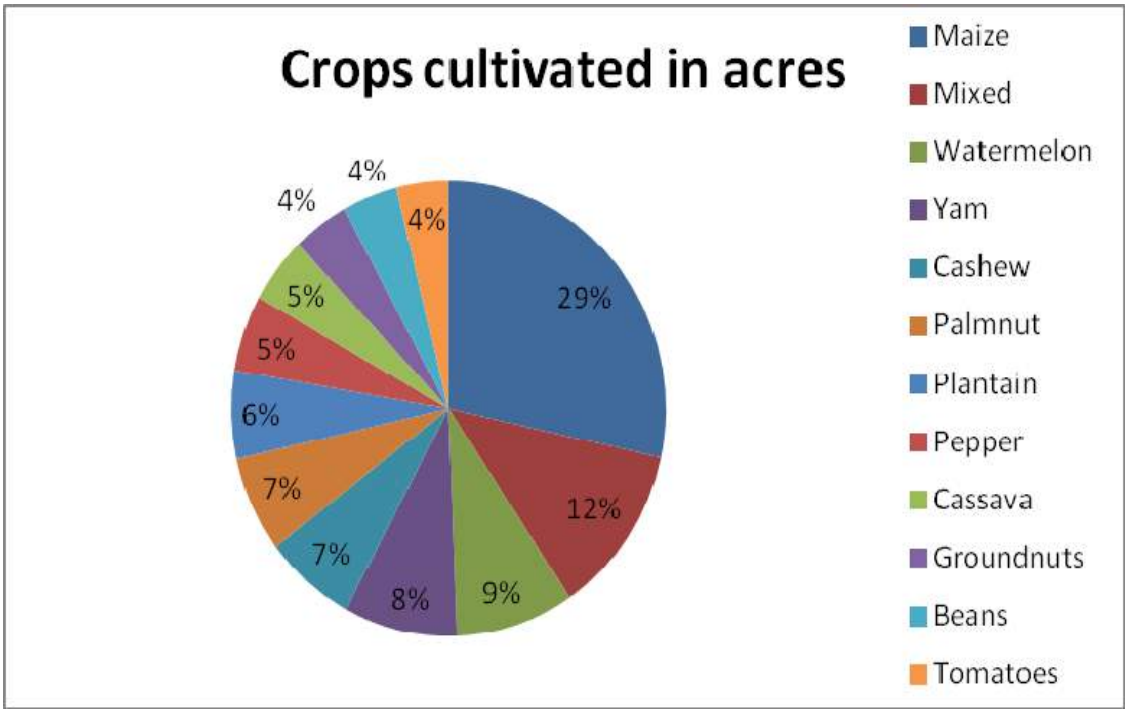

Figure 15:. Crops cultivated by repsondents in acres.

Mixed cultivation systems are also frequently encountered and commonly include okro, garden eggs, cocoyam, sweet potato and onion. Tomatoes have been mentioned as one of the main crops produced to sell on the market, but this is not reflected in the acres of farmland reserved for the production. The average size of farmland belonging to one household is 11.6 acres (4.7 ha), according to farmers' estimations. This is slightly more than the communities surrounding Asubima FR (4 ha) (Abeney et al. 2008). Crops produced most often were maize, yam and groundnut.

47% of the households included in this assessment were farming within reserve boundaries, 28% completely and 19% partially (figure 16).

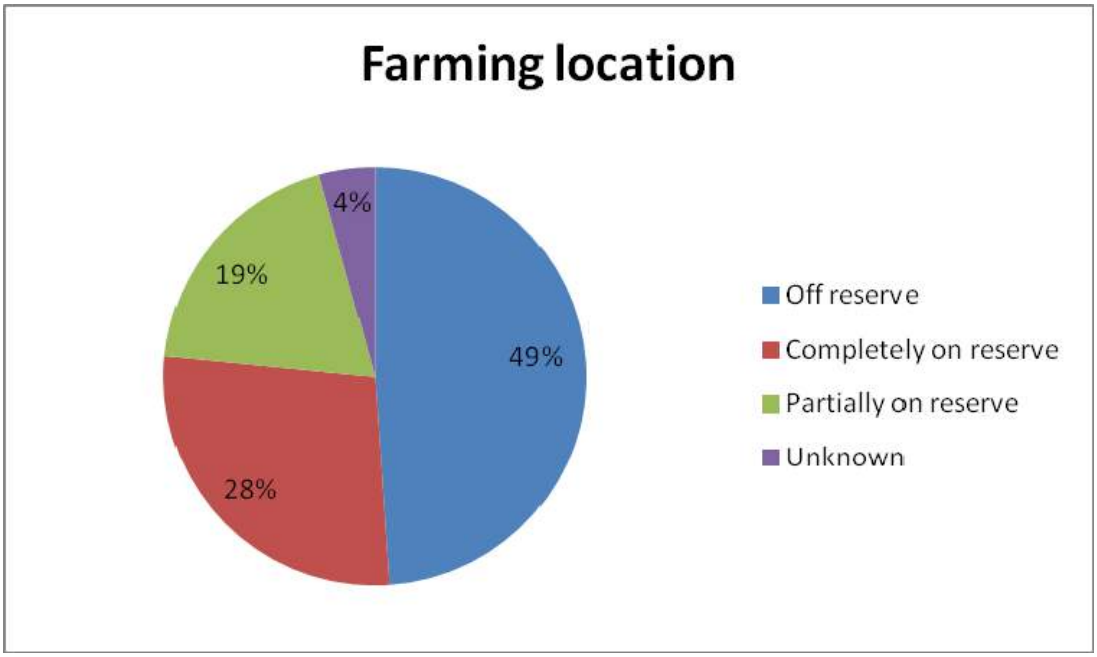

Figure 16: Location of farms in relation to Afrensu Brohuma forest reserve.

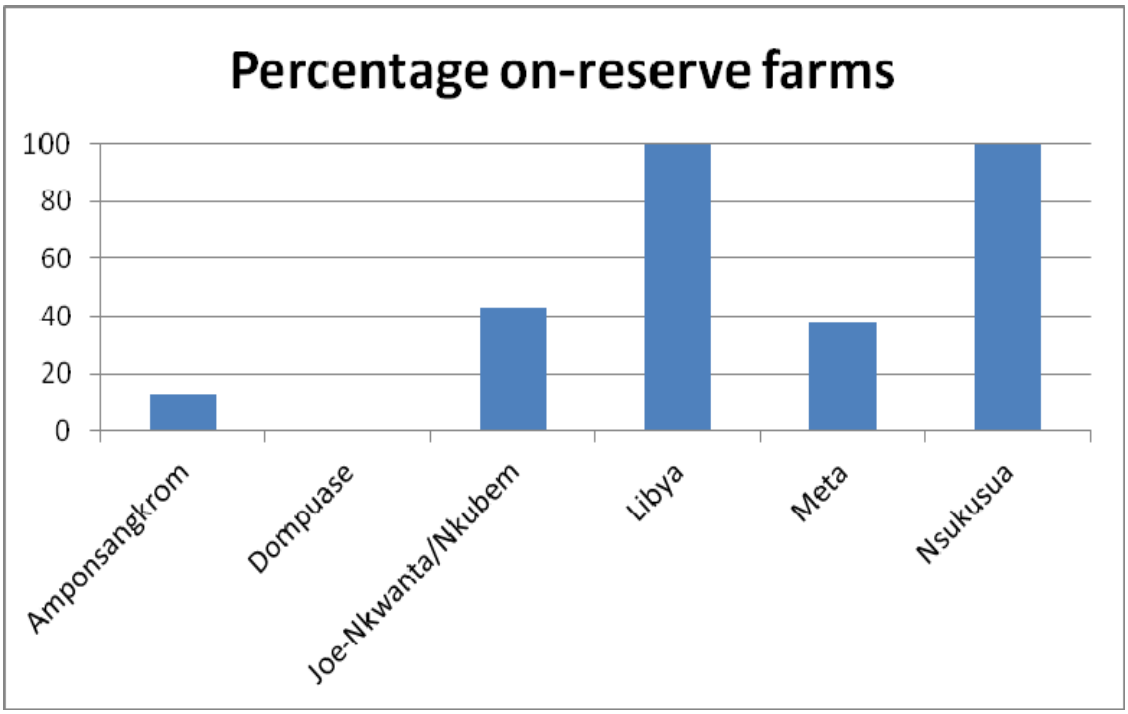

Figure 17: Percentage of farms located within the forest reserve, per village

In figure 17 above, the percentage of households farming completely or partially within reserve boundaries is displayed per village. All of the households in Libya and Nsukusua farmed on the reserve, because Libya is situated within reserve boundaries and Nsukusua borders the reserve. The people in Dompuase did not

farm within reserve boundaries, because they are too far away from Afrensu Brohuma FR.

4.1.7 General information

Land ownership

Most farmers lease the land from a landlord for either GHc 40 or GHc 50 per month. Some of the farmers reported a benefit sharing agreement, paying 10% - 30% of their yield returns to the landowner. For farmers farming within the reserve, the rules of Form Ghana apply. No rent payments or benefit sharing agreements were reported within reserve boundaries.

Characteristics of settlements

The community members indicate that their settlements are of varying age. Libya and Amponsankrom are said to be established about 10 years ago, at the time of the largest peak in migration numbers, depicted in figure 4.7), Nsukusua 30 years ago, at the migration peak following the 1980's draught, and Joe-Nkwanta over 100 years ago. The oldest man present in Joe-Nkwanta was there since 1977.

The houses are all constructed of the same materials; walls from mud and bamboo, roofs of speargrass. Some roofs were reinforced with corrugated iron and some walls were plastered. A house typically consists of multiple rooms (3 on average) of app. 10m^2 each.

Employment at Form Ghana

The number of people in permanent employment has risen from 127 to 172, while the number of people finding casual / contract employment increased from 300 to 400 in 2010 and 2011 respectively (Ogoe et al. 2011).

4.1.8 Culture and tradition

The forest reserve does not have a spiritual meaning for the people living in the communities bordering the reserve. The communities have very few ceremonies that take place on their premises. After the first harvesting, there is usually a celebration, where some of the harvest is donated to the chief. Originally, this was the way that chiefs lived; they received food and gifts from the people for their services. Nowadays the chiefs often don't receive enough to live from, so they have jobs on the side to make money for their subsistence. This is why they often live in town and no longer within their chiefdom.

Births and funerals are not allowed to take place within the communities. When a person dies, the body is taken to a town or city and buried there. Pregnant women travel to a town nearby or to their hometown to give birth. If a child is born in the village, an offering should be made to pacify the ancestors (sheep, chickens,

drinks). However, even after explaining this, we did encounter a midwife living in one of the villages, who claimed that a lot of babies were born there and offerings were not always taken seriously.
In Nsukusua, 'kalla' is celebrated, at the beginning of the planting season. As part of the ceremony, the community members brew a local drink and people from surrounding villages are invited to join the celebration.

4.1.9 Indigenous knowledge of ecological dynamics of the reserve

Everybody knows about the great fire of 1983, in which the whole reserve was burnt. After the fire, the forest was further depleted by illegal loggers. The government granted permits to the communities to reforest in the degraded areas. Teak and cassia were planted as a fire belt (Meta), mixed with crop cultivation. Farmers then entered the forest reserve to farm there as well, because it was no longer considered 'forest'.

Figure 18:. Interviews conducted in villages

Stakeholder analysis

Many say that the land has not recovered since the fire outbreaks; soils have become less fertile, grasses make it difficult to farm, water quality degraded, there are no timber trees and no animals remaining. Before the fire, the forest was said to be

'rich', with a large variety of animals and good timber species. Now, the people living near the forest reserve still use it for fire wood, mangos, pawpaw palm nuts, snails, mushrooms, other leaf vegetables and construction materials.
Several stakeholders have been included in the social survey: the Offinso District Forestry Office, the District Assembly in Akumadan, the District Education Center in Akumadan, the District Fire Office in Nkenkasu, the Akumadan Health Center, the Akumadan Hene and the Nkenkasu Hene.

All of the stakeholders knew about the proposed project by Form Ghana. Their overall impression on the proposed project was positive. All of the stakeholders foresaw a net benefit from the project and expressed that the communication with Form Ghana was good.

There are quarterly meetings for stakeholders where information is shared. According to the Offinso District Forestry Office however, most of the stakeholders do not attend these meetings, which makes them less relevant. This is probably because the stakeholders expect money for attending. In the last meeting the major topic was to improve the fire fighting capacity by bringing communities together. Certification issues (VCS) were dealt with as well.

The main benefits indicated by the stakeholders are summed up below.

Social

- Research purpose for students
- Illegal activities of farmers are better managed, taking pressure off the government
- Proper maintenance of dam and roads
- Preserving the forest for future generation, otherwise they might never know the local species
- In time, animals will come back to the forest and those coming out can be hunted by the villagers.
- FG provides a model farm for others to learn from
- Minimization of fire hazard
- Improvement of aesthetic values

Economical

- Job opportunity for fringe communities and illegal communities inside the reserve
- Economic boost for the district
- Contribution to the growing demand for teak

Ecological

- Increase in tree cover
- Conservation of buffer zones to protect waterways
- Conservation of local species
- Soil improvement by enhanced vegetation cover
- Quality of land reclaimed
- Climate change mitigation

The main concerns mentioned by the stakeholders were of a social nature:

- The benefit sharing agreement is perceived as unfair: 90% goes to a foreign investor and 10% to Ghana. 2% for the community is unacceptable. Before the white people came in, the Ghanaians had their own land tenure system: 2/3 for the farmer, 1/3 for the owner. According to some, this should have been the basis for the calculations of this project, but government officials have not considered this.
- The access to the forest reserve is made very difficult or even denied to local farmers.
- Even though they understand they are operating illegally in a Forest Reserve, community members would like to be compensated when they leave their farms
- The social responsibility activities (sanitation program) that Form Ghana will initiate haven't started yet.
- Procedures for processing proposals take very long with Form Ghana. The District Assembly sent in a proposal but did not get response.
- Teak is not a good timber species because it takes water from the farmers fringing the plantation. Instead we should have the same concept but then with indigenous species, which should be supported by the government.

Stakeholder profiles

<u>District forestry office</u>

Afrensu Brohuma Forest Reserve falls under the authority of the district forestry office in Offinso. The office is in charge of systematic weeding along reserve boundaries for fire control purposes, and boundary planting to suppress weeds and to demarcate the boundary. Also, they register the resources entering/exiting the reserve, the development and maintenance of planted areas,the activities of the private developer(s), criminal offenses and communication aspects (road, telecommunication network, etc.). Also, they take note of some biological characteristics, such as climatic conditions and botanical observations.

There are 5 forestry officers that go on patrol in the Forest Reserve: a range supervisor and 4 forest guards. They bring out a monthly report on the state of the activities mentioned above, based on observations from regular patrols. On these patrols, communities are visited to check for illegalities.

Fire Office – Nkenkasu

The Nkenkasu office was built in 1995 by the NDC party. The district fire office has a staff of 3 people and limited equipment (dry powder and CO2 fire extinguishers, no trucks, no pick-ups), so they cannot fight fire at this moment. In case of fire, they call the fire stations of Techiman (30km)and Offinso (80km). There used to be a truck ca 3 years ago but it was destroyed in an accident. New trucks have been supplied to the district by the Dutch government last year but they have not been awarded to Nkenkasu fire office.

There is a conflict between Nkenkasu fire office and Akumadan fire station about which office should become the district fire office. Nkenkasu used to house the district fire office but at the moment the office in Akumadan has grown bigger and they built a new fire office. The conflict has not yet been resolved. This may be the reason for the poor equipment of the Nkenkasu fire office.

The activities carried out by the office now concentrate on education and fire prevention. Fire volunteers are gathered in the communities and trained to prevent and extinguish fires by creating a fire belt, early weeding, not to burn their land, use no fire arms and in case a fire gets out of hand: set fire to safe from fire. Six communities are involved, and each of them is visited once a month if they can find transportation to get there. Each fire volunteer is registered and receives an ID. The volunteers are organized with a chairman, secretary and financial secretary. Prevention is achieved by promotion of first aid kits, announced from the information centre. However, the last training recorded In their record book was dated 2000. The office will ask Form Ghana for funds for their fire education program.

Nkenkasu fire office is currently writing a proposal for providing training to the staff of Form Ghana on fire protection as Form Ghana indicated they needed support on this matter.

District Assembly

The District Assembly (DA) is the local political body, responsible for the implementation of national policy on the district level. An example is their policy to fight climate change, by raising awareness for tree planting and by implementing the Ghana afforestation program. The concept of the program is similar to that of Form

Ghana; lease land from land-owners and ask locals to plant teak and intercrop. Unfortunately, the program is 'limping' now, because community workers did not receive their payments and the number of workers has gone down from 400 to 200 now. The DA hopes to get the project back on its feet soon.

Health Office – Akumadan

There are several health facilities in the district; the Health Center and Health office in Akumadan, the Distrct Hospital in Nkenkasu, and two larger hospitals in Offinso and Techiman (St. Patrick Hospital and Holy Family Hospital respectively). St Patrick's hospital in Offinso has an eye specialist.
The Akumadan Health Center has the following departments: consulting department (clinic), Out Patients Department (OPD), maternity, dispensary (pharmacy), recordkeeping, laboratory and reproductive and child health unit.

The OPD takes temperature, bodyweight and blood pressure of patients to get a first indication of their health. The reproductive and child health unit tests for diseases and provides public health education in schools. The Health Office deals with day to day administration of health centers and hospitals and the welfare of their staff in the region. They supervise projects for health support in villages.

One of the projects run by the health centers is the CHPS (Community-based Health Planning and Services). The program is implemented nationwide and started in Offinso North District in 2008. It is government-funded and runs well. The activities of CHPS are:
The program is aimed at improvement of health in the remote communities. To this extent, health posts are set up in remote locations and mobile clinics drive around the communities to aid people that do not have the means of transportation to reach the health posts. Also, there is an education project to educate community members about health issues.

Education office in Akumadan
Although the percentage of schooled people in the district increases, it is still very low. The main problem addressed by the education officer is the schooling of people living in remote communities. Children can't reach the schools in the towns because of a lack of transportation. The facilities within villages are often poorly equipped (lack of furniture, books, writing materials) and it is difficult to find teachers prepared to teach and live in the communities, without the facilities that they are used to in the towns; proper accommodation, electricity etc. Education officers are supposed to check education facilities in the villages but there is not enough

transport (6 officers, 5 motorbikes) and the fuel is at their own expenses. Therefore, supervision is not effective.

The education office runs a program that teaches people from the village to become teachers at their own village. They are trained for 3 years in the town during holidays (I think). They receive the training for free if they serve at least 3 years of service in their community. The Global Partnership in Education is the donor agency for this program.

The previous government launched a school feeding program where children were offered free breakfast and lunch at school. The program is strongly politically inclined. It runs mostly in towns, not in villages, where it is more needed (no markets at hand). The DA decides which communities are included.

4.2 Ecological survey

4.2.1 Flora study

For determining tree presence, two different baseline situations were distinguished in the project area; deforested area (plantation) and degraded forest (buffer zone). Tree presence in the degraded forest areas was determined in Asubima forest reserve, but since this borders Afrensu Brohuma forest reserve, it can be considered representative for Afrensu Brohuma as well. York, the most common invasive tree in the area, was found in relatively high number in the buffer zone (43 trees/ha) (see table 4.2). Also some indigenous species were represented, such as Ofram, Wawa and Otie (Appendix B, table B1). The numbers were a lot lower than for york: 0.05 trees/ha on average. *Ceiba pentandra* (Onyina) was the most frequently occurring indigenous tree: 0,5 trees/ha. In total, 57 indigenous tree species were found in the degraded forest areas; ca. 410 trees per ha. No teak was found in the buffer zone.

In the deforested areas (figure 4.15), hardly any indigenous trees could be found: 2 trees/ha, with a total of 43 species (Appendix B, table B2). The species encountered are presented in Appendix B, table B3. Teak was the most frequently occurring tree species (49 trees/ha), followed by york (12 trees/ha). These values are based on data covering over 1,000 hectares and are representative for the whole project area. Many of these trees are coppices with multiple stems. All stems (also of the same tree) are separately included in the numbers presented in this report. Hence, the numbers are likely to be higher than in reality.

Table 4.2. Number of trees per ha in Afrensu Brohuma Forest Reserve.

	Degraded forest	Deforested area
Teak	0	49
York	43	12
Indigenous	410	2

Mr. A. Prosper Manu conducted a biodiversity assessment in the degraded forest areas (the future riparian buffer zones) of Afrensu Brohuma Forest Reserve. He recorded a total of 110 plant species from 49 families. A list of species, their scientific names, life-form (shrub, tree, liana, herb, grass and rush) and the number of plots in which the species occurred is presented in Appendix B, table B3. The families with the highest number of species were *Leguminosae (Caesalpiniaceae)* (7 species), *Malvaceae (Sterculiaceae)* (6 species), *Meliaceae* (5 species) and *Euphorbiaceae* (5 species). For 22 families, only a single species was recorded. The most common species in the area was *Chromolaena odorata*, a herb present in 13

plots. The herb *Pennisetum purpureum* (Elephant grass) is the second most common species. Both of these species are indicators for severe land degradation. Most of the recorded species were trees (59%). Ferns were the least abundant life form in the area (2%) (table 4.3). This may be caused by the open canopy, favoring the growth of grass species. Mr. A. Prosper Manu found a total of 65 tree species in the degraded forest areas. For comparison; an internal monitoring report from Form Ghana, with data from 2012, presented a total of 56 species found in the degraded forest area (Appendix B, table B1) and 43 species found in the deforested parts of Asubima Forest reserve (Appendix B, table B2).

Table 4.3. *The number of different plant species found per vegetation category*

	Trees	Herbs	Lianas	Shrubs	Grasses	Ferns	Unknow
Number of species	65	14	13	8	7	2	1
Percentage	59	13	12	7	6	2	1

Figure 19:. Deforested area in Afrensu Brohuma Forest Reserve

4.2.2 Fauna study

Small mammals

A total of 9 small mammal species was recorded in the study area (Appendix C, table C1). The most frequently observed species were *Praomys tullbergi* (5 times) and *Crocidura crossei* (5 times). *Lemniscomys striatus* and *Crocidura jouvenetae* were the least observed species, with only one sighting of each species. No bat species were recorded in this assessment. However, large quantities of the straw-coloured fruit bat (*Eidolon helvum*) can be observed flying over the plantation area at dusk. In daytime, the bats rest in trees at the plantation site.

Both quantity of observations and species richness were higher in the indigenous riparian forest than in the teak plantation. According to the Shannon-Wiener index for species diversity, biodiversity was slightly higher in the indigenous riparian forest (95.46%) than in the teak plantation (92.84%) (Appendix C, table C2).

Avifauna

In total, 44 bird species were recorded (Appendix C, table C3). The moustached grass warbler was the mostly frequently recorded species. This is likely to be the result of the abundance of grasses in the area, providing suitable habitat for the moustached grass warbler and other weaver species. Three uncommon species were recorded; *Vidua sp., Cinnyris cupreus* and *Centropus senegalensis*. Although mixed-species flocks were regularly encountered, they were not particularly common and comprised a relatively small number of individuals.

Butterflies

A total of 75 species of butterflies was recorded (Appendix C, table C4). The majority of individuals was collected using hand-held nets along transect lines (70.7% of the total capture), while baited traps yielded only about 29.3% of the collected individuals. Interestingly, these traps were highly effective in collecting members of the genus *Charaxes*.

An order as heterogeneous as *Lepidoptera* requires a wide range of sampling methods. This was beyond the scope of this rapid assessment, so this study concentrated on sampling diurnal *Lepidoptera*, which are relatively easy to collect and observe. In total, 41 species of the *Lepidoptera* family were recorded in Afrensu Brohuma Forest Reserve, 13 of which are classified by Larsen (2005b) as species commonly found in moist evergreen and semi-deciduous forests.

Most of the individuals were collected in the indigenous riparian forest (55.6%), which is in accordance with Sundufo and Dumbuya (2007).

Larsen (2005a) introduced a system of ranking butterfly species according to their rarity, based on the percentage of positive records of a species in relation to the number of visitations to a site. Most of the species of butterflies recorded during the present survey had a ranking of 1–3 (very common to not rare). However, a few species recorded had a high ranking status, indicating their rarity. For example, the following species were ranked as 4 (rare): *Charaxes petersi*, *Euriphene incerta* and *Euphaedra inanum*. Below are comments of interesting butterfly species recorded (distribution information according to Larsen, 2005a.)

1. *Charaxes petersi* (Van Someren, 1969)
   A rare butterfly, recorded from Konongo, Tano Offin and Mamang River in Ghana. It is an inhabitant of rain forest in good condition. The species is endemic to the area west of the Dahomey Gap, from Sierra Leone to the Volta Region.
2. *Euriphene incerta* (Aurivillius, 1912)
   This species, distinctly rare west of the Dahomey Gap and in western Nigeria, is found in wetter forests in good condition where it can be found alongside other species of *Euriphene* e.g., *E*. *barombina* .Recorded in Ghana from Kakum and Mamang River.
3. *Euphaedra inanum* (Butler, 1873)
   This species is known from Guinea-Bissau, Guinea, Sierra Leone, Côte d'Ivoire and Ghana (type locality - Ashanti). Though widespread in all types of forest, in Ghana it is distinctly scarce.

Although this is butterfly survey was only a rapid assessment, and the first to be performed in Afrensu Brohuma Forest Reserve, the results indicate a rich *Lepidoptera* fauna with a high proportion of forest species.

Medium sized mammals

Nine medium mammal species were identified (Appendix C, table C5). The most individuals were observed in the indigenous forest (29), when compared to the teak plantation (8), and both sites were equally diverse (8 species). The most frequently encountered species in Afrensu Brohuma was the Giant Pouched Rat (37 times). The least encountered species was the black duiker (2 times).

Many mammal species expected to inhabit the area were not observed, possibly as a result of hunting and forest degradation in the past. The black duiker seems threatened in Ghana as hunting and habitat destruction are prevalent throughout its range. They are not adaptive to habitat changes like other mammalian species and will decline in disturbed habitats.

Numerous footpaths and three shotgun shells were recorded in the Afrensu Brohuma FR, suggesting that hunting and other human activities were executed here in the past. Interviews conducted amongst local community members proved that people were unaware of the closing of the hunting season, as stipulated in Ghana's national wildlife regulations. Local communities have easy access to the reserve.

4.3 Hydrological survey

The data show that the water in the streams is of drinking quality (according to WHO standards) for all factors except iron, colour and turbidity. It shows that the contamination of the water is minimal.

4.4 Soil survey

The soils in the area have developed in weathered sandstone. As a result they generally have a sandy loam to sandy clay loam texture. Deeper horizons have a clay loam to clay texture due to illuviation of clay particles.

The same soil series as found in the soil survey of the neighbouring Asubima forest reserve have been observed in Afrensu Brohuma. These series are the deep soils of the Bediesi and Sutawa series, and the shallow soils of the Pimpimso series. The well drained soils, the Bediesi series, are dusky red to reddish brown at the surface, and red in deeper horizons. The moderately drained soils, the Sutawa series, are dark brown to brown at the surface to strong brown in deeper horizons. The Pimpimso series are soils which are found in places where sandstone is at or near the surface. These soils are quite shallow and have highly weathered rock or rock fragments within 50 cm from the surface. In the survey of Asubima the Bediesi series were classified as suitable for teak, the Sutawa series as moderately suitable, and the Pimpimso series as marginally suitable.

Shallow soils are found in several blocks within Afrensu Brohuma Forest Reserve, mainly on hill slopes. In these blocks stunted growth of young teak has been observed. The main cause is the shallow soil, but growth is also obstructed by weeds which overgrow young teak plants. It is doubtful whether affords to reduce weed growth will pay off; the shallow soil will still remain only marginally suitable for teak. The area where the last teak trees were planted has deep soils of the Bediesi series. In this area many farmers' fields were observed. In all other blocks deep soils have been found of both Bediesi and Sutawa series. There is a connection between the presence of farmers' fields and deep soils, which is not surprising.

Mineral parts of all soils in the region have a low Effective Cation Exchange Capacity (ECEC), which means that their holding capacity for nutrients is very low. Organic matter however has a high ECEC; it can hold nutrients which are important for plant growth. It can also hold a large quantity of water; it acts like a sponge in the soil. Organic matter itself consists mainly of carbon, hydrogen and nitrogen. Yearly about 2% of the organic matter is broken down by micro-organisms, resulting in release of carbondioxyde and nitrate after a mineralization process. The nitrate is taken up by plants, which is why organic matter is an important source of nitrogen for plants. The mineralized organic matter is in the cycle of a natural forest replenished by fallen leaves, branches and trees.

In a good forest soil live, besides plant roots, approximately 25 tons of living organisms per ha, of which 20 tons of micro-organisms. These living organisms are responsible for the making of the major number of pores and holes in the soil, which are on their turn responsible for a good drainage.

All the above mentioned factors stress the need for proper care and maintenance of organic matter in the soil. In fact, most of the wealth of these tropical soils, poor in minerals, is in the organic matter. It is recommended to keep the topsoil as much as possible undisturbed during operations of land preparation and clearing. Whenever possible, burning should be avoided as it destroys organic matter and living organisms in the soils. Under plantation, fallen leaves and branches should be left behind on the soil as much as possible in order to replenish soil organic matter. However care should be taken to prevent forest fires.

For plant growth most important nutrients are nitrogen (N), phosphorous (P) and potassium (K). The soils in the area are low in nitrogen and phosphorous. When timber is harvested, a large quantity of plant nutrients, taken up by the trees, is removed from the soil. Such a removal is interrupting the natural cycle. For a sustainable production the nutrients removed from the soil should be replenished, if not, an impoverished soil, less suitable for any production or vegetation, is left behind. Therefore it is recommended to estimate the quantity of nutrients which is removed by cutting the teak trees and to replenish these nutrients to the soil as fertilizer during the life cycle of the teak trees. As a side effect trees will have a better growth as no shortage of nutrients will occur.

5. *Social and environmental impact assessment*

5.1 Impact analyses

The impact assessment presented below depicts the expected positive and negative social and environmental effects of the proposed project. The format of the assessment and the ranking of the activities are according to Martin Fecteau's checklist (Table 5.1 and 5.2). This method combines three criteria: duration, extension, and magnitude of the impact. To evaluate the relative importance of the impact, other criteria are taken into account as well, the so-called weight age criteria: revers-ibility, probability of occurrence, and legal and social values. Then, the cumulative character of each impact on other impacts is associated. The environmental measures are envisaged with respect to the relative importance of the impact. Final-ly, the importance of the residual impact was evaluated (CAFECO 2009). The con-tents are based on the plantation management plan, flora and fauna inventories, interviews with local stakeholders and socio-economic survey data. FSC™ (FSC-C044035) and EPA standards for Environmental Impact Assessments have been taken into account, with regard to the aim of Form Ghana to obtain an FSC™ (FSC-C044035) certificate for the plantation.

Table 5.1. Explanation of terms

Magnitude		
Extent		**Local** – impacts that affect the project area.
		Regional – impacts that affect the region as determined by administrative boundaries (here the Ashanti region of Northwest Ghana).
		National – impacts that affect nationally important environmental resources.
		International – impacts that affect internationally important resources such as areas protected by international conventions.
Duration		**Temporary** – impacts are predicted to be of short duration and occasional.
		Short-term – impacts that are predicted to last only for the duration of the construction period.
		Long-term – impacts that will continue for the life of the Project, but ceases when the Project stops operating.
		Permanent – impacts that cause a permanent change in the affected receptor or resource (e.g. removal or destruction of ecological habitat) that endures substantially beyond the Project lifetime.
Intensity		**Negligible** – the impact on the environment is not detectable or there is no perceptible change to people's way of life.
		Low – the impact affects the environment in such a way that natural functions and processes are not affected or the communities are able to adapt.
		Medium – where the affected environment is altered but natural functions and processes continue, albeit in a modified way or the communities are able to adapt with some difficulties.
		High – where natural functions or processes are altered to the extent that it will temporarily or permanently cease or the communities affected will not be able to adapt to changes.

Table 5.2. Rating of the matrix.

	Likelihood		
Magnitude	Unlikely	Likely	Definite
Negligible	Negligible	Negligible	Minor
Low	Negligible	Minor	Minor
Medium	Minor	Moderate	Moderate
High	Moderate	Major	Major

Table 5.3 a. Negative impact of plantation establishment on the ecology

Activity/source of impact	Effects of the impact	Evaluation of the importance of the impact			
		Extent	Duration	Intensity	Importance
Site clearing	Loss of habitat	Local	Short term	Low	Minor
	Biodiversity reduction	Local	Temporary	Low	Minor
Road construction	Habitat fragmentation	Local	Long term	Low	Minor
Planting *Tectona grandis*	Disturbance of balance in local ecosystem	Local	Permanent	Low	Minor
	Uncontrolled weed spreading	Regional	Long term	Medium	Moderate
	Introduction of exotic pests and diseases	Regional	Permanent	Medium	Minor
	Landscape disturbance	Regional	Permanent	Medium	Moderate
Silvicultural interventions (i.e. thinning, pruning, weeding, use of Round-up)	Habitat disturbance	Local	Long term	Low	Minor
	Environmental damage	Local	Long term	Low	Minor

Table 5.3 b. Positive impact of plantation establishment on the ecology

Activity/source of impact	Effects of the impact	Evaluation of the importance of the impact			
		Extent	Duration	Intensity	Importance
Planting *Tectona grandis*	Reduction of wind erosion	Local	Permanent	Low	Negligible
	Reduction of pressure on natural for-est for timber	International	Permanent	Medium	Moderate
	Carbon sequestration	Local	Permanent	Low	Minor
	Improvement of micro-climate	Local	Permanent	Low	Minor
Planting indigenous trees in plantation	Increased conservation value	Local	Permanent	High	Major
	Increased biodiversity	Local	Permanent	Medium	Moderate
Buffer zone restoration	Provide refugia for wildlife population	Local	Permanent	Medium	Moderate
Wild-fire control	Decrease fire hazard	Local	Long term	High	Major
Monitoring and patrolling in the area	Reduced hunting/poaching activities	Local	Long term	Low	Minor
	Protection of natural ecosystem	Local	Long term	High	Major
Intercropping	Weed control	Local	Short term	Low	Minor

Table 5.4 a. Negative impact of plantation establishment on the hydrology

Activity/source of impact	Effects of the impact	Evaluation of the importance of the impact			
		Extent	Duration	Intensity	Importance
Site clearing	Flood incidents downstream	Local	Short term	Low	Negligible
	Increased turbidity	Local	Short term	Low	Minor
	Increase in surface runoff due to the reduction of infiltration and soil erosion	Local	Short term	Low	Minor
Usage of Roundup	"Eutrophication" in the surface water causing growth of vegetation and affecting aquatic life.	Regional	Permanent	High	Moderate
	High levels of chemicals can affect the quality of water, the aquatic life and even the supply of freshwater.	Regional	Long term	Medium	Minor

Table 5.4 b. Positive impact of plantation establishment on the hydrology

Activity/source of impact	Effects of the impact	Evaluation of the importance of the impact			
		Extent	Duration	Intensity	Importance
Planting in degraded areas	Increase in soil water storage	Regional	Long term	Medium	Moderate
	Reduced evaporation	Local	Long term	Medium	Moderate
	Moderation of water temperature	Local	Long term	Low	Negligible
	Enhancing aquatic biodiversity	Local	Long term	Medium	Moderate
Buffer zone restoration and protection	Protection of water bodies from farming and other human disturbance	Local	Long term	High	Major

Table 5.5 a. Negative impact of plantation establishment on the soil

Activity/source of impact	Effects of the impact	Evaluation of the importance of the impact			
		Extent	Duration	Intensity	Importance
Site clearing	Soil compaction	Local	Long term	Low	Minor
	Soil erosion, loss of arable soil in the area	Local	Long term	Low	Minor
	Soil fertility reduction	Local	Long term	Low	Minor
Waste production	Soil pollution by empty containers (agrochemicals, hydro-carbon substances such as oil, grease, lubricant, etc…), dirty towels, etc…	Local	Long term	Medium	Minor

Table 5.5 b. Positive impact of plantation establishment on the soil

Activity/source of impact	Effects of the impact	Evaluation of the importance of the impac			
		Extent	Duration	Intensity	Importance
Planting in degraded areas	Erosion reduction	Local	Long term	Low	Minor
	Surface runoff reduction	Local	Long term	Low	Minor
	Increased soil infiltration	Local	Long term	Low	Minor
	Increase of soil organic matter content	Local	Long term	Low	Minor
Adoption of Reduced Impact Logging (RIL) techniques (incl. building erosion channels and respecting buffer zones)	Soil erosion control	Local	Long term	Medium	Minor
	Reduced erosion risk	Local	Long term	Low	Minor

Table 5.6 a. Negative impact on the socio-economical situation

Activity/source of impact	Effects of the impact	Evaluation of the importance of the impact			
		Extent	Duration	Intensity	Importance
Land conversion to plantation forest	Loss of farmland	Regional	Long term	Medium	Moderate
	Increased risk of poaching	Local	Long term	Low	Minor
	Crop damage of fringing farmers due to new pests introduced by forest environment	Regional	Long term	Medium	Moderate
Implementing FSC™ (FSC-C044035) rules & regulations; prohibi-tion of the use of fertilizer, herbicides, pesticides	Reduced production potential	Local	Long term	Medium	Moderate
	No storage capacity on farmland	Local	Long term	Low	Minor
Commercial exploitation of forest reserve	Perceived inequity; foreigners gain from local land	Regional	Long term	Medium	Moderate
Employment of local people	Exposure to health and safety risks	Local	Long term	Low	Minor
Increased pressure on road network	Increased risk of road accidents	Local	Permanent	Negligible	Negligible
	Increased air and noise pollution	Local	Permanent	Negligible	Negligible
Establish intercropping system on the plantation	Limit of 2 years of farming before canopy closure	Local	Long term	Medium	Moderate
	Restrictions in choice of crops (no cassava, plantain)	Local	Long term	Low	Minor

Table 5.6 b. Positive impact on the socio-economic situation

Activity/source of impact	Effects of the impact	Evaluation of the importance of the impact			
		Extent	Duration	Intensity	Importance
Employment of plantation workers	Secured income	Local	Long term	High	Major
	Reduced dependency on farm produce	Local	Long term	Medium	Moderate
	Workers are provided with healthcare	Local	Long term	Low	Minor
Establish intercropping system on the plantation	Reduce illegal farming activities within forest boundaries	Local	Long term	Low	Minor
	Offer security of land to farmers	Local	Long term	Low	Minor
	Offer 'free' farmland; no rent, no benefit sharing	Local	Long term	Low	Minor
Training of plantation workers	Increase local knowledge level	Regional	Permanent	Medium	Moderate
	Increase chances on labor market	Regional	Permanent	Medium	Moderate
	Increase security after learning about fire protection	Regional	Permanent	Medium	Moderate
Land conversion to plantation forest	Provide forest services to local people; game, fire wood, poles, fodder etc.	Regional	Long term	Low	Minor
	Improved yield of farmland be-	Regional	Long term	Low	Minor

Activity/source of impact	Effects of the impact	Evaluation of the importance of the impact			
		Extent	Duration	Intensity	Importance
	cause of improved microclimate; increased humidity, shading etc.				
Infrastructural development	Improved road network, improved connectivity town services	Regional	Permanent	Medium	Moderate

5.2 SWOT analysis

The SWOT matrix below describes the concept of project strengths, weaknesses, opportunities and threats. With respect to the proposed project if any inherent or internal item, issue, plan, strategy, policy or regulation is determined to be a positive component or inclusion to the project then it is described as a strength of the project. If the identified item is determined to be negative and likely to create difficulties for the project then it is an inherent weakness. On the other hand if external provisions (e.g. government policy of reforestation), issue or entity such as traditional authority's concern for the forests, and other regulatory issues or some wider consideration reinforces the proposed project then that is described as positive. Otherwise this situation would be a threat if found to be a negative one (e.g. hostile communities or government legal provision that is against certain or all objectives of the proposed project) and not in the interest of the effective implementation of project strategies or plans. Thus findings from the SEIA and other wider considerations are considered for this analysis.

Table 5.7. SWOT matrix used for opportunity analysis

	Positive	Negative
Internal	Strength	Weakness
External	Opportunity	Threat

Strengths

The vision of Form Ghana is to ensure sustainability in ecological, social and economical sense. Strong aspects of the proposed project, in support of the local ecology, are the planting of indigenous tree species in the plantation, restoration and reforestation of the riparian buffer zones, which serve as wildlife refugia, adopting the RIL strategy and avoiding the use of fertilizer and chemical pesticides or herbicides. These measures are likely to result in increased biodiversity and increased conservation value of the project area. The aspired FSC™ (FSC-C044035) certificate will contribute to the compliance with these objectives.

Social sustainability is incorporated in the proposed project in several ways. The project offers long-term employment to local people (Ogoe et al. 2011). Employees will be provided with proper working conditions, considering health, safety, and sound wages. This provides alternative income for farming, making communities less dependent on their crop yields. Job creation and income security are therefore two of the major positive impacts created by the proposed project.

Other benefits to the local socio-economic situation are improvements to the road network and improved knowledge regarding fire combating and other safety regulations. Farmers that illegally exploit the forest reserve will be offered an agreement with Form Ghana to intercrop their own food crops with the freshly planted teak seedlings. This will reduce illegality and provide security for the farmers within forest reserve boundaries.

The economical sustainability of the reforestation project is guaranteed by a well-designed, low risk business plan that has proved its functionality in the adjacent project site, managed by Form Ghana: Asubima Forest Reserve.

Globally, the project will have a positive effect on the pressure on natural forests for timber production. The natural forest cover decreases rapidly, amplifying the importance of forest plantations.

Weaknesses

The use of chemicals for eliminating weeds is inevitable in the first years of seedling establishment. This causes damage to the environment. The damage is limited by using Round-up, a chemical approved by FSC™ (FSC-C044035) and said to be relatively environmentally friendly.

The largest part of the plantation (ca. 90%) will consist of a monoculture of *Tectona grandis*, an exotic tree species, creating a landscape that does not reflect the local ecology. This can be considered a decrease in landscape value. However, the natural forest that was originally standing in the project site has been severely damaged or removed completely. The forest that is still standing will be conserved and the buffer zones will be reinforced with new seedlings of indigenous tree species to mitigate the landscape alteration.

The total area used as farmland in the region will be reduced by project implementation. Although illegal, large part of the project site have been used as farmland for many years. This farmland will be converted to forest plantation when the project is established. Farmers are given the opportunity to do intercropping within plantation boundaries until canopy closure, mitigating the effect of the land conversion. However, after 2 or 3 years, the farmers are still forced to find new farmland or choose to become a plantation worker.

People depending on farmland fringing the project area as well as farmers intercropping within project boundaries have indicated that they experience new pests and diseases harming their crops. The altered microclimate may attract different microfauna and fungi, and the prohibition of pesticides can cause them to spread rapidly on the farmland of intercropping farmers, but also at the fringing farmlands. Farmers intercropping on the plantation further experience a reduction in production quantity because they cannot burn their land, are not allowed to use fertilizers or pesticides and cannot store their products in sheds on-site. However, it should not be forgotten that the farmers are currently farming within the reserve illegally. Given the uncertainty of their situation, the legal option of intercropping may still be preferred.

The first impression of the project can cause a perception of inequity, both regionally and nationally, because of the foreign exploitation of protected areas. Good communi-

cation amongst all stakeholders and national authorities (embassies, governmental institutions) is of great importance to inform people about the true nature of the project.

Opportunities

The reforestation project has been designed so that it can be repeated in other, similarly degraded areas. This provides opportunities for up-scaling to more degraded forest reserves in the area. Also, local farmers have been inspired to copy the concept on their own land. These initiatives contribute to meeting the increasing global timber demand.

Threats

The threat of wild-fires is continuously present, especially in the adjacent farmland and open grassland; the fires are likely to spread rapidly. This could cause unexpected loss of revenues. In addition, the project largely depends on the political stability of the country. The land-lease construction works only as long as the agreement of all parties lasts.

Figure 20: Example of a teak plantation in poor condition.

The balance between sound ecological and social management, and business focus is delicate. It can easily be disturbed if communication between the stakeholders is not sufficient. It is therefore essential to keep all parties informed on project progress and management decisions. Furthermore, stakeholders have high expectations of the company. When these expectations exceed reality, this could lead to a lack of trust in the

company. Care should be taken that no false promises are made and expectations are not raised to unrealistic extends.

Timber plantations require long-term investments. It takes a relatively long time before returns can be expected, increasing the risk of any situation to occur that can cause damage to the plantation.

Monocultures hold the risk of quick spreading of diseases. This risk is mitigated by the conservation of buffer zones within the plantation and the 10% indigenous trees planted within plantation boundaries.

Increased population pressure and decreased soil fertility cause shortage of farmland, increasing pressure on forest reserves and other protected areas. This increased pressure on land is likely to become an important risk factor in the future.

6. DISCUSSION

6.1 Socio-economic study

No major negative impacts of the proposed project were identified in this SEIA. The moderate impacts are related to the loss of farmland and reduced productivity of farmers now farming within the reserve. However, this impact should be considered in the light of their illegal status now, farming within reserve boundaries. The people from Libya expressed that they preferred the restrictions posed by the proposed project to the uncertainty of their illegal situation, in which they constantly fear eviction by the Forestry Commission. However, many of the surrounding farmers complained about the land-use restrictions posed by the FSC™ (FSC-C044035) regulations and some expressed their concerns about the quantity of their yield and whether it would be sufficient for their families to live from. Also, the farmers within the reserve wondered where they could go after canopy closure would make farming impossible.

The benefit sharing agreement was another topic of discussion, especially amongst the chiefs of the surrounding townships. They expressed their concerns about the money flowing back to the communities. If they are engaged by the company from the very beginning however, this risk can be mitigated.

Generally the company can be sure of much good will from all sides; government, traditional land owners interested in royalties or economic benefit and farmers seeking security of access to farm land. Thus the company can continue to implement its action plan, taking into account the recommendations made in this report.

6.2 Ecological survey

Vegetation cover will be significantly improved compared to the current, degraded state of the reserve. Planting indigenous trees species on parts of the teak plantation will enhance vegetation diversity, which promotes overall biodiversity in the area. Loss of habitat is temporary (during site preparation and clear-felling), and will most likely be reversed once the teak starts growing. Considering the current degraded state of the reserve, covered mainly with farm and grassland, it is highly unlikely that species richness will reduce. Remnant trees and forest are conserved. The buffer zones and indigenous patches of the plantation can serve as wildlife refugia because hunting and poaching in the area will be controlled by intensive monitoring, executed by Form Ghana employees. These monitoring activities will aid in the prevention and control of wild-fires as well. In addition, spreading of weeds will be largely controlled. In the first two years of plantation establishment, farmers intercropping their food-crops in the plantation will keep out the weeds manually. After the first two years, canopy closure will naturally hamper weed growth.

On a global level, the proposed plantation will contribute to the mitigation of CO2 emissions by carbon storage and reduce the pressure on natural forests to meet with demands for timber production.

It is however recommended that Form Ghana will consider planting more indigenous species in order to promote biodiversity on the plantation. Monocultures can disturb the natural ecological balance and enhance the risk of uncontrolled spreading of pests and diseases. Other equally valuable tree species that are indigenous, such as Odum and Wawa, grow well and have relatively short rotation cycles.

6.3 Hydrological survey

During site clearing, soil erosion and surface runoff are expected to increase, resulting in reduced soil fertility. Negative consequences for water quality like increased river turbidity and eutrophication are limited because of the filter function of the riparian buffer zones. This should be of short duration however, since reforestation is expected to considerably decrease the soil erosion. Risk of eutrophication is mitigated by the prohibition of fertilizer and toxic pesticides. Soil fertility will be improved by the restoration of the organic matter component, produced by decomposition of leaf litter from the teak trees. Roads provide a challenge to soil erosion. Risks can be mitigated by sound construction management.

Water quality will further improve by restoration of the buffer zones along the riverbanks. This will reduce influx of sediment and chemicals in the water and lower the water temperature by providing shade. River banks will be protected from human activities, safeguarding the future recovery of the riparian zone.

6.4 Soil survey

Site clearing temporarily increase the risk of soil erosion and may cause local compaction of the soil, decreasing overall soil fertility. These negative effects are likely to be reversed when the seedlings start growing and their roots have developed; soil organic matter contents increase, surface runoff decreases and soil infiltration increases.

As mentioned in the results section, organic matter is essential to soil fertility. As this is easily lost in these types of soils, there is an urgent need for proper care and maintenance of organic matter in the soil. In fact, most of the wealth of these tropical soils, poor in minerals, is in the organic matter. It is recommended to keep the topsoil as much as possible undisturbed during operations of land preparation and clearing. Whenever possible, burning should be avoided as it destroys organic matter and living organisms in the soils. Under plantation, fallen leaves and branches should be left behind on the soil as much as possible in order to replenish soil organic matter. However care should be taken to prevent forest fires.

For a sustainable production the nutrients removed from the soil by harvesting timber should be replenished, if not, an impoverished soil, less suitable for any production or vegetation, is left behind. Therefore it is recommended to estimate the quantity of nutrients which is removed by cutting the teak trees and to replenish these nutrients to the soil as fertilizer during the life cycle of the teak trees. As a side effect trees will have a better growth as no shortage of nutrients will occur.

7. CONCLUSIONS & RECOMMENDATIONS

7.1 General conclusions

The project is expected to have an overall positive impact on the environment and on the society in the project area. The environment benefits from the reforestation of the area with teak since it can reduce many of the negative impacts caused by land degradation of Afrensu Brohuma Forest Reserve. Economically, commercial teak planting offers a respectable and readily profitable market worldwide. In potential, this provides a sustainable basis for the responsible management of Afrensu Brohuma Forest Reserve.

Although threats to the project have been identified in this report, most of them can be prevented or mitigated with appropriate management solutions. Based on the outcomes of this report, benefits seem to outweigh the negative effects of this project.

7.2 Recommendations

Ecology
Forest management should include implementation and enforcement of regulations to reduce hunting in the reserve. The farmers and employees in the reserve should be educated on the importance of mammalian conservation and associated laws (close season regulations) so that they understand the conservation ideology and effectively help on law enforcement.

Socio-economic
Involving all stakeholders concerned with the project from the very beginning will facilitate sound social management of the project. The government (Forestry Commission) should be consulted regularly for legal and political issues. Land lease agreements should be discussed with the local land owners (chiefs), and local communities should be closely involved in the process of plantation development.
Furthermore, conduction of scientific research in the plantations should be encouraged. Students can be invited to investigate the process and collect data for internship purposes.

Hydrology
It is important to keep the riparian buffer zones in place and to improve them where possible in order to keep the filtering function in optimal condition.

Soil
It is recommended to keep the topsoil as much as possible undisturbed during operations of land preparation and clearing. Whenever possible, burning should be avoided as it destroys organic matter and living organisms in the soils. Under plantation, fallen

leaves and branches should be left behind on the soil as much as possible in order to replenish soil organic matter. However care should be taken to prevent forest fires. It is also recommended to estimate the quantity of nutrients which is removed by cutting the teak trees and to replenish these nutrients to the soil as fertilizer during the life cycle of the teak trees. As a side effect trees will have a better growth as no shortage of nutrients will occur.

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APPENDIX A. QUESTIONNAIRE FOR THE SOCIO-ECONOMIC STUDY

1. Household

a. Identification

	Name	Code (ID)
Household		
Village		
District		
Primary respondent		
Secondary respondent		
GPS coordinates (UTM)		

b. Household head

Details	
Marital status[1]	
Year of household formation	
Place of birth	
If not born there, year of arrival in village	
Ethnicity	
Residence (months/year)	

c. Characteristics

	Presence (Y/N)	Availability (h/day)
Electricity		
Running water		

Nearest…	Distance (km)	Time (min)	Mode of transportation[2]	Specifications
Forest				
Water source				
Hospital				
Primary school				
Secondary school				
Dirt road				
Paved road				
Market				
Village center				

[1] 1: Married and living together, 2: Married but spouse working away, 3: Widow(er), 4: Divorced, 5: Never married, 9: Other, specify…

[2] 1: On foot, 2: Bicycle, 3: Car, 4: Bus, 9: Other, specify...

d. Composition

PID	Name	Sex (F/M)	Marital status[3]	Relation to household head[4]	Year of birth	Place of birth	Year of arrival in village	Residence (Month/ year)	Ethnicity	Education (years)	Occupation	Health condition now[6]	Frequency of illness in the past 6 months

[3] 1: Married and living together, 2: Married but spouse working away, 3: Widow(er), 4: Divorced, 5: Never married, 9: Other, specify…

[4] 1: Spouse (legally married or cohabiting), 2: son/daughter, 3: son/daughter in law, 4: Grandchild, 5: Mother/father, 6: Mother/father in law, 7: Brother/sister, 8: Brother/sister in law, 9: Uncle/aunt, 10: Nephew/niece, 11: step/foster child, 12: Other family, 13: Not related

[5] 1: Shop/trade, 2: Agricultural processing, 3: Handicraft, 4: Carpentry, 5: Other forest based, 6: Other skilled labor, 7: Transport (car/boat/…), 8: Lodging/restaurant, 9: Brewing, 10: Brick making, 11: Landlord/real estate, 12: Herbalist/traditional healer/witch doctor, 13: Quarrying, 19: Other, specify…

[6] 1: Healthy, 2: Light illness, 3: Severe illness, 4: Chronic illness, 5: Disabled, 9: Other, specify…

2. Housing

a. characteristics

Type	Ownership[7]	Wall construction[8]	Roof construction[9]	Surface (m^2)

3. Land

a. Ownership

Category	Area (ha)	Ownership[1]	Top 3 products grown/harvested in the past 12 months[11]			Buyers	Livestoc type[13]	Cattle amount
Natural forest								
Managed fores								
Plantation								
Cropland								
Pasture								
Agroforestry								
Silvipasture								
Fallow								
Other								

b. Characteristics

Pesticides	No/Yes, type:
Fertilizer	No/Yes, type:
Benefit sharing	% tenant, % land-lord
Ratio private/commercial production	
Location	On/Of reserve

[7] 0: no house, 1: own the house on their own, 2: own the house with other household(s), 3: renting the house alone, 4: renting the house with other household(s), 5: other, specify…

[8] 1: mud/soil, 2: wooden (boards/trunks), 3: metal sheets, 4: bricks or concrete, 5: reeds/straw/grass/fibers, 9: other, specify…

[9] 1: thatch, 2: wooden (boards), 3: metal sheets, 4: tiles, 9: other, specify…

[10] 1: Self-owned, 2: Tenant, 3: other, specify...

[11] 1: Tomato, 2: Cassava, 3: Corn, 4: Chilli peppers, 5: Yams, 6: Groundnut, 7: Beans, 8: Okra, 9: Garden egg, 19: Other, specify...

[12] 1: Market customers, 2: Company, 3: Shop/retail, 4: Village people, 9: Other, specify...

[13] 1: Cows, 2: Goats, 3: Pigs, 4: Sheep, 5: Chickens, 6: horses, 9: Other, specify...

4. Forest

a. Collected forest products

Products	Type	% of Total use
Food (eg bushmea		
Fuelwood		
NTFP		
Building materials		
Medication		
Pestles		

b. Spiritual value

Activities	Occurence (Y/N	Frequency (#/yr)
Burial		
Rituals		
Praying		
Festivals		
Marriage		
Other, specify..		

c. Historical perspective

Features	Condition before deforesta-tion[14]	Condition now[14]
Large trees		
Soil fertility		
Fish		
Wildlife		
Productive plant		
Water quality		
Water quantity		

[14] 1: poor, 2: fair, 3: average, 4: good, 5: excellent

APPENDIX B. FLORA INVENTORY OF AFBR

Table B1. List of indigenous tree species found in the riparian buffer zones

Scientific name	Number
Albiza ferruginea	2
Albizia adianthifolia	1
Albizia zygia	12
Alchornea cordifolia	6
Alstonia boonei	2
Amphinas pterocarpoides	2
Anthonotha macrophylla	2
Antiaris toxicaria	4
Baphia nitida	2
Blighia sapida	1
Blighia welwitschii	2
Bombax buonopozense	3
Broussonetia papyrifera	18
Canarium schweinfurthii	1
Carapa procera	5
Ceiba pentandra	9
Celtis milbraedii	1
Cleistopholis patens	6
Cola gigantea	1
Cola milenii	1
Corynanthe tachyceras	1
Daniellia thurifera	2
Distemonanthus benthamianus	1
Dracaena perrottelii	3
Ficus exasperata	5
Ficus sur	5
Glyphaea brevis	5
Hallea ledermannii	1
Khaya ivorensis	1
Lacaniodiscus cupanoides	1
Lannea welwitschii	5
Lonchoearpus sericeus	2
Mansonia altissima	1
Mareya micrantha	2
Margaritaria discoidea	5
Massularia acuminata	5
Melletia zechiana	2

Scientific name	Number
Microdesmis puberula	1
Milletia zechiana	2
Nesogordonia papaverifera	1
Newbouldia faenis	2
Piptadeniastriun africanum	1
Pouteria altissima	1
Rauvolfia vomitoria	5
Rhodognaphalon brevicuspe	1
Ricinodendron heudelotii	9
Spathodea campanulata	7
Sterculia tragacanta	11
Strombosia pustulata	1
Strophanthus hispidus	1
Tabernaemontana africana	2
Terminalia superba	1
Trema orientialis	2
Trichilia prieuriana	7
Triplochiton scleroxylon	2
Veronica amygdalina	3
Unknown	2
Total individuals	**190**

Species found in buffer zones of Asubima forest reserve, during to an internal monitoring assessment by Form Ghana

Table B2. List of remnant indigenous tree species

Scientific name	Local name	Number
Afzelia africana	Papao	1
Albizia ferruginea	Awiemfosamina	4
Albizia zygia	Okoro	2
Alstoonia boonei	Nyame Dua	16
Antiaris toxicaria	Kyenkyen	18
Amphimas pterocarpoides	Yaya	1
Blighia sapida	Akye	1
Bombax buonopozense	Akonkodie	66
Canarium Schweinfurthii	Bediwonua	1
Ceiba pentandra	Onyina	117
Chrysophyllum perpulgrum	Atabene	1
Chrysophyllum sp.	Akasan	1
Cleistopholis patens	Ngononkyene	4
Cola gigantea	Wabire	90
Cola millenii	Ananse-Dodowa	17
Entandrophragma utile	Efoobrodedwo	4
Erythrophleum ivorense	Potrodum	2
Ficus exasperata	Nyankyerene	1
Ficus sur	Nwadua	10
Holarrhena floribunda	Sese	1
Khaya anthoteca	Mahogany	22
Khaya ivorensis	Dubini	28
Lannea welwitschii	Kumanini	1
Milicia excelsa	Odum	2
Morus mesozygia	Wonton	2
Naclea diderrichii	Kusia	1
Nesogordonia papaverifera	Danta	3
Petersianthus macrocarpus	Esia	1
Pouteria altissima	Asanfema-Bere	1
Pouteria aningeri	Asanfema-Nini	4
Pterygota macrocarpa	Kyereye	1
Pycnanthus angolensis	Otie	7
Spathodium campanulatum	Akuakua-Ninsuo	5
Sterculia oblonga	Ohaa	4
Sterculia tragacantha	Sofo	23
Terminalia ivorensis	Emire	1
Terminalia superba	Ofram	2
Tetrapleura tetraptera	Prekese	3

Scientific name	Local name	Number
Trichilia monadelpha	Tanuro	3
Triplochiton scleroxylon	Wawa	11
Vitex ferruginea	Otwentrowa	1
Anogasis grandufolia	Anogasis	1
Trichilia prieuriana	Kakadikro	1
Total individuals		**486**

Above species were found in the deforested areas of Asubima forest reserve, during internal monitoring efforts by Form Ghana.

Table B3. List of plant species found in Afrensu Brohuma

Family	Species	Life form	No of Plots
Acanthaceae	*Asystasia* sp.	Herb	1
	Eremomastax polysperma	Herb	1
Agavaceae	*Dracaena elliotii*	Shrub	1
	Dracaena phrynoides	Shrub	1
Anacardiaceae	*Lannea welwetschii*	Tree	10
Annonaceae	*Cleistophlis patens*	Tree	4
	Monodora tennifolia	Tree	2
	Uvaria afzelii	Tree	4
Apocynaceae	*Alabia barteri*	Liana	4
	Baissea occidentalis	-	1
	Anchomanes difformis	Liana	10
	Chromolaena odorata	Herb	13
Asteraceae (Composi-teae)	*Vernonia cinerea*	Herb	1
Bignoniaceae	*Stereospermum acumina-tissimum*	Tree	4
Boraginaceae	*Cordia millennia*	Tree	4
Bromeliaceae	*Ananas comosus*	Herb	1
Burseraceae	*Canarium schweinfurthii*	Tree	1
Cleomaceae	*Cleome viscose*	Herb	7
Combretaceae	*Terminalia ivorensis*	Tree	2
	Terminalia superba	Tree	5
Commelinaceae	*Commelina* sp.	Herb	11
Connaraceae	*Agelaea nitida*	Liana	1
	Cnestis ferriginea	Liana	7
Cucurbitaceae	*Momordica foetida*	Liana	1
	Telfairia occidentalis	Liana	1
Cyperaceae	*Scleria boivinii*	Herb	1
Dracaenaceae	*Dracaena ovate*	Herb	1
Ebenaceae	*Diospyros gabonensis*	Tree	2
Euphorbiaceae	*Alchornea cordifolia*	Shrub	1
	Macaranga barteri	Tree	1
	Macaranga heurifolia	Tree	3
	Margaritaria discoidea	Tree	2
	Spondianthus preussii	Tree	1
Fabaceae	*Albizia adienthifolia*	Tree	2
	Albizia zygia	Tree	7
	Aubrevillea platycarpa	Tree	4
	Griffonia simplicifolia	Liana	7
Filicineae	*Cyclosorus Striatus*	Fern	1

Family	Species	Life form	No of Plots
Flacourtiaceae	*Homalium stipulaceum*	Tree	1
Graminae	*Panicum maximum*	Grass	7
	Saccharym officinalis	Grass	1
	Setaria barbata	Grass	1
	Sporobus pyramidalis	Grass	1
Guttiferae	*Garcinia smeathmannii*	Tree	1
Leguminosae (Caes)	*Daniellia thurifera*	Tree	4
	Daniellia ogea	Tree	2
	Dialium aubrevillei	Tree	4
	Distemonanthus bentha-mianus	Tree	1
	Gilbertiodendron limba	Tree	1
	Gilbertodendron splendi-dum	Tree	5
	Hymenostegia afzelii	Tree	2
Leguminosae (Mim)	*Piptadeniastrum africanum*	Tree	2
	Tetrapleura chavalieri	Tree	2
Leguminosae (Pap)	*Amphimas pterocarpoides*	Tree	2
	Baphia nitida	Shrub	4
	Dalbergia saxatilis	Tree	2
	Desmodium ascendense	Herb	1
Malvaceae(Bombacaceae)	*Ceiba pentandra*	Tree	9
	Rhodognaphalon brevi-cuspe	Tree	2
Malvaceae(Sterculiaceae)	*Nesogordonia papaverifera*	Tree	2
	Cola gigantean	Tree	2
	Cola millenni	Tree	4
	Sterculia rhinopetala	Tree	4
	Sterculia oblonga	Tree	3
	Triplochiton scleroxylon	Tree	1
Malvaceae (Tilliaceae)	*Glyphaea brevis*	Tree	2
Marantaceae	*Hypselodelphis velutina*	Shrub	2
	Marantochloa mannii	Shrub	2
Meliaceae	*Entandrophragma ango-lense*	Tree	2
	Entandrophragma cylindri-cum	Tree	1
	Entandrophragma utile	Tree	2
	Khaya ivorensis	Tree	2
	Trichilia monadelpha	Tree	2
Moroceae	*Antiaris toxicaria*	Tree	11

Family	Species	Life form	No of Plots
	Broussonetia papyrifera	Tree	11
	Ficus variifolia	Tree	1
	Milicia excels	Tree	2
Myristicaceae	*Pynanthus angolensis*	Herb	12
Olacaceae	*Coula edulis*	Tree	2
	Heisteria parvifolia	Shrub	1
	Strombosia pustulata	Tree	2
Palmae	*Laccosperma opacum*	Liana	2
	Raphia palma-pinus	Tree	3
Pandaceae	*Panda oleosa*	Tree	1
Passifloraceae	*Adenia rumicifolia*	Liana	2
Poaceae	*Pennisetum purpureum*	Grass	7
	Imperata cylindrical	Grass	1
	Rottboelia exaltata	Grass	3
Pterydophyta	*Nepholepis sp.*	Fern	2
Rubiaceae	*Chassalia kolly*	Liana	1
	Dictyandra arborescens	Shrub	1
Sapindaceae	*Blighia sapida*	Tree	1
	Blighia welwitschii	Tree	1
	Majidea fosteri	Tree	1
Sapotaceae	*Chrysophyllum perpul-chrum*	Tree	1
	Pouteria alnifolia	Tree	1
Santalaceae	*Okonbaka aubrevillei*	Tree	1
Solanaceae	*Solanum torvum*	Liana	1
Ulmaceae	*Celtis adolfi*	Herb	2
	Celtis mildbraedii	Tree	3
	Celtis wightii	Tree	1
	Celtis zenkeri	Tree	1
Violaceae	*Rinorea afzelii*	Liana	1
	Rinorea oblongifolia	Tree	2
Zingiberaceae	*Aframomum stanfieldii*	Herb	1
Unknown	*Ananse tromohoma*	Herb	2
	Toantini	Liana	1
	Odenia rumicifolia	Tree	1
	Fema	Tree	1
	Sope	Tree	1

List compiled by A. Prosper Manu, 2011).

APPENDIX C. FAUNA INVENTORY AFBR

Table C1. List of small mammal species sightings.

Species	Common name	Indigenous forest	Teak plantation
Mastomys natalensis	Multimammate rat	2	1
Mus minutoides	African Pygmy Mouse	-	2
Mus erytholeucus		3	-
Praomys tullbergi	Soft-furred mouse	2	3
Lemniscomys striatus	Striped Grass Mouse	1	-
Lophuromys sikapusi	Rusty-bellied rat	3	1
Crocidura obscurior	West African Pygmy Shrew	2	-
Crocidura crossei	Crosse's Shrew	4	1
Crocidura jouvenetae	Jouvenet's shrew	1	-
Total		**18**	**8**

Table C2. Small mammal characteristics

Parameters	Indigenous forest	Teak plantation
Number of trap nights	576	576
Number of individuals	18	8
Number of species	8	5
Average population size	2.25	1.6
Shannon-Wiener index (log)	2.864	2.156
Shannon-Wiener index (In)	1.985	1.494
Shannon-Wiener index (adjusted)	95.46%	92.84%

Table C3. List of bird species

Family	Species	Common name	Status
Accipitridae	*Kaupifalco monogrammicus*	Lizzard Buzzard	Least common
	Aquila wahlbergi	Wahlberg's Eagle	Common
Apodidae	*Cypsium parvus*	African Palm Swift	Common
Bucerotidae	*Tockus nasutus*	African Grey Hornbill	Common
	Tockus fasciatus	African Pied Hornbill	Common
Buphagidae	*Buphagus africanus*	Yellow Billed Oxpecker	Locally common
Cisticolidae	*Cisticola natalensis*	Croaking Cisticola	Common
Columbidae	*Columba unicincta*	Afep Pigeon	Common
	Streptopelia semitorquata	Red eye Dove	Common
	Turtur tympanistria	Tambourine Dove	Common
	Columba guinea	Speckled Pigeon	Common
	Streptopelia turtur	European Turtledove	Localised resident
	Streptopelia senegalensis	Laughing (Palm) Dove	Abundant
Coraciidae	*Corocias cyanogaster*	Blue Bellied Roller	Common resident
	Eurystomus glaucurus	Broad Billed Roller	Locally common resident
	Eurystomus gularis	Blue-throated Roller	Common
Corvidae	*Corvus albis*	Pie Crow	Common and widespread
cuculidae	*Centropus senegalensis*	Senegal Coucal	Uncommon
Dicruridae	*Dicrurus adsimilis*	Fork-tailed Drongo	Common
Estrildidae	*Spermestes bicolor*	Black and White Mannikin	Common
	Spermestes cucullata	Bronze Mannikin	Abundance
	Lagonosticta senegala	Red-billed Firefinch	Common
Fringillidae	*Serinus mozambicus*	Yellow Fronted Canary	Common
Indicatoridae	*Indicator monor*	Lesser Honey	Common
Motacillidae	*Macronyx croceus*	Yellow Throated Longclaw	Common
Muscicapidae	*Myrmecocichla albifrons*	White-fronted Black Chat	Locally Common
Nectariniidae	*Cyanomitra verticalis*	Green-headed Sunbird	Common
	Cinnyris venustus	Variable (Yellow-	Common

Family	Species	Common name	Status
		breasted) Sunbird	
	Cinnyris cupreus	Copper Sunbird	Uncommon
Oriolidae	*Oriolus nigripennis*	Black winged Oriole	Common
Ploeciedae	*Ploceus cucullatus*	Village (spotted-backed) Weaver	Common
	Ploceus velatus	Southern Masked Weaver	Common and widespread
	Ploceus luteolus	Little Weaver	Locally common
	Ploceus nigerrimus	Vieillots's black Weaver	Common
	Anaplectes melanotis	Red-headed Weaver	Locally common
	Malimbus erythrogaster	Red-Bellied Malimbe	Locally common
	Malimbus malimbicus	Crested Malimbe	Fairly common
	Quelea cardinalis	Red-Headed Quelea	Locally Common
Pycnonotidae	*Pycnonotus barbatus*	Common Bulbul	Abundant
Sylviidae	*Melocichla mentalis*	Moustached Grass Warbler	Locally common
	Locustella luscinioides	Savi's Warbler	Locally common
	Acrocephalus arundinaceus	Great Reed-Warbler	Common
	Acrocephalus schoenobaenus	Sedge Warbler	Common
Viduidae	*Vidua macroura*	Pin-tailed Whydah	Common
	Vidua sp.		Uncommon

Table C4. List of butterfly species

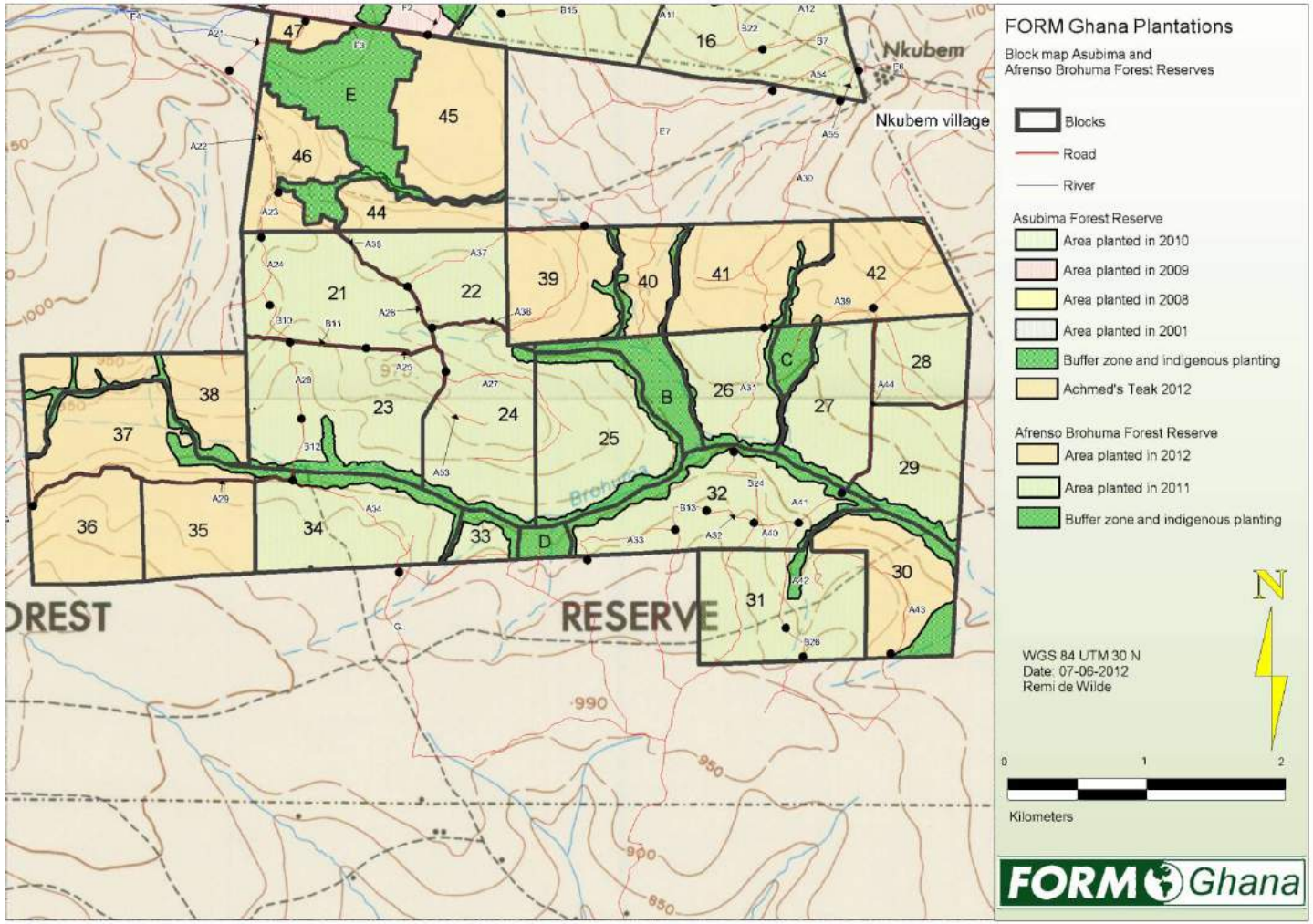
Family	Species
Papilionidae	*Papilio dardanus*
	Papilio menestheus
	Papilio demodocus
	Papilio zenobia
	Graphium policenes
Pieridae	*Eurema hecabe*
	Eurema desjardinsii
	Nepheronia thalassina
	Nepheronia pharis
	Belenois calypso
Lycaenidae	*Liptena flavicans*
	Liptena similis
	Mimeresia seminifa
	Pentila pauli
	Euliphyra leucyania
	Euliphyra hewitsoni
	Anthene liodes
	Anthene rubricinctus
	Chilades eleusis
Charaxinae	*Charaxes ameliae*
	Charaxes bipunctatus
	Charaxes boueti
	Charaxes petersi
	Palla ussheri
	Palla Decius
Limenitidinae	*Euriphene barombina*
	Euriphene simplex
	Euriphene incerta
	Bebearia maledicta
	Euphaedra gausape
	Euphaedra jenetta
	Euphaedra francina
	Euphaedra inanum
	Neptis metella
	Neptis melicerta
Heliconiinae	*Acraea alciope*
	Acraea rogersi
	Acraea epaea

Family	Species
Hesperiinae	*Pardeleodes incerta*
	Xanthodisca astrap
	Meza meza

Table C5. List of medium sized mammals

Family	Species	Common name	Mode of observation	Indigenous forest	Teak Plantation	CITES
Artiodactyla	*Tragelaphus scriptus*	Bushbuck	FP	4	-	II
	Cephalophus maxwelli	Maxwell Duiker	FP	2	4	II
	Cephalophus niger	Black Duiker	FP	-	2	II
Carvivora	*Civittictis civetta*	African Civet	FP	7	4	I
	Nandinia binotata	African Palm-civet	FP	9	9	I
Logomorgomorpha	*Lepus capensis*	Togo Hare	FP	1	8	
Rodenta	*Thryonomys swinderianus*	Grasscutter	FP,FS	6	14	
	Euxenus erythropus	Striped Squirrel	FP,FS	12	6	II
	Cricetomys gambianus	Giant Pouched Rat	FP	29	8	II

APPENDIX D. MAP OF AFBR



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