

## HCVF Analysis

Analysis of the High Conservation Value Forest areas of  
Afrensu Brohuma Forest Reserve, Ashanti Region, Ghana

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## Client

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### ADDENDUM

This addendum is made to clarify the surfaces under management in the area of the Akumadan plantation of Form Ghana in Ghana. In the past, different methodologies used by different institutions caused different results (surfaces) and confusion. The data below are based on GIS mapping carried out in April 2017 by Form Ghana and will be used in all documentation as from publication date.

| FOREST RESERVE        | YEAR of planting (ha) | TOTAL AREA (ha) | Planted with INDIGENOUS (ha) | Planted with TEAK (ha) | UNPRO-DUCTIVE* (ha) | AREA PER RESERVE (ha) |
|-----------------------|-----------------------|-----------------|------------------------------|------------------------|---------------------|-----------------------|
| ASUBIMA               | 2001                  | 66,09           | 11,56                        | 53,76                  | 0,77                | 1667,48               |
|                       | 2006                  | 107,48          | 15,05                        | 91,41                  | 1,03                |                       |
|                       | 2008                  | 171,52          | 22,35                        | 148,16                 | 1,01                |                       |
|                       | 2009                  | 609,03          | 92,27                        | 512,57                 | 4,18                |                       |
|                       | 2010                  | 713,36          | 88,46                        | 612,51                 | 12,40               |                       |
| AFRENSU BROHUMA       | 2011                  | 986,37          | 132,75                       | 844,32                 | 9,30                | 1779,86               |
|                       | 2012                  | 793,49          | 127,80                       | 663,12                 | 2,56                |                       |
| <b>TOTAL AKUMADAN</b> |                       | <b>3447,34</b>  | <b>490,24</b>                | <b>2925,84</b>         | <b>31,25</b>        | <b>3447,34</b>        |

*\*) 'Unproductive' is not reforested (because of presence of rocks or shallow soils, streams or roads).*

The addendum applies to the Management Plan Akumadan and all plans and reports.

Publication date: 1<sup>st</sup> of May, 2017



M. Willem Fourie  
Managing Director Form Ghana

# 1. Introduction

Form Ghana commissioned Form international to conduct a High Conservation Value Forest (HCVF) analysis to contribute to the sustainable implementation of the company's reforestation activities in the Afrensu Brohuma Forest Reserve. According to Rayden et al. (2006), "All types of forests are unique and important and of conservation value but High Conservation Value Forests (HCVFs) are simply forests with outstanding significant values that are of critical importance, which needs to be appropriately managed or protected in order to maintain or enhance the identified values". Consequently, reforestation activities shall consider that the high conservation values of the project area, if present, can be managed and protected.

## **Form international**

Form international is a Dutch consultancy firm established in 1992. It offers high quality advice on forest management, certification and technical assistance to plantation establishment and management. Form international has extensive experience in tropical forest management, mainly in West and Central Africa and is also active in Europe on Chain-of-Custody (CoC) certification and PEFC conformity assessments.

Form international advises branch organizations, international timber and forest companies, NGO's and many other organizations that play a role in the direct or indirect amelioration of forest management. Using a pragmatic approach, Form international's knowledge and experience in the field of sustainable forest management and certification is translated into a concrete advice ready to be implemented in the day-to-day forest operations of her clients.

## **Form Ghana**

Form Ghana is a reforestation company established in 2007, which aims at large-scale reforestation of degraded forest reserves in Ghana while conserving and restoring natural, riparian forest. Form Ghana is currently active in Offinso North district, 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. In 2010, the Forestry Commission has given permission to Form Ghana to establish a plantation in the Forest Reserve and the first 869 ha of Teak were planted in 2011.

## **Government of Ghana**

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 of farmers. 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. 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. In their effort to restore the forest, Form Ghana has signed a land lease agreement with traditional land owners and the Forestry Commission of Ghana for

the reforestation project in Afrensu Brohuma Forest Reserve. This land lease and benefit sharing agreement 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.

### **Form Ghana's unique sustainability concept**

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™).

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

- Both exotic (i.e. Teak) and indigenous tree species (>10%) will be planted on the lease area;
- Degraded riparian zones will be actively restored and conserved;
- The company will work 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 will be offered the opportunity for intercropping in the first two years of planting.

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 which are 30 meters on each side of the waterway. The carbon storage function of the plantation forests has the potential to contribute to climate change mitigation. Trees planted on the plantations consist for a maximum of 90% Teak and at least 10% mixed indigenous species (e.g. Ofram, Emeri, Wawa).

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. Farmers are not allowed to farm within forest reserves according to national laws, so the issue of land grabbing is largely avoided by operating within reserve boundaries.

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). 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.

Employees are offered a safe and healthy working environment, with good employment terms, favorable (health) 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. Surrounding communities are allowed access to the plantation for collection of fire-wood and other NTFP's. Farmers are offered the opportunity to intercrop within the plantation, with respect for the terms and conditions that apply under FSC 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. Form Ghana hires local people as plantation and nursery workers, security, and fire fighting squad members.

### **High Conservation Value Forests**

According to FSC principles, an FSC certified company should ensure 'maintenance of high conservation value forests – to maintain or enhance the attributes which define such forests.' These High Conservation Value Forests (HCVFs) first have to be identified in the project area before they can be maintained or enhanced. The Forest Stewardship Council (FSC™) has provided a definition for High Conservation Value Areas, with 6 'High Conservation Values' (see below). We adopt this definition, replacing 'areas' with 'forests', since this is the focus of Form Ghana as a forest plantation company.

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#### **Box 1: FSC™ definition of HCVF**

High Conservation Value Forests possess one or more of the following attributes:

1. Forests containing globally, regionally or nationally significant concentrations of biodiversity values (e.g. endemism, endangered species, refugia);
2. Forests containing globally, regionally or nationally significant large landscape level forests, contained within, or containing the management unit, where viable populations of most if not all naturally occurring species exist in natural patterns of distribution and abundance;
3. Forests that are in or contain rare, threatened or endangered ecosystems;
4. Forests that provide basic services of nature in critical situations (e.g. watershed protection, erosion control);
5. Forests fundamental to meeting basic needs of local communities (e.g. subsistence, health);
6. Forests critical to local communities' traditional cultural identity (areas of cultural, ecological, economic or religious significance identified in cooperation with such local communities).

This report provides an analysis of the High Conservation Values of Afrensu Brohuma Forest reserve. The definition of HCVF is adopted from FSC, as shown in Box 1. This report however replaced 'areas' with 'forests', since that is the focus of Form Ghana as a forest plantation company.



## 2. Methodology

This report presents an analyses of the presence (or absence) of the six aforementioned attributes in the part of Afrensu Brohuma Forest Reserve (Afrensu Brohuma FR) that is managed by Form Ghana. For the correct interpretation of the six HCVFs, the national HCVF toolkit developed for Ghana was applied during the identification (Rayden *et al.*, 2006).

### 2.1 Data collection

The study employed literature review, field research and stakeholder consultation to obtain the required data for these analyses. For the methodology of the field survey, please refer to Appendix A-D. The literature review made use of the following documents:

#### Literature

- IUCN red list status for each of the encountered species
- Literature on biodiversity in the vicinity of Afrensu Brohuma FR
- Ghana Wildlife Conservation Regulations (1971) and Amendments (1988)
- Map of GSBA's in Ghana

#### Field research

- Social and Environmental Impact Assessment (SEIA) (Tollenaar, 2012)
- Monitoring report (Form international, 2012)
- Frog biodiversity (De Laat, 2010)
- Snake biodiversity (Hodoli, 2011)
- Mammal biodiversity (Quansah, 2011)
- Hydrological assessment Afrensu Brohuma FR (Form Ghana, 2013)

The SEIA consists of an environmental assessment and a socio-economic assessment including a stakeholder consultation. The environmental assessment contains information on land use stratification, vegetation (species and characteristics), fauna (mammals, birds, reptiles, butterflies) and hydrological characteristics of the area. The monitoring data provides more detailed information on flora and fauna diversity. Additional data on biodiversity (frogs, snakes and mammals) was obtained from studies performed in neighbouring Asubima Forest Reserve which is assumed to be representative for the Afrensu Brohuma FR. Most of the above-mentioned reports can be downloaded on the website: [www.formghana.com](http://www.formghana.com) (tab: downloads).

The conservation status of each species was assessed using the IUCN Red List and the Ghana national Wildlife Conservation Regulations (1971) and Amendments (1988). The latter distinguishes between three different levels of conservation priority: first, second and third schedule species. The regulations that apply for each of these categories are noted in the box below.

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## **Ghana Wildlife Conservation Regulation (1971)**

### *First schedule*

Animals completely protected

### *Second schedule*

The hunting, capturing or destroying of any species listed in the schedule is absolutely prohibited between 1<sup>st</sup> August and 1<sup>st</sup> December in year any year. The hunting, capturing or destroying of any young or adult accompanied by its young of any species listed in this schedule is absolutely prohibited at all times

### *Third schedule*

The hunting, capturing or destroying of any species listed in this schedule is absolutely prohibited between 1<sup>st</sup> August and 1<sup>st</sup> December in any year.

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Watersamples were taken at 11 strategic points at outlets and inlets of waterways in Afrensu Brohuma FR and analyzed in a laboratory in June 2013, see figure 2. The following parameters were measured and the values compared to the maximum values for safe drinking water according to the WHO: Temperature, pH, Turbidity (NTU), Apparent colour (PtCo), Conductivity ( $\mu\text{s}/\text{cm}$ ), Dissolved solids, Suspended solids, Total solids, Alkalinity, Hardness, Calcium Hardness, Magnesium Hardness, Calcium, Magnesium, Chloride, Nitrate, Sulphate, Iron, Copper.

### **Stakeholder consultation**

- Stakeholder consultation performed in Afrensu Brohuma FR by Tollenaar (2012) as part of the SEIA
- Stakeholder meetings
- Specific feedback on HCVF analysis

Information was derived from the stakeholder meetings organized three times a year by Form Ghana, since 2009. Stakeholder groups include farmers, traditional land owners, environmental NGOs, and the Forestry Commission (government). Main subjects on the agenda are intercropping and FSC certification. During these meetings, stakeholders are informed about the company's developments, future plans and ongoing studies commissioned by the company. Stakeholders do have the opportunity to bring issues for discussion and also provide input into the company's plans.

After a draft version of this report was available, a number of stakeholders from renowned Ghanaian and international organisations were asked for their input, comments and suggestions.

The following organizations have been approached: Tropenbos, Kwame Nkrumah University of Science and Technology (KNUST), Institute of Renewable Natural Resources department of KNUST, Proforest, IUCN, WCS and WWF.

## 3. Characteristics Afrensu Brohuma Forest Reserve

### 3.1 Study area

Afrensu Brohuma Forest Reserve (FR) is located in the Ashanti Region in the High Forest Zone of Ghana. Although this may imply that the area is forested, this is not the case anymore as the forest reserve is highly degraded due to logging, illegal farming activities and extensive wildfires (Abeney *et al.*, 2008). Since the nineties, there is a presidential policy to actively restore the ecological, social and economic values of the degraded Forest Reserves in Ghana. In 2001, the government of Ghana developed the National Forest Plantation Development Plan as a reforestation strategy where commercial reforestation was proposed as one of the solutions to reverse further degradation of the Forest Reserves.

Form Ghana acquired a land lease contract (validity 50 years renewable) for 1,778 hectares (ha) of land located in the southern part of the Asubima FR and 1,808 hectares in the Afrensu Brohuma FR. The south of the Asubima FR borders with the Afrensu Brohuma FR as shown in figure 1.

In Afrensu Brohuma Forest Reserve, planting of timber trees started in 2011 and was completed in June 2012. The few remnant trees were conserved while new tree species planted consist predominantly of Teak (*Tectona grandis*) and a mixture of indigenous species (at least 10%), like Ofram (*Terminalia superba*), Emeri (*Terminalia ivorensis*) and Wawa (*Triplochiton scleroxylon*). Indigenous species were planted in some of the plantation areas and in the areas near water courses that have been set aside as buffer zones for the protection of waterways and the conservation and restoration of natural forest.

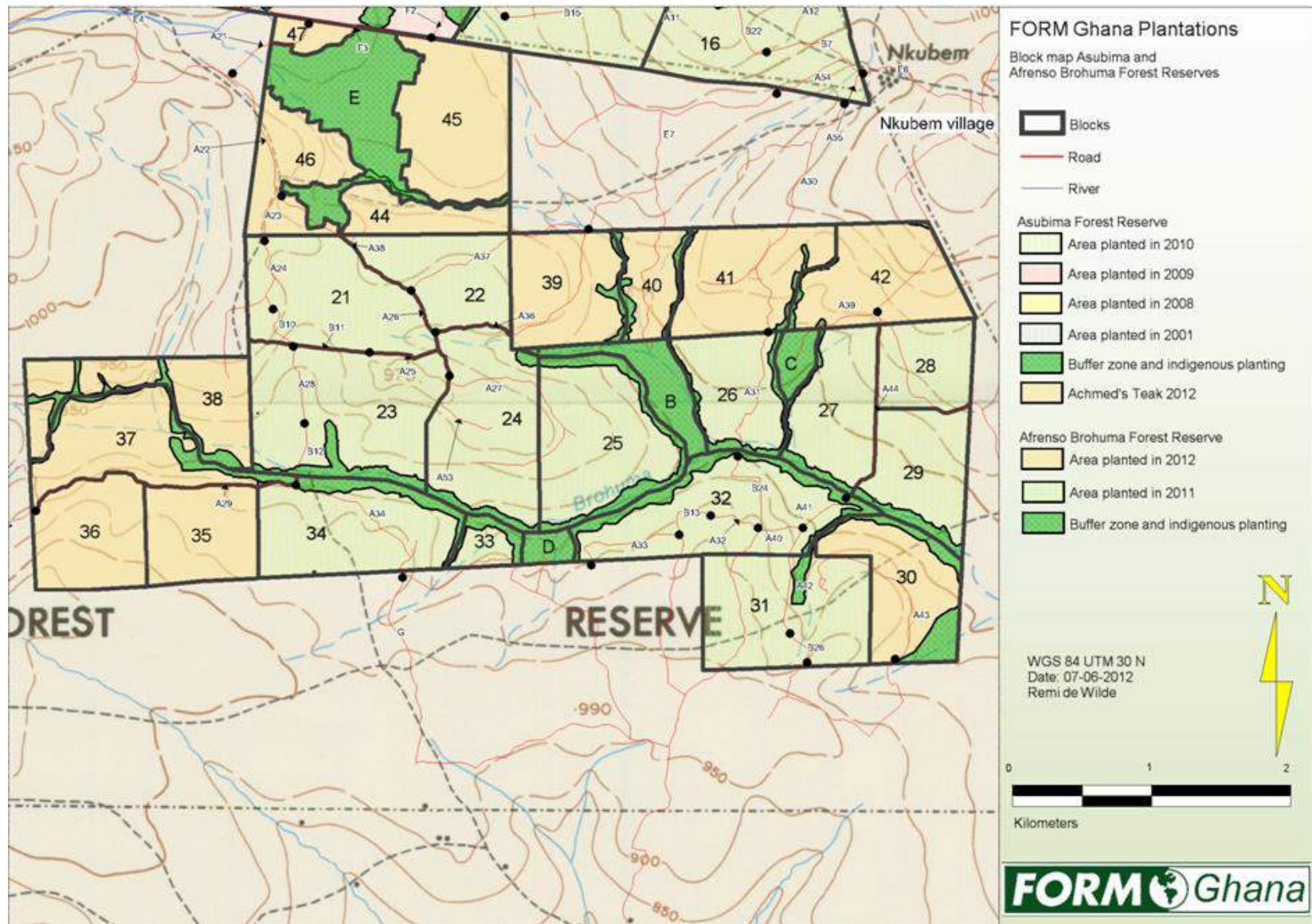


Figure 1. Land leased by Form Ghana for reforestation purposes.

## 3.2 Abiotic environment

### Relief

Afrensu Brohuma Forest Reserve is an undulating area, with some rocky outcrops spread out over the terrain (Sools & Wanders, 2010). Overall, the height varies from approximately 270m to about 435m.

### Climate

The reserve lies at the northern fringes of the dry semi-deciduous forest ecological zone of Ghana (Agyeman *et al.*, 2001). The zone has a tropical monsoon climate with alternating wet and dry seasons. The long wet season starts around mid-March and ends in mid-July. It is followed by a short dry season until the end of August. From September till the end of October, there is a short rainy season, followed by a long dry season from November till mid-March. Total annual rainfall is 1227 mm on average. Temperatures vary with the seasons. February, March and April are generally the warmest months and July and August the coolest. Mean annual temperature lays around 26° C. During dry seasons, wildfires are common in Afrensu Brohuma FR.

### Hydrography

Several streams drain Afrensu Brohuma FR. Measurements of turbidity and chemical composition (pH, dissolved oxygen, nitrogen content, conductivity) show that the water in Afrensu Brohuma Forest Reserve is not suitable for drinking.

Although turbidity per se does not have to be a risk for people's health, it is an indicator for possible presence of contaminants that do threaten health. Also, it interferes with disinfection of water. For effective disinfection, turbidity should be lower than 1 NTU, and definitely not exceed 5 NTU. Turbidity in these samples ranges from 4.3 to 423.8 NTU.

No health-based guideline value is proposed for color in drinking-water but commonly values below 15 PtCo are acceptable to consumers. In the Afrensu Brohuma samples, apparent color ranges from 34 PtCo to 3469 PtCo.

Ph reaches levels of 5.8, a little below the range of 6.5 – 8.5 recommended by the WHO.

Calcium, magnesium, nitrate and chloride do not exceed recommended maximum levels. Hardness, conductivity and alkalinity are also within acceptable range.

Copper and iron levels however are high. No health-based guideline value is proposed for iron by the WHO but it is recommended to maintain levels below 0.3 mg/l because iron promotes the growth of "iron bacteria", which derive their energy from the oxidation of ferrous iron to ferric iron and in the process deposit a slimy coating on the piping. At levels above 0.3 mg/l, iron stains laundry and plumbing fixtures. Iron levels in these samples reach up to 1.9 mg/l.

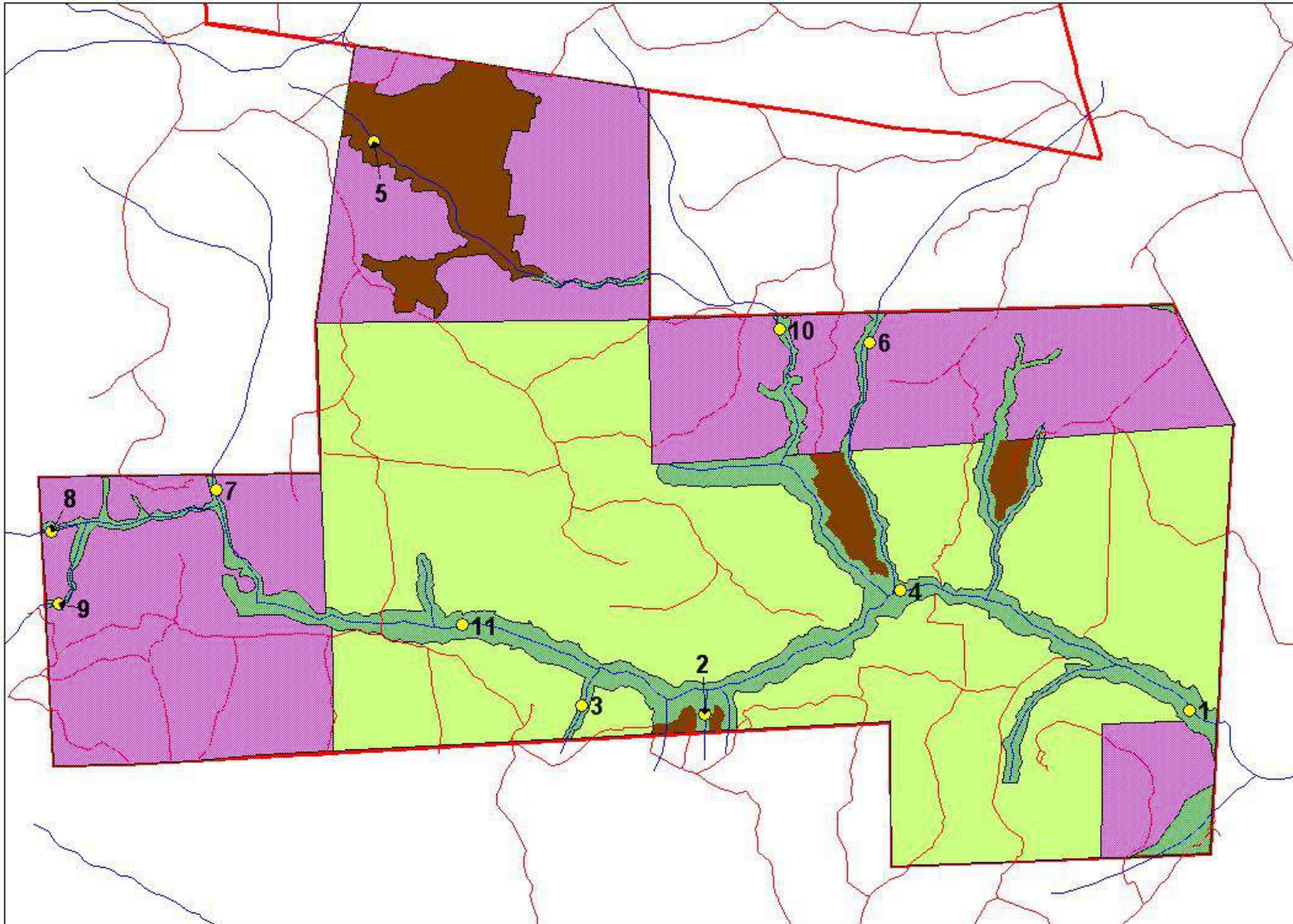
The health-based guideline for copper is set at 2 mg/l by the WHO. Overall high concentrations can interfere with the intended domestic uses of the water. Staining of sanitary ware and laundry may occur at copper concentrations above 1 mg/l. At levels above 5 mg/l, copper also imparts a colour and an undesirable bitter taste to water. The guideline

value is exceeded in two of the samples (2.3 and 3.9 mg/l). In the other samples levels are generally low (0.03-0.96mg/l).

Considering these outcomes, nearly all streams are polluted quite severely. This situation is a major concern to the project, and much effort is being put in the restoration of the 30 meter buffer zones along the water courses in order to remedy this problem. It is expected that vegetation will reduce erosion and prevent chemicals from entering the water.

### **Infrastructure**

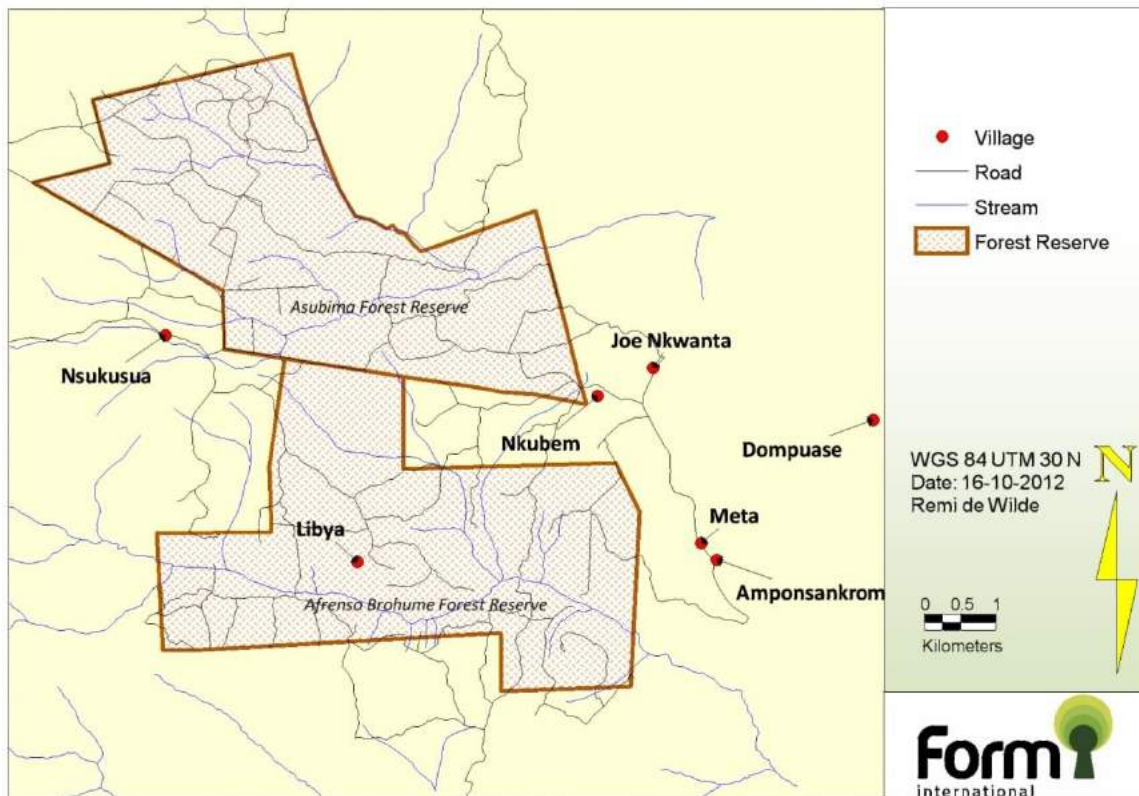
To the west of Afrensu Brohuma FR, on a distance of approximately 7-10km, lies a major road connecting Kumasi to Techiman. Within the plantation area, Form Ghana constructed a network of gravel roads, partly by upgrading old farmers' and loggers' roads. Ideally, quadrant boundaries were used as in-roads, saving surface for planting and often shortening distances. The maintenance of these roads is undertaken by Form Ghana.



**Figure 2.** Water sample points taken in Afrensu Brohuma Forest Reserve.

### 3.3 Social environment

At a distance of about 7 km from the reserve lies Akumadan, the nearest town, while Techiman (23 km further north than Akumadan) is the nearest major town (about 80,000 inhabitants). Seven communities around the Forest Reserve were included in the social assessment; Libya, Meta, Joe-Nkwanta, Nkubem, Dompuse, Amponsankrom and Nsukusua (figure 3).



**Figure 3.** Selected villages for interviews and questionnaires.

#### 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, 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 sheets and some walls were plastered. A house typically consists of multiple rooms (3 on average) of app. 10m<sup>2</sup> each.

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 the average number 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 some of their children had moved out of the village, either temporarily or permanently. The largest household included



in the social assessment 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.

### **Livelihood**

Living conditions are generally quite poor in the area. The communities included in this assessment had no electricity, no source of treated water (except one borehole in Meta), no access to paved roads and no medical clinic. Dirt roads were poorly maintained. As a consequence, it is difficult for the community members to reach hospitals (Akumadan Health Centre and the District Hospital in Nkenkasu, on average 12km away) or markets, where farmers sell their products (Akumadan, Nkoranza, Techiman and Abofour).

### **Population composition**

Most respondents (53%) were not born in the village that they currently live in. Many of the respondents to the SEIA (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. 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 favourable climatic conditions for farming due to 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.

### **Land use**

The reserve has turned in to savannah in most places. Although illegal, farmers from fringing communities have entered the reserve to use parts of it as farmland. Some migrants even settled within the reserve.

Crops produced by most farmers are maize, yam and groundnut. The largest areas were used for cultivation of maize, watermelon and yam. Mixed cultivation systems are frequently encountered and commonly include okra, garden eggs, cocoyam, sweet potato and onion. The average size of farmland belonging to one household is 11.6 acres (4.7 ha), according to farmers' estimations.

47% of the households included in this assessment were farming within reserve boundaries. 28% of the households had all of their land within the reserve, 19% had some land within and some outside reserve boundaries. Most farmers lease the land from a landlord, while some of the farmers reported a benefit sharing agreement. The farmers farming illegally within the reserve can now farm there legally, as long as they abide by the rules of Form Ghana.

After Form Ghana established a plantation in the reserve, the farmers can participate in an intercropping system, designed by Form Ghana. In this way, they can continue their farming activities in the area, although there are certain rules as to when crops can be planted (after the Teak seedlings have been planted), which crops can be planted (no cassava, no plantain), and for what period farmers can do intercropping in a particular plot (2-3 years).

### **Employment**

Form Ghana employs permanent workers and casual workers. The number of people in permanent employment has increased from 127 in 2010 to 172 in 2011, while the number of

people finding casual or contract employment increased from 300 to 400 in 2010 and 2011 respectively (Ogoe *et al.* 2011). The number of casual workers depends on the season.

The workers are voluntarily represented by the labour union with which the management holds regular meetings. All workers enjoy a free hot meal each working day and free medical care and are trained on site in various disciplines of reforestation and mechanical skills. The International Labour Organisation and national labour regulations apply. The social aspects of the employment by Form are positively experienced in the commercial environment of Akumadan, residence of most of the workers.

### **Stakeholder survey**

Several stakeholders have been included in the social survey; farmers (local communities), government institutions (Offinso District Forest Services Division, the District Assembly in Akumadan), service providers (District Education Centre in Akumadan, District Fire Office in Nkenkasu, Akumadan Health Centre) and traditional land owners (Akumadan Hene and Nkenkasu Hene).

### **Stakeholder perception**

Many say that the land has not recovered since the great fire outbreak of 1983; 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 the collection of mainly fire wood. Sometimes, mangos, pawpaw palm nuts, snails, mushrooms, leafy vegetables and construction materials are collected in the reserve.

### **Spiritual meaning of forest reserve**

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.

### 3.4 Biological environment

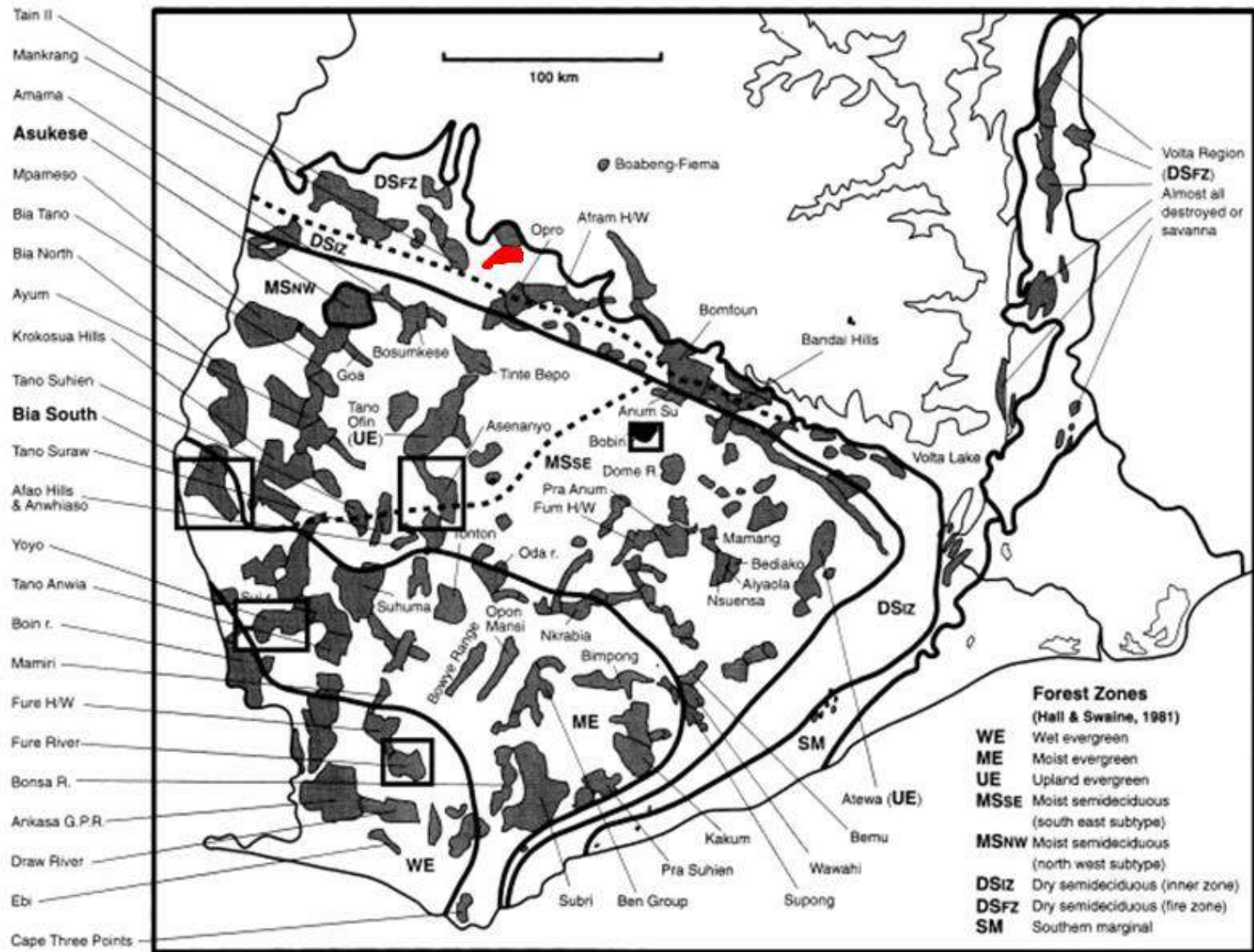
Before the biodiversity of Afrensu Brohuma FR is described, the area is put in a context by describing the biodiversity and conservation status in Ghana and the direct surroundings of the forest reserves. Then, the reserves are divided into broad categories: stratification of land-uses that are present within the area. Finally, an overview is given of the vegetation and fauna recorded in Afrensu Brohuma FR.

#### **Context**

In West-Africa, the Upper Guinea Forest Ecosystems are recognized as one of the 25 global biodiversity hotspots (MES, 2002). Afrensu Brohuma originally used to be part of these forests, but nowadays the reserve has been degraded so severely that the forest cover has been removed completely. The area can therefore be classified as modified habitat. A modified habitat is defined by the ISS of the AfDB (2013) as follows: Modified habitats: habitats whose primary ecological functions have been significantly altered by human activities and whose original species composition, richness and abundance have been reduced, with evidence of colonization by non-native species of flora and fauna.

Originally, 36% of Ghana used to be covered by forest. This share has drastically reduced by the end of the 20<sup>th</sup> century: to 23% in 1972, 13.3% in 1990, and 10.2% in 2000 (Van Roosbroeck, 2006). The Government's Forestry Commission has designated 29 Forest Reserves as Globally Significant Biodiversity Areas (GSBAs). Further, there are 16 wildlife reserves and 6 Ramsar sites. There are no GSBAs, wildlife reserves nor Ramsar sites in the vicinity of the area managed by Form Ghana. For an overview of the Forest Reserves of Ghana, and the Forest Zones in which Afrensu Brohuma Forest Reserve lays, see figure 4.

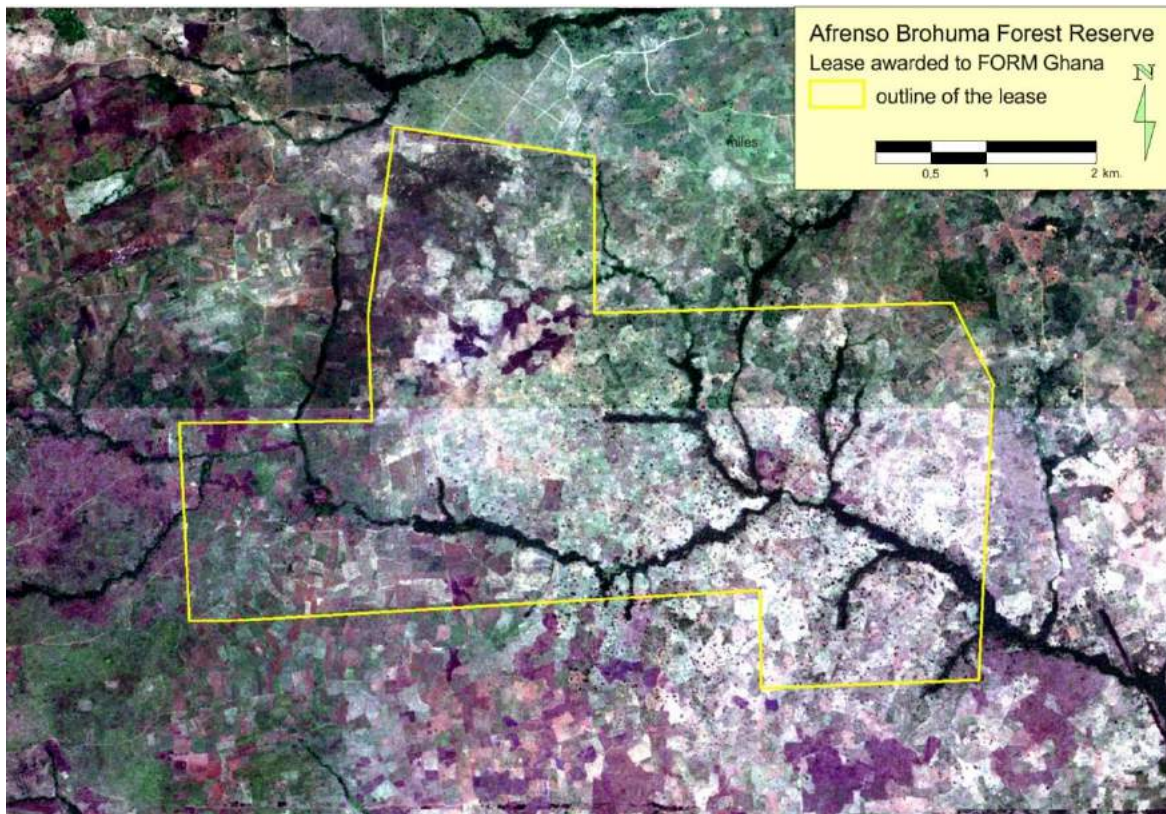
Afrensu Brohuma FR falls under the jurisdiction of Offinso North District Forest Services Division part of the Offinso Forest District. There are portions of Afrensu Brohuma FR that are not managed by Form Ghana, but by other private investors or by the government of Ghana. About 20 to 30 kilometres west of the forest reserve (and west of the major road) lay Yaya FR and Mankrang FR. Both of these forest reserves are also highly degraded. In parts of Yaya FR, reforestation activities started in 2002 under the Modified Taungya System (MTS), where the Government of Ghana cooperates with the local farmers to establish timber plantations with shared benefits.



**Figure 4.** Map showing Forest Reserves and Forest zones in Southern Ghana. Afrensu Brohuma Forest Reserve is coloured in red, bordering Asubima Forest Reserve in the North. Source: Hawthorne et al. (2012).

## Stratification

The satellite image from 2012 demonstrates that little forest remained in Afrensu Brohuma FR before Form Ghana began its reforestation activities (figure 5). Inventory on the ground confirmed this. The vegetation in areas where no reforestation activities had been carried out by Form Ghana consisted predominantly of human induced grassland containing the invasive species Elephant grass (*Pennisetum purpureum*), Camphor grass (*Chromolaena odorata*), Paper mulberry (*Broussonetia papyfera*) and Blady grass (*Imperata cylindrica*) (Abeney *et al.*, 2008).



**Figure 5.** Rapid-eye satellite image (stretched, true colour), 2011. The yellow line represents the outline of the land lease in Afrensu Brohuma FR, awarded to Form Ghana. Dark green coloured areas are buffer zones along waterways.

Initially, four different types of land-use were identified within the area under management by Form Ghana: farmland, grassland, remnant natural forest, and small-scale plantations (Abeney *et al.*, 2008). The farmland is characterised by small-scale annual food-crops, such as onion, tomato, maize and yams. After a while the soil becomes exhausted of nutrients and minerals, and the farmers move to another patch. The fallow farmlands turn into grassland, which covers large parts of the forest reserve. Remnant forest is severely degraded. Hardly any trees remain (figure 6). Some patches can be found where teak trees were planted, which now remain as solitary trees within the grassy areas.



**Figure 6.** Degraded forest area in Afrensu Brohuma Forest Reserve

Now that the entire area is replanted, the following land use types have been created:

1. Riparian forest

This type of forest is found bordering the various streams in the area. Around the streams, 30 meter wide buffer zones are created by Form Ghana, which allow natural vegetation to regenerate, and also function as fire-breaks. Furthermore, it improves the connectivity for wildlife to move around the area. Besides natural regeneration, indigenous tree species are planted in these buffer zones to facilitate reforestation.

2. Teak plantation

In the area destined for timber plantation, Form Ghana has planted mainly Teak (*Tectona grandis*) (figure 7).



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### 3. Indigenous tree plantation

Some parts of the plantation area are planted with indigenous tree species (figure 8).



**Figure 8.** Indigenous tree plantation in fringing Asubima Forest Reserve.

In the plantation areas, new tree species planted consist mainly of Teak (*Tectona grandis*), while in the riparian buffer zones and in some smaller parts of the plantation a mixture of indigenous species is planted, including Mahogany (*Khaya anthotheca*), Ofram (*Terminalia superba*), Emeri (*Terminalia ivorensis*), Onyina (*Ceiba pentandra*), Kusia (*Nauclea diderrichii*), Kokrodua (*Pericopsis elata*), Awiemfosamina (*Albizia ferruginea*), Bonsamdua (*Distemonantus benthamianus*), Mansonia (*Mansonia altissima*), Bombax (*Rhodognaphalon brevicuspe*), Potrodom (*Erythrophleum ivorensis*), Wawa (*Triplochiton scleroxylon*) and Watapuo (*Cola gigantea*).

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 not determined in Afrensu Brohuma Forest Reserve itself, but rather in the bordering Asubima Forest Reserve. Considering the fact that the two reserves are adjacent to each other and share similar ecology, these data are considered representative for Afrensu Brohuma Forest reserve as well.

#### **Vegetation**

York (*Broussonetia papyfera*), the most common invasive tree in the area, was found in relatively high numbers in the buffer zone (43 trees/ha). Also some indigenous species were represented, such as Ofram, Wawa and Otie. 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, hardly any indigenous trees could be found: 2 trees/ha, with a total of 43 species. 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.

A biodiversity assessment was carried out in the degraded forest areas (the future riparian buffer zones) of Afrensu Brohuma Forest Reserve by Manu in 2011. The study recorded a total of 110 plant species from 49 families. 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*, an herb present in 13 plots. The grass *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%). This may be caused by the open canopy, favouring the growth of grass species. A total of 65 tree species was found in the degraded forest areas. For comparison, an internal monitoring report from Form Ghana presented a total of 56 species found in the degraded forest area and 43 species found in the deforested parts of Asubima Forest Reserve (Form Ghana, 2012).

## **Fauna**

The fauna inventory executed within the framework of the SEIA showed the presence of very few animals specifically linked to forest environments; most were common to occur in savannah habitats (Tollenaar, 2012). Biodiversity monitoring revealed that several species of medium sized mammals, small mammals, birds, reptiles, amphibians and insects are present in the area (Manu, 2011). These are discussed below.

Inventories of reptiles and amphibians took place in the fringing Asubima Forest Reserve. Considering the similarity of the ecology between the two forest reserves, it can be assumed that species composition of fauna in Asubima FR can be considered to apply for Afrensu Brohuma Forest Reserve as well.

## **Medium sized mammals**

Nine medium sized mammal species were identified (see table 1). Most individuals were observed in the natural forest (29), 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 (*Cricetomys gambianus*), which was observed 37 times. The least encountered species was the Black Duiker (*Cephalophus niger*), signalled only 2 times. The African civet and the African palm civet are listed as First Schedule species in the Ghana Wildlife Conservation Regulations, according to the amendment of 1988. The Black duiker, Maxwell's duiker, bushbuck and Togo hare are listed as Second Schedule species and the Giant pouched rat is listed under the Third Schedule.



**Table 1.** List of medium sized mammals found in Afrensu Brohuma FR.

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

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.

### Small mammals

A total of 9 small mammal species was recorded in the study area (see table 2). The most frequently observed species were the Soft-furred mouse (*Praomys tullbergi*) (observed 5 times) and the West African pygmy shrew (*Crocidura crossei*) (observed 5 times). The Striped grass mouse (*Lemniscomys striatus*) and Jouvenet's shrew (*Crocidura jouvenetae*) were the least observed species, with only one sighting of each species.

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 (95.5%) than in the Teak plantation (92.8%).

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.

**Table 2.** List of small mammal species found in Afrensu Brohuma FR.

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

### Birds

In total, 44 bird species were recorded. The moustached grass warbler was the most 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.

### Reptiles: crocodile and snakes

The dwarf crocodile, or broad-fronted crocodile (*Osteolaemus tetraspis*) was spotted in the buffer zone of Asubima FR, close to Afrensu Brohuma FR, by Form Ghana staff in 2010. This species is IUCN red listed as vulnerable and also listed on CITES Appendix I. The species is also included as a First Schedule species in the Ghana Wildlife Conservation Regulations (1971). In 2011, Form Ghana staff also observed a Slender-snouted crocodile (*Crocodylus cataphractus*), which resided within the forest reserve for a while (figure 9). The status of the Slender-snouted crocodile is not determined, according to the IUCN red list website the data needs updating. The species is also listed as a First Schedule species in the Ghana Wildlife Conservation Regulations (1971).



**Figure 9.** Slender-snouted crocodile (*Crocodylus cataphractus*) on Form Ghana premises

During a snake survey held in Asubima FR by Hodoli in 2011, six species were recorded: the grass snake (*Phammophis sibilans*), the green mamba (*Dendroaspis viridis*), the green snake (*Philothamnus sp.*), the blind snake (*Ramphotyphlops braminus*), the royal python (*Python regius*) and the African rock python (*Python sebae*). Out of these six species, none are red-listed (IUCN, 2011) but the royal python and the African rock python are listed in Appendix II of CITES. This means “they are not necessarily threatened with extinction, but trade must be controlled in order to avoid utilization incompatible with their survival” (CITES, 2011).

#### **Amphibians: frogs**

Eighteen frog and two toad species were found in Asubima FR, in a study carried out in 2010 by de Laat. None of these frogs are red-listed nor CITES-listed (IUCN Red List, 2011; CITES, 2011).

#### **Insects: butterflies**

A total of 75 species of butterflies was recorded. The majority of individual species 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%).

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.)

*Charaxes petersi* (Van Someren, 1969)

A rare butterfly, recorded in the vicinity of Konongo, in Tano Ofin Forest Reserve and near 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 in Ghana.

*Euriphene incerta* (Aurivillius, 1912)

This species, which is distinctly rare to the west of the Dahomey Gap and in western Nigeria, is found in good condition in wetter forests, where it lives alongside other species of *Euriphene* e.g., *E. barombina*. The species is recorded in Ghana from Kakum and Mamang River.

*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 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.

## 4. High Conservation Value Forests Analysis

Based on the information presented in the previous chapter, an analysis was done on the presence or absence of each of the six High Conservation Value Forests in the area of Afrensu Brohuma FR managed by Form Ghana.

### 4.1 High Conservation Value 1

*“Forest areas containing globally, regionally or nationally significant concentrations of biodiversity values (e.g. endangered species, endemism, refugia).”*

According to the Ghanaian interpretation of HCV 1, the value of a forest area is considered high when it:

1. equals the status of protected areas, i.e. national parks, resources reserves, global protection reserves, globally significant biodiversity areas (GSBAs), hill sanctuaries, provenance protection areas and wildlife sanctuaries (Rayden *et al.*, 2006), or;
2. refers to forest that contain outstanding concentrations of threatened or endangered species, i.e. GSBAs, concentrations of globally threatened IUCN red-listed species, or species nationally listed as protected under the National Wildlife Conservation Regulation (Rayden *et al.*, 2006).

No portion of Afrensu Brohuma Forest Reserve has been set aside as protected or Globally Significant Biodiversity area (GSBA), nor is there any national park bordering Afrensu Brohuma FR (see appendix D).

No endangered plants or animals were encountered during biodiversity monitoring (Manu, 2011). Apart from formal monitoring, the dwarf crocodile (*Osteolaemus tetraspis*) was spotted in the buffer zone of Asubima FR, close to Afrensu Brohuma FR, by Form Ghana staff in 2010. This species is IUCN red listed as vulnerable and also listed on CITES Appendix I. The species is also included as a First Schedule species in the Ghana Wildlife Conservation Regulations (1971). However, there is currently no information that outstanding concentrations of threatened or endangered species are present in the area.

The African dwarf crocodile's geographic range is limited to West-Africa and part of Central Africa, it is native to Ghana. It is a freshwater crocodile that has terrestrial nesting sites and basking areas (Crocodile Specialist Group, 1996), either in tropical rainforest or tropical grassland. They remain in their burrows near the water's edge during the day and come out at night to hunt in the water, along the banks of the river or pool and into the forest. *O. tetraspis* feeds mainly on fish, frogs and crustaceans (Bristol Zoo, 2014). Female dwarf crocodiles build their nest at the beginning of the wet season. The nest, situated near the water, is a mound of wet, decaying vegetation that incubates the eggs in 85 to 105 days due to the heat generated by the decomposition of the plant material (Wikipedia, 2014). The African dwarf crocodile is vulnerable to habitat change (a.o. deforestation) and hunting (Bristol Zoo, 2014; Wikipedia, 2014). The creation of buffer zones around water bodies where natural riparian forest is restored could provide suitable habitat to the African dwarf crocodile. Further, control of hunting will protect it from ending up as bushmeat.

To conclude, High Conservation Value 1 is not present in the area of Afrensu Brohuma FR that is managed by Form Ghana.

## 4.2 High Conservation Value 2

*“Forest areas containing globally, regionally or nationally significant large landscape level forests, contained within, or containing the management unit, where viable populations of most if not all naturally occurring species exist in natural patterns of distribution and abundance.”*

Intact Forest Landscapes are defined as “an area of at least 50,000 ha of forest that is un-fragmented by roads or other forms of man-made disturbance” (p.10 Rayden *et al.*, 2006). According to the global database of Intact Forest Landscapes, developed by Greenpeace, the Rainforest Action Network and the World Resources, no forest areas in Ghana meet these criteria.

Abeney *et al.* (2008) confirm that no intact ecosystem can be found in Asubima FR at the time of the SEIA (2007-2008), which also applies to Afrensu Brohuma Forest Reserve (Tollenaar, 2012).

Therefore, it can be concluded that High Conservation Value 2 is not present in Afrensu Brohuma FR.

## 4.3 High Conservation Value 3

*“Forest areas that are in or contain rare, threatened or endangered ecosystems.”*

During the workshop organised for the development of the HCVF Toolkit for Ghana, participants agreed that ‘ecosystems’ would be defined as both ‘broad forest types’ and smaller ‘habitat types’, considering those that:

1. are naturally rare;
2. have been dramatically reduced from their original extent due to the activities of man;
3. are so threatened by existing and planned activities that they should be considered threatened/endangered” (p.11 Rayden *et al.*, 2006)

Afrensu Brohuma FR is located in the Dry Semi-Deciduous Forest Zone. According to the Toolkit, the Dry Semi-Deciduous forest type has been reduced in extent and quality and is threatened by current and future changes (Rayden *et al.*, 2006). It is indeed confirmed that in Afrensu Brohuma FR, the forest area has been reduced both in extent and quality. For that reason, according to Rayden *et al.* (2006) the area is a candidate for HCVF 3. However, basal area calculations in fringing Asubima Forest Reserve showed that Mean Basal Area was less than 5m<sup>2</sup> per ha. According to Manu (2011), Afrensu Brohuma was even more degraded than Asubima FR, which makes it no longer a forest area. Restoration of this habitat is therefore a management priority, concretized by the restoration of natural forest in the buffer zones and the planting of indigenous tree species.

It can be concluded that HCVF 3 is currently not present in Afrensu Brohuma FR. Restoration of the natural habitat is included in the management plan.

#### 4.4 High Conservation Value 4

*“Forest areas that provide basic services of nature in critical situations (e.g. watershed protection, erosion control).”*

Besides watershed protection and erosion control, forest providing barriers to destructive fire may be classified as HCVF, more specifically parts of forest reserves along road margins and when there is evidence of a fire risk from the activities of man. Finally, forests that play a critical role in local climate regulation (e.g. dramatically increased fire risk or exposure to drying winds, negatively affecting agriculture) could be designated as HCVF. Forest areas situated in the transition zone (between the High Forest Zone and the dry savannah) that provide protection against the North East trade winds and/or ‘Harmattan’ dry winds will be considered potential HCVF (Rayden *et al.*, 2006).

There is currently no forest on steep slopes or forest protecting head waters in Afrensu Brohuma FR. Little forest remains protecting the watercourses in the forest reserve. The vegetation present before planting could no longer provide a purifying or regulating function for the water bodies, or serve as a protection against fire or strong winds.

Measurements of hydrological characteristics in streams in Afrensu Brohuma FR show that nearly all streams are polluted quite severely. This situation is a major concern to the project, and much effort is being put in the restoration of the 30 meter buffer zones along the water courses in order to remedy this problem. It is expected that vegetation will reduce erosion and prevent chemicals from entering the water.

Afrensu Brohuma Forest Reserve is located in the transition zone of dry to wet climatic conditions. Wildfires occur frequently during the dry season. As part of their management plan, Form Ghana restores the vegetation in the riparian buffer zones in order to facilitate the natural protection of water courses, conserve biodiversity and perform the function of a fire-belt.

The need for forest to protect the water courses and to function as a fire-belt indicates that High Conservation Value 4 is present in potential. At the moment, however, as restoration of the buffer zone is still an on-going process, it can be concluded that HCVF 4 is not applicable to Afrensu Brohuma Forest Reserve.

#### 4.5 High Conservation Value 5

*“Forest areas fundamental to meeting basic needs of local communities (e.g. subsistence, health).”*

According to the Ghanaian interpretation of HCVFs, “a forest will be considered HCVF when it is the source of a basic need in a situation where the majority of the local people or the

poorest population among the local people have no realistic alternative” (p.18 Rayden *et al.*, 2006). Basic needs include: food (e.g. bush meat when this is a fundamental protein component of their diet), NTFP harvesting (for essential household income), medicines (in absence of local clinics or when this is the only affordable option), building materials, fuel wood or pestles. Immigrants and very remote settlers are more likely to suffer from extreme poverty that will make them more dependent on their direct environment for their survival (Rayden *et al.*, 2006).

The SEIA carried out by Tollenaar (2012) shows that all identified fringe communities depend on agriculture for their livelihoods, none depend on the resources from the forest itself for essential household income. In fact, since there is hardly any forest left, resources have been exhausted and are no longer available to the communities. The main resource collected in the reserve is firewood. The reserve is not the only place where fire wood is collected. The farms and surrounding bush are equally well-forested as the reserve itself.

It can therefore be concluded that High Conservation Value 5 is not present in Afrensu Brohuma Forest Reserve since the few reserve is not fundamental to meet the basic needs of the communities. The few resources that are produced within the forest reserve are produced outside of the forest reserve as well.

#### **4.6 High Conservation Value 6**

*“Forest areas critical to local communities’ traditional cultural identity (areas of cultural, ecological, economic or religious significance identified in cooperation with such local communities).”*

For forest-adjacent communities, forests often have a deep spiritual and cultural meaning. Practices expressing this cultural identity, traditional beliefs and norms are reflected in pouring libations, in saying prayers to forest gods, festivals and rituals, folklores and oral history, and location of burial sites for stool and skin occupants. In Ghana, generally these types of HCVF are associated with dense/ intact forests, the so-called sacred groves (Rayden *et al.*, 2006).

Findings from the SEIA (Tollenaar, 2012) did not indicate areas that are of importance for the cultural identity of those living near the area under lease contract by Form Ghana. 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. As the reserve has been degraded significantly, the place is not really considered to be a forest anymore; hence the values that were once attributed to forests are lost.

It can be concluded that this High Conservation Value is not found in the area of Afrensu Brohuma Forest Reserve that is managed by Form Ghana.

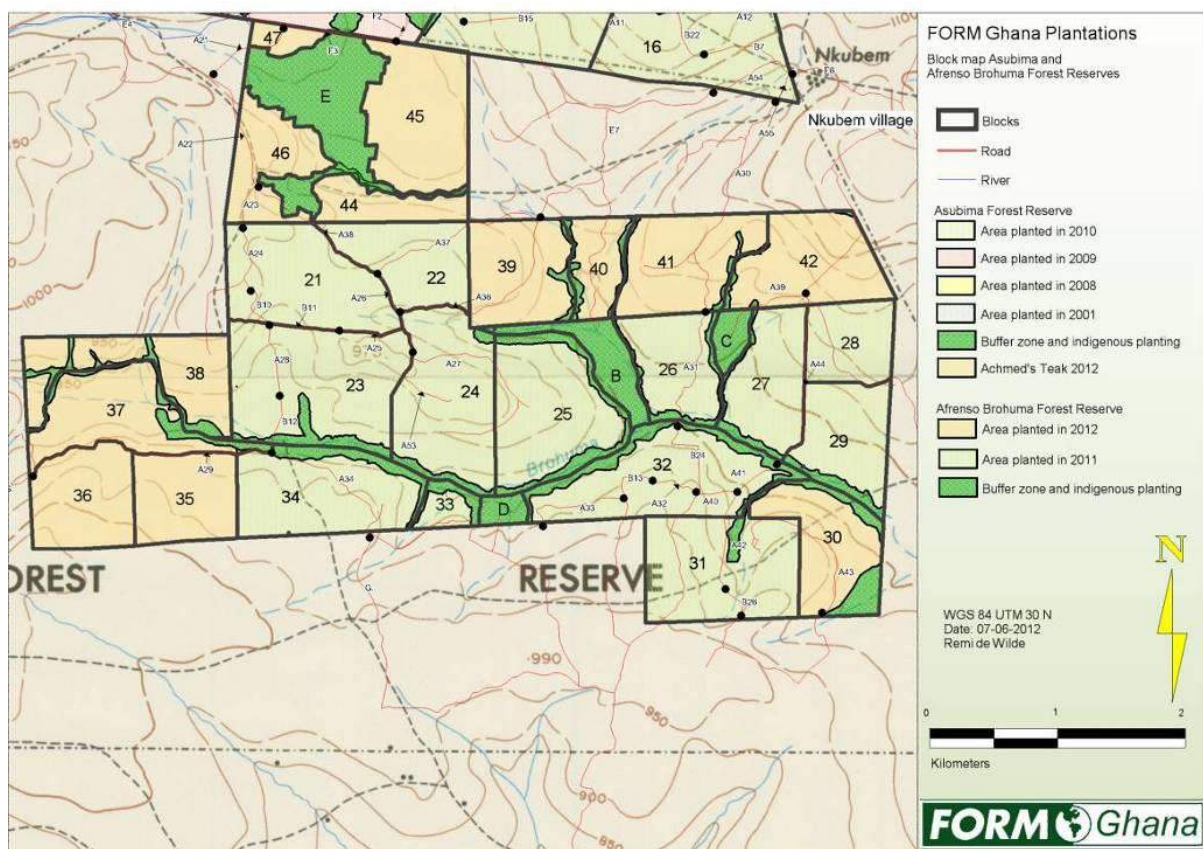


## 5. Conclusion and management implications

The buffer zones in Afrensu Brohuma Forest Reserve are highly degraded and cannot be classified as high conservation value forests.

Management of the buffer zones is geared towards protection and restoration using indigenous species of local provenance (cf. recommendation 6.4.4 in Rayden *et al.*, 2006). The current state of the vegetation makes it obvious that the watercourses are not sufficiently protected by a buffer zone of intact vegetation. Form Ghana is actively engaged in the restoration of natural buffer zones and the monitoring of water quality to find out if the efforts are successful. Seeds of the Kokrodua (*Pericopsis elata*) tree have been used to produce seedlings that were planted in the buffer zones scattered over the area to boost population and safeguard the species for the future. Finally, all animals are protected by management and hunting is strictly forbidden. This is controlled by the security team that patrols the area.

The map presented below shows the locations of these buffer zones (figure 10). In total, the buffer zones cover a surface of 222 ha which is equivalent to 13% of the total area under management by Form Ghana.



**Figure 10.** Map showing the locations of the buffer zones in Afrensu Brohuma FR

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## **Appendix A – Methodology of socio-economic study**

### **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, Dompuse, Amponsankrom and Nsukusua. 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. 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.

## Appendix B – Methodology of environmental study

### 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<sup>2</sup> (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<sup>2</sup> 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.

### 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 trapping (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.

### **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).

### **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 represented 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 2010 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).



## **Appendix C – Methodology of hydrology and soil survey**

### **Hydrological survey**

A hydrological survey was executed in Afrensu Brohuma Forest Reserve in 2013. 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 ( $\mu\text{s/cm}$ ), Dissolved solids, Alkalinity, Hardness, Calcium Hardness, Magnesium Hardness, Calcium, Magnesium, Chloride, Nitrate, Phosphate, Iron.

### **Soil survey**

Data for the soil survey are obtained from 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.

# Appendix D – Map of Vegetation zones and forest reserves in Ghana

Globally Significant Biodiversity Areas (GSBA's) are indicated in red. Please note that complete reserves are indicated as GSBA, while in reality the GSBA's are determined per compartment.

