

# HCV, HCS and Biodiversity Assessment of SAPH's Bettie Concession

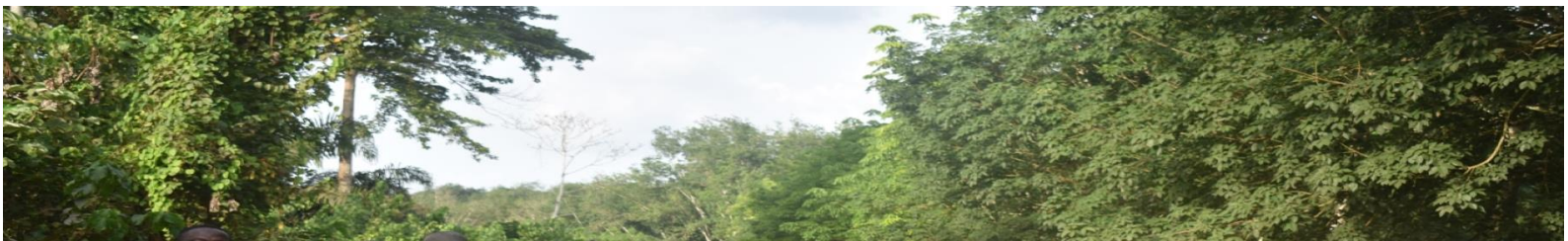
May, 2022

## About KNUST

The Kwame Nkrumah University of Science and Technology (KNUST) is a public university, as well as the largest university in the Kumasi Metropolis in the Ashanti Region of Ghana. In April 2022, KNUST was ranked as the best university in Africa in terms of Quality Education. This was contained in the 2022 Times Higher Education World University Impact Ranking, which includes more than 1,600 universities across 99 countries and territories.

KNUST is committed to ethical standards in all its activities, including in its research and in the respect for its employees and students. The University's Ethics Policy stipulates that KNUST has an obligation to all its stakeholders to observe and maintain high ethical standards in all transactions. The Act establishing the University defines its mandate, which essentially is to provide higher education, undertake research, disseminate knowledge and foster relationships with the outside persons and bodies. The strategic mandate of the University is derived from Science and Technology in its name.

The field team comprised experts from the Department of Wildlife and Range Management, KNUST and the Forest Services Division of Ghana with specialties in wildlife ecology, aquatic ecology, botany and GIS/mapping. The team has conducted several HCV studies across West Africa.



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# 1. Introduction

The Bettie Rubber Plantation is one of the Société Africaine de Plantations d'Hévéas (SAPH) Sites in Cote D'ivoire. SAPH is part of the Societe Internationale de Plantations d'Hevea (SIPH) group. The SIPH group has similar rubber plantations in Ghana (GREL), Nigeria (RENL) and Liberia (CRC). The company is expanding rubber plantation in its existing Bettie Rubber Plantation in the Bettie District, in southeastern Cote d'Ivoire. The Bettie Rubber Plantation Site has about 5,100 Hectares of land which comprised of 3,454.14 ha rubber plantation; 1,242.84 ha reserved as biodiversity protection and 400 ha yet to be planted. As part of its expansion programme, the company also intends to commence land preparation and plant on the additional valued areas, which totals up to about 400 ha. A social and environmental assessments of the potential impacts of proposed projects have to be conducted before land preparation commences in any case.

SAPH is committed to demonstrating sound environmental management in all its operations and meeting the SIFCA Environmental and Social Charters. This requires that the company should identify all areas necessary for the protection of biodiversity and minimize the impacts of their operations on the environment and on society. As part of this commitment, SAPH asked consultants from the Kwame Nkrumah University of Science and Technology (KNUST) to conduct an independent High Conservation Value assessment of the unplanted valued areas marked for the rubber plantation expansion. This independent assessment would help the company demonstrate their efforts towards protecting HCVs before it commences land preparation. This is in line with SIFCA's Environmental and Social Charter as well as meeting the performance standards of the International Finance Company (IFC) which has been adopted by PROPARCO. The carbon stock of the proposed development area and major potential sources of emissions that may result directly from the development were also identified and estimated.

This report describes the methodology adopted, team composition, HCV findings and management and monitoring recommendations for the Bettie Rubber Estate. The main objectives of the assessment were to:

1. Identify all HCVs within the unplanted valued areas that can be affected by the proposed plantation development programme;
2. Identify the threats to the management of the HCVs within the unplanted valued areas;
3. Provide management and monitoring recommendations for ensuring the continuous existence of identified HCVs within the broader management area, and
4. Undertake an HCA assessment of the management area as a basis for monitoring.

All these objectives are aimed at collectively demonstrating SAPH's commitment to meeting its own Environmental and Social Charter as well as demonstrating compliance with international best practice.

The Bettie Rubber Estate consists of three management areas namely: the rubber plantations, biodiversity zone and valued zone. The rubber plantation consists of rubber plantations at various stages of development. The biodiversity zone comprises of reserved small patches of degraded secondary forests and riparian biodiversity buffers while the valued zone is an

unplanted area that has been valued for planting rubber and consists primarily of farmlands and bush fallows.

## **1.1 About the HCV Concept**

High Conservation Values (HCVs) refer to biological, ecological, social or cultural values of outstanding significance at the national, regional or global scale and which require special protection for their maintenance and/or enhancement (Proforest, 2019). The aim of the HCV concept is directed at classifying areas of high importance and identifying strategies to manage, protect and improve their values. The HCV concept was originally developed in 1999 by the Forest Stewardship Council (FSC) and has since been widely used in the context of FSC certification for sustainable forestry. The HCV concept is recognized globally and has been adopted for use beyond forest certification. Currently its application covers land-use planning and awareness in conservation. The increasing use of the concept beyond forest certification results from the availability of toolkits to guide available interest groups. If used properly, the concept will facilitate interested stakeholders to protect vital conservation values during operations and generate sustainable and responsible management of natural resources.

## **1.4 Summary of the 6 HCV categories**

**HCV 1:** Concentrations of biological diversity including endemic species, and rare, threatened, or endangered (RTE) species that are significant at global, regional or national levels.

**HCV 2:** Large landscape-level ecosystems and ecosystem mosaics that are significant at global, regional or national levels, and that contain viable populations of the great majority of the naturally occurring species in natural patterns of distribution and abundance.

**HCV 3:** Rare, threatened, or endangered ecosystems, habitats or refugia. **HCV 4:** Basic ecosystem services in critical situations including protection of water catchments and control of erosion of vulnerable soils and slopes.

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**HCV 5:** Sites and resources fundamental for satisfying the necessities of local communities or indigenous peoples (for example for livelihoods, health, nutrition, water), identified through engagement with these communities or indigenous peoples.

**HCV 6:** Sites, resources, habitats, and landscapes of global or national cultural, archaeological or historical significance, and/or of critical cultural, ecological, economic or religious/sacred importance for the traditional cultures of local communities or indigenous peoples, identified through engagement with these local communities or indigenous peoples.

## 2 Description of the assessment area

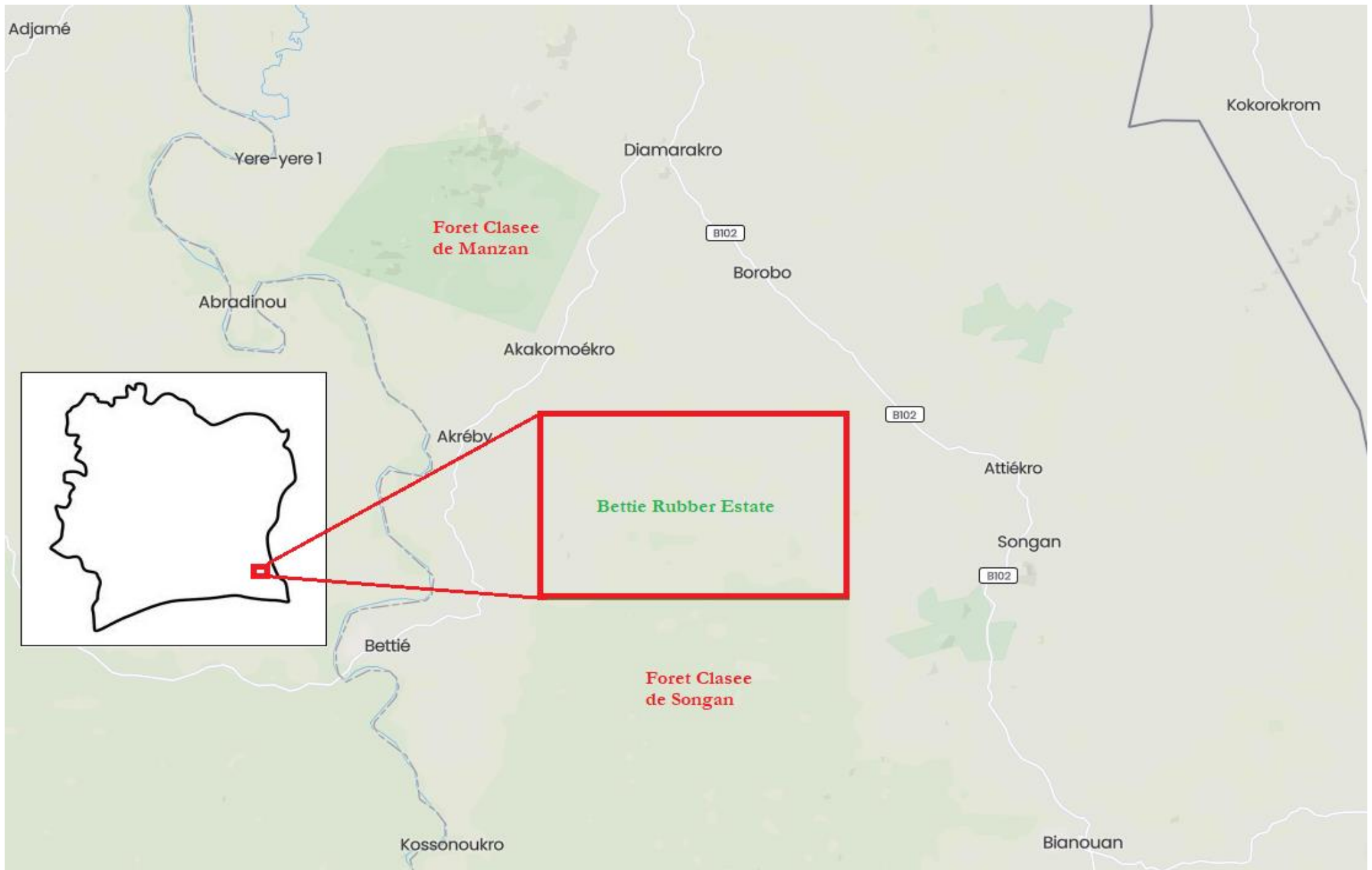
### 2.1 Site description

The Bettie Rubber Estate covers a total of 5,100 ha of land, out of which 3,454.14 ha is rubber plantation and 1,242.84 ha has been reserved for biodiversity protection. An additional area, totaling up to 400 ha has been valued pending development into rubber. The estate is named after the Bettie town, which is about 6 km from the estate in the Indenie-Djuabin Region of the Comoe District in eastern Cote d'Ivoire (Figure 1).

The Bettie Rubber Estate is located within the wet-semi-Equatorial climatic zone of the West African sub- region. The area receives nine (9) months of rainfall with two peak periods in May and June, and September and October. Generally, the annual rainfall ranges between 1500mm and 1800mm. Temperatures are generally warm ranging between 28°C and 37°C. The highest temperatures are recorded between February and March while the lowest is in August. Natural vegetation in this zone typically consists of upper canopy trees reaching up to heights ranging from 40m to 60m in height. Tree species are largely deciduous which means they shed their leaves during certain periods of the year specifically in the dry season.

The area is drained by the Comoe River and its tributaries. The Comoe River and some of its larger tributaries are perennial and contribute significantly to local livelihoods in terms of fishing activity. The drainage pattern is basically dendritic with relatively high soil fertility for the cultivation of food and cash crops.

The natural vegetation within the Bettie Rubber Estate is heavily degraded with little forest cover. The area is still under intensive use as agricultural lands with rubber being the major cash crops. Plantain, maize and cassava are the predominant food crops in the estate. Areas that are not currently under cultivation are dominated by various grass species and weeds such as *Chromolaena odorata*. There are hardly any well- developed secondary forests in the estate and the dominant tree species identified are highly degraded light demanders including *Cecropia peltate* ( $n = 48$ ), *Elaeise guineense* ( $n = 14$ ), *Hallea ledermannii* ( $n = 14$ ) and *Raphia hookeri* ( $n = 12$ ) with diameter at breast heights not exceeding 35 cm.



**Figure 1:** Location of the Bettie Rubber Estate in eastern Cote d'Ivoire.

## 2.5 Threats to forests and biodiversity

Loss of forest and habitat degradation due to human activities are the major threats to biodiversity in the area. Major determinants of forest loss resulting in wildlife habitat degradation is agriculture from both the rubber plantation and subsistence food crops. Prolonged shifting cultivation from growing food crops may become a threat to the long-term survival of forests because fallowed areas could increase the risk of fires to spread deep into forest areas.

In order to restore these degraded forests, SAPH will need to put in place key strategies that support tree regeneration. SAPH will need to be very innovative in dealing with the situation since fringe communities have long used these areas for livelihood needs. Additionally, the proximity of the estate to fringe communities provides easy access to farmers and loggers, who convert the remaining forest patches. Farmers only leave a few economic trees on their farms as shade trees or to be later used for construction purposes.

An additional biodiversity threat is due to the activities of hunters. The bush-meat demand in neighbouring towns like Bettie is high and encourages the hunting and trading in the various wildlife species to flourish. Rodents and ungulates are the most preferred species, followed by primates and small carnivore species.

## 3 HCV Assessment Team

Table 1 shows the names and affiliations of the HCV Assessment Team.

**Table 1:** HCV Assessment Team

Name	Institution	Role	Expertise
Emmanuel Danquah	KNUST	Team Leader	Wildlife Ecology – Mammalogist
Alfred Assumang	KNUST	Member	Wildlife Ecology – Wildlife Social Dimensions
Ben Ossom	KNUST	Member	Wildlife Ecology – Ornithologist
Elvis Bawah	KNUST	Member	GIS/Mapping, Hydrology and Drainage
Peter Akomatey	FSD	Member	Forest Ecology – Botanist

Short profiles on the HCV Assessment Team are presented in Appendix 1.



## **4 Methodology and Timeline**

Methodology used include desk reviews, community engagements and field enumerations.

### **4.1 Desk Reviews:**

A review of pertinent literature including web documents and reports related to the Bettie project area was conducted. Also, literature on the wider landscape and environs were consulted to gather information on land use land cover trends and environmental variables.

### **4.2 Community Engagements**

Communities were consulted within the Bettie Rubber Estate to obtain the following information:

1. Main sources of livelihoods and their level of dependence on the Bettie Rubber Estate;
2. Types of forest products harvested from the estate;
3. Benefits gained from the estate area;
4. community special interests (scared sites, shrines, etc.) within the estate; and
5. issues concerning food security and land needs for farming.

Names of communities and respondents consulted are listed in Appendix 2.

### 4.3 Risk assessment

A risk assessment was conducted in the Valued Zone of the Bettie Rubber Estate (BRE). This was done using recommendations of the HCV Resource Network (Table 2).

**Table 2:** Risk Assessment Results of the Valued Zone in the Bettie Rubber Estate (BRE)

Indicators of Potential Risks	Finding	Details
<b>Scale</b>		
Will the operation cover or affect more than 50,000 ha?	No	The Valued Zone comprises of four unplanted areas within the Bettie Rubber Estate (BRE) that have been marked for rubber plantation expansion. In total, the Valued Zone covers 400 ha. Hence, the proposed project is a low-scale and low intensity operation.
<b>Intensity</b>		
Is conversion of more than 500 ha of natural ecosystem or habitat planned?	No	The Valued Zone is a highly degraded landscape and composed mainly of farmlands and fallowed areas.
<b>Risk</b>		
Does the assessor hold a provisional HCV license	No	The assessor has vast experience in HCV assessments in rubber and oil palm plantation development in several countries in Africa including Ghana, Nigeria, Cameroon, Tanzania, Liberia, Zambia and Cote d'Ivoire.
Does the project area contain, border or overlap with any priority biodiversity areas?	No	The Valued Zone does not contain or directly border/overlap with any priority biodiversity area. It is found within the BRE.
Are there local or indigenous peoples living in/using the area who have claims to land, water and or natural resources in the project area?	No	There are no local or indigenous peoples who have claims to land, water and or natural resources in the Valued Zone.
Is the HCV assessment taking place outside of a recognized certification scheme?	Yes	The HCV assessment was not peer reviewed as part of the HCV ALS programme requirement. However, it forms part of the SAPH's commitment to protecting biodiversity conservation values.

## 4.4 Field work

Data collection started on 22<sup>nd</sup> April, 2022 and ended on 28<sup>th</sup> April, 2022 (Table 3). Fieldwork involved a biological (flora and fauna) survey and a socioeconomic assessment. The SAPH GIS team provided all relevant maps to facilitate the field work.

**Table 3:** Timelines of Key Activities Conducted

Start Dates	Activity
19 <sup>th</sup> April, 2022	Travel from Kumasi to Abura (GREL Site)
20 <sup>th</sup> April, 2022	Travel from Abura (GREL Site) to Abidjan
21 <sup>st</sup> April, 2022	Management meeting and travel to Bettie
22 <sup>nd</sup> April, 2022	Biological and Social Surveys
23 <sup>rd</sup> April, 2022	Biological and Social Surveys
24 <sup>th</sup> April, 2022	Biological and Social Surveys
25 <sup>h</sup> April, 2022	Biological and Social Surveys
26 <sup>th</sup> April, 2022	Biological and Social Surveys
27 <sup>th</sup> April, 2022	Biological and Social Surveys
28 <sup>th</sup> April, 2022	Management briefing on highlights of fieldwork
29 <sup>th</sup> April, 2022	Abidjan to Ghana

### 4.4.1 Sampling and Experimental design

For the flora and fauna surveys, data was collected using predetermined sampling plots. A stratified sampling method was employed to ensure a fair coverage of the Bettie Rubber Estate. A grid was superimposed on a map of the BRE for selection of plots and transects.

The Bettie Rubber Estate (BRE) comprises 3 main management areas (Figure 2), namely:

1. Rubber plantations at various stages of development (3454.14 ha);
2. Non-planted biodiversity zones (forest buffers) with clearly marked HCVs including one sacred forest, two cemeteries and several small riparian forest fragments (1,242.84 ha), and
3. Non-planted zones that have been valued to be used for planting rubber (400 ha)

Based on the management areas, the field sampling methods were designed to generate and monitor baseline flora and fauna abundances in the Biodiversity Zone and also assess HCVs in the Valued Zone that is yet to be planted. The rubber plantation was not included in the assessments because SAPH has an official monitoring process ongoing. A socioeconomic survey was also conducted to assess general community perception on project development and its impacts.

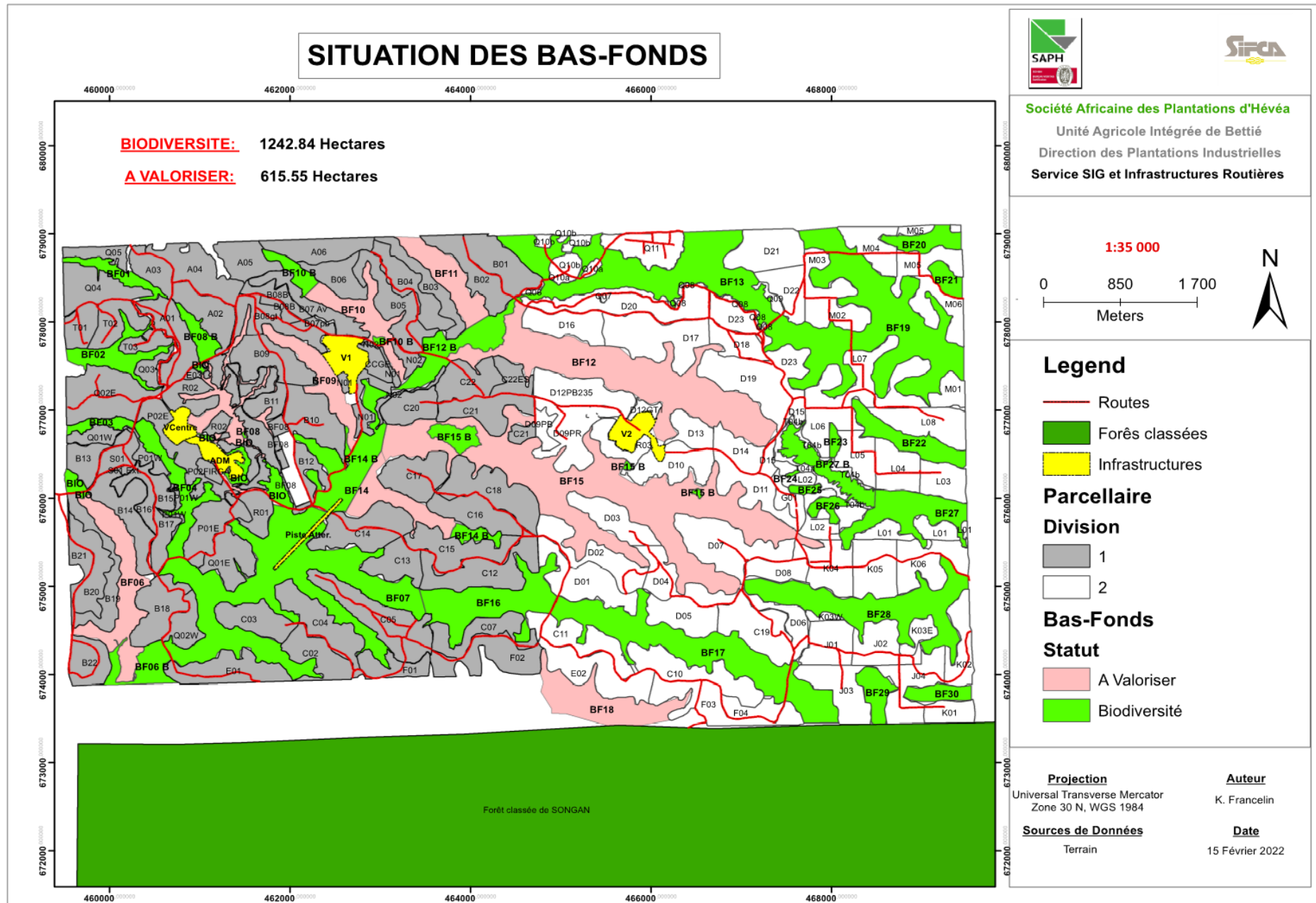


Figure 2: Map of the Bettie Rubber Estate showing distribution of rubber plantations, biodiversity zones and valued zones

#### 4.4.2 Flora survey

For monitoring biodiversity, twenty-three (23) Permanent Sample Plots (PSPs) were laid systematically within the various buffers in the biodiversity zones using grids in GIS software (Figure 3). Each PSP measured 30 meters by 30 meters (size of 0.09 ha). For the HCV assessments, one strip transect (length 1km) was laid across the middle of each of the four valued areas using grids in GIS software. A middle survey line was cut and the transect boundaries used for data collection was determined at 10m on each side away from the middle line.

Using the middle line, spotters walked and recorded all trees and lianas above 10cm Diameter at Breast Height (DBH) Records of the tree species and their DBH were measured, using a diameter tape. In addition to the DBH measurements, the height of each individual tree was estimated with a clinometer. Features of conservation interest, land use type, evidence of human activities including farms and hunting activity were also noted and recorded.



**Plate 1:** Tree DBH measurements conducted in the field

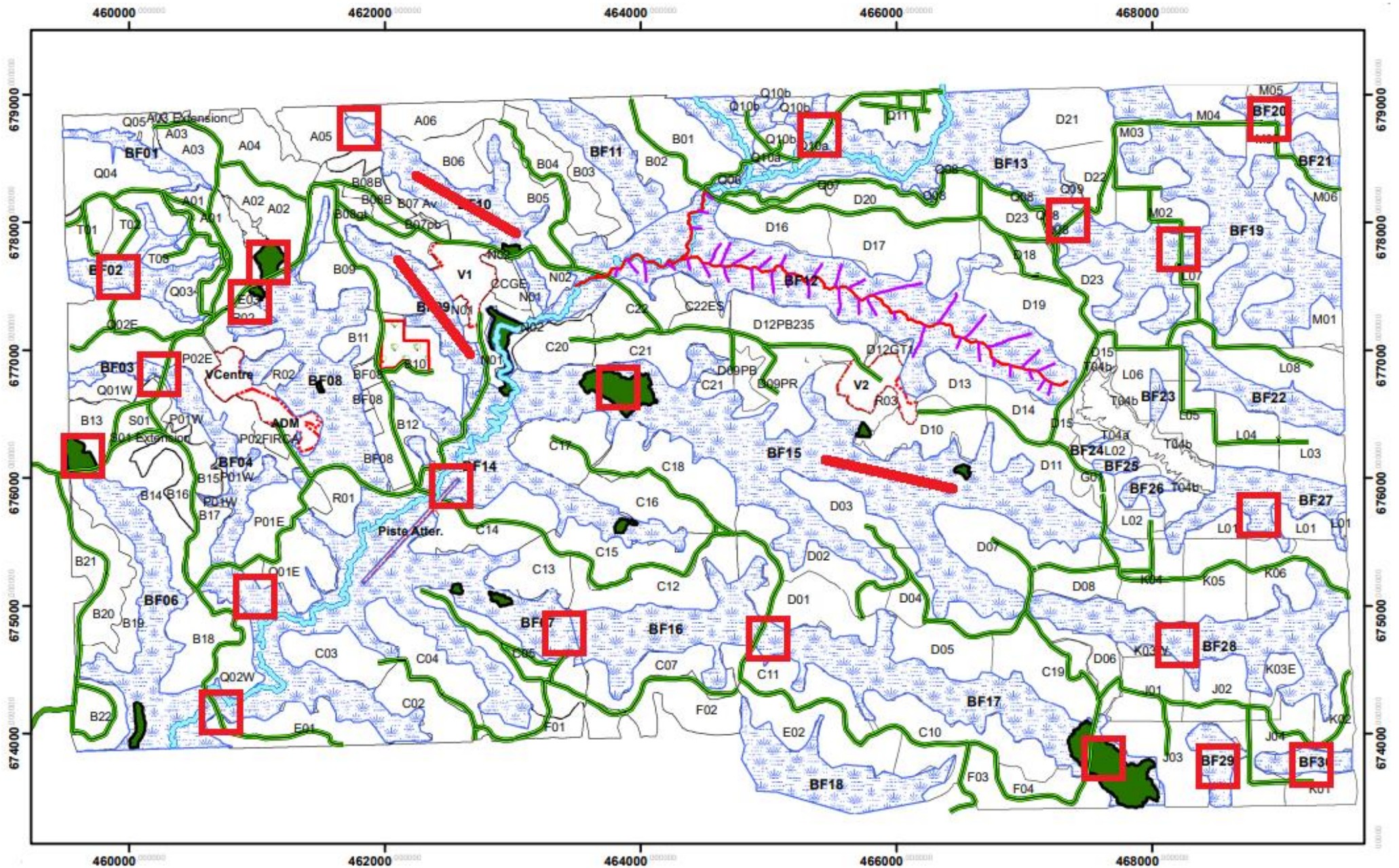


Figure 3: Map of the Bettie Rubber Estate showing distribution of plots (squares) and strip transects (lines)

#### 4.4.3 Carbon Stock Estimation

An approximately 1.0% sampling rate (6.0ha) was used to determine the sample size for the estimation of the total carbon stock for the valued zone (400 ha) within the Bettie Rubber Estate. The tree above ground biomass was calculated using the allometric model of Chave *et al.* (2014) which uses tree height, stem diameter and wood density as covariates (Equation 1).

$$\text{Equation 1..... } AGB = 0.0673 \times (\rho D^2 H)^{0.976}$$

Where *AGB* is aboveground dry biomass (in kg);  $\rho$  is wood density ( $\text{g/cm}^3$ ); *D* is diameter at breast height (cm) and *H* is the height (m).

Tree carbon content was calculated from above ground biomass based on the assumption that carbon concentration is about half (47.5%) of the biomass (Proforest, 2019).

The African Wood Density Database (Carsan *et al.*, 2012) and Global Wood Density Database (Chave *et al.*, 2009; Zanne *et al.*, 2009) was used to generate information on wood density. For not evaluated species, the mean wood density of matching genus or matching family were adopted. ArcGIS version 10.2 was used in data analysis.

#### 4.4.4 Fauna survey

##### Mammals

Information on large mammals was systematically obtained by direct observation and record of signs (vocalizations, droppings and footprints) along trails and foot paths within the PSPs. Surveys were conducted during the early hours of the day and evenings. Additional information was obtained by interviewing local people, particularly hunters. Pictures in field guides (Stuart and Stuart, 2006 and Happold, 1990) were also shown to them to aid in the identification of the mammals. It also gave the opportunity for others to corroborate or challenge the authenticity of information gathered from the field.

Small terrestrial mammal surveys involved direct observations of rodent signs including feeding signs and refuge examinations (searching in rodent burrows) within the PSPs. All captured animals were identified using Happold (1990), sexed and released.

##### Avifauna

Bird surveys were also conducted systematically within the PSPs. Direct observations, including visual as well as vocal records were made to determine bird species occurrence. Pictures in the field guide (Barrow and Demey, 2008) were shown to the local people to help in the identification. Particular attention was paid to species of special interest, notably rare or threatened species and key or unusual species

##### Herpetofauna

Reptiles and amphibian surveys involved direct observations and systematic refuge examinations (searching under rocks, logs, in rotten tree stumps, in leaf litter, old termite mounds and rodent burrows) within the PSPs. Main reference for identifying herpetofauna was Hughes (1988).

#### **4.4.5 Conservation Status**

The conservation status of the identified flora and fauna was assessed using the International Union for the Conservation of Nature (IUCN) guidelines. The IUCN Red List of Threatened Species (2022) provides taxonomic, conservation status and distribution information on taxa that have been evaluated using the IUCN Red List Categories and Criteria (Appendix 1). The main purpose of the IUCN Red List is to catalogue and highlight those taxa that are facing a higher risk of global extinction (i.e. those listed as Critically Endangered, Endangered and Vulnerable). The IUCN Red List also includes information on taxa that are categorized as Extinct or Extinct in the Wild; and taxa that cannot be evaluated because of insufficient information (Data Deficient).

#### **4.4.6 Community Engagements**

Community engagements involved interviewing fringe communities around Bettie Rubber Estate (BRE) to gain information on key socio-economic and cultural issues, including:

1. Local livelihoods and level of dependency on natural resources in the BRE;
2. Benefits gained from the BRE including the types of forest products harvested;
3. Potential HCVs in the Valued Zone and threats posed to these HCVs; and
4. Community perception of plantation activities in the BRE, food security issues as well as identify community land needs for farming.



## 5 Identification of HCVs in the Valued Zone of the BRE

This section presents an overview of the HCVs identified in the Valued Zone of the Bettie Rubber Estate (BRE). The definitions and explanations of the HCVs follow the requirements contained in the Global HCV Toolkit and the Common Guidance for HCV identification.

**Table 4:** Tabular presentation of potential HCVs present in the Valued Zone

HCV	Description	Present	Absent
HCV 1.1	Protected Areas		
HCV1.2	High concentration of species		
HCV 2	Large landscape-level ecosystems		
HCV 3	Rare, threatened or endangered ecosystems, habitats or refugia		
HCV 4.1	Areas that are important for watershed protection		
HCV 4.2	Areas critical for erosion control		
HCV 4.3	Areas serving as natural barriers against destructive wildfires		
HCV 4.4	Areas that play a critical role in climate regulation		
HCV 5	Areas providing basic needs of local communities		
HCV 6	Areas with critical socio-cultural or traditional/religious importance		

### 5.1 HCV 1: Globally, Regionally or Nationally Significant Concentrations of Biodiversity Values

HCV 1 refers to areas of high species concentrations including rare, threatened, endangered or endemic species, unusual assemblages of ecological or taxonomic groups and extraordinary seasonal concentrations of species. It also refers to areas that contain critical habitats that are used seasonally or in extreme years for the survival of species. All areas which contain such species or the habitats necessary for their continued survival may be considered as HCV areas. These species must be present in global, regional or nationally significant concentrations. There are two sub-categories under HCV 1. These are:

1. HCV1.1: Protected areas (including National Parks, Resource Reserves, Global Protection Reserves, Globally Significant Biodiversity Area, Hill Sanctuaries, Provenance Protection Areas and Wildlife Sanctuaries) and
2. HCV 1.2: High concentrations of species that are categorized as Critically Endangered (CR), Endangered (E), or Vulnerable (VU) under the IUCN Red List, Appendix I of CITES or those listed as protected under the country's legislations (either state or national).

### 5.1.1 HCV 1.1 Protected Areas

The Valued Zone within the Bettie Rubber Estate (BRE) is a highly modified landscape and does not contain any protected areas. Though the BRE is positioned less than 10km southwards of the Forêt Classée de la Manzan and also shares its southern boundaries with the Forêt Classée de la Songan (Songan Classified Forest), there are no contiguous forest cover or other intact ecosystems between the management area and these two protected areas, as BRE contains a lot of highly modified ecosystems. Based on the high intensity of forest loss within BRE, it is very unlikely that the conversion of the Valued Zone to rubber plantations would have any direct adverse impact on the nearby protected areas.

Hence HCV 1.1 is concluded to be **ABSENT** in the Valued Zone.

### 5.1.2 HCV 1.2 Rare, Threatened and Endangered Species

None of the identified fauna species during the assessment are considered either rare, threatened, endangered or nationally protected. All the species are associated with highly degraded landscapes and are listed as *Least Concern* (LC) species on the IUCN's Red List 2022. The valued zone supports very low wildlife densities and species diversity. The most commonly occurring bird species were the African-pied Hornbill, *Tockus fasciatus* and Common Bulbul, *Pycnonotus barbatus* whilst the only common mammal species was the Bushbuck; *Tragelaphus scriptus*.

Flora species were dominated by species associated with farmlands and recent fallows. However, single observations of one Endangered species, *Omphalocarpum ahia* and two Vulnerable species, *Guarea cedrata* and *Nauclea diderrichii* were recorded.

A total of 38 individuals of 20 plant species belonging to 13 families were identified in the Valued Zone. The area is generally heavily impacted by agriculture which has severely limited the diversity of plant species in the concession. Dominance (70%) of pioneer species such as *Cecropia peltata* points to loss of shade-bearing plant species typical of undisturbed forest.

All the species identified are well represented in the wider landscape and are well protected by conservation efforts in the nearby Songan and Manzan Classified Forests, hence they are not considered as HCV 1.2. Also, none of the recorded tree species of conservation interest existed in locally significant viable populations within the BRE.

Hence, HCV 1.2 is concluded to be **ABSENT** in the Valued Zone.

## 5.2 HCV 2 Globally, Regionally or Nationally Significant Large Landscape Level Ecosystem of Ecosystem Mosaic

HCV 2 refers to globally, regionally or nationally significant large landscape forests contained within or containing the management unit where viable populations of species occur in natural patterns of distribution and abundance. This includes areas that provide connectivity between two or more forest fragments for the movement of wildlife.

The Valued Zone is a highly modified landscape that have been fragmented by human activities and farms. There are no areas that contain large landscape level forests or

ecosystems. Though the BRE shares its southern boundary with the Songan Classified Forest, it does not contain any globally, regionally or nationally significant large landscape forests or its associated naturally occurring populations of viable key species. Also, BRE does not serve as wildlife corridor or provide connectivity between the Songan Classified Forest and any other larger forest complexes. The eastern, western and northern boundaries of the BRE are under heavy human pressure to plant rubber, hence does not contain intact landscapes that harbour any viable naturally occurring species.

Hence HCV 2 is concluded to be **ABSENT** in the Valued Zone.



**Plate 2:** Typical ongoing degradation recorded in the Valued Zone

### **5.3 HCV 3: Areas that contain Rare, Threatened and Endangered Ecosystems**

HCV 3 refers to natural areas that contain rare, threatened, and endangered ecosystems or sensitive areas that are so threatened by existing and planned activities that they should be considered threatened/endangered.

The Valued Zone is a highly modified landscape that have been fragmented by human activities and farms. Also, there is no significant patch of natural forest that is so threatened by existing and planned activities that they should be considered threatened/endangered.

Hence HCV 3 is concluded to be **ABSENT** in the Valued Zone.

### **5.4 HCV 4: Areas that provide basic Ecosystem Services in critical situations**

HCV 4 has four sub-categories.

#### **5.4.1 HCV 4.1: Areas important for watershed protection**

HCV 4.1 refers to areas critical for the maintenance/regulation of river flows, preventing severe floods, or maintaining water quality, where these services are critical e.g., where the rivers or streams provide downstream communities with water for drinking, irrigation or fishing. It also includes areas that help maintain fragile or rare aquatic ecosystems or prevent damage to important infrastructure such as dams.

Most fringe communities have access to potable water from boreholes so generally, water from rivers and streams are not critical to their survival. However, some small settlements like Behibrokro and Tanokro depend on streams from the BRE as a source of water.

Hence HCV 4.1 is concluded to be **PRESENT** in the Valued Zone.

#### **5.4.2 HCV 4.2: Areas Critical to Erosion Control**

HCV 4.2 refers to areas that naturally prevent erosion and landslide occurrence. This includes catchment area forests, riparian forests and forest shelter belts that prevent serious wind erosion where this would severely impact on local livelihoods, including agriculture. Others are forests adjacent to reservoirs, water works or hydro power systems.

There are no steep slopes in the BRE making the landscape relatively flat. Hence the removal of the natural vegetation will not lead to serious erosion and siltation of nearby water-bodies. Fortunately, SAPH has an ongoing policy to protect all catchment area forests and riparian forests and will ensure that operations are not done in such areas that will increase the risk of severe erosion.

Hence HCV 4.2 is concluded to be **ABSENT** in the Valued Zone.

#### **5.4.3 HCV 4.3: Areas providing barriers to destructive fire**

HCV 4.3 refers to all vegetation that helps to prevent the spread of destructive wildfires particularly into areas containing HCVs. If natural forests are kept protected, they can serve as breaks that prevent wildfires because of their minimum undergrowth and moist litter layers. Even though, all natural forests within the Valued Zone have been severely degraded, there is no history of recurrent wildfires, possibly because of the wet climatic conditions.

Hence HCV 4.3 is concluded to be **ABSENT** in the Valued Zone.

#### **5.4.4 HCV 4.4: Areas that play a critical role in local climate regulation**

HCV 4.4 refers to areas that play a critical role in regulating climate and where loss or severe degradation of that area would result in catastrophic changes to local climatic conditions, such as dramatically increased fire risk, or exposure to drying winds that would compromise productive agriculture.

The natural vegetation is very much modified within the Valued Zone and there are no vegetation or ecosystems that can be said to be performing the function of critically maintaining or moderating the local climate.

Hence HCV 4.4 is concluded to be **ABSENT** in the Valued Zone.

### **HCV 5: Areas fundamental to meeting basic needs**

HCV 5 refers to areas that serve the basic needs of a significant number of fringe communities in terms of food, NTFP harvesting, livelihoods; medicinal materials, building materials and other basic needs

Our community engagements revealed that these basic needs were not confined to BRE alone but also occurred outside the estate including on farms and other areas in the natural landscape. Protein from hunting animals was also supplemented from meat realized from reared animals such as poultry, livestock and from the local markets. Thus, there is limited dependence of fringe communities on products found in BRE because these products are widely available and also easily accessible in other areas in the natural environment.

Hence HCV 5 is concluded to be **ABSENT** in the Valued Zone.

### **HCV 6: Areas critical to the traditional cultural identity of local communities**

HCV 6 refers to areas that serve the interests of communities in terms of cultural and spiritual values. An area is considered as HCV if it defines the cultural identity of the local people such that its absence may lead to cultural erosion.

Though there are some traditional/religious sites under protection within the BRE, none was found in the Valued Zone.

Hence HCV 6 is concluded to be **ABSENT** in the Valued Zone.

## 6 Carbon stock assessment and summary

### 6.1 Results of the carbon stock assessment

The natural vegetation cover of the Bettie Rubber Estate (BRE) is highly degraded, consisting largely of rubber plantations, a few reserved secondary forest patches, farms and fallows.

Within the entire BRE, 10.07ha of plots and strip transects were surveyed. A total of 233 living trees including 233 stems with DBH  $\geq$  10 cm were sampled. These trees belong to 20 species in 13 families. The most abundant species in the estate were pioneer species such as *Cecropia peltate*. These are plant species typical of disturbed forest. Total biomass estimated for these trees corresponded to 88.13 tons of carbon (Table 5).

**Table 5:** Summary of trees (N) and stems with DBH  $\geq$  10 cm and above ground carbon

Area designation	Area sampled (ha)	Stems	Carbon (t)
Bettie Rubber Estate	10.07	233	161.77

Within the BRE, the Reserved Forest patches yielded highest carbon (44.06 t/ha). This was followed by the Biodiversity Buffers (22.74 t/ha).

The Valued Zone yielded the lowest carbon (2.94 t/ha) even though it was the most extensively sampled (79.44%). The vegetation cover was mainly fallows and subsistent farms, hence, was associated with lowest carbon stock (Table 6). No significant carbon areas were identified in the Valued Zone.

**Table 6:** Total carbon stock in trees with DBH $\geq$ 10 cm in different vegetation types

Management Zones	Number of plots	Area (ha)	Proportion	Total carbon	Carbon in tons	Carbon (t/ha)	CO <sub>2</sub> /tons/Ha
Biodiversity Buffers	15	1.35	13.41	47062.26	47.06	22.74	83.44
Reserved Forests	8	0.72	7.15	91196.07	91.20	44.06	161.69
Valued Zone	4	8	79.44	23513.74	23.51	2.94	10.79
<b>Total</b>	<b>27</b>	<b>10.07</b>	<b>100.00%</b>	<b>161772.06</b>	<b>161.77</b>	<b>69.73</b>	<b>255.91</b>

The five most abundant tree species that contributed highly to the carbon stock of BRE were *Cecropia peltata*, *Elaeis guineensis*, *Hallea ledermannii*, *Raphia hookeri* and *Alstonia boonei* (Table 7).

**Table 7:** List of ten most abundant species in Plot 1 and their contribution

Species name	BA (m <sup>2</sup> )	Carbon (t)	N
<i>Cecropia peltata</i>	1.58	3.77	48
<i>Elaeis guineensis</i>	2.15	8.19	14
<i>Hallea ledermannii</i>	1.35	7.48	14
<i>Raphia hookeri</i>	1.30	9.36	12
<i>Alstonia boonei</i>	1.44	7.84	10
<i>Carapa procera</i>	0.55	3.14	10
<i>Gilbertiodendron limba</i>	0.24	1.35	7
<i>Terminalia superba</i>	0.66	3.54	7
<i>Ceiba pentandra</i>	1.53	6.87	6
<i>Ricinodendron heudelotii</i>	0.73	3.02	6

## 6.2 Summary of carbon assessment

Reserved Forests of the BRE yielded the highest carbon in tons per ha, followed by Biodiversity Buffers.

The Valued Zone yielded the lowest carbon even though it was the most extensively sampled area. The vegetation cover was mainly fallows and subsistent farms, hence, was associated with lowest carbon stock. No significant carbon areas were identified in the Valued Zone.

## 7 Summary of community engagements

### 7.1 Profile of respondents

Majority (61%) of the randomly selected respondents were males (Table 8). In terms of respondents' age, it emerged that those considered being within the youth group, that is 18 to forty years were equally balanced with people above 40 years. It is perceived that the average age of respondents would have an influence on responses as well as the commitment of participants towards proposed NTFPs management activities. The percentage of migrant respondents is higher than natives, nevertheless, these figures may not necessarily reflect the general trend of settlement in the area.

**Table 8:** Gender, age and residential status of respondents (percentage)

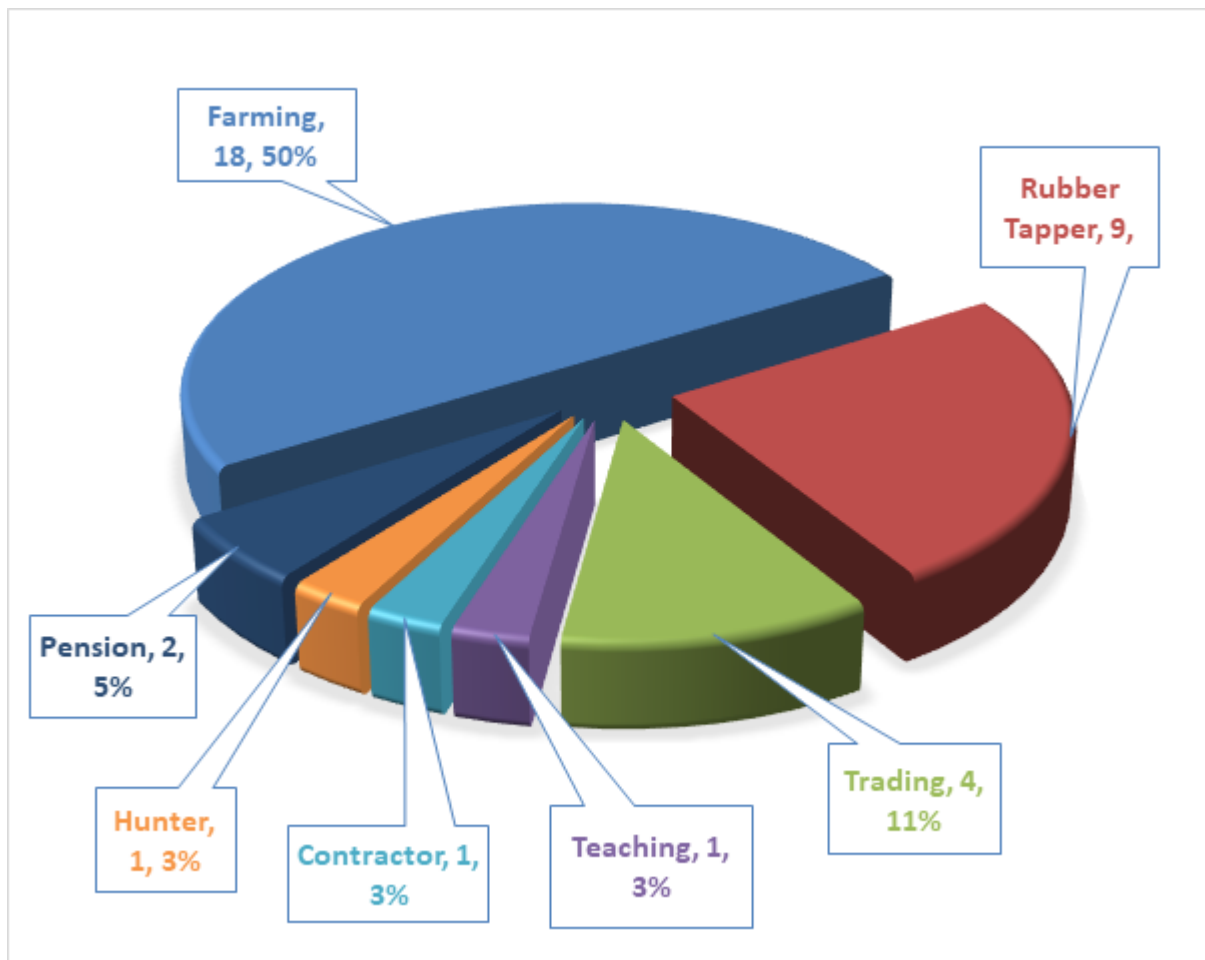
Characteristic		Range
Gender	Male	22 (61)
	Female	14 (39)
Age (years)	18 to 40	18 (50)
	More than40	18 (50)
Residential Status	Natives	12 (33)
	Migrants	24 (67)





**Plate 3:** Community engagement at Village 2

The main occupation of respondents was farming (Figure 4). Respondents also engaged in other livelihoods like rubber tapping and trading in foodstuffs and provisions. The interviews also covered employees from the education sector and other allied institutions thus securing different perspectives on issues. In addition, those involved in commercial NTFP activities were specially interviewed. The consumption of ‘kutuku’ a locally brewed gin from palm wine was popular amongst the local populace, however, it was surprising to not record any palm wine tappers within the respondents sampled.

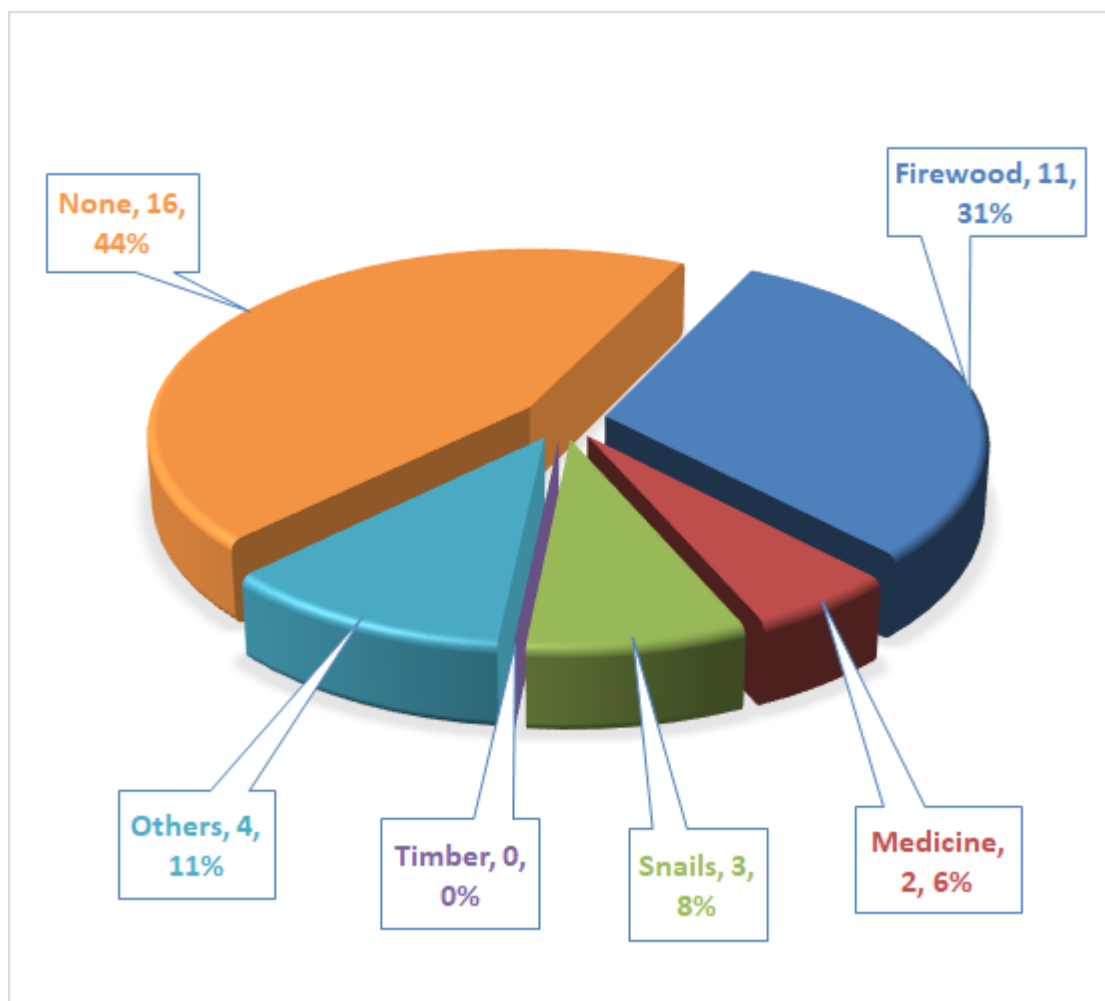


**Figure 4:** Distribution of livelihoods within the fringe communities

### 7.2 Extent of NTFP usage

Respondents were interviewed to assess their extent of NTFPs patronage from the BRE (Figure 5). The percentage of respondents patronizing a particular product was then analyzed. Surprisingly, a significant number of respondents (44%) did not patronize any NTFPs from the BRE. Apart from this non-user group, certain household products such as fuel-wood was the most sort after NTFP in the estate and was used in many (31%) of the households interviewed.

Within the others category, wild-yam and mushrooms were popular food items for the fringe communities as consumption is around 11% of households (Figure 5). Gathering of snails was next (8%) and was also relatively popular as a protein addition to locally prepared food at home. Snails were also sold on nearby local markets for additional cash income, depending on the need.



**Figure 5:** Distribution of NTFP benefits obtained by fringe communities

Harvesting medicinal products from the estate was of relatively low benefit to the communities. This was expected since the Bettie township was just a few minutes' drive from the project area and people could easily buy drugs for their ailments. In all only two respondents mentioned using plants for medicinal purposes. Cola, which is regarded as stimulant and quite popular amongst the Northern immigrant communities was not represented. Again, none of the respondents was engaged in timber felling from the BRE. This is not surprising, since most parts of the BRE is degraded and does not harbour any significant forests remnants.

## 8 HCV management and monitoring

This section presents conclusions and recommendations for managing any identified HCV in the Valued Zone in order to ensure their continued existence.

### 8.1 Specific Conclusions on the Valued Zone

The following conclusions are made based on the field and stakeholder engagements:

1. The Valued Zone is a highly modified landscape within the BRE with no contiguous forest cover or intact ecosystems, hence yielded the lowest total carbon. None of the recorded species existed in locally significant viable populations.
2. None of the fringe communities hold claims of traditional tenure or traditional/religious rights over any part of the Valued Zone.
3. Fringe communities were not critically dependent on the Valued Zone for their basic needs and the area did not serve any critical socio-cultural, traditional or religious purposes.
4. Streams were identified in the Valued Area that flow downstream into communities.

### 8.2 Specific Recommendations for the Valued Zone

1. Six HCV categories were assessed in the Valued Zone and HCV 4.1 (presence of streams) was identified to be present. This does not necessarily preclude plantation development in the zone. Thus, it is expected that SAPH maps out all streams within the Valued Zone and take immediate steps to delineate them with the appropriate forest buffers before any land preparation. The SIFCA Biodiversity Conservation Measures (2015) for protecting watercourses (rivers, creeks and streams) recommends the following ranges of buffer widths for different watercourse widths;

**Table 8:** SIFCA Biodiversity Conservation Measures (2015) for protecting watercourses

Watercourse Width	Buffer Width
0 to <5m	10m native vegetation on both sides of the river
5 to <20m	20m native vegetation on both sides of the river
>20m	60m native vegetation on both sides of the river

2. These buffers will be marked for protection from all plantation activities. Such precautionary measures will reduce contamination of these waterbodies to affect aquatic life and downstream human users. Because the Valued Zone was assessed to be highly degraded, it is also important that SAPH ensures the protection of these waterbodies for conservation purposes.
3. Given the above considerations, the Valued Zone is generally considered suitable for rubber plantation development.

### 8.3 Conservation Achievements for the Bettie Rubber Estate

SAPH needs to be applauded for its conservation initiatives. First, a significant land area of 1,242.84 ha (24%) of the entire Bettie Rubber Estate (BRE) has been dedicated to biodiversity conservation. Initial conservation efforts within BRE included the reservation of remnant secondary forests and classifying them as Reserved Forests (Table 9, Figure 6). These Reserved Forests are composed of 15 small forest fragments that are scattered across the estate with sizes ranging from 0.24 ha to 16.50 ha. Together, they total up to 57.02 ha. Out of the 15 Reserved Forests, two are community cemeteries (HCV 6) while one is a sacred forest (HCV 6). The remaining 12 Reserved Forests protect local watercourses making them HCV 1. Additionally, five of them contain tree species of international conservation concern (HCV 4). All these features are outside the Valued Zone.

**Table 9:** Characteristics of Reserved Forests and their HCV Status in the BRE

Name	Position	Perimeter (m)	Area (ha)	Recorded Species of Conservation Concern	HCV Status
Cimetière	V1	471.83	1.16		HCV 6
Foret Sacrée	BF08	470.77	0.77		HCV 6
Cimetière	V2	384.79	0.73		HCV 6
Reserve	BF17	2146.20	16.50	<i>Hallea ledermannii</i> (VU)	HCV 1 & 4
Foret DG	BF07	353.29	0.65		
Reserve	BF07	585.86	1.04		
Reserve	BF14	617.99	0.99	<i>Khaya ivorensis</i> (VU)	HCV 1 & 4
Reserve	BF15	459.42	0.77		
Reserve	BF15	1255.07	6.79	<i>Lophira alata</i> (VU)	HCV 1 & 4
Reserve	BF08	242.77	0.24		
Reserve	BF15	1822.59	11.73		
Reserve	BF17	1139.64	4.75		
Reserve	BF06	866.82	2.36		
Reserve	BF05	910.63	4.25	<i>Hallea ledermannii</i> (VU)	HCV 1 & 4
Reserve	A01	917.72	4.29	<i>Hallea ledermannii</i> (VU)	HCV 1 & 4
<b>Total</b>		<b>13645.40</b>	<b>57.02</b>		

SAPH continues to expand its conservation initiatives within the BRE and has implemented an innovative strategy that seeks to expand the existing Reserved Forests (Figure 6) by linking them with Biodiversity Buffers (Figure 7). In so doing, the total conservation area has increased from the 57.02 ha to the current 1,242.84 ha. This initiative needs to be commended because these buffers safeguard representative areas in the broader Bettie Rubber Estate (BRE) and also ensure greater linkage and genetic connectivity within the estate.

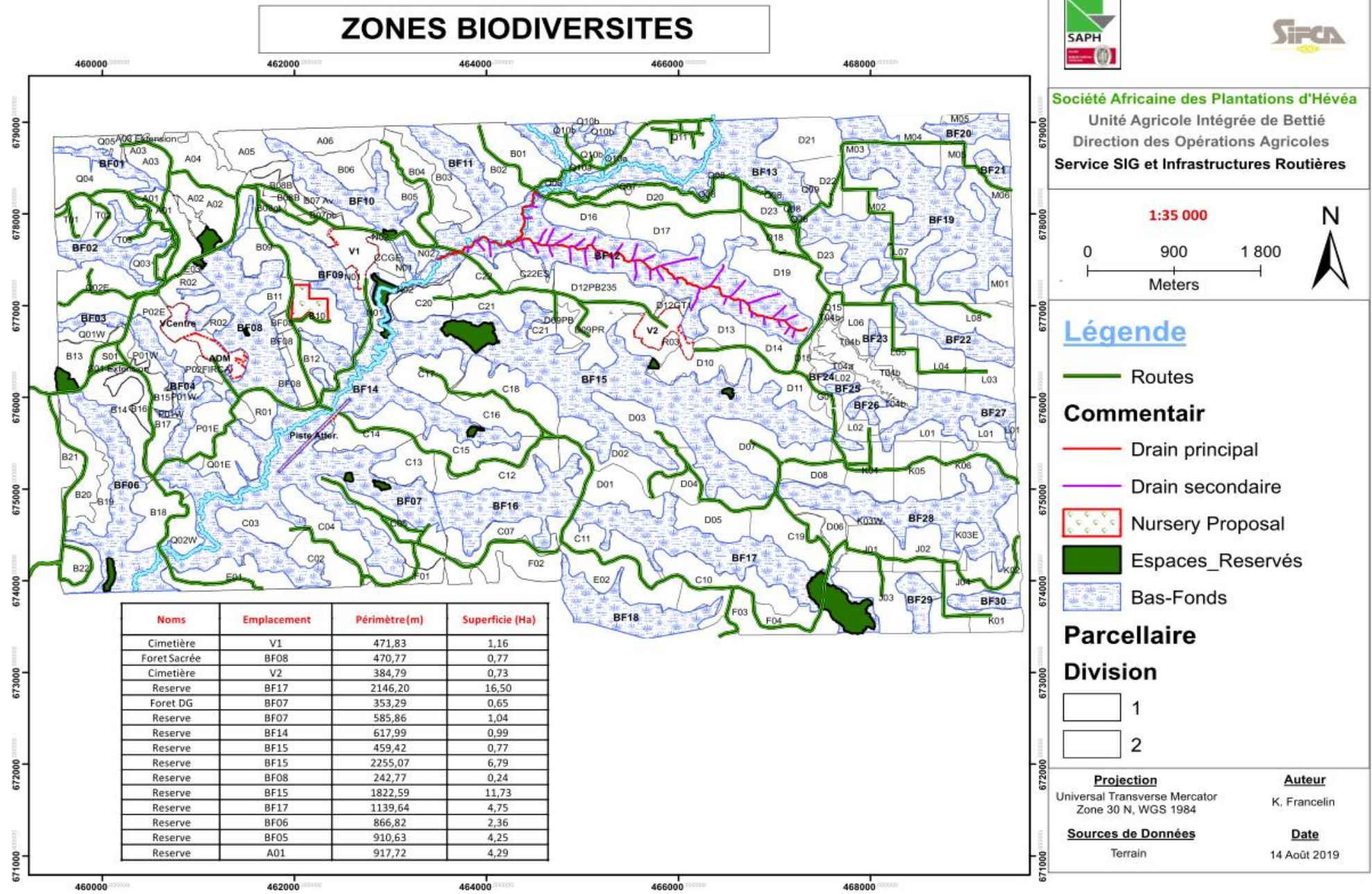
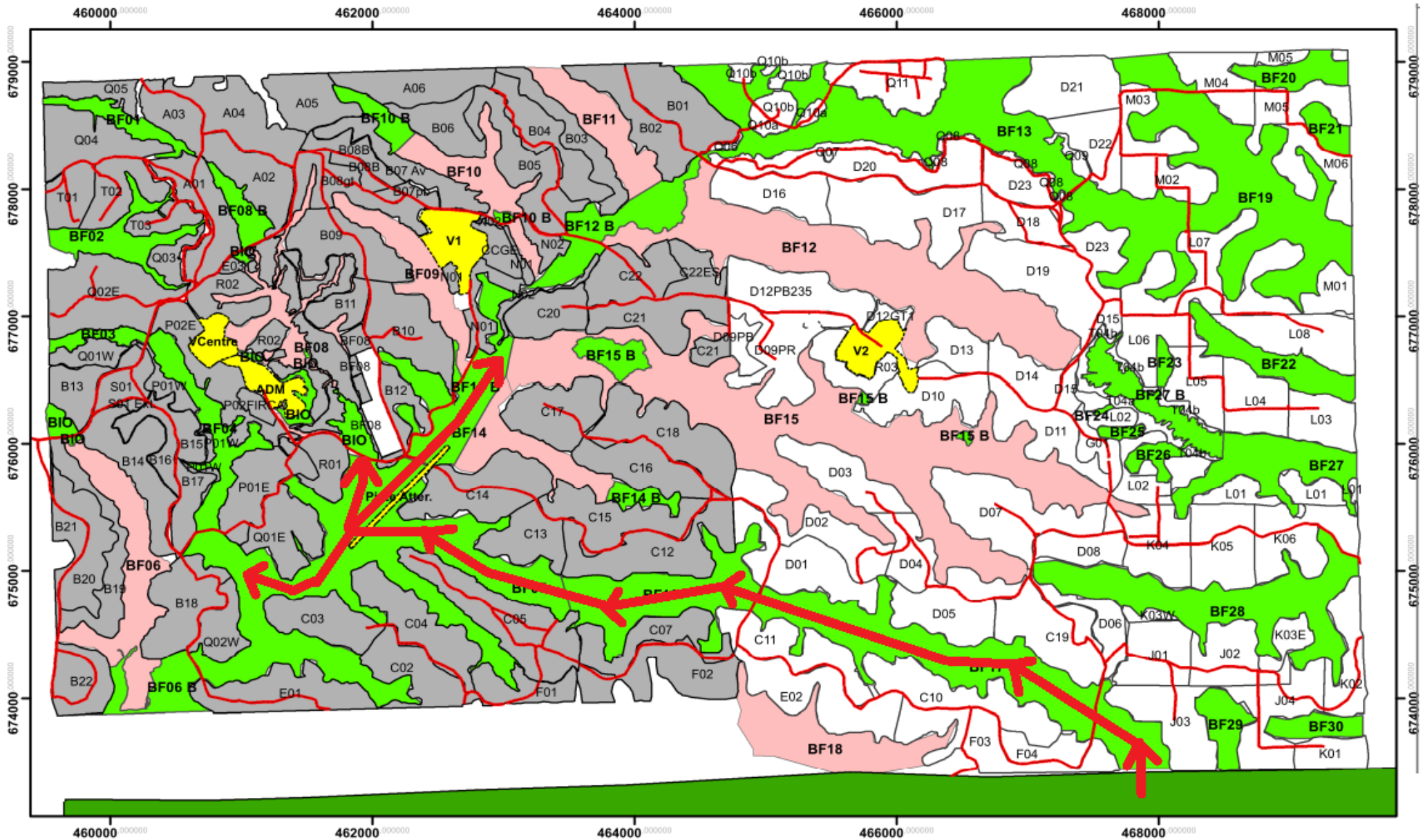


Figure 6: Map of the Bettie Rubber Estate showing distribution of biodiversity zones



**Figure 7:** Map of the Bettie Rubber Estate showing distribution of Biodiversity Buffers and expected wildlife migration corridor (red arrow line)

## 8.4 General Recommendations for Bettie Rubber Estate

1. A detailed mapping of waterbodies in BRE is vital before any land preparation. This forms a basis for connecting the riparian vegetation with the buffers to allow easy wildlife movement and also enhance the genetic and ecological functionalities of these corridors. Mapping of all riparian buffers should be done for both permanent and seasonal streams.
2. The assessment team recorded several illegal human activities within the Biodiversity Buffers. These included farming and hunting activities which result in further habitat degradation and wildlife habitat loss. SAPH should as a matter of urgency implement a formal system of surveillance to monitor unauthorized human activities in the Biodiversity Zone. In addition, the 23 established Permanent Sampling Plots (PSPs) provides baseline data for monitoring biodiversity and illegal human activity in the Biodiversity Zone.
3. SAPH should increase community education on the importance of the Biodiversity Zone to wildlife conservation. This will decrease the number of illegal human activities within the zone. Some community members did not realize they were conducting an illegality because they thought Biodiversity Zone was an 'unattended' land that they could farm.
4. As part of its social responsibility, SAPH could set aside a land for communities to engage in farming. Another innovative way is to engage fringe communities in restoring heavily degraded areas back to forest. SAPH could adopt the Taungya System from Ghana where farmers are registered with parcels of degraded forest to plant crops and also plant and cater for native economic tree species supplied to them by the company. In this approach, farmers are able to farm on their lands for a maximum of 3-4 years after which the trees overtake their crops and they can no longer farm. This can be done progressively until all degraded areas are restored.



**Plate 4:** A captured young bushbuck found at Village Two

## 8.4 Summary management/monitoring recommendations for HCV 4.1

**Table 10:** Management and monitoring recommendations for the identified HCV (HCV 4.1)

<b>Main threats</b>
<ul style="list-style-type: none"> <li>• Conversion of riparian forests/wildlife habitat around streams to rubber plantation</li> <li>• Pollution of streams from fertilizer and weedicide applications</li> <li>• Loss of potable water due to pollution from agrochemical run-off and siltation</li> <li>• Reduction in habitat quality for aquatic biota due to siltation and agrochemical run-off</li> </ul>
<b>Management recommendations</b>
<ul style="list-style-type: none"> <li>• All riparian buffers in the concession should be set aside for conservation.</li> <li>• All such areas should be clearly mapped and delimited on the ground to avoid accidental conversion.</li> <li>• A buffer zone of at least 10m should be left around the headwaters and other water bodies in the concession.</li> <li>• No agrochemicals use in buffer zones</li> </ul>
<b>Monitoring recommendations</b>
<ul style="list-style-type: none"> <li>• Ensure that the boundaries of the set-aside buffers remain intact</li> <li>• Monitor the implementation of SOPs on use of agrochemicals close to waterbodies</li> <li>• Periodic (bi-annual) assessment and monitoring of water quality and fauna presence</li> </ul>



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**Plate 5:** The field team

# Appendix

## Appendix 1: The International Union for Conservation of Nature and Natural Resources (IUCN, 2022)

The International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species (2022) provides taxonomic, conservation status and distribution information on taxa that have been evaluated using the IUCN Red List Categories and Criteria. The main purpose of the IUCN Red List is to catalogue and highlight those taxa that are facing a higher risk of global extinction (i.e. those listed as Critically Endangered, Endangered and Vulnerable). The IUCN Red List also includes information on taxa that are categorized as Extinct or Extinct in the Wild; on taxa that cannot be evaluated because of insufficient information (i.e. are Data Deficient); and on taxa that are either close to meeting the threatened thresholds or that would be threatened were it not for an ongoing taxon-specific conservation programme (i.e. Near Threatened) (<http://www.redlist.org>)

The following categories have been developed:

- (1) EX (Extinct) - No reasonable doubt that the last individual has died
- (2) EW (Extinct in the Wild) - Known only to survive in captivity or as a naturalized populations well outside its previous range
- (3) CR (Critically Endangered) - The species is in imminent risk of extinction in the wild
- (4) EN (Endangered) - The species is facing an extremely high risk of extinction in the wild
- (5) VU (Vulnerable) - The species is facing a high risk of extinction in the wild
- (6) NT (Near Threatened) - The species does not meet any of the criteria that would categorize it as risking extinction but it is likely to do so in the future
- (7) LC (Least Concern) - There are no current identifiable risks to the species
- (8) DD (Data Deficient) - There is inadequate information to make an assessment of the risks to this species

## Appendix 2: Short descriptions of the Ghana field team

### 1. Professor Emmanuel Danquah (PhD) (Wildlife Ecologist - Mammalogist)



Prof. Emmanuel Danquah has PhD in Wildlife and Range Management and over 20 years of experience working on natural resource management. Emmanuel is the Dean of the Faculty of Renewable Natural Resources at the Kwame Nkrumah University of Science and Technology in Ghana where his work includes planning and management of wildlife and forestry projects. Emmanuel has participated in many High Conservation Value assessments for rubber and oil palm plantation development in several countries in Africa including Ghana, Nigeria, Cameroon, Gabon, Tanzania, Ethiopia, Liberia, Zambia and Cote d'Ivoire. His recent areas of research include HCV assessments, biodiversity monitoring and impact assessments of natural resource-based projects, green economies in biosphere reserves, endangered species management, protected areas governance, indigenous people and conservation, and traditional knowledge in natural resource management. His scholarly interests also span the fields of endangered species management, climate change impacts, collaborative resources management, sustainable livelihood support systems, human-wildlife coexistence and ecological & environmental impact assessments.

#### 4. Mr. Alfred Kwabena Assumang (Wildlife Ecology – Wildlife Social Dimensions)



Mr. Alfred Kwabena Assumang has an MPhil in Wildlife and Range Management and is currently a PhD student at the Department of Wildlife and Range Management, Faculty of Renewable Natural Resources, KNUST. Alfred's experience ranges from natural resources management to ecological surveys and community collaborative management projects. He has worked with diverse academic and research-based organizations and rural community advocacy groups. He has been involved in training wildlife guards in conducting field research, data collection and analysis protocols. Mr. Assumang has computer skills in various software including the Paleontological Statistics (PAST), Microsoft Office Suit ECOM software and Statistical Software Package for Social Sciences (SPSS) for data analysis.

## 2. Mr. Ben Ossom (Wildlife Ecologist - Ornithologist)



Mr. Benjamin Ossom is a Senior Technician at the Department of Wildlife and Range Management. Mr. Ossom's areas of expertise include wildlife surveys focusing on avifaunal surveys, species identification and implementing biodiversity conservation field protocols. Mr. Ossom has a BSc. Degree in Natural Resources Management from the Department of Wildlife and Range Management, KNUST. He has gained the requisite work experience as a Field Technician in the Department and has been part of several biodiversity projects funded by local and international organizations like The Rufford Foundation and Mohammed Bin Zayed Species Conservation Fund. Mr. Ossom served as a Research Assistant (Avifauna) on the KNUST Biodiversity Inventory Project with funding from the KNUST Research Fund (KReF) and the Biodiversity Monitoring Project for FORM Ghana's Asubima Plantations. He was also the main Ornithologist in several research projects including the Monitoring of Biodiversity at Newmont Golden Ridge Ltd Ahafo Mines Project, Biodiversity in the Forest and Oil Palm Plantations (NCRC Project), Biodiversity in the Forest and Cocoa landscapes (NCRC Project), Monitoring and Relocation of Wildlife in Newmont Golden Ridge Ltd, Akyem Project Area and Faunal Surveys and Preparation of Management Plans for selected Forest Reserves in Forest and Savanna regions of Ghana. He has over 30 technical reports to his credit

### 3. Mr. Peter Akomatey (Forest Ecology – Botanist)



Mr. Peter Akomatey has a BSc in Natural Resources Management from the Faculty of Renewable Natural Resources. Peter currently works at the Forestry Commission of Ghana as a Forest Range Manager (Curator). Over the years Mr. Akomatey has emerged as a committed botanist at the Forestry Commission of Ghana, providing practical conservation interventions aimed at contributing to the sustainable management of species and their ecological habitats. He has led field teams in acquiring baseline information on flora species in various protected areas in Ghana. He has extensive capabilities and skills in botanical surveys and management issues. Has adequate years of experience in the development of environmental management plans at park, district level and also at landscape/ecosystem levels.



Plate 6: Mr. Francelin Kouadio, SAPH



Plate 7: Mr. Ago



Plate 8: Mr. Eric



Plate 7: Mr. Kofi and Mr. xxxxxxxxxx



### Appendix 3: Names and Rank of Respondents and their Communities

No	Name of Respondent	Name of community	Category or Rank
1	Kwame Theodore	Behibrokro	Community Elder
2	Papa Kwadwo	Behibrokro	Community member
3	Ouedraogo Daouda	Akrebi	Community member
4	Gadjeo Kablah Didier	Akrebi	Palace Elder
5	Ngouan Napeh Jean Baptist	Akrebi	Palace Elder
6		Akrebi	Chief
7	Plea Kofi Cilestian	Akrebi	Palace Elder
8	Assemien Assemien Mathew	Akrebi	Palace Elder
9		Akrebi	Community member
10		Akrebi	Community member
11	Abjo Kwasi Johnson	Akrebi	Community member
12	Akua Monica	Akrebi	Community member
13	Akua Monica Jnr	Akrebi	Community member
14	Kwaku Pra	Akrebi	Community member
15	Kwadwo Ango	Akrebi	Community member
16	Kwaku Miyan	Akrebi	Community member
17		Akrebi	Community member
18	Tano Amoah	Akrebi	Community member
19		Village One	Community member
20		Village One	Community member
21	Palenfo Malenpo	Tanokro	Community member
22	Kambire Janet	Tanokro	Community member
23	Adjadja Beatrice	Village Two	Teacher's Wife
24	Kama dongo	Village Two	Community member
25	Hien mathew	Village Two	Community member
26		Village Two	Community member
27		Village Two	Community member

28	Ncho olga	Village Two	Community member
29	Jamila dabire	Village Two	Community member
30	Mama	Village Two	Community member
31		Village Two	Community member
32		Village Two	Community member
33	Dadie Irmand	Village Two	Teacher
34		Village Two	Hunter
35		Village Two	Community member
36	Jamila' Sister	Village Two	Community member

#### Appendix 4: List of Tree Species Recorded in the Biodiversity and Valued Zones in the Bettie Concession

SCIENTIFIC NAME	LOCAL NAME	FAMILY	IUCN	GUILD	Biodiversity	Valued	Grand Total
<i>Albizia adianthifolia</i>	Bangbaye	Mimosaceae	Least Concern	NPLD	2	0	2
<i>Albizia zygia</i>	Ouochi	Mimosaceae	Least Concern	NPLD	3	1	4
<i>Alstonia boonei</i>	Emien	Apocynaceae	Least Concern	Pioneer	10	0	10
<i>Amphimas pterocarpoides</i>	Lati	Papilionaceae	Least Concern	NPLD	0	1	1
<i>Aningeria altissima</i>	Grogoli	Sapotaceae	Least Concern	NPLD	3	0	3
<i>Anthocleista nobilis</i>	Brobro	Gentianaceae	Least Concern	Pioneer/swamp	2	0	2
<i>Anthonotha fragrans</i>	Adonmoteu	Caesalpiniaceae	Least Concern	NPLD	1	0	1
<i>Antiaris toxicaria</i>	Ako	Moraceae	Least Concern	NPLD	1	0	1
<i>Bombax brevicuspe</i>	Kondroti	Malvaceae	Vulnerable	Pioneer	2	0	2
<i>Bombax buonopozense</i>	Kapokier (Oba)	Malvaceae	Least Concern	Pioneer	0	1	1
<i>Bridelia grandis</i>	Tchikuébi/Tougbibi	Euphorbiaceae	Not evaluated	Pioneer	3	0	3
<i>Calpocalyx brevibracteatus</i>	Pétépré	Mimosaceae	Least Concern	Shade-bearing	1	0	1
<i>Canarium schweinfurthii</i>	Aiélé	Burseraceae	Not Evaluated	Pioneer	2	1	3
<i>Carapa procera</i>	Dona	Meliaceae	Least Concern	Shade-bearing	9	1	10
<i>Cecropia peltata</i>		Cecropiaceae	Least Concern	Pioneer	33	15	48
<i>Ceiba pentandra</i>	Fromager	Malvaceae	Least Concern	Pioneer	3	3	6
<i>Cleistopholis patens</i>	Sobou	Annonaceae	Least Concern	Pioneer	4	0	4
<i>Cola gigantea</i>	Grand Ouara	Malvaceae	Least Concern	NPLD	2	0	2
<i>Cola nitida</i>	Colatier	Malvaceae	Least Concern	Shade-bearing	3	0	3
<i>Dacryodes klaineana</i>	Adjouaba	Burseraceae	Least Concern	Shade-bearing	3	0	3
<i>Daniella thurifera</i>	Faro	Caesalpiniaceae	Least Concern	Pioneer	1	0	1
<i>Dialium aubrevillei</i>	Kropio	Caesalpiniaceae	Not Evaluated	Shade-bearing	1	0	1
<i>Diospyros sanza-minika</i>	Sanza Minika	Ebenaceae	Not Evaluated	Shade-bearing	1	0	1

SCIENTIFIC NAME	LOCAL NAME	FAMILY	IUCN	GUILD	Biodiversity	Valued	Grand Total
<i>Discoglyprena caloneura</i>	Akoret	Euphorbiaceae	Least Concern	Pioneer	1	1	2
<i>Elaeis guineensis</i>	Palmier à huile	Palmae	Least Concern	Pioneer	13	1	14
<i>Ficus exasperata</i>	Dédé	Moraceae	Least Concern	Pioneer	1	0	1
<i>Gilbertiodendron limba</i>	Médjilagba-limba	Caesalpiniaceae	Least Concern	NPLD	7	0	7
<i>Guarea cedrata</i>	Bossé	Meliaceae	Vulnerable	Shade-bearing	0	1	1
<i>Hallea ledermannii</i>	Bahia	Rubiaceae	Vulnerable	Swamp	14	0	14
<i>Harungana madagascariensis</i>	Ouombé	Guttiferae	Least Concern	Pioneer	1	0	1
<i>Heritiera utilis</i>	Niangon	Malvaceae	Vulnerable	NPLD	2	0	2
<i>Hexalobus crispiflorus</i>	Siélébé	Annonaceae	Least Concern	Shade-bearing	1	0	1
<i>Homalium letestui</i>	Méléfoufou	Salicaceae	Not Evaluated	NPLD	1	0	1
<i>Hymenostegia afzelii</i>	Kouékoué	Caesalpiniaceae	Not Evaluated	Shade-bearing	1	0	1
<i>Khaya ivorensis</i>	Acajou de Bassam	Meliaceae	Vulnerable	NPLD	1	0	1
<i>Lannea welwitschii</i>	Loloti	Anacardiaceae	Least Concern	Pioneer	3	1	4
<i>Lophira alata</i>	Azobé	Ochnaceae	Vulnerable	Pioneer	1	0	1
<i>Macaranga barteri</i>	Tofé Dola	Euphorbiaceae	Least Concern	Pioneer	1	1	2
<i>Margaritaria discoidea</i>	Lié	Euphorbiaceae	Least Concern	Pioneer	1	2	3
<i>Musanga cecropioides</i>	Parasolier	Cecropiaceae	Least Concern	Pioneer	1	0	1
<i>Nauclea diderrichii</i>	Bilinga-Badi	Rubiaceae	Vulnerable	Pioneer	1	1	2
<i>Omphalocarpum ahia</i>	Agua à grandes feuilles	Sapotaceae	Endangered	Swamp	1	2	3
<i>Parinari excelsa</i>	Sougué à g. feuilles	Chrysobalanaceae	Least Concern	NPLD	1	0	1
<i>Parkia bicolor</i>	Lo	Mimosaceae	Least Concern	NPLD	1	0	1
<i>Pentaclethra macrophylla</i>	Ovala	Mimosaceae	Least Concern	NPLD	1	0	1
<i>Petersianthus macrocapus</i>	Abalé	Lecythidaceae	Least Concern	Pioneer	2	0	2
<i>Piptadeniastrum africanum</i>	Dabéma	Mimosaceae	Least Concern	NPLD	2	1	3

SCIENTIFIC NAME	LOCAL NAME	FAMILY	IUCN	GUILD	Biodiversity	Valued	Grand Total
<i>Psydrax parviflora</i>	Tekbé à grandes feuilles	Rubiaceae	Least Concern	Pioneer	1	0	1
<i>Raphia hookeri</i>	Raphia	Palmae	Least Concern	Swamp	12	0	12
<i>Ricinodendron heudelotii</i>	Eho	Euphorbiaceae	Vulnerable	Pioneer	6	0	6
<i>Scaphopetalum amoenum</i>	Aroro	Malvaceae	Not Evaluated	Shade-bearing	2	0	2
<i>Spathodea campanulata</i>	Tulipier du Gabon	Bignoniaceae	Least Concern	Pioneer	1	0	1
<i>Sterculia tragacantha</i>	Poré Poré	Malvaceae	Least Concern	Pioneer	2	0	2
<i>Strombosia glaucescens</i>		Olacaceae	Least Concern	Shade-bearing	1	0	1
<i>Symphonia globulifera</i>	Beu	Guttiferae	Least Concern	Swamp	1	0	1
<i>Terminalia ivorensis</i>	Framiré	Combretaceae	Vulnerable	Pioneer	1	0	1
<i>Terminalia superba</i>	Fraké (Limba)	Combretaceae	Least Concern	Pioneer	7	0	7
<i>Tetrapleura tetraptera</i>	Eséhésé	Mimosaceae	Least Concern	Pioneer	0	1	1
<i>Tetrorchidium didymostemon</i>		Euphorbiaceae	Least Concern	Pioneer	2	1	3
<i>Treculia africana</i>	Bléblendou	Moraceae	Not Evaluated	NPLD	1	0	1
<i>Trema orientalis</i>	Adaschia	Ulmaceae	Least Concern	Pioneer	0	1	1
<i>Trichilia monadelpha</i>	Banaye	Meliaceae	Least Concern	NPLD	2	0	2
<i>Uapaca guineensis</i>	Rikio	Euphorbiaceae	Least Concern	NPLD	3	0	3
<i>Uapaca heudelotii</i>	Rikio des rivières	Euphorbiaceae	Least Concern	Swamp	1	0	1
<i>Zanthoxylum gilletii</i>	Bahé (Olon-dur)	Rutaceae	Least Concern	Pioneer	2	1	3
<i>Zanthoxylum leprieurii</i>	Boulé barkélé	Rutaceae	Not Evaluated	Pioneer	1	0	1
<b>Grand Total</b>					<b>195</b>	<b>38</b>	<b>233</b>

## Appendix 5: List of Bird Species Recorded in the Biodiversity and Valued Zones in the Bettie Concession

SCIENTIFIC NAME	COMMON NAME	FAMILY	IUCN	Biodiversity	Valued	Grand Total
<i>Tockus fasciatus</i>	African-pied Hornbill	Bucerotidae	Least Concern	22	6	28
<i>Andropadus virens</i>	Little Greenbul	Pycnonotidae	Least Concern	12	5	17
<i>Pycnonotus barbatus</i>	Common Bulbul	Pycnonotidae	Least Concern	18	8	26
<i>Ceuthmochares aereus</i>	Yellowbill	Cuculidae	Least Concern	1	0	1
<i>Pogoniulus subsulphureus</i>	Yellow-throated Tinkerbird	Capitonidae	Least Concern	10	2	12
<i>Pogoniulus atrofavus</i>	Red-rumped Tinkerbird	Capitonidae	Least Concern	5	1	6
<i>Oriolus brachyrhynchus</i>	Western Black-headed Oriole	Oriolidae	Least Concern	0	1	1
<i>Camaroptera superciliaris</i>	Yellow-browed Camaroptera	Cisticolidae	Least Concern	6	1	7
<i>Centropus senegalensis</i>	Senegal Coucal	Cuculidae	Least Concern	9	2	11
<i>Dyaphorophyia castanea</i>	Chestnut wattle-eye	Platysteiridae	Least Concern	3	0	3
<i>Turtur tympanistria</i>	Tambourine-Dove	Columbidae	Least Concern	8	6	14
<i>Hylia prasina</i>	Green Hylia	Silviidae	Least Concern	8	1	9
<i>Terpsiphone rufiventer</i>	Red-bellied Paradise Flycatcher	Monarchidae	Least Concern	7	0	7
<i>Bleda canicapillus</i>	Grey-headed Bristlebill	Pycnonotidae	Least Concern	1	0	1
<i>Treron calvus</i>	African Green Pigeon	Columbidae	Least Concern	2	6	8
<i>Hedydipna callaris</i>	Collard Sunbird	Nectariniidae	Least Concern	1	0	1
<i>Macrosphenus kemp</i>	Kemp's Longbill	Silviidae	Least Concern	1	0	1
<i>Camaroptera brachyura</i>	Grey-backed Camaroptera	Cisticolidae	Least Concern	6	0	6
<i>Nigrita canicapillus</i>	Grey-headed Negrofinch	Estrildidae	Least Concern	7	3	10
<i>Prinia subflava</i>	Tawny-flanked Prinia	Cisticolidae	Least Concern	5	0	5
<i>Trachylaemus purpuratus</i>	Yellow-billed Barbet	Capitonidae	Least Concern	4	0	4
<i>Malimbus rubricollis</i>	Red-vented Malimbe	Ploceidae	Least Concern	2	0	2
<i>Andropadus latirostris</i>	Yellow-whiskered Greenbul	Pycnonotidae	Least Concern	5	1	6

SCIENTIFIC NAME	COMMON NAME	FAMILY	IUCN	Biodiversity	Valued	Grand Total
<i>Halcyon senegalensis</i>	Woodland Kingfisher	Alcedinidae	Least Concern	7	2	9
<i>Baeopogon indicator</i>	Honeyguide Greenbul	Pycnonotidae	Least Concern	1	0	1
<i>Cinnyris chloropygius</i>	Olive-bellied Sunbird	Nectariniidae	Least Concern	1	0	1
<i>Gymnobucco peli</i>	Bristle-nosed Barbet	Capitonidae	Least Concern	5	1	6
<i>Camaroptera chloronota</i>	Olive-green Camaroptera	Cisticolidae	Least Concern	1	0	1
<i>Chrysococcyx klaas</i>	Klaas's Cuckoo	Cuculidae	Least Concern	5	2	7
<i>Streptopelia semitorquata</i>	Red-eyed Dove	Columbidae	Least Concern	7	8	15
<i>Cisticola lateralis</i>	Whistling Cisticola	Cisticolidae	Least Concern	6	2	8
<i>Dicrurus modestus</i>	Velvet-mantled Drongo	Dicruridae	Least Concern	6	2	8
<i>Muscicapa comitata</i>	Dusky-blue Flycatcher	Muscicapidae	Least Concern	5	0	5
<i>Spermestes cucullatus</i>	Bronze-Mannikin	Estrildidae	Least Concern	2	5	7
<i>Turtur afer</i>	Blue-spotted Wood Dove	Columbidae	Least Concern	2	2	4
<i>Corvus albus</i>	Pied Crow	Corvidae	Least Concern	3	3	6
<i>Ploceus cucullatus</i>	Village Weaver	Ploceidae	Least Concern	2	10	12
<i>Platysteira cyanea</i>	Common Wattle-eye	Platysteiridae	Least Concern	1	1	2
<i>Buteo auguralis</i>	Red-necked Buzzard	Accipitrdae	Least Concern	2	2	4
<i>Milvus migrans parasitus</i>	Yellow-billed Kite	Accipitrdae	Least Concern	4	0	4
<i>Merops pusillus</i>	Little-bee eater	Meropidae	Least Concern	5	0	5
<i>Spermestes bicolor</i>	Black and White Mannikin	Estrildidae	Least Concern	6	4	10
<i>Francolinus bicalaratus</i>	Double-spurred Francolin	Phasianidae	Least Concern	2	1	3
<i>Spermophaga haematina</i>	Western Bluebill	Estrildidae	Least Concern	4	0	4
<i>Falco ardosiaceus</i>	Grey Kestrel	Falconidae	Least Concern	1	0	1
<i>Malimbus rubricollis</i>	Red-headed Malimbe	Ploceidae	Least Concern	3	0	3
<i>Ixobrychus minutus</i>	Dwarf Bittern	Ardeidae	Least Concern	1	0	1

SCIENTIFIC NAME	COMMON NAME	FAMILY	IUCN	Biodiversity	Valued	Grand Total
<i>Lybius vielloti</i>	Vieillot's Barbet	Capitonidae	Least Concern	2	2	4
<i>Merops albicollis</i>	White-throated Bee eater	Meropidae	Least Concern	0	8	8
<i>Chrysococcyx caprius</i>	Didric Cuckoo	Cuculidae	Least Concern	0	1	1
<i>Nigrita bicolor</i>	Chestnut-breasted Negrofinch	Estrildidae	Least Concern	0	1	1
<i>Kaupifalco monogrammicus</i>	Lizard Buzzard	Accipitridae	Least Concern	1	0	1
<i>Cisticola erythrops</i>	Red-faced Cisticola	Cisticolidae	Least Concern	1	0	1
<i>Hypergerus atriceps</i>	Oriole Warbler	Oriolidae	Least Concern	1	0	1
<i>Lybius vielloti</i>	Vieillot's Black Weaver	Ploceidae	Least Concern	4	0	4
<i>Gymnobucco calvus</i>	Naked-faced Barbet	Capitonidae	Least Concern	3	0	3
<i>Megaceryle maxima</i>	Giant Kingfisher	Alcedinidae	Least Concern	1	0	1
<i>Cinnyris superbus</i>	Superb Sunbird	Nectariniidae	Least Concern	1	0	1
<i>Dendrocygna viduata</i>	White-faced Whistling Duck	Anatidae	Least Concern			
<b>Grand Total</b>				<b>239</b>	<b>100</b>	<b>339</b>



## Appendix 6: List of Mammal Species Recorded in the Biodiversity and Valued Zones in the Bettie Concession

SCIENTIFIC NAME	COMMON NAME	FAMILY	IUCN	Biodiversity	Valued	Grand Total
<i>Tragelaphus scriptus</i>	Bush Buck	Bovidae	Least Concern	12	4	16
<i>Cephalophus maxwelli</i>	Maxwell's Duiker	Antelopinae	Least Concern	6	2	8
<i>Thryonomys swinderianus</i>	Marsh Cane Rat	Thryomyidae	Least Concern	5	0	5
<i>Cricetomys gambiensis</i>	Giant Gambian Rat	Cricetomyinae	Least Concern	4	0	4
<i>Atilax paludinosus</i>	Marsh Mongoose	Herpestidae	Least Concern	7	0	7
<i>Funisciurus pyrropus</i>	Fire-footed Rope Squirrel	Sciuridae	Least Concern	5	0	5
<i>Potamochoerus porcus</i>	Red River Hog	Suidae	Least Concern	2	0	2
<i>Galagoides demidovii</i>	Demidoff's Galago	Galagidae	Least Concern	1	0	1
<i>Perodicticus potto potto</i>	Bossman's Potto	Lorisidae	Least Concern	1	0	1
<i>Civettictus civetta</i>	African Civet	Viverridae	Least Concern	4	0	4
<i>Genetta getta</i>	Genet	Viverridae	Least Concern	2	0	2
<i>Galerella saguinea</i>	Slender Mongoose	Herpestidae	Least Concern	2	0	2
<b>Grand Total</b>				<b>53</b>	<b>6</b>	<b>59</b>

