

# Hɛn Mpoano

## Land Use Land Cover Assessment of Cape Three Points Forest and Linked Ecosystems

### Assessment Report



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**Cover photo:** Logged timber within the Cape Three Points forest reserve (Credit, HM)

## Acronyms

AP	Aerial Photograph
CEPF	Critical Ecosystem Partnership Fund
CREMA	Community Resources Management Area
CRMC	Community Resources Management Committee
CTPFR	Cape Three Points Forest Reserve
GPS	Global Positioning System
GSBA	Global Significant Biodiversity Area
HM	Hen Mpoano
IBA	International Bird Area
LULC	Land Use Land Cover
OLI	Operational Land Imager
TM	Thematic Mapper
UAV	Unmanned Aerial Vehicle
UTM	Universal Transverse Mercator

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## 1.0 Introduction

The Cape Three Points Forest Reserve (CTPFR) is located in the Ahanta West Municipal of the Western Region. It is among the few remaining coastal rainforest reserves in West Africa. It is the only extensive remnant of intact moist evergreen rain forest in Ghana (Hall & Swaine, 1976). The Cape Three Points Forest Reserve is a relatively small forest reserve with an area of 5,112 hectares (51.12 km<sup>2</sup>). The reserve derives its name from three promontories, which lay some 2.5 km of its southern boundary (Forestry Commission, 2007-2011). Since 1999 the forest has been recognized as a Globally Significant Biodiversity Area (GSBA) and an Important Bird Area (IBA) because of its exceptionally high level of biological diversity

Floristically, the forest reserve is the second most diverse reserve in Ghana. Recent surveys conducted in the reserve recorded over 27 tree species; 17 species of medium and large mammals and 45 species of butterflies. Key fauna in the reserve include *Cephalophus dorsalis*, *Cephalophus agilbyi*, *Cephalophus monticola maxwelli*, *Neotragus pygmaeus*, *Cercocebus torquarus lunulatus*, *Periodictus potto*, *Nandinia bionotata*, *Crosarchus obscurus*, *Dendrohyrax arboreous dorsalis*, *Manis gigantean*, *Manis tetradactyla/tricuspis*, *Anthrurus africanus*, *Cricetomys gambianus/emini*, *Galago senegalensis* among others. Notable flora species including some globally rare plant species (Black Star species) in the forest reserve are *Afrosalsaligia afzelia*, *Chrysophyllum azaqvieaie*, *Cynometra ananta* and *Dideloticiuidae* spp.

It is also recognized as an Important Bird Area (IBA) globally as habitat for the conservation of bird populations. Three globally-threatened bird species are known to occur in this forest- the "near threatened" hornbill *Ceratogymna elata*, the "vulnerable" greenbulls *Bleda eximius* and *Criniger olivaceus*, which are uncommon but characteristic of this type of primary forest (Dowsett et al., 2005).

### Research problem, purpose and objectives

Despite this high biological diversity, the ecological integrity of the reserve, including the forest quality and extent is increasingly threatened by human activities. Farming along the fringes of the forest is reducing the size of the forest buffer. Illegal logging, illegal mining, charcoal production and wildlife poaching are also on the rise within the forest and along its boundaries. Recent discovery and production of offshore oil and gas in the Western region of Ghana is increasing the pressure on land around the periphery of the forest for establishing large scale oil and gas facilities. Furthermore, land use conversion from forestry to perennial tree crops is accelerating deforestation and degradation of the peripheral areas of CTPFR resulting in replacement of natural forests by monoculture stands, primarily of rubber and oil palm.

These pressures are mounting at a time when communities fringing the forest have no feeling of ownership of the forest but only perceive it as government owned. Yet, communities, mainly

from the Ahanta and Nzema ethnicities have a strong stake in the forest reserve as they continue to depend on forest ecosystem goods and services for survival. Local communities also regard the forest reserve as home of ancestral spirits who provide protection and success.

The purpose of this research is to assess the current status of the Cape Three Points Forest reserve and the adjacent mangrove wetlands through the analysis of spatial data in order to inform development of a management action plan to protect the forest and the mangrove ecosystems.

Specifically, the research sought to;

1. assess changes in land cover within the management area over time
2. map out the current extent of mangroves in the management area
3. delineate different zones within the management area

## 2.0 Materials and Methods

### Management Area

The Cape Three Points Management area lies between latitude 4° 44 and 4° 56 North and longitude 2° 12 and 1° 55' West. The management area covers 34,864.55 hectares and comprises the Cape Three Points Forest Reserve (which is approximately 51.12 km<sup>2</sup>) and the adjacent mangrove ecosystems. There are a number of communities fringing these ecosystems. Eleven of these fringing communities constitute the Cape Three Points-Princess Town Community Resources Management Area (CREMA). These communities are Animakrom, Adalazo, Seremowu, Nkwantanan, Asuboe, Princess Town, Aketakyi, Cape Three Points, Ketakor, Akwidaa and Akyinim

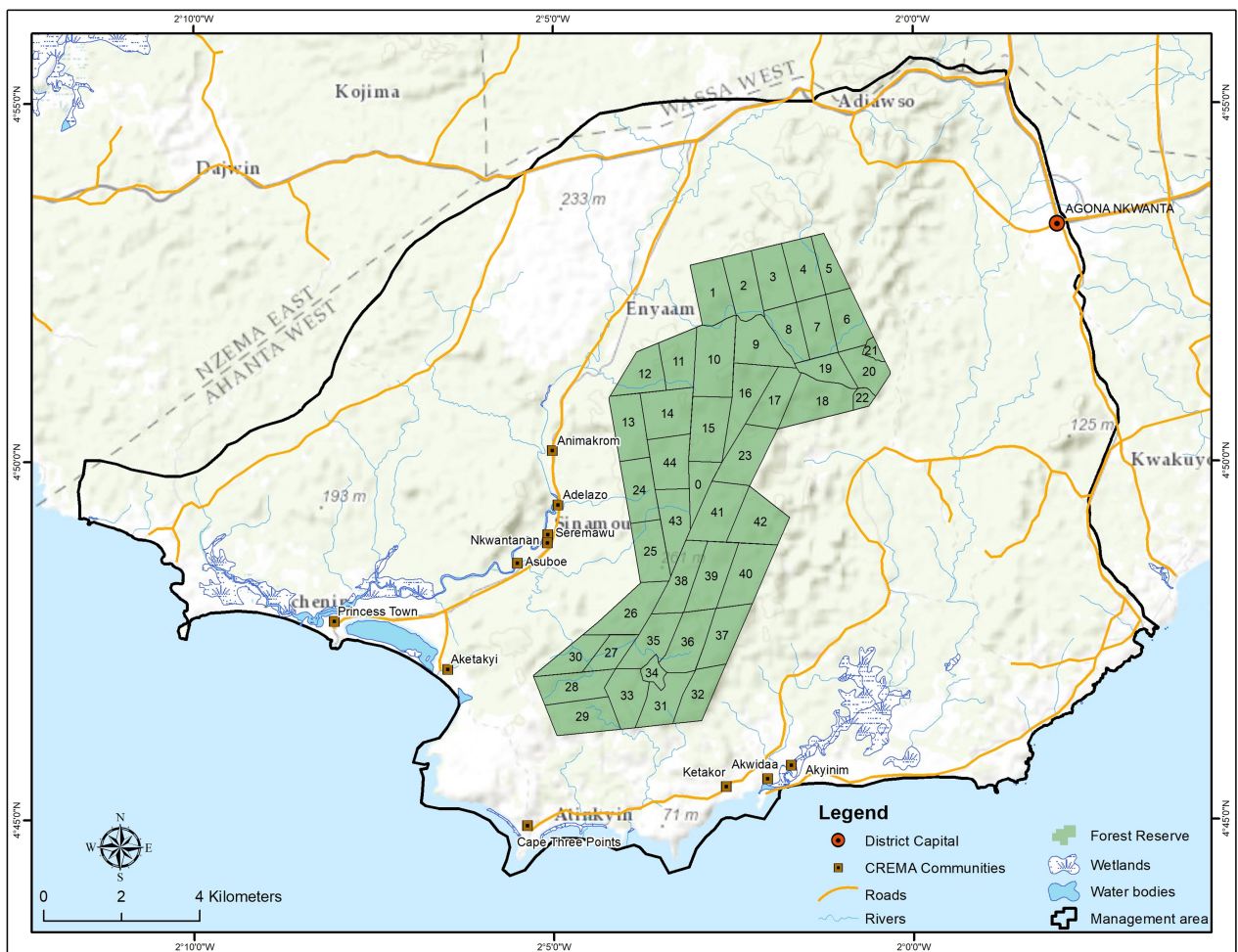


Figure 1: Cape Three Points Management Area



## **Cape Three Points Forest Reserve and Mangrove ecosystems**

The Cape Three Points Forest Reserve lies between latitude 4° 53' and 4° 46' North and longitude 2° 00' and 2° 05' West. The reserve derives its name from three promontories, which lay some 2.5km of its southerly boundary. It is a compact block of forest, which has the Abora-Aketakyi road to the west, the Abora-Agona Nkwanta road to the north and northeast and the Agona Nkwanta-Akwidaa road to the west. The total area of the forest reserve is 5112 ha. There are about seven admitted farms within the reserve with a total of 0.77km<sup>2</sup>.

The Cape Three Points Forest Reserve is surrounded by habitat corridors with coastal wetlands. The forest is traversed by small tributaries which feed the Nyan River on the western side and the Ezile River on the eastern side. Mangroves cover the estuaries and banks of these 2 major rivers. Other water bodies like the Ehunli lagoon and other ponds and lagoons are covered with mangrove. The mangroves provide ecosystem goods and services including protecting the coastline from tidal waves and storm surges; acting as biological filters in polluted coastal areas; supporting aquatic food-chains; and shielding a large number of juvenile aquatic organisms

## **Data**

### **Remote Sensing data**

The multi-temporal data was acquired from the Landsat Satellite constellation to analyse changes in Land use land cover (LULC) between 1986 and 2016. The 2 satellite images used were Landsat 5 Thematic Mapper (TM) data from 1986 and Landsat 8 Operational Land Imager (OLI) data from 2016. The two Landsat data both have a resolution of 30 meters.

Another remotely sensed data used in the study was true colour orthorectified digital aerial photo (AP). The digital AP was acquired in 2005 and has a spatial resolution of 0.5 meters. In areas where there were data gaps, the project deployed Unmanned Aerial Vehicle (UAV) technology to collect additional data in 2019 to fill the identified spatial data gaps.

The characteristics of the four data sets are shown in Figure 1 below.

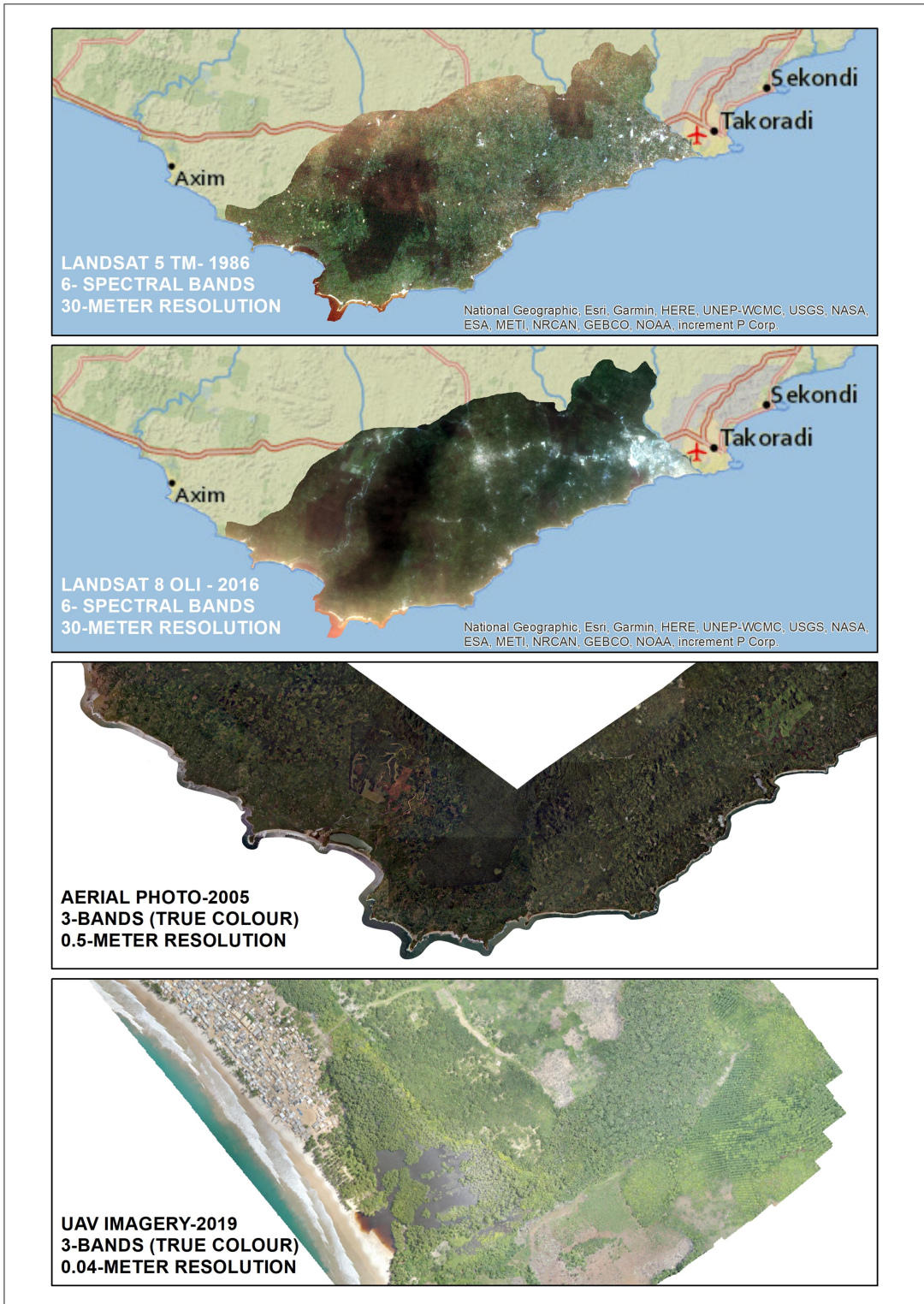


Figure 2: Characteristics of remote sensing data used for the assessment

## **Ancillary data**

Other ancillary GIS data like shapefiles of the streams and rivers in the study area were used in the study.

## **GPS Survey data**

A GPS survey of mangrove sites was conducted at the study site. Handheld GPS devices and other mobile devices were deployed to collect in-situ data on the current status of mangroves. The GPS data was collected in March 2019.

## **Data processing and analysis**

### **Participatory mapping of mangroves**

The assessment was carried out using participatory mapping processes. This involved the use of digital orthophotos of the management area taken in 2005 by Ghana Survey Department. In addition to the images, other ancillary data like shapefiles of rivers and wetlands were deployed in this mapping exercise. The images were printed at a scale of 1:15,000 on A0 (33.1 X 46.8 inches) canvas material.

In each of the communities involved in the mapping exercise, residents and other stakeholders were mobilized to participate. The selected communities were Akwidaa, Akyinim and Princess town. These are the communities with the highest concentration of mangrove ecosystems. With the help of permanent markers, residents delineated mangrove extent on the maps based on discussions and consensus among them.

The maps were photographed and geo-referenced into a GIS software environment. Using visual interpretation and guided by the result of the participatory mapping, the extent of mangroves and other targeted features were digitized off the 2005 orthophotos and UAV images. In addition, GPS survey of the area was conducted to ground truth and to validate the participatory mapping. The ground truthing exercise involved community members who relied mostly on the mangrove ecosystem for their livelihood. Community assistants and data collectors surveyed specific areas within the wetland with Garmin GPSMAP64 handheld GPS units and mobile devices running the Geo Tracker App. Data from the field were used to validate the results of the participatory mapping.



Figure 3: Participatory mapping process with community members

**Land Use land Cover Analysis**

Land use land cover (LUCC) maps were derived from the 2 Landsat time series images (1986 and 2016). Both images were geometrically corrected and re-projected into UTM zone 30N. The area of interest (Ahanta West municipal) was then subset and enhanced.

Using supervised classification method (maximum likelihood) in ArcGIS 10.6.1 software, both images were classified into 7 main classes (Cropland, Artificial areas, Rainforest, Wetlands, Water bodies, Cash crops and Shrubland/Sparse vegetation) to provide a basis for the analysis of land use land cover change. Microsoft Excel was then used to calculate the change in the land use land cover classes over the 30 year period.

Table 1: Description of Land use Land Cover classes

LULC CLASS NAME	CLASS DESCRIPTION
<b>Cropland</b>	Farmed lands (plantain, cassava, maize), recently cleared forest and recently planted rubber farms
<b>Artificial areas</b>	Cover resulting from human activities such as urban development, extraction or deposition of materials. This includes urban areas, villages, paved/unpaved roads, car/lorry parks, bare lands, playing fields
<b>Rainforest</b>	Usually tall, densely growing, broadleaved evergreen or semi-deciduous forest.
<b>Wetland</b>	This represents areas with vegetation cover which is either flooded permanently or for during a particular season with saline, fresh or brackish water.
<b>Water body</b>	Areas covered by natural water bodies such as ocean, lakes, ponds, rivers or stream
<b>Cash crop</b>	Mature rubber and palm trees located mostly in plantation farms
<b>Shrubland/Sparse vegetation</b>	Short tree species or woody vegetation smaller than 5 meters in height and non-tree vegetation such as herbs and grasses.

### 3.0 Results

This section presents the result of the assessment and provides some discussions for each one of them. It is organized to address the three specific objectives of the assessment.

#### Land use land cover (LULC) Assessment

##### *Past Landscape*

The landscape of Ahanta West municipal in 1986 was generally characterized by vast areas of croplands interspersed with isolated settlements. Over 66% of the municipality had either been cultivated once or was under some form of farming. The municipal had 9,526.32 hectares of rainforest which included the Cape three points forest reserve and the surrounding buffer zone. The rainforest constituted 16.16% of the landscape. Connected to the rainforest were coastal wetlands, particularly mangrove forests, which extended from the estuaries of major rivers in the municipality. At the time, cash crops covered an area of 5,035.95 hectares, constituting 8.54% of the entire mapping area. Major plantations were confined to the northwest and east of the reserve and also the northeastern section of the municipal.

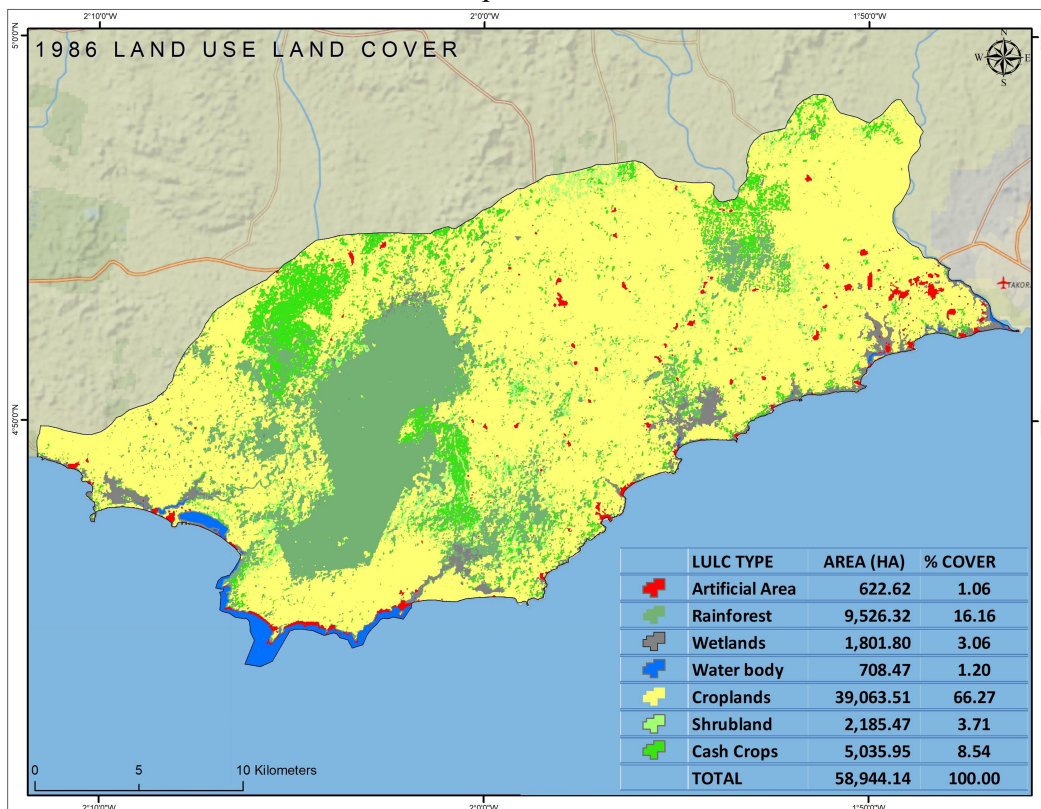


Figure 4: Past land use land cover of the Ahanta West Municipality

***Present Landscape***

The land use land cover information extracted from the 2016 imagery is a true reflection of the landscape during the time of the assessment. The present landscape is characterized by significant areas of settled (artificial) areas and cash crop plantations. Both the distribution and extent of rubber and oil palm plantations changed significantly. Over 21% of the municipality is currently covered with cash crops. Rainforest, on the other hand covered a total area of 5,181.93 hectares, constituting 8.79% of the mapped area.

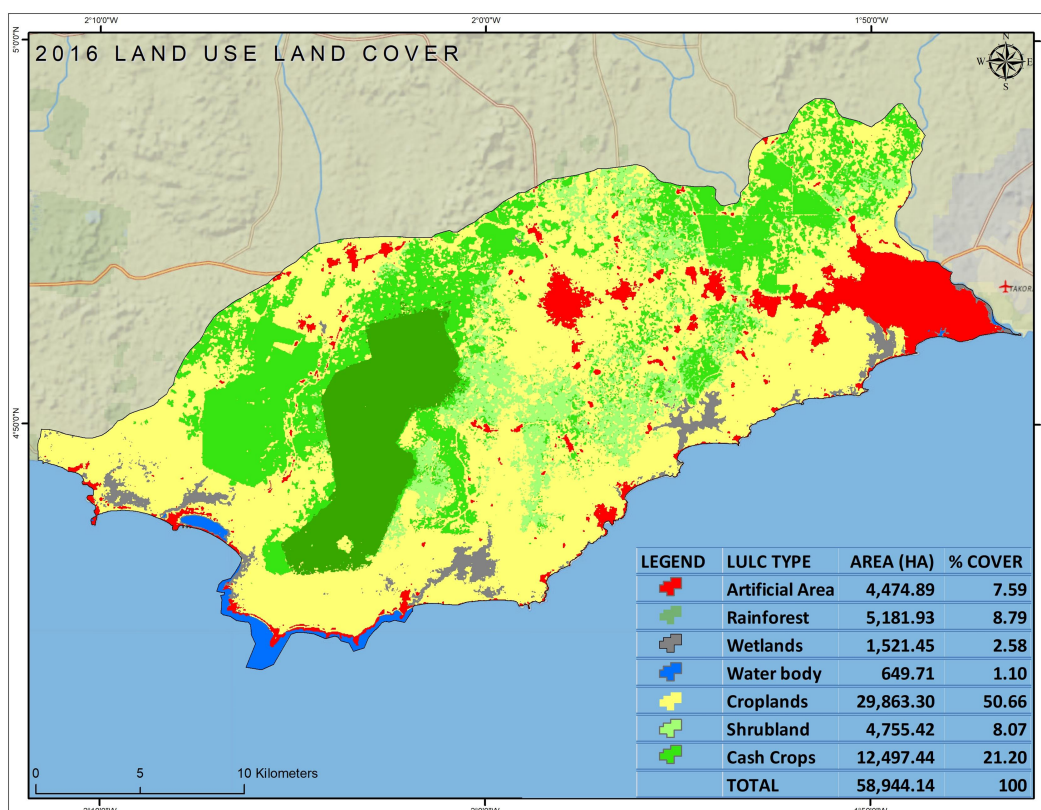


Figure 5: Present land use land cover of the Ahanta West Municipality

***Changes in Past and Current Landscapes***

The entire municipality (where the management area is a subset) has gone through tremendous transition over the 30 year period under investigation. Significant changes that have occurred on the landscape could be linked to rapid urbanization and economic activities such as large scale cash crop plantation. These drivers have had considerable impact on the Cape Three Points forest reserve and adjoining wetlands.

Table 2: Changes in Land use land cover classes from 1986 to 2016

LULC TYPE	1986		2016		% CHANGE
	AREA (HA)	AREA (%)	AREA (HA)	AREA (%)	
Artificial Area	622.62	1.06	4,474.89	7.59	618.72
Rainforest	9,526.32	16.16	5,181.93	8.79	-45.60
Wetlands	1,801.80	3.06	1,521.45	2.58	-15.56
Water body	708.47	1.20	649.71	1.10	-8.29
Croplands	39,063.51	66.27	29,863.30	50.66	-23.55
Shrubland	2,185.47	3.71	4,755.42	8.07	117.59
Cash Crops	5,035.95	8.54	12,497.44	21.20	148.16
<b>TOTAL</b>	<b>58,944.14</b>	<b>100</b>	<b>58,944.14</b>	<b>100</b>	

Between the period of 1986 and 2016, the total extent of rainforest reduced by more than 45%. Over 4,300 hectares of the rainforest has been converted to other uses, particularly for agricultural purposes. This has resulted in the complete depletion of the forest reserve buffer zone exposing the reserve and leading to encroachment. The analysis of the satellite images indicates possible encroachment along the northern boundary of the forest reserve. The depletion of the buffer zone has also led to the fragmentation of the wildlife habitat. The ecological corridor which existed and aided movement of wildlife between the reserve and the wetland/mangrove ecosystems has been significantly altered. Mangrove ecosystems are known for the associated biodiversity they support. They are well noted for the provision of habitat for high concentrations of birds, mammals, amphibians, reptiles and inveterate species. They also serve as habitats, sanctuaries and breeding grounds for migratory birds. The replacement of the riparian forest and natural forest buffers by monoculture stands, primarily of rubber and oil palm might have grave consequences on the abundance and distribution of biodiversity.

### Status of Mangrove Ecosystems

Mangroves are an assemblage of tropical and sub-tropical halophytes (salt tolerant) woody plants which grow in loose wet soils of brackish-to-saline estuaries and shorelines in the tropics and sub-tropics (Aheto et al, 2011; Heumann, 2011). In the Cape Three Points management area, mangroves are found along the estuaries of the 2 major rivers, namely Nyan and Ezile. Other mangrove forests are located along the banks of streams and lagoons. A total of 554.93 hectares of healthy mangroves were mapped. Four species of true mangroves and some mangrove associates such as acrosticum were identified. The true mangrove species identified were *Avicenia germinas*, *Rhizophora mangle*, *Laguncularia racemosa* and *Conocarpus erectus*.

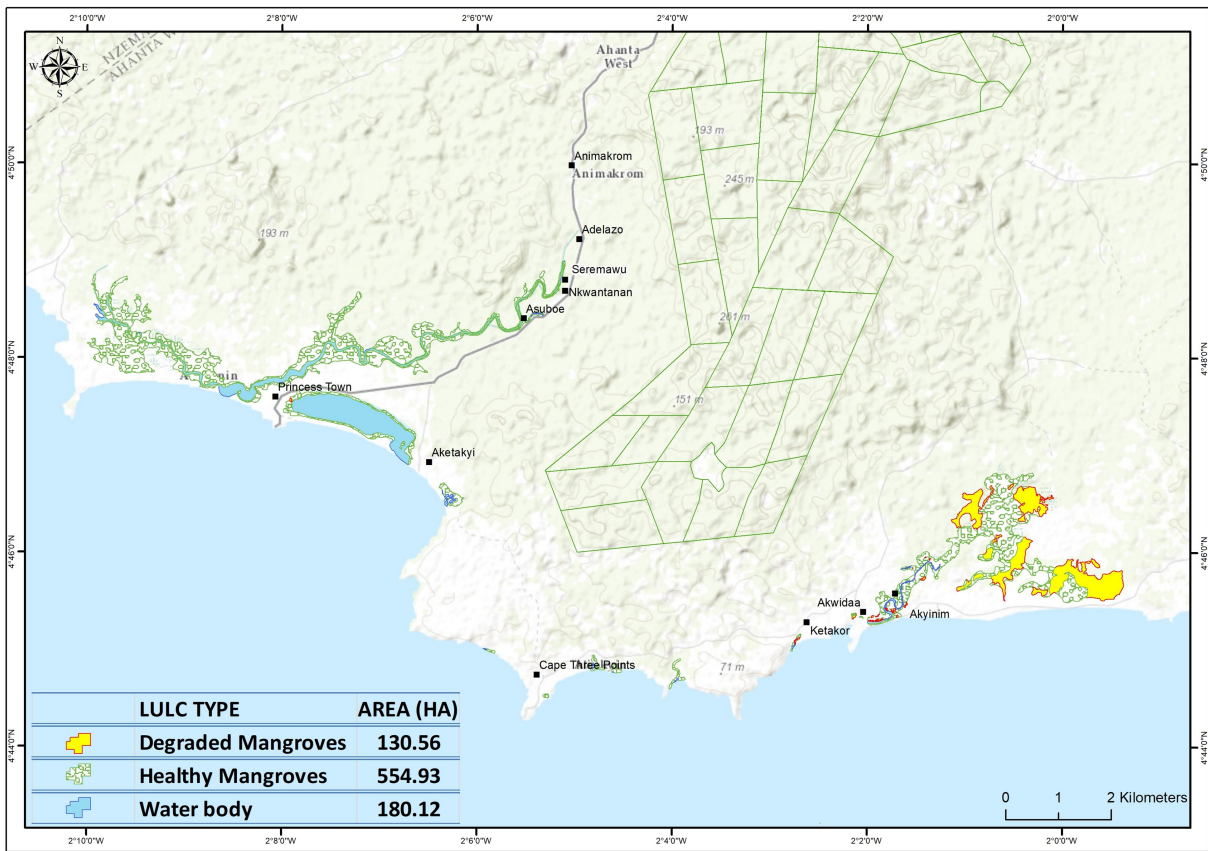


Figure 6: Distribution and extent of mangroves in the management area

People who live in mangrove areas get wood (for fuel, building materials, etc), fish, crabs, snails and oysters either directly from mangrove or its associated environment (Gordon and Ayivor, 2003; Spalding et al, 2010, Ajonina, 2011). Over the years, mangroves have been exploited by the local populations mostly for fuel, building construction and charcoal production. Over the past decade, the management area has lost a total 130.56 hectares of healthy mangroves through natural and anthropogenic factors. The degraded mangroves represents about a fifth (19%) of the area previously covered with mangroves leaving 554.93 hectares of mangroves intact. Mangrove exploitation is more predominant in the western section of the management area than the eastern. The Ezile River, for instance has lost 130.17 hectares of the mangroves already. The Nyan River and the Ehunli lagoon have rather experienced minimal exploitation of the mangrove forest.



## Management Zones Description

Despite the threat to the quality and extent of the forest reserve and the mangrove ecosystems, the Cape Three Points management area could still be the home of biologically rich and diverse ecosystem if the right management actions are taken. To contribute to management decision-making within the management area, the study attempted delineate different management zone and discuss possible actions that could be taken within those zones.

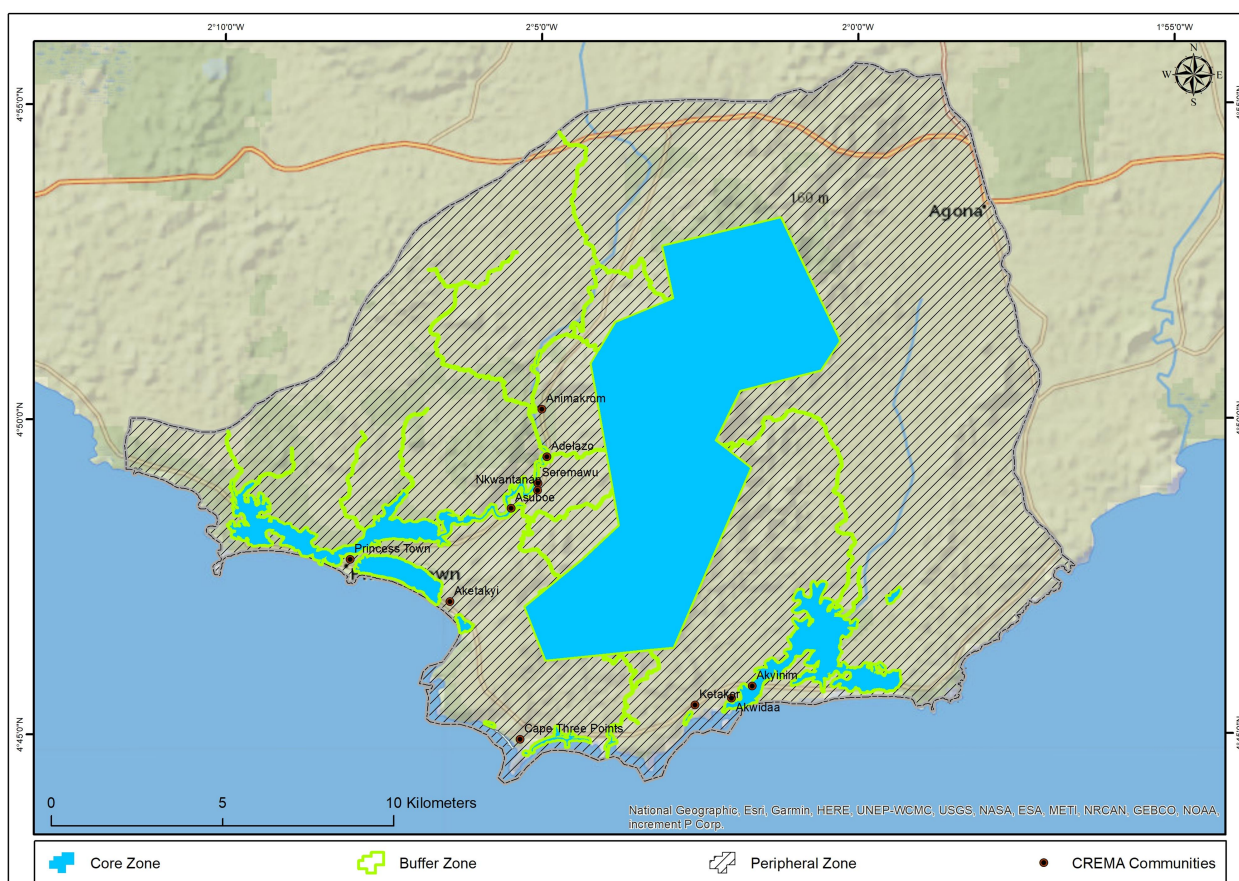


Figure 7: Map showing different management zones within the management area

In order to sustain the health and integrity of these important ecosystems and to restore the ecological connectivity between the reserve and the adjoining wetlands, three (3) management zones were delineated. These are the core, buffer and the peripheral zones.





### Core Zone

This zone covers the remaining block of rainforest as well as all water bodies. The zone also encompasses wetlands vegetation, wet soils, slopes and vegetative cover within 300 feet

measured from the bank of the main river channel. It is a fully protected zone. No logging or harvesting will be permitted in this zone.

## **Buffer Zone**

The zone encompasses a 10-meter forest buffer around the reserve, the mandatory river buffer zone and all other wetland areas outside the Core zone. The mandatory river buffer zone is a land area on or contiguous to the main river channel or wetland that shall be retained in its natural or undisturbed condition. According to the recommended design standards for Riparian Buffer Zones, the following buffer widths are recommended;

-  **Minor perennial streams:** 10 to 20 meters
-  **Important seasonal streams:** 10 to 15 meters
-  **Streams within forest reserves:** 10 to 50 meters
-  **Wetlands:** 30 meters around the perimeter as defined from the high water elevation.

## **Peripheral Zone**

The peripheral zone comprises all the remaining part of the management area outside the Core and Buffer zones.

## 4.0 Conclusion

The Cape Three Points management area has undergone tremendous land use land cover transitions over the past 3 decades. The land use land cover analysis and the participatory mapping revealed that over 4,300 hectares of the rainforest have been converted to other uses; additional 130.56 hectares of mangroves have also been lost. The pressure on the landscape to support the burgeoning population and their economic activities has not only affected the health and extent of the Cape Three Points forest reserve, but also the ecological connectivity between the reserve and the adjoining coastal wetland and mangrove forests. Management actions specifically for protecting the remaining rainforest and mangrove ecosystems are urgently required to safeguard remaining ecosystems and to assure continuous flow of wildlife along this corridor.

### Recommendation

Based on the results of the assessment, the management area has been demarcated into 3 zones. Regulations for these zones will be different but complementary in many ways thereby ensuring a coherent set of operational rules for protection of the entire landscape. Recommended actions that can be taken in each management zones are explained below.

**Core zone:** This zone is fully protected and comprises the forest reserve and the mangrove ecosystems in the management area. Actions in this zone should be consistent with strict protection of the reserve, mangrove forests, associated vegetation and water bodies.

**Buffer zone:** The Buffer zone is partially protected. Permits are required for harvesting trees in this zone. The allocation of permits and harvesting quotas can be supervised by community resource management committees (CRMCS) using powers conferred on them through district byelaws and traditional authorities. Potential rules will include minimum cutting size restrictions; rotational harvesting cycles, felling restrictions, sustainable resource exploitation among others.

**Peripheral zone:** This zone will have minimal protection and will allow for wise use practices including conservation and best management practices.

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**Photo Gallery**



**Satellite image showing admitted farms in the reserve**



**Rubber plantation sharing boundary with the forest**



**Land Use Land Cover assessment of Cape Three Points Forest and linked ecosystems: Assessment Report**



**Exit route for transporting carved logs (canoe) from the reserve**



**Logged and abandoned timber within the forest reserve**

**Land Use Land Cover assessment of Cape Three Points Forest and linked ecosystems: Assessment Report**



**Aerial photo showing the devastating effect of illegal mining in the wetlands**



**The forest canopy as captured by a drone**



**Land Use Land Cover assessment of Cape Three Points Forest and linked ecosystems: Assessment Report**



**Logged and abandoned timber within the forest reserve**



**Healthy mangrove stands lining the banks of the Nyan River**