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ASSESSMENT OF FLORA AND FAUNA OF ECOLOGICAL AND SOCIO-ECONOMIC SIGNIFICANCE WITHIN THE ANLO BEACH WETLAND COMPLEX FOR IMPROVED MANAGEMENT AND LIVELIHOOD OUTCOMES

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Cover photo: Fisherman from Anlo Beach casting net to obtain fish samples for researchers.
Photo credit: Cephas Asare

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EXECUTIVE SUMMARY

The failure to recognize and account for the ecological and socioeconomic functions of the Anlo Beach Wetland Complex has led to varying intensity of degradation in various parts of the wetland. This study utilized spatial and ecological techniques to establish the status of the wetland in order to propose sustainable management and conservation strategies. Socioeconomic surveys involving 200 respondents were also taken into account to estimate the direct, indirect as well as existence/option values of the wetland. The results show an annual lower bound value of services of the total forest area estimated over $ 1 million. This aggregate value stems from consumptive uses in the form of wood extraction and non-consumptive uses such as fish nursery, biodiversity functions, and flood protection including future potential uses e.g. recreational and pure existence values. Despite the ecological and socioeconomic benefits, the mangrove cover is threatened. Over a period of twenty years (1994-2014) mangrove area decreased from 594.60 to 517.90 hectares amounting to 15% loss. Mean height and tree diameter of most dominant mangrove species (*Avicennia germinans*) was 2.5 m and 2.5 cm respectively. These suggest low structural development of the mangroves. The development of saltpans is another contributory factor to mangrove wetland degradation. Indeed, the wetland also serves as an important habitat and ecological niche for important juvenile marine, brackish water and freshwater fish species. The continued destruction of the wetland could therefore affect the recruitment of juvenile fish species into the adult population with severe ramifications for local livelihoods. We conclude that the use of mangrove wetland resources in its various forms do not follow a sustainable path on account of ecological and socioeconomic considerations. We recommend the district assembly to play a more active role in mangrove management beyond the development of bye-laws for the wetland. In particular the marine and coastal management sub-committee must collaborate with the Anlo Beach traditional council to develop a sustainable management framework that takes into account open and closed access areas for mangrove exploitation and the designation and creation of afforestation areas. The creation of supplementary livelihoods is central to the process.

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1.0 INTRODUCTION

1.1 Project Goal and Objectives

The Anlo Beach wetland in the Western Region of Ghana is threatened by degradation despite its immense ecological functions and socio-cultural values to the community. This situation has been precipitated as a result of the over-exploitation of mangrove wood for fish smoking, dumping of solid waste as well as bad fishing practices. Unfortunately in Ghana, not much has been achieved in terms of ecological and social assessment studies on wetlands that could inform participatory management and conservation of wetlands in the country. This study was undertaken against this background with the aim of providing scientific baseline data on mangroves and fisheries of the wetland that could be useful as part of information required for developing a broader wetland management plan for Anlo Beach. Specifically, the information gathered in this report will:

- facilitate the creation of local institutions for conservation
- improve wetland management practices
- improve livelihoods in riparian communities
- deepen stakeholder participation in land use planning at the district level
- help mangrove restoration efforts
- lead to better managed areas through developing social norms that prohibit over-exploitation of wetland resources
- help to formulate management plans and community action plans
- assist community leaders specify roles and responsibilities of stakeholders and land use policies that recognize and reserve the wetland for conservation

In order to be able to achieve the issues raised above, the assessment utilized integrated methodological approaches involving:

I. Use of aerial photographs to facilitate participatory mapping of the wetland resources in general
II. Identification of the geographical locations of the mangroves wetlands in particular (lattitude and longitude, boundaries and size of the wetlands).
III. Determination of the biological diversity (richness and evenness), abundance of the mangrove species, and estimation of their threatened status

IV. Estimation of the water quality parameters
V. Determination of the fisheries composition and biodiversity
VI. Identification of the socio-economic values of the wetlands to the fringe community

1.2 Mangrove wetlands

According to the International Union for the Conservation of Nature (IUCN)(1989), mangrove wetlands include one of the most threatened of the world's ecosystems. Climate change and demands placed by humans on mangrove natural resources through unsustainable use have resulted in rapid changes and decline in their biodiversity. Consequently, this has significantly reduced the capacity of the ecosystems to provide the needed goods and services that are required by humans. Mangroves are coastal forests found in sheltered estuaries and along river banks and lagoons in tropical and sub-tropical countries. Mangroves are highly specialized plants that have developed unusual adaptations to the unique environmental conditions in which they are found. Being woody halophytes which grow in loose wet soils of brackish to saline estuaries and are found along shorelines, they are thus subjected to tidal influences. Infact, the current estimate of mangrove wetlands in the world is less than half of what it once was (Spalding et al., 1997; Spiers, 1999) and much of what remains is in a degraded condition (Giri et al., 2010). In Ghana, most of the physical losses have been attributed to rapid urbanization and widespread poverty in coastal areas (World Bank, 1992), improper waste management practices and toxicity due to heavy metals and the absence of observable value for many of its goods and services because they are not traded on markets. Regardless, mangroves directly support local subsistence by providing timber for building and wildlife for food. Indeed, mangrove resources have been increasingly subjected to exploitation for agricultural purposes while chemical and biological degradation have been subtle over the long term. In addition, there is a lack of political commitment and institutional capacity to invest in the critical monitoring and rehabilitation of mangrove resources in the country (Aheto, 2011).

Worldwide, 20 families, 27 genera and an estimated 70 species of mangroves have been documented (Alongi, 2002) of which mainly three genera namely Rhizophora, Avicennia and Laguncularia have been discovered in Ghana (Aheto, et. al., 2011). In terms of distribution, a study by Giri et al. (2010) revealed that the total mangrove forest globally in 2000 was 137,760 km^2 with the largest extent found in Asia (42%), followed by Africa (20%), North and Central America (15%), Oceania (12%) and South America (11%) with the total mangrove area accounting for 0.7% of total tropical forests of the world.

Despite this limited value, mangroves fulfill a range of important ecological and socioeconomic services. They are among the most productive and biologically important ecosystems of the world. They stabilize shorelines and reduce the devastating impact of natural disasters such as tsunamis, hurricanes and forms of coastal erosion. Aside providing fuel and building materials for local communities (Giri et al., 2010), mangroves wetlands also support the conservation of biological diversity by providing habitats, spawning grounds, nurseries and nutrients for a number of aquatic organisms. These include a range of endangered species of amphibians and reptiles. Also, a wide range of commercial and non-commercial fish and shellfish of commercial value also depend on these coastal forests.

2.0 MATERIALS AND METHODS

2.1 Study Area

Anlo Beach is a relatively small fishing community in the Shama District of the Western Region of Ghana (Figure 1). Statistics from the Planning Unit of the Shama District Assembly indicate a population of 2,231 comprising 1,028 males and 1,203 females (CRC/FoN, 2010). The landscape is mainly flat with no hills nor elevations within the vicinity of the community. The shoreline is characterized by curved sandy beach and the ocean areas are open with pounding surf. It is precariously sandwiched between the wetlands and the sea with the widest breadth being approximately a hundred (100) metres separating the two water bodies (CRC/FoN, 2010). This study was conducted within one of the wetlands along the southern part of the Pra River in the Shama district. The site is located between latitudes 50 1' 30"N and 50 3' 5"N, and between longitudes 1°34'30"W and 1°37'30"W and comprises relatively disturbed mangroves on both sides of the major road that connects the fringing communities to the market center. Communities surrounding this mangrove site are Anlo Beach, Krobo, Fawomanye and Bosomdo.

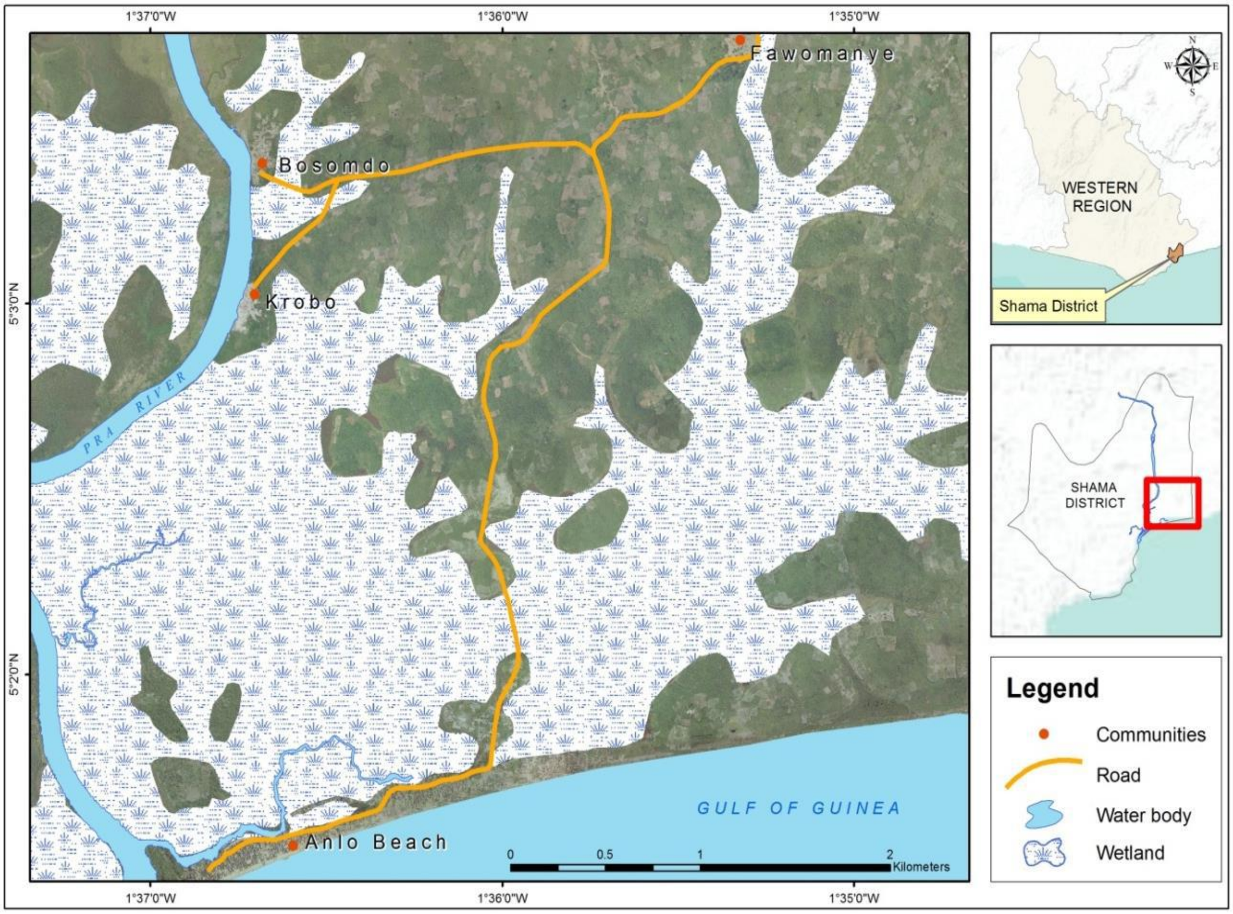

Figure 1: Map of the study area

2.2. Geographic Assessment

A true color ortho-rectified digital aerial photo was the main remote sensing data that was used for the mapping. The digital orthophotos were acquired in May 2005 by Ghana Survey Department and have a spatial resolution of 0.5 meters. Other ancillary GIS data-like shape files of the Pra River and its major tributaries, contour and roads were all sourced. A combination of GPS survey and participatory approaches were adopted for the mangrove mapping. The two approaches were necessary because of the unavailability of historical data for the area. The combined approach did not only help in mapping the past and present mangrove extent, but also to identify other land use and land cover (LULC) types in the area of concern.

The pre-processed orthophotos were mosaicked and subset to include only low-elevation areas where mangroves are likely to be found. A method similar to Fatoyinbo and Simard (2013) with the help of a 10 meter interval contour data set, all areas with elevations lower than 10 meters were first identified. A GPS survey of mangrove sites were conducted through a series of field visits from 17th May to 3rd July, 2014. The period for the field trips coincided with the raining regime of the area, making accessibility to certain parts of the forest very difficult. The survey of the mangrove forests was conducted with a Trimble Juno SB Handheld and Garmin Rino 530HCx GPS units. Locations of mangrove boundaries and other attributes like the mangrove species, and adjacent land cover were recorded. Preliminary mangrove maps were then generated (through visual interpretation of the digital orthophotos) based on the initial site visits and the result of the participatory mapping. Follow-up visits to some areas identified on the preliminary maps were conducted to validate the initial LULC map and to generate the final maps.

The participatory mapping was conducted in 2 communities around the mangroves, Anlo Beach and Krobo. The two communities were chosen because of their proximity to the mangroves. The Digital orthophotos were printed at a scale of 1:4000 on 2 glossy 33.11” x 46.8” (A0) papers. The exercise involved elderly men and women as well as some youth who had lived in the communities for over 20 years and were exposed to the mangroves either through their occupation or other mangrove related activities. Members of the two communities were guided to delineate and map out the past and the present mangrove coverage as well as the other land cover types (Figure 2). Aside mapping the current and the past mangrove extent, the informants were asked questions bordering on a number of mangrove-related issues including the benefits the community derive from the mangrove products and the associated environment; the causes of mangrove degradation in the past and what the current threats to mangroves were. It was observed among other things that the women in Krobo community depended largely on the harvesting of periwinkles for their livelihood. The maps were later scanned, geo-referenced and digitized to complement the effort from the GPS survey.

Figure 2: Community members mapping out past and present mangrove coverage and land cover types

2.3 Fisheries Survey

Fish samples were obtained from the catches of fishermen. The fish samples were preserved in ice and transported to the laboratory at the University of Cape Coast for further examination. The fish were sorted and identified to their families and species using manuals and keys on finfishes and shellfishes in Ghana and West Africa (Rutherford, 1971; Schneider, 1990; Dankwa, Abban and Teugels, 1999; Paugy, Leveque and Teugels, 2003). The fish specimens were also weighed using an electronic scale and hand held balance (for heavier fish) and length measurements taken using measuring board. The total length (TL) and Standard length (SL) of finfish; carapace width (CW) of crab, and Body length of prawn specimen were measured to the nearest 0.01cm and each fish specimen weighed to the nearest 0.01g and recorded. The Standard length of finfish was measured from the tip of the snout to the base of the caudal fin and the total length measured from the tip of the snout to the end of the caudal fin. Body length of prawn specimens were measured from the rostrum to the telson.

The origin of the fish species with respect to whether they are marine, brackish or freshwater was also documented in this study.

2.4 Mangroves Survey

Fifty by fifty meter plot at two sites were demarcated for the study. Sections were established using Garmin Rino 530HCx GPS .Five transects, 12.5 m apart were set perpendicular to the shoreline and five 5m x 5m areas were demarcated on each transect at 12.5 m intervals for sampling (Figure 3).

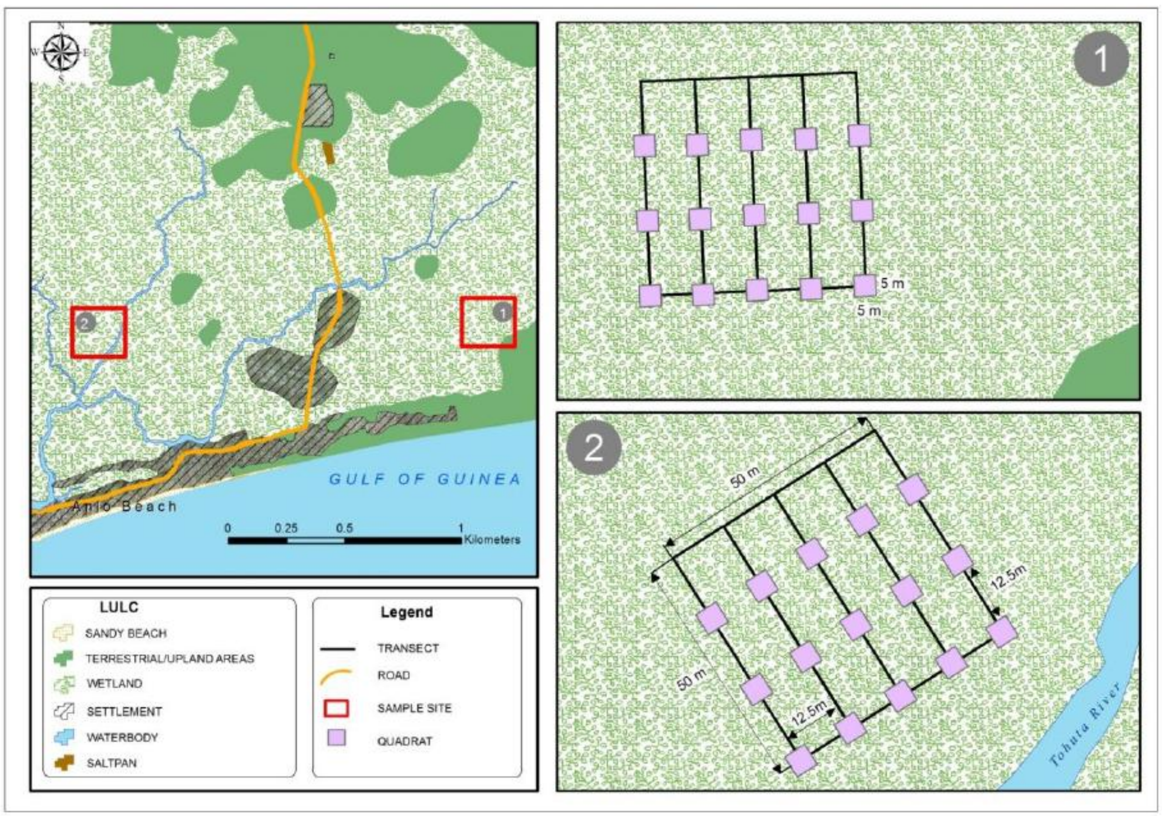

Figure 3: Map showing mangrove sampling locations

Samples of flowers, stems, leaves, fruits, silt roots, prop roots and propagules from the mangrove trees at both sites were used for mangrove species identification. Each species occurring in a quadrat was counted for the determination of species frequency, relative frequency, species composition (relative abundance) and relative dominance. The heights of all trees of each species in the quadrats were estimated using a 3 m pole with one meter markings. The diameter at breast height (DBH) of trees from each species was determined using digital vernier calipers (Figure 4). The mean tree height, the diameter at breast height and basal area of each species were computed. The density and importance value for each species were also calculated.

Figure 4: Researcher measuring DBH of mangrove trees

The density of mangrove tree species (Di), their basal area (B_A) and importance values (I_V) were calculated according to Cintronand Schaeffer-Novelli (1984).

***Density*:**

Density of mangrove species was calculated as the number of trees per sampling area (25 m^2)

$$D_i = n_i / A \qquad (2)$$

Where, D_i = Density of species i; n_i = Total number of species i and

A = Sampling area (5 m x 5 m)

***Basal area of trees*:**

Basal area is a product of pie (π) and the radius squared

$$B_A = \pi r^2 \tag{3}$$

Where r = D/2, D = Diameter at breast height and π = 3.142

***Frequency*:**

The frequency of a species was calculated by dividing the total number of individuals of that species by the total number of individuals of all species.

Frequency of species i = Number of individuals of species i / Total Number of individuals of all species

***Relative frequency*:**

The relative frequency of a species was calculated by dividing the frequency of that species by the summation of frequencies of all species, multiplied by 100 %.

$$(R_f) = (\text{Frequency of species i} / \sum \text{Frequencies of all species}) \text{ X } 100 \tag{4}$$

***Relative density*:**

The relative density of a species was calculated by dividing the density of that species by the summation of densities of all species multiplied by 100 %.

$$(R_d) = (\text{Density of species I} / \sum \text{Densities of all species}) \text{ X } 100 \tag{5}$$

***Relative dominance*:**

The relative dominance of a species was calculated by dividing the basal area of that species by the summation of basal areas of all species multiplied by 100 %.

$$(R_D) = (B_A \text{ of species i} / \sum B_A \text{ of all species}) \text{ X } 100 \tag{6}$$

***Importance Values*:**

The importance value (I_V) of a species is calculated by adding the values of relative frequency, relative abundance and relative dominance.

$$I_V = (\text{Relative frequency} + \text{Relative abundance} + \text{Relative dominance}) \tag{7}$$

2.5 Assessment of Aquatic Environmental Parameters

Aquatic environmental parameters were assessed based on measurements of Dissolved Oxygen (DO), pH, Salinity and Temperature using Horiba Water Quality Checker U-10). Water quality was assessed based on predetermined standards for critical standards. Measurements were made at the surface and mid-water at five locations namely Tsimini, Kodogoli, Mieza, Tohuta and Aburi (Figure 5). Analysis was based on mean and standard deviations of the parameters involved.

Figure 5: Water sampling locations

2.5 Socioeconomic Survey

Information was obtained from 200 randomly selected residents from different households in the community using formal questionnaire. Instructional sessions were organized for the research assistants prior to the main interviews. Data was gathered from respondents in June 2014 and covered the following:

- Demographic profile of respondents
- Places of origin

- Occupation
- Income levels (including also mangroves income)
- Local traditions/ taboos on wetlands
- Community management plans/ bye-laws on mangrove resource use
- Compliance to local rules/ regulations, etc.

Statistical evaluation of the responses was done mainly for frequency counts and percentages using Statistical Package for Social Sciences (SPSS) Software (Version 16.0).

Even though the Total Economic Value (TEV) of the wetland was not estimated in this study, some indication of the economic value of the mangrove wetland in particular was conducted with reference to the value components of the system namely the *Direct-use values, Indirect-use values, Option values and Existence values.*

The findings were analyzed by comparing two scenarios following Adger et al. (1995). In the first, forests are conserved at the present level, and provide a stream of goods and services including timber and non timber products, recreation, climate regulation, carbon sequestration, existence value and so forth. In an extreme alternative scenario, forests and the above benefit streams are absent.

The Total Economic Value is defined as the amount of resources, expressed in common units of money that society would be willing to sacrifice to avoid the move from situation 1 to situation 2, or, that society would be willing to accept as compensation if such a move were to take place.

Total economic value is given by the sum of a number of components (see Pearce, 1993):

Total Economic Value (TEV) = Direct-use value + Indirect-use value + Option value + Existence value (1)

Direct use values include revenues from timber and values of non-timber forest products. While timber values are not the main focus of interest of this paper, the sector is considered to have considerable commercial potential given appropriate management regimes.

Indirect-use values or "functional" values relate to the ecological functions performed by forests, such as global biogeochemical cycling, the protection of soils, and the regulation of watersheds.

Option value or quasi-option value (Arrow and Fisher, 1974; Henry, 1974) is the expected value of the information on the benefits of an asset, conditional on its preservation enabling an increase in the stock of knowledge relevant to the utilization of the asset. A frequently evoked example of quasi-option value is associated with genetic resources; for example, future pharmaceuticals developed from plant materials.

Existence value relates to the value of environmental assets irrespective of current or optional uses. Empirical measures of existence values based on donations to conservation organizations, or on the contingent valuation method suggest these can be a significant element in total economic value, especially in contexts where the asset has unique characteristics or cultural significance.

3.0 RESULTS AND DISCUSSION

3.1 Geographic assessment and participatory surveys

The application of traditional remote sensing approach for mapping mangroves is well documented. Traditional mangrove remote sensing typically involves the use of aerial photography and high resolution satellite image (i.e., spatial resolution between 5 and 100 m) and techniques such as visual interpretation, supervised and unsupervised classification of image (Green *et al*, 1998; Heumann, 2011). The combined approach of GPS survey and participatory mapping exercise (Figure 6) resulted in the generation of the past and present LULC maps. Aside mangroves, other land use and land cover types like wetland (including marsh and other wetland vegetation rather than mangroves); water body (the Pra River and its tributaries); settlement or built-up area; terrestrial/upland areas (including all high-elevated areas around the wetland where farming is predominant); roads; and sandy beach were also mapped.

Figure 6: Participatory survey (2014)

3.2 Past Land use and land cover

Due to the unavailability of historical data for the study area, a participatory mapping approach was adopted to understand and map out the past mangrove coverage and that of the adjacent land cover types. This exercise was conducted in Anlo Beach and Krobo. The participants were guided to delineate the extent of the mangroves as far back as 20 years ago (i.e. 1994). This is because one significant land use conversion that resulted in a massive loss of mangroves happened during this period - salt mining. Though the salt production was very short-lived, the indelible scar that it left to the landscape is very glaring. It was also gathered through the participatory mapping exercise that though the people of Anlo Beach exploit the resources in the entire wetland, the inhabitants of Krobo only rely on the mangroves and wetland resources in their immediate vicinity.

Table 1: Statistics of Past LULC (1994)

PAST LULC TYPE	AREA (Hectares)	PERCENT COVER
Bare area	19.4	1.1
Farms	806.0	45.3
Mangrove	594.6	33.4
Settlement	28.5	1.6
Water body	99.5	5.6
Wetland	226.5	12.7
Road	5.8	0.3
Total	1780.3	100.0

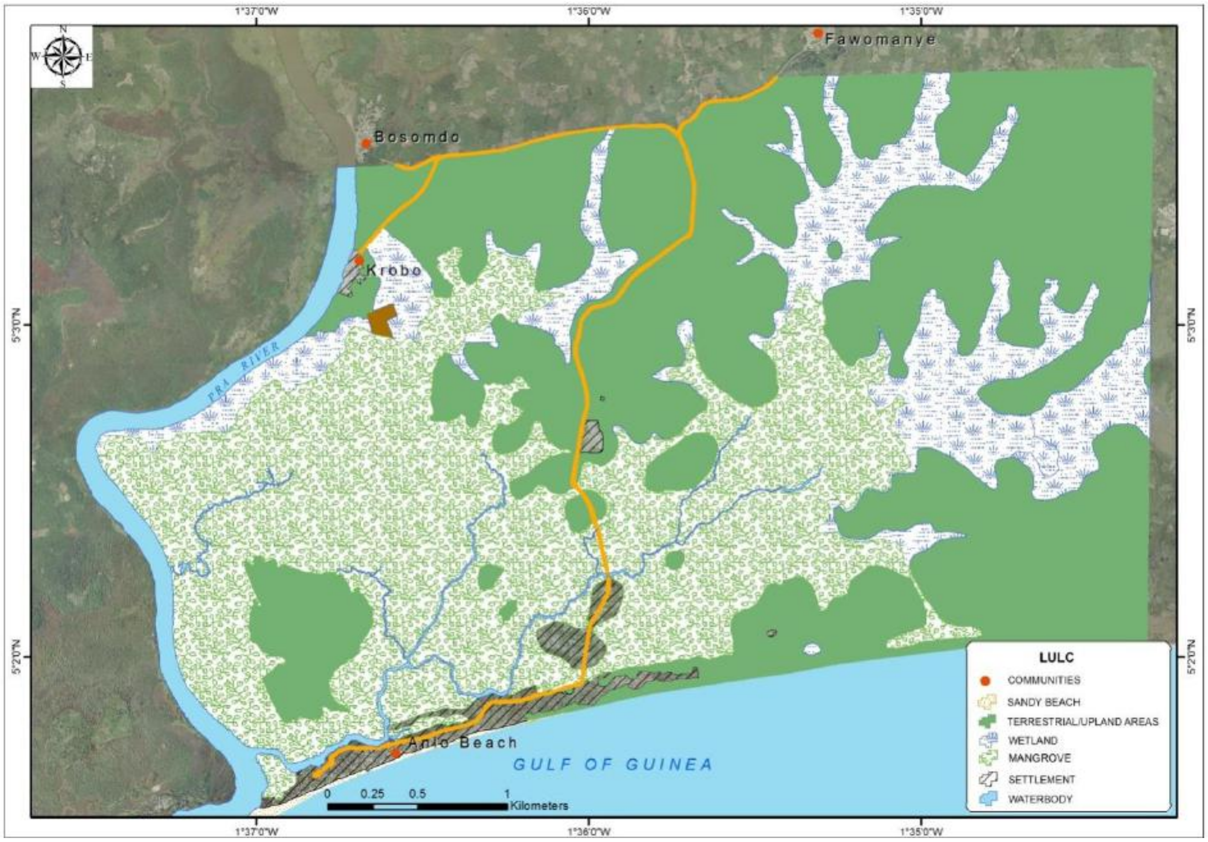

Figure 7: Past land use and land cover map (1994)

3.3 Present Land use and land cover

The current landscape is characterised by over 800 hectares of wetland separated by the only road that connects Anlo Beach to the other communities and the main market center (Beposo)(Figure 8). The wetland is watered permanently by the Pra River and some smaller rivers including the Tohuta, Aburi, Mieza, Tsimini and Kodogoli.

Table 2: Statistics of Present LULC (2014)

PRESENT LULC TYPE	AREA (Hectares)	PERCENT COVER
SANDY BEACH	19.4	1.1
TERRESTRIAL AREA	793.6	44.6
MANGROVE	517.9	29.1
ROAD	5.8	0.3
SALTPAN	5.6	0.3
SETTLEMENT	40.9	2.3
WATERBODY	98.8	5.6
WETLAND	298.2	16.7
TOTAL	1780.3	100

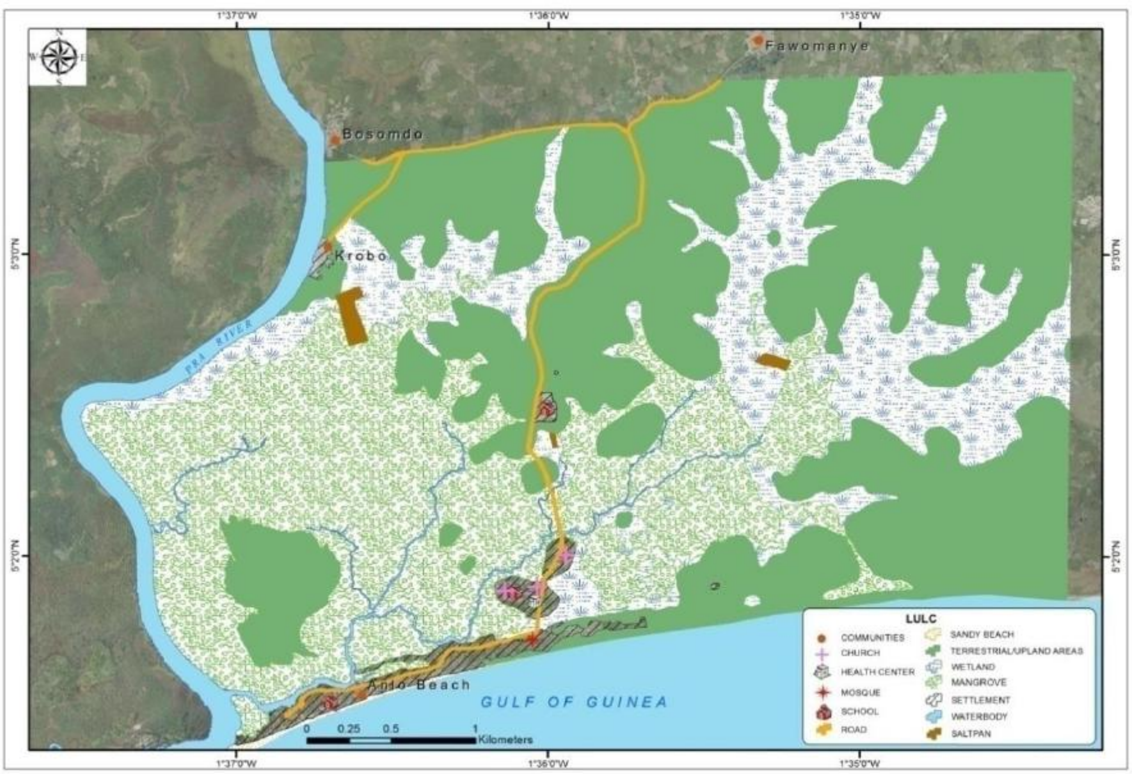

Figure 8: Present land use and land cover map (2014)

Currently, the mangroves cover an area of 518 hectares, constituting 64% of the entire wetland. They comprise scattered, discontinuous stands of disturbed mangroves mostly of the riverine type (Kathiresan & Bingham, 2001). The site has four mangrove species: *Avicennia germinans, Laguncularia racemosa, Conocarpus erectus* and *Rhizophora mangle*.

Also for the purposes of delineating land cover, a mangrove restoration area of 371.75 hectares was mapped out (Figure 9).

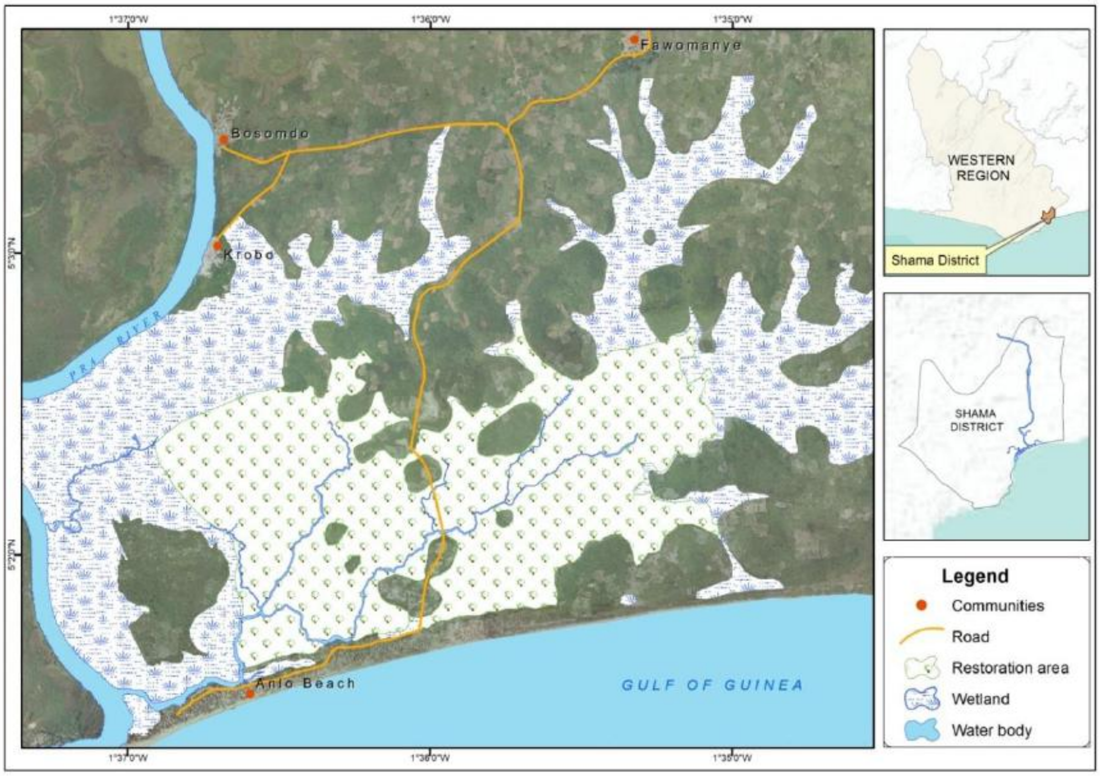

Figure 9: Mangrove restoration area

3.4 Change in Mangrove extent

The spatial dimension of the mangroves in the area of study has changed significantly over the period under consideration (1994- 2014)

Table 3: Mangrove coverage change (1994-2014)

Years	Mangrove Extent (hectares)	Change (Area)	Change (percent)
1994	594.6		
2014	517.9	(76.7)	14.8

Over 76 hectares of mangroves have been lost over the period, that is, an average of 3.8 hectares of mangrove was lost yearly. This loss constitutes 14.8% of the total mangroves that covered the area 20 years ago. The remaining 517.9 hectares of mangroves are short and very sparse (figure 10) with evidence of cutting at various spots. The loss could be attributed to excessive cutting by the surrounding community members for fuel (particularly the Rhizophora) and also the construction of 3 salt pans about 15 years ago. It was also observed that easy accessibility to the mangroves is a mojor contributing factor to the degradation of this important ecosystem leading to stunted and sparsely distributed trees.

Figure 10: Sparsely distributed mangrove trees in the Anlo Beach wetlands

3.5 Assessment of aquatic environmental parameters

Measurements of physico-chemical parameters of the five sampling stations are presented in Table 4. These sampling stations were the sites where fish were sampled. Dissolved oxygen levels of Kodogoli were relatively higher ranging between 4.55 and 7.32 mg/l with a mean of 5.54 ± 1.29mg/l whilst lower DO values ranging between 1.84 – 2.14 mg/l and a mean of 1.92 ± 0.11mg/l were recorded for Tohuta. The pH ranges of Tsimini, and Kodogoli were respectively determined as 4.63-6.0 and 6.28-6.95 whilst those of Mieza, Tohuta and Aburi were given as 7.07-7.23, 7.90-8.02 and 7.35-7.49. Low salinities of 0.21-0.86 ‰ and 0.43-0.89 ‰ were recorded for Tsimini and Tohuta, respectively. However, the salinity of Kodogoli ranged from 1.59-2.40‰ with a mean of 1.97± 0.36 with combined salinities of Aburi and Mieza ranging from 1.34-1.95‰.

Table 4: Physico-chemical parameters of the five sampling stations

Physico-chemical Parameters	Sampling stations				
	Tsimini (F1)	Kodogoli (F2)	Mieza (F3)	Tohuta (F4)	Aburi (F5)
Measured at Various Sites (F1-F5)	5°2'38"N , 1°35'35"W	5°1'55"N, 1°36'14"W	5°1'43"N , 1°36'58"W	5°2'31"N , 1°36'17"W	5°2'3"N , 1°36'34"W
Dissolved Oxygen (mg/l)	1.61 - 3.20* (2.30 ± 0.66)	4.55 - 7.32* (5.54 ± 1.29)	3.79 - 4.93* (4.32 ± 0.48)	1.84 - 2.14* (1.92 ± 0.11)	3.58 - 3.87* (3.76 ± 0.12)
pH	4.63 - 6.0* (4.98 ± 0.54)	6.28 - 6.95* (6.66 ± 0.31)	7.07 - 7.23* (7.13 ± 0.07)	7.90 - 8.02* (7.95 ± 0.05)	7.35 - 7.49* (7.42 ± 0.06)
Salinity (‰)	0.21 - 0.86* (0.62 ± 0.31)	1.59 - 2.40* (1.97 ± 0.36)	1.54 - 1.95* (1.75 ± 0.18)	0.43 - 0.89* (0.51 ± 0.19)	1.34 - 1.49* (1.43 ± 0.06)
Temperature (^{o}C)	29.1 - 30.0* (29.50 ± 0.3)	24.6 - 27.0* (25.80 ±1.1)	26.9 - 28.4* (27.67 ± 0.7)	31.5 - 31.8* (31.67 ±0.1)	26.8 - 27.1* (26.90 ± 0.1)

*= range with corresponding mean ± standard deviation in bracket

Dissolved Oxygen (DO) is a critical water quality parameter for estimating the health of aquatic systems. It is the measurement of oxygen dissolved in water which is available to fish and other aquatic life. The DO content of water results from photosynthetic and respiratory activities of the flora and fauna in the water as well as the mixing of atmospheric oxygen with the water through wind and stream current action. The result generally indicates low DO concentration at all sites ranging from 2.31-4.32 mg/l. The pH measures the hydrogen ion concentration of water. It provides a gauge of the relative acid or alkaline nature of the sample. The scale is logarithmic and therefore there is a tenfold change in acidity or alkalinity per unit change. For example, water with pH of 6 is ten times more acidic than water with a pH of 7. The values recorded occur witin tolerable limits for aquatic life. The salinity values measured generally reflect brackish water conditions, providing moderated conditions for brackish, marine and freshwater fish species. Generally, temperature levels have many fundamental effects on water quality. The data shows that colder areas of water hold more oxygen than warmer waters.

3.6 Fisheries assessment

In general, 328 specimens composed of finfishes and crustaceans belonging to 26 species and 24 genera were sampled from the sampling stations (Table 5). With the exception of *Sarotherodon melanotheron* (19.21%), *Mugil cephalus* (9.15%), *Bostrychus africanus* (7.32%), and *Tilapia zillii* (4.27%), further analyses on the other finfishes were ignored due to their few numbers. The standard lengths of *S. melanotheron* and *T. zillii* ranged from 3.4 - 14.3cm and 4.1 - 15.8cm, respectively. However, *B. africanus* had a standard length range of 6.2 - 10.7cm with that of *M. cephalus* ranging from 5.7 - 21.4cm. The modal length classes for *S. melanotheron* and *T. zillii* were determined as 6.0 – 6.9 (28.6%) and 4.0 - 4.9 (42.9%), respectively. The modal length classes of *B. africanus* and *M. cephalus* were coincidentally observed to be similar (8.0-8.9) with analogous compositions (33.3%).

Table 5: Fish species sampled from the various stations (basic statistics on the dominant species)

Species (Ecological niche i.e. M=marine; B=Brackishwater; and F= Freshwater)	N	Composition (%)	Standard Length (cm)			Composition of modal class (%)
			Min	Max	Modal class	
Finfishes						
Sarotherodon melanotheron (B)	63	19.21	3.4	14.3	6.0 – 6.9	28.6
Tilapia zillii (F)	14	4.27	4.1	15.8	4.0 – 4.9	42.9
Hemichromis fasciatus (F)	1	0.30	-	-	-	-
Bostrychus africanus (F)	24	7.32	6.2	10.7	8.0 – 8.9	33.3
Liza falcipinnis(M)	4	1.22	-	-	-	-
Mugil cephalus(M)	30	9.15	5.7	21.4	8.0 – 8.9	33.3
Gobinellus occidentalis (F)	13	3.96	-	-	-	-
Eleotris sp (F)	2	0.60	-	-	-	-
Echelus myrus (M)	1	0.30	-	-	-	-

Species (Ecological niche i.e. M=marine; B=Brackishwater; and F= Freshwater)	N	Composition (%)	Standard Length (cm)			Composition of modal class (%)
			Min	Max	Modal class	
Aplocheilichthys spilauchen (F)	8	2.44	-	-	-	-
Periophthalmus barbarous (B)	11	3.35	-	-	-	-
Schilbe mandibularis (F)	2	0.61	-	-	-	-
Mycteroperca rubra (M)	1	0.30	-	-	-	-
Gobiodes sagitta (F)	3	0.91	-	-	-	-
Arius gigas (M)	7	2.13	-	-	-	-
Elops lacerta (M)	12	3.66	-	-	-	-
Kribia nana (F)	3	0.91	-	-	-	-
Pomadasys incises (M)	3	0.91	-	-	-	-
Pomadasys jubelini (M)	1	0.30	-	-	-	-
Lutjanus sp (M)	1	0.90	-	-	-	-
Dicologoglossa hexaphthalma (M)	3	0.91	-	-	-	-
Eucinostomus melanopterus (M)	2	0.61	-	-	-	-
Psettias sebae (M)	1	0.31	-	-	-	-
Crustaceans						
Penaeus kerathurus (M)	17	5.18	1.0	1.8*	-	-
Penaeus notialis (M)	63	19.21	0.3	1.5*	-	-
Callinectes amnicola (M)	36	10.98	1.7	5.0*	-	-

*=Carapace width; N = sample size

Note: Species with few numerical compositions were not subjected to further analysis.

Analysis was limited to the carapace width relative to the crustaceans sampled. Hence, carapace widths of *P. kerathurus* (5.18%) and *P. notialis* (19.21%) ranged from 1.0 – 1.8 cm and 0.3 – 1.5 cm, respectively. However, *C. amnicola* (10.98%) had carapace width ranging from 1.7 - 5.0 cm. The species occurrence, diversity, evenness and richness are presented in

Table 6. Sampling stations denoted by F3 (*d* =3.19) and F4 (*d* =3.02) had relatively higher species richness than F2 (*d* =1.69) and F1 (*d* =2.29).

Table 6: Occurrence and biodiversity of fish species sampled from all the sampling stations

Species	Sampling stations			
	F1	F2	F3	F4
Finfishes				
Sarotherodon melanotheron	-	+	+	+
Tilapia zillii	+	+	+	+
Hemichromis fasciatus	-	-	-	+
Bostrychus africanus	+	+	-	-
Liza falcipinnis	+	-	+	-
Mugil cephalus	-	-	-	+
Gobinellus occidentalis	+	+	+	-
Eleotris sp	+	-	+	-
Echeius myrus	+	-	-	-
Aplocheilichthys spilauchen	-	+	-	-
Periophthalmus barbarous	-	+	+	-
Schilbe mandibularis	-	+	+	-
Mycteroperca rubra	-	+	-	-
Gobiodes sagittal	-	-	+	-
Arius gigas	-	-	+	+
Elops lacerta	-	-	+	+
Kribia nana	-	-	+	-
Pomadasys incises	-	-	+	+
Pomadasys jubelini	-	-	-	+
Lutjanus sp	-	-	+	+
Dicologoglossa hexaphthalma	-	-	-	+
Eucinostomus melanopterus	-	-	-	+
Psettias sebae	-	-	-	+
Crustaceans				
Penaeus kerathurus	-	-	+	+

Species	Sampling stations			
	F1	F2	F3	F4
Penaeus notialis	+	+	+	+
Callinectes amnicola	+	+	+	+
Indices				
Number of genera	8	10	15	13
Number of species	8	10	16	15
Margalef's index of Richness (*d*)	1.69	2.29	3.19	3.02
Shannon-Wiener diversity (*H´*)	1.40	1.97	1.61	2.11
Pielou's evenness (*J´*)	0.7	0.9	0.6	0.8

+ indicates present; - indicates absence in the samples

Of all the sampling stations, F4 (*H´*= 2.11) had the highest species diversity followed by F2 (*H´*= 1.97). However, F1 (*H´*= 1.40) recorded the lowest species diversity. In general, individuals were somewhat evenly distributed among the species (*J´*≥ 0.6). However, individuals in F2 (*J´*= 0.9) were more evenly distributed among the species. Compositions of the various fish species caught from all the stations are shown in Figure 11.

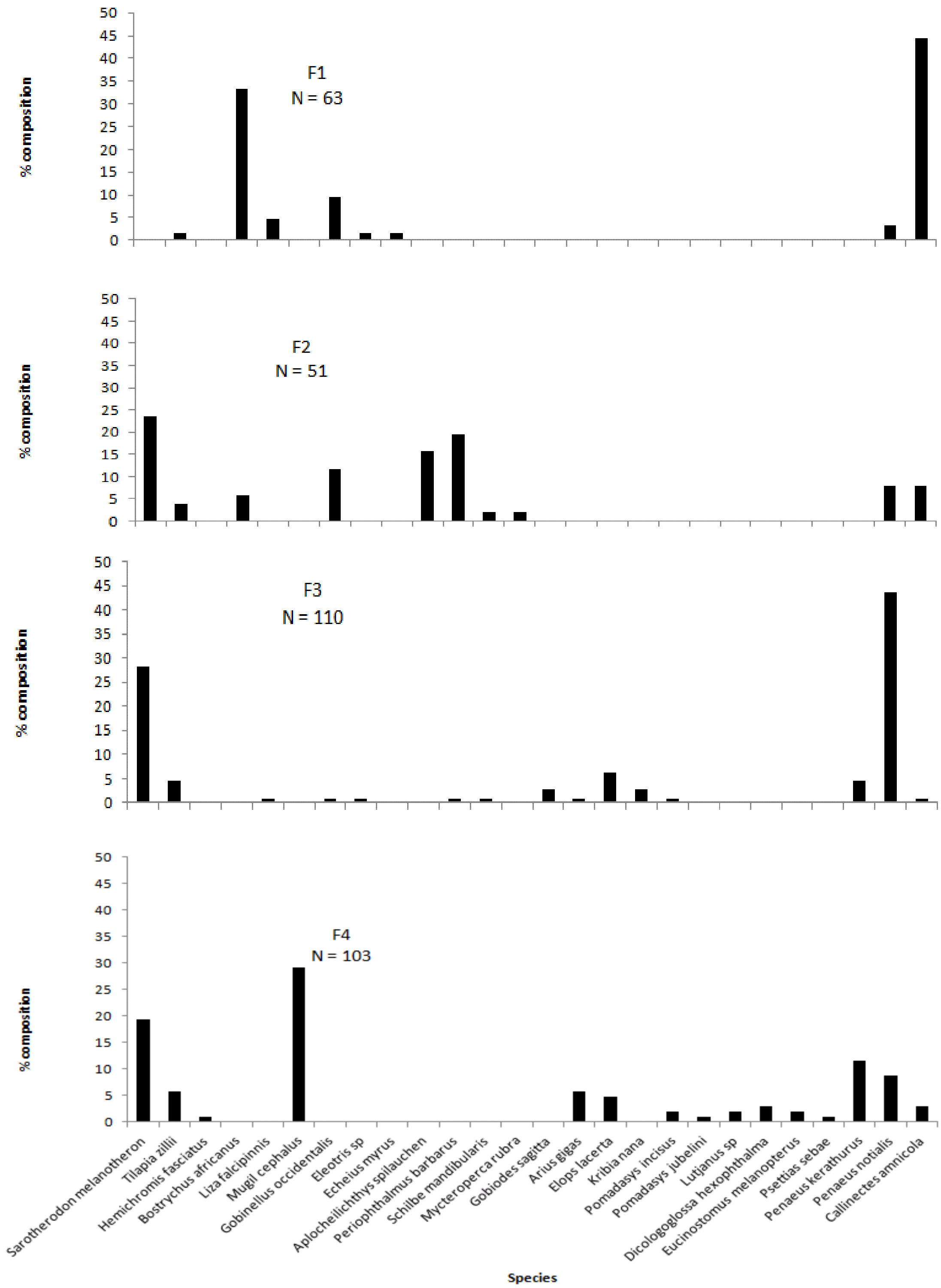

Figure 11: Percentage composition of fish species sampled from all the four sampling stations (F1-F4)

Generally, *Tilapia zillii*, *Callinectes amnicola* and *Penaeus notialis* were encountered in all the sampling stations. Also, apart from sampling station F1, *S. melanotheron* was observed in all the other sampling stations. However, the fish community in F1 was dominated by *Callinectes amnicola (44.4%)* followed by *Bostrychus africanus* (33.3%) with each of the rest contributing less than 10%. *S. melanotheron* notably constituted 23.5% of the fish community in F2 whereas *Periophthalmus barbarus and Aplocheilichthys spilauchen* were represented by 19.6% and 15.7%, respectively. With the exception of *Gobinellus occidentalis* (11.8%), each one of the remaining fish species sampled from F2 was minimally represented (< 8%). *Penaeus notialis* (43.2%) dominated the F3 fish community followed by *S. melanotheron* (27.9 %) whilst each of the other fish species caught from the station contributed less than 6.5 %. *Mugil cephalus* and *S. melanotheron* correspondingly constituted 29.1% and 19.4% of the fish community of sampling station F4 whilst *Penaeus kerathurus and P. notialis* orderly made of 11.7% and 8.7% of the fish community.

3.7 Analysis of growth parameters of dominant species

Maximum and minimum body weights of *Mugil cephalus* obtained from all the sampling stations were determined as 257.62g and 4.9g, respectively. Using scatter plot, the relationship between body weight and standard length was described by the equation: $BW = 0.0158SL^{3.2}$, where BW = body weight in grams and SL = standard length in centimetres (Figure 12). There was a strong correlation between body weight and standard length of *M. cephalus* population sampled from the stations (r = 0.99).

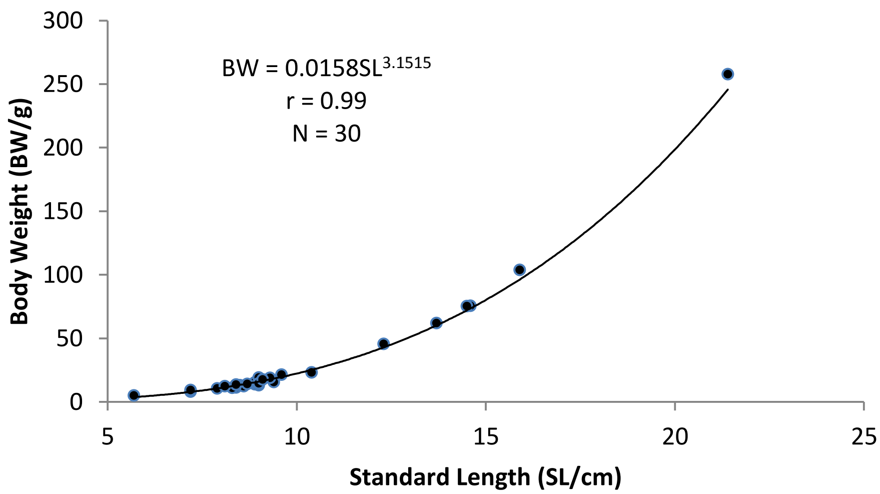

Figure 12: Length-weight relationship of *Mugil cephalus* obtained from the various sampling stations (N = sample size)

Weights of *S. melanotheron* and *Tilapia zillii* sampled from all the stations ranged between 2.3 - 157.1 g and 3.11 – 204.46 g, respectively. Figures 13 and 14 illustrate the relationship between standard length and body weight of *S. melanotheron* and *Tilapia zillii*, respectively. The relationships were exponential and described by the equations: $BW = 0.0608SL^{2.9}$ for *S. melanotheron* and $BW = 0.0471SL^{3.1}$ for *T. zillii*. There was a strong correlation between standard length and body weight of *S. melanotheron* (r = 0.98) as well as *T. zillii* (r = 1.0).

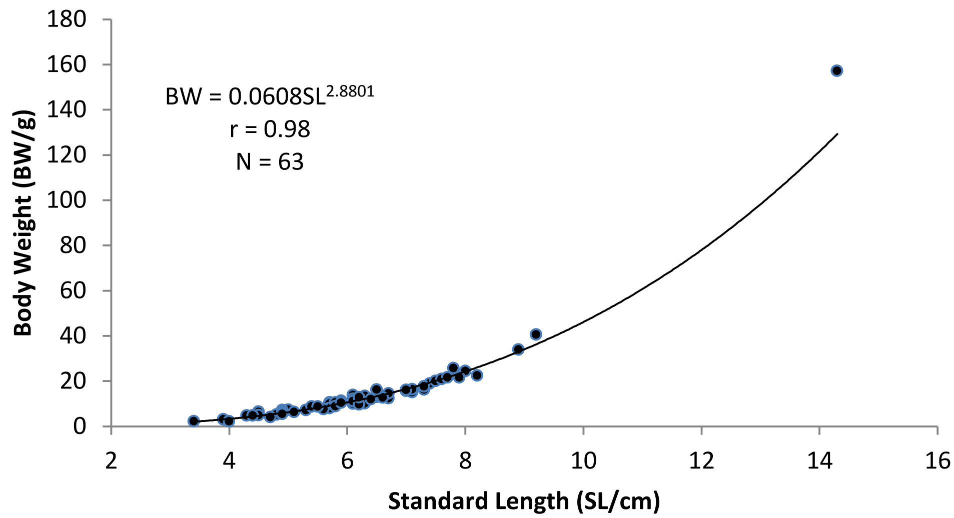

Figure 13: Length-weight relationship of *Sarotherodon melanotheron caught* from the various sampling stations (N = sample size)

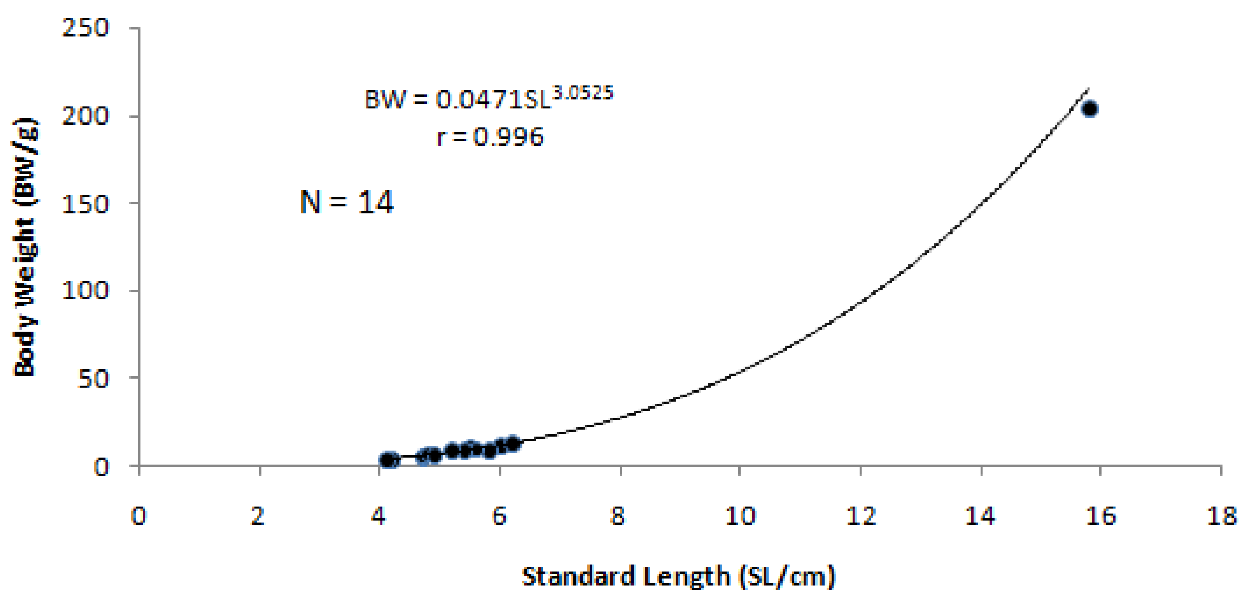

Figure 14: Length-weight relationship of Tilapia zillii sampled from the various sampling stations (N = sample size)

Weight range of *Bostrychus africanus* was 6.78 - 35.18 g. However, length and weight of the species were related through an equation generated as Bw = $0.0204SL^{3.2}$ (Figure 15). Their length and weight were strongly correlated (r = 0.99).

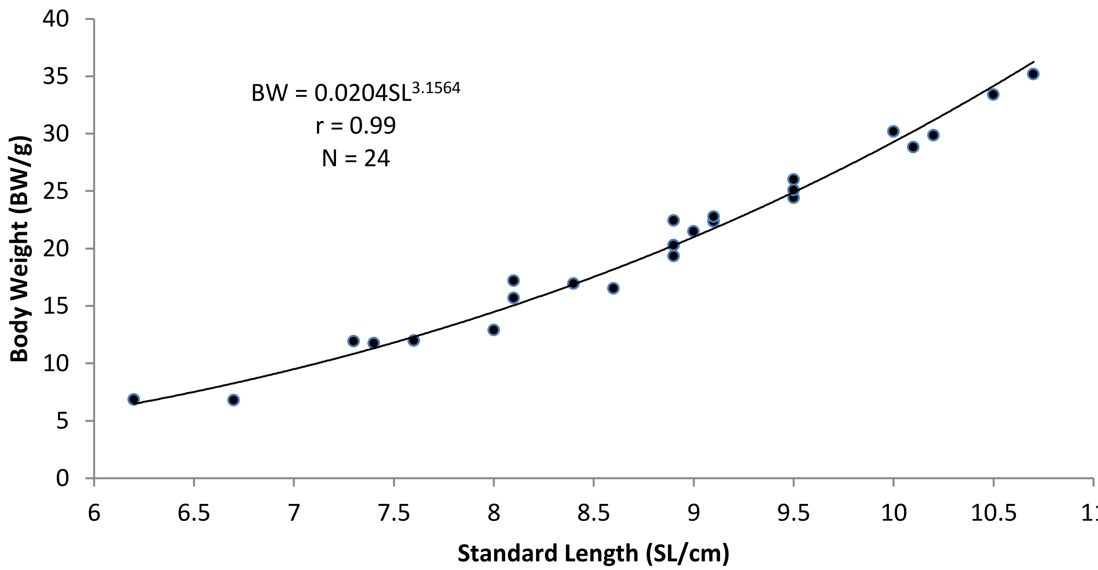

Figure 15: Length-weight relationship of *Bostrychus africanus sampled* from the various sampling stations (N = sample size)

3.8 Mangrove Species Composition

From the samples of mangrove tree parts (flowers, stems, leaves, fruits stilt roots, prop roots and propagules) collected and identified, four species of mangrove were noticed (*Rhizophora mangle, Avicennia germinans, Laguncularia racemosa* and *conocarpus erectus*). However, the *conocarpus sp* were found to be in small fringes estimated to be 3 individuals per area encountered. The structural attributes of the mangrove forest stands at the sites are shown in Table 7. Mangrove forests were dominated by *A. germinans* as shown by the importance value and the relative values of frequency, density and dominance.

Table 7: Mangrove tree parameters

Species	Density (No. of individuals/ m^2)	Relative Values (%)			Importance Value (I_V)
		Frequency	Density	Dominance	
Rhizophora mangle	0.19	18.83	18.83	27.42	65.09
Laguncularia racemosa	0.32	31.56	31.56	42.05	105.18
Avicennia germinans	0.5	49.60	49.60	30.53	129.73

The mean height of mangroves found at both sites is shown in Figure 16a, with *Rhizophora mangle* trees being taller (3.5 ± 1.28 m) than *Laguncularia racemosa* (2.4 ± 0.91 m) and *Avicennia germinans* (2.37 ± 0.82) at site two. *Avicennia germinans* which was the only species recorded at site one had an estimated height of 1.90 ± 0.81. However, the observed differences in the height were not significant ($p > 0.05$). *Rhizophora mangle*, *Laguncularia racemosa* and *Avicennia germinans* had densities of 0.19 individuals/m^2, 0.32 individuals/m^2 and 0.5 individuals/m^2

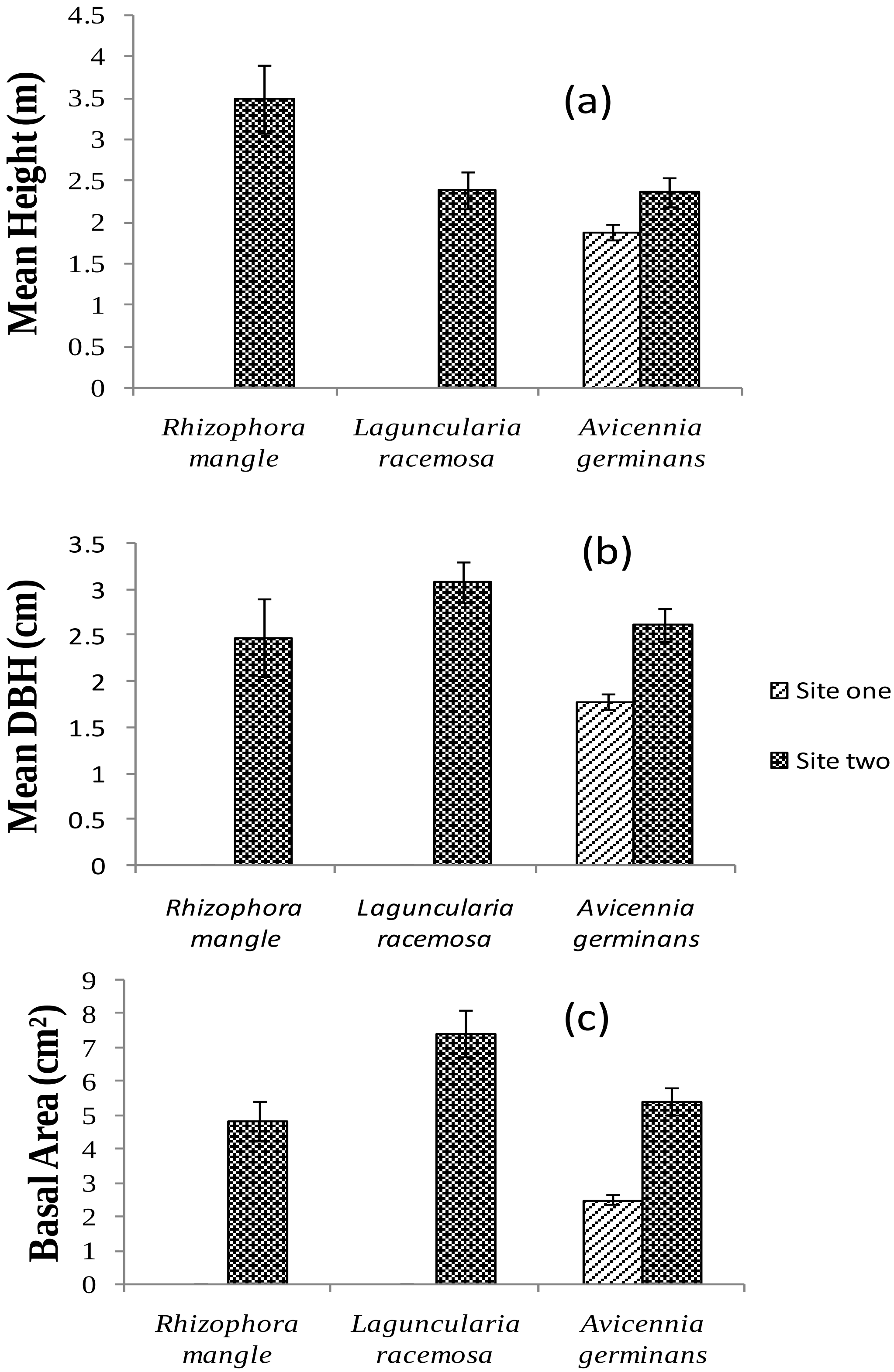

Figure 16: Mangrove species sampled: (a) Mean height (b) Mean DBH and (c) Mean Basal area

Figure 16b shows the mean diameter at breast height of mangroves found at both sites. On the average, *Avicennia germinans* found at site one (2.62 ± 2.03) was bigger than that of site two (1.90 ± 0.81). *Rhizophora mangle* and *Laguncularia racemosa* at site two had diameter at breast height of 2.48 ± 1.00 cm and 3.08 ± 3.03 cm respectively. However, the observed differences in diameter at breast height were not significant ($p > 0.05$). Figure16c indicates the basal area of mangroves found at both sites. The *Avicennia germinans* trees at site two had larger basal area (5.40 cm^2) than those at site one (2.50 cm^2). *Laguncularia racemosa* and *Avicennia germinans* encountered at site two recorded basal area values of 7.44 cm^2 and 5.4 cm^2 respectively. However, the observed differences in basal area were not significant ($p > 0.05$).

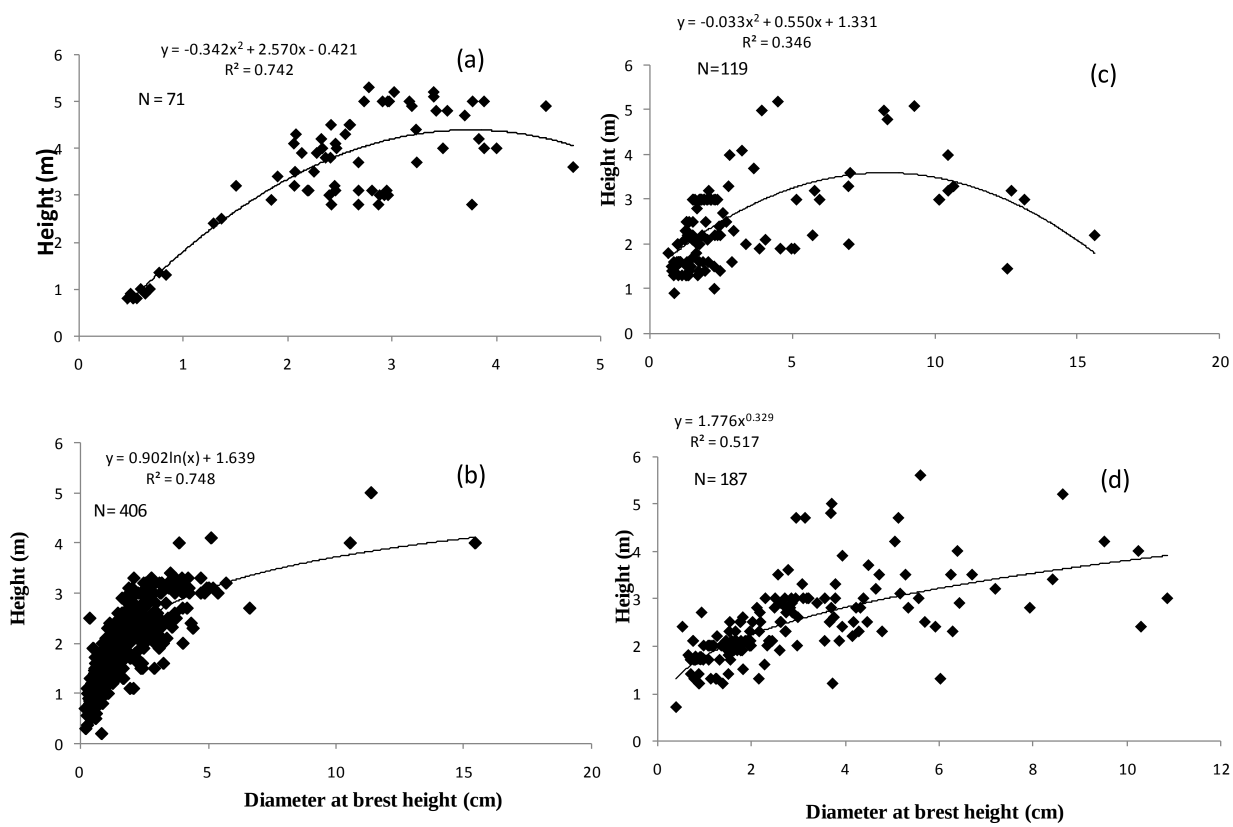

Figure 17: Analysis of growth parameters (a) R. mangle (b) L. racemosa at site 2 and for A. germinans at site 1 referring to (c) and (d) respectively

Figure 17 shows the regression analysis of the relationship between height and diameter at breast height for *Rhizophora mangle* at site two. The coefficient of determination, $R^2 = 0.74$ suggest a moderate and average uniform structural development of the tree.

For instance, Figure 17b shows the regression analysis of the relationship between height and diameter at breast height for *Laguncularia racemosa* at site two. The coefficient of determination (R^2) was estimated at 0.35. Figures 17c and 17d show the regression analysis of the relationship between height and diameter at breast height for *Avicennia germinans* at both sites. The coefficients of determination of sites one and two were estimated at 0.75 and 0.52 respectively. This study recorded three species of mangroves namely *Avicennia germinans*, *Laguncularia racemosa* and *Rhizophora mangle* in the sampled areas. The study was conducted within limited sampling area, and therefore the species of mangroves probably could have been more if the study covered larger areas. So far, five (5) species of mangroves have been found in Ghana namely *Avicennia germinans*, *Laguncularia racemosa*, *Rhizophora harrisonii, Rhizophora mangle and Rhizophora racemosa* (UNEP, 2007),

According to Gehring, Park & Denich (2008), diameter at breast height (DBH) and height (H) are standard measures for investigating large plants. Pellengrini, Soares, Chaves, Estrada and Cavalcanti (2009) also documented that, a forest with low structural development has a DBH between 1.6 cm and 3.1 cm and mean H of the most developed trees between 2.4 m and 4.7 m. In relation to this, it is noteworthy that the mean canopy height of mangrove at site two for *Rhizophora mangle* was 3.5 ± 1.28 cm with a mean DBH of 2.48 ± 1.00 cm, *Laguncularia racemosa* 2.4 ± 0.91 cm with a mean D of 3.08 ± 3.03 cm and *Avicennia germinans* 2.37 ± 0.82cm with a mean D of 1.90 ± 0.81cm. The canopy height and DBH of *Avicennia germinans* at site one were estimated at 1.90 ± 0.81 cm and 2.62 ± 2.03 cm respectively. Therefore it is concluded that the mangrove forests at Anlo Beach wetland are of low structural development.

The low structural development of the trees may be attributed to their indiscriminate cutting by residents which reduce their potential to grow in height and size. Structural development is impeded due to natural or anthropogenic factors including over exploitation (Andrews *et* al., l984). Indeed, clearing of mangrove forests or simple formation of canopy gaps can also change the physical and chemical characteristics of the underlying soil leading to sulphide activity in the sediment (Alongi, 1996). Such an event could damage and reduce growth of mangroves (Youssef & Saenger, 1998). In fact, disturbance such as cutting of mangrove trees can increase the rate of sulphide activity and hence affect the structural development of the trees (Alongi, 1996).

The importance value (I_V) which is also a relative measure of the ecological contribution of a species in terms of relative frequency, relative density and relative dominance was found to be highest for *A. germinans* estimated to be 129.73, followed by *L. racemosa* recording 105.18 and *R. mangle* which recorded the least in terms of this parameter amounting to 65.09 at site two. This result confirms that *A. germinans* is the principal mangrove species around the Anlo beach wetland ecosystem even though *L. racemosa* mangrove species around this wetland ecosystem recorded a relative dominance value of 42.05 which is higher than that of *A. germinans* with 30.53.

9.0 Demographic profile of respondents

Two hundred respondents were randomly selected for the socio-economic survey of the Anlo beach wetland. Of the total, 45.5% of the respondents ranged within the age group 31-50 was followed by a younger generation of 15-30 years that constituted 41% of respondents (Table 8).

Table 8: Age range of respondents

Age (years)	Frequency	Percent
15-30	82	41.0
31-50	91	45.5
51-75	25	12.5
Not applicable	2	1.0
Total	200	100.0

All the 200 respondents were migrants from different parts of Ghana (Table 9). The respondents therefore do not have absolute ownership of the land they settled in. Apart from 3% of the respondents who migrated from Nzema, Ada and Wa, the remaining 97% were Ewes from the Volta Region of Ghana (Table 9). Of these 58% migrated from Dzita, a major fishing community in the Volta Region (VR) accounting for reason why most of the respondents are engaged in fishing and its related activities as their primary occupation (Table 11).

The fact that the migrant settlers do not have absolute ownership of the land has led to some conflicts among resource users in relation to mangrove extraction. On one hand, there are conflicts between the “landowners’ (the Fantes from Shama) and the Ewes (migrant settlers from the Volta Region) because the latter are perceived to be “pilfering” resources belonging to their hosts. On the other hand, there are instances of conflicts amongst community members for pilfering already harvested mangroves that belong to others; One of the respondents narrated an ordeal relating to issues of conflict in mangrove extraction in the community. He stated, *"there has been instances in the past where the Fantes just waited for us to go through all the laborious processes and finish extracting, and brought it home only to come to seize them from us" - these could have resulted in incidences of violence but our leaders restrained the youth who also, already knew they were wrong in some way".*

Table 9: Place of origin of respondents

Place of Origin	Frequency	Percent	Valid Percent
Dzita (Volta Region)	116	58.0	58.0
Akatsi (Volta Region)	10	5.0	5.0
Anloga (Volta Region)	33	16.5	16.5
Atsito (Volta Region)	3	1.5	1.5
Anyanui (Volta Region)	5	2.5	2.5
Not applicable	2	1.0	1.0
Evui (Volta Region)	4	2.0	2.0
Wuti (Volta Region)	8	4.0	4.0
Keta (Volta Region)	5	2.5	2.5
Afiadenyigba (Volta Region)	1	.5	.5
Dekpor (Volta Region)	1	.5	.5
WA (Upper West Region)	1	.5	.5
Agbozume (Volta Region)	5	2.5	2.5
Ada (Greater Accra)	1	.5	.5
Lakple (Volta Region)	3	1.5	1.5
Half Assini (Western Region)	2	1.0	1.0
Total	200	100.0	100.0

The respondents generally had a low level of education e.g. forty-two (42%) of the respondents had no formal education, 19.5% and 42% of all respondents had primary and middle/JHS education respectively (Table 10).

Table 10: Education level of respondents

Level of Education	Frequency	Percent
Primary	39	19.5
Middle/JHS	84	42.0
Secondary	26	13.0
Tertiary	9	4.5
No Formal Education	42	21.0
Total	200	100.0

Fishing and farming are the respondents' major livelihood activities (Table 11). Although fishing is the predominant activity, farming is practiced intensely during lean fishing seasons, since most fishermen and fishmongers double as farmers. Although only a percentage of the respondents indicated selling of firewood as their primary occupation (Table 11), its perceived that the very few respondents who had made it beyond JHS level of education, as the latter group of respondents claimed, exploited mangrove trees for sale in order to support their education. It was added that though such people wouldn't extract mangrove trees as their main occupation, they would do that as a secondary source of income. This could be the reason why more people (5%) are engaged in selling of firewood as secondary occupation (table 12) than as primary (which is only 1%).

Table 11: Primary occupation of respondents

Primary Occupation	Frequency	Percent
Fishing	44	22.0
Fishmonger	9	4.5
Fish smoker	13	6.5
Hire dresser	7	3.5
Teacher	14	7.0
Farmer	44	22.0
Not applicable	27	13.5
selling of firewood	2	1.0
Trader	22	11.0
Repairer	2	1.0
Builder	3	1.5
Dressmaking	10	5.0
Driving	2	1.0
Student	1	.5
Total	200	100.0

Majority (37%) of the respondents have their incomes ranging from GH¢100 and GH¢500 per month. Only 1.5% of the respondents earn more than GH¢1,000 being the highest income earners, whereas the least income earners earn less than GH¢100, accounting for 15% of the respondents (Table 12). The findings suggest that the respondents were generally low income earners.

Table 12: Income level of respondents

Income/month (GH¢)	Frequency	Percent
100-500	74	37.0
501-800	19	9.5
801-1000	7	3.5
1001 and above	3	1.5
Not applicable	67	33.5
20-99	30	15.0
Total	200	100.0

Table 13 shows purpose of extracting mangrove resources, focusing on whether they are for commercial or domestic purposes. Most respondents use the resources domestically than for commercial purposes.

Table 13: Mangrove use among respondents

Mangrove usage	Frequency	Percent
Domestic	85	42.5
Commercial	53	26.5
Not applicable	62	31.0
Total	200	100.0

With regards to the direct usage, majority of the respondents specifically explained that they use the mangrove and wetland areas mainly for the purpose of acquiring Timber, Firewood, Fish, Crabs and Shrimps (Table 14). However, the predominant usage was for wood and fisheries accounting for 27.5% of the total respondents.

Table 14: Direct use of mangrove and wetland resources by respondents

Direct Usage of Mangrove Wetland Resources	Frequency	Percent
Timber/Poles/Firewood/Fish/crabs	38	19.0
Firewood/Fish/Crab/Shrimps	28	14.0
Timber/Firewood/Leaves/Fish/crabs/Shrimps	1	.5
Timber/Firewood/Fish/Crab/Shrimps	55	27.5
Firewood/Fish	11	5.5
Firewood	21	10.5
Firewood/Fish/crab	13	6.5
Firewood/Seed/Fish/Crabs/Shrimps	4	2.0
Firewood/Crabs/Shrimps	5	2.5
Firewood/Leaves/Crabs/Shrimps	2	1.0
Firewood/Charcoal	1	.5
Timber/Firewood/Fish/shrimps	4	2.0
Fish/Crabs	1	.5
Firewood/Fish/Shrimps	3	1.5
Timber/Fish	1	.5
Firewood/Leaves/Fish/Crabs/Shrimps	1	.5
Timber/Firewood/Seeds/Fish/crab	2	1.0
Timber/Firewood/Leaves/Fish/Crabs/Shrimps/wildlife	1	.5
Firewood/Leaves/Crabs/Shrimps/Wildlife	1	.5
Firewood/Leaves/Fish/Crabs	1	.5
Timber/Poles/Firewood/Fish	4	2.0
Firewood/Charcoal/Fish/Crabs/shrimps	1	.5
Timber/Poles/Firewood/Leaves/Fish/Crabs	1	.5
Total	200	100.0

In estimating the economic benefits accrued from wetland resources, 25% of the respondents indicated benefits amounting to GH¢100-GH¢500 per month while 3.5% of the respondents indicated values ranging from GH¢500- GH¢800. A low number of the respondents (2.5%) indicated benefits amounting to above GH¢ 800 per month (Table 15). This study confirms earlier studies by Aheto (2011) which revealed that lower income earners relied more on mangrove wetland resources than higher income earners

Table 15: Respondents' direct use value of mangrove and other wetland resources

Direct Use Value of Mangrove Wetland Resources (GH¢)	Frequency	Percent
100-500	50	25.0
501-800	7	3.5
801- 1000	5	2.5
1001 and above	1	.5
Not applicable	116	58.0
Below 100	21	10.5
Total	200	100.0

The main indirect use of the mangrove and wetland resources centered on biodiversity and transportation confirmed by 22% of the respondents, followed by fish nursery, flood protection and habitat, indicated by 20% of respondents (Table 16).

Table 16: Indirect use of mangrove and wetland resources by respondents

Indirect Usage of Mangrove Wetland Resources	Frequency	Percent
Flood protection/Fish nursery/Habitant/Transportation	10	5.0
Fish nursery/Transportation	8	4.0
Flood protection/Fish nursery/Habitat	28	14.0
Not applicable	25	12.5
Fish nursery/Habitant/Transportation	8	4.0
Biodiversity/Transportation	44	22.0
Biodiversity	2	1.0
Fish nursery	40	20.0

Indirect Usage of Mangrove Wetland Resources	Frequency	Percent
Fish nursery/Biodiversity	13	6.5
Fish nursery/Biodiversity/Transportation	4	2.0
Fish nursery/Habitant	3	1.5
Flood protection/Fish nursery/Transportation	9	4.5
Flood protection/Fish nursery/Biodiversity/Habitant/Transportation	3	1.5
Fish nursery/Storm protection/Habitant/Transportation	1	.5
Transportation	1	.5
Flood Protection/Fish nursery/Biodiversity/transportation	1	.5
Total	200	100.0

Table 17: Valuation of indirect use of mangrove and other wetland resources

Indirect Use Value of Mangrove Wetland Resources (GH¢)	Frequency	Percent
501-800	3	1.5
800 and above	42	21.0
Not applicable	155	77.5
Total	200	100.0

In the valuation of the Indirect use, 1.5% of the respondents indicated accrued benefits of between GH¢500 and GH¢800, while 21% indicated above GH¢800. The rest had no idea as to the worth of the indirect benefits from the mangrove and wetland resources (Table 17). In comparison to values ascribed to direct uses, the value placed on indirect values suggest that community places greater priority on their immediate subsistence requirements leading to widespread exploitation of the resource. According to majority of the respondents, the use of the wetland for recreation and livelihood support are the main existence or option use values of the resources (Table 18). With the exception of a few respondents who could valuate the existence use, 78% majority could not estimate the existence/option use value of the mangroves and wetland resources (Table 22).

Table 18: Existence/option use of mangrove and wetland resources by respondents

Existence/Option Values of Mangrove Wetland Resources	Frequency	Percent
Livelihood support/Hunting/Aesthetic	27	13.5
Not applicable	30	15.0
Recreational area	30	15.0
Hunting	5	2.5
Livelihood Support	40	20.0
Livelihood/Recreational	40	20.0
Livelihood support/Hunting	14	7.0
Livelihood support/Aesthetic	5	2.5
Livelihood support/Ecotourism	2	1.0
Livelihood support/Recreational area/Ecotourism	1	.5
Culture heritage	2	1.0
Livelihood support/Culture Heritage	1	.5
Livelihood Support/Recreational area/Hunting	2	1.0
Recreational area/Culture heritage	1	.5
Total	200	100.0

Table 19: Respondents' valuation of existence/option use of mangrove and wetland resources

Existence/ Option Value of Mangrove Wetland Resources (GH¢)	Frequency	Percent
100-500	7	3.5
501-800	10	5.0
810-1000	18	9.0
1010 and above	9	4.5
Not applicable	156	78.0
Total	200	100.0

Over sixty percent (60.5%) of the respondents indicated there were taboos and local traditions governing the use, protection and conservation of the mangrove resources (Table 21). While some couldn't specify any taboo some explained that the formerly designated a no-go-areas for mangrove extraction no longer exist. Over sixty percent (60.5%) indicated mangrove management rules including:

- No cutting of young mangrove trees
- Replanting mangrove trees through afforestation programme
- More education and sensitization on the benefits of the mangrove

Table 20: Local traditions and taboos governing use of mangrove resources

Existence of traditions/ taboos governing mangrove use	Frequency	Percent
Yes	121	60.5
No	75	37.5
Not applicable	4	2.0
Total	200	100.0

Soliciting the respondents' ideas on how to manage the mangroves and wetlands at large, they noted among others that there was the need for transplanting of mangrove seeds, and possible alternative livelihood opportunities to help them diversify their livelihood sources. They also called for extensive education and sensitization on the benefits they could accrue from the mangrove.

4.0 CONCLUSION AND RECOMMENDATIONS

This study deplored a multidisciplinary approach to assess the flora and fauna of ecological and socioeconomic significance within the Anlo Beach Wetland Complex. It is aimed at aiding improved management of the wetland in order to facilitate the creation of local institutions for conservation of the wetland by the adoption of a multi-stakeholder management practice. The findings show that mangrove wetlands have been degraded despite its immense ecological and socio-cultural benefits to the community. For example original mangrove cover has decreased from 594.6 ha to 517.9 ha amounting to 15% loss over a period of twenty years (1994-2014) largely attributed to cutting for fuel wood and building construction. The development of saltpans is a contributory factor to mangrove degradation. The contribution of the wetland to fisheries production cannot be underscored. As the fisheries data indicate, the wetland serves as an important habitat for several commercial marine, brackishwater and freshwater fish species, most of which are juvenile. The continued destruction of the wetland could therefore affect fish recruitment into the adult population with severe ramification for local livelihoods. Furthermore, analysis of mangrove studies reveals that the mangroves are of low structural development with reference to height, density and basal area of the three species found mainly Rhizophora, Avicennia and Laguncularia. On the basis of the findings, we conclude that the Anlo Beach wetland is threatened as a result of high reliance on the wetland resources predicated by low income and educational status of community members.

The following recommendations are therefore proposed:

- Establishment of woodlot for the community will go a long way to reduce the pressure and dependency on the mangrove trees. Any such initiative however should involve the broader community (not be skewed towards certain personalities alone) with broader participation, especially by the youth. In doing so, appropriate land tenure issues must first be critically looked at.

- The need for the District Assembly to assist the community on processes of developing the community's own bye-laws regarding the wetlands is very crucial to the sustainability of the mangroves.

- Monitoring of fish stocks in the wetland and associated hydrographic parameters

- Scientific information would be required on shorebirds and sea turtles as part of wildlife monitoring

- The District's sub-committee responsible for marine and coastal resources management must collaborate with the community leaders and the Shama traditional council to design a strategic regulatory open and close access seasons for mangrove extraction and replanting as well as creating community owned alternative livelihood activities.

- Replanting of mangrove seedlings should as a matter of urgency be encouraged. The season for such replanting exercises must be critically assessed. It would be very good to do the planting right after the major raining season, since stagnant fresh water could kill the replanted seedlings.

- Education and sensitization on the importance of mangroves should be intensified in the community.

- Detailed study of the suitability of mangrove species for fish smoking should be conducted to ascertain the perception of the local people on the use of rhizophora mangroves as the preferred fuel wood for fish smoking.

- Establish community-based groups and increase women participation in the communities' wetland management.

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DATA SHEETS FOR ANLO BEACH

FISHERIES SURVEY

1. **Fisheries Monitoring** (Fish Bio-data)

Wetland Name/Location: ………………………………………………………………

Date: ……………………

Time: ……………………..

Species (Common or Scientific Name): ……………………………………………

Serial No.	Total Length (cm)	Fork Length (cm)	Body Weight (g)

MANGROVES SURVEY

Mangroves Monitoring Data Sheet

2. Date: ……………………… Time: ……………………………

3. Wetland Name/Location: ……………………………………………………

4. Name of species: ……………………………………………………

5. Number of individuals of the species: ……………………………………………………

Number of Quadrat (5 m x 5 m)	**Transect No.__________**													
	Height (m)							DBH (cm)						
1														
2														
3														
4														

WATER QUALITY MONITORING

Date: …………………………..

Wetland Name/Location: ………………………………………………………………………

Parameter	Number per date of visit									
SITE 1										
Dissolved Oxygen										
pH										
Turbidity										
Salinity										
Conductivity										
Temperature										
SITE 2										
Dissolved Oxygen										
pH										
Turbidity										
Salinity										
Conductivity										
Temperature										
SITE 3										
Dissolved Oxygen										
pH										
Turbidity										
Salinity										
Conductivity										
Temperature										

INTERVIEW GUIDE FOR ANLO BEACH

MANGROVE USERS

1. PROFILE OF RESPONDENT

Date:	Primary Occupation:
Age:	Secondary Occupation:
Education:	Sex:
Family size:	Place of Origin:
Marital status:	Income:

2. USE AND NON-USE VALUES OF MANGROVES

Type of use (tick)			
a) Direct Use Values	Value (GH¢)/ month	***c) Existence/ Option Values***	Value (GH¢)/ month
☐ Timber/poles		☐ Livelihood support	
☐ Firewood		☐ Coastal protection	
☐ Charcoal		☐ Recreational area	
☐ Leaves		☐ Cultural heritage	
☐ Seeds		☐ Ecotourism	
☐ Bark		☐ Others (please specify)	
☐ Fish		☐	
☐ Crabs			
☐ Shrimps			
☐ Wildlife			

b) Indirect Use Values			
☐ Flood protection			
☐ Fish nursery			
☐ Storm protection			
☐ Biodiversity			
☐ Habitat			
☐			

3. MANGROVE MANAGEMENT ISSUES

a) In which year did you start harvesting mangrove product(s) stated above? b) Have you encountered problems obtaining any of the resource(s) mentioned and why have they arisen?
c) What kinds of conflicts have arisen in the use of the mangroves in the community?
d) Are there any local traditions, taboos or laws governing the use, protection or conservation of the mangrove resources? If yes, specify them please

e) Are there any community management plans for sustainable use of the mangroves i.e. social commands or bye-laws? If yes, what are they and who oversees its implementation?
f) How do you see the need for such a plan/ rules/ bye-law?
g) Is there compliance of laid down plans/ rules or bye-laws? If no, how can they be enforced from your point of view?
h) What plans do you envisage for the management of the mangrove wetlands in the community?