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SUSTAINABLE FISHERIES MANAGEMENT PROJECT (SFMP)

Analysis of Spatial Planning Options: Ankobra

September 2015

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Cover photo:
Trip to Mangrove Concentration Sites led by Community Participants and Guides (Credit: Spatial Solutions)

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ACRONYMS

CEDECOM	Central Region Development Commission
CEWEFIA	Central and Western Region Fishmongers Improvement Association
CLaT	Child Labour and Trafficking
DAA	Development Action Association
DSW	Department of Social Welfare
FoN	Friends of Nation
SFMP	Sustainable Fisheries Management Program
SNV	Netherlands Development Organization
USAID	United States Agency for International Development
WFCL	Worst Forms of Child Labour

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

1 GENERAL BACKGROUND OF THE PROJECT

1.1 Introduction

The River Ankobra flows about 120 miles (190 km) southwards into the Gulf of Guinea from the northeast of Wiawso[1]. The river's meeting point with the sea/Atlantic Ocean is at the village of Sanwoma in the Western Region. The river acts as the boundary between Ellembelle District and the Nzema East Municipal. Over the years, the River Ankobra has played a significant role in the socio-economic activities of individuals and companies within its catchment area. Also, it is a major source of revenue generation for national development.

However, for some time the scope of exploitation of the Ankobra has been stretched to the point that if proper control mechanisms are not put in place, the Ankobra resources can no longer sustain the existence of its beneficiaries. There are numerous problems that have emanated in the Ankobra basin due to uncontrolled human exploitations mostly from illegal activities. These human activities have now affected the entire ecosystem both the flora and fauna within the Ankobra). Water pollution from mining activities is affecting aquatic animals as well as human beings.

Illegal logging particularly the destruction of mangroves for both construction and domestic uses have directly and adversely impacted fish stock and livelihoods of people in the area. Development of settlements and other human activities including unorthodox cutting of bamboo have degraded the riparian lands along the river.

Sustainable agriculture requires that soil and water quality be maintained. Some farm practices have the potential to cause environmental harm, which may affect human and marine animals. However, clearing of land for commercial and individual farms along the banks of the Ankobra has become quite common. The riparian areas serve many ecological functions, some of which act to protect water quality or maintain an ecological balance in a water body are hugely impacted by such commercial farm developments.

The aforementioned problems and many more to be discussed later affect the marine ecosystem. The irony of this situation is that there seem to be less attention paid to the problems in the Ankobra though its contribution to national development and livelihood of surrounding communities is quite enormous. Different attempts to solve the Ankobra problems have been initiated by various stakeholders but commitments and results have been minimal.

One of the sensitive areas affected by human activities in the Ankobra estuarine is the marine ecosystems and particularly the fish stock which has witnessed massive decline over the years. Fishing stock has been affected in several ways. Firstly, the mining activities which create water pollution through chemical deposits have negative impact on all living organism in the river of which fishes are the most affected. Secondly, the depletion of mangrove for biofuel and construction deny fishes a safe haven for breeding. These and others including methods employed in fishing have affected fish stock recognized through dwindling fish catch over the years.

Fish stock depletion has tremendous effect on livelihoods of coastal fisher folks and the nutritional aspects of the nation as a whole. There is also the possibility for the extinction of

[1] Encyclopedia Britannica (2012), The Ankobra River, website Information

certain fish breed. The effect of our human activities may not be known to communities that are causing such problems. Responsible agencies mostly government agencies though are aware of these problems, efforts to solve them has been minimal at best. Concerned private organizations as well as donors have made efforts at addressing some of these problems. One of such efforts emanated from the USAID through the American government under the Sustainable Fisheies Management Project (SFMP).

1.2 The purpose of the SFMP in the Ankobra

The USAID through its previous involvement in projects like CSLP has already recognized a host of these problems in the Ankobra River estuarine and its effect on the ecosystem. The immediate impact of these is fish stock depletion and its multiplier effect on livelihoods. The lack of effective response to solve these problems in the Ankobra as already mentioned has prompted the USAID on the importance of continuing and contributing to previous attempts by the district assembly, the government, the private sector, the communities and the CSLP. This time the USAID's effort is through the Sustainable Fisheries Management Project (SFMP) which has been tasked with improving and increasing fish stock in Ghana in the next five years (2015 – 2019). The resuscitating of the Ankobra ecosystem will contribute to the overall mandate of SFMP which is to replenish the general fish stock in the country. Its aim is to accomplish this through the implementation of the following activities;

- Identification of the different land uses in the estuarine
- Which of the land uses are posing a threat to the estuarine
- Which of the land uses are a threat to the mangroves depletion
- Involve stakeholders in the study to expose them to dangers posed by humans to the ecosystem
- Disseminate information gathered as a means of exposing to the general public the threats of human activities and how these can be minimized

1.3 Project Area

From the river source to the estuary at Sanwoma, Ankobra is about 110 km long. However, due to limitations with resources especially time, the study is unable to cover the entire stretch of the river. As a result, the SFMP has selected the area of the Ankobra closer to the sea where mangroves and human settlements are concentrated. The emphasis on mangroves in the selection of the project area stems from the fact that mangroves are important nursery grounds for many demersal fish species. The project therefore stretches from the main estuary at Sanwoma to Kukoavile within a 2.5 km buffer along the River, covering communities at both sides as shown by figure 1.1. There are ten communities within the area.

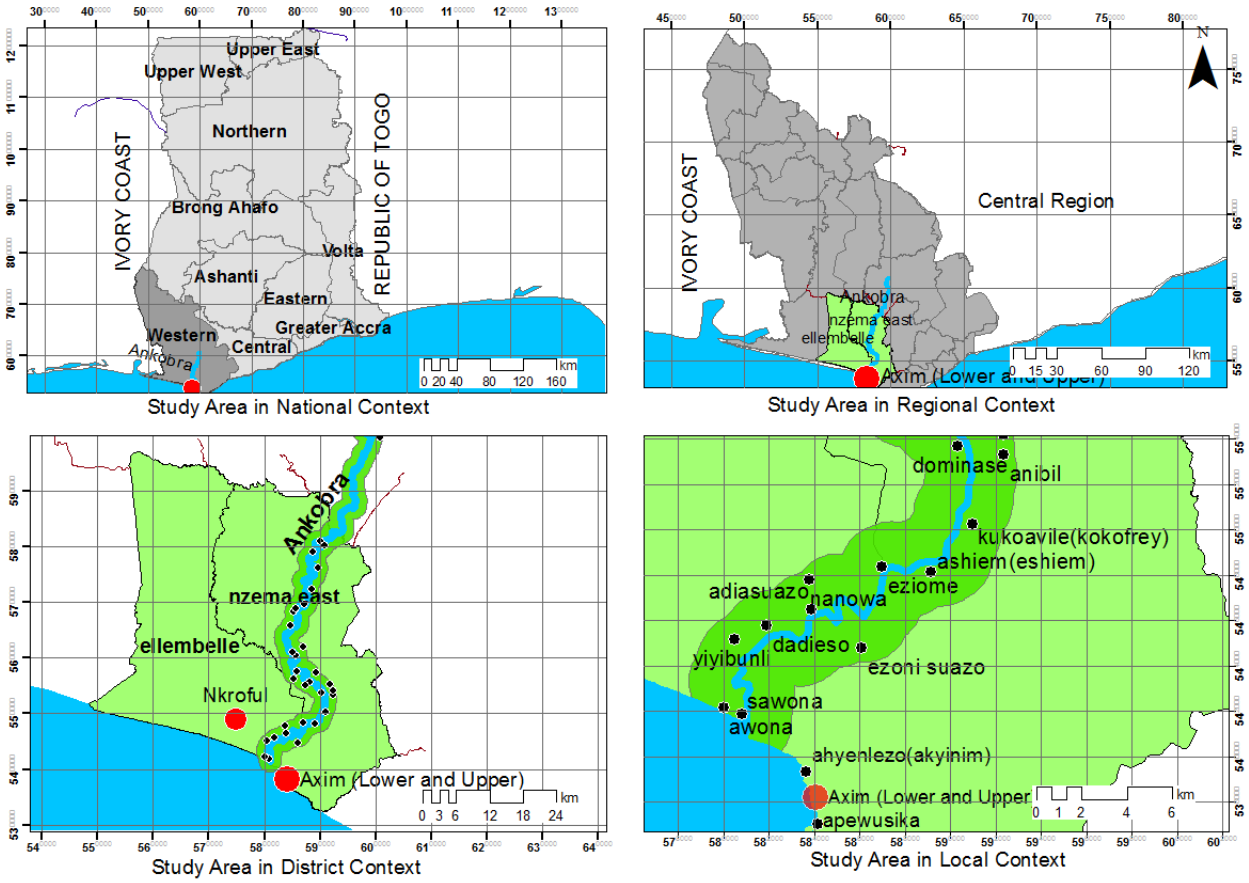


Figure 1 Location of Study of Area

Source: Spatial Solutions 2015 Based on Ghana Statistical Service Data

1.4 Scope of the Project

The project will examine land uses in the Ankobra estuarine and their implications for the current ecosystem as well as future spatial implications for the sustainability of the Ankobra particularly the mangroves. Particular attention will be focused on the land use implications for the mangroves and the extent of its exploitation.

1.5 Limitations of the Project

As part of the SFMP, the project has benefitted from all available support required for its execution and completion. However, there were few challenges which were beyond the control of the SFMP managers. These have been discussed below;

1.5.1 Duration

The project in the first year has been constrained by time due to its slow start resulting from administrative procedures. Some of the valuable data acquired like the rapid eye satellite imagery needed additional time to be processed. The limited timeframe within the six months period (year one) assigned for data acquisition and processing made it impossible for the completion of this task. Basically, year one was only six months. Some of this information will be processed and made available in year two. The information will be used for further updates and similar projects will be executed in other locations.

1.5.2 Coverage

It would have been appropriate to examine the entire River Ankobra particularly of the northern areas where heavy mining activities and deforestation are occurring especially in the Tarkwa, Bogoso and Nsuta areas. A lot of the activities have caused extensive water pollution and influence the salinity of the water in the project area and further into the sea. These activities have serious concerns for the marine ecosystem of the entire Ankobra River and the ocean. However, time and resources will not permit such an extensive study and secondary information from uncovered areas served as supplement to available data.

Plate 1 Focus group discussion at Sanwoma

Plate 2 Focus group discussions at Kukoavile

1.5.3 Data Availability

Demographic data has been difficult to access since most of the Ghana Statistical Services data analysis have not been disaggregated to cover most of the settlements due to their sizes and population threshold. In addition, some of the new settlements were not in existence during the 2010 census. However, through community interviews and focus group discussions, the differing sizes of the communities including population changes are estimated.

Another setback was the unavailability of updated satellite images. Though much reliable, the Landsat satellite imagery used for land cover changes ranges from 1990 to 2010. The next reliable and updated image was the rapid-eye which needed further processing. Community

participatory mapping was the alternative reliable method used to supplement the Landsat data.

In addition to the data being dated, organizations such as Adamus resources that own large concessions of the Ankobra area have undertaken similar sustainability projects in the area but have not been forthcoming in data sharing. Though officials of the company have granted interviews to the project team, the actual results of the company's Bio-Diversity Action Plan for the Ankobra has not been disclosed.

2 PHYSICAL AND SOCIO-ECONOMIC CHARACTERISTICS OF PROJECT AREA

2.1 Physical Characteristics

The physical and natural environments are essential elements that partly determine the socioeconomic development of the Ankobra estuarine. This stems from the fact that, apart from being potential resources, they also serve as receptacle for development activities. Critical components of the physical and natural environment that require extensive analysis in relation to the overall objective of the project include wetlands, vegetation and settlements.

According to Wayo (2002) the wet evergreen forest ecological-zone covers most of the southern downstream section of the Ankobra Basin[2]. It has relatively poor soils and therefore is not attractive to cocoa farmers. However, plantations of rubber trees, oil palm and coconut palm dominate the zone.

Settlement pattern of the project area is more of a linear type highly influenced by the Ankobra River course and tributaries. The benefits derived from closeness to the river cannot be overemphasized as most of the activities among the communities are water dependent. The sizes of the settlements are quite small and as will be pointed out by land cover analysis under section 3, forms a minute proportion of the project area.

2.2 Socio-economic profile and Benefits of the Ankobra Estuarine

The project area is entirely rural as the population of the local communities ranges from about 25 in Eshiem to 3,500 in Sanwoma. Kukoavile, the second largest community also inhabits an estimated 1,200 people. Either directly or indirectly, the people in the communities depend on the River and its basin for their livelihoods.

The water, a major resource in the Basin is used for domestic and industrial purposes, especially, in the metal extraction industries, but insignificantly in the agriculture sector because of the abundance of rainfall in the area throughout the year.

The main occupation within the area is agriculture, which employs about 65% of the entire population. The majority of the people indulge in slash and burn or shifting cultivation on a subsistence scale. They grow staples such as plantain, cassava and cocoyam. However, companies like Ghana Rubber Estate Limited (GREL) as well as individuals in the basin cultivate cash crops like, oil palm, and rubber.

[2] Wayo Seini (200), Agricultural Growth and Competitiveness under Policy Reforms in Ghana, ISSER, University of Ghana, Legon.

Though the hallmark of the Ankobra Basin is the intensive mining operations, which are of utmost importance in context of the national economy, the only active mining is operated by Adamus Resources whose concessions cover majority of the basin under the project area. More than ten large-scale surface gold and other metal mining companies are hosted in the basin up stream in the areas of Tarkwa, Bogoso and Nsuta. In addition, many small-scale ventures and illegal mining (galamsey) operations are also found in the basin.

2.2.1 Existing Mining Activity in the Area

Though the hallmark of the Ankobra Basin is the intensive mining operations, which are of importance in context of the national revenue generation, the only active mining is operated by Adamus Resources (AR) whose concessions cover majority of the basin under the project area. As shown by figure 2.1, part of AR mining concession covers the entire sensitive area under the project on both sides of the Ankobra. Their influence covers administrative boundaries of both Ellembelle District and Nzema East Municipality.

Though the company owns a large concession about only five percent of their authorized operational area is being mined though they actively continue with mining prospecting within their concession. Currently, the influence of the mining activity on the ecosystem is not significant. However, there is a possibility to increase production as potential deposit areas emerge.

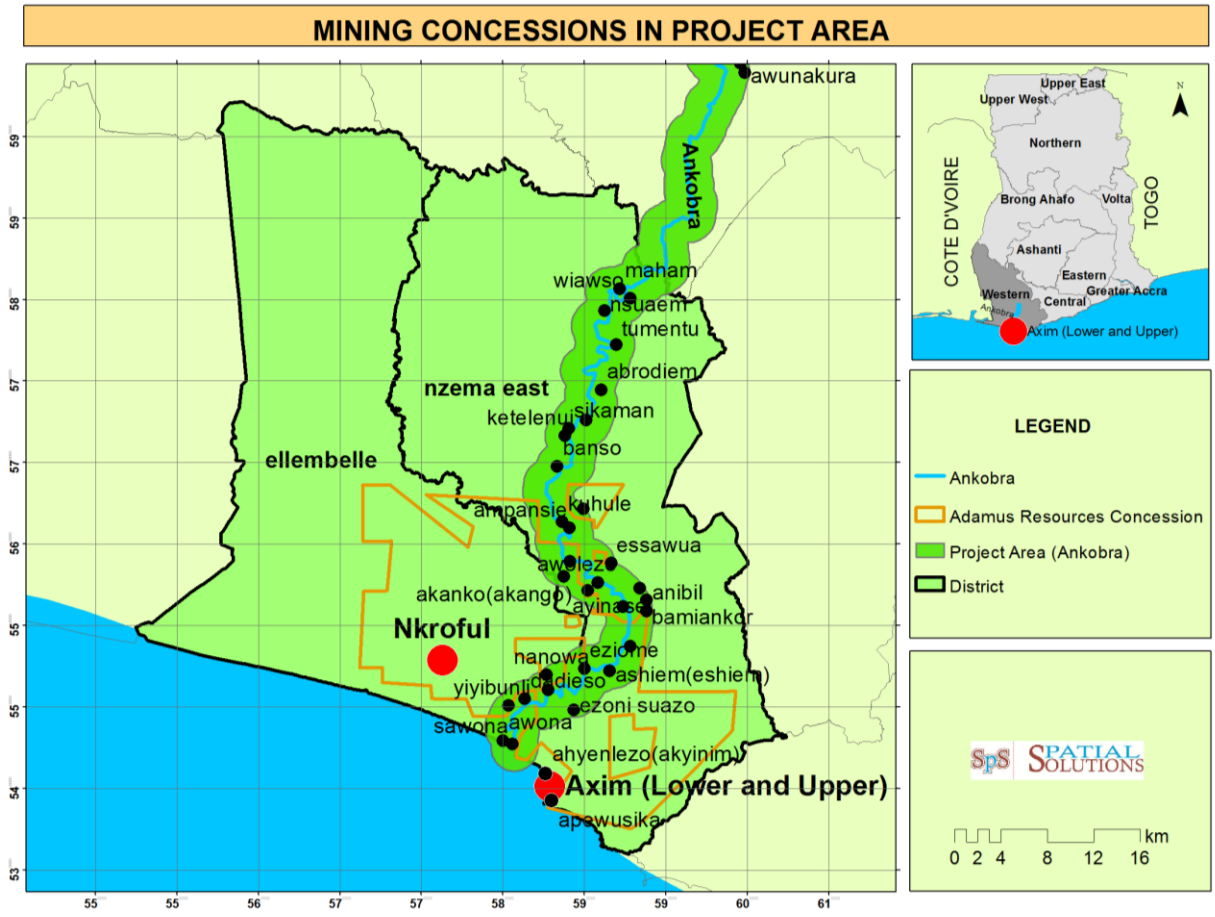


Figure 2 Mining Concessions in Study Area

Source: Spatial Solutions 2015 Based on Adamus Resources Data

2.2.2 Fishing, Logging and Farming in the Study Area

There is little fishing in the basin. Commercial fishing activities are confined to Sanwoma, the only major fishing community within the basin. Other fishing activities take place in the streams and rivers on a subsistence scale.

Logging is an important industry within the basin and harvesting of bamboo and mangroves as well as other commercial tree is carried out extensively within the project area. Most of the bamboo supplied to Accra for furniture making come from the Ankobra area. Fuel wood, harvested mainly from the forests, is the main source of energy for the residents within the basin.

Generally, a greater percentage of the people rely on farming done on subsistence basis resulting in low levels of incomes.

2.3 Social Infrastructure

It is envisaged that availability or non-availability of social facilities may influence behavioural processes of the community and the way they react to their environment particularly the use of the coastal line as alternative for different activities. It is easier to

implement proposals for Ankobra ecosystem sustainability if there are educated and healthy communities that also have the necessary infrastructural support systems.

All the communities visited have social gathering centers where meetings and social programs are held. These places also act as official places for information dissemination. Though some of them are small in size almost all of them were in good condition probably due to the quality of construction materials used. The only three communities with improvised market have them located next to these community centers.

2.3.1 Educational Facilities

The most social amenities needed in all communities are education and health facilities yet they are lacking. Out of the ten settlements four have basic (primary) education facilities. The only communities with Junior High Schools (JHS) are Sanwoma, Kukoavile and Adelekazo. Though some of the schools' physical structures appear strong, majority of them are in dilapidated state as shown in pictures below.

Plate 3 Primary School at Sawoma

Plate 4 Primary School at Adelekazo

Plate 5 School at Eshiem

Plate 6 Primary School at Kukoavile

2.3.2 Health Facilities

Apart from Sanwoma which has a community-based health planning and services (CHPS) compound, all the other settlements do not have health facilities. Sources of drinking water for about 95 percent of the communities are from streams and hand dug wells provided by charity organizations. About 90 percent of the wells have dried up. There are no proper sanitation facilities for managing waste. Solid waste from the communities is dumped in the river, streams and the sea depending on the location of the community and the closeness of these sources mentioned. A few of the villages have public places of convenience whilst areas like Sanwoma resort to open defecation along the beach and in the bushes at the outskirts of settlements.

If there has to be a measurement of poverty using the access deprivation index with indicators like access to electricity, potable water, sanitation and proper roofing then the conclusion can be drawn that most of the people in the communities are poor. The lack of access and poverty levels may indirectly have a correlation with the extent of devastation of the Ankobra estuarine by the community. Proposal to address the problems of the Ankobra may also look at access to social infrastructure as well.

3 LAND COVER DYNAMICS IN THE PROJECT AREA

Satellite data from the Forestry Commission relating to the period 1990 to 2010 broadly classifies land cover in Ghana into five types; Wetlands, Forestlands, Croplands, Grasslands and Settlement cover[3]. Details of the type of satellite data and modalities of classification can be found in appendix 2. Despite that the data is about five years old and extremely generalised for a local study such as the one being undertaken, it is the only available source for understanding land cover dynamics for a longer period such as two decades. The need for a more refined, detailed and updated satellite imagery to better inform spatial analysis of land cover dynamics has not only been identified but the process of acquisition has started.

Understanding and quantifying mangrove changes as well as identifying areas of gains and losses better serves the overall objective of the project. The Ankobra estuary is dominated by two main species of mangroves – Rhizophora and Avicennia. However, the broad land cover data does not specifically classifies mangroves as a distinct land cover type. From the modalities of existing land cover classification, ecosystems literature and observations of the study area, wet and forest lands appear to be the closest proxies to mangroves. Subsequently, the dynamics, trends and patterns relating to the two land cover types have been emphasised.

3.1 Land Cover Changes and Composition in the Study Area, 1990 and 2010

The study area which is within a 2.5 km buffer along Ankobra River (from the estuary to Kukoavile) covers about 100 km^2. The spatial planning guidelines of Ghana also prescribe a 50 metre[4] buffer reservation along water bodies. This section therefore examines land cover composition and dynamics between 1990 and 2010 for two spatial scales; the 50 metre buffer and the entire study area (2.5 km buffer).

3.2 Land Cover Dynamics in 50m Buffer

3.2.1 Land Cover Composition, 1990 and 2010

The 50 meter buffer stretches from the estuary to Kukoavile extending over an estimated 19.5 m^2 total land area. The area was largely constituted by forest and wetlands in 1990 as the two absorbed about 99 percent of the total land area with the former holding the highest (50 percent) as shown by figure 3.4 There was no settlement cover within the buffer in 1990 whiles grass and crop lands held only 0.9 and 0.1 percent of the buffer area respectively.

Evidence of massive human interactions within the 50 meter buffer area over the two-decade period is observed. From table 3.1, forest lands decreased woefully by about 380,000 m^2 by 2010. Contrary to the decline in forest lands, other land cover types appreciated. Wetlands increased from about 950,000 m^2 in 1990 to 1.1 million m^2 in 2010, triggering an increase in share from slightly below (49 percent) to over half (56 percent). Wet and forest lands accounted for 87 percent – about 12 percent less of the previous share - of the buffer area in 2010. Some settlements expanded to cover about 12,000 m^2 of the buffer area while grass land pushed its share of total land area from below a percent to close to a tenth (8.5 percent) during the two decades under consideration.. In the quest for livelihoods, farming activities increased during the period as the croplands increased significantly from just about 3,000 m^2 to 79,000 m^2.

[3] Forestry Commission, 2013, Land Use and Land Use Change and Forestry, Ministry of Land and Natural Resources.

[4] Ministry of Environment, Science and Technology, Town and Country Planning Department (2011), Zoning Guidelines and Planning Standards. Republic of Ghana.

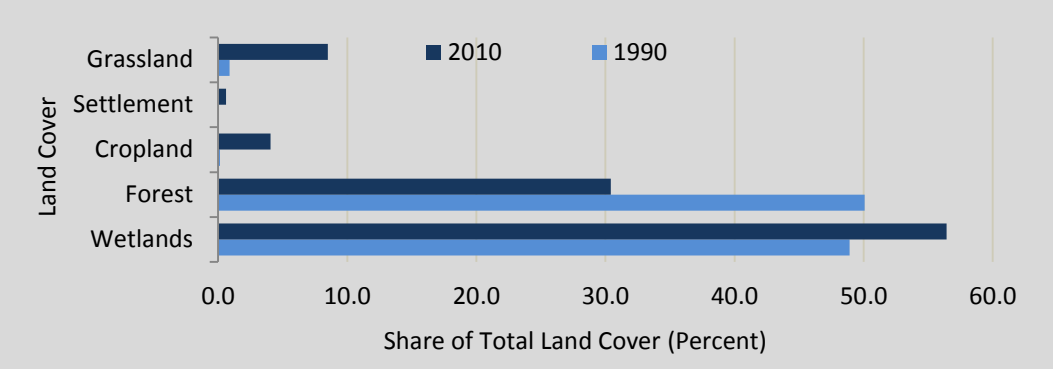


Figure 3 Land Cover Composition in 50m Buffer along Ankobra River

Source: Spatial Solutions 2015 Based on Forestry Commission's Land Cover Data

The annual rate at which farming activities are undertaken in the 50 meter buffer preservation far exceeds any other land cover change as croplands grew by about 18 percent (annually) shown by table 1. On the other hand, forestlands declined by an alarming 2.4 percent annually over the period. The rapid growth of croplands juxtaposed by the steadily fall in forestlands presents perhaps, at the local level, the competing strands between the quest for economic development (livelihoods) and environmental preservation. However, it must be emphasized that when well-managed, the two can be mutually complementing. Grass lands also increased at a significantly high rate compared with a mild increase in wetlands. Does the growth in wetlands connote no loss in the land cover within the 50 m buffer over the period?

Table 1 Summary of land Cover Composition within 50m buffer

	Area '000 (sqm)		Share (%)		AGR (%)
	1990	2010	1990	2010	
Wetlands	950	1,103	48.9	56.4	0.7
Forestland	973	594	50.1	30.4	-2.4
Cropland	3	79	0.1	4.1	18.1
Settlement	0	12	0.0	0.6	
Grassland	17	166	0.9	8.5	12.1
Total	1,942	1,955	100	100	

Source: Spatial Solutions 2015 Based on Forestry Commission's Land Cover Data

3.2.2 Wetland Change, 1990 – 2010

In spite of the fact that wetlands within the 50 meter buffer area appreciated, one cannot be absolute that there were no wetland losses during the two decades. In exploring the question above, this section examines changes in wetlands between 1990 and 2010.

From figure 4, close to 6 percent (53,000 m^2) of wetlands in 1990 were taken over by other land cover types with forest and grass lands being highest recipient. Settlements consumed about 11,000 m (1.2 percent) of wetlands while an estimated 6,000 (0.6) was converted into cropping. It thus, means that some areas within the buffer are gaining wetlands whereas others are losing. There is however, a positive net sum change in the land cover. In spite of

this, the losses in some areas in a zone supposed to be preserved raise deep seated issues regarding the protection of ecosystem along the Ankobra River and in Ghana as a whole.

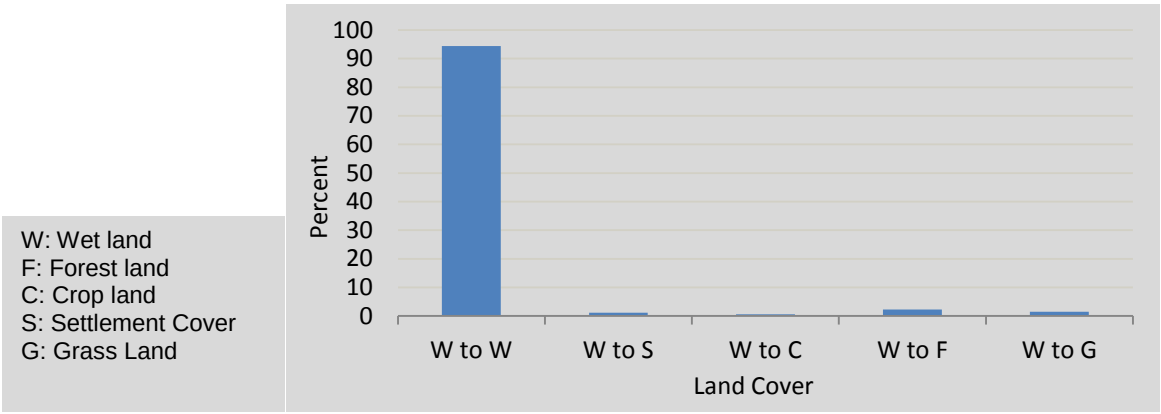


Figure 4 Wetland Change, 1990 – 2010

Source: Spatial Solutions 2015 Based on Forestry Commission's Land Cover Data

3.2.3 Dynamics of Declining Forest Cover in the 50m Buffer, 1990 – 2010

Forest lands together with wetlands, do not only serve as proxies for mangroves from the existing land cover data but more importantly, forms an integral part of the ecosystem within the zone. As pointed out earlier, forest lands are declining in a zone meant to be protected. This section examines in details the dynamics of forest cover which has been presented in figure 4.

Over 40 percent of forestlands were lost between 1990 and 2010. Perhaps a mild consolation is that 20 percent (200,000 m^2) of forestlands were taken over by wetlands. About 15 percent (140,000 m^2) of the deforested lands were replaced by grass lands whereas croplands consumed 7.5 percent (73,000 m^2). Settlements absorbed the least (900 m^2) of forest lands during the period

One issue which arises at this point is how grasslands consume forestlands? Further probing through consultations with some key informants and community leaders in the study area revealed that grasslands are gained at the expense of forestlands when farmers in an attempt at cropping, deforest the latter, burn and leave the land for some time before cropping. Grasses crop up during the period between burning and actual cropping. Going by this explanation, increases in grasslands can be added to that of croplands to fully estimate the impact of the quest for livelihoods on forest lands. Croplands, grasslands and settlements collectively subsuming about 215,000 m^2 forest lands can directly be attributed to human interventions in the ecosystem.

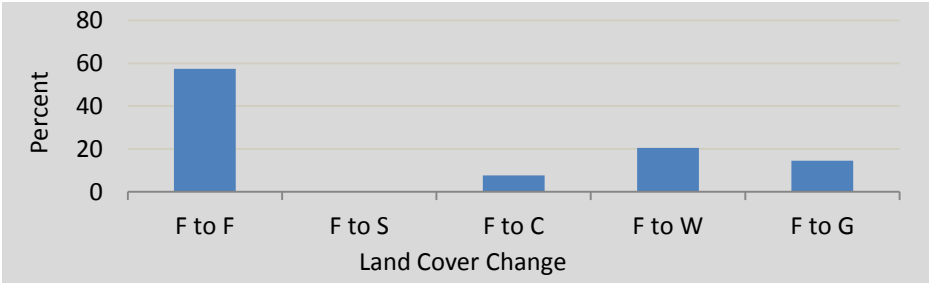


Figure 5 Forest Cover Change within 50 m Buffer, 1990 – 2010

Source: Spatial Solutions 2015 Based on Forestry Commission's Land Cover Data

3.3 Land Cover Composition within 2.5 km Buffer (Study Area), 1990 – 2010

There are striking differences in land cover dynamics and patterns in the study area as compared with that within the 50 meter buffer. First, in 1990, unlike the latter – which was more of an equal split between forest and wet lands -, the study area was about 90 percent forest. As spatially shown by figure 3.4, with the exception of the eastern parts of Ezoni Suaso – which was dominantly wetlands -, the forest cover in 1990 was found almost everywhere in the study area.

Wetlands, the second largest land cover in 1990, accounted for about 5 percent (4.4 km^2) of the study area whereas settlements absorbed the least share of 0.2 percent (0.2 km^2). In addition to the concentration in Ezoni Suaso area, wetlands were largely found along Ankobra as it assumed the River's shape. Among the selected study communities, only Kukoavile had significant settlement cover in 1990.

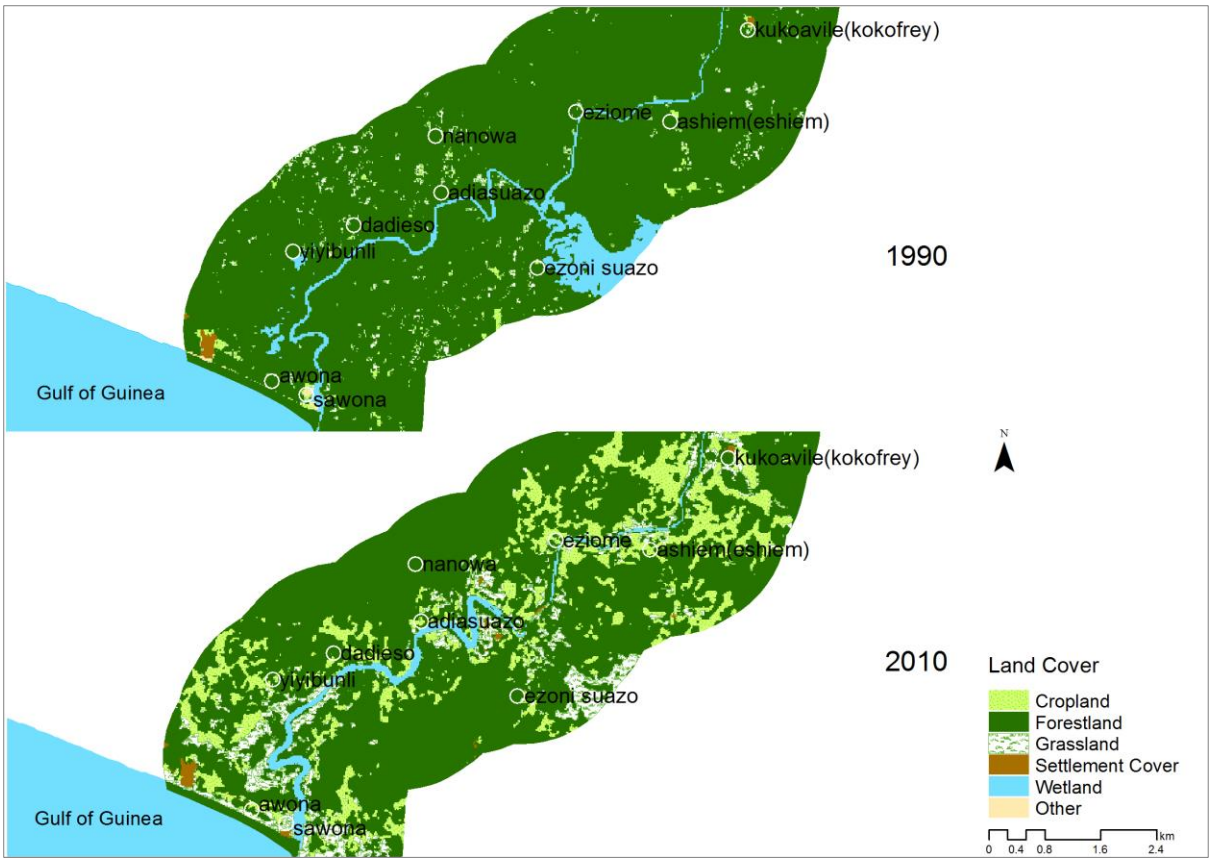


Figure 6 Land Cover Composition in the Study Area, 1990 and 2010

Source: Spatial Solutions 2015 Based on Forestry Commission's Land Cover Data

In 2010, the two land cover types that best represent mangroves declined. Forest cover fell in share of land area from 90 to about 70 percent as over 17 km^2 were lost. The annual rate of decline of forestlands stood at 1.1 percent over the period as shown by table 3.2. Generally, from figure 3.4, the fall in forest cover is more visible in areas with settlements especially, between Eziome, Eshiem and Kukoavile; west and southern parts of Yiyibunli; between Adiasuaso and Eziome; and around Sawoma and Awona.

The monumental loss of forest cover is attributable to several factors but of interest is the logging of mangroves. Mangroves logging do not only account for wetlands decrease but as well forestland decline.

Contrary to the general increase in wetlands within the 50 meter buffer, over 2 km^2 were lost in the study area in 2010. The land cover fell rapidly than forestlands as it recorded annual decline rate of -3.3 percent during the two decades. Notably, the huge concentration of wetlands in the western parts of Ezoni Suaso was lost in 2010. Again, pockets of wetlands to the south of Yiyibunli and northern part of Awona diminished during the two – decade interval.

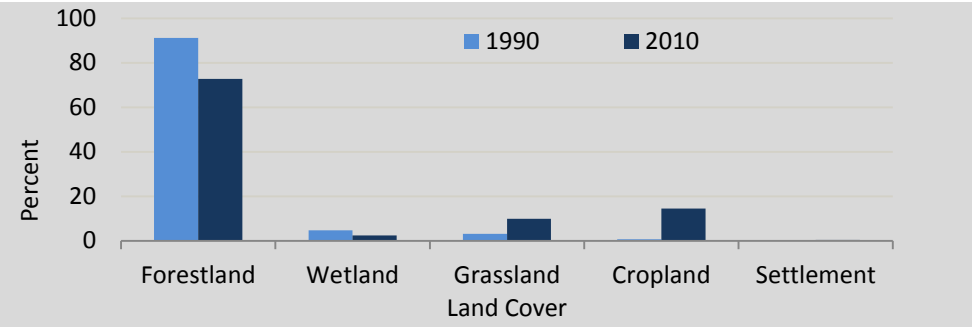


Figure 7 Land Cover Composition and Change in the Study Area

Source: Spatial Solutions 2015 Based on Forestry Commission's Land Cover Data

Croplands, grasslands and Settlement cover on the hand increased. The increase in croplands was particularly striking as the land cover jumped from occupying the least but one share (0.7 percent) of land area in 1990 to the second largest (14.5 percent) in 2010 and in the process, gained close to 13 km2 of lands previously held by other land cover types. The annual rate of growth in croplands is even more imposing. Over the period, the land cover grew at an accelerated pace of above 16 percent annually. From figure 3.4, cropland increase is observed along wetlands and around settlements. However, significant concentration of the increase is found between Kukoavile, Eziome and Eshiem as well as the west and southern areas of Yiyibunli. The study area, a zone designated as nature reserve in the Spatial Development Frameworks (SDFs) of the two districts (Nzema East and Ellembelle) is thus fast turning into farmlands. Again, this practically demonstrates how at the local level, the quest for survival (livelihoods) conflicts the preservation of the natural environment or ecosystem.

Grasslands which as pointed out earlier from local knowledge can be seen as a function of croplands also grew rapidly at an annual rate of 6 percent. With about 6.4 km2 gains, the land cover increased its share of land area from a little over 3 percent in 1990 to a tenth in 2010. Grassland increase is particularly found between Sawoma and Yiyibunli, along the wetlands and western part of Ezoni Suaso, an area which was formerly occupied by wetlands.

The two decades also witnessed expansion of existing settlements and proliferation of new ones. As spatially presented by figure 3.4, settlement expansion is notable in Sanwoma and Kukoavile. In all, settlement cover grew significantly at 2.8 percent annually, gaining over about 0.2 km2 of land at the expense of the marine ecosystem.

Table 2 Summary of land Cover Composition and Change in the Study Area

	Area (km^2)		Change (km^2)	Share (%)		AGR (%)
	1990	2010		1990	2010	
Wetland	4.38	2.25	-2.13	4.72	2.42	-3.28
Forestland	84.85	67.69	-17.16	91.27	72.74	-1.12
Cropland	0.66	13.50	12.84	0.71	14.51	16.31
Settlement	0.21	0.37	0.15	0.23	0.40	2.77
Grassland	2.86	9.25	6.39	3.08	9.94	6.05
	93	93		100	100	

Source: Spatial Solutions 2015 Based on Forestry Commission's Land Cover Data

3.4 Wetlands Change and Distance from Ankobra River

At this point, it is clear that the dynamics of wetlands over the two decade interval – as to whether there is net sum increase or decrease – varies with distance. For instance, as earlier established, there is net sum increase in wetlands within 50 meter buffer from Ankobra as compared with a general fall in the land cover in the entire study area (which is within 2.5 km buffer). Stemming from this, the details of wetlands gains and losses at varying distances from the River has been closely examined and presented by figure 3.6.

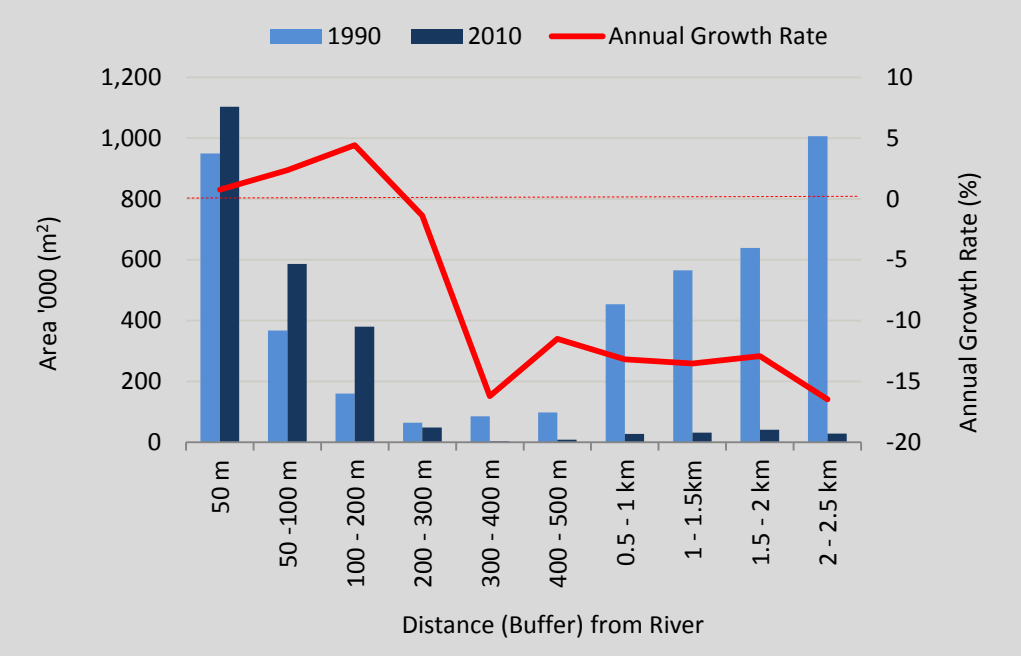


Figure 8 Wetlands Change and Distance from Ankobra River

Source: Spatial Solutions 2015 Based on Forestry Commission's Land Cover Data

From figure 3.6, distance of 200 meters from Ankobra was the turning point beyond which wetlands generally began to fall. What differs after the 200 meter is the extent of fall in the land cover. Preceding the turning point distance (200 m), the annual rate of growth in the land cover increased from 0.7 percent within 50 meter buffer to 2.4 percent between 50 and 100 meter buffer and attained its peak of 4.4 percent between 100 and 200 meter buffer. The rate then started turning negative between 200 and 300 meter buffer and reached an alarming -16.2 percent in the 300 – 400meter buffer. The annual rate at which wetlands were diminishing decreased to -11.5 percent in the 400 – 500 meter but only to resume an increase in the 0.5 – 1 km buffer and further to 1 – 1.5 km. The last buffer (2 - 2.5 km) in the study area recorded the highest annual decline rate of 16.5 percent. Spatial evidence of the rate of depletion in wetlands with increasing distance from the River is presented by figure 3.7. The heavy decline in the 0.5 to 2.5 km buffers is largely influenced by the loss in the Ezoni Suaso area.

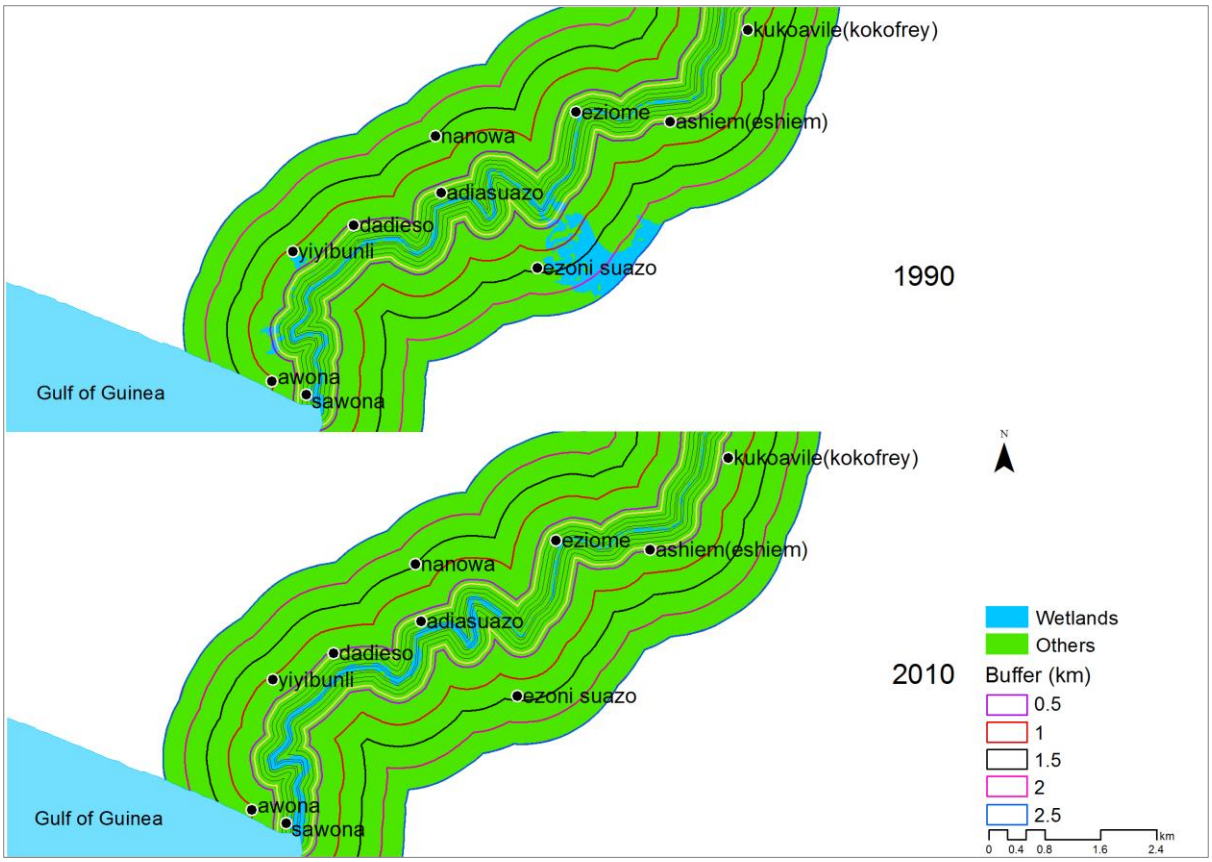


Figure 9 Spatial Overview of Wetlands Change and Distance from Ankobra

Source: Spatial Solutions 2015 Based on Forestry Commission's Land Cover Data

3.5 Dynamics of Wetland Change in Study Area, 1990 – 2010

Having established the fast rate of depletion of wetlands, this section examines the details of the depletion as to which land cover type is absorbing what quantum. About two thirds (3 km^2) of wetlands in 1990 were taken over by other land types during the 20 year period as shown by figure 3.8. Perhaps a consolation for the diminishing wetlands is that more than a third (37 percent) of the loss was to forestlands which also represent a vital component of the ecosystem.

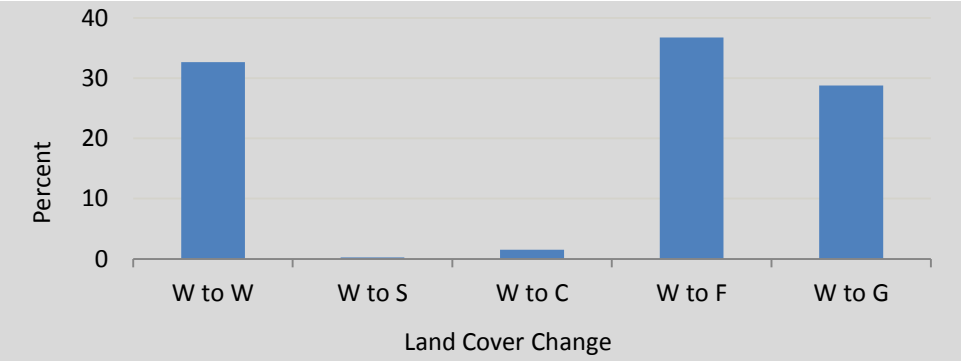


Figure 10 Wetland Change in Study Area, 1990 – 2010

Source: Spatial Solutions 2015 Based on Forestry Commission's Land Cover Data

It was observed from field survey that despite the depletion of mangroves in some areas, other areas had mangroves which had grown as big trees with large trunks. From the modalities of the satellite data classification (which is presented in appendix), the closest attribution to the change from wet to forest lands could be the reclassification of previous wetlands as forestlands owing to the growth of mangroves over the two decades. However, as pointed out earlier, a more detailed satellite data is required to provide much clarity as to the exact dynamics of land cover change.

Grasslands, croplands and settlement cover which as argued earlier are human induced, consumed about 30 percent (1.3 km^2) of wetlands during the period. Spatially, as presented by figure 3.9, the change from wet to grass lands occurred largely at the western parts of Ezoni Suazo.

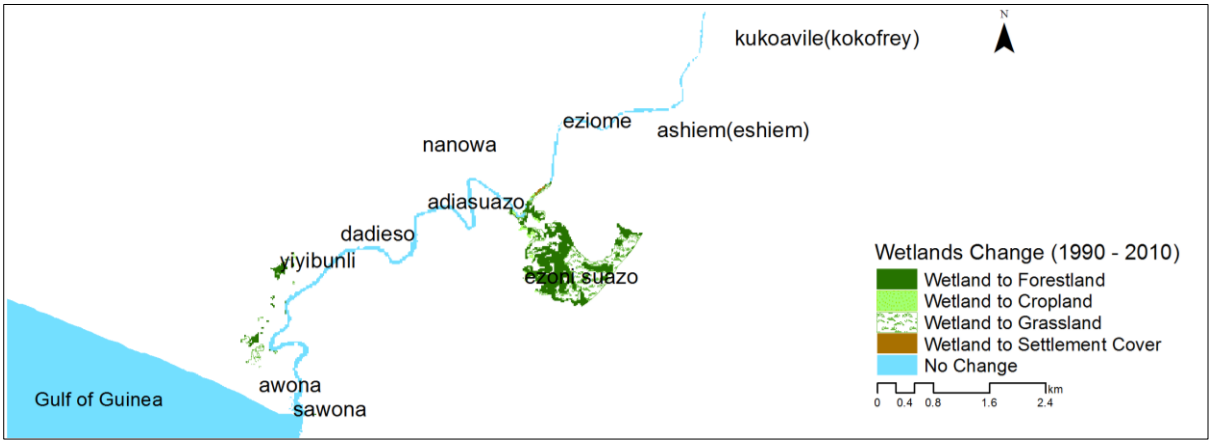


Figure 11 Spatial Overview of the Dynamics of Wetlands Change, 1990 - 2010

Source: Spatial Solutions 2015 Based on Forestry Commission's Land Cover Data

3.6 Forest Cover Change and Distance from Ankobra River

As earlier identified, there was a decline in forestland in both the 50 meter buffer and the entire study area. This section examines in detail the dynamics of forest cover change and distance from Ankobra River. From figure 3.10, for all distances considered, forest cover loss is observed. What differs among the distances (buffer rings) is the extent of forest cover depreciation.

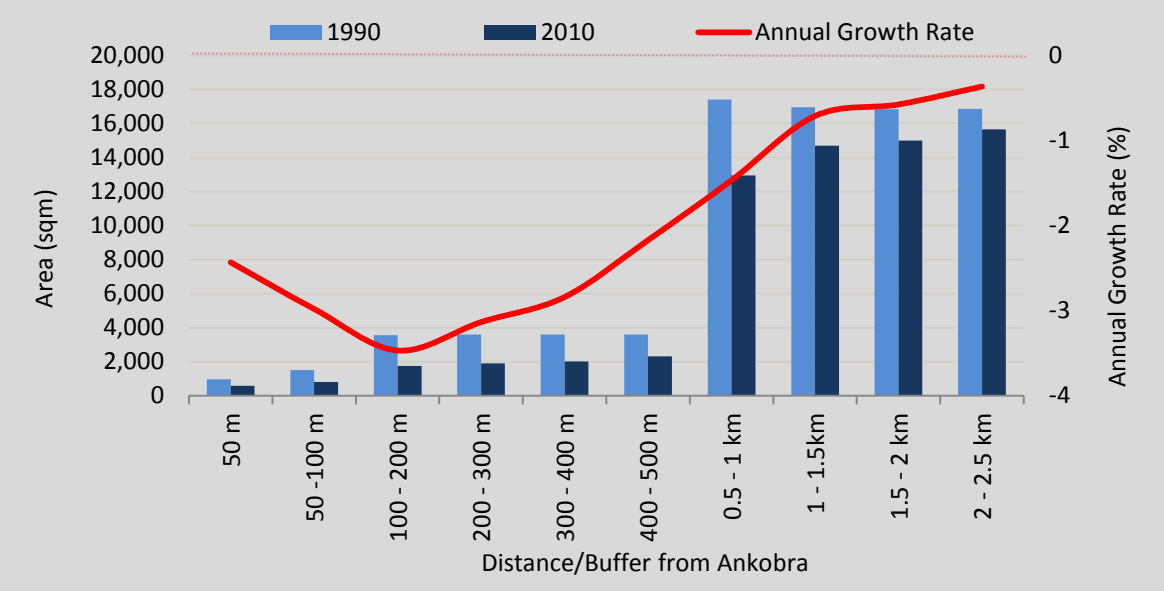


Figure 12 Forest Cover Change and Distance from Ankobra River

Source: Spatial Solutions 2015 Based on Forestry Commission's Land Cover Data

The annual rate of decline in forest cover increased from 2.4 percent in the 50 meter buffer to 3 percent in the next buffer (50 – 100 m) and further to a peak of 3.5 percent in the 100 – 200 m buffer. The decline in the land cover within the first three buffer rings (50, 100 and 200 m) largely occurred at areas closer to settlements especially, between Sanwoma and Adiasuazo as shown by figure 3.11.

Beyond the distance between 100 and 200 m, unlike wetlands, the annual rate of decline in forest cover falls. Following this trend, the highest considered distance (2 -2.5 km) the lowest annual decline rate (0.4 percent). Among the 500 m interval rings, 0.5 – 1 km buffer recorded the highest annual decline rate (1.5 percent). This loss occurred predominantly at areas around Kukoavile, Sanwoma and southern parts of Yiyibunli.

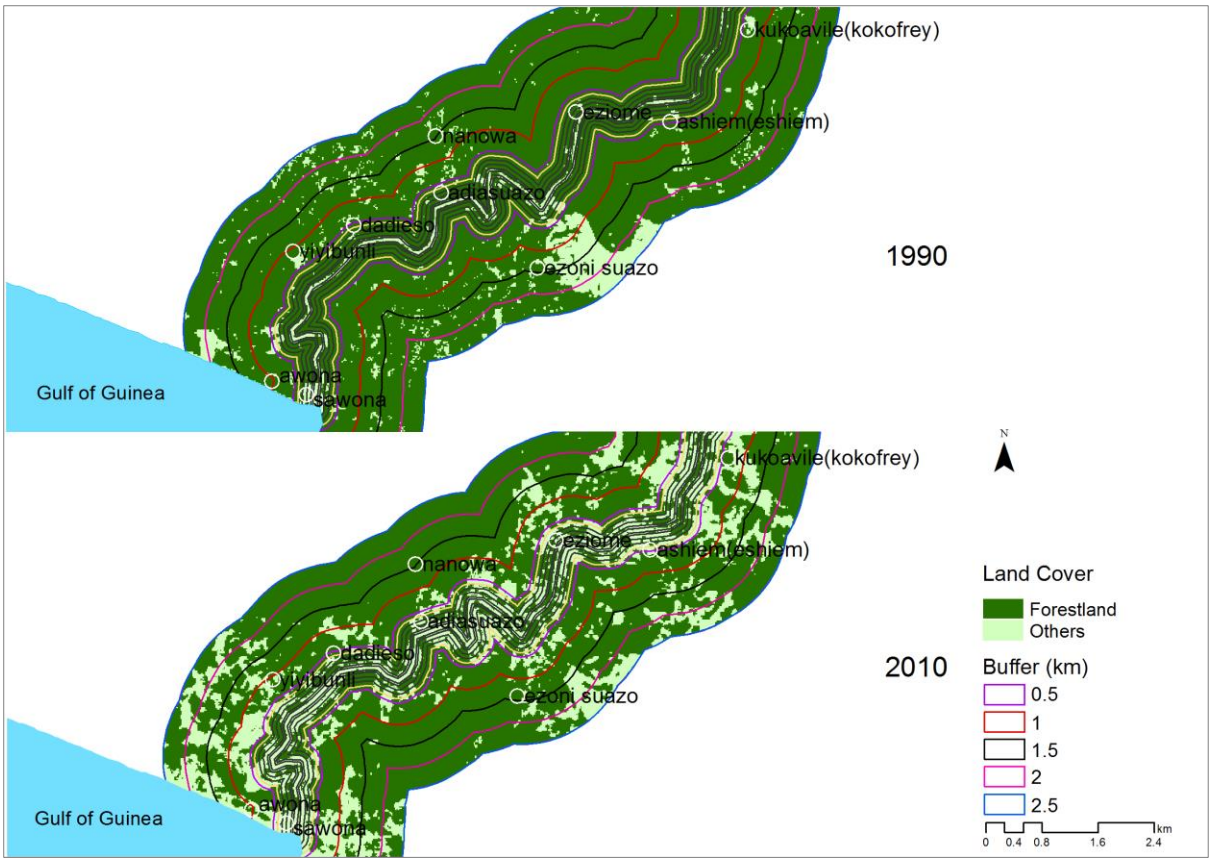


Figure 13 Forest Cover Change and Distance from Ankobra

Source: Spatial Solutions 2015 Based on Forestry Commission's Land Cover Data

3.7 Forest Cover Change in the Study Area, 1990 – 2010

Wetlands are declining steeply but even more alarming, is the accelerated rate at which forest lands are diminishing. About a quarter (21.4 km^2) of forestlands in 1990 were lost over the two decades. About 60 percent (13 km) of the forestland loss was to croplands. In all, as shown by figure 3.12, croplands consumed 15 percent of forest lands that existed in 1990. Grasslands also absorbed about 35 percent (7.6 km) of forestland loss which represents 9 percent of forestlands in 1990. As earlier advanced, within the context of the study area, grasslands arise normally owing to farming related activities. Farming activities (crop and grass lands) accounted for about 95 percent of losses in forestlands.

The expansion of existing settlement coupled with the formation of new ones subsumed the least (0.1 percent) proportion of forestlands. However, in assessing holistically, the impact of settlements formation, growth and expansion on the ecosystem, it is important to factor the impact of the activities of the people that make up the settlements. Thus, the high increase in crop and grass lands at the expense of forestlands is highly related to that seemingly small increase in settlement cover.

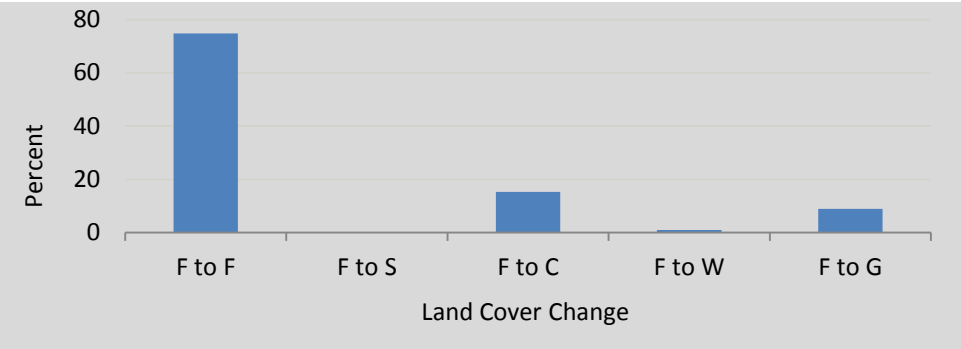


Figure 14 Forest Cover Change in the Study Area, 1990 – 2010

Source: Spatial Solutions 2015 Based on Forestry Commission Land Cover Data

Spatially, from figure 3.13, the change from forest to crop lands is generally scattered. That notwithstanding, significant concentration is observed around the settlements more especially, areas between Kukoaville and Eziome; western parts of Yiyibunli; and areas between Adiasuazo and Eziome. The people are thus, farming closer to where they live. The change from forest to grass lands is more visible around Sawoma and between Yiyibunli and Awona. Wetlands also absorbed about 0.8 percent of forest lands between 1990 and 2010. This largely occurred along Ankobra River between Sawoma and Adiasuazo.

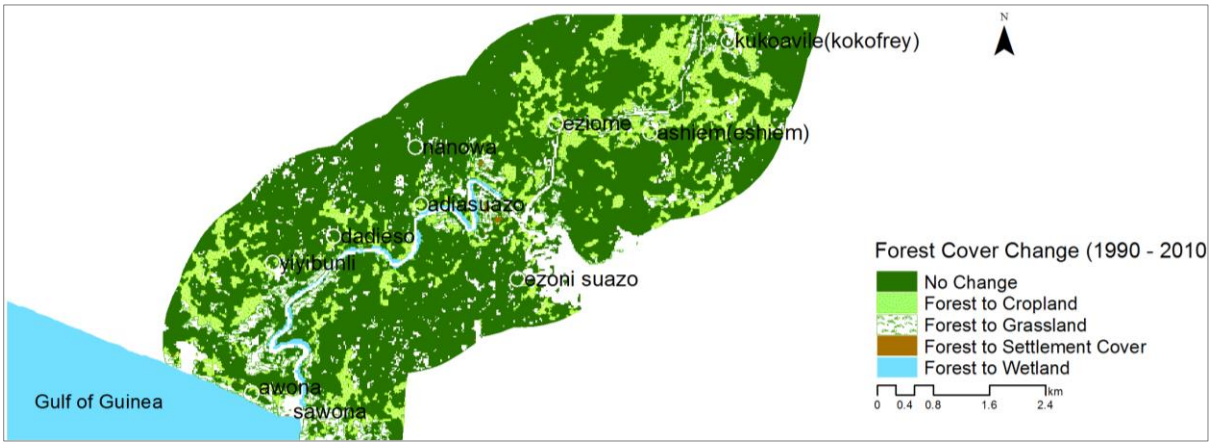


Figure 15 Spatial Overview of the Dynamics of Forest Cover Change, 1990 - 2010

Source: Spatial Solutions 2015 Based on Forestry Commission's Land Cover Data

3.8 Summary of Key Issues from Spatial Analysis Affecting the Marine Ecosystem

A number of issues have emanated from the spatial analysis of land cover patterns and dynamics over the two decade period which adversely affects the replenishment of depleting fishing stock in the basin. These include the following:

- The natural environment/ecosystem in the study area has been severely altered as collaborated by pictures in appendix 4 which shows the extent of change between March 2012 and October 2015;
- Forest and wet lands which serve as proxies for mangroves in the study area experienced massive net sum decline;

- Forest cover which constituted about 95 percent of the study area in 1990 diminished woefully in 2010 in both the 50 meter buffer and the entire study area;
- The annual rate of decline in forest cover is more severe in the 50 meter buffer than the entire study area;
- The massive loss of forest cover is widespread but more visible around major settlements;
- Wetlands recorded net sum increase in the 50 meter buffer but evidence of substantial depreciation in some areas is observed;
- The annual rate of decline of wetlands generally increases with increasing distance from the River;
- Croplands increased at a rapid pace in both the 50 meter buffer and study area than any other land cover type;
- As a result of farming related activities, grasslands increased at a significantly high rate;
- About 95 percent of forest cover loss is accounted for by farming and its related activities;
- The change from forest to crop lands is widespread but particularly overwhelming around settlements;
- Existing settlements expanded whilst new ones emerged at the expense of the marine ecosystem;
- Extremely loose enforcement of spatial planning guidelines in the study area; and weak implementation of the Spatial Development Frameworks of the two districts.

Conclusion

From all indications the land cover in the Ankobra area has changed generally demonstrating negative impacts for the ecosystem. These facts as shown by satellite information will be further explained and triangulated with current field data. As mentioned earlier, the SFMP is in the process of acquiring updated satellite images to cover the period up to 2015 which obviously will show further land cover changes. In any case the indications on land cover changes are quite alarming and as responses to address the Ankobra problems are to a larger extent absent except for effort from a few NGOs (CRC, Hen Mpoano), the need for immediate attention cannot be overemphasized.

4 PROBLEMS AFFECTING FISH REPLENISHMENT IN THE ANKOBRA ESTUARY; OBSERVATIONS FROM FIELD SURVEY

In addition to the analyses of existing satellite land cover data, the team embarked on field survey. The findings from field observations and interviews have been presented to complement and corroborate that from the land cover analyses. This is particularly necessary considering the limitations with the satellite land cover data which has been explained earlier.

Though the Ankobra estuarine is a major source of revenue generation for the nation and also provide the livelihood for all the communities, the extensive utilization of the resources has put the area under consistent threat. From the field survey, the basin is under siege from mining, logging, farming and settlement proliferation taking place along the length and breadth of the basin.

4.1 Logging of Mangrove and Bamboos

Affirming the alarming depletion of forest and wetlands from the land cover analysis, evidence of massive logging of mangroves and bamboo in the estuary was observed.

Mangroves are logged as fuel wood and serve as the main source of energy to the communities within the estuarine. They are mostly used for the smoking of fish. Aside its domestic purpose there is a surge in the use of mangroves for commercial purposes. From the field survey, mangroves closer to Sanwoma where fishing is the main economic activity have been depleted. The cutting is now being extended to communities like Eziome.

Further into the northern part of the estuary, close to Adelekazo, are concentrations of Rhizophora and Avicennia stands which have grown into huge trees. The sizes of these mangroves have attracted illegal loggers who move into these forests with heavy logging machinery to log for the construction industry. The inaccessibility of the area has also worsened the situation as these illegal activities go unchecked. The forestry commission through the district assemblies is the government agency responsible to check illegal logging but have been silent due to lack of logistics to operate.

Plate 7 Depleted Mangroves

Plate 8 Illegally Logged Mangroves being transported

Plate 9 Illegally Logged Mangroves

Plate 10 Illegally Cut Bamboos awaiting Transportation

Bamboo cutting is one of the major activities that take place at the edge of the river as shown by plate 10. Though bamboo cutting is not to be discouraged completely - as it generates livelihoods for the communities, the methods employed for cutting are destructive and unsustainable. The clear cut method is usually adopted leading to complete destruction of most of the bamboo concentrated areas along the River. Bamboo cutting causes intense destruction to the ecosystem by the impact that they create on flora and fauna and also the on damages caused to riparian lands. The bamboo that are of no commercial value are set ablaze after they are dried causing bushfire and severely destroying the marine ecosystem.

4.2 Proliferation of New Settlements on River Banks

The field survey identified the emergence of settlements in some areas along the River, confirming the increase in settlement cover from the land cover analysis. Settlement proliferation is part of expected human activities that occur as population grows and society expands. However, it is expected to be guided by proper planning as a means of avoiding unsustainable development.

The basin is currently experiencing new sporadic settlement development along the river banks with all kinds of human activities taking place (see plate 11). Intensive palm wine tapping which eventually are brewed into liquor has become a major activity driving these settlements development and all these are occurring on riparian lands. The extent of pollution

caused by these human activities though cannot be quantified. One can deduce that in the absence of proper sanitation in these newly developing settlements, most of the waste emanating from these communities will eventually end up in the sea.

Plate 11 Emerging Settlement at Ankobra River Bank

Plate 12 Insanitary Condition at River Bank

4.3 Poor Sanitation

Sanitary facilities are not available in most communities and where they are provided the conditions are quite poor. Settlements like Adrekazo which close to the river dump most of their refuse into the Ankobra River and these are drained into the sea. Sanwoma, the largest community in the area uses both the river and sea as their dump sites. The health implication from the pollution can create problem for the community and certainly for the marine ecosystem.

4.4 Plantation Farming on River Banks

Large tract of land has been cleared for rubber plantation farming close to the river banks. There are also a few tracts of cocoa and oil palm plantations in the same area. These farming activities are extensively influenced by companies like GREL and Norpalm who provide credit facilities to out-growers. This partly accounts for the rapid growth of croplands and grassland observed under the land cover analysis. Until the rubber trees are matured, the effect on the ecosystem is quite high as previous virgin forest will be lost till seven years when the rubber would mature.

See changes in the ecosystem of the Ankobra caused by farming and other human activities between 2012 and 2015 in appendix 4.

Plate 13 Land Cleared for Rubber Plantation

4.5 Mining Activities on the Ankobra River

The entire Ankobra Basin contains deposits of all the minerals produced and exported from Ghana. Hence, much investment has gone into mining prospecting and mineral exploitation with a steady increase in the operations at the expense of an accelerated rate of deforestation and pollution. The largest mining concessions are located mostly in the mid-eastern portions of the basin mainly in Tarkwa, Nsuta and Bogoso. The mining activities with profound effect on the ecosystem within the Ankobra estuarine can be categorized into two groupings which include heavy industrial mining as practiced by the companies upstream in Tarkwa, Bogoso, Prestea, Nsuta and Awaso. The second group include small scale mining which are conducted by private companies and individuals either legally or illegally. Activities of these mining companies are hardly regulated and supervised. According to the WRC all these companies dump untreated mining affluent directly into the Ankobra[5]

Undoubtedly, the aquatic ecosystems of the Ankobra Basin are under a significant pressure due to the poor surface water quality as a result of mining activities, poor solid waste infrastructure and lack of environmental awareness. Therefore, in defining the minimum amount of flow required to maintain the aquatic ecosystems of the basin, a certain acceptable water quality level for the sustenance of these ecosystems must be specified and maintained.

[5] Water Resources Commission (2009), Ankobra – Integrated Water Resource Management (IWRM) Plan, Final Report

Furthermore, the flow of the Ankobra River and its tributaries particularly during the dry season has a significant impact on the flora and fauna associated with the prevailing aquatic system. Water quality decline and Water pollution have been identified as the leading water management problems in the basin. This is due mainly to disposal of untreated mining effluents from locations such as Tarkwa, Beposo, Prestea, Nsuta and Awaso.

According to a study conducted by the Water Resource Commission (WRC) "the largest source of arsenic seems to be along the Ankobra River from Prestea downstream to Dominase". Dominase is the largest commercial center in the SMFP Ankobra project area and the river flows downstream directly through the identified areas into the sea at Sawoma.

4.6 Poor Quality of Water

A report from a study conducted by the WRC indicates that the amount of arsenic transported by the river in 2006 were 18,000 kg/ year. High levels of cyanide in the river were reported in the WRC report cited above. Therefore, one of the major challenges in the Ankobra River Basin is the impact of mining activities on the quality of the surface water of the basin. Even from the layperson's point of view the Ankobra River particularly the southern coastal part is highly polluted and with the increase amount of mining, legal and illegal, the arsenic levels would have tripled between 2006 and 2015.

Plate 14 Polluted River Ankobra

Degradation of the water quality of River Ankobra as indicated in the figure poses series of threats. The increased turbidity, arsenic loads from old mine dumps and exposure of arsenic bearing rocks from the activities of the mining operations as well as accidental spillages from the mines are a threat to the quality of the surface water and pose a major threat to fishes.

If not monitored, the large-scale mining operations and growing number of illegal mining activities within the basin have the potential of increasing suspended solids of the river, and consequently the turbidity of the water. Also as indicated earlier, these activities tend to increase the arsenic loading of the river. Furthermore, the increasing use of the river for the disposal of both solid and liquid waste by the riparian communities also poses a threat to the water quality. The implications of the above to the water resources in the basin are:

- Dwindling availability of good quality water for potable use;
- High water treatment cost;

- High disease prevalence and accidental deaths resulting from metallic poisoning and associated high medical costs;
- loss of biodiversity; and
- Water use conflicts

4.7 Influence of Natural Causes

Climate change over the years has had an influence on the Ankobra River, the estuary at Sanwoma and Kukoavile village. The ecological zone (wet evergreen) under which the project area falls experience a lot of rainfall which has increased over the years. The satellite image from 1990 to 2010 shows an increase in the size of the wetland forming part of the river. Villagers from Kukoavile complained that every year in the last 10 years the village turns into an island surrounded by the Ankobra River and its tributaries during the rainy season. The floods can render the village inactive for almost two weeks.

Whilst Kukoavile's flooding problem is perennial that of Sanwoma is a daily occurrence based on the tidal regime of the ocean. Every high tide means some degree of flooding in the community. These floods recede every morning but the problem of living under such conditions obviously will affect livelihoods and progress within the community.

Conclusion

Most of the aforementioned problems are corroborating the evidence provided by the satellite images and are showing the trends as they exist at the time of data gathering. The Landsat data ends in 2010 whilst the field data are as current as two months ago in 2015 indicating a time interval of five years. One can only imagine the extent of destruction which the Ankobra ecosystem has suffered in the absence of satellite data. From 1990 through 2010 and 2015, there is enough evidence to indicate that the Ankobra ecosystem is under serious threats. The concern and the way forward should provide *palliative* measures at solving the problem.

5 ATTEMPTS AND WAY FORWARD

5.1 Past Attempts at Protecting the Ankobra Estuarine

National

Though the importance of the Ankobra toward livelihoods and other forms of national development have been recognized by all beneficiaries (National, private sector and communities), much has not been accomplished towards the protection of the Ankobra estuary from stakeholders. The government through the Environmental Protection Agency (EPA) has enacted regulations to protect the Ankobra River and its estuary from mining activities, but enforcement has been quite low. In addition, attempts at controlling illegal mining activities have been poor. These failures have resulted in massive amount of pollution affecting the marine ecosystem downstream and into the sea.

The Water Resources Commission (WRC) has formulated an integrated water resources management plan for the Ankobra river Basin. This takes a basin-wide planning approach involving stakeholder participation, awareness raising, capacity building and training, and environmental engineering. It is believed that this approach could lead to the sustainable implementation of effective measures to improve land use practices and management of liquid and solid wastes from the mining activities as well as from the towns and communities within the basin. However, there implementation of the IWRM plan is mainly concentrated in

the northern part of the Ankobra where the big mining companies are located. The southern part where the estuary is found is hardly mentioned in the monitory of the Ankobra by the Ankobra Basin Board. [6]Other initiatives have already been undertaken towards the goal of reviving the threatened riverine environment, prominently through the recent Mining Sector Support Programme, which included activities in the Ankobra Basin.

Private Companies

Endeavor Mining Company (formerly Adamus Resources) a mining company with massive concession covering the entire southern part of the Ankobra (see figure 1) has also made an attempt through the development of a bio-diversity action plan (BAP) to protect and preserve the flora and fauna within their entire concession area. Key among their strategies is the development of a protected area network where certain species which are seriously under threat will be given special attention with respect to protection and conservation within the concession of Endeavor Mining Company. In addition to the protected area network, there will be conscious efforts to protect special habitat areas of national and international interest such as the mangroves and bamboo forest along the Ankobra and Ramsar site at Amansuri, the Ankasa Conservation Area, Draw River Reserve and the Ebi River Reserve through the hierarchy of ***avoid – reduce – remedy – compensate***[7]. Whilst the plan aims at protecting and restoring the biodiversity of the area, it does not include how to regulate the activities of other stakeholders including the illegal mining activities. As part of the shortfall of the Adamus plan, public education and dissemination of the plan has not been made to the general public including the district assemblies.

District Assemblies

Both district assemblies through the preparation of spatial development framework in 2012 designated a 50 meter buffer from the river estuarine as conservation areas. Beyond the preparation of the SDF, no other efforts have been initiated from the district assemblies to regulate the activities in the Ankobra River and its estuarine. The Nzema East Municipal Assembly acknowledges the importance of the Ankobra and purchased a boat to assist in monitoring the activities in the river. This all important responsibility has been abandoned five years ago when the boat broke down due to lack of maintenance.

Donor Agencies

The USAID funded ICFG Initiative conducted a preliminary assessment of carbon stocks in the mangrove and swamp forest ecosystems in the greater Amanzule wetlands (spanning from the Ankobra River to the western shoreline bordering Cote d'Ivoire). The objective of the assessment was to generate baseline information on total carbon stocks, as well as carbon stock changes associated with various land-use dynamics in the wetlands. The intention was to generate useful data that will give insights for decision-making regarding REDD+ potentials in the landscape. Given the enormous carbon stocks that were recorded in the wetlands, relative to terrestrial forests and land cover, interests in a possible REDD+ initiative were heightened. However, critical data gaps for a viable REDD+ pathway remained unanswered

[6] Water Resources Commission (2015), Annual Report.
[7] Endeavor Mining, 2014. Biodiversity Action Plan for Nzema Gold Corporations 2014 – 2019.

The USAID funded CSLP is collaborating with Hen Mpoano to pilot a co-management process for the conservation of the Amanzule wetlands, which includes the lower Ankobra basin mangrove ecosystem. The lessons learned in the pilot phase will inform district and community level governance mechanisms for the wetlands.

5.2 The Way Forward

There is no doubt that the Ankobra estuarine which the SFMP is analyzing is under intense threat from mainly human activities with natural occurrences playing an insignificant role. From the satellite images, the ecosystem in 1990 was pristine dominated by about 93 percent forest land. This clearly depicts that human activities were quite low. However, by 2010 there has been a massive change in the land use dynamics. Human settlements have sprung up and though in terms of land use representation only about 1.4 percent of the entire land under study is occupied as settlements. It is rather the activities of the people within these settlements that have adversely impacted the ecosystem.

These satellite images are corroborated with field data collected between March to August in 2015. Human activities may have caused more degradation than observed in the 2010 satellite images of the area since more settlements are springing up along the Ankobra river banks. Crop lands are increasing because farming is the main livelihood of these communities. Illegal logging is on the rise because no government authority from the districts, regional or national administration checks these activities. In all these occurrences, it is the forest and wetlands that suffer the most.

From field observation it is mainly mangroves that dominates in the area is classified as forest followed by bamboos. By using mangroves as a proxy for forest, the intense depletion of mangrove for construction and as firewood for smoking fish has a direct bearing on the depletion of demersal fish stock. From field interviews certain types of fish breed as seen in plate 15 that were in abundance 10 to 15 years ago are now becoming rare breed.

Plate 15 Fish breed now rare in the Ankobra River

Most of the Ankobra river problems especially with regards to quality are ascribed to activities of the major mining companies and illegal mining. Though this may be true in terms of water quality which may affect the marine ecosystem, there is no direct correlation between mining activities in the project area and forest (mangrove) destruction.

The serious threats facing the ecosystem in the project area – particularly mangrove destruction – are spearheaded by members within the communities. In developing recommendations for the Ankobra estuary, attention should focus on halting the forest depletion, maintenance and restoration of the ecosystem. Recommendations on controlling pollution of the river and the sea should principally be targeted at the mining companies both legal and illegal.

5.3 Recommendations

All actors and stakeholders within the project area have a role to play in addressing problems which have been identified as major contributory factors to the Ankobra estuary. From the national level to the district assembly level the missing link is enforcement of existing regulations enacted to protect the Ankobra River and for that matter all major rivers, streams and forest across the country. At the community level the weak link is awareness creation. Basically a combination of enforcement and education will be paramount to halting the depletion, maintaining and restoring the Ankobra ecosystem. The recommendations have been categorized into two approaches which are short term and long term.

5.3.1 Short Term Recommendation

Enforcement of Zoning Regulations and Other National Laws

The TCPD zoning manual stipulates that all water bodies should have buffers created on both sides to protect riparian lands. For major rivers like Ankobra, there should be a 50 meter buffer zone where human activities are prohibited. The SDFs of both Ellembelle District Assembly and Nzema East Municipality shown in figure 3.14 take cognizance of this zoning regulation and earmarked a 50 meter buffer on both sides of the Ankobra as conservation area yet both districts have failed to enforce it.

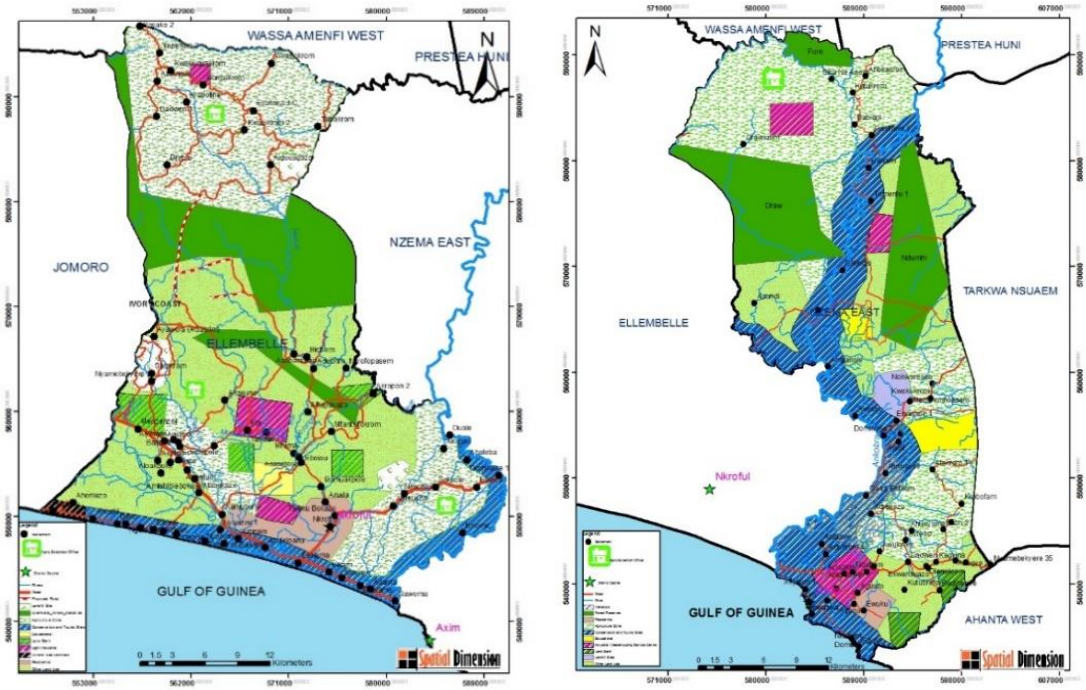


Figure 16 SDFs of Ellembelle District and Nzema East Municipal

Source: Spatial Development Framework for Ezema East Municipal and Ellembelle District

The districts should as a matter of urgency should provide the necessary logistics that will expedite the immediate regular inspection trip to the Ankobra project area. The Forestry Commission should do likewise to also halt the massive deforestation occurring in the area. The approach can be implemented joint by all the departments if the proper arrangements are made.

- **Regular Community Consultations and Education**

It was quite clear during the validation exercise that the communities particularly the women are aware of the dangers of mangrove depletion and farming on riparian land. However, as time elapsed the men will revert to cutting mangrove to sell as firewood for smoking fish. As put by one woman participant - *we are aware of the dangers of mangrove destruction but our men get upset when ask to desist from mangrove cutting.*

Constant education by the district, the government and concerned NGOs and donors through the media outlets will be an effective tool to curb the forest destruction. Visits to communities regularly to educate them will also be helpful. Erection of billboards will be quite helpful.

- **Community Members to Act as Watchdogs**

Community members through education should become watchdogs and monitor the illegal activities particularly logging and report any of such activities to their leaders. Persistence of such illegalities should be reported to the appropriate authorities in this case the assemblyman or woman and eventually to the district/municipal assemblies.

- **Monitoring the Externalities**

A major problem confronting the Ankobra estuary is the pollution caused by mining companies whose control are outside the influence of the communities and probably the local authorities. The regional administration through the Regional Coordinating Council (RCC) should liaise with the ministries and departments responsible for monitoring the activities of mining companies both legal and illegal to control the activities of these companies from polluting the river. The government should completely find means to totally halting illegal mining in the Ankobra.

5.3.2 Long Term Recommendations

- **Demarcation of Zones and Restoration of Mangroves and other trees**

The 50 meter buffer border should be marked by planting special trees to indicate visible prohibitive areas. Replanting of mangroves and other trees within the buffer zone should be initiated by the district and other agencies (NGOS, Donors, Private Companies) in collaboration with the active participation of the communities. The communities should be encouraged to own these buffer zones and ensure their maintenance and check on any encroachment. The assemblies should reward communities that keep their buffer zones in pristine conditions. Whilst creating a sense of ownership and pride, community control of sensitive areas act as one of the effective means of curbing environmental threats from human activities.

- **Educational Curriculum to Reflect on Local Environmental Concerns**

Curriculum for teaching in the few community schools should emphasize on environmental conservation issues using the current problems in the Ankobra and the coastal degradation as relevant examples. The *caring for the future* mentality in the youth start with relevant education on the environment they live in. The Ankobra estuary needs communities whose mentality on the use of mangroves is positive devoid of unsubstantiated views. The two districts assemblies (Nzema East and Ellembelle) should ensure that the District Education Unit reviews the curriculum of schools in the Ankobra area to include environmental topics specifically about the sustainability of the Ankobra River and its importance to livelihoods.

- **Responding to Nature and Climate Change**

The village of Kukoavile to address its perennial flooding should develop a 30 meter buffer as greenbelt around the village. This will address the recurring but serious erosion problems during the rainy season. The assembly should initiate the greenbelt with active community participation and hand it over to them to care and maintained.

For the village of Sanwoma and it daily flooding a series of studies by different organizations have ended with recommendations for relocation to a much safer land which is close by. Interviews with villagers suggest a divided opinion over the resettlement. In the absence of receiving material and financial support from the assemblies for relocating, the villagers find it impossible to do so. Most of them prefer the erection of a sea defense wall option to relocation and resettlement. Though their preference is the expensive option, the SFMP study draw the same conclusion for the simple fact that the social cost of relocation though cannot be valued in monetary terms can be quite expensive. Relocation implies denying the community of Sanwoma their livelihoods which is the dependent on the sea. Easy access to the sea is unimaginable for them.

- **Involvement of Communities in Preparation of District Spatial Plans**

District development reports hardly reach the communities and if they do, one wonders the number of people can read a technical report. However, their involvement in the preparation of such plans exposes them to some of the permissible and non-permissible activities within their communities. This in itself is an effective learning process for the communities apart from building the usual community ownership of projects. Providing them with outcomes and recommendation of studies alone does not really create an impact than actual involvement. If ecosystems are to be protected the people who impact the ecosystem should be involved.. The SFMP emphasis on community involvement is a laudable approach and should be sustained by the districts and all other stakeholders.

Conclusion

The Ankobra estuary/river area offers a lot of opportunities for national growth both for the government and the communities. The area has lots of natural resources ranging from mineral resources, timber and an ecosystem that remains the main source of livelihoods for the residence.

However, visible indications show an over- exploitation and abuse of the resources by its beneficiaries. The River Ankobra and its estuary are under serious human threats and cannot

be sustainable if current exploitation goes unchecked. The SMFP has unearthed most of these problems and their causes and has come up with recommendations. Most of these problems are solvable but they demand active commitment from all stakeholders particularly the government of Ghana who is represented at the local level by districts, municipalities and metropolitan assemblies. In the case of the Ankobra, the Ellembelle District and the Nzema East Municipalities should be the leaders in any attempts to resolve issues in the Ankobra Basin.

One of the key actors who should play a major role in the restoration of the Ankobra is the mining companies who own massive concessions in the area. The impacts from mining activities both legal and illegal are tremendous. A major contribution of these companies will be to provide restoration plans for the entire basin that centers on provision of in situ projects and a massive reduction in the water pollution levels.

Majority of the recommendations demand government intervention and commitment. There is a limit to what the powerless and mostly uneducated communities can do.

APPENDICES

Appendix 1: What are Riparian lands?

A riparian area is defined as the strip of moisture-loving vegetation growing along the edge of a natural water body. The exact boundary of the riparian area is often difficult to determine because it is a zone of transition between the water body and the upland vegetation. A riparian management zone usually extends from the water's edge to the upland area.

Importance of Riparian Land[8]

Healthy riparian areas perform several basic functions which help maintain good water quality.

- Natural riparian vegetation usually has deep roots. The deep root mass helps maintain the bank or shoreline structure by holding the soil together. This vegetation provides a barrier to the erosive power of the water. By reducing erosion, less sediment is transported to the water body. Reducing sediment helps keep fish spawning areas clear, reduces nutrients, and makes water treatment easier.
- Riparian vegetation can also help reduce the amount of sediment and nutrients that are transported in runoff. The vegetation physically traps sediment in surface flow, and uses the nutrients in the shallow sub-surface flow.
- Some riparian vegetation is a source of large woody debris. When floating or beached in a water body, debris provides shelter for fish and habitat for aquatic insects. In flowing water, the debris also traps sediment and helps create structure (pools, riffles and runs) in the stream. Pools, riffles and runs are important components of a stream's ability to maintain aquatic life.
- Riparian vegetation provides shade. Shade helps regulate stream temperatures by controlling the amount of sunlight that reaches the stream. Most fish species prefer the cooler temperature of shaded streams. Shady areas also provide refuge areas for fish. Less algae grows in shaded streams because reduced sunlight limits photosynthesis.
- Riparian vegetation is a source of small organic debris, which may include leaves, twigs and terrestrial insects. This debris is an important food source for many aquatic organisms.
- Riparian vegetation helps reduce stream velocity during high flow events. This helps to slow down the natural erosion of the stream bed. Rapid erosion of the stream bed results in a lowering of the local groundwater table. Once the groundwater table is lowered, it is very difficult for water-loving plants to re-establish.

What are Some Indicators of an Unhealthy Riparian Zone?

Managed riparian areas are generally considered healthy if they are well-vegetated with a diverse group of plants that have a deep binding root mass, and have the age classes of vegetation that allow for regrowth. These types of plants are important in helping to ensure that the riparian area functions the way it should. The different age classes ensure that if the riparian area is used for forage, it will be sustainable. As long as the forage is sustainable, it will provide economic returns for a producer.

[8] Phyllis Bongard and Gary Wyatt (2010), Riparian Land Series, University of Minnesota.

Healthy riparian areas differ from one water body to another, particularly with respect to plant species and structure. On the other hand, unhealthy riparian areas have several similarities.

Common features of unhealthy riparian areas often include a lack of woody vegetation and an abundance of bare or trampled ground.

- An abundance of weeds and non-native plant species is caused by removal of the native vegetation. Often these plants do not have the deep binding root mass that the native plants had and stream banks become unstable and highly erodible.
- A lack of shade-providing trees promotes greater sunlight penetration, leading to warmer stream temperatures and a decreased capacity to hold dissolved oxygen. These factors can lead to an increase in algal growth and a decrease in the abundance of aquatic organisms.
- A lack of tree saplings is caused by over-grazing. These saplings are needed to replace the mature trees as they age.
- Slumping and erosion of the bare ground increases sediments in the stream, lowering water quality.

Appendix 2: Modalities for Definition of Land Cover Types

Forest Land: This includes all land with woody vegetation consistent with thresholds used to define Forest Land in the national greenhouse gas inventory. It also includes systems with a vegetation structure that currently fall below, but in situ could potentially reach the proposed national values used by to define the Forest Land category in Ghana as follows:
- Minimum Mapping Unit (MMU) is 1.0ha
- Minimum crown cover is 15%
- Potential to reach minimum height at maturity (in situ) as 5m

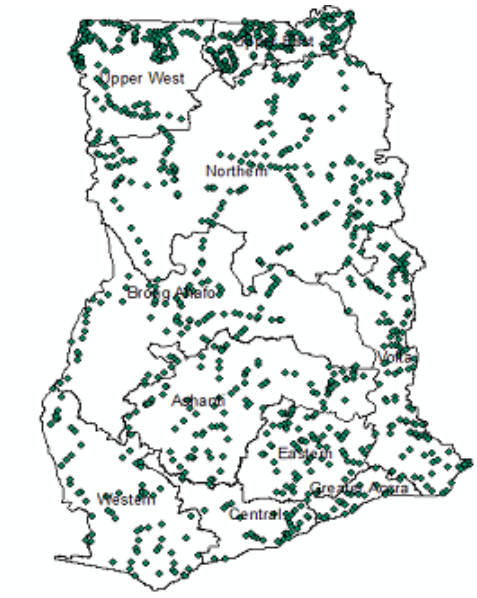
Cropland: This includes crop land (currently cropped or in fallow), including rice fields, and agro-forestry systems where the vegetation structure falls below the thresholds used for the Forest Land category. This includes land where over 50% of any defined area is used for agriculture.

Grassland: This includes rangelands and pasture lands that are not considered Cropland. It also includes herbs and brushes that fall below the threshold values used in the Forest Land category such as the other wooded land following the FAO definition in Ghana:
- CC < 15% and > 10%, height > 5m, MMU > 0.5ha
- CC 5% - 10%, height > 5m, MMU > 0.5ha
- Shrubs, bushes and trees CC > 10%, Height < 5m, MMU > 0.5ha

Wetlands: These include areas of peat extraction and land that is covered or saturated by water for all or part of the year (e.g., peat lands) and that does not fall into the forest land, cropland, and grassland or settlements categories. It also includes reservoirs as a managed sub-division and natural rivers and lakes as unmanaged sub-divisions.

Settlements: These include all developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories.

Ground Truthing Sites



Source: Ghana Forestry Commission, 2013

Appendix 3: Images from Field Study

Field Assistants from the Ankobra Community

Bamboo Piled for Transport

Traps for crustaceans

Project Team from Hen Mpoano, Spatial Solutions, and District Assemblies

Main means of transport in Ankobra Basin

Participatory mapping exercise

Appendix 4: Part of Ankobra Ecosystem from 2012 to 2015

Ankobra in September 2012

Ankobra in October 2015

Ankobra in October 2015 – note change in water color and vegetative cover

Ankobra Estuary 2012

Ankobra Estuary 2015