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# SUSTAINABLE FISHERIES MANAGEMENT PROJECT (SFMP)

## Ankobra Estuarine Community Climate Vulnerability Assessment



**Hen Mpoano**



This publication is available electronically on the Coastal Resources Center's website at [http://www.crc.uri.edu/projects\\_page/ghanasfmp/](http://www.crc.uri.edu/projects_page/ghanasfmp/) and Hen Mpoano's website at <http://www.henmpoano.org>

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**Cover photo:** A small cottage along the bank of the Ankobra river  
(Credit: Hen Mpoano Photo)

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## **ACRONYMS**

ADRA	Adventist Relief Agency
CBO	Community-Based Organization
CCVI	Coastal Community Vulnerability Index
CRC	Coastal Resources Center at the Graduate School of Oceanography, University of Rhode Island
EPA	Environmental Protection Agency
FSSD	Fisheries Statistics and Survey Division
GREL	Ghana Rubber Estate Limited
GIS	Geographic Information System
ICFG	Integrated Coastal and Fisheries Governance
NADMO	National Disaster Management Organization
NCCP	National Climate Change Policy
NGO	Non-Governmental Organization
SFMP	Sustainable Fisheries Management Program
TCPD	Town and Country Planning Department
UNFCCC	United Nations Framework Convention on Climate Change
URI	University of Rhode Island
USAID	United States Agency for International Development
USA	United States of America
WRC	Water Resource Commission

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## INTRODUCTION

The USAID Ghana Sustainable Fisheries Management Project (SFMP) is a five-year program aimed at rebuilding Ghana's marine fish stocks and catches through the adoption of responsible fishing practices.

The (SFMP) project contributes to the Government of Ghana's fisheries development objectives and USAID's Feed the Future Initiative goals of improved food security, economic growth and poverty alleviation. Working closely with the Ministry of Fisheries and Aquaculture Development and the Fisheries Commission, USAID/Ghana SFMP aims to end overfishing of key stocks important to local food security through a multi-pronged approach:

- Improved legal enabling conditions for co-management, use rights and effort-reduction strategies
- Strengthened information systems and science-informed decision-making
- Increased constituencies that provide the political and public support needed to rebuild fish stocks
- Implementation of applied management initiatives for several target fisheries ecosystems

Closely linked to the primary objective of the SFMP are activities aimed at resilience against climate change impacts and strengthening coastal spatial planning and decision making processes to foster protection of water-dependent uses of the coast and coastal adaptation to climate change.

Against this background, climate vulnerability assessment was conducted in 5 estuarine communities of the Ankobra river. A complementary analysis of spatial options – this is available in a separate report - for managing the estuary and associated mangrove forest ecosystem was also undertaken. The purpose of the vulnerability assessment was to uncover the sources of livelihood vulnerability in the estuarine communities and identify opportunities for building household, community as well as ecosystem resilience against climate and non-climate stressors.

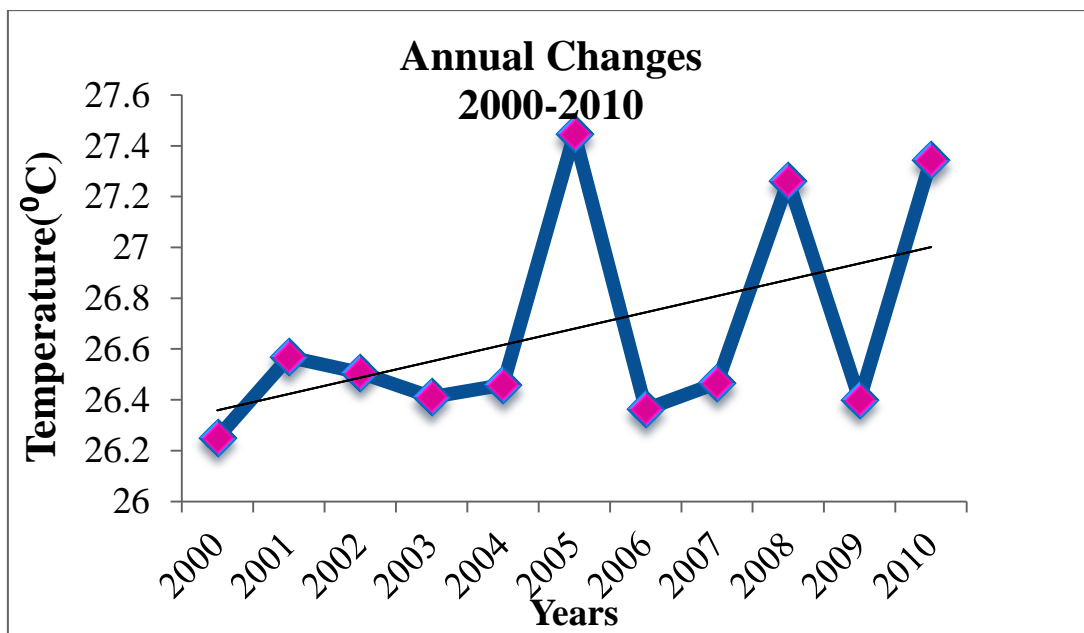
### **Overview of coastal climate change trends, projections and implications in Ghana**

Ghana is endowed with a coastline that stretches 565 km and comprises a sandy east coast and west coast on the extremities as well as a central coast characterized by rocky beaches interspersed with short sections of sandy beaches (EPA, 2000). Dotted along this stretch of coastline are major infrastructure of cultural and economic significance, notably fishing ports, fishing settlements, harbours, energy processing facilities, tourism and recreation facilities, forts and castles. In addition, this coastline is rich in biodiversity assets and characterized by unique ecosystems that provide not only vital ecological services and functions but also the basis of food and livelihood security for the predominantly poor coastal dwellers. About 90 lagoons along Ghana's coast are also among the available habitats for marine resources, and provide vital seasonal income and subsistence fish and crustacean catches for nearby communities (Finegold et al., 2010).

Unfortunately, Ghana's rich coastal ecosystems and biodiversity are being threatened and subjected to rapid degradation from human activities including marine and land based pollution, overexploitation of marine fisheries and unsustainable land use practices. Human drivers as well as natural causes of coastal ecosystem degradation – notably shoreline erosion

- are influenced and magnified by climate change parameters such as sea level rise, increasing air and sea surface temperatures, flooding and extreme weather events. Although conclusions of various global climate models vary enormously, they all point to a common trend and confirm coastal climate change and vulnerability in Ghana. Climate scenarios developed for the first national communication to the UNFCCC indicated **sea level rise** of 2.1mm per year over the last 40 years with projections of 5.8cm, 16.5cm and 34.5cm by 2020, 2050 and 2080 respectively (NCCP, 2012). This will have devastating consequences for communities within the 30m contour of the coastal zone. General **rainfall** levels have been reducing and its patterns increasingly becoming erratic in the coastal areas. With less predictable rainfall patterns, uncertain and heavy storm events are more likely to cause flooding and storm damage in coastal areas. While rainfall projections are characterized by high uncertainty, available estimates by Minia *et.al* (2004) indicate a decline by 1.1% and 20.5% between 2020 and 2080 respectively, and for the same period, they project **temperature increase** of 0.8°C and 5.4°C respectively.

Stanturf *et al.*, 2011 observed a positive correlation between increasing mean annual air temperature along Ghana’s coast between 1960 and 2000 and sea surface temperature over the same period. This is consistent with increasing decadal trend in sea surface temperature observed from monitoring stations of the Fisheries Statistics and Survey Division (FSSD) shown in figure 1 below. Rising sea surface temperature in Ghana’s waters will have potential negative implications for the timing and intensity of the coastal upwelling and productivity, particularly of the small pelagic fish complex (Stanturf *et al.*, 2011).



**Figure 1: Trend in Sea Surface Temperature, 2000 – 2010**

**Source: Modified from FSSD, 2015**

### **Natural hazards and coastal climate change issues in Western Region**

Coastlines and flood plains are dynamic systems that have always posed risks as places to build, whether or not people recognize those dangers. As population grows and development intensifies in the region, demand for land is rising, even in increasingly risky shoreline locations. Coastal areas and settlements exposed to the climate impacts threatening the region

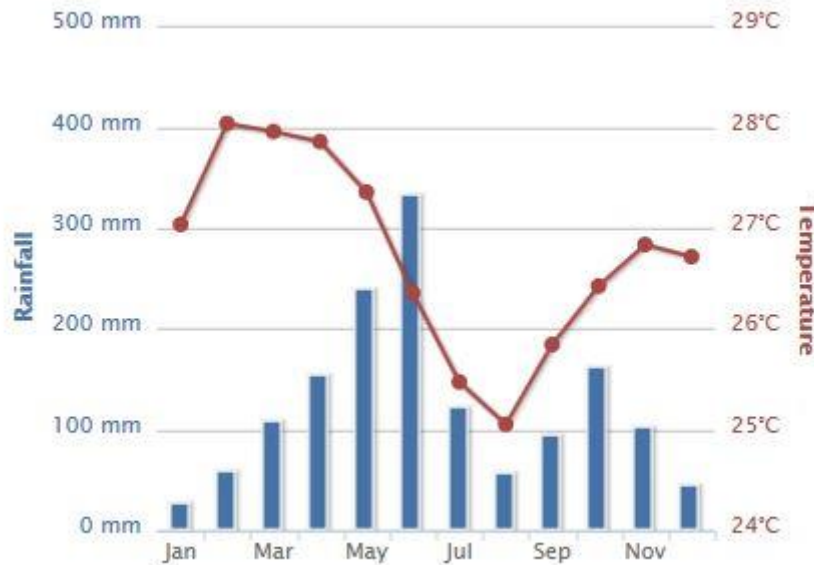


are sensitive to them in differing degrees, for example, some settlements are built in dangerous low-lying areas while others are setback from eroding shorelines and flood-prone wetlands. Sea level rise in the Western Region can have a number of impacts including accelerating erosion; coastal flooding; threatening the functioning of piers, docks and seawalls; shifting estuaries to ocean salinity levels; contaminating coastal fresh water wells; and intruding on coastal river water supply intakes. The World Bank estimated that 170 km<sup>2</sup> of the Western Region's coast (defined as the area up to 30m in elevation) will be exposed to sea level rise impacts, affecting an existing population of 16,830. In addition to the potential economic effects of sea level rise and accelerated erosion, extensive coastal wetlands in the Western Region will be impacted by sea level rise. As the rising ocean erodes the shoreline, these wetlands will be transformed from closed to open lagoons, with a loss of vital fish habitat and biodiversity in the process. Similarly, mangrove areas will be adversely impacted by sea level rise.

Over 80 landing sites and beaches used to offload and process catch, moor or beach boats are perilously exposed to shoreline erosion and flooding. In recent decades, many of them have been buffeted by waves and erosion to such an extent that shore protection structures have been installed. However, many of the structures did not adequately serve their intended function or have simply failed, such as in Axim and Shama old town in the Nzema East and Shama districts respectively.

Studies on shoreline erosion in the Western region show mixed results due to differences in methodological approaches for estimating shoreline change. Based on estimates by Wiafe (2011), between 1974 and 2005, shorelines in Western Ghana retreated at an average rate of 1m per year with considerable variation along the coast. Studies conducted by Boateng (2012), also indicate annual erosion rate of 1.6m for segments of the region's south east facing shore. All these studies point to a progressive increase in shoreline erosion of the region's coast.

As with all future rainfall predictions, there is high degree of uncertainty in rainfall projections for the Western region. Noteworthy however, are rainfall trends shown by data recorded by local rainfall stations operated by the Ghana Meteorological Agency on the Ankobra basin and included in the basin's integrated water resources management plan. These data, recorded between 1970 and 2001, show that the Ankobra basin is characterized by a bi-modal rainfall regime with two seasons, extending from April to June and from September to November, and records a mean annual rainfall of 1,700mm (WRC, 2009). Available meteorological data also shows that the Ankobra Basin is characterized by uniformly high temperatures throughout the year with a mean annual temperature of about 26°C. March is the hottest month in the basin with a mean monthly temperature of about 27-29°C. August is the coolest month with a mean temperature of 24-25°C. Diurnal variation of 3°-5°C from the mean is observed in the basin (WRC, 2009). These observations are consistent with temperature and rainfall trends recorded over more than 100 years for the lower Ankobra basin as shown in Figure 2.



**Figure 2: Annual rainfall and temperature trends for Ankobra lower basin, 1901 – 2012**

Source: [http://sdwebx.worldbank.org/climateportalb/home.cfm?page=country\\_profile&CCode=GHA&ThisTab=ClimateBaseline](http://sdwebx.worldbank.org/climateportalb/home.cfm?page=country_profile&CCode=GHA&ThisTab=ClimateBaseline)

The relatively high annual temperatures and rainfall decline in the Ankobra basin contribute to the reduction in river runoff (WRC, 2009), a phenomenon which is gaining prominence during the dry seasons.

Livelihoods of the Western region’s coastal population as well as ecosystems are being impacted significantly, and in ways that communities and district level planning processes are not able to adequately respond. This is evident in the assessment conducted by the ICFG initiative to examine adaptive capacity of 77 coastal communities in 4 districts of the Western region, where the key findings show that majority of coastal communities have weak ability to respond to emergencies generated by natural hazards, they suffer social and economic development challenges that are worsening, and they have a relatively low ability to manage coastal resources in a way that will ensure sustained productivity and environmental quality.

## **ASSESSMENT OF NON-CLIMATE STRESSORS, CLIMATE VULNERABILITY AND IMPACTS IN ANKOBRA ESTUARINE COMMUNITIES**

### **Assessment Approach**

This assessment was carried out in 5 Ankobra estuarine communities – Adelekazo, Eziome, Ajomoro Eshiem, Kukuaveli and Sanwoma - locally referred to as “*river state*” communities. We conceptualized vulnerability as a characteristic of social and ecological systems that is generated by multiple factors and processes. In this context, vulnerability is a dynamic process generated by social and physical factors that shape people’s ability to cope with, recover from, or adapt to external stresses placed on their livelihoods and well-being (O’Brien et al., 2004 ; Kelly and Adger 200).



**Figure 3: Map of the study area showing the five estuarine communities**

First, we reviewed relevant secondary literature and also gathered primary information through workshops, key informant interviews and participatory assessment techniques, notably hazard mapping, vulnerability matrix, seasonal calendar and historical timeline of climate-related events (see annex for details on focus group and assessment instrument). These approaches were supplemented with GIS based assessment of land cover (refer to annex for report on land cover mapping) to understand vulnerability of critical fishery habitat and mangrove ecosystems to human-induced threats as well as analysis of spatial options – compiled in a separate report - for managing the Ankobra estuary and associated mangrove ecosystem. Second, the process of information gathering and analysis involved community leaders, regional TCPD officials as well as planners from Nzema East and Ellembelle districts. Third, the results of the assessment were subjected to validation as a way of soliciting further stakeholder input and incorporating local knowledge on the drivers of vulnerability into the assessment process. Finally, the assessment adopted a holistic approach



by taking into account the specific context of livelihood dependence on natural resources within the Ankobra estuarine communities and how this influences socio-economic, governance, livelihood, physical and climate-related dimensions of vulnerability.



**Figure 4: Data collection in some of the communities**

### **Socio-economic and governance dimensions of vulnerability**

Coastal Community Vulnerability Index (CCVI) was constructed to evaluate the social and governance factors contributing to vulnerability in the estuarine communities. The process for evaluating the contribution of these factors to vulnerability was adapted from Orencio and Fujii, 2013. First, we identified 15 indicators from literature and broadly categorized them under 4 main factors – food security, land tenure, governance and institutions and demography - contributing to vulnerability (see annex – focus group and assessment instrument). Scores on a scale of 1 (low vulnerability) to 5 (high vulnerability) were assigned to the indicators based on perceptions of focus group participants in each community. The values of each indicator that contributed to the 4 factors were quantified from the aggregation of their respective values assigned through the focus group discussions. Based on the assumption that each of the 4 factors contributes equally to vulnerability, a balanced weighted average approach was used (Hahn et al. 2009; Orencio & Fujii, 2013). Consequently, the values for each indicator ( $Index_{si}$ ) followed a process of standardization using the equation below;

$$Index_{si} = \frac{V_{ss} - V_{min}}{V_{min} - V_{max}}$$

$V_{ss}$  is the score assigned an indicator, while  $V_{max}$  and  $V_{min}$  are respective maximum and minimum scores respectively based on the scales set for each indicator. All  $Index_{si}$  resulting were respectively combined to determine the values of the 4 (food security, land tenure, governance and institutions and demography) factors according to the following equation;

$$F = \sum_{i=1}^n \frac{Index_{si}}{n_{si}}$$

$F$  is determined based on the average of indicator values ( $Index_{si}$ ), divided by the total number of factors that contribute to that  $F$ . All levels of contribution of the 4 (four) factors ( $F$ ) were scaled from 0 (high contribution) to 1 (low contribution) and averaged for the purposes of creating one CCVI value for each community. The results are summarized below.

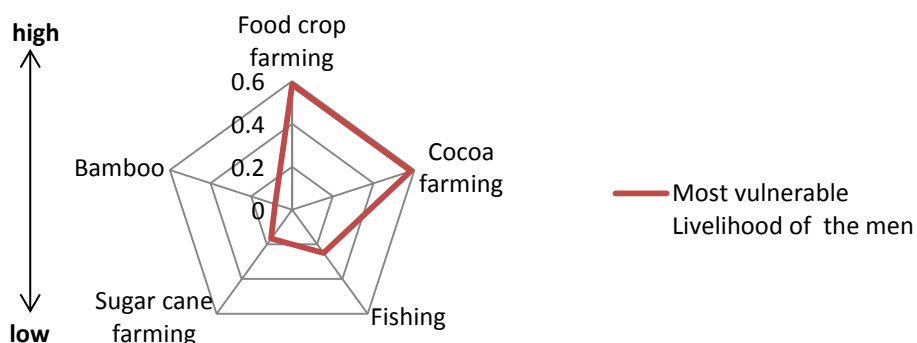
## Results

### Non-climate and climate sources of vulnerability

#### Eziome

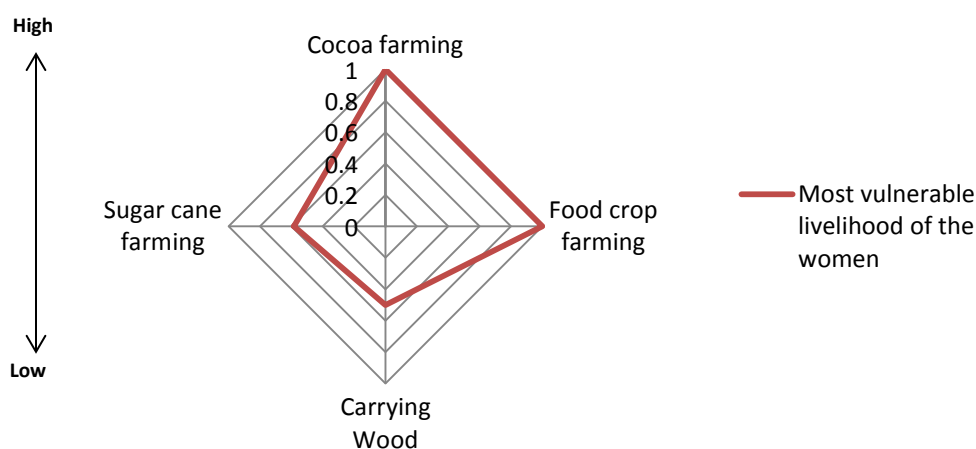
The men of Eziome are mostly involved in food crop and cocoa farming. Other livelihood options identified among the men include fishing, sugar cane cultivation and bamboo harvesting. The women are also food crop, cocoa farmers, carriers of forest wood and sugar cane growers. These livelihoods are mostly impacted by flooding, pests and diseases, polluted river and high temperatures. According to both men and women, food crop and cocoa farming are highly impacted by these stressors.

### Most vulnerable Livelihood of the men



**Figure 5 Most vulnerable livelihoods of men in Eziome**

## Most vulnerable livelihood of the women



**Figure 6 Most vulnerable livelihoods for women in Eziome**

### **Kukuaveli**

The men in Kukuaveli are mostly farmers (food crop, cocoa and coconut) and alcohol distillers. Fishing is done by most men in the community on daily basis, especially during the raining season. Women on the other hand ranked cocoa farming, food crop farming, trading, wood carrier and coconut oil making as the most important livelihoods. Flooding and erratic rainfall patterns impact all these livelihood activities to varying degrees. Rainfall often results in flooding which affects farms, houses, drinking water and makes movement very difficult. The rain is followed quickly by the dry season which marks the beginning of a severe outbreak of pest and diseases. According to a focus group participant;

*“March is often dry with high temperatures that destroy our crops and dry up our drinking water”.*

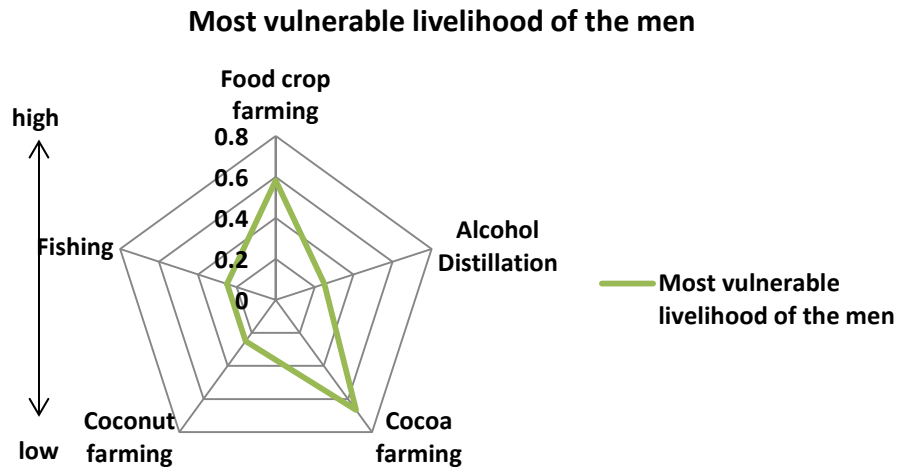
Fishing is done to supplement limited food stock during the periods of severe flooding because with the flood comes abundance of fish. Individuals whose houses are on hilly grounds do backyard farming to support their families. Children are prevented from going to school and certain places during period of inundation.

*“The floods are getting worse by the year. Attempts to cope with the floods by deepening natural drains never worked”*

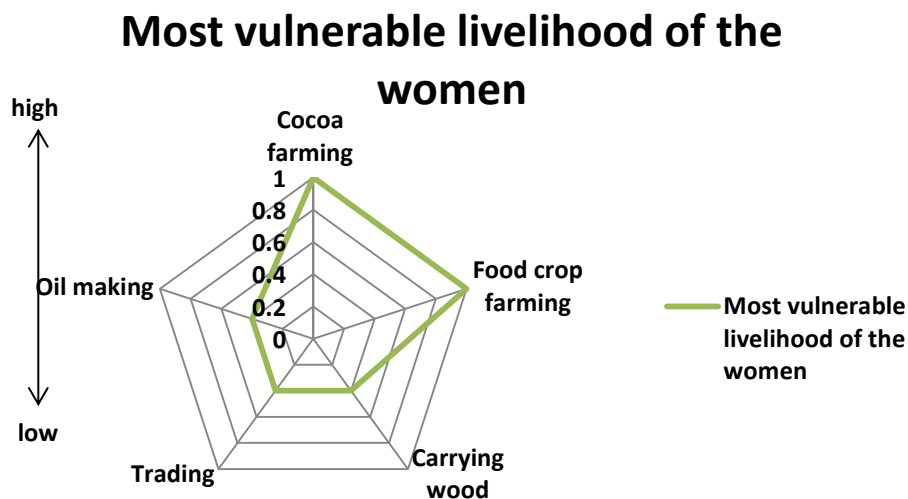
Cocoa is planted from May to July and harvested twice in the year. The first harvest is between June-July and the second is from October-November.

*“The harvest coincides with the raining season which is also in June-July thus making cocoa farming very difficult as we are unable to transport to the market center”.*

With the flooding comes food scarcity that continues to September. To cope with the food scarcity some individuals migrate to Badukrom, Akango, Benso, Kadadwen, etc. to find jobs.



**Figure 7 Most vulnerable livelihoods of men in Kukuaveli**



**Figure 8 Most vulnerable livelihoods of women in Kukuaveli**

### **Sanwoma**

Fishing is the mainstay of the men in Sanwoma. This practice happens both in the river and ocean. Although to a lesser extent than fishing, farming is another important livelihood activity (cocoa cultivation and food crop including vegetables) that involves the men. Sanwoma is noted for its intense exploitation of mangrove trees mostly for fish smoking and building. Rubber plantation is gradually expanding as more people are converting their farmlands into rubber, with the support of GREL. The women are mostly fishmongers, traders, food crop farmers, shell fish and fuel wood harvesters.

The annual flooding was identified to impact significantly on all the livelihood options of the women. Food crop farmers are impacted significantly by all the stressors identified. High tides also affect all the livelihood activities at varying degrees. Climate and non-climate related hazards associated with the identified livelihoods were irregular rainfall pattern, storms, floods, sanitation, pests and diseases. Coconut oil production is least vulnerable to all the hazards. None of the identified hazards has any impact at all on this livelihood option. Fishing is significantly impacted by the irregular rainfall pattern, storms and sanitation. Food crop farmers on the other hand, have to deal with all the identified hazards with the exception of sanitation

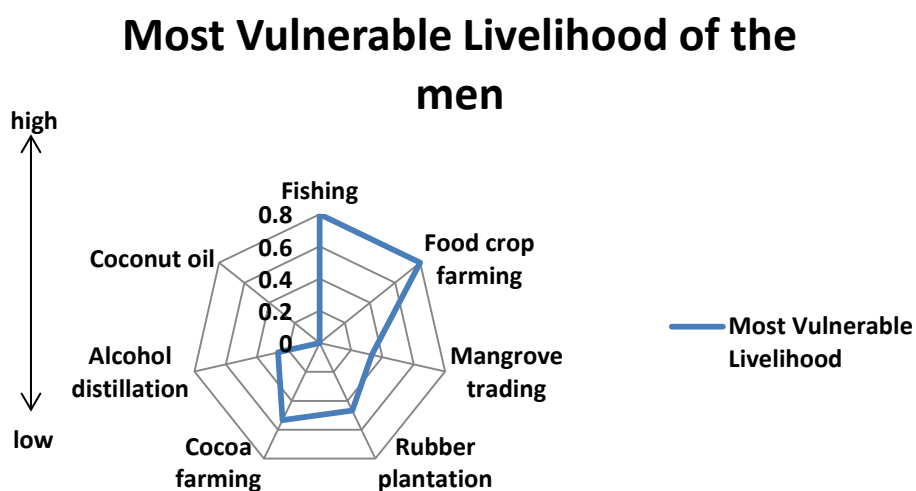
Inundation in Sanwoma happens on daily basis based on the tidal regime of the ocean. Every high tide means some degree of flooding in the community. Residents indicate that the floods have intensified in recent times and have attributed this to the road construction, indecent waste disposal in the open ocean and the offshore oil and gas industry.

*“The flooding wasn’t this serious. It intensified as a result of the destruction of a drainage system at the bank of the river during the construction of the main road 30 years ago. The frequent floods are also the result of filth and the off-shore oil and gas activities”.*

The phenomenon is however exacerbated in the raining season when the volume of water in the Ankobra increases significantly.

The daily floods have led to the destruction of personal assets including furniture and fish smokers. The inundation which occurs twice in 24 hours (one during the day and the other at night) makes living along the coast quite unbearable. However, only few people have relocated to the new site due to the high cost of land.

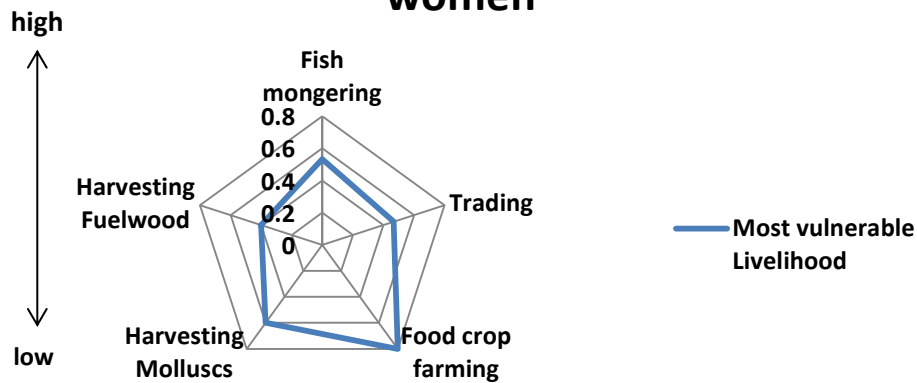
The impact of the flood is very intense in the old site due to the topography. The intensity reduces with distance from the coast. The new site and the houses located in the extreme west of the old site are not affected by this hazard. These places therefore serve as safe location for temporary relocation during a severe flood. Fish mongers also sojourn with friends and relatives in these safe places and use their smokers in the event of floods. Fish mongers are the most vulnerable to the hazards in the community because they process their fish close to the coast where erosion and flooding are most severe.



**Figure 9 Most vulnerable livelihoods of men in Sanwoma**



## Most vulnerable Livelihood of the women



**Figure 10 Most vulnerable livelihoods of women in Sanwoma**

### **Adelekazo**

The major livelihood activities identified with the men were ranked as follows; alcohol distillation, fishing, mining (*galamsey*), food crop farming, coconut and oil palm plantation. The women on the other hand are engaged in *galamsey*, cocoa farming, rubber plantation and trading as the main occupations. Food farming as a livelihood option is impacted significantly by all the hazards, namely flooding, high temperatures, storm, transportation, pests and diseases. Cocoa farmers are also impacted in varying degrees by these hazards. Transportation affects significantly all livelihood activities while pest and disease on the other hand impacts all livelihood options significantly except *galamsey* and trading.

Adelekezo experiences increased pest and diseases, high temperatures and salinity of drinking water in March. Food scarcity also begins in the same month (March) and ends in August.

*“Our drinking water is not good. We will be very happy if you can help us get a pipe. Our water tastes salty at times (especially when the temperatures are high) which makes drinking very difficult”*

The first and major season for the rains is from May to July whilst the second rains come in the month of October. With the rainy season comes flooding of the community which restricts movement in and out of the community.

*“During the floods, we walk for five miles before we get to (Dadwen) the community where we can get car to continue our journey because no car comes here. We sometimes use woods to create a raft to cross the waters”*

To cope with the flooding and food scarcity households and individuals migrate in June and July to engage in menial work to earn their living elsewhere. Attempts to minimize the impact of the floods by creating drains, blocking and diverting the flood flow to the community using sack filled with sand did not work. .

*“Even though cocoa harvest is in June –July access to market site is not possible due to the floods, leading to losses and the inability to raise money.”*

## Most Vulnerable Livelihood of the men

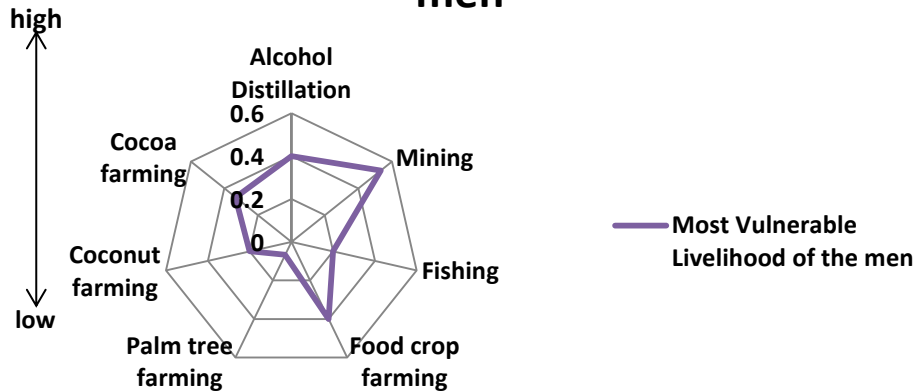


Figure 11 Most vulnerable livelihoods of men in Adelekazo

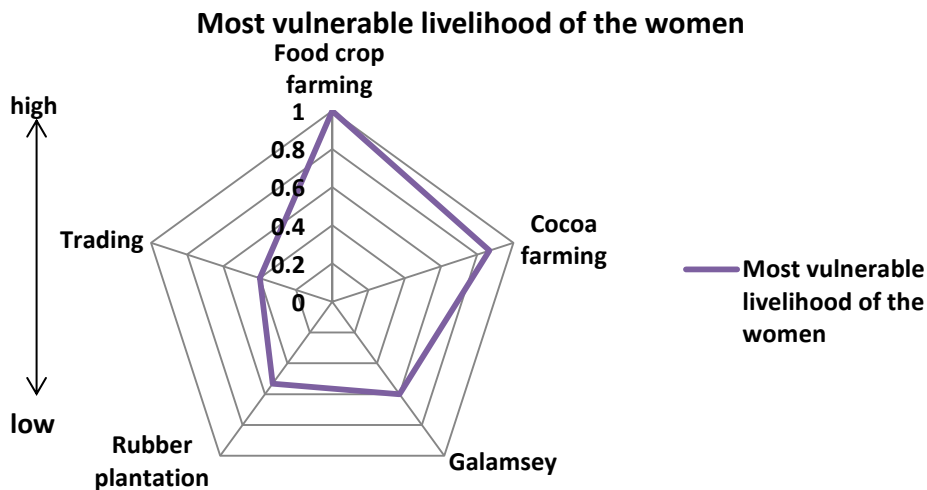


Figure 12 Most vulnerable livelihoods of women in Adelekazo

### *Ajomoro Eshiem*

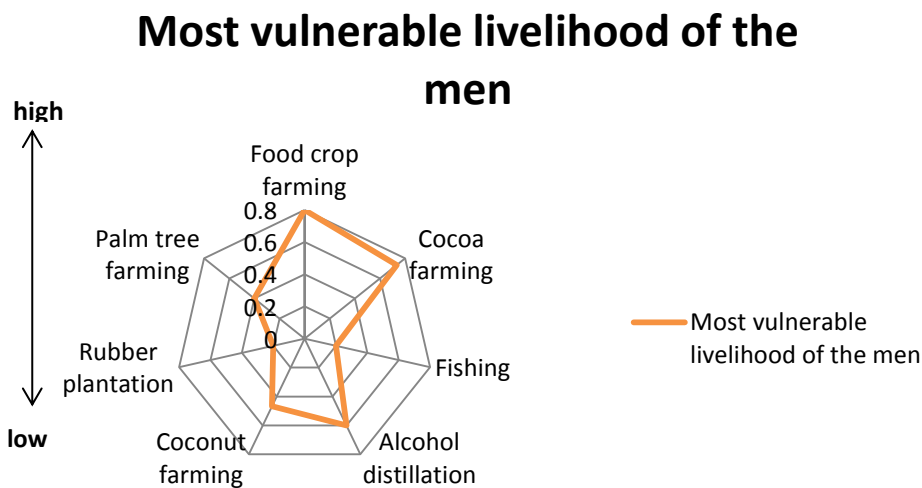
Priority ranking of the livelihoods of the men of Ajomoro Eshiem revealed food crop farming, cocoa, fishing, alcohol distillation, coconut farming and rubber plantation as the major livelihood activities. With the exception of alcohol distillation and trading, the women engage in similar livelihood activities as the men.

High temperatures and river salinity is experienced in March. During this time drinking water taste salty and very difficult to drink. Those with money buy sachet water or add alum in the water to settle the dust particles. The poor are often vulnerable during these times.

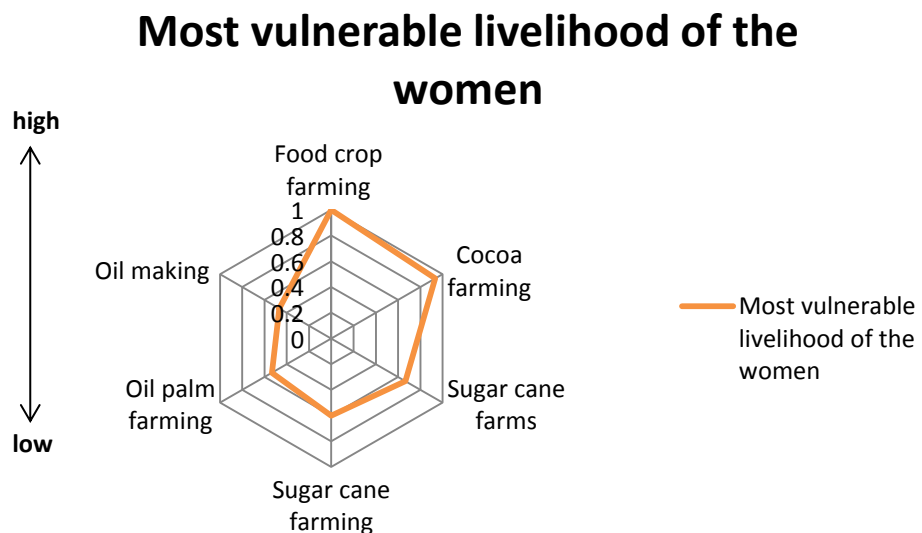
The rainy season causes floods from June to August. Community members depend on relatives who are not affected much by the floods for shelter during this time. Cocoa is harvested (April and May) a bit earlier to avoid the rains and the flood.

Restriction in movement to farms and nearby communities as a result of the flood results in food scarcity in June-July. Communities with larger boats take advantage of the situation to make money.

*“Food is generally scarce in June-July because of the floods which greatly affect our movement. However fish is always in abundance and is our major source of livelihoods during the floods”*



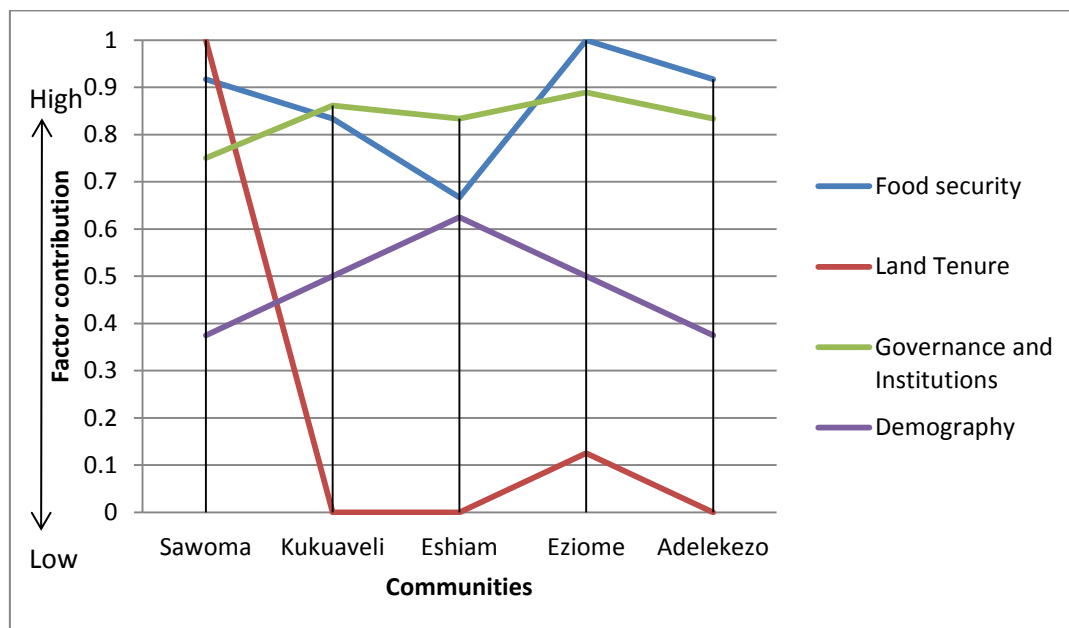
**Figure 13 Most vulnerable livelihoods of men in Ajomoro Eshiem**



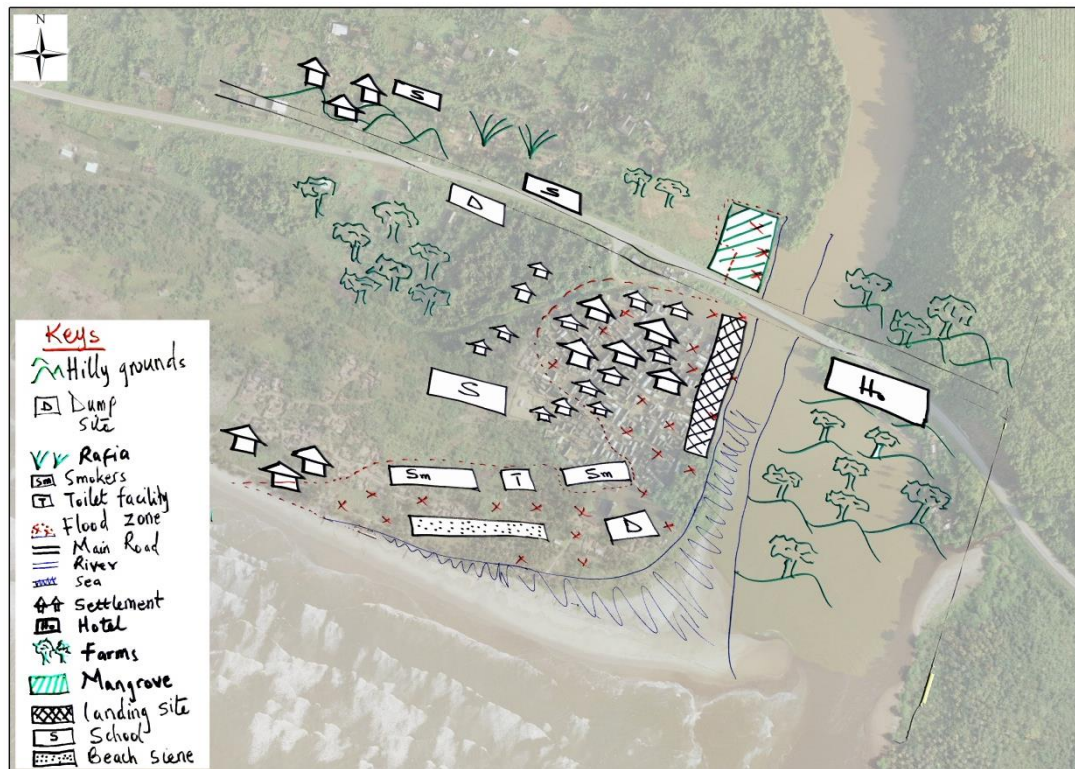
**Figure 14 Most vulnerable livelihoods of women in Ajomoro Eshiem**

## Comparison across 5 communities

Except for Sanwoma, land tenure is not a major contributory factor to vulnerability in the estuarine communities. However, food security, governance and institutions as well as demographical factors contribute highly to vulnerability in all communities. This is depicted by the corresponding low values recorded by each community on these factors. There are also differences among the communities relative to the contribution of each factor to vulnerability as shown in fig. 5. Among the four factors, food security and governance and institutions are the major causes of vulnerability, as depicted by their values in fig 5. These results suggest that communities are made vulnerable by their high dependence on natural resources for food and income, as well as lack of effective natural resource management practices at the community level.



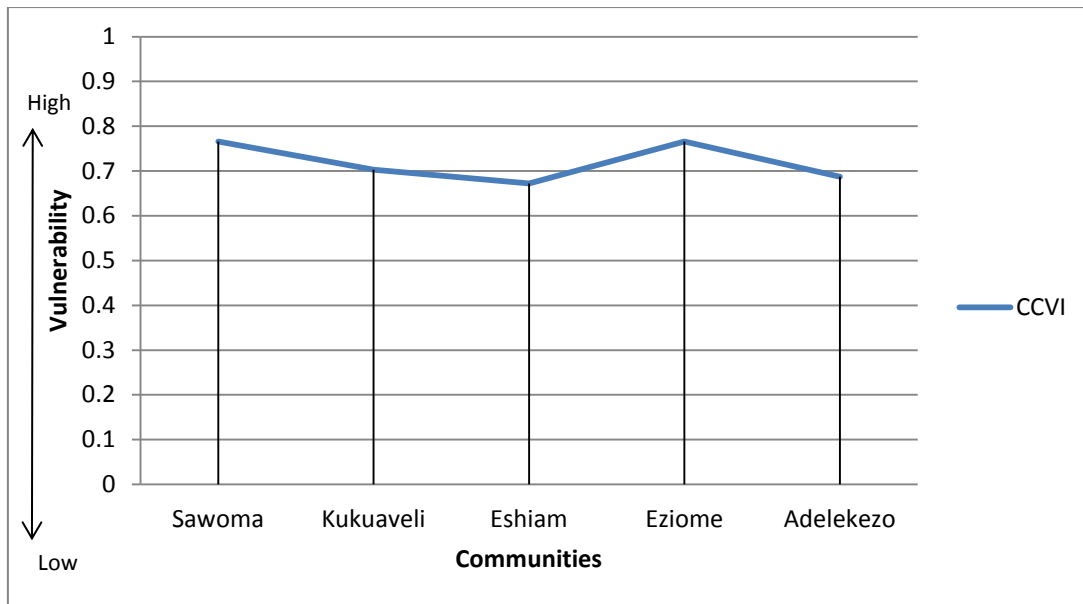
**Figure 15 Factor contribution to overall vulnerability in 5 estuarine communities**



**Figure 16 : Flood hazard map of Sanwoma showing vulnerable settlement areas and landing site**

### **Coastal Community Vulnerability Index**

While all the 5 estuarine communities recorded low CCVI, indicating high overall vulnerability (fig.7), the case of Sanwoma and Eziome requires special mention because they recorded the lowest among the 5 communities as shown in fig.7. Furthermore, the SFMP's focus on Sanwoma for fish processing technology dissemination requires that a climate vulnerability lens is applied in order to target interventions effectively. Unlike the other communities, land tenure insecurity, coupled with high costs involved in accessing land for farming and or resettlement is a major source of vulnerability in Sanwoma. This partly explains the reason resettlement will not be a viable adaptation option for the people of Sanwoma, at least, in the short to medium term. The limited availability of land and space, given the low elevation and physical vulnerability of this community, is a source of additional constrain on siting of fish processing facilities. The highest elevation in this community is 14 meters above sea level and over 341 buildings including fish smoking facilities lie within the riparian buffer of 300 meters – development in this area is prohibited according to TCPD regulations.



**Figure 17 Resulting CCVI of 5 estuarine communities**

## **WAY FORWARD FOR BUILDING ECOSYSTEM AND LIVELIHOOD RESILIENCE**

The analysis shows that the estuarine communities are vulnerable because of their direct dependence on natural resources as sources of food and livelihood security. It also reveals that the major contributors to livelihood vulnerability are not only climate-related such as flooding, increasing temperatures and evolving sea level rise, but also non-climate in nature. These non-climate factors are endogenous to the estuarine communities, thereby constraining their ability to recover from, and adapt to, climate impacts. Key among the non-climate causes of vulnerability is the absence of collective action for managing natural resources at the community level. Yet these resources are perceived to be communal owned and shared by the estuarine communities. Lack of action at the community level is made worse by weak governance mechanisms at the district and regional level to sustainably manage the Ankobra estuary and associated forests, mangrove ecosystem and biodiversity. There is the need to initiate short-term and long-term actions aimed at establishing the enabling conditions for building livelihood and ecosystem resilience in the Ankobra area

### **Short term actions**

Given the intricate vulnerability context of the estuarine communities, resilience building processes should make use of leverage points that will generate quick wins and also lay the foundation for moving forward with long-term measures for community-based management of the estuary. These actions should include;

- Piloting Village Savings and Loan Associations (VSLAs) in coordination with the CSLP. The CSLP has already initiated mangrove reforestation in the broader Ankobra landscape, and this is a promising activity and strategy for empowering the five estuarine villages to participate in community-based management processes for the estuarine resource.
- Sanwoma and its residents are vulnerable to hazards, notably flooding and evolving sea level rise. Findings from the vulnerability assessment suggest that residents'

relocation from this community is remains elusive and at best, presents a long-term adaptation option to these stressors. Furthermore the assessment revealed that impact of flooding on fish processing as a livelihood option is disproportionately high. SpS in coordination with CRC and HM should facilitate the development of flood risk plans as part to inform siting decisions for fish processing facilities. This should be done in parallel or prior to widespread dissemination of fish smoking technologies. Areas for siting these facilities should also be designated in district spatial plans to ensure long term protection of these sites for such uses.

- Detailed analysis of satellite imagery will be conducted to build upon initial effort in year one to produce land use land cover data for the Ankobra estuary ecosystem. The land cover will be extracted from 2013 RapidEye imagery and will follow the same protocol that was used during the ICFG initiative. The land cover data will provide the baseline for detailed mangrove mapping in the Ankobra estuary. The products from these mapping efforts will support improved management and lay the ground work for updating the spatial plans for both Nzema East and Ellembelle districts to incorporate uses that are conservation oriented and support the fishery habitat protection.

### Long term actions

- **River basin and catchment management approaches** – maintenance of riparian hydrological balance in the Ankobra basin is required for perpetual freshwater flow to sustain a healthy estuarine and marine fishery. The present upstream land uses, which include alluvial gold mining activities is a potential source of heavy metal pollution that will likely impact estuarine fish recruitment and ultimately, productively. Long term monitoring of water quality to inform basin- wide good management practices is required among other measures to address weak river basin governance. Water quality and estuarine fishery health monitoring as well as watershed management programmes presents collaborative opportunities for UCC's center for coastal management and Hen Mpoano to model behavior for ICM practice in the Ankobra region.
- **Land cover mapping to monitor change over time** - key drivers such as mining, farming and settlement development are rapidly transforming the landscape and aquatic environment in the Ankobra region. The area deserves refined land cover mapping to inform regional level terrestrial land use decision making processes and also support long-term monitoring of land cover change.

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## ANNEX

### Summary Village Assessments

#### *Eziome*

##### Physical hazards

###### *Settlement*

Eziome is situated on a hill about 100 meters west of the Ankobra River. It's a small community with about 20 houses. The buildings in this community are well spaced and constructed with locally available resources like mud and bamboo. The size of the settlement, according to the older members of the community, has reduced significantly over the years after residents embarked on an en masse migration following a dispute between the leaders of Eziome and Bokro. This has resulted in the collapse of the only school and toilet facility after years of abandonment.

###### *Road Network*

Eziome has no motorable roads. The main means of transportation is water and land (footpath). Residents need to cross the Ankobra River and trek several kilometers to access some basic services like market, school, health facility, etc. in communities like Dominase, Apatam and even Axim. Others walk through the wetlands to nearby Bokro and Saloma.

###### *Drainage*

The entire community of Eziome is perched on a small hill surrounded by wetlands and rivers. The Ankobra and two other tributary rivers sandwich the community which is deprived of engineered drains.

###### *Waste Disposals*

There are neither waste disposal sites nor toilet facilities in the community. Waste is generally disposed of in the backyard.

###### *Hazards*

The major hazard in the community is periodic inundation. Community members indicate that

*"the frequency of the inundation has intensified after a major event in 2009. The community has recorded at least one flood every year since this event,"*

Though Eziome is situated on a hill, the surrounding lowlands are wetlands and flood prone. The situation of the community notwithstanding, the drainage system of the area is also a contributing factor to the hazard. The Ankobra River and two other tributary rivers- Ayeho and Subanga rivers, sandwich the community making the inhabitants vulnerable during the raining seasons.

During the raining season, especially in July, the heavy downpour causes the rivers to overflow their banks, flooding the surrounding wetlands causing the destruction of food and

cash crops and restricting movement of community members. All livelihood activities (except fishing) come to a halt for several weeks during such floods



**Figure 18 Community map showing flood hazard areas in Eziome**

*Community map showing flood hazard areas*

Residents, however, depend on farm produce from their backyard garden and resort to fishing as an alternative livelihood option to supplement the limited harvest. Farm produce that are harvested before the floods are kept in the community and either shared among families or sold after the event. Residents who have farms on the nearby hills may also access their farms with canoes. Most vulnerable to this hazard are children and people whose farms are located in the wetlands.

Socio economic and governance dimensions of vulnerability

*Food Security*

The level of fish catch is perceived to be very low and it is perceived that the decline in the fishery begun in the 1990s. Illegal alluvial gold mining operation on the Ankobra and mangrove degradation is perceived as some of the causes of depleting fish stock in the river and estuary. Food crop is also perceived to be affected by seasonal inundation from the Ankobra river. The nearest food market is Dominase which is about 5 kilometers from the village. People from the community normally trek for more than 3 hours or boat ride for more than 5 hours to the market destination. However, access to, and cost of land as well as its availability for food and cash crop production does not pose vulnerability for this community

### *Governance and institutions*

Leadership at the community level is weak and is partly the reason for poor community based natural resource management decision making and governance. There is also the perception that they are powerless in the face of the political and market forces driving degradation of the Ankobra resources such as illegal mining and dumping of tailings from Adamus resources operations

*“Even if we devise rules for managing natural resources, we will not be successful because the resources are shared among several communities downstream and upstream of the Ankobra River. We can decide to do the right thing but you don’t have control over what others do.”*

While the Ankobra river has been the source of drinking water for this community, recent mining operations have made drinking from this source unsafe. Drinking water is not within the reach of this community. Presently, community folks trek over 3 hours to access sachet drinking water. Despite these difficulties, NGOs operation does not reach this community. Past efforts by Adventist Relief Agency (ADRA) resulted in the construction of a community center. Furthermore; basic services from the local government are not forthcoming, partly because their concerns are not articulated by the assemblyperson. The community is also affected by changes in the electoral areas which sees them being placed under Ellembelle district on certain occasions and at certain times, Nzema East Municipality.

Perceptions about climate change and its impacts were high among a cross-section of the community and this included the mention of events such as extremely high morning temperatures and changing rainfall patterns. Consequently, during the dry seasons, people from this community migrate to other areas in search of livelihood opportunities This temporal migration also occur in response to inundation from the river, which often result in destruction of crops. Nonetheless, the community does not have existing plans and measures in place to proactively respond to these impacts.

Despite the foregoing challenges, poverty is not perceived to be rife among community members. They perceive the surrounding natural resources as source of survival and wellbeing. In the words of a community leader,

*“It will be sad for anyone in this community to claim to be poor. Outsiders come to exploit our resources for food and income, how much more those of us living with the resources.”*

It is however, worthy to note that despite the perception of the resources as source of wealth, little effort is being made to conserve and sustainably use these same resources which are the essence of their lives.

### Social vulnerability scores

		Eziom
Food Security	Perception of fish abundance	5
	Perception of food crop abundance	5
	Access to food market	5
Land Tenure	Complexity in accessing land	1
	Cost of land	2
Governance and Institutions	Communal involvement in natural resource decision making process	5
	Local norms are applied to regulate access to natural resources	5
	Access to sources of drinking water	4
	Effectiveness of natural resource management systems	5
	Availability and functionality of CBO's (social networks)	5
	Effectiveness of local leadership	5
	Responsiveness of local government	5
	Perception and awareness of climate related risks	2
	Emergency preparedness	5
	Demography	Migration patterns
Perception of poverty		2

### Historical Timeline of Key Events and Climate Related Hazards

Period	Event
Prior to 1970s	Major migration of community folks to Bokro as strategy to gain access to market and proximity to road transportation network Relocation of settlement from upland to areas of low elevation, close to river bank. Booming local wine distillery; a major source of income
1970- 1980	High fish abundance in Ankobra river Major flooding event resulting in relocation of settlement back to areas of high elevation Disaster response and relief provided by ADRA
1990 -2000	Agro business support from ADRA including agro inputs supplies
2000	Migration of youth to engage in illegal mining activities

### Sources of livelihood vulnerability for men

The people of Eziome depend heavily on the available natural resources for their livelihood. Wetlands and the rivers serve as source of drinking water and mollusks (e.g. crabs, snails and periwinkles). Mangrove is not exploited by the community members; residents however, harvest mollusk and set traps in the mangroves for fish. The people of Eziome also harvest bamboo for the construction of their houses, cocoa platforms and bridge.

The men of Eziome are mostly involved in food crop farming and cocoa cultivation. Other livelihood options identified among the men include fishing, sugar cane cultivation and bamboo production. These livelihoods are impacted differently by some climate and non-climate related hazards.

The following are the livelihoods and associated challenges for men.

<b>Livelihood</b>	<b>Challenges</b>
Food crop farming	Pest and diseases Flooding High temperatures
Cocoa farming	Flooding Pest and diseases
Fishing	Polluted rivers
Sugar cane cultivation	Flooding
Bamboo production	High temperatures Flood

*Vulnerability matrix – men*

	Flooding	Polluted river	Pest/ Diseases	High temperatures
Food crop farming	3	0	3	1
Cocoa farming	3	0	3	1
Fishing	0	3	0	0
Sugar cane	2	0	0	0
Bamboo	0	0	0	1

*\*Scoring system is as follows: 3 = significant impact on the Livelihood option 2 = medium impact on the Livelihood option 1 = low impact on the Livelihood option 0 = no impact on the Livelihood option*

Four climate and non-climate related hazards have a toll on the various livelihood options on the men. The degree of the impact of the hazards on the livelihood options are shown in the table above. The seasonal flood regimes impact heavily on three major livelihood activities. The deluged cocoa, sugar cane and food crop farms means loss of produce and extreme hardship. Extremely high temperatures in the dry season impact lightly on bamboo production, food crop and cocoa cultivation. Cocoa and food crop farmers are mostly faced with the challenge of controlling pests and diseases which have significant impact on their livelihood throughout the year.

### Sources of livelihood vulnerability for women

The women identified and ranked their livelihood activities as cocoa farming, food crop farming, sugar cane and carrying of wood. The following are the prioritized list of livelihoods for women and associated challenges.

<b>Livelihood Activity</b>	<b>Challenges</b>
Cocoa farming	Pest and diseases Flooding High temperatures Storm
Food crop farming	High temperatures Flooding Snake bites Pest and diseases Storm
Sugar cane	Pest and diseases Flooding Transportation-Conveying food crops to the road side
Carrying wood	Storm Flooding

### *Vulnerability matrix – women*

<b>Livelihood Activities</b>	<b>Hazards</b>			
	Flooding	Storms	High temperatures	Pest and Diseases
Cocoa farming	3	3	3	3
Food crop Farming	3	3	3	3
Carrying Wood	3	3	0	0
Sugar cane	3	1	1	2

*\*Scoring system is as follows: 3 = significant impact on the Livelihood option 2 = medium impact on the Livelihood option 1 = low impact on the Livelihood option 0 = no impact on the Livelihood option*

The annual floods impact heavily on all the four livelihood options of the women. Cocoa and food crop farming are impacted significantly by all the four identified hazards.

<b>Hazard</b>	<b>Coping Strategies</b>	<b>Expected Coping Strategies</b>	<b>Constraints</b>
Flooding	The men fish and trade their catch with the women Farming on the hills Visiting the market on Saturdays with big boat. The boat visits once in a week Most of the children of school going age are often sent to live with relatives in Axim, Apatam, etc where they can access some certain facilities	Big boats to facilitate movement during floods Supply of relief items during flood events The provision of a health facility	Financial Travel cost and distance
High Temperatures	Mixed farming of cocoa and other food crops like plantain to provide shade for the cocoa seedling	Pipe borne water (mechanized bore hole)	
Storms	No coping strategy.		
Polluted rivers	The use of sachet water	Pipe borne water (mechanized bore hole)	
Pest and diseases	Destroying affected trees Spraying Fertilizer application <i>“Those who are able to afford pesticides do so but majority of us don’t use any pesticide because they are very expensive”</i>	Pesticides and fungicides Farming gadget Government intervention in exchange for cocoa	Difficulty in soliciting support from external sources because of the small number of people in the community. Community members have formed an association to seek financial support

## Seasonal Calendar

Events	Months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Planting cocoa												
Flooding												
Harvesting cocoa												
Fishing												
Raining season												
Dry season												
Migration												
Pest and Diseases												
Food scarcity												

The major raining season runs from May to July which coincides with the flooding in June-July. To avoid the floods some households and individual often migrate/travel in March before the rains. Others have resorted to farming on hilly grounds where the floods cannot affect the crops.

Despite the negative impact of the floods such as destruction of houses, farms, pollution of drinking water, etc., it should be noted that fishing thrives during this period. Fishing is thus done from May to July as a major source of livelihood during this period.

*‘‘We get a lot of fish during the floods’’*

Cocoa is planted from July to August and harvested from June to August. The period of harvest unfortunately coincides with the raining season and the inundation results in loss of farm produce.

These problems, coupled with dry season experienced in February and March and the fact that pest and diseases affect farms all year long in the community, result in food scarcity all year apart from April and May.

### ***Kukuaveli***

#### Physical hazards

##### *Settlement*

Settlement is nucleated mostly with very limited spaces between buildings. The buildings are mostly single storey compound houses built with cement /mud with iron sheets, bamboo, etc. The elevation of the settlement is generally higher than the surrounding wetland areas.

##### *Road Network*

Kukuaveli has one major road that connects the community to the main market area and the nearby Ajomaro Eshiem. There is only one road in the community that intersects the major road. Transportation is mostly by road, river or on foot. There are a number of footpaths leading to farms and nearby communities.



### *Drainage*

Two tributary rivers of the Ankobra surround the community making flooding a recurrent event. The Fenven river is the only source of drinking water in the community, It is also the bathing place for community members There are no engineered drains in the community; however, there are a number of natural drains which lead to the nearby wetlands.

### *Waste Disposals*

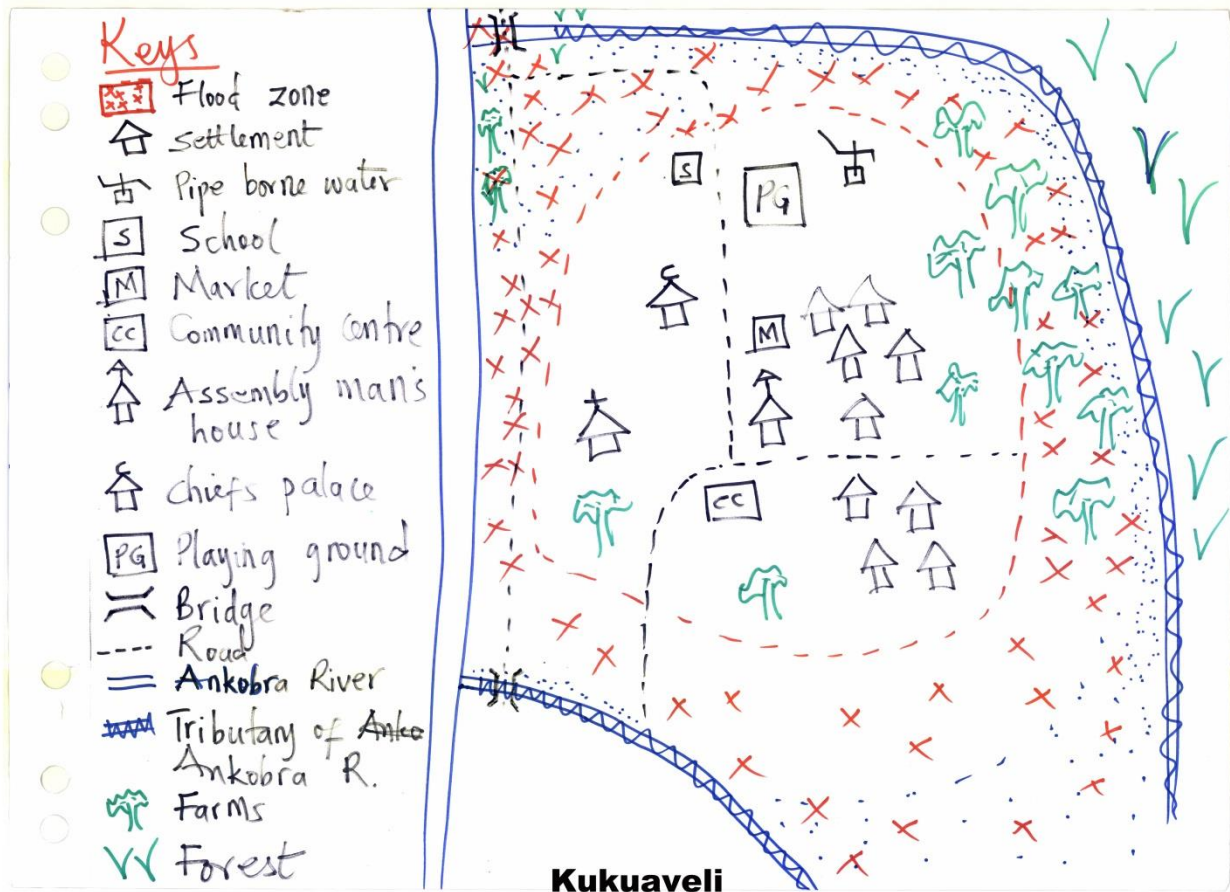
There are no waste disposal sites in Kukuaveli. Waste is generally disposed of indiscriminately in the wetlands. There are also no toilet facilities in the community. Sanitation is therefore a major issue in the community.

### *Hazards*

Due to the location of the community with surrounding low-lying wetland areas crisscrossed by rivers, flooding happens to be the major hazard the community faces. The community members recounted that there was a major flooding event in 1987 and another one in 2009. The community has since 2009 been a victim of floods every year.

Though the settlement itself is not flooded, almost all the economic activities in the community are halted during a flood event. Cocoa, rubber and food crop farms are completely covered and the entire community is cut from other communities for weeks. The settlement therefore becomes the haven for already harvested crops and wood.

Children are most at risk from the flood because they could easily drown. Moreover, the hazard impacts all economic activities except fishing, which peaks when the rivers flood. During the floods, residents depend on crops from their backyard garden and farm produce that were harvested before the event. Owners of small canoes are able to transport some goods across the water; however the community has very few canoes (less than 10). Some residents, particularly fishermen, supplement the limited food stock of the family with their catch.



**Figure 19 Community map showing flood hazard areas n Kukuaveli**

*Community map showing flood hazard areas*

Socio-economic and governance dimensions of vulnerability

*Food Security*

Inhabitants of this community perceive a decline of food and fish over the last decade. Reasons ascribed to this decline include bad fishing practices and declining fertility of soils for food crop production. Food crop markets are not within easy reach. Inhabitants trek over 5 miles to access these markets.

*Land tenure*

Access to land for food crop production is relatively easy in this community. The cost of land is also not an issue. Share cropping is usually practiced, making it possible for land owners to share benefits with tenant farmers.

*Governance and institutions*

There are no traditional management systems for natural resources. Perhaps, the people of Kukuaveli have lost the sense of place and connection with their natural environment which is the basis of their livelihoods. Traditional norms are not adhered to. Neither are there sanctions for engaging in socially unacceptable practices such as illegal logging of forest

timber. The community expressed a general sense of a disempowered society because the drivers of ecosystem degradation, particularly mining is perceived to be uncontrollable at the community level.

### *Demography*

In the last few years, migration has increased in Kukuaveli. Emigrants are usually the youth who find no options for a better quality of life in this community. It was expressed that poverty has increased as a result of migration.

### Social vulnerability scores for Kukuaveli

		Kukuaveli
Food Security	Perception of fish abundance	5
	Perception of food crop abundance	4
	Access to food market	4
Land Tenure	Complexity in accessing land	1
	Cost of land	1
Governance and Institutions	Communal involvement in natural resource decision making process	5
	Local norms are applied to regulate access to natural resources	4
	Access to sources of drinking water	4
	Effectiveness of natural resource management systems	5
	Availability and functionality of CBO's (social networks)	5
	Effectiveness of local leadership	5
	Responsiveness of local government	5
	Perception and awareness of climate related risks	2
	Emergency preparedness	5
Demography	Migration patterns	4
	Perception of poverty	2

### Historical Timeline of Key Events and Climate Related Hazards

Period	Event
Prior to 1940	First settlement in the swamps of Ankobra tributary; major livelihood was cultivation of high yielding <i>Xanthosoma</i> variety
1940 – 1950s	flooding resulting in relocation from river bank to high elevation area- present location of community access to settlement is by crossing tributaries of Ankobra
1950 – 1990s	Major construction activities such as construction of link road from northern part of Nzema east to community by government; construction of access road and wood bridge to community by private timber company; construction of class room blocks
1968;1987;2009; 2014	Major flooding events hits community

2000	Construction of borehole. However, water from this source is unwholesome as a result of high concentration of iron
2013	Connection to national electricity grid

#### Sources of livelihood vulnerability for men

Kukuaveli is blessed with many natural resources most of which are exploited at different times of the year. Some of the available resources include bamboo, terrestrial forests, rocks, massive wetlands and rivers. Residents get fish, mollucks and water from the wetlands. The wetlands are also the source of the raffia trees which are utilized for local wine distillation. Bamboo is cut and sold for construction purposes and the forest is the source of timber products. The land is also suitable for mining and farming (cocoa, rubber, sugar cane and food crop). Residents claim Kukuaveli also has *a massive rock reserve which could be a potential quarry or tourist site*

Five out of 10 livelihood activities that were identified by the men were ranked as the most important. The men are mostly farmers (food crop, cocoa and coconut) and alcohol distillers. Fishing is done by most men in the community on daily basis, especially during the raining season.

Below are the livelihood activities and associated challenges.

Livelihood	Challenges
Food crop farming	Flooding Rodents/Pests
Alcohol Distillation	Flooding
Cocoa farming	Flooding Pests/Diseases Fertilizer/Spraying Cost
Coconut	Flooding Pests/Diseases
Fishing	Polluted river (Ankobra)

#### Vulnerability matrix – men

	Flooding	Pests/Diseases	Polluted river	Lack of Fertilizer/spray
Food crop farming	3	2	0	2
Alcohol Distillation	2	1	0	0
Cocoa farming	2	3	0	3
Coconut farming	1	2	0	0
Fishing	0	0	3	0

*\*Scoring system is as follows: 3 = significant impact on the Livelihood option 2 = medium impact on the Livelihood option 1 = low impact on the Livelihood option 0 = no impact on the Livelihood option*

Four most important hazards to the livelihoods of the men were identified as flooding, pests and diseases, pollution (Ankobra River) and lack of funds for servicing farms. Four out of the five livelihood activities (except fishing) are impacted at varying degrees by flooding and pests/diseases. This is compounded by the lack of funds to service cocoa and food crop farms through the application of fertilizer and spraying of pesticides. Farmers are to some extent able to control rodents like grasscutters by setting traps in the farms. The polluted Ankobra River affects the fish catch. Residents attribute the turbid waters of the Ankobra to the activities of illegal miners who operate upriver. The two other rivers in the community- Fenven and Mamawili are the mainstay of most of the fishing activities since they are not polluted.

#### Sources of vulnerability for women

The pairwise ranking of the nine (9) livelihood activities that women engage in resulted in the five activities listed in the table below as the most important. The women are mostly involved in food crop and cocoa farming for their livelihood. The following are the livelihood activities and associated challenges.

Livelihood	Challenges
Food crop farming	Flooding High temperatures Rodent, pest and diseases
Cocoa farming	Flooding Pest and diseases High temperatures Storms High cost of pesticides
Trading	Buying on credit and unable to pay Lack of market Floods
Carrying of wood	Flooding Storm Harmful reptiles
Oil (copra)	Flooding Erratic rainfall

*Vulnerability matrix- women*

Livelihood Activities	Hazards				
	Flood	Storm	Erratic Rainfall	Pest and Diseases	High temperatures
Cocoa farming	3	3	3	3	3
Food crop Farming	3	3	3	3	3
Carrying wood	3	2	1	0	0
Trading	3	1	1	0	1
Oil making	3	1	2	0	0

*\*Scoring system is as follows: 3 = significant impact on the Livelihood option 2 = medium impact on the Livelihood option 1 = low impact on the Livelihood option 0 = no impact on the Livelihood option*

The five greatest hazards that are associated with the above activities are flooding, storms, erratic rainfall, high temperatures and pests and diseases. Flooding impacts significantly on

all the five major livelihood options women engage in. Storm and erratic rainfall also affect all the five activities at varying degrees. Farmers are impacted more by high temperatures as well as pests and diseases.

<b>Hazard</b>	<b>Coping Strategies</b>	<b>Expected Coping Strategies</b>	<b>Constraints</b>
Flooding	Backyard gardens Migration to Badukrom, Akango, Benso, Kadadwen, etc to work The use of small canoes Fishing done to supplement limited food stock	Constructmion and filling of road Big gutters/drains Relief items Terracing in farms	Financial constraint Lack of Government support
High Temperatures	Hiding under big trees for some time		
Pest and Diseases	Cutting mistletoes with cutlass Destroying infected trees eg. Coconut Weeding frequently Mixed cropping. Eg introducing cocoa to a dying coconut farm	Pesticides and spraying machines Government intervention in cocoa production in exchange for cocoa	
Polluted river	No coping strategy	Fish ponds (Aquaculture)	
Storms	No coping strategy	Heavy oil processing machine able to withstand storms	

Seasonal calendar of key activities and events

<b>Events</b>	<b>Months</b>											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Raining season	■	■				■	■					■
Dry Season			■									
Cocoa planting					■	■	■					
Cocoa Harvest						■	■			■	■	
Flooding						■	■					
Food Scarcity						■	■	■	■			
Migration								■	■			
Pest and Diseases			■	■	■							

Rainfall in Kukuaveli is experienced two times in the year with the first one occurring from June to July and the second from December through to February. The rainfall often results in flooding which affects farms, houses, drinking water and makes movement very difficult. The latter rain is followed quickly by the dry season. The dry season also marks the beginning of a severe outbreak of pest and diseases which continues until May.

*“March is often dry with high temperatures that destroy our crops and dry up our drinking water”.*

Fishing is done to supplement limited food stock during the periods of severe flooding because with the flood comes abundance of fish. Individuals whose houses are on hilly grounds do backyard farming to support their families. Children are prevented from going to school and certain places during period of inundation.

*“The floods are getting worse by the year. Attempts to cope with the floods by deepening natural drains never worked”*

Cocoa is planted from May to July and harvested twice in the year. The first harvest is between June-July and the second is from October-November.

*“The harvest coincides with the raining season which is also in June-July thus making cocoa farming very difficult as we are unable to transport to the market centre”.*

With the flooding comes food scarcity that continues to September. To cope with the food scarcity some individuals migrate to Badukrom, Akango, Benso and Kadadwen to work between August and September after the rainfall.

## **Sanwoma**

### Physical hazards

#### *Settlement*

Sanwoma is comprised of three nucleated settlement areas- Old site, New site and Anlo Village. The new site is an emerging area to the north (across the Takoradi-Elubo road) of the original settlement. The Anlo village on the other hand is an old settlement of migrant Ewe settlers.

Most of the buildings along the coast (old site and Anlo village) were built with local materials including raffia, thatch, bamboo, and palm fronds. Buildings are mostly nucleated.

Smoking facilities are lined up along the coast for easy access and quick processing of the fish from the landing sites. Most of these facilities are in groups and it includes the Cosmos Energy funded fish smoking facility. Some individual fishmongers also have their smokers close to their houses. Sanwoma is a major fishing community in this part of the region.

#### *Road Network*

Residents of Sanwoma have direct access to the first class N1 road which is in very good condition. The settlement pattern also allows for the movement of vehicle in the sandy streets that connect the coast to the main road during low tide. This makes transportation of fresh and processed fish from the landing sites and processing facilities easy.

#### *Drainage*

Sanwoma is located at the Ankobra estuary, immediately after the bridge on the N1 road. Through the labour of the people, the community has an engineered drain that runs along the northern part of the road.

### *Waste Disposal*

There are three disposal sites in the community two of which are located next to the beach. The other site is located along the N1 road. Residents however admit that people dispose their waste indiscriminately along the beach.

The community has one toilet facility which was sponsored by the European Union and the Government of Ghana under the Micro- Projects program. Though the use of the facility is free, some community members still defecate on the beach.

### *Hazards*

There are a number of hazards in the community, however, inundation and coastal erosion impacts the community most. The erosion of the coast has led to a significant loss of the coastal land and coconut trees that hitherto protected the adjoining community from storms and floods. The impact of the coastal erosion is very severe along the southern coastline.

Inundation in Sanwoma happens on daily basis based on the tidal regime of the ocean. Every high tide means some degree of flooding in the community. Residents indicate that the floods have intensified in recent times and have attributed this to the road construction, indecent waste disposal in the open ocean and the offshore oil and gas industry.

*“The flooding wasn’t this serious. It intensified as a result of the destruction of a drainage system at the bank of the river during the construction of the main road 30 years ago. The frequent floods are also the result of filth and the off-shore oil and gas activities”.*

The phenomenon is however exacerbated in the raining season when the volume of water in the Ankobra increases significantly.

The daily floods have led to the destruction of personal assets including furniture and fish smokers. The inundation which occurs twice in 24 hours (one during the day and the other at night) makes living along the coast quite unbearable. However, only few people have relocated to the new site due to the high cost of land.

The impact of the flood is very intense in the old site due to the topography. The intensity reduces with distance from the coast. The new site and the houses located in the extreme west of the old site are not affected by this hazard. These places therefore serve as safe location for temporary relocation during a severe flood. Fish mongers also sojourn with friends and relatives in these safe places and use their smokers in the event of floods.

Fish mongers are the most vulnerable to the hazards in the community because they process their fish close to the coast where erosion and flooding are most severe.





**Figure 20 Community map showing flood hazard areas in Sanwoma**

*Community map showing flood hazard areas*

Socio-economic and governance dimensions of vulnerability

*Food Security*

The community perceived a drastic decline in fish catch since 2000. The low fish catch in recent times was attributed to the use of light and chemicals for fishing, algal bloom and the restricted area where fishing activities are allowed. The community also lamented the drastic reduction in food crop as a result the conversion of food crop farmlands for the plantation of cash crops such as rubber and cocoa. Prices of goods and market products together with the distance to food markets are other challenges faced by the community

*Land tenure security*

Availability of land for food crop production and access to other natural resource is complex and cumbersome. Community members attributed this to the conversion of vast farmlands for cash crop production. Cost of land in Sanwoma is high. As one of the focus group participant puts it;

*“The new site serves as a safe place due to the hilly nature so we sometimes seek shelter there when the flood is intense. We are unable to resettle there due to the high cost of land there. A piece of land sells for two thousand cedis”*

*Governance and institutions*

Leadership at the community is perceived to be weak. This, according to the participants, is the result of the politicization of the local leadership.

*“For the local leaders to perform, the government should recognize the authority of the community not their representatives”*

The responsiveness of the local government is also low, a problem they attribute to the inactiveness of their assemblyperson. The presence and functionality of CBOs, on the other hand is fairly high. Organizations like Tullow, Cosmos (supply-chain), NADMO, Hess and others have been available and to some extent functional in the community. The community categorically stated that Hess and Cosmos have initiated scholarship programs for children in the communities. They have also supported the community with smoking ovens for fish processing.

Sanwoma is currently not prepared for any emergency or disaster albeit the high awareness and perception about climate change and its impacts.

### *Demography*

The people of Sanwoma perceive poverty as the lack of access to basic needs such as shelter, food security and others. They therefore believe that poverty is not in the extreme since resources still exist in their environment for the provision of these needs. Consequently, the migration of people from the community in search of jobs is very minimal. The community, On the other hand, is a major destination for migrant fishermen from other fishing communities along the entire coastline of the country.

### Social vulnerability scores for Sanwoma

Themes	Indicators	Score
Food Security	Perception of fish abundance	5
	Perception of food crop abundance	5
	Access to food market	4
Land Tenure	Complexity in accessing land	5
	Cost of land	5
Governance and Institutions	Communal involvement in natural resource decision making process	5
	Local norms are applied to regulate access to natural resources	5
	Access to sources of drinking water	1
	Effectiveness of natural resource management systems	5
	Availability and functionality of CBO's (social networks)	2
	Effectiveness of local leadership	5
	Responsiveness of local government	5
Demography	Perception and awareness of climate related risks	3
	Emergency preparedness	5
	Migration patterns	3

	Perception of poverty	2
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### Historical Timeline of Key Events and Climate Related Hazards

Period	Event
1930 - 1940	Booming sawmill industry in Sanwoma that relies on forest timber from Ankobra area; major food crop production from river bank; Anlo settlers introduce beach seine fishing ; booming fishing industry; major settlement development around sawmill industry, present new site characterized by clearing areas of coconut plantation
1950 - 1960	Decline of sawmill industry; settlement development at ocean front
1960 - 1990	Fishing becomes the major livelihood activity
1990 – present time	Declining fishing industry characterized by low standard of living

### Sources of livelihood vulnerability for men

Fishing is the mainstay of the people of Sanwoma. Fishing is done both in the river and in the ocean. Farming (cocoa cultivation and food crop including vegetables) is another important livelihood activity that involves most of the men. Sanwoma is noted for its intense exploitation of mangrove trees mostly for smoking and building. Rubber plantation is gradually expanding as more people are converting their farmlands into rubber, with the support of GREL. Seven out of the 11 identified livelihood activities were ranked most dominant by the men and the following challenges were identified with the major livelihood activities of the men.

Livelihood	Challenges
Fishing	Storms/Excessive rainfall Sanitation Excessive sunshine Capital
Food crop farming	Pests and Diseases Irregular rainfall Erosion and deposition of soil Flooding Bush burning
Mangrove selling	Storms Safety issues Marketing (seasonal)
Cocoa farming	Pests and Disease Fertilizer application/cost Access to market (poor road network from cocoa farms)
Rubber plantation	Pests and Diseases Capital Fertilizer application
Alcohol Distillation	Safety issues Storms
Coconut Oil	Weather conditions/Seasons

	Irregular rainfall	Storms	Pest/ Diseases	Flood	Sanitation
Fishing	3	3	0	0	3
Food crop farming	3	3	3	3	0
Mangrove trading	1	1	0	3	0
Rubber plantation	2	2	3	0	0
Cocoa farming	2	1	3	2	0
Alcohol distillation	1	0	0	3	0
Coconut oil	0	0	0	0	0

*Vulnerability matrix - men*

*\*Scoring system is as follows: 3 = significant impact on the Livelihood option 2 = medium impact on the Livelihood option 1 = low impact on the Livelihood option 0 = no impact on the Livelihood option*

Climate and non-climate related hazards associated with the identified livelihoods were irregular rainfall pattern, storms, floods, sanitation, pests and diseases. Coconut oil production is least vulnerable to all the hazards. None of the identified hazards has any impact at all on this livelihood option.

Fishing is significantly impacted by the irregular rainfall pattern, storms and sanitation. Food crop farmers on the other hand, have to deal with all the identified hazards with the exception of sanitation

Sources of livelihood vulnerability for women

Pairwise ranking of sixteen (16) livelihood options by women revealed fish mongering, trading, food crop farming, harvesting mollusks (periwinkle) and harvesting fuel wood as the major sources of livelihood among the women.

The following challenges were identified with the major livelihood activities of the women.

<b>Livelihood</b>	<b>Challenges</b>
Fish Mongering	Marketing High cost of materials and equipment Smoke Flooding as a result of the high tides and seasonal rainfall Storage facilities
Fire Wood	Land availability-Don't have own land to draw from Travel long distance to get fuel wood as a result of the forest and mangrove depletion Lack of market during the lean seasons Unable to work during the rainy seasons Risk issues

Mollusks harvesting	Inadequate canoes Accessibility- Most women don't know how to paddle the canoe Mangrove harbours harmful animals (mosquitoes) High tides/Flooding Lack of storage facilities Lack of market
Food crop farming	Flooding at low land areas Soil infertility Lack of market Lack of lands for food crops because most of the land have been converted to rubber plantations Pest and diseases
Trading	Lack of market (especially in the rainy seasons when there is lot of flood) High cost of labour

*Vulnerability matrix -women*

Livelihood Activities	Hazards				
	Flooding	High Tides	High temperatures	Pest and diseases	Spoil of catch and foods
Fish mongering	3	2	0	0	3
Trading	3	1	0	0	3
Food crop farming	3	0	3	3	3
Harvesting Molluscs	3	3	0	0	3
Harvesting Fuelwood	3	2	0	0	1

*\*Scoring system is as follows: 3 = significant impact on the Livelihood option 2 = medium impact on the Livelihood option 1 = low impact on the Livelihood option 0 = no impact on the Livelihood option*

The annual flooding was identified to impact significantly on all the livelihood options of the women. Food crop farmers are impacted significantly by all the stressors identified. High tides also affect all the livelihood activities at varying degrees

Hazard	Coping Strategies	Expected Coping Strategies	Constraints
Flooding	Sojourn with relatives and friends for shelter when hit by flood Some are relocating to the new site Farming on hilly areas Temporary structures made of local materials like raffia and thatches <i>“We rebuild our houses with raffia which is relatively cheaper “</i> Trenches in rubber farms Terracing in farms	Resettling at the new site Building Cement houses Sea defence wall/ engineered drains Create more trenches in cash crop farms	Financial constraints as a plot of land at the new site is 2,000 cedis Cost of putting up cement house is very high
Loss of fish and farm produce	Selling on credit Selling at a lower cost so as to sell before they spoil	Market Training on packaging for non-traditional markets and export Storage facilities	
High tides	Migrating to the new site (the affluent)		
Sanitation	No coping strategy Litter from seine nets are left at the beach	Provision of dustbins at landing sites Collecting and selling sachet rubber from landings for reuse/recycling Training/education	

Seasonal calendar of key activities and events

Events	Months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainy Season												
Dry season												
Flooding												
Peak season (fish)												
Lean season (fish)												
Food Scarcity												
Peak season (Molluscs)												

Sanwoma community experiences flood all year long. High tide is the major cause of flooding in the community. Flooding is however massive in the rainy seasons (May to July) which follows directly after the dry season (March to April). Houses and properties are destroyed as a result of the floods.

Peak seasons for fish and molluscs (periwinkle) are August - December and May - July respectively. Lean season for fish is January and February. During the peak season fish is in abundance and getting market becomes a problem.

### **Adelekezo**

#### Physical hazards

##### *Settlement*

Adelekezo is a settlement located about 9.5 kilometers from the Ankobra River. It is surrounded by wetlands and drained by a major tributary of the Ankobra called River Hammar. The settlement is nucleated and building construction is done with a combination of local (mud, bamboo, thatch, etc) and foreign materials (cement, roofing sheets, etc)

##### *Road Network*

The community has one major road that connects with Averebo. This road is untarred and gets disconnected from other communities when there is flood.

##### *Drainage*

The entire community of Adelekezo is surrounded by a vast wetland area (mostly mangroves) and the River Hammar. The community does not have any engineered drains. There are, however, natural drains formed from erosion of the soil.

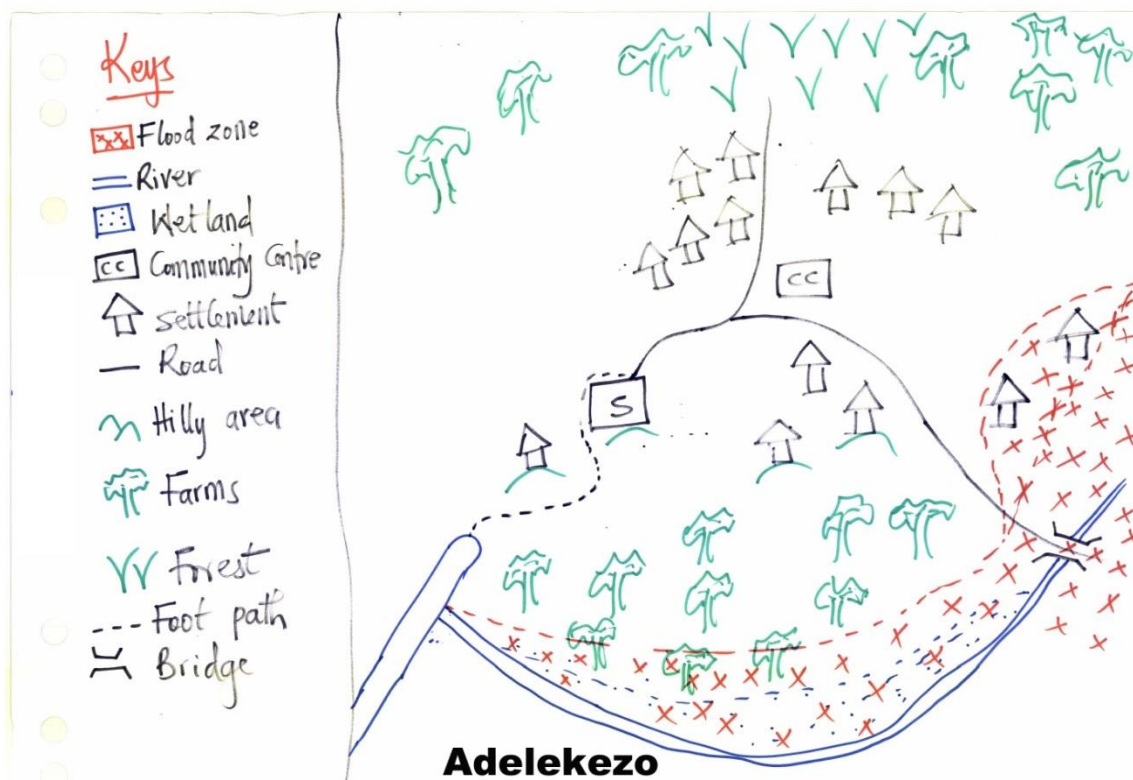
##### *Waste Disposal*

There are neither waste disposal sites nor toilet facilities in the community. Waste is generally disposed of in the backyard.

##### *Hazards*

The major hazard in the community is floods. The inundation makes access to any other location outside the community very challenging. Almost all economic activities are halted during the floods.





**Figure 21 Community map showing flood hazard areas in Adelekezo**

*Community map showing flood hazard areas*

### Socio-economic and governance dimensions of vulnerability

#### *Food Security*

The community has witnessed a drastic reduction in fish and food crops production. Illegal gold mining operation on the Ankobra is perceived as the main cause of declining fish stock in the river. The fall in the food crop abundance was associated with depleting soil fertility of farmlands. Access to food market is difficult. The nearest food market is Dominase which is about 10 kilometers from the community. However, access to, and cost of land for food and cash crop production does not pose vulnerability for Adelekazo

#### *Governance and Institutions*

There is complete absence of CBO's activities in the community and the responsiveness level of the District Assembly is low. Furthermore, there are no bye laws or customs that govern the utilization of the natural resources. Despite the above difficulties, the community has maintained a vast area of undisturbed mangroves for years. The community members perceive that the effectiveness of the local leadership and the internal arrangements such as occasional warnings and reminders explain the existence of the pristine mangrove.

The only dugout well in the community produces far less water for the entire community. During the dry season, access to water becomes very difficult. The water becomes salty and very scanty. People travel long distances to get potable water.

Perceptions about climate change and its impacts were relatively high among the community members. This, according to the focus group participants, is evidenced by the change in rainfall patterns. The community however, does not have any proactive measures or capacity to curb or combat any emerging disaster. Migration among the youth in particular is relatively high. This happens often before the raining season when individuals leave to engage in menial work to earn their living elsewhere. Members of the community don't perceive themselves as poor, despite the many challenges they have to deal with. They however believe that the current condition can best be described as hardship.

#### Social vulnerability scores for Adelekezo

Themes	Indicators	Score
Food Security	Perception of fish abundance	5
	Perception of food crop abundance	5
	Access to food market	4
Land Tenure	Complexity in accessing land	1
	Cost of land	1
Governance and Institutions	Communal involvement in natural resource decision making process	5
	Local norms are applied to regulate access to natural resources	5
	Access to sources of drinking water	5
	Effectiveness of natural resource management systems	5
	Availability and functionality of CBO's (social networks)	5
	Effectiveness of local leadership	2
	Responsiveness of local government	5
	Perception and awareness of climate related risks	2
	Emergency preparedness	5
Demography	Migration patterns	2
	Perception of poverty	3

#### Historical Timeline of Key Events and Climate Related Hazards

Period	Event
1968;1987;2009	Major flooding event resulting in destruction of settlement and farmlands
1982	Incidence of cholera resulting in loss of more than 10 lives
Dry seasons	Major water crisis hits community

#### Sources of livelihood vulnerability for men

The major livelihood activities identified with the men were ranked as follows using pairwise ranking method; Alcohol distillation, followed by fishing and illegal mining activities (*galamsey*), food crop farming, coconut and palm tree farming. Interestingly, the people of Adelekezo do not exploit mangroves at all. The large stretch of mangroves (about 10 km from the confluence with Ankobra) looks pristine and undisturbed. The residents don't seem to know the importance and value of this ecosystem. The following challenges were identified with the major livelihood activities of the men.



**Figure 22 Stands of mangroves in Adelekezo**

*Stands of mangroves in Adelekezo*

<b>Livelihood</b>	<b>Challenges</b>
Alcohol Distillation	Flooding Extreme temperature causing water to dry Changes in the seasons
Mining( <i>Galamsey</i> )	Flooding Security issues Lack of land Clack of drinking water in the dry season
Fishing	Pollution Salt intrusion in the dry sea leading to decline in fish catch
Food crop farming	Pests and Diseases Flooding Seasonal changes
Palm tree farming	Market for produce
Coconut Farming	Pests/diseases
Cocoa Farming	Pests and Disease Flooding Lack of funds

*Vulnerability matrix- men*

	Flooding	Pests/ Diseases	Market	Land	Pollution
Alcohol Distillation	3	3	0	0	0
Mining	3	0	2	3	0
Fishing	0	0	0	0	3
Food crop farming	3	2	0	0	1
Palm tree farming	0	1	0	0	0
Coconut farming	0	3	0	0	0
Cocoa farming	2	3	0	0	0

*\*Scoring system is as follows: 3 = significant impact on the Livelihood option 2 = medium impact on the Livelihood option 1 = low impact on the Livelihood option 0 = no impact on the Livelihood option*

Pollution was identified as the only hazard that impacts significantly on fishing. Miners are faced with flooding, market and the unavailability of land. Flooding in the community impacts significantly on the livelihoods of alcohol distillers, miners, and cocoa and food crop farmers

Sources of livelihood vulnerability for women

Pairwise ranking of twelve (12) livelihood activities engaged in by the women of Adekazo revealed food farming, Galamsey, cocoa farming, Rubber plantation and trading as the major sources of livelihood for women in Adekazo. The following challenges were identified with the livelihood activities of women.

Livelihood	Challenges
Food farming	Pest and diseases Lack of marketing Bad roads to transport produce to market area High temperatures Storm
Cocoa farming	Pest and diseases Flooding Difficulty getting produce to buyers
<i>Galamsey</i>	Flooding
Rubber plantation	Flooding Weeds Pest and diseases
Trading	Transportation Bad roads

*Vulnerability matrix- women*

Livelihood	Hazards				
	Flooding	High temperatures	Storm	Transportation	Pest and diseases
Food farming	3	3	3	3	3
Cocoa farming	3	2	2	3	3
Galamsey	3	0	3	3	0
Rubber plantation	1	0	1	3	3
Trading	2	0	1	3	0

*\*Scoring system is as follows: 3 = significant impact on the Livelihood option 2 = medium impact on the Livelihood option 1 = low impact on the Livelihood option 0 = no impact on the Livelihood option*

Food farming as a livelihood option is impacted significantly by all the hazards. Cocoa farmers are also impacted in varying degrees by all the hazards. Transportation affects significantly all livelihood activities while pest and disease on the other hand also affect all livelihood options significantly, with the exception of galamsey and trading.

Hazard	Coping strategy	Expecting coping strategy	Constraints
Flooding	<p>“Attempts to block and divert the flow of water to the community using sack filled with sand did not work”</p> <p>The use of canoes and raft to cross the flood to adjoining communities</p> <p>Taking refuge in the elevated areas in the community</p> <p>“Gullies are dug for the water to flow but they are not very effective”</p> <p>People depend on food crop farms in their backyard</p>	Road and bridge Clinic	Financial constraint
High temperature	No coping strategy		
Unavailability of land for mining	No coping strategy		
Polluted water	No coping strategy	Dredging the water Aquaculture as alternative livelihood	
Storm	No coping strategy		

Transportation (Road and bridge)	<i>“Pregnant women are carried by two men in cloth tied to a stick for 5 miles before we get a vehicle to the nearest health facility”.</i>	Good road and bridge	Financial constraint “We don’t have the money to construct good road and bridge”
Pest and diseases	Spraying with pesticides and fungicides	More pesticides and fungicides.	Financial constraints

Seasonal calendar of key activities and events

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Salinity of river												
Food scarcity												
Rainy Season												
Flooding												
Migration												
High temperatures												
Cocoa harvest												
Rubber Harvest												
Abundance of Pest and diseases												

Adelekezo experiences increased pest and diseases, high temperatures and salinity of drinking water in March. Food scarcity also begins in the same month (March) and ends in August.

*“Our drinking water is not good. We will be very happy if you can help us get a pipe. Our water tastes salty at times (especially when the temperatures are high) which makes drinking very difficult”*

The First and major season for the rains is from May to July whilst the second rains come in the month of October. With the rainy season comes flooding of the community which causes a lot of destruction in the community. Movement in and out of the community is difficult during the floods.

*“We walk for five miles before we get to (Dadwen) the community where we can get car to continue our journey during the floods because no car comes here. We sometimes use woods to create a raft to cross the waters”*

To cope with the flooding and food scarcity households and individuals migrate in June and July to engage in menial work to earn their living elsewhere. Attempts to minimize the impact of the floods by creating drains, blocking and diverting the flood flow to the community using sack filled with sand did not work.

Rubber is harvested all year long with the exception of February and March while cocoa is harvested in June and July.

*“Even though cocoa harvest is in June –July, access to market site is not possible due to the floods, leading to losses and the inability to raise money.”*

## **Ajomoro Eshiem**

### Physical hazards

#### *Settlement*

Ajomoro Eshiem is situated between Eziome and Kukuaveli, on the eastern bank of the Ankobra River. Buildings are mostly nucleated and built with local materials. The elevation of the Eshiem settlement is generally higher than the surrounding wetland areas

#### *Road Network*

Eshiem has one major road that connects the community to the main market in Domenase through Kukuaveli. The graveled road is motorable in most part of the dry season. There are a number of footpaths to nearby communities.

#### *Drainage*

In addition to the Ankobra River, the people of Eshiem have access to the Mamawili River which is a tributary of Ankobra. There are no engineered drains in the community; however, there are a number of natural drains which lead to the nearby wetlands

#### *Waste Disposal*

There are neither toilet facilities nor specific waste disposal sites in Eshiem. Residents admit that waste is generally disposed of in the bushes and adjoining wetlands.

#### *Hazards*

The topography of the community coupled with the two adjacent rivers and their wetlands make the residents of Eshiem susceptible to flooding. The settlement was built on top of a small hill which drops gradually into the low lying wetlands which serve as reservoir for water during the raining season. The flooding which is a yearly event was very severe in 1968, 1978, 2009 and 2013. The inundation makes access to any other location outside the community very challenging. Almost all economic activities are affected in one way or the other by the inundation which often takes long time to recede.

People cope in this situation by relocating temporarily with friends and relatives whose houses are not affected by the hazard. Farmers who are able to harvest their crops before the rains or flood share farm produce with relatives and friends. Other farmers who have backyard gardens depend on the farm produce during the period. In some cases, traders from surrounding communities take advantage of the flooding situation to sell food at high cost to the people of Eshiem.

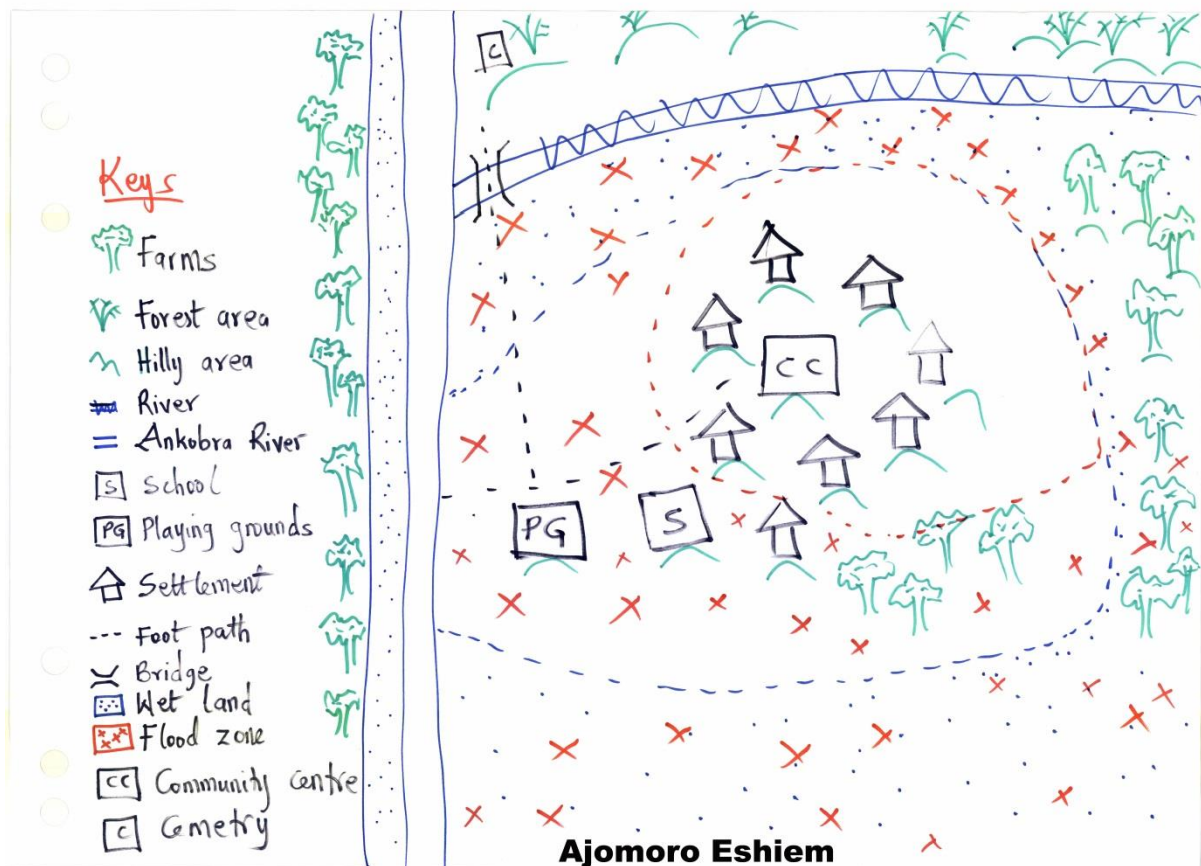
*“Most vulnerable are the poor who are unable to buy food from the men from the Kuzaku community during the flood”*

Closely related to this hazard is the polluted water of the Ankobra River.

*“The flood keeps getting worse with time and we believe the activities of galamsey operators in the river is a contributing factor”*



Residents are of the perception that the activities of the illegal miners upriver are causing a lot of sedimentation down the river course. When the volume of the water increases during the raining season, the river floods its banks and affects farms, buildings and other assets.



**Figure 23 Community map showing flood hazard areas in Ajomoro Eshiem**

*Community map showing flood hazard areas*

The people of Eshiem also believe that the polluted water in the Ankobra contains some harmful chemicals which does not only cause decline in fish catch, but also kill the food crop and cocoa along the banks of the river.

Socio-economic and governance dimensions of vulnerability

*Food Security*

The level of fish catch is perceived to be very low. Gold mining operation on the Ankobra by Adamus Resources is perceived as the major cause of depleting fish stock in the river. Meetings between community leaders and officials of Adamus have not yielded any positive results. Food crop is also perceived to be low in recent times. Seasonal flooding (particularly the major one that hit the community in 2014) has affected food and cash crop production significantly. However, access to food market does not pose vulnerability for this community except when there is a deluge. Land for food and cash crop production is free and easily accessible in this community.

*Governance and Institutions*



The management of natural resources is currently not vested in any authority. There are no bye-laws or customs that govern the resources in the community. The presence and functionality of CBOs in the community are also very minimal. The community members recall that one NGO visited sometime in the past. The responsiveness level of the District Assembly is also low. However, leadership at the community level is effective. There is difficulty in accessing water in the community. The available water source (a stream) dries up easily especially during the dry season.

Perceptions about climate change and its impacts were relatively high among the community members. Community members observed changes in rainfall patterns over the years.

*“In the past we had a lot of rain in August, but the trend has changed”.*

There are also no proactive measures present in the community that are aimed at providing emergency services in times of disaster.

Poverty is perceived to be very low in the community partly because most of the farmers have entered into cash crop farming in addition to the food crop farming for subsistence. Migration however is very high among the youth who travel far from home to look for greener pastures before or the raining season.

#### Social vulnerability scores for Eshiem

Themes	Indicators	Score
Food Security	Perception of fish abundance	5
	Perception of food crop abundance	4
	Access to food market	2
Land Tenure	Complexity in accessing land	1
	Cost of land	1
Governance and Institutions	Communal involvement in natural resource decision making process	5
	Local norms are applied to regulate access to natural resources	5
	Access to sources of drinking water	4
	Effectiveness of natural resource management systems	5
	Availability and functionality of CBO's (social networks)	5
	Effectiveness of local leadership	2
	Responsiveness of local government	5
	Perception and awareness of climate related risks	3
	Emergency preparedness	5
	Demography	Migration patterns
Perception of poverty		2

#### Historical timeline of key events and climate related hazards

Period	Event
1968; 1987;2009;2014	Major flooding event destroyed farmlands and settlements
1970s	Operation of union boat owned by wine distillery association
1980s	Booming local wine distillery
1990s	Decline of wine distillery

### Sources of livelihood vulnerability for men

A priority ranking of the livelihood options for men in Eshiem revealed food crop farming, cocoa, fishing, alcohol distillation, coconut farming and rubber farming as the major livelihood activities men engaged in. Below are the livelihoods and associated challenges.

Livelihood	Challenges
Food crop farming	Market/price Pests/Diseases Flood Chemicals from polluted river
Cocoa farming	Flooding Pests/Diseases Capital Chemicals from polluted river
Fishing	Polluted water
Alcohol Distillation	Flooding Market/price
Coconut	Access to processing machine Access to electricity Pests/Diseases
Rubber plantation	Chemicals from polluted river
Palm tree farming	Marketing

*Vulnerability matrix- men*

	Flooding	Pests/ Diseases	Market	Pollution	Distance
Food crop farming	3	2	2	2	3
Cocoa farming	3	3	1	3	1
Fishing	0	0	0	3	0
Alcohol	2	2	3	0	2
Coconut farming	2	1	1	0	3
Rubber plantation	1	0	0	2	0
Palm tree farming	0	1	2	2	1

*\*Scoring system is as follows: 3 = significant impact on the Livelihood option 2 = medium impact on the Livelihood option 1 = low impact on the Livelihood option 0 = no impact on the Livelihood option*

Food crop and cocoa farmers are impacted by all the hazards in varying degrees. Pollution is the only hazard found to impact fishing. People who depend on rubber plantations for their livelihoods are impacted by flooding and pollution in varying degrees.

### Sources of livelihood vulnerability for women

The main livelihood options among women are food farming, cocoa farming, carrying wood, coconut farming and sugar cane farming. The following are some livelihood related challenges identified by the women.

<b>Livelihood</b>	<b>Challenges</b>
Food Farming	Rodent, Pest and diseases Flooding High temperatures Marketing
Cocoa farming	Rodent, pest and diseases Flooding Weeds Distance to market (Dorminase) High temperatures in March
Sugar Cane	Pest and diseases Flooding
Wood carriers	Harmful animals in the forest Flooding Storms
Oil palm farming	Pest and disease Flooding
Oil making	Polluted water

#### *Vulnerability matrix - women*

	Flooding	High temperatures	Storm	Pest and diseases	Salinity
Food farming	3	3	3	3	3
Cocoa farming	3	3	2	3	3
Sugar cane farming	3	0	1	3	3
Wood carrying	3	0	3	0	3
Oil palm farming	3	0	1	1	3
Oil making	3	0	1	0	3

*\*Scoring system is as follows: 3 = significant impact on the Livelihood option 2 = medium impact on the Livelihood option 1 = low impact on the Livelihood option 0 = no impact on the Livelihood option*

Flooding and salinity were identified to impact significantly on all livelihood options. Farmers were significantly affected by all the hazards identified. Storms affect all the livelihood activities in varying degrees.

Hazard	Copping strategy	Expecting coping strategy	Constraint
Flooding	Moving into house of relatives whose houses are not affected by the hazard Buying from traders from neighbouring communities Sharing harvested farm produce with family and friends	“the best way to avoid the flooding is to relocate but there isn’t any land anywhere”	“Land scarcity as we are surrounded by water and other part are also low lying areas”
High temperatures	No coping strategy		
Storm	No coping strategy		
Salinity	Those with money buy alum to settle the dust particles in the water. Others buy sachet water	Mechanized bore hole	Financial constraint
Pest and diseases	Spraying with pesticides	Pesticides and fungicides Spraying machines	Financial constraint
Marketing	Preserving cassava and maize by drying in the sun.		

Seasonal calendar of key activities and events

Hazards	Months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
High Salinity												
Fish Abundance												
Cocoa Harvest												
Food Abundance												
High temperatures												
Food Scarcity												
Flooding												

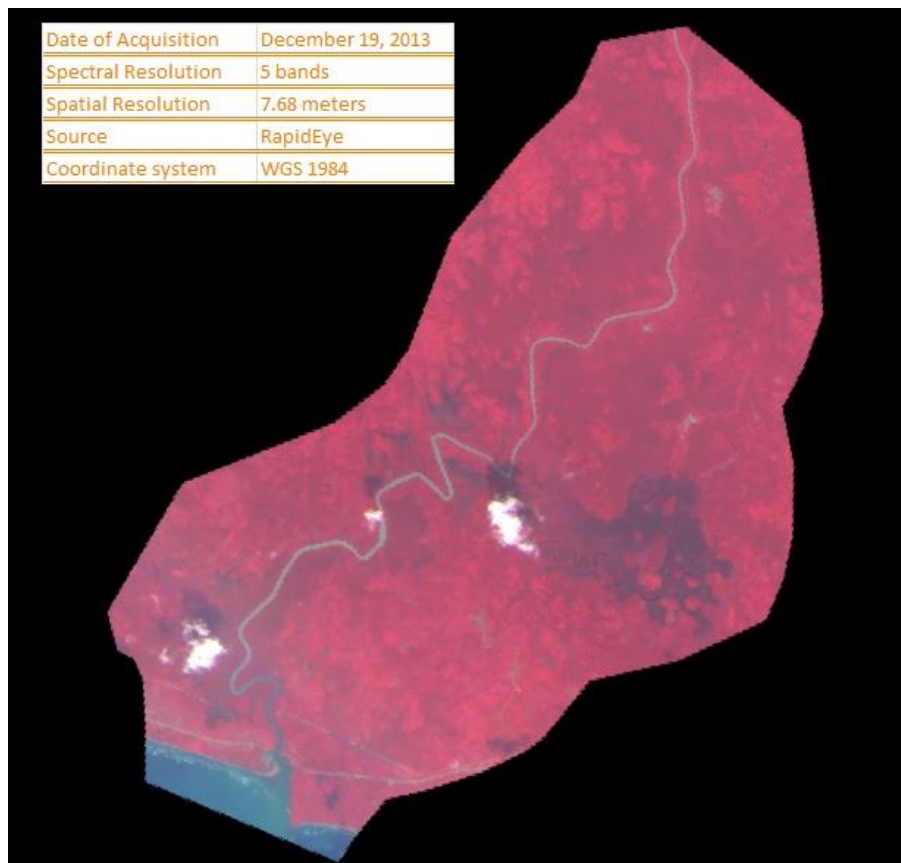
High temperatures and river salinity is experienced in March. During this time drinking water taste salty and very difficult to drink. Those with money buy sachet water or add alum in the water to settle the dust particles. The poor are often vulnerable during these times.

The rainy season causes floods from June to August. Community members depend on relatives who are not affected much by the floods for shelter during this time. Cocoa is harvested (April and May) a bit earlier to avoid the rains and the flood.

Restriction in movement to farms and nearby communities as a result of the flood results in food scarcity in June-July. Communities with larger boats take advantage of the situation to make money.

*“Food is generally scarce in June-July because of the floods which greatly affect our movement. However fish is always in abundance and is our major source of livelihoods during the floods”*

### Land Cover mapping and Remote sensing data



**Figure 24** The RapidEye image of the area with bands 5,3,2 displayed in RGB

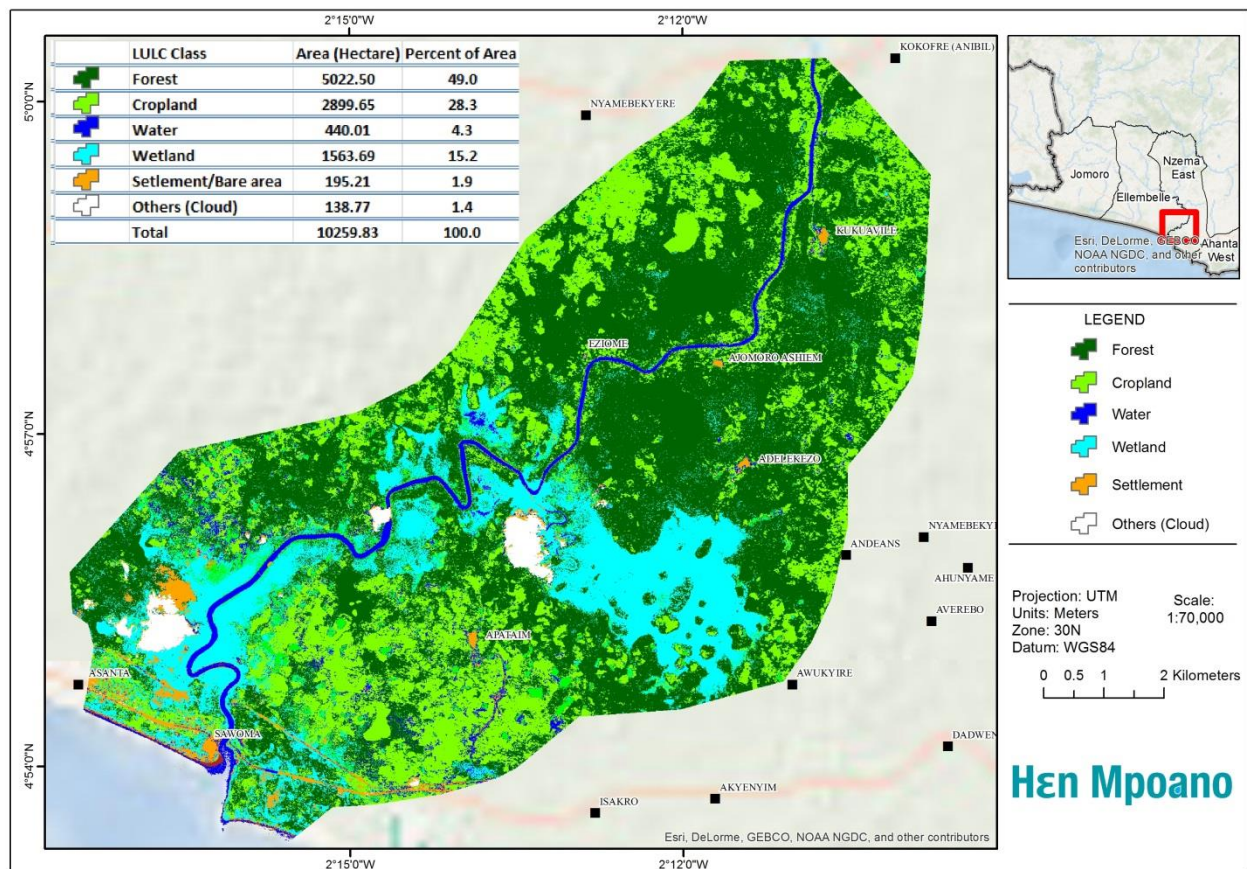
*The RapidEye image of the area with bands 5,3,2 displayed in RGB*

A RapidEye image of the area was the main remote sensing data used. The RapidEye data were acquired in December 2013 and have a spatial resolution of 7.7 meters.

#### **Data Processing and Analysis**

The individual image layers of the RapidEye were stacked together into a single multispectral image. The area of interest (study area) was then subset before the image was projected into UTM zone 30N. A supervised classification method was adopted for the thematic information extraction. In the Erdas Imagine (version 2014) environment, signatures for the different classes were used to train the software for a supervised classification. The training signatures were based on a prior knowledge of the landscape and GPS points collected during a recce. The maximum likelihood algorithm was used to extract six (6) thematic classes- Forest, Cropland, Water, Wetland, Settlement/Bare area and other (mostly cloud).

## Land cover classification of Ankobra Ecosystem



**Figure 25** Land cover map of the study area

### *Land cover map of the study area*

Initial classification of the RapidEye image for the Ankobra ecosystem identified six main cover types. The classes were forestland comprising mostly of terrestrial forest stands; cropland which consist of both food crop and cash crop farms; settlement including rock outcrops, bare areas and sandy beach; wetlands including mangroves; water bodies and the cloud. It is important to note that the cloud cover and haze from the image acquisition process presented some challenges. For instance, some areas covered by clouds and their shadows were misclassified as settlements.

Cropland constituted 28 percent (2900 hectares) of the total area while forestland and wetland constituted 49 percent (representing 5023 hectares) and 15 percent (representing 1564 hectares) respectively.

This is a very rapid classification of the area and does not include any validation of the classes. Field visits will be conducted to ascertain the accuracy or otherwise of the classification process. The land cover mapping did not discriminate mangroves from the other wetland vegetation. This will be done later after a GPS survey of mangroves is conducted. The classified map serves as a basemap of cover types in the area which can be modified with a cloud free imagery. It could also serve as the basis for estimating changes in land cover over time with some additional historical data.

## **Focus Group and Assessment Instrument**

### **Background information**

The Sustainable Fisheries Management Project (*USAID/SFMP*) is a five-year initiative (October 1, 2014 – September 30, 2019) supported by the U.S. Agency for International Development (USAID-Ghana). It is implemented through a cooperative agreement with the University of Rhode Island (URI). The main goal of the *USAID/SFMP* Project is to rebuild marine fisheries stocks and catches through adoption of responsible fishing practices.

Overfishing due to an increasing number of boats and fishers in an open access fishery and weak governance all contribute to a fishery on the verge of collapse. At risk are not only the livelihoods of more than 25,000 Ghanaians engaged in the fishery sector but also the food security of the nation. In addition to the crisis in the fishery, coastal communities are vulnerable to hazards and evolving impacts of climate change, particularly sea level rise, flooding, less frequent rainfall as well as non-climate stressors including mangrove degradation, poor land use, landlessness, poverty etc.

The SFMP strategy is to engage with you (stakeholders) to identify the vulnerabilities specific to your community, and areas of greatest impact, and together, search for solutions to reduce vulnerability and build your community's resilience against climate change and other stressors. Consequently, we invite you to participate in this vulnerability and resilience assessment. The result of the assessment will be communicated back to the community and validated at the district level in order to provide future planning orientations aimed at improving livelihood resilience in the Ankobra region.

*Your cooperation in answering the questions below and contributions to the focus group discussions shall be very much appreciated. You are assured that answers will be handled with strict confidentiality.*

Themes	Indicators	Score					Relevance for climate change vulnerability
		1	2	3	4	5	
Food security	Perception of fish abundance	Very abundant	Fairly abundant	Neither / nor	A little bit abundant	Very scarce	Fluctuations of fishery production and other natural resources will have an impact on livelihood strategies and outcomes of coastal communities (Coulthard S., 2008; Sarch M-T, Allison EH, 2000).
	Perception of food crop abundance	Very abundant	Fairly abundant	Neither / nor	A little bit abundant	Very scarce	Climate change affects agriculture and food production in complex ways. It is a serious threat to food security in many developing countries, adversely affecting food availability, access to food, stability of food supplies, and food utilization (Lagos & Wirth 2009)
	Access to food market	Very accessible	Fairly accessible	Neither / nor	A little bit accessible	Not at all accessible	Households and communities that are isolated and therefore travel more than 30 minutes to reach food markets are more vulnerable. Limited access to commercial infrastructure limits opportunities to sell excess produce or engage in other entrepreneurial activities in times of crisis (Adger et al. 2004).
Land tenure security	Complexity in accessing land	Always simple/ not complex	A little bit complex	Neither / nor	Fairly complex	Very complex	The direct impacts of climate change on human land use systems and land occupation could potentially have a range of impacts on land access and tenure, with both direct and indirect negative repercussions on human livelihoods, welfare and prosperity(Qaun & Dyer 2008)



Themes	Indicators	Score					Relevance for climate change vulnerability
		1	2	3	4	5	
	Cost of land	Free	Not expensive	Neither / nor	Fairly expensive	Very Expensive	Poorer residents and urban migrants are often forced to settle in low lying or otherwise hazard prone areas which are more vulnerable to the impact of flooding and coastal storms, because of the lack of any affordable alternatives(Qaun & Dyer 2008)
Governance and institutions	Communal involvement in natural resource decision making process	Always involved	Sometimes involved	Neither / nor	Slightly involved	Not involved at all	Informed decision-making, transparency, and prioritisation each form key elements of adaptive capacity. (Chishakwe & Murray 2012)
	Local norms are applied to regulate access to natural resources	Effectively applied	Fairly applied	Neither / nor	A little bit	Not at all	Regulation can be used to enable or constrain certain types of activity, with direct, indirect, deliberate or unintended impact on Climate Change issues (Undp et al. 2010)
	Access to sources of drinking water	Easily accessible	Somewhat accessible	Neither / nor	Access with difficulty	Not accessible	The ability of system to ensure equitable access and entitlement to key resources and assets is a fundamental characteristic of adaptive capacity(Chishakwe & Murray 2012).
Themes	Indicators	Score					Relevance for climate change vulnerability
		1	2	3	4	5	

	Effectiveness of natural resource management systems	Very effective	Effective	Neither / nor	Little bit effective	Not effective	Effective management of natural systems is critical for disaster risk mitigation (Abramowitz et al. 2002)
	Availability and functionality of CBO's (social networks)	Always available and functional	Fairly available & functional	Neither / nor	A little bit available and functional	Not at all available & functional	Engaging CBOs has the potential for designing and implementing locally appropriate approaches, creating greater local ownership, and developing program continuity beyond donor-funded project duration. Many NGOs have assisted CBOs or supported small-scale collective action on reducing vulnerability (The Asia Foundation, 2011)

Themes	Indicators	Score					Relevance for climate change vulnerability
		1	2	3	4	5	
	Effectiveness of local leadership	Effective	Fairly effective	Neither / nor	A lit bit effective	Not effective	It has been argued that even if the economic incentives for adaptation in different communities are the same, the resultant degree of adaptation activities of the residents of each community will vary depending on how deep and to what extent leadership can influence the residents of individual communities (Sekine et al., 2009)
	Responsiveness of local government	Very responsive	Responsive	Neither/ nor	A little bit responsive	Not at all responsive	It is no longer acceptable for local government to base projections for the future on the lessons of the past. Predictive models that take into account the latest projections of climate change from the Intergovernmental Panel on Climate Change (IPCC) integrated with more local knowledge are required (Hunter et al. 2010).
	Perception and awareness of climate related risks	Very high level of awareness	High level of awareness	Average level of awareness	Low level of awareness	unaware	The adaptation level of people to the adverse impact of climate change depends upon their awareness level(Sarkar & Padaria, 2010)

Themes	Indicators	Score					Relevance for climate change vulnerability
		1	2	3	4	5	
	Emergency preparedness	Well prepared	prepared	Neither / nor	Somewhat prepared	Unprepared	For disaster risk management to be effective, institutional structures and management tools to respond to weather-induced catastrophic events should be key elements of local and national adaptation strategies(Pollner et al. 2010)
Demography	Migration patterns	No migration	low	Neutral	Seasonal	high	Mobility is an adaptation strategy but can also increase a community's vulnerability to stressors.
	Perception of poverty	Very low	low	Average	high	Very high	Poor people are more prone to live in hazard prone areas but are less likely to invest in adaptation measures because they have more immediate priorities (Adger et al, 2004) and limited options. Poor communities often face higher levels of risk than affluent communities (United Nations, 2001) and the coping capacities of the poor are already strained.

<b>PRA Method</b>	<b>Objectives</b>	<b>Procedure</b>	<b>Learning and Discussion</b>
<i>1.)Physical vulnerability</i> (Hazard Mapping)	Determine the views of local communities about the manifestation of climate change impact	Draw boundaries of community and identify critical facilities and resources in the community; <u>settlement</u> : pattern, extent of settlement growth and expansion, nature of buildings, spatial distribution of smoking facilities, landing beach, settlement topography. <u>Road network (Accessibility)</u> internal accessibility, distance between community and the major road, condition of roads, <u>Drainage</u> Location and effectiveness of engineered and natural drains <u>Waste disposal</u> waste disposal sites Identifying the hazards; Sources and types of hazards eg. erosion, flooding, salt water intrusion, river pollution, pest and diseases invasion, etc.	When the map is complete, ask the group members the following questions: What are some of the manifestation of climate change in the communities not captured on the hazard map? What are the impact of such manifestations What are the impacts of the hazards identified? Are the hazards different now than they were 10/20/30 years ago (depending on age of participants)? How? Are there places in the community that are safe from the hazards? Are these safe places used to protect from hazards (e.g. to store food and inputs, or to shelter livestock)? Who are the members of the community who are most at risk from the different hazards? Why? How do people in the community currently cope with the impacts of the specific hazards identified? Are the current coping strategies working?
<b>PRA Method</b>	<b>Objectives</b>	<b>Procedure</b>	<b>Learning and Discussion</b>

2.)Vulnerability matrix	<p>To determine livelihood patterns and resource use practices</p> <p>To determine the hazards that have the most serious impact on livelihood assets</p> <p>To determine which livelihoods assets are most vulnerable</p> <p>To identify coping strategies currently used to address livelihood vulnerability</p>	<p>Ask the group to list livelihoods assets / resources.</p> <p>These do not have to be only resources that they currently have, but also those they consider to be most important in achieving well-being. Ask the group to prioritize <u>5 most important</u> livelihood resources and <u>5 greatest climate and non-climate related hazards</u> to their livelihoods</p> <p>Prepare a matrix with livelihood assets on the vertical and hazards on the horizontal and ask the group to decide on the degree of impact that each of the hazards has on each of the resources based on the following scoring criteria;</p> <p>3 = significant impact on the resource  2 = medium impact on the resource  1 = low impact on the resource  0 = no impact on the resource</p>	<p>When the matrix is complete, ask the group members the following questions:</p> <p>What coping strategies are currently used to deal with the hazards identified? Are they working?</p> <p>Are there different strategies that you would like to adopt which would reduce the impact of hazards on their livelihoods?</p> <p>What resources do you have that would help you to adopt these new strategies? What are the constraints to adopting these new strategies?</p>
3.Institutional Mapping	<p>To better understand institutional arrangements and influence on resource utilization and management</p>	<p>Key Informants:</p> <p>Local leaders (chiefs, assembly persons)</p> <p>Representatives of community-based organizations (CBOs) such as farmer’s groups, water and sanitation committees, savings and credit groups, etc.</p> <p>Representatives of women’s groups or other rights-based groups</p>	<p>Which organizations (governmental, non-governmental and community-based) are involved in addressing key issues and problems (both climate and non-climate in your community)</p> <p>What do they do?</p> <p>What are the local customs and rules that govern livelihood resources (estuary, mangrove, fisheries etc) utilization and management</p> <p>What is the nature of sanctions imposed on violators of these rules</p>
<b>PRA Method</b>	<b>Objectives</b>	<b>Procedure</b>	<b>Learning and Discussion</b>

<p>4. Historical timeline</p>	<p>To get an insight into past hazards, changes in their nature, intensity and behavior          To make people aware of trends and changes over time          To evaluate extent of risk analysis, planning and investment for the future</p>	<p>Ask people if they can recall major events in the community such as:          major hazards and their effects          changes in land use (crops, forest cover, houses etc.)          changes in land tenure          changes in food security and nutrition          changes in administration and organization          major political events</p>	<p>When the timeline is complete, ask the group members the following questions:          Are there any trends or changes in the frequency of events over time?          What are current strategies to cope during the difficult events? Are they working?          Have coping strategies changed based on the changing frequency of events?          What events do you expect will occur in the future? When?          Does this perception of future events affect your plans for the future?</p>
<p>5. Seasonal calendar</p>	<p>To identify periods of stress, hazards, diseases, hunger, vulnerability,          To understand livelihoods and coping strategies          To analyze changes in seasonal activities          To evaluate use of climate information for planning</p>	<p>Ask people to list seasons, events, conditions, etc., and arrange these along the vertical axis. The list should include:          Holidays and festivals          Planting and harvest seasons          Periods of food scarcity          Times of migration          Timing of hazards/disasters such as cyclones, droughts and floods          When common seasonal illnesses occur Etc.          When the key events have been listed, plot the timing of them in the table based on agreement among the participants.</p>	<p>When the calendar is complete, ask the group members the following questions:          What are the most important livelihoods strategies employed at different points of the year?          What are current strategies to cope during the difficult times? Are they working?          Are there any differences in the timing of seasons and events as compared to 10/20/30 years ago?          Have livelihoods/coping strategies changed based on the changing seasons or events?          How are decisions made on timing of livelihoods strategies?</p>