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# A Climate Change and Natural Hazards Vulnerability Assessment and Adaptation Plan for Dixcove, Ahanta West District



May 2013

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**Hen Mpoano**

THE  
UNIVERSITY  
OF RHODE ISLAND  
GRADUATE SCHOOL  
OF OCEANOGRAPHY



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**Cover Photo:** *Fishing boats with colorful flags in the harbor of Dixcove*

**Cover Photo Credit:** *Hilary Stevens*

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## I. INTRODUCTION

This report builds on and complements several activities of the Hen Mpoano program in Ghana's Western Region to provide tools for district officials to better coordinate with local leaders and enhance community development activities. Over the past two years, several of the program's activities have engaged the communities and the districts in participatory assessments (2010 Rapid Assessment of Coastal Communities in the Western Region: Summary of Findings for Ahanta West District, March 2010), capacity building related to spatial planning (2011 GIS training), livelihoods (fisheries profile) and climate change assessment (Regional vulnerability) and training (University of Cape Coast Climate Change course in 2011 and 2012).

### *Purpose*

The purposes of this activity are to investigate the physical vulnerabilities of the community of Dixcove to the impacts of climate change and to complement previous work on sensitivity and adaptive capacity of the community. This activity supports the overarching Hen Mpoano goal of improved governance in the Western Region. In particular, our aim is to enhance the capacities of District officials and community leaders to incorporate coastal resources management and governance into their planning efforts, and to ensure that natural hazards and vulnerabilities are accounted for and integrated into their strategies.

### IMPORTANT DEFINITIONS

**Adaptive capacity:** potential or ability of built, natural, and human systems to adapt to impacts of climate change and variability with minimal potential damage or cost.

**Exposure:** the extent to which a system comes into contact with climate hazards or specific climate impacts.

**Potential Impact:** Exposure and Sensitivity combined determine the potential impact or to what degree the community could experience negative impacts from climate change. The greater the exposure and/or sensitivity, the greater the potential impact.

**Resilience:** ecological and social capacity to cope with, adjust to and recover from external stresses and disturbances. It is the flip side of vulnerability. Therefore, if you increase resilience of a community or resources, you will decrease their vulnerability.

**Sensitivity:** the degree to which a built, natural, or human system is negatively affected by changes in climate conditions (for example temperature and precipitation) or specific climate change impacts (for example sea level rise, increased water temperature).

**Vulnerability:** the degree to which a human or natural system is susceptible to, or unable to cope with, adverse effects of climate change. Vulnerability is a function of exposure, sensitivity to climate impacts and related adaptive capacity.

from *CTI Workbook LEAP*

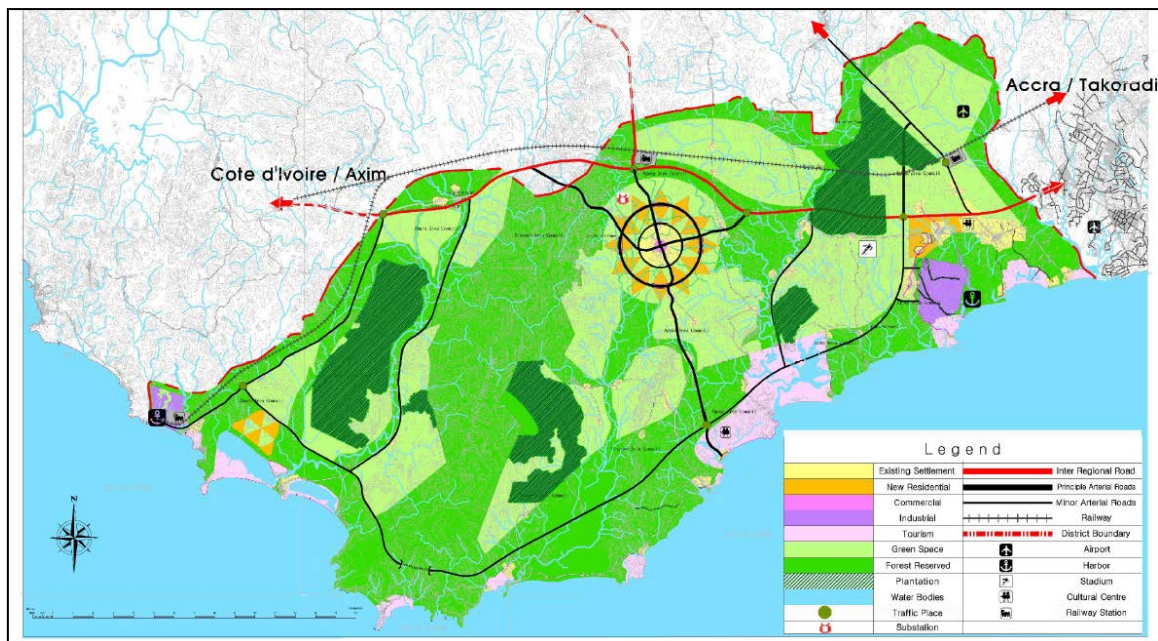
A thorough vulnerability assessment requires an understanding of the impacts of climate change, how a community is exposed to those impacts, how sensitive it is, and what adaptive capacity it possesses. That vulnerability assessment can then be used to develop an adaption plan that will fit into the overall development plan for the community in question. This outreach activity in Dixcove collected information about the physical impacts of climate change on the town, and how the livelihoods and well-being of the residents are being affected. This information indicates the exposure of the town to climate change and it provides, in combination with previously gathered data on sensitivity and adaptive capacity, a fuller picture of the overall vulnerability.

## II. BACKGROUND

### *Planning Context*

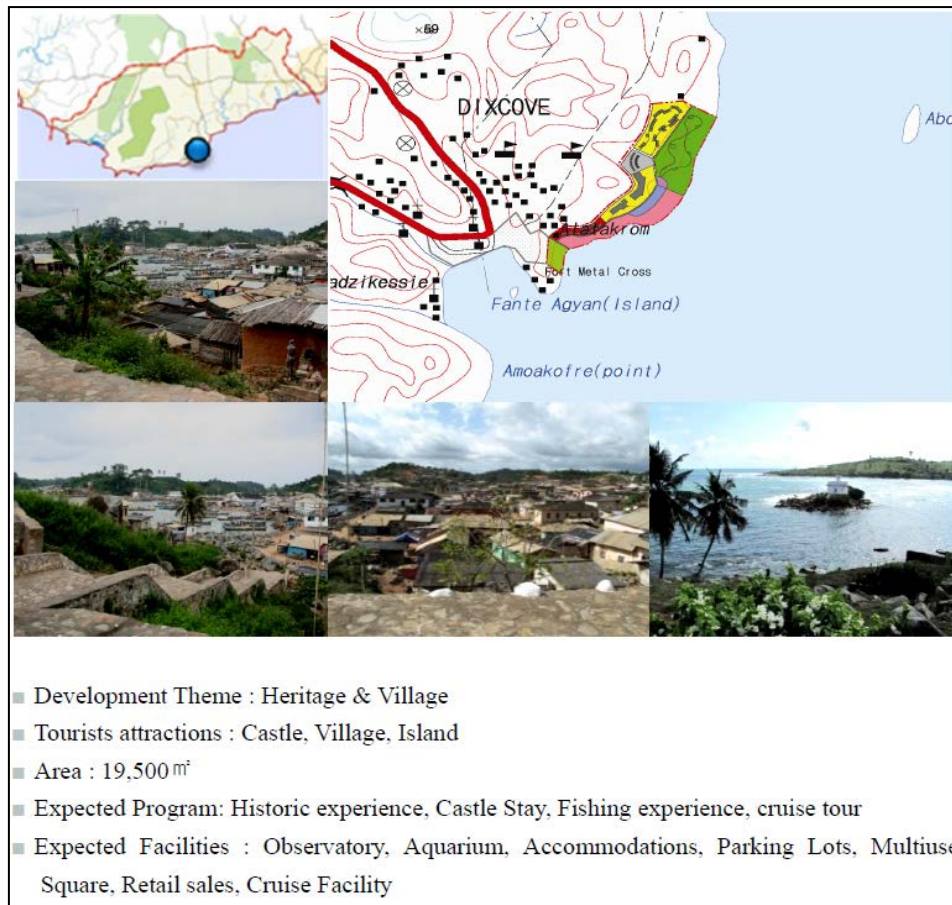
#### **Dixcove as represented in current Spatial Planning policies**

The only current plan in place at the national level, the 2012 National Infrastructure Plan, designates the coast as a services and tourism zone. The Western Region Spatial Development Framework (WRSDF 2012) designates key settlements for Ahanta West and identifies the coast between the Ankobra River and Butre estuaries as an area of high landscape and amenity value where oil and mining related industrial development should be avoided. The WRSDF plan outlines several sectors for Ahanta West, including Agriculture – Industrial/Forest, Food/Fishing/Livestock and related industries and Tourism.



**Figure 1: Korean Plan for Ahanta West showing Dixcove at the western end of a tourism zone (pink)**

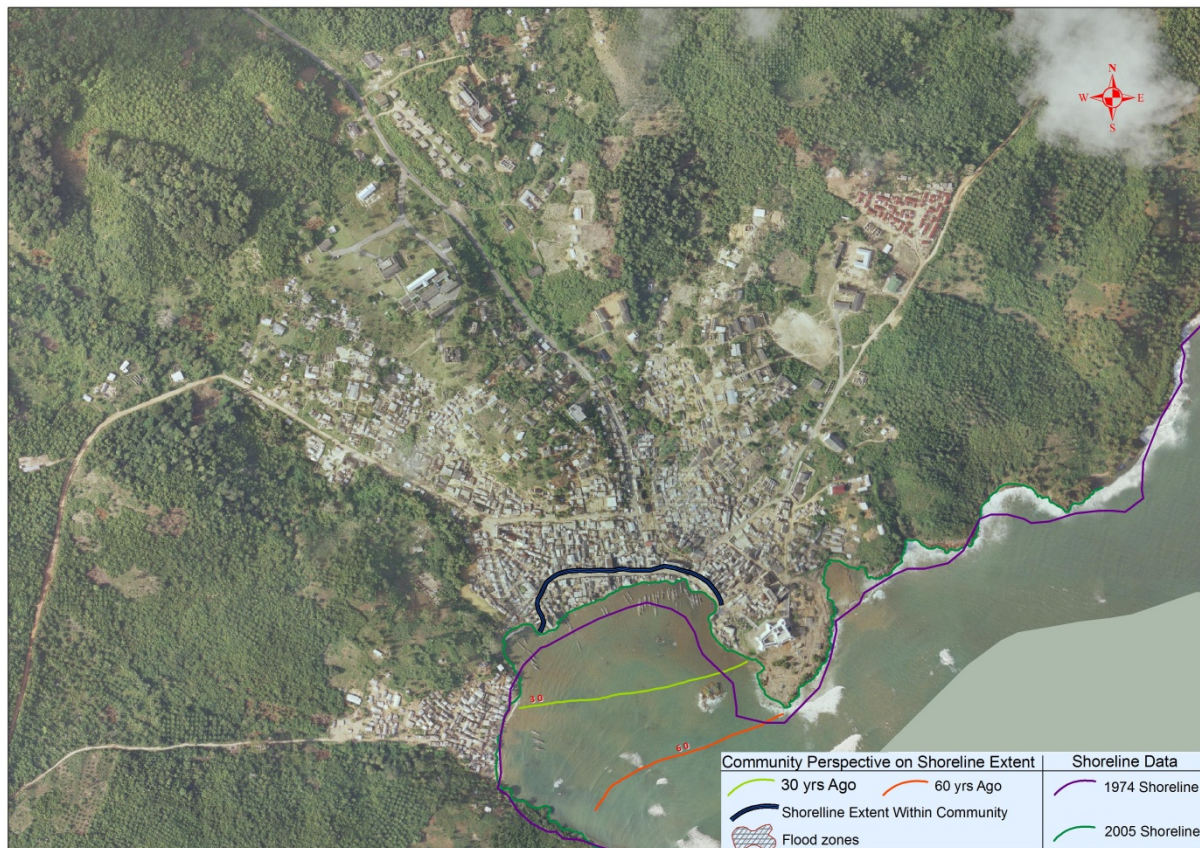
The Korean International Cooperation Agency (KOICA) developed a proposal with the District in 2010-2012, to look at tourism hubs and services in the region. The KOICA Plan designated Dixcove as a tourist town with a theme of “Heritage and Village” and expected facilities to include “Observatory, Aquarium, Accommodations, Parking Lots, Multi-use Square, Retail Sales and Cruise Facility” (Fig.2):



**Figure 2: Details of tourism amenities in Dixcove as highlighted in the Korean Plan**

Currently, the Ahanta West District is the subject of a Sub Regional Spatial Plan of the six coastal districts (2012), and has a Medium Term Development Plan (2010-2013) and District Spatial Development Framework, all of which reinforce the Korean view that this town is likely to be the subject of tourism development. Locally, there are no plans other than for individual plots or small developments.

## Key Coastal Features and Physical Characteristics of Dixcove



**Figure 3: The shoreline in Dixcove has eroded dramatically in recent years. Satellite images show some erosion, while anecdotal historic shorelines are much more dramatic.**

Dixcove is a major and historic settlement of Ahanta West. The main occupations are fishing and farming, but Dixcove is also the site of one of the forty-two former European trading forts along the coast of Ghana, which gives opportunities for tourism.

### Demographics, settlement patterns and facilities

Dixcove has an estimated population of 7000. Most of the houses are made of cement block and aluminum roof, although a few are mud. The community is divided into Upper Dixcove and Lower Dixcove, separated by the main road that leads into town. Each division has its own traditional rulers (Chief fisherman, Chief and his elders). Lower Dixcove, with most of the houses, is on the west side of the community while Upper Dixcove is on the east.

Local amenities include basic schools (both public and private), electricity, pipe-borne water, boreholes, toilet facilities, police station, hospital, post office etc. 80% of households in the community are connected to the national electric grid while 50% of the households have pipe-borne water. Only 30% of households have individual toilet facilities and the rest use communal toilets. The community benefits from a well-designed water supply system that includes three boreholes, one of which supplies the pip-borne water system. Numerous wells augment the water supply, although many of them are reportedly drawing salty water in the dry season. The Dixcove hospital is the primary medical facility in the Ahanta West District. It has one doctor on staff and approximately 15 medical assistants.



The community has public and private basic schools. In 2009, 70.5% of 44 candidates passed the B.E.C.E. According to the teachers interviewed, the decline in fish catch has resulted in truancy, inability of families to purchase learning materials and even buy food. These challenges coupled with poor parental care and lack of community discipline negatively affect the performance of pupils.

## **Economy and livelihood**

### *Fisheries*

The major source of livelihood is fishing, with about 90% of men in the community involved in the sector. Typically the men go to sea while the women process and market the catch. Dixcove is a center of commerce with people coming from nearby communities to buy fresh and smoked fish.

There are currently 160 canoes at Lower Dixcove and 200 at Upper Dixcove, all of which use drift gill nets. The community is noted for catching big fish species. Species caught are sardines, tuna and shark. Some fishing is done in the lagoon for subsistence, with the lagoon tilapia as the main species.

### *Agriculture*

The area also has agriculture for food supply and income generation. Until recently the main cash crop was coconut. However, with the onset of Cape St Paul Wilt disease, most of the original trees died and are only recently being replaced by more expensive disease-resistant hybrids. Meanwhile most farmers have changed to oil palm production, but this is less profitable. Oil palm and coconuts are widely interspersed with subsistence food crops, particularly cassava.

### *Other employment*

The decline in fish stocks and agricultural incomes has caused increasing poverty. The development of tourism and oil and gas related opportunities could help to reverse this, if suitable vocational education and access are provided. Dixcove, with the regional hospital, is an important service center for surrounding communities and the District.

### *Tourism*

Fort Metal Cross is located at the west end of Upper Dixcove. It was constructed by the British in 1692, and is now a national monument. The fort is currently leased to a British national who is building a tourism facility on the grounds. The fort itself is open to visitors with guided tours being offered. This is part of a wider tourism enclave which stretches from Discove to Busua and the Butre estuary.

### III. VULNERABILITY ASSESSMENT

#### *Methods*

CRC methods were used for this assessment. The Adapting to Coastal Climate Change guidebook (2009) and the latest USAID guidance emphasizing working with community vision and development goals were combined to determine the climate change impacts and the options for mainstreaming adaptation. Sensitivity and adaptive capacity have been investigated in earlier community visits, so this effort focused on exposure to physical impacts of climate change, and how to incorporate climate awareness into planning.

Data was collected from targeted interviews with experts and community leaders, site visits, and review of maps, historic data and satellite images. This data was compared with previously collected vulnerability data as well and other findings to yield a comprehensive picture of the community development issues and climate change vulnerability.

#### **Climate Context**

There is evidence of climate change in Ghana, in the form of increasing temperatures; rainfall variability, including unpredictable extreme events; sea-level rise; and loss of carbon sinks. These climate impacts have direct bearing on Ghana’s socio-economic structure, especially with its reliance on sectors that are sensitive to climate change – agriculture, fishing, forestry and energy. The Government of Ghana recognizes that climate change adaptation must be main-streamed into policies and sectoral activities to achieve sustainable growth. The vision outlined in the National Climate Change Policy Framework (NCCP) is: “To ensure a climate resilient and climate compatible economy while achieving sustainable development through equitable low carbon economic growth”. The NCCPF provides strategic direction and coordinates issues of climate change in Ghana. The three objectives of the Policy are (1) effective adaptation, (2) social development and (3) mitigation. To address the adaptation issues in Ghana, four thematic areas have been identified. These are (1) energy and infrastructure, (2) natural resources management, (3) agriculture and food security and (4) disaster preparedness and response.

<p><b>National Policy and Program Areas</b></p> <ul style="list-style-type: none"><li>•Energy and Infrastructure</li><li>•Natural Resources Management</li><li>•Agriculture &amp; Food Security</li><li>•Disaster Preparedness &amp; Response</li></ul> <p>Key Themes</p> <ul style="list-style-type: none"><li>•Governance &amp; Coordination</li><li>•Capacity Building</li><li>•Science, Technology and Innovation</li><li>•Finance</li><li>•International Cooperation</li><li>•Information, Communication, Education</li><li>•Monitoring and Reporting</li></ul> <p>Source: Ghana National Climate Change Policy, Ministry of Environment Science and Technology, 2012</p>
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A recent summary and explanation of climate scenarios for Ghana has been prepared by Stanturf et al. (2011). Mean annual temperature is expected to increase 1.0 to 3.0 ° C by the 2060s, with variations among regions. For the coastal savannah zone, temperatures are estimated to increase about 1.7 ° C by 2050 and 2.5 - 2.7 ° C by 2080. Sea surface temperatures are also expected to increase. Minia et al. (2008) project that sea-surface temperatures will rise from the annual base mean of 26.2 ° C by 0.4, 1.4, and 2.7° C for the years 2020, 2050, and 2080.

Projections of precipitation amounts and patterns in the different regions of Ghana are inconsistent. Stanturf et al. point out that “forecasted changes in precipitation ranged from 52 percent decreases to 44 percent increases in wet season rainfall by 2080. The overall ensemble prediction across emission scenarios gives a slight increase in wet season rainfall of  $2.65 \pm 13.96$  percent by 2050 and  $3.88 \pm 19.41$  percent by 2080. The variability among the models' precipitation changes is not very different from the inter-annual variability currently experienced in the region.”

Modeling of future projections of temperature and sea level rise is limited, but shows some trends. The projected mean annual temperature is likely to see 1.5 - 3° C increase by the 2060s. The global projection for sea level show accelerated rates of rising. Working with global data and best-available local estimates, McSweeney et al. (2008) predicted that sea level along the coast of Ghana would rise by 0.1-0.5 meters by 2090, relative to 1990 levels.

## **Key Coastal Issues Impacted by Climate and Non-climate Stressors**

### ***Fisheries***

Fishing is the major livelihood, however, many fishers say that catch quantity and quality has declined, and they are travelling to longer distance to get fish.

#### Key issues:

Fishermen at Dixcove believe fish stocks have declined compared to 50 years ago due to:

- Unauthorized/unsustainable fishing methods including lights, carbide and dynamite, pair trawlers and very small net mesh
- Increased numbers of vessels as population is grows and more people are fishing
- The supply of premix fuel is inadequate; fishermen have to go to other communities where they hear of fuel availability or buy from fuel station outlets at elevated prices
- Outboard motors and parts are often scarce, which raises demand and prices. Lack of access to credit facilities worsens the problem.
- Fishing around oil rigs is now restricted, which fishermen feel is decreasing the catch.

#### Climate Stressors

Increased temperature stresses fish populations; sea level rise can impact mangrove by drowning them, if they cannot migrate landward or if sediment is lacking; changes in freshwater flow may affect the types and health of mangroves and habitat; increased rainfall may increase pollution and sedimentation to the river and estuaries.

#### Non-climate stressors

Fish landing area eroding; mangroves depleted by harvesting, overharvesting of fish, use of illegal fishing practices, lack of enforcement of regulations and customary practices, affecting water quality; lack of sanitation programs results in waste disposal adjacent to the coast and lagoon.

### ***Rapid development and demand for housing in the area***

Discovery of oil in Ahanta West District has increased the demand for industrial development. Tourism interests are putting pressure on coastal areas. People living near the harbor in Dixcove have already been displaced by erosion. Many families have relocated to

stream bank areas and are subject to frequent flooding. This issue of relocation from the waterfront area is likely to continue and increase as erosion reduces area available to them.

#### Key Issues

- Land is being sold without thought to community needs and benefits
- There are insufficient local development plans, and those that exist are outdated and not followed (see the Annex for draft proposals)
- The permitting process is not well developed and is easily circumvented by investors.
- Relocation of displaced people is happening in a highly disorganized way, with people moving to undesirable areas and causing further land use conflicts.

#### Climate stressors

Increased rainfall exacerbates flooding near stream banks, making those areas unsafe; sea level rise exacerbates coastal erosion.

#### Non-climate stressors

Tourism and oil & gas industries are expanding, coastal erosion is displacing residents, land use decisions are increasingly influenced by outside money rather than local needs.

#### ***Community Infrastructure vulnerable to flooding and erosion***

The shoreline in Dixcove has been eroding for many years, as indicated by satellite imagery and anecdotal evidence. Many buildings originally constructed near the shore have been inundated and destroyed. The community requested assistance from the Regional Hydrology Office, which manages shoreline protection. Construction of a concrete revetment to reclaim a portion of the harbor began around 2010. However the project was never completed. The densely-settled area adjacent to the shore is regularly flooded during the highest tides, typically in August. Dixcove also has numerous rainwater drainages that overflow and flood streets and neighborhoods in rainy weather.

#### Key Issues:

- Ongoing erosion has already destroyed many buildings and currently threatens the landing site and the densely settled center of town across from it.
- Stormwater drains are insufficient for increasingly intense rainfall so they frequently overflow into adjacent neighborhoods.

#### Climate stressors

Sea level rise is a contributing factor to coastal erosion. Variable rain patterns strain the drainage system and cause localized flooding.

#### Non-climate stressors

Wave energy is eroding the shoreline, and poorly constructed shoreline reinforcements and other development are exacerbating the problem.

#### ***Community well-being and health***

Access to services is limited, including education and sanitation. While the water supply system is quite robust, sanitation remains a concern in the town. Existing toilets were improperly designed and/or sited and are not maintained, so many neighborhoods lack proper facilities. Some toilets drain directly into the ocean, leading to public health concerns. Disposal of human waste and garbage on beaches and in the lagoon remain common practice.

### Key Issues:

- Sanitation remains a persistent problem in Dixcove. Toilet facilities are insufficient, and behavior change will require significant public outreach.
- Falling standard of education contributing to insubstantial human resource development. Schools are overcrowded and understaffed.

### Climate stressors

Stagnant water breeds mosquitoes which can carry malaria and elephantiasis. Change in rainfall is affecting circulation pattern and water quality.

### Non-climate stressors

Declining fisheries-based economy is impacting students' ability to afford to remain in school, and patients to afford health care. Changes in the economy due to oil and gas development are bringing in new social problems and greater disparity. Waste disposal behaviors are pollution beaches and surface water bodies.

### ***Governance Related Issues***

Dixcove is governed by both traditional chiefs and a unit within the Ahanta West District. The town is divided into Lower and Upper Dixcove with separate chiefs, Assembly representatives, and other governance units.

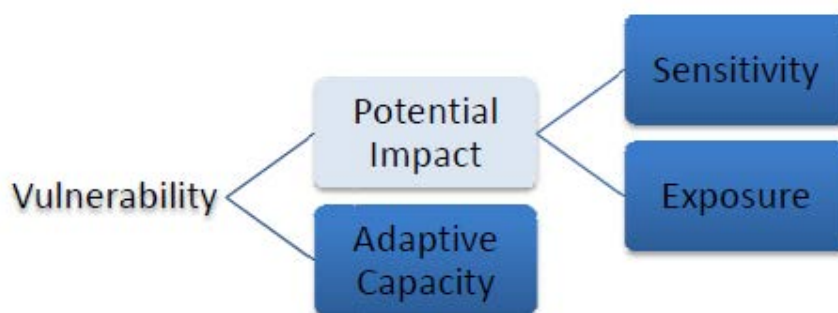
### Key Issues:

1. The fact that a community as small as Dixcove is split into two administrative districts complicates governance of common issues and slows development.
2. The chieftaincy dispute in Upper Dixcove further complicates the issue.

Government coordination is not always adequate, for example the shoreline defense installed by the regional office lacked local input.

### ***Approach***

Vulnerability is a function of the exposure to impacts of climate change, the sensitivity to those impacts, and the adaptive capacity of the community to respond to the changes and challenges they face. The potential impacts are affected by the hazard, the sensitivity and the exposure to climate and non-climate stressors.



The 2010 community assessment and the 2012 rapid vulnerability assessment provide insight into the high vulnerability of the community of Dixcove (Table 1).

**Table 1: Vulnerability scores for Dixcove. Source: Climate Change and Natural Hazards Issues in Coastal Districts of the Western Region**

Thematic Area	Topic Area	Score (ranked 0=low, 4=high)
Governance and Leadership	Leadership & Local Organization	2
	Security & Order	2
Coastal Resources Management	Resource Condition	0
	Land Use Decision Making	2
Natural Hazards and Risks	Public Awareness	1
	Emergency Preparedness	1
Economy and Society	Livelihood & Rural Economy	2
	Marginalized	0

These vulnerability assessment results show that in general Dixcove is a community with fairly low adaptive capacity. It particularly highlights the poor condition of the coastal resources, as well as the challenges for Dixcove’s marginalized peoples. The community’s relative strengths (which are still not strong) lie in its governance and decision-making.

Dixcove’s weak adaptive capacity is compounded by its high level of exposure to several climate change impacts. Sea level rise, changes in weather patterns and rising sea temperature are impacting the physical security and well-being of the community. The very same features that make the town desirable as a port, its river outlet and natural harbor, also expose it to coastal flooding and erosion.

Understanding of these features, and relative strengths and weaknesses can inform adaptation plans by indicating where to focus activities and what actions are most likely to be successful.

## IV. ADAPTATION ACTIONS TOWARD A CLIMATE RESILIENT DIXCOVE

Recommendations for improved resilience in Dixcove based on the output of the earlier vulnerability assessment and this recent physical assessment are summarized below. When identifying actions to build adaptive capacity, it is useful to look at a framework for managing a system, where four capacities - Physical, Organizational, Social and Economic – combine to help a community adapt to the impacts of climate change.

**Table 2: Adaptation Action recommendations based on CRC's vulnerability assessment**

<b>Potential Actions to Support Dixcove’s improved resilience</b>	
<p><b>Physical</b></p> <ol style="list-style-type: none"> <li>1. Install additional water supply tank</li> <li>2. Wetlands/lagoon restoration</li> <li>3. Shoreline management plan</li> <li>4. Improve drainage system to handle increased rainfall</li> <li>5. Design and construction of bridges to handle increased flooding risks</li> <li>6. Mechanization of additional borehole</li> <li>7. Prepare spatial plans with transportation system including coastal road and town bypass</li> </ol>	<p><b>Organizational</b></p> <ol style="list-style-type: none"> <li>1. Enstoolment of chief for Upper Dixcove</li> <li>2. Facilitate establishment of a Committee on Shoreline Management, with Regional Hydrology and representatives from each district</li> <li>3. Coordination among Dasgift, CWSB, DA and Assemblyman</li> <li>4. Prepare Structure Plans with Statutory Planning Committee</li> </ol>
<p><b>Social</b></p> <ol style="list-style-type: none"> <li>1. Construction of toilet facilities</li> <li>2. Public education on sanitation to encourage use of toilets</li> <li>3. Plan for new settlement areas</li> <li>4. Refuse bins, proper dumping, recycling</li> </ol>	<p><b>Economic</b></p> <ol style="list-style-type: none"> <li>1. Introduce and encourage agriculture production as an alternative livelihood.</li> <li>2. Access tourism and Oil and Gas markets.</li> <li>3. Improved facilities at fish butchering and market site.</li> </ol>

After reviewing the physical vulnerability of the Dixcove community and taking into consideration the adaptive capacity of the community as well as the larger district in which it lies, several options have been developed for management of the shoreline and planning for future development in the area, as recommended for physical adaptation actions. Further details and maps appear in the Annex.

### ***Shoreline management options:***

The options for actively dealing with the flooding which were considered are:

1. Construct a breakwater at the mouth of the Dixcove bay.

The breakwater will reduce the erosive impact of the high tides, but it will also decrease circulation and trap polluted waters, creating an unhealthy and unsightly harbor area. The likely effect of this on flood levels needs to be evaluated.

2. Construct sea defenses on existing shore line, extending from the new landing site

Such sea defenses, if properly combined with shore front structures, would be costly. If they were to prevent flooding into the two principle water course areas, those water courses would have to be engineered to drain at higher level, and flood protected areas at the lower level would be subjected to the use of holding tanks during periods of high water levels. All of this engineering would be extremely costly, and risky if not completed properly, as with the previous shoreline protection effort.

3. Prepare for new long term shoreline position as shown in Annex 1 Section 3

In this case the likely course of high tides and flooding would be predicted so that construction of a new shoreline could be initiated. This could only be achieved if new settlement area is created into which residents in future flooded areas could be decanted, prior to demolitions and new shoreline constructions taking place.

Of the three options, the third is likely to happen anyway: the question is whether the response is, as now, an ad-hoc and chaotic process of resettlement or whether it is planned. The other options could be considered on the basis of some significant investment in future infrastructure as part of the financing of a town of 30,000 with accompanying tourism and leisure facilities.

### ***Spatial planning action points:***

The following actions are recommended:

1. Ahanta West District should commission a Structure Plan to identify Local Plan Areas, zoning, and the major road and drainage routes, encompassing Dixcove, Busua and the whole designated tourism area including the Butre estuary and wetlands.
2. Main (feeder) road and drainage (water buffers) reservations should be identified in the Structure Plan and implemented as a matter of urgency. These should be designed to minimize disruption to existing development (not least to minimize compensation) but should be firmly established with no compromise as to their functionality.
3. Areas which are to be the subject of Local Plans should be identified in the Structure Plan and prioritized for:
  - Resettlement: new houses for flood prone areas should be built as soon as possible. If possible flooded areas should be demolished.
  - Upgrading of slum areas
  - New development

Preparation of the Structure Plan and some Local Plans, with action programs, should be incorporated into District Medium Term Development Plan 2010-14 and subsequent plans.

1. Inward investment opportunities should be identified to drive further development: residential, farming, fishing, processing and packaging, tourism and leisure, oil and gas and related industries. Land value increases should be captured for infrastructure development, including shore line improvements.



2. A program for preparing the Structure Plans and Local Plans should be drawn up as soon as possible, and should follow the most urgent needs (resettlement) and strongest opportunities (residential and tourism/leisure development).

## UPDATE

Frequent erosion and coastal flooding problems along the waterfront, as well as the density of population and lack of proper toilet facilities, led to unsanitary practices in handling fish catch, which raised public health concerns. Hen Mpoano partnered with the Fisheries Co-management Forum in Dixcove to construct new tables for handling and initial processing of fish at the landing site. The Co-management Forum is collecting and managing user fees for the fish tables, which will cover expenses for long-term maintenance. The use of fish tables at the landing site will not only ensure hygienic handling of fish and also enhance fish marketability.

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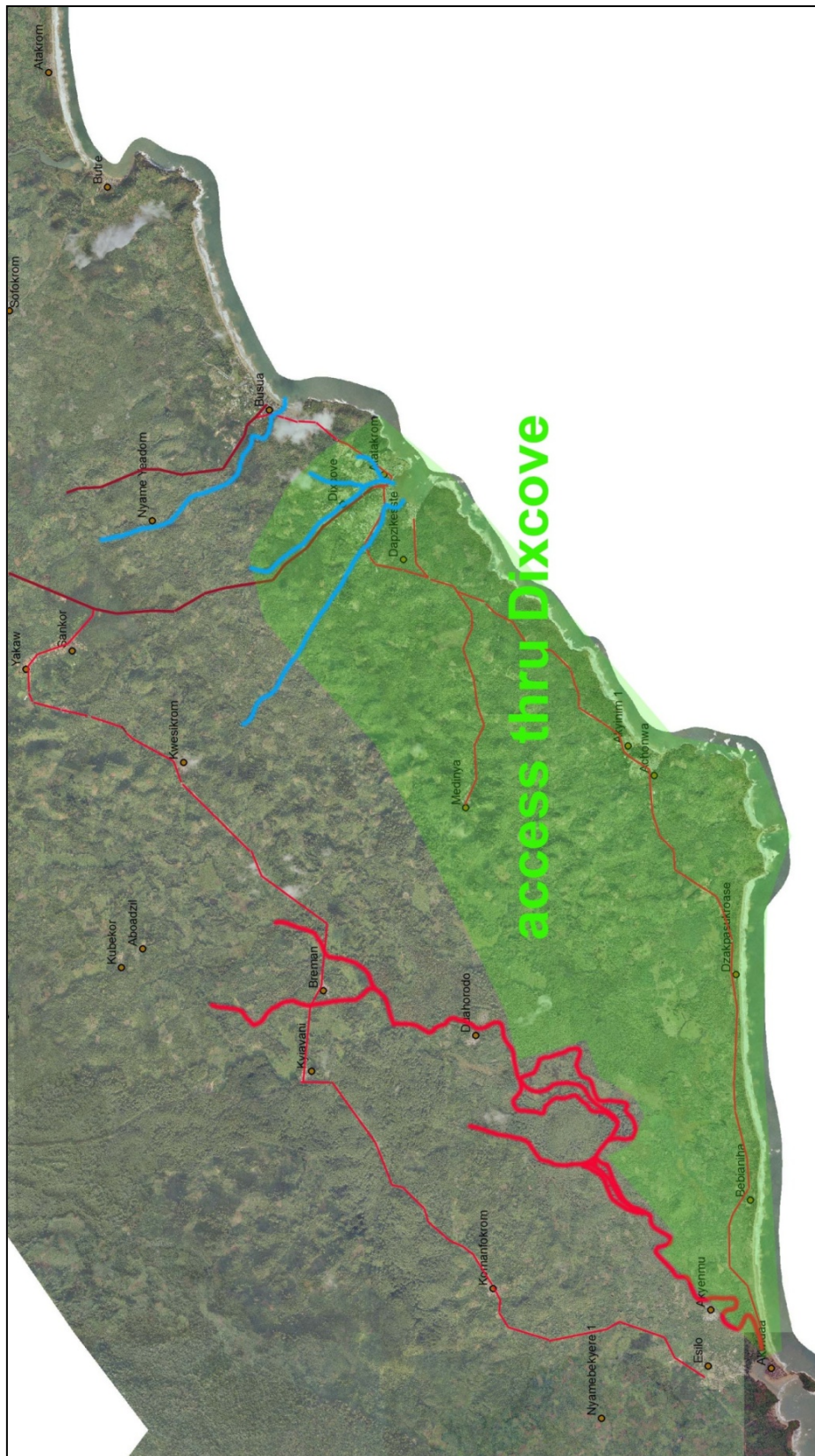
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## **ANNEX I**

For the Dixcove support exercise, three levels of plan were examined:

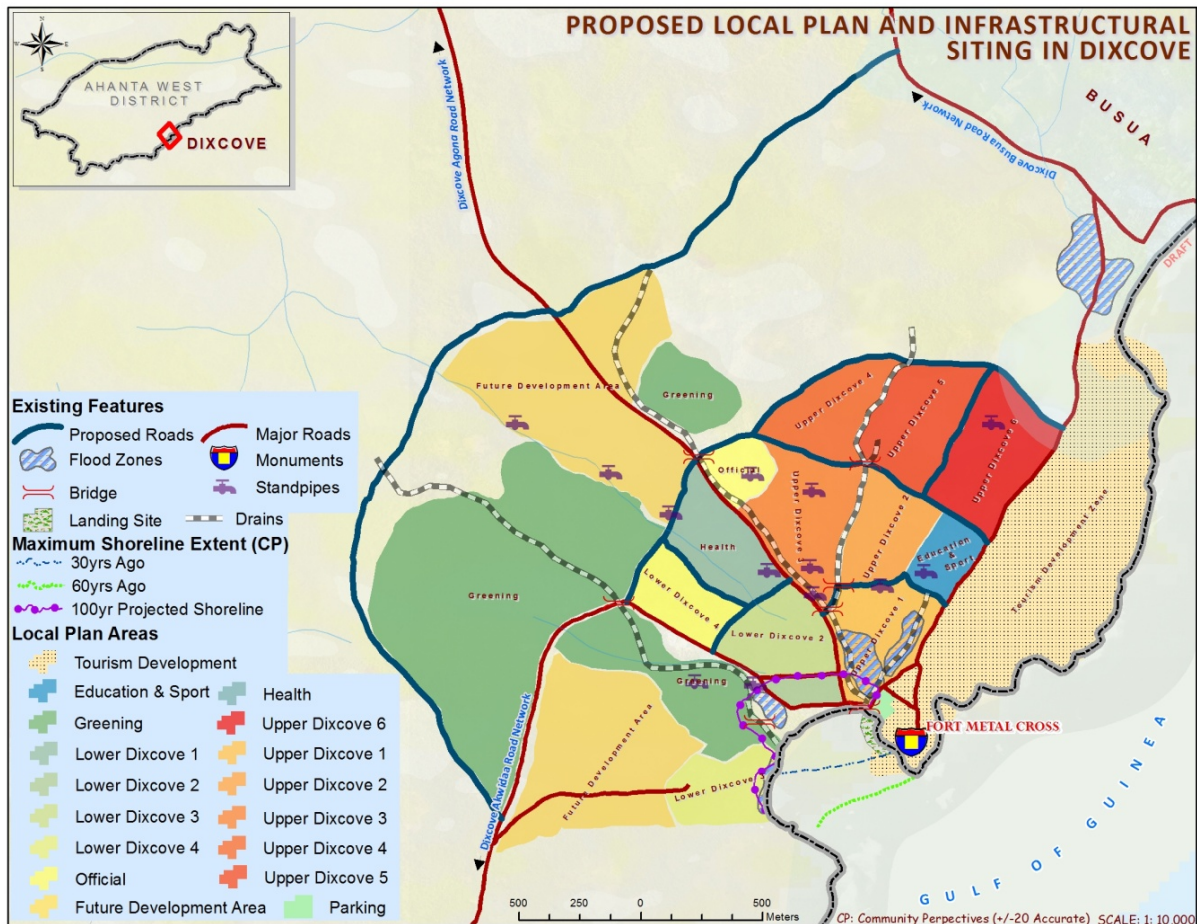
1. The wider locational context,
2. The town and its setting, and
3. Detail of flooded areas within the town.

**1. District Context from Akwidaa to Butre**



Due to the lack of bridge at Akwidaa, an area stretching from Akwidaa (bottom right) south of the Ezile River (as shown in green above) is accessed only through Dixcove, which makes it an important centre for these other communities.

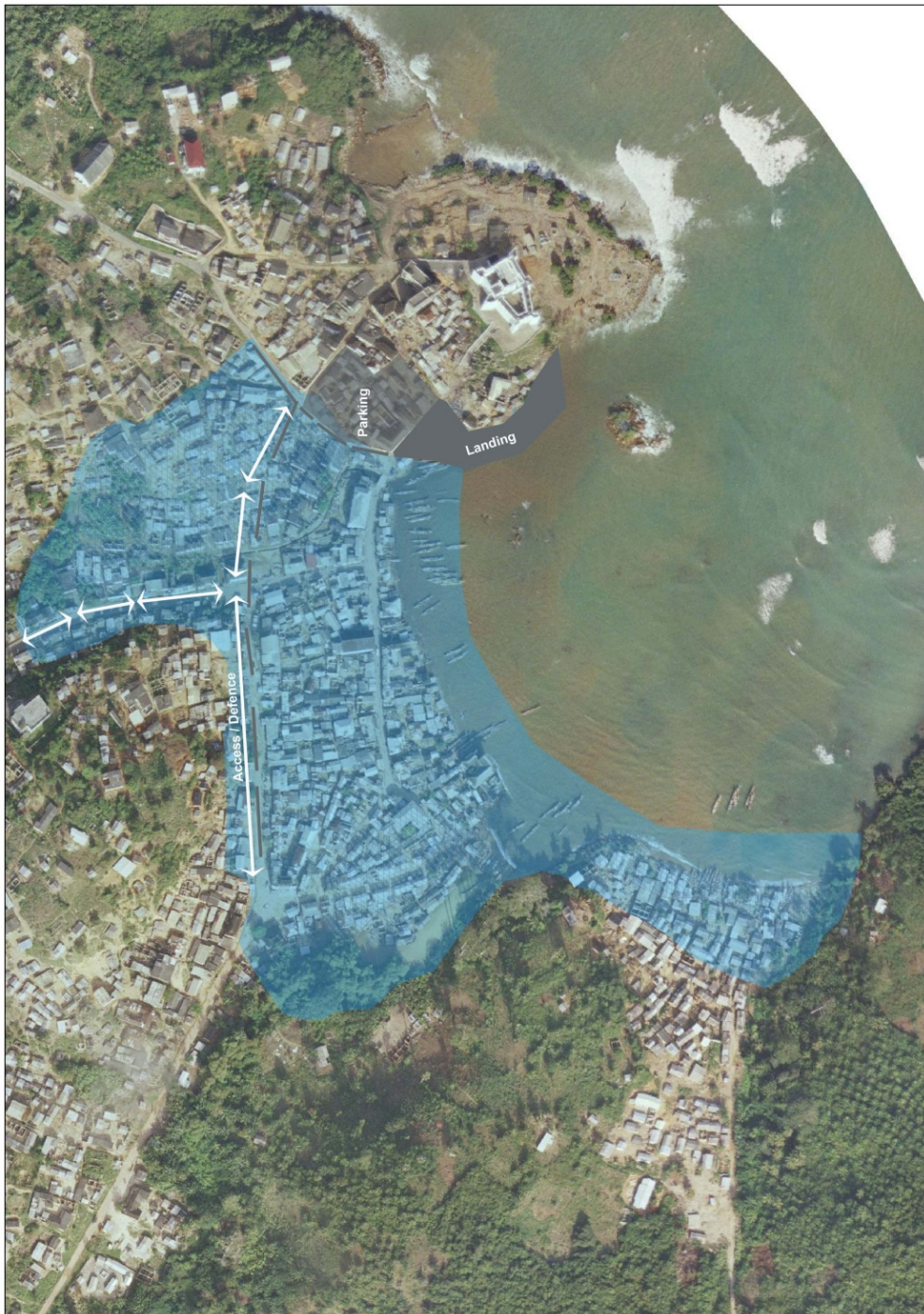
## 2. Proposed Local Plan and Infrastructure Siting



Sketch Plan by CRC March 2013

The town is growing in an unplanned fashion. A Structure Plan of which a sketch draft is shown above is needed to be prepared by the Assembly in conjunction with the communities of Dixcove. These will need to be checked against population capacity and projections, and the Plan should be extended to cover Busua, which is likely to merge with Dixcove in the longer term.

### 3. Details of shoreline implications



Predicted 100 year flooded areas based on current sea level rise predictions (shaded blue) with proposed new shorefront, access roads, landing site and car park