WOMEN SHELLFISHERS AND FOOD SECURITY PROJECT

Technical Report on Site Based Research in Ghana and The Gambia

Drivers and Threats Affecting Mangrove Forest Dynamics in Ghana and The Gambia

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Photo Caption: A woman fetching water at the landing site where shellfish boiling happens in the Tanbi Estuary.

Photo Credit: ICRAF (Lalisa Duguma).

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ACRONYMS

CFs	Community Forests
CPAs	Community Protected Areas
CSR	Corporate Social Responsibility
DPSIR	Driver, Pressure, State, Impact, Response
EbA	The Large-scale ecosystem based adaptation project in the Gambia
FGD	Focus Group Discussions
GCF	Green Climate Fund
GMW	Global Mangrove Watch
ICRAF	International Centre for Research in Agroforestry
MECCNAR	Ministry of Environment, Climate Change and Natural Resources
NGOs	Non-Governmental Organizations
PES	Payment for Ecosystem Services
REDD+	Reducing Emissions from Deforestation and Forest Degradation
TRY	TRY Oyster Women's Association
UNEP	United Nations Environment Programme
USAID	United States Agency for International Development
WSFS	Women Shellfishers and Food Security Project

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SUMMARY

Mangroves are one of the most important vegetation types in coastal areas. They provide numerous ecosystem services, including wood, edible products (fish, oyster, etc.), coastal area stabilization, and many more. However, despite such immense contributions, mangrove forests are being converted into other land uses that seem more attractive economically in Ghana and The Gambia. In other cases, the vegetation is degraded due to the increased extraction and pollution from waste dumping. This report examines the main drivers and pressures that affect the spatial dynamics of this vital resource. Propositions on how to respond to or mitigate these pressures are also provided.

This study used the DPSIR (Drivers-Pressures-State-Impacts-Responses) analytical framework and situation modeling proposed by USAID. Four critical drivers and threats were identified: population dynamics, economic activities, natural factors, and sporadic seasonal drivers. For each of these drivers, the main threats they exert on the mangroves are discussed using the community perspectives as the basis. Response options such as policy, practices, governance, and behavioral responses were identified. Practical pathways to implement these responses include developing management plans, 'adopt a mangrove' approach, promoting participatory designed co-management models, devising incentive schemes (e.g., Payment for ecosystem services, etc.), and awareness creation. A sample action plan for restoring and conserving mangroves is provided for practitioners to adapt the plan to their contexts.

1. INTRODUCTION: THE MANGROVE FOREST DYNAMICS IN GHANA AND THE GAMBIA

Ghana lost most of its mangroves in the last few decades. As of 2016, there were approximately 200 square kilometers of mangroves remaining. In The Gambia, mangroves covered nearly 600 km^2 (Table 1) as of 2016, roughly 2.1 percent of the total mangrove cover in Africa. Four major mangrove species are dominant in both countries - *Avicennia africana, Rhizophora racemose, Laguncularia racemosa* and *Rhizophora mangle*. According to the Global Mangrove Watch (GMW, 2021), Ghana and The Gambia have experienced losses of their original mangrove forests. Nonetheless, between 1996 and 2016, The Gambia had a net increase in mangrove cover while Ghana experienced a net loss of its mangrove cover despite investments in restoration (Table 1). Ghana has less mangrove area, smaller mean height and overall carbon stock than The Gambia. lower

Table 1: Summary attributes of mangrove conditions in Ghana and The Gambia.

Country	Mangrove area (2016) (km^2)	Mangrove area change (1996-2016) (km^2)*	Mean mangrove height (m)	Mean carbon stock (t/ha)
Ghana	204.18	-23.78 (-12%)	5.89	40.47
The Gambia	597.17	+2.45 (0.4%)	9.30	54.98

Note: * Numbers in the bracket show percentage changes during the reference period.

Despite a positive total net gain in mangrove area from 1996-2016 in The Gambia, various authors noted a decline over time in some site-specific contexts. Ceesay et al. (2017) estimated this decline in Tanbi Wetlands National Park of The Gambia at 6 percent between 1973 and 2012 and attributed it to increased salinity which negatively affects mangrove regrowth and rejuvenation. Bah (2019) estimated this decline at 5.54 percent between 1984 and 1994, 7.18 percent between 1994 and 2007 and 22.02 percent between 2007 and 2017 in the Central River Region of The Gambia. This significant decline was attributed to increasing temperature and decreased in rainfall.

Our own analysis of mangrove cover dynamics in Ghana and The Gambia between 2000 to 2020 found similar trends as reported by the Global Mangrove Watch though the magnitude of change was different, probably due to differences in the time period considered for analysis. We found that Ghana has continued losing its mangrove forests. The net loss in the mangrove area was 53,942 ha. During the same period, The Gambia gained a net 7,784 ha of mangrove cover. Investments in mangrove area restoration contributed to this gain, although well documented data on restoration activities is scanty. Most of the restoration efforts are driven largely by community efforts, although some are funded by donors through national government initiatives, for example the large-scale ecosystem-based adaptation (EbA) project implemented by the Ministry of Environment, Climate

Change and Natural Resources (MECCNAR) funded through a grant from the Green Climate Fund (GCF) has invested in mangrove restoration.

Mangrove forest cover alone does not tell the whole story of change over time. There is good anecdotal evidence that mangrove forest degradation is occurring due to selective cutting or harvesting which may not result in total loss of mangrove cover but leads to its gradual disappearance. Thus, the dynamics must also be looked at from a quality perspective (i.e., vegetation density and vegetation health) and from a quantity perspective (i.e. vegetation cover or area coverage). Ecosystem services (e.g. wood, habitat, feed, etc.) provided by mangrove ecosystems are the result of the combination of both the cover and vegetation quality.

This mangrove vegetation dynamic observed in both countries is critical because it directly or indirectly affects the livelihoods of thousands of households who depend on this particular vegetation type. Mangrove vegetation losses are of particular interest because shellfish and oyster production depend on it, as Carney (2017) indicated (Figure 1).

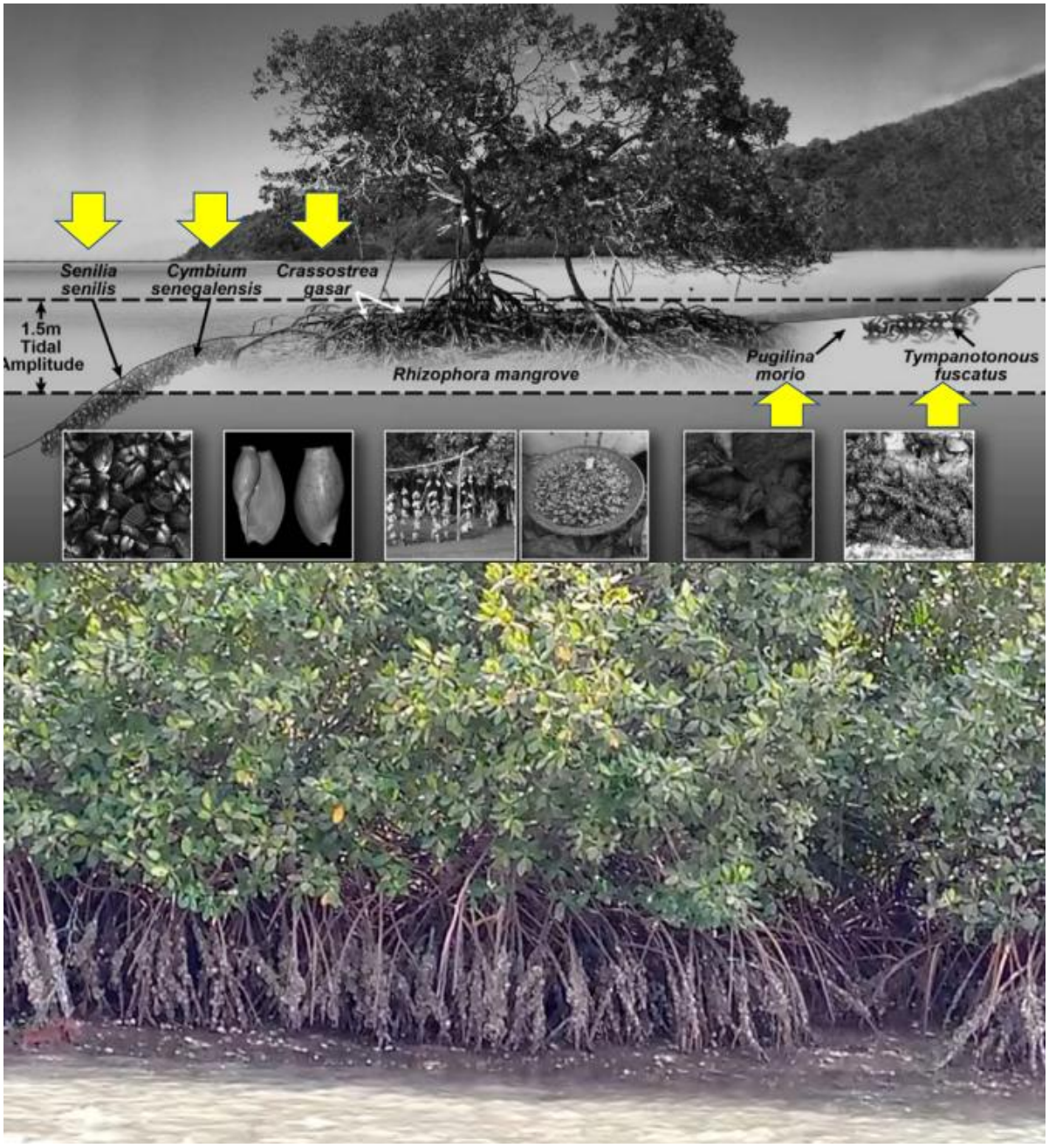

Figure 1: Edible shellfish types associated with mangroves in the Senegambian mangrove ecosystem (Illustration on top is modified from Carney (2017), and the bottom photo taken by the authors in Allahein area).

This assessment has two main objectives. First, it explores the drivers of change in mangrove areas in Ghana and The Gambia. Secondly, it identifies the potential response options, mechanisms, and implementation pathways to improve mangrove forest management and the associated livelihoods of communities dependent on this ecosystem.

2. APPROACHES

2.1 Data collection and aggregation

To acquire the information that is needed to achieve the two objectives of the analysis, a three-step approach was used.

- First, we started with the existing literature and identified the widely known drivers, threats and stresses affecting the mangrove ecosystems. The search for the relevant literature was done using the snowballing technique as the number of publications on the topic is limited for a systematic review. The identified documents were scrutinized for generalizable sets of drivers and threats relevant to the two countries emphasized in this report.
- The second step was to review details from the preliminary survey for the site selection exercise. The communities visited reported various factors that affected the extent of the mangrove ecosystems in their surroundings.
- The last piece of information for the analysis was from the focus group discussions (FGD) held in the six sites in the two countries. In The Gambia, 15 FGDs were undertaken in Tanbi, Bulock and Allahein areas. Five FGDs were conducted in Ghana in the three sites selected – Densu, Whin, and Narkwa.

2.2 Situation Analysis and the DPSIR framework

The USAID Biodiversity How-to Guide I (USAID 2016) (commonly known as the conservation standards) provides a practical tool that helps to understand the situational context of biodiversity programming. This guide offers a step-by-step approach to understand the actions necessary for planning interventions for biodiversity management. For effective intervention designs to tackle biodiversity losses, USAID (2016) emphasizes the need to understand the contexts within which such degradation (or loss) is happening and the factors responsible for the trend. These factors are commonly framed as drivers and threats that cause stress to biodiversity and/or affect the ecosystem directly. Drivers in this context are defined as factors that lead human beings to take actions that affect the ecosystem either positively or negatively. Hence, drivers could take the form of an opportunity or a constraint. Therefore, threats result from the drivers' influences, especially for those having constraining effects on the ecosystem. They are defined as human actions that directly affect the ecosystem of interest (e.g., mangroves). Hence, the USAID Biodiversity Guide How-to Guide I helps intervention planners to have a good understanding of the situation within which activities are going to be implemented. As a result of the analyses conducted in Ghana and The Gambia discussed in detail below, a simplified generic Situation Analysis that describes the relevant drivers and threats and their relationship to the biodiversity of coastal vegetation and adjacent terrestrial ecosystems is presented in Annex 1.

Related to this Guide is the DPSIR (Driver, Pressure, State, Impact, Response) framework (Figure 2), a widely used tool for response action planning in any ecosystem through a structured way of analyzing the context, understanding the problem, the resulting ecosystem state, and design effective, efficient and equitable intervention options (responses). It is widely used in natural resources management, mainly where ecosystem state changes are often observed, and intervention designs need a structured and inclusive process to frame the appropriate responses. It has been used for coastal area management in China (Lin et al., 2007), in Indonesia (Vermaat et al., 2012), in Mexico (Ávila-Flores et al., 2017), in South Africa (Adams and Rajkaran, 2021), and in the United Kingdom (Atkins et al., 2011). There is a strong conceptual similarity between the DPSIR and "The Conservation Standards." The drivers are the same in both approaches. In DPSIR, both the pressures and threats are taken as one. The *State* in DPSIR is similar to the *Biodiversity Focal Interest* in The Conservation Standards; the *Impacts* in DPSIR are similar to the *Human Wellbeing* in the Conservation Standards; the *Responses* in DPSIR are similar to the *Strategic Approaches and actions* in The Conservation Standards.

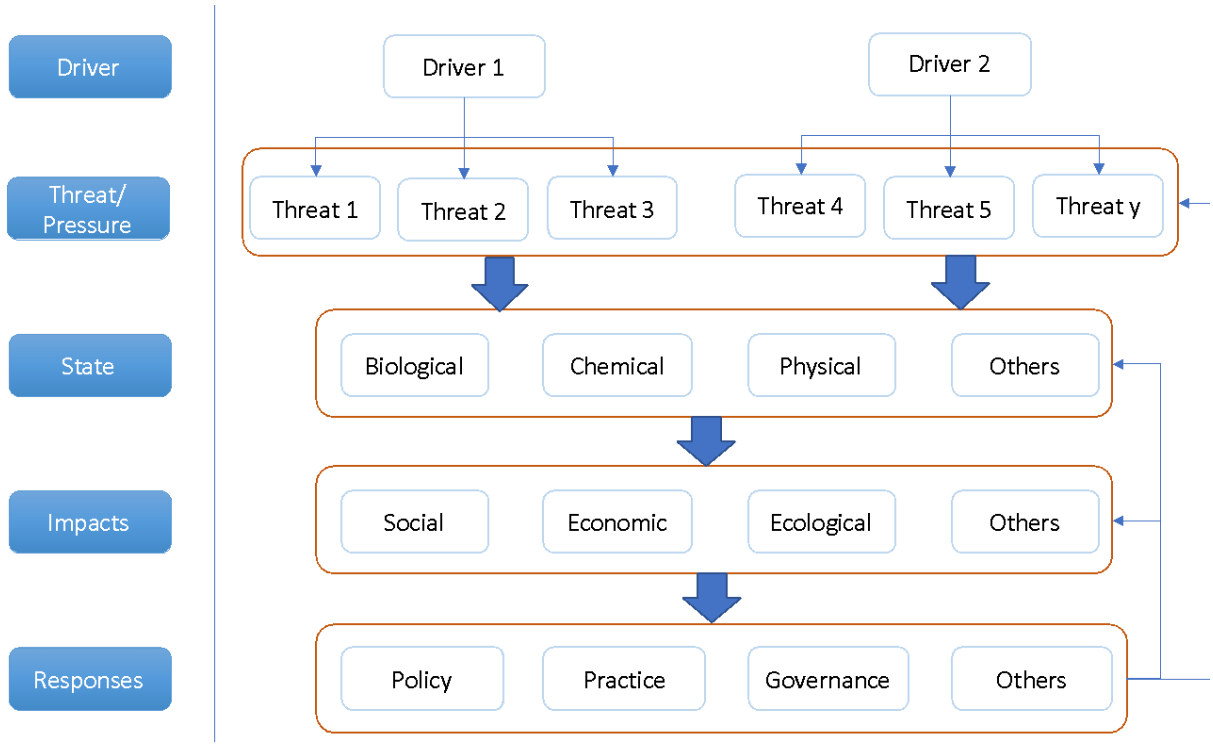

Figure 2: The DPSIR framework.

A Driver within the DPSIR is the same as the one in the USAID Biodiversity How-to Guide I and is an underlying factor that creates pressure that affects the ecosystem. It does not directly affect the system (ecosystem), but it generates factors that directly affect the system. Pressure is any activity,

event, or thing that directly affects the system (ecosystem) and is the same as the threats mentioned in the USAID Biodiversity How-to Guide I. Hence, throughout this report, any reference to Pressure is synonymous with the Threats as described in the USAID Biodiversity How-to Guide I.

Elliott (2011) and Atkins et al. (2011) identify two main categories of pressures: endogenic managed pressures and exogenic unmanaged pressures:

- Endogenic managed pressures usually are within the system boundary and arise from elements from within the system. Management responses for such pressures focus on controlling the causes and consequences of the pressures. Endogenic managed pressures occur from two leading causes- things we extract from the ecosystem (extraction pressure) and things we put into the system (pollutants, wastes, the introduction of exotic species, etc.)
- Exogenic unmanaged pressures often arise from outside the system, or their causes are not known due to a lack of in-depth knowledge about them (Atkins et al., 2011). There is limited control on such factors at a management level, and responses for such pressures focus on managing the consequences. For example, sea-level rise and warming sea surfaces are among the key exogenic stresses in coastal ecosystems resulting from climate change effects. Still, there is little one can do at a coastal ecosystem level to manage them, but rather, emphasis should be on adaptation strategies that could help reduce the consequences of the pressures.

Understanding such typologies of pressures is fundamental in framing the appropriate management responses to manage their impacts on the ecosystems.

The state is the resulting condition of the system after the impacts are exerted on it. This, for example, could be a degraded mangrove ecosystem, polluted water, eroded coastal lands, etc. The state change of an ecosystem can be visible or invisible. Most physical changes can be seen by the naked eye, while chemical changes may not always be that visible and require in-depth investigation to ascertain it. Biological changes can be both observable and not. Tree species diversity changes can easily be observed but how pollution in coastal waters affects the fruiting or flowering of certain tree species is not always visible. Diversity changes at the micro-level may also not be observable unless aided.

Pressures and threats result in impacts that could be socio-economic and/or ecological. Socio-economic impacts are the effects of changes on the societal benefits. Ecological impacts result from changes in the biodiversity of a given coastal ecosystem. Responses are interventions to manage the impacts, consequences, and factors that create change in the state of the ecosystem, which then leads to social, economic, and ecological impacts. Responses can be practices, policies, regulation or governance responses such as community empowerment to better manage resources.

3. DEFINING THE SYSTEM BOUNDARY (SCOPE) FOR THE ANALYSIS

The focus of the analysis is a system (a mangrove ecosystem), which needs to be defined according to the context in which the changes are occurring (Atkins et al., 2011). A proper definition of the system is always critical for identifying the DPSIR elements that help in appropriate intervention designs. Failure in doing so may result in weak response actions that may not be responding to the drivers and pressures causing the changes that need to be addressed.

Depending on the nature or complexity of the system, in some cases, a nested DPSIR could also be used although the various nested DPSIR elements still interact and influence one another. However, the use of nested DPSIR depends on the depth of details available to break down the main system into different subsystems that may require their own DPSIR models.

A system is usually composed of natural systems, designed elements, or manufactured elements and social structures (Atkins et al., 2011). Hence, a detailed account of each of these pieces is crucial to design intervention. Figures 3 and 4 illustrate the biophysical system description attributes of the sites in the two countries. The descriptions of each of them in the context of the mangrove ecosystem are presented below.

- Natural elements: these are elements of the system that are largely described as natural. This includes the biophysical elements such as the water bodies, the coastal area, mangrove forests, surrounding landscapes and land features, and the biodiversity in such land and water bodies.
- Designed elements: These are the structures developed by humans in the forms of land uses (settlements, aquaculture, ports, urban areas, agriculture (rice farming, irrigation, etc.), tourism, etc.), built structures (factories, infrastructures, irrigation facilities, power stations, refineries, military facilities, etc.). Designed elements could also include the policy aspects such as gazettement of a coastal ecosystem as a conservation corridor, Ramsar site, etc.
- Social structures: Social structures and configurations affect ecosystems significantly. In coastal ecosystems where the dependency on fishing activities is high, complex social elements such as gender, ethnicity, social class (wealth status), residential status (local communities versus settlers) is at play. For instance, near coastal areas, women often dominate livelihood activities. Shellfishing is predominantly done by women's groups. At the same time, men usually go to deeper parts of the ocean for fishing.

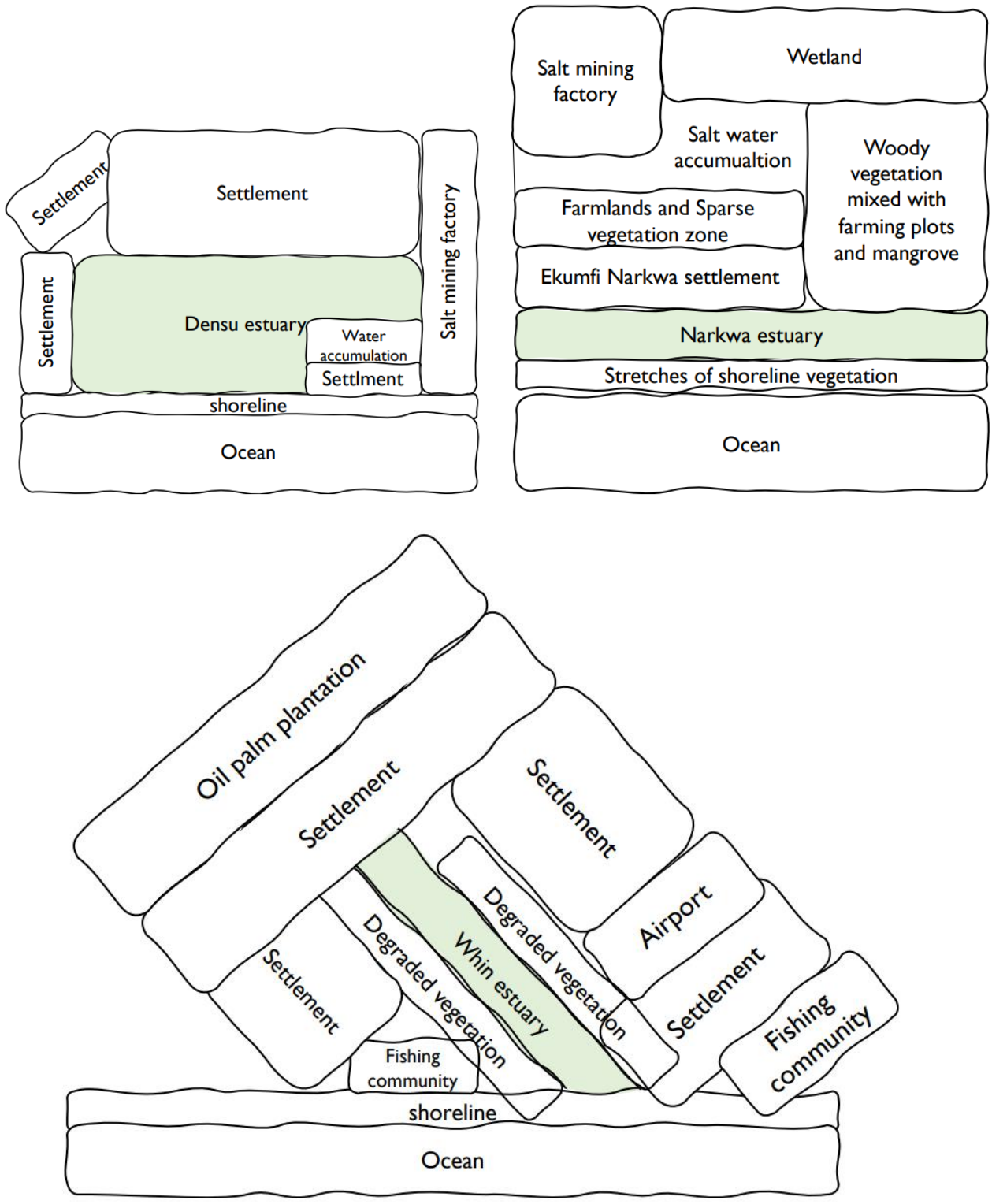

Figure 3: A structured visualization of land cover and land use in the three sites in Ghana. Note that representation is not to scale.

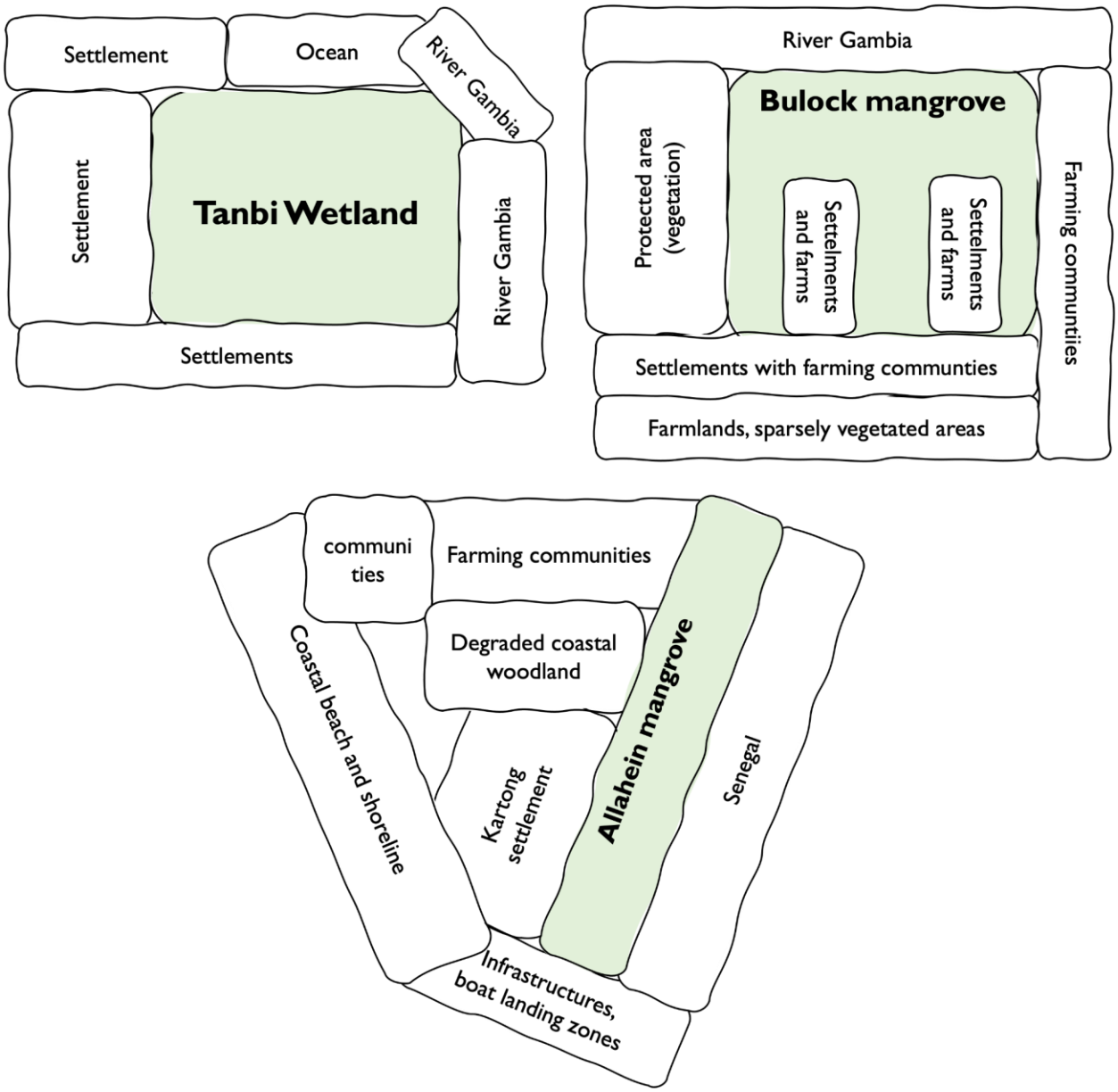

Figure 4: A structured visualization of land cover and land use in the three sites in The Gambia. Note: that representation is not to scale.

4. OVERARCHING DRIVERS AND THREATS

The main drivers and threats affecting mangrove ecosystems in both Ghana and The Gambia can be clustered under population pressures, economic (livelihood) activities, natural factors, and other sporadic factors. The sections below provide a detailed account of each within the context of Ghana and The Gambia.

4.1 Population dynamics and the associated needs

The coastlines of West Africa have some of the largest and fastest-growing human populations. Many communities rely on mangrove wood as a primary fuel source for the treatment of fish and other uses, and urban growth and increased demand for charcoal, fuelwood, and agricultural land are rising drivers of deforestation and the destruction of mangroves. Combined with rising water levels, severe weather erosion, and more violent storm surges, these variables pose significant and increasing threats to mangroves (UNEP, 2007).

Population growth influences mangrove forests in various ways (Figure 5). As in any other part of the countries under study, the human population in and around the estuaries is increasing, although accurate statistics are not available.

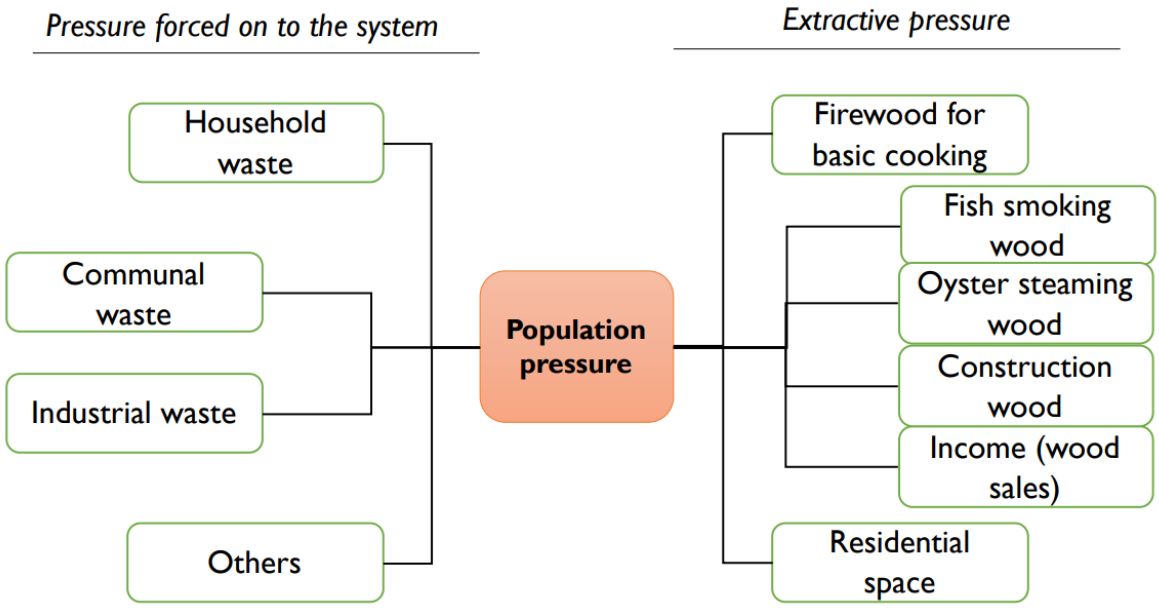

Figure 5: Summary of typologies of pressures exerted by population changes around coastal areas. Note that wood sales is both a population pressure issue and an economic issue which are often intertwined.

Extractive pressures include the following:

- Wood for energy: The increasing demand for energy with the population increase in the estuaries affects mangroves significantly. With most of the estuaries not having access to electricity, the dependence on wood for energy is high. The cheapest source of firewood is thus the mangrove and the surrounding coastal forests. The increase in human population in the areas surrounding the estuaries also affects mangroves by inflating the extraction pressure for firewood. In general, mangroves have fewer exploitation restrictions than other forest ecosystems. This is mainly due to the fact that mangrove areas in both countries are small compared to other forest types. Mangrove wood is also the most commonly used wood to smoke fish harvested from the ocean. It is the most easily accessible wood for such uses. In areas where fish products are destined for distant markets, use of wood for fish smoking is increasing. Fish smoking and oyster steaming (Figure 6) are predominantly fishery-related wood consumption. This is in addition to the basic household energy needs. Mangrove wood commercialization is also a critical problem as wood demand for construction increases due to an increase in population. Rhun palm trees around wetland areas have also been lost due to construction demand.

Figure 6: Fish smoking in The Gambia.

- Wood for construction: Residential houses for low-income communities that often are engaged in shellfishing activities are made of wood. With the increasing human population in

the estuaries and surrounding landscapes, wood extraction for construction also increases as people living in such areas are primarily poor and cannot afford the more expensive non wood construction materials. Some members of the community even engage in harvesting and selling poles and logs for construction as alternative income sources are limited.

- Wood for sale: With increasing population, demand for wood (especially for energy and construction) increases hence attracting exploitation of mangroves for wood sales. Such activities become rampant when other livelihood options in the areas fail to be as productive as expected. The sale of firewood to nearby urban and peri-urban settlements is a typical fallback livelihood option for women in coastal areas.
- Pollution: In addition to the wood extraction for domestic and income purposes, increasing the human population along the coast also affects the ecosystem through pollution that contaminates the water bodies and reduces fishery productivity, which leads people to engage in other livelihood activities that generate income. Declining fishery productivity could threaten the future of coastal forests, including mangroves as cutting forests is in many cases an immediate fallback option to generate income to support fishing community livelihoods.

Table 2: Characterizing population related threats to mangroves in Ghana.

Identified drivers	Relevance of identified driver per site: High, Medium or Low		
	Densu	Whin	Narkwa
Demand for wood for domestic energy	High	Medium	Medium
Demand for construction wood	Medium	Medium	Medium
Demand for food leading to land clearing for farming	High	Medium	Medium
Land clearing for residential spaces	High	Medium	Medium
Household wastes	Medium	Low	Low
Communal wastes	High	Medium	Medium
Settlement based community infrastructures	High	Medium	Medium

Figure 7 shows the significant expansion of residential space in the Densu area, reclaiming a large part of what used to be a wetland. Addae and Oppelt (2019) showed the significant expansions of human settlements in and around the Greater Accra Metropolitan Area.

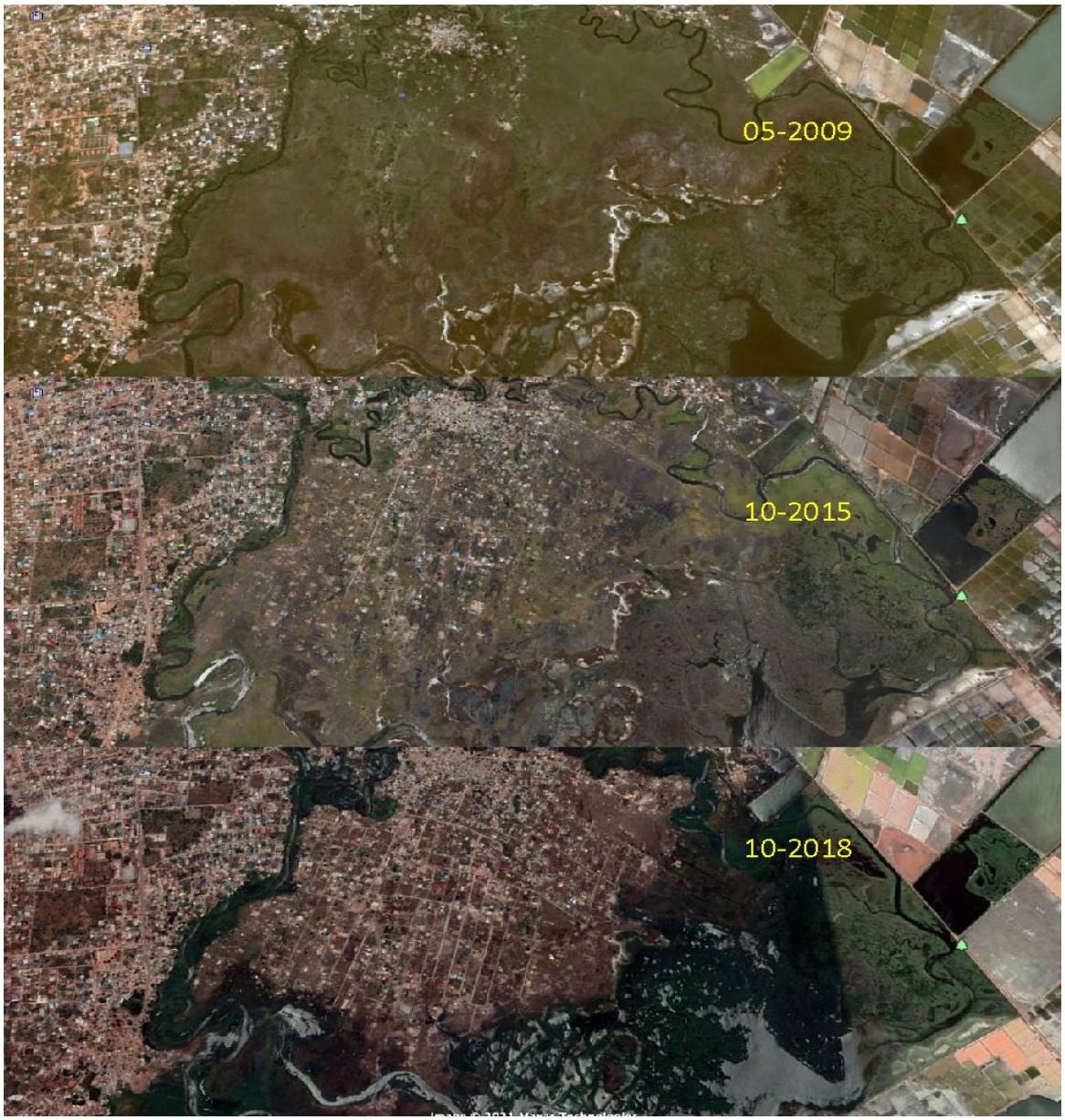

Figure 7: A typical land reclamation happening in Densu Estuary, Ghana (Courtesy of Google Earth). Note the dramatic changes in the size of the settlement as indicated by the arrow. Numbers on the figure are month-year labels of when the image was captured.

Urbanization (settlement expansion) is a growing pressure in coastal areas (Figure 7 and Figure 8). With more people migrating to such locations, residential spaces are expanding as it attracts more residents. Land reclamation activities for settlement and, hence, constructing houses along the waterways, often sand inundation in the nontidal rice fields occurs. This results in diminishing livelihood returns, pushing people to harvest mangroves for marketing as raw wood or charcoal. With the declining mangrove quality and area, oyster populations were reported to be declining, further putting

the livelihood of the most vulnerable groups such as women and children at its worst. In the past, rhun palm trees used to dominate the wetland surrounding the Tanbi but now all of those are gone, and mangrove exploitation has intensified. A summary of human population related threats on mangrove ecosystems in Tanbi, Bulock and Allahein is shown in Table 3.

Table 3: Characterizing population related threats to mangroves in The Gambia.

Identified drivers	Relevance of the identified driver per sites: High, Medium or Low.		
	Tanbi	Bulock	Allahein
▪ Demand for wood for domestic energy	High	High	High
▪ Demand for construction wood	High	High	High
▪ Land clearing for farming	High	High	High
▪ Land clearing for residential spaces	High	Medium	Medium
▪ Household and communal wastes resulting from increased human population	High	Medium	Medium
▪ Expanding settlement-based community infrastructures	High	Medium	High

With more people moving into the urban and peri-urban areas, community infrastructure development such as schools, health facilities and markets intensifies. This, in turn, may require additional reclamation of wetlands or coastal areas, which threatens mangroves and other coastal vegetation. The need for residential spaces is therefore increasing pressure on the mangrove resource base. With this again, the level of environmental pollution also increases as waste management practices are generally weak.

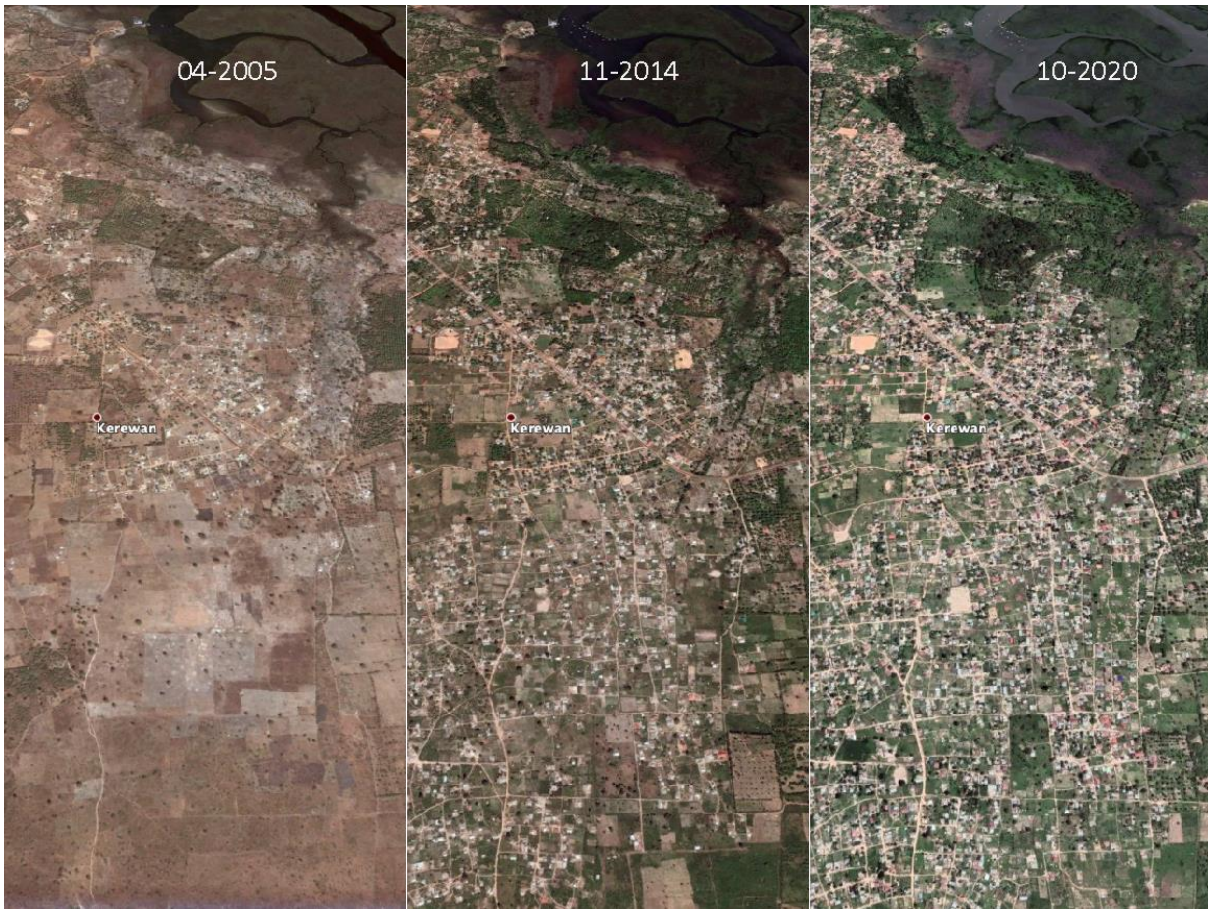

Figure 8: A sample illustration of how Kerewan, one of the villages in Tanbi wetland, has expanded over time, placing extensive population pressure on the ecosystems (Courtesy of Google Earth). Note the expansion and density of settlements over time.

The intense pressure of household and communal wastes on Tanbi Wetlands is shown in Figure 9

Figure 9: Non-point pollution sources around Tanbi wetlands.

The ongoing land reclamation activities happening around coastal areas also affect mangroves indirectly. For instance, due to the land reclamation activities for settlement and hence the construction of houses along the waterways, often sand inundation in the nontidal rice fields occurs in The Gambia. This results in diminishing livelihood returns, pushing people to harvest mangroves for marketing as wood and/or charcoal. With the declining mangrove quality and area, the oyster population was reported to be declining, further putting the livelihood of the most vulnerable groups such as women and children under threat. Under such circumstances, communities that have few alternative livelihood options could begin exploiting the nearby resources with market values such as wood, charcoal, etc.

Nonetheless, such anthropogenic pressures on mangroves are not uncommon, as other scholars have elaborated (see Kairo et al., 2002; Duke et al., 2000). Amplified by anthropogenic processes, urban

development, firewood collection and marketing, conversion of mangrove areas to agricultural fields, and tourism/recreation (Simier et al., 2006) remain key challenges facing this ecosystem.

4.2 Economic drivers and threats

Among the emerging drivers and threats of mangrove ecosystems degradation in numerous countries are the investments in economic development happening in such fragile ecosystems. Well-planned economic development activities typically have proper environmental safeguards but in many of the countries such as Ghana and The Gambia, enforcement of rules and regulations that could protect mangrove ecosystems from destruction or overexploitation are generally weak. As a result, the priority for economic development supersedes the protection of the coastal ecosystems, as observed in both countries. In addition to the weak enforcement, people (usually workers) migrate to the coasts to areas with more infrastructural developments to work as laborers. This, in turn, increases the density of people in coastal areas that depend on mangroves for their energy needs and also temporary shelters often made of wood. This is usually quite common when factories are set up at such locations. Table 4 and 5 present the detailed insights into the threats.

Table 4: Characterizing economic activity related drivers and threats to mangroves in Ghana.

Identified drivers and threats	Relevance of the identified pressures per site: high, medium, low or N/A		
	Densu	Whin	Narkwa
Extraction and sales of fuelwood and construction wood	High	Medium	Medium
Aquaculture development	N/A	Low	N/A
Expansion of rice farming	N/A	N/A	N/A
Commercial agricultural expansion	High	Medium	High
Tourism and recreation/cultural activities	Medium	Low	Low
Oyster collection by cutting roots of mangroves	High	Low	Low
Oyster steaming (boiling) wood	Medium	Medium	Medium
Wood carvings, Wooden fences, houses, and boat construction	Low	Low	Low
Cutting mangroves for fish smoking	High	High	High
Medicinal uses	Low	Low	Low
Traditional aquaculture using mangrove woods to mimic the mangrove environment	High	Low	Medium
Salt mining and creation of spaces and piping pathways	High	Low	Medium

*N/A: not applicable.

Table 5: Characterizing economic activity related drivers and threats on mangroves in The Gambia.

Drivers and threats	Relevance of the identified pressure per site: high, medium or low		
	Tanbi	Bulock	Allahein
Extraction and sales of fuelwood and construction wood	High	Medium	High
Aquaculture development	Low	Low	Low
Expansion of rice farming	High	High	High
Commercial agricultural expansion	High	Medium	High
Tourism and recreation/cultural activities	Medium	Medium	High
Oyster collection by cutting roots of mangroves	High	High	High
Oyster steaming (boiling) wood	High	High	High
Wood carvings, wooden fences, houses & boat construction	High	Medium	High
Cutting mangroves for fish smoking	High	High	High
Extraction for medicinal purposes	Low	Low	Low
Traditional aquaculture using mangrove woods to mimic the mangrove environment	Medium	Low	Low

Other economic drivers and threats affecting mangrove ecosystems include:

- Wood harvesting: Extraction and sales of fuelwood and construction wood is prevalent in many of the villages in the three land-seascapes.
- Aquaculture: Aquaculture development for fish and shellfish production can lead to extensive mangrove loss for instance, Friess et al. (2019) reported 50 percent of mangroves in The Philippines were lost to aquaculture between 1951 and 199. The expansion of aquaculture farms in coastal areas has led to the conversion of mangroves more rapidly (Pattanaik & Prasad, 2011; Herbeck et al., 2020). The authors reported a significant increase in conversion of mangroves into aquaculture to supply aquatic food to the growing population. Hence, aquaculture that is not well-planned affects mangroves considerably. In Ghana and The Gambia trends in conversion to aquaculture are not as significant as is the case in The Philippines, but aquaculture development in coastal areas is often highlighted as an opportunity and may be developed more rapidly in the future.
- Traditional aquaculture: This method uses mangroves in fish farms to mimic the mangrove environment for fish (Feka and Ajonina, 2011). The mangrove stems also serve as the hiding places for the fish hatchlings, especially to avoid predation by birds in particular.
- Rice farming: Rice farming in adjacent riverbanks where the estuaries are located affects the mangrove ecosystem substantively (Figure 10).
- Commercial agricultural expansion (e.g., rice cultivation in The Gambia (Bagbohouna et al., 2018), etc.: Commercial farming is not only done on mangrove land, but also the surrounding

mangroves suffer from the non-point pollutants that cause eutrophication and hence affect marine life, including shellfish, and other fish.

- Tourism and recreation/cultural activities.
- Oyster collection by cutting roots of mangroves.
- Wood carvings, wooden fences, houses, and boat construction.
- Medicinal uses: (Feka and Ajonina, 2011; Friess et al., 2019; Satyanarayana et al., 2012; Teas, 1982).

Figure 10: Commercial agricultural expansion displacing mangroves: rice farms on the banks of the Gambia River (Courtesy of Google Earth).

Figure 11: Piles of wood (including mangroves stems) near an oyster processing area in Bulock, The Gambia.

4.3 Natural factors

Natural factors are primarily related to climatic and hydrological variations (Alongi, 2008). Factors such as sea-level rise, precipitation changes, temperature, and coastal storms impact the mangroves. Sea level rise is likely to cause changes in salinity, flood duration, frequency, and magnitude. Since mangroves are extremely sensitive to such changes, their growth and survival are interrupted (Blasco et al., 1996; Ward et al., 2016). Though studies have shown that mangroves can adapt to sea-level change, this is dependent on the level of the rise and sediment accretion and peat available (Friess et al., 2019). Flooding, sedimentation, and erosion can cause death and changes in mangroves composition due to insufficient oxygen, a phenomenon widely reported. In most West African countries, increased erosion leads to low growth of mangroves, although this has not been affirmed (Blasco et al., 1996). For instance, in The Gambia, mangroves died due to change in hydrological conditions between January and March 1982 (Blasco et al., 1996). Mangroves are sensitive such that any alteration in hydrological conditions hinders their growth.

Storms are more likely to affect the mangroves. With the global increase in extreme weather events such as tsunamis, cyclones, and hurricanes, mangrove ecosystems are highly threatened. Despite mangroves having features that can withstand intense storms, hurricanes and cyclones will uproot the mangrove plant, destroy the canopy and branches, leading to death, displacement, and burying them in the sea (Ward et al., 2016).

Temperature and precipitation are determinants of mangrove cover, distribution, and growth. Therefore, a reduction in rainfall leads to temperature and soil salinity increases, which hinders the mangrove's rejuvenation, survival, and productivity. Temperature also interferes with the ability of mangroves to store carbon dioxide, photosynthetic action, and evaporation rates.

4.4 Other sporadic factors

There are several other drivers that could lead to changes in the state of mangroves. For example, political instability. During periods of political instability, law enforcement is usually weak and challenged, exposing most resources to unregulated exploitation. The impact becomes even greater in contexts where there is either no legal protection for such habitats or where the pressure for the demand for wood is already high.

Transborder exploitation is another issue, for example, the cross-border woody vegetation exploitation happening between the southern border of The Gambia and Casamance Senegal (Fent et al., 2019). The mangrove resource exploitation around Allahein, especially between The Gambia and Senegal, is another case. Such unregulated exploitation often shifts to zones with weaker law enforcement, thus putting constant pressure on the ecosystem.

Land management practices can also lead to mangrove ecosystem degradation. Rice paddy cultivation areas are often burnt for land clearance. Such farmland clearing happens mainly using uncontrolled fire, which can end up burning ecosystems around coastal areas. During the dry season, mangrove forests are highly exposed to such damage, especially in The Gambia.

5. CHANGE IN THE STATE OF THE MANGROVES AND THE ASSOCIATED IMPACTS

Mangroves serve as important habitats for diverse plant and animal species, all interacting in a complex manner. As a result of the drivers and threats described above, physical, chemical, and biological changes can happen in the mangrove ecosystem (Tables 6 and 7). These changes, in turn, result in different outcomes that threaten the sustainability of the ecosystem itself.

The most notable state change observable by the communities is the mangrove cover change in their respective villages and landscapes. In Ghana (Table 6), there is a notable perception by communities confirming that mangroves are disappearing from their areas except for the restoration efforts in Densu. In The Gambia (Table 7), the communities notably perceived improved mangrove cover in their respective villages.

Table 6: State of mangroves in the selected sites as per the communities' view in Ghana.

Land-seascape	Villages	Mangrove condition (Past - 5-10 years)	Mangrove condition (Present - Current state)	Mangrove condition (Desired future - 5-10 years)
Densu	Bortianor	Better cover in the past	Has drastically reduced	Wish to have restored mangroves
	Tsokomey & Tetegu	It was there and then was degraded	Degraded, but restoration is also ongoing.	To plant more mangroves and plant coconut and other species to protect water and give shade
Narkwa	Narkwa	None (Used to be there 10 yrs. ago)	None	None, as the land is already taken for settlements.
Whin	Apremdo	It had good mangrove cover in the past.	Reduced, the current mangrove is only the re-sprouting ones	Hope it will remain in its current situation
	Amanful	Better cover in the past	Has reduced	Hope for restored mangrove

The community's aspiration in the future indicates a strong interest in restoring mangroves and conserving existing ones to enhance mangrove cover in their respective villages. In many villages in Ghana, restoration of degraded or deforested mangroves remains a high priority except in villages where the mangrove areas are already converted into other use, such as settlements. In The Gambia, there is a strong need for investments in restoring the degraded areas (either in the form of afforestation or reforestation) and conserving the existing mangrove cover so that any further loss of mangrove vegetation does not occur.

Table 7: State of mangroves in the selected sites as per the communities' view in The Gambia..

Land-seascape	Location/ villages where FGDs took place	Mangrove condition (Past - 5-10 years)	Mangrove condition (Present - Current state)	Mangrove condition (Desired future - 5-10 years)
Tanbi	Kamalo	Fewer mangroves, heavy harvesting	It is improving due to the reforestation	Even more mangroves are needed
	Lamin	Mangrove cover was increasing	Declining due to increase in harvesting	Hoping to increase to have more oysters by increasing mangroves
	Fanjikunda-FGD1	Mangrove cover was increasing	Improving	Good to improve mangrove cover
	Fanjikunda - FGD2	Mangrove cover was increasing	Degrading	-
	Fanjikunda - FGD3	Mangrove cover was increasing	Degrading	Good to improve mangrove cover
	Old Jeshwang	Mangrove cover was increasing	Improving	Good to improve mangrove cover
Bulock	Bulock - FGD1	Good cover	Good cover	Aim to increase mangrove cover
	Bulock - FGD2	Many mangroves	No change, ongoing restoration	More mangrove areas are needed.
	Bulock - FGD3	Mangrove cover was increasing	Mangrove cover was increasing	Good to improve mangrove cover
	Bintang	Mangrove cover was increasing	Mangrove cover was increasing	Good to improve mangrove cover
Allahein	Kartong - FGD1	Good cover in the past	The mangrove cover is okay.	Intend to plant more mangrove
	Kartong- FGD2	Good and healthy mangrove	Mangrove cover is increasing	Will be good to have more mangrove.
	Kartong - FGD3	Mangrove cover was increasing	Mangrove cover is increasing	Good to improve mangrove cover
	Kartong - FGD 4	Mangrove cover was increasing	Mangrove cover is increasing	Good to improve mangrove cover
	Berending	It was degraded.	Mangrove cover is increasing	Good to improve mangrove cover

According to the details obtained from focus group discussions in five villages from the three sites in Ghana, mangrove ecosystems are declining both in spatial extent and in quality. Mangrove area changes were primarily driven by encroachments of mangrove lands and harvesting of mangroves for various uses. In the communities' view, the ecosystem is also changing from a quality perspective. The main drivers behind such changes being: 1) pollution due to farm chemicals from agricultural activities in

the adjacent farms; 2) open defecation in the lagoons and estuaries; 3) release of effluents into the lagoon especially waste from businesses operators, e.g., hotels and guest houses. Table 8 provides a summary of changes in mangrove ecosystems across the six sites in the two countries studied.

Table 8: Changes in the state of mangrove ecosystems.

Change Type	Detailed attributes	Description
Physical changes	Mangrove forest area	When mangroves are exploited for various purposes, the area may change. Coastal reclamation also has reduced the mangrove area as the land is used for other functions.
	Mangrove forest diversity	The diversity of species may change over time if extraction targets only specific species. Overexploitation may also threaten selected age groups of some species, creating gaps in vegetation structure hence threatening the future of some species.
Chemical changes	Mangrove ecosystem chemical characteristics change	With point source pollution (e.g., hospitality centers in Whin Estuary, Salt mining sites in Narkwa and Densu) and non-point source pollution from households and communities channeled into the water system, coastal areas face considerable chemical content changes. This results in water quality changes which then affect the productivity of aquaculture and fishery activities.
Biological changes	Changes in fauna diversity around and in mangroves	Birds and other terrestrial and marine animals that depend on mangroves will likely change.
Socio-economic changes	Changes in livelihood activities of people resulting from the changing state of the ecosystem	Communities began to adopt diverse income generating activities such as trading, selling of fish, and other products demanded by the surrounding population. If the mangroves and the surrounding ecosystems provide the goods and services required in a proper manner, communities may stick to their usual ways of living in their ecosystems. The growing engagement of communities in fish selling and other petty trade in Ghana's coastal areas is a good example of how people diversify income generating activities when the ecosystem fails to deliver the ecosystem goods and services.
	Changes in the human population movement	When mangrove productivity increases, it attracts people from other areas to the landscape. This is why there are temporary shellfishers who are engaged in oyster harvesting in the Bullock area coming from far away during good production seasons. On the other hand, when its productivity diminishes, people begin to go back to urban areas to earn a living. This pushes people to move to urban and high-density areas in search of other income generating activities.

As the result of the state changes described above, ecosystem services and other benefits from mangrove ecosystems could be affected. Three broad impact typologies can be identified.

Provisioning services loss (Socio-economic impacts):

- With mangrove areas shrinking, the materials extracted from the vegetation also shrinks.
- Shell fishing productivity will decline because shell fishing is almost impossible without mangrove vegetation.
- Fishery production changes due to changes in ecosystem attributes, affected by changes in ecosystem quality. This directly affects the ecosystem level food web resulting in some species migrating due to lack of food and habitat. Mangroves serve as a breeding ground for fish, oysters, and other shellfish.

Regulating services loss:

- Mangroves protect the terrestrial ecosystems against coastal erosion effects. Properties at the coast are often exposed to tidal wave damage if the mangrove vegetation cover is not there. The mangroves absorb the pressure from the tides and reduce the damage due to waves.

Ecological impacts:

- With the pressures being exerted on the mangrove ecosystems and the resulting changes in area and quality of mangroves, marine wildlife (e.g. fish, crustaceans, etc.) and other terrestrial animals such as birds that depend on mangrove ecosystems for feeding, reproduction and habitat will likely migrate. Pelican Island, located between The Gambia and Senegal in the Allahein Estuary, is a typical nesting and breeding site for pelicans and other bird types, mainly feeding on aquatic animals reproducing in the mangroves.

The Situation Analysis in Annex 1 also illustrates these linkages and provides a general framework for considering response options to improve mangrove management discussed in Section 7 below.

6. PROPOSED INDICATORS FOR MANGROVE HEALTH MONITORING

Understanding the health of the mangrove forests is a very crucial aspect of monitoring the vegetation condition. As part of the focus group discussions, in-depth deliberations were made with the communities to get their views on what important indicators should be considered. From the 20 FGDs conducted in the six sites in Ghana and The Gambia, the following are the critical indicators proposed.

- *Mangrove leaf color:* Mangrove vegetation is typically evergreen except for a few species. A healthy mangrove has green leaves all year round as it is situated in or close to water bodies. The discussants suggested that the yellow leaf is an indication of unhealthy vegetation. In some instances, the community emphasized that for unhealthy mangroves, the discoloration of leaves could be of different ones, e.g., brownish leaves, necrotic leaves (spotted damage to the leaves), etc.
- *Tree vigor:* Among the critical features of mangroves highlighted were canopy opening, and tree height was mentioned frequently as an important one. Mangroves, depending on their species, normally have small to medium-sized stems with spreading crowns. The canopy gaps of healthy mangroves are usually smaller, implying a low leaf area index, which generally is an indicator of stress or disturbance on the vegetation. Unhealthy mangrove vegetation has weak and tiny stems in some cases, with branches drying at the tips. It may also have yellow color leaves.
- *Sprouting capacity and regeneration:* For communities in Ghana, sprouting ability is one of the key indicators for mangroves to be considered healthy. If mangrove vegetation is healthy, there should be sufficient seedlings and saplings that are emerging from underneath the vegetation. Regeneration is the only means of natural vegetation succession. Regeneration can be impeded by a change in the soil and water chemistry and also by sediment deposition that influences the emergence of the young mangrove seedling and saplings.
- *Shellfish productivity:* The communities believe that healthy mangroves also lead to higher shellfish productivity. When the vegetation is healthy, typically, it provides an attractive habitat for the shellfish species, hence a better chance of collecting more shellfish. Most of the FGDs in The Gambia revealed that oyster productivity is the key indicator for healthy mangroves
- *Animal (macrofauna) diversity:* Healthy mangroves attract a variety of macrofauna. Among the most frequent macrofauna in mangrove ecosystems are birds, crabs, snails, slugs, etc. Higher diversity is an indicator of better mangrove health. The diversity creates an interdependent food web hence attracting even more animals into the mangrove, thereby adding to the enrichment of the ecosystem. Among the discussants in The Gambia, the return of a few bird species was reported with mangroves improving, and hence this return of avifauna can be a good indicator for mangrove health.

In the literature, some additional indicators such as soil stability, water quality, etc., are mentioned. However, for the local communities, the most straightforward indicators are those listed above. It is by looking at one or more of the above indicators that the communities decide on the state of the mangrove.

7. RESPONSE OPTIONS TO IMPROVE MANGROVE MANAGEMENT

Table 9 and 10 summarize the main response actions to improve mangrove ecosystem management. Several activities are geared towards promoting mangrove growth. These include effective mangrove rehabilitation programs that aim at planting mangroves, but these should be undertaken cautiously to not introduce exotic species that may affect others (Friess et al., 2019). Response actions also include creating awareness and involving the local community in the conservation and management of mangroves to enhance a community-based approach to mangrove protection (Aheto et al., 2016). Involvement will reduce the anthropogenic drivers of mangrove degradation and promote growth. For instance, in the Tanbi Wetland in The Gambia, the TRY Oyster Women's Association was formed for shellfisheries management and resulted in actions in favor of sustainable exploitation of mangroves by bringing unity to create awareness among oyster collectors (Lau and Scales, 2016). In this case, a participatory rights-based shellfisheries co-management approach created a governance framework that empowered and motivated women as shellfisheries managers to more actively steward the mangrove ecosystems on which their shellfisheries depend. Legal frameworks and policies established to protect mangrove ecosystems need to be strictly implemented with strict actions taken for the lawbreakers to reduce mangrove logging and clearance for agriculture and fishing.

Increasing research, collaboration, data sharing and funding of mangrove projects and women's shellfisheries will provide sufficient knowledge and resources needed to maintain mangrove ecosystems. Through provision of incentives loans and credits such as carbon trade and payment for ecosystem services, for example, a well-known PES (Payment for Ecosystem Services) project in Kenya a community led Mikoko Pamoja project in Gazi Bay has been able to plant about 117 ha of mangrove that had been lost to wood products (Friess et al., 2019). The *Livelihoods Carbon Fund project in Senegal* is also a well-known example targeting more than 7000 hectares for restoration. Table 9 shows the necessary level of various response measures to conserve the mangroves in Ghana.

Table 9: Typologies of responses to address mangrove ecosystem declines in Ghana.

Responses	Details	Necessity of proposed measures per site: High, Medium, Low, or N/A.		
		Densu	Whin	Narkwa
Policy responses	▪ Promoting co-management strategies with communities	High	High	High
	▪ Regulatory measures on environmental pollution.	High	High	High
	▪ Regulatory measures about coastal reclamation through land use regulation;	Medium	Low	Low
	▪ Regulatory measures on mangrove ecosystem management and utilization (rational use)	High	Medium	Medium
	▪ Land use/ Urban planning policies	High	High	Medium
	▪ Aquaculture policies	Low	Low	Low
	▪ Awareness creation	High	High	High
Practice responses	▪ Restoration of mangrove ecosystems	High	Medium	Low
	▪ Conservation of mangrove ecosystems	High	Medium	Medium
	▪ Livelihood diversification (tourism, farming,)	Low	High	High
	▪ Substitution for Mangrove services (woodlots for fuel & construction wood)	High	High	High
	▪ Shellfishery management that is integrated with mangrove habitat protection	High	High	High
Governance responses	▪ Legal protection (Conservation status) of mangrove ecosystems.	High	Medium	Medium
	▪ Management plan for utilization and conservation	High	Medium	Medium
	▪ Management plan for shellfish utilization and conservation	High	High	High
	▪ Institutionalization of Community-based management strategies	High	Low	Low
	▪ Institutionalization of Community-based management strategies for shellfisheries	High	High	High
	▪ Cross-border resource management guidelines	N/A.	N/A	N/A
Behavioral response	▪ Change of attitude for wise use of resources	High	High	High

*N/A - not applicable.

Table 10 shows the necessary level of various response measures to conserve the mangroves in The Gambia.

Table 10: Typologies of responses to address mangrove ecosystem declines in The Gambia.

Responses	Details	Necessity of the proposed measures per site: High, Medium, Low or N/A		
		Tanbi	Bulock	Allahein
Policy responses	Enabling and promoting co-management and rights-based strategies with communities	High	High	High
	Facilitating mangrove restoration and management in community forestry and community protected areas	High	High	High
	Regulatory measures on environmental pollution.	High	Medium	High
	Regulatory measures about coastal reclamation through land use regulation	High	Medium	High
	Regulatory measures on mangrove ecosystem management and utilization (rational use)	High	High	High
	Land use/Urban planning policies	High	Medium	High
	Aquaculture policies	Medium	Medium	High
	Awareness creation	High	High	High
Practice responses	Restoration of mangrove ecosystems	High	Medium	High
	Conservation of mangrove ecosystems	High	High	High
	Livelihood diversification (tourism, farming, etc.)	High	Medium	High
	Substitution for Mangrove services (woodlots for fuel and construction wood, etc.)	High	High	High
	Shellfishery management integrated with mangrove habitat protection	High	High	High
Governance responses	Legal protection (Conservation status) of mangrove ecosystems.	High	Medium	High
	Management plan for mangrove utilization and conservation	High	High	High
	Management plan for shellfish utilization and conservation	High	High	High

Responses	Details	Necessity of the proposed measures per site: High, Medium, Low or N/A		
		Tanbi	Bulock	Allahein
	Institutionalization of Community-based management strategies for mangroves	Medium	High	High
	Institutionalization of Community-based management strategies for shellfisheries	High	High	High
	Cross-border resource management guidelines	Low	N/A	High
Behavioral response	Change of attitude for wise use of resources	High	High	High

*N/A - not applicable.

8. PRACTICAL PATHWAYS FOR IMPLEMENTING THE POTENTIAL INTERVENTIONS FOR MANGROVE MANAGEMENT

As indicated in the response section above, there are many interventions that could be undertaken to improve management of mangroves in Ghana and The Gambia. Table 11 lays out practical approaches that may apply in these two countries.

Table 11: Approaches for implementing interventions that could improve mangrove management.

Approach	Relevant actors	Approach description	Pros	Cons
Co-management of mangroves with communities and co-management of shellfisheries in mangrove areas with women shellfishers as an entry point for mangrove management	Community organizations; resource user groups; responsible government departments (see the TRY co-management model case)	Empower local communities to assume management of mangroves (and/or shellfisheries) through delegation of use-rights and management responsibilities that enable resource users, their families, and their communities to benefit directly from responsible and sustainable natural resource management, incentivizing good practices.	Communities know the landscape very well, are in proximity to the resources to be managed, and can leverage social capital. Government often has weak capacity in vast and often remote land/seascapes to provide the data needed for decision-making, to regulate, enforce, and monitor effectively and timely, and to provide transparency and accountability.	Local governance challenges with the communities. Building local community capacity is a process requiring time and resources.
Restoring mangroves in the field	Government departments. NGOs; Communities	Direct action on the ground through the support of NGOs and Government departments	Investments may be helpful to start the rehabilitation process.	Funds may be limited, and sustainability may be a challenge.
'Adopt a mangrove plot'	Local communities (see the community forest model case)	Plots of mangroves allocated to local communities to manage them responsibly. A guiding accountability framework is needed so that mangroves are not depleted due to mismanagement and free rider problems.	Community access to use rights of such resources creates a sense of responsibility and empowerment.	Free riders (those who do not contribute to management interventions but want to enjoy the benefits of the resources). Communities may sometimes be powerless against such individuals.

Approach	Relevant actors	Approach description	Pros	Cons
	Private companies; Parastatals (state-owned companies)	Companies operating in proximity to the mangroves could adopt a plot of mangrove to manage it as part of their Corporate Social Responsibility (CSR).	The accountability procedure can be easier as the responsibilities are tagged to a specific entity.	CSR approaches usually face changes in sustainability as the investment depends on the revenues and functionality of the company itself.
	Schools, Universities	Educational institutions could be managing parcels of mangroves.	Continued engagement and hence better follow-up is possible.	Resource limitations may hamper the effort of educational institutions.
	Government departments	Responsible government departments should make deliberate efforts and resource allocation to curb mangrove loss.	Direct responsibility and accountability at the government departments.	Shifts in government priorities and instabilities could affect continued support besides the limited capacities governments have.
Incentives for conservation	Governments, Carbon and ecosystem services buyers	Mangroves usually attract a strong blue carbon credit (biomass carbon and soil carbon) through Reducing Emissions from Deforestation and Forest Degradation (REDD+).	A significant level of resources that can complement community development and even the mangrove restoration.	Upfront investments in developing the mechanism, and monitoring tools.
		Payment for ecosystem services (coastal disaster risk reduction, biodiversity conservation, etc.)	Same as above	Same as above

Approach	Relevant actors	Approach description	Pros	Cons
Awareness creation	Co-management entities, Community leaders, Women shellfishers, Educational institutions, companies, government agencies, NGOs	Focused and informed communications tailored to an array of target audiences that mangroves are important and wise use is mandatory. Stakeholder engagement.	If messages, stakeholder engagement, and action research are well crafted and delivered, they can lead to behavioral changes.	How much of what people hear translates to action depends on the contexts and circumstances.

9. LESSONS FROM THE EXISTING APPROACHES TO PROMOTE MANGROVE ECOSYSTEM MANAGEMENT

Though not extensive, two cases present themselves as potential learning opportunities to advance the management of mangrove ecosystems to improve shellfish productivity and thus improved income and nutrition, especially for women headed households who depend on this activity.

Case #1: The TRY Oyster Women's Association (TRY) case of rights-based shellfisheries co-management as an entry point for mangrove conservation and a co-management model for mangrove ecosystem management - Equator initiative case study (UNDP, 2013).

TRY Oyster Women's Association (hereafter referred to as TRY) was established in 2007 as a non-profit association to bring together women oyster and cockle harvesters based in the Tanbi wetland area. It brings together over 500 oyster harvesters drawn from about 15 villages in Greater Banjul co-managing over 6,300 ha of wetland reserve. TRY community groups receive technical trainings and capacity building on sustainable harvesting, and on enterprise development beyond shellfishing. Since January of 2012, the Ministry of Fisheries in The Gambia signed into law a co-management plan that gave TRY exclusive use rights to the oyster and cockle fisheries within the Tanbi wetlands complex and gave members the powers to pass by-laws governing sustainable resource use (UNDP, 2013).

The need for TRY arose because the women who are engaged in the harvesting activities did it with no coordination and there was no regulation to manage the extent of harvesting happening in the wetland, which threatened the ecosystem and the future livelihood of the women dependent on that. Further, despite high demand for the oyster and cockle in The Gambia, shellfishers remained poor and economically marginalized despite the high risks associated with the activity. Oyster harvesting is also seasonal, exposing shellfishers to financial risks in the off-season.

TRY gained traction as more women began to also focus on securing their future rather than only considering what could be obtained from the ecosystem today. This resulted in consensus on a management measure reducing the harvesting season from six months annually to only four to allow for oyster growth and reproduction. The association also helped harvesters gain collective voice when marketing, and the longer closed season resulted in larger oysters that received a higher market price. Through the association, many women shellfishers received both technical and material support for sustainable shellfisheries management, which included the need to maintain a healthy mangrove ecosystem for better productivity of shellfishing activities.

The catalytic effect of the association led to the development of the *shellfishery co-management plan for the Tanbi Wetlands Complex* and motivated and empowered the women shellfishers as stewards of the mangrove ecosystem, which enhanced restoration of the degraded mangrove areas and management and conservation of the remaining mangrove vegetation. The shellfishery management

plan sets clear biological, ecological, social and economic goals, bringing together relevant government agencies operating in the Tanbi. Some of the particular activities under different goals include (a) creation and improving equitable oyster value and supply chain, (b) replanting and rehabilitating mangrove forests, (c) development of aquaculture, (d) education and health services provision, and (e) microfinance development to support members in accessing credit and savings services. It also meant the mutual understanding between the women groups and responsible government agencies (Fisheries, Parks and Wildlife, etc.) created favorable working relations that resulted in reduced mangrove vegetation loss and increased restoration thus better livelihood and environmental benefits to the communities.

As a result of TRY's interventions, biodiversity conservation is improved, through reduced destruction of mangrove forests from oyster harvesting and from unsustainable timber harvesting through value addition and income diversification. Defining the fresh oyster harvesting period from March to June and including it in the co-management plan has helped reduce mangrove destruction and allowed growth of oysters to maturity. Improved oyster harvesting technologies, such as a shift from cutting the mangroves roots using machetes to using small knives targeting only the oyster, have also significantly reduced destruction. The interventions are also improving the livelihood conditions of the oyster harvesters, through among others income and revenue streams diversification, improved working conditions, enhanced collective bargaining to empower women in getting good prices for their products, and raising women's voices and authority in mangrove resources management in relation to shellfisheries.

Based on the biodiversity and livelihood impacts that TRY is making in the area, there is a call for increased co-management of natural resources and increased recognition of the roles that communities play in resource management. Raising community voices will play a crucial role in diversifying income generation and simultaneously promoting natural resources management.

The TRY model introduced an integrated portfolio of complementary strategies to reduce the pressure on the ecosystem from the women harvesters. First, through training on better sanitation, women groups were able to sell their oysters at relatively better prices. Increasing the income of the women groups by improving the sanitation standards reduces the need for women to cut down the mangroves to sell as energy sources, for example. Second, the collective savings the women groups managed to put in place when they have a good production and sale also cushions them against economic vulnerabilities during closed seasons and when there are other economic shocks and stresses. If they do not have such savings, the next frontier for getting income to support livelihood needs could be exploiting the mangroves to sell them and provide food for their families. Third, the level of awareness about the importance of the mangroves for the communities and their future also improved. This is why the women are motivated in restoring degraded mangrove areas and are pro-actively seeking to engage their communities in these efforts. TRY also in several instances has alerted government authorities on illegal mangrove cutting by commercial operators, facilitating government

to play more effectively play its' enforcement role. In spite of these strategies, reducing pressure on the Tanbi's shellfisheries and mangrove ecosystems while improving livelihoods remains a formidable challenge. In addition, what the model has not yet addressed is the livelihood and other needs of mangrove resource users other than shellfishers.

The TRY rights-based shellfishery co-management model was adapted and replicated with similar success and outcomes for improved oyster and associated mangrove ecosystem management in the case of the *Densu Delta community based fisheries co-management plan* for oysters in Ghana.

Case #2: Community forestry in The Gambia as a potential entry point for mangrove restoration.

The Gambia has been experimenting the community forestry approach for over two decades now. The centralized approach on forest governance has failed to save the forests and woodlands from deforestation and further degradation. There was a wide power imbalance between the communities who depend on the forests and woodlands and the institutions entitled to implement the centralized forest management models. As a result, communities who lived and sustained the forests and woodlands were sidelined and decisions to manage the forests and woodlands were coming from the institutions headed by technical experts who often had little understanding of the local context of how the people and the forests and woodlands interacted. The protectionist model (e.g., fencing and guarding forests) that were behind the community exclusion from using forests have not saved the forests, either. When all these proved futile, the search for solutions led 'the experts' back to the communities. This became the conception of the community framework in The Gambia and in wider Africa. That is how community forestry became the central focus of the 1995 Forest Policy and the Forest Bill of 1998. The community forestry framework became the main pathway to empower communities to own the resource, manage it wisely and benefit from it without any sense of tenure insecurity. The policy aimed to hand over 200,000 ha of forest to communities by 2019, though this target seems not to have been achieved. Latest reports (as of 2015) indicate there are about 333 Community Forests (CFs) with a total area of 31,682 ha, roughly 7.4 percent of total forest area. Community Protected Areas (CPAs) followed the same path to be given out to communities to manage and use wisely. They are often prioritized for wildlife protection and management unlike the CFs which are for forest and woodland management.

CFs in the North Bank region of the country do have a significant share of mangrove cover. Among the CFs with considerable mangrove area include Ndanka CF, Kubandarr CF, Balengho CF, Bassick CF, Dibba Kunda CF, Jurunko CF, Sami Kuta & Koto CF, Karantaba CF and Suwareh kunda CF. CFs around Barrow Kunda (Jarra East district) also have large mangrove areas that are being managed within the community forestry framework. Similarly, community protected areas in Kiang West National Park also have significant parts of their vegetation managed by communities. In general, several CFs and CPAs in the North Bank Region, Lower River Region along the River Gambia and

some community areas in the Central River Region have plots of mangroves within their boundaries or adjacent to them. Where degradation happened, some of the CFs have also begun restoring mangroves through planting to revive the ecosystem services generated by this vegetation type. For example, there is already an ongoing mangrove restoration activity happening in Bulock area as this area is among the numerous sites that depend on shellfishery activities which in turn strongly relies on the health of the mangrove vegetation. Bullock has been affected by mangrove die back in the 1980s and 1990s. Thus, the lessons and experiences from this community managed area could be especially useful to advance co-management models that can be integrated into currently recognized CF and CPA areas.

In both the CF and CPA cases the communities enter into agreement with the government to comply with the proposed management plan that is developed together with the forestry and wildlife experts. Any deviance from the agreed management plan may lead to the cancellation of the community's management and use rights. In principle, this model is a similar co-management model to that of TRY.

10. THE NEED FOR A CO-MANAGEMENT MODEL BEYOND THE SHELLFISHERIES CO-MANAGEMENT AND COMMUNITY FORESTRY FRAMEWORKS

Mangroves as forests often are under the authority of the forestry departments but when they do not occupy large tracts of land, they are often left as parts of the wetland systems which often falls under the fishery or parks and wildlife departments. This floating nature of affiliation of many stretches of mangroves, call for a modified management model so that the mangroves get the attention of both the forestry and parks and wildlife or fisheries departments. Figure 12 presents a mangrove ecosystem co-management model that brings together stakeholders having roles and responsibilities in managing this unique vegetation.

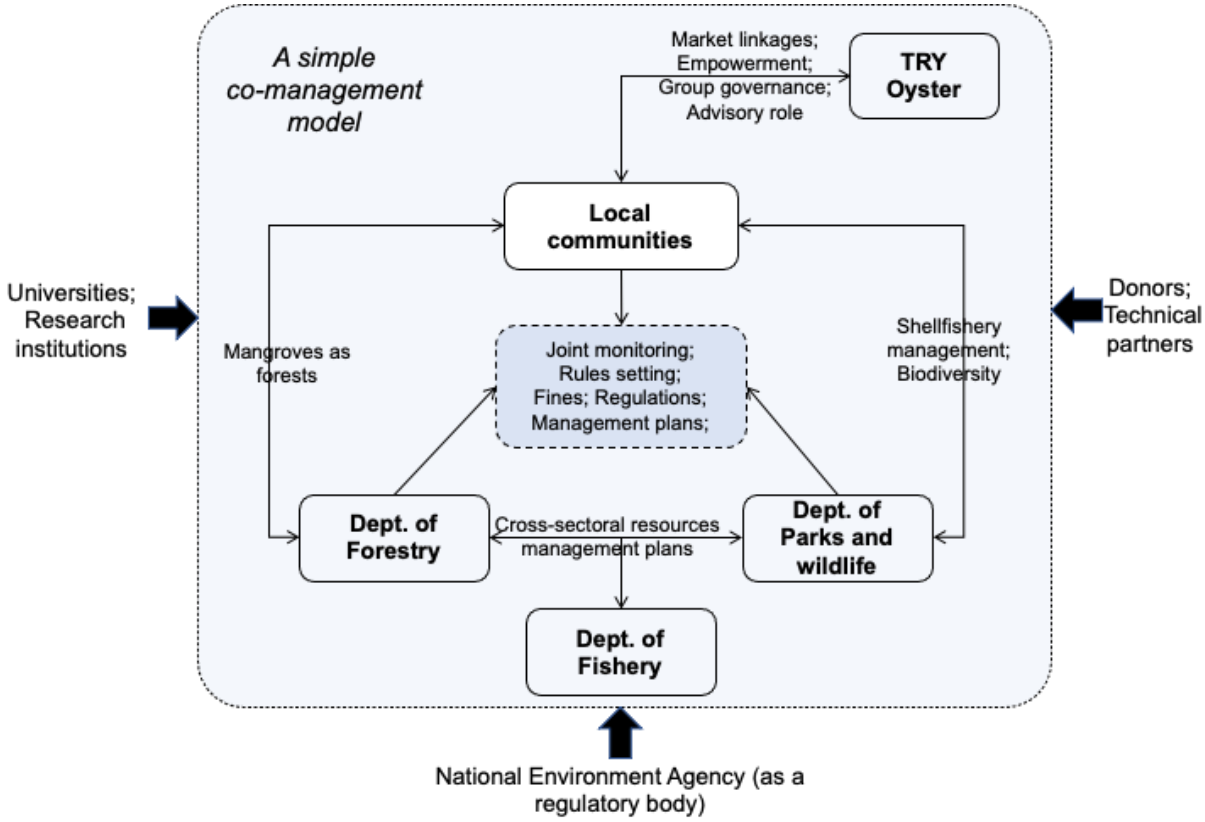

Figure 12: A modified mangrove ecosystem co-management model that may be applicable and designed using The Gambia as a case study.

11. RESTORING AND CONSERVING MANGROVE ECOSYSTEMS: TOWARDS AN ACTION PLAN

The threats facing mangrove ecosystems are immense in both Ghana and The Gambia. To avoid any further loss of this critical ecosystem and vegetation and the ecosystem services it provides, there is a need for deliberate investment in the restoration and conservation of the mangrove vegetation. Such interventions will be so crucial to secure and further improve the livelihood of communities dependent on this ecosystem for their subsistence needs.

Though mangrove management should follow adaptive management principles (since every mangrove ecosystem has a different context), there is still a need to have a generalized, adaptable action plan that could be deployed in saving the remnant mangrove areas and restore the degraded ones. Below is a simplified action plan with selected elements that can be adapted in various contexts to help restore the ecosystem.

Element 1: Understand the mangrove ecosystem to be managed:

- The species composition of the mangrove ecosystem
- The overall biological diversity of the mangrove ecosystem
- The edaphic factors, i.e., soil and soil conditions
- The local hydrology, particularly the tidal wave attributes (strength, frequency, timings, etc.)
- The human-mangrove relationships in the land-seascape

Element 2: Understanding the drivers and threats to the mangrove ecosystem:

- Human (anthropogenic) factors, i.e., extractive uses, encroachments, pollution
- Livestock and animal encroachments
- Fire intrusion
- Flooding and tidal damage
- Disease and insects' attack
- Salinity problems
- Other natural threats

Element 3: Response plans and choices of interventions:

- Conserving existing mangrove vegetation
- Restoring using wildings or naturally regenerated seedlings
- Restoring using mangrove propagules
- Restoring using nursery raised seedlings
- Assisted natural regeneration by reducing exposure to stressors such livestock, fire, etc.

Element 4: Operational plan development:

- Stakeholders' engagement, i.e., participatory co-designs
- Developing an implementation plan (when, where, who, etc.)
- Demarcation of intervention zones
- Financing mechanisms (government resources, donor-funded, private sector, community investments, etc.)
- Staffing and role description
- Training plans
- Monitoring and evaluation protocols

Element 5: Sustainability and resource use protocols:

- Sustainability plans (how to continue managing the resource after the projects)
- Benefits realization and resource use guidelines (once the restoration scheme is achieved, it is important to articulate how proper and sustainable resource use schemes are implemented)
- Incentive infrastructure to sustain mangrove management

These five elements and the associated details are essential features that need to be considered to conserve and restore mangrove ecosystems, especially where pressure on resources is intense. The structured approach also helps to make the mangrove management plan more practical and achievable. Such an action plan could be adapted to the context of the sites in Ghana and The Gambia.

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ANNEX 1: A generic situation model representing the interconnectedness between the drivers, threats, and ecosystems.