TECHNICAL REPORT

WEST AFRICA COASTAL AREAS HIGH-LEVEL PLATFORM

BENEFITS OF MANGROVE AFFORESTATION AND RESTORATION PROGRAMS IN GHANA

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ACRONYMS AND ABBREVIATIONS

BCR	Benefit-cost ratio
CM	Carbon material
DBH	Diameter at breast-high
GWS	Ghana Wildlife Society
ha	hectare
IRR	Internal rate of return
NPV	Net present value
PPP$	Purchasing Power Parity Dollar
TEV	Total economic value
WTP	Willingness to pay

All amounts in US dollars ($) unless otherwise stated

EXECUTIVE SUMMARY

Ghana's mangrove ecosystems constitute a very important natural resource in the country's coastal region, where more than a quarter of the population resides. These areas not only support the gathering of timber and nontimber forest products; they also provide a myriad of ecosystem services, from carbon sequestration to protection from storms, floods, and erosion; the processing of waste and nutrient pollution; support for aquaculture and agriculture; and habitats for both aquatic and terrestrial species.

However, between 1980 and 2014, the mangrove area in Ghana has been reduced from 181 to 114 square kilometers (sq km). This represents a loss of nearly 33 percent, and is mainly due to the unsustainable harvesting of mangroves. The harvesting of mangroves for their direct benefits can result in the loss of whole mangrove areas, as well as the associated ecosystem benefits they provide, which often exceed the direct benefits.

Understanding the full benefits that mangroves provide can help raise awareness of the need to preserve them for the overall betterment of society. Full accounting of the benefits that can be realized from mangroves them can also help to justify redevelopment of mangroves in areas where such planting is feasible. **The objective of the current study is to estimate the total economic value (TEV) of current mangrove areas in Ghana by considering the whole range of benefits they provide, and to use those estimated values in economic cost-benefit analyses**.

This study focuses on the respective values of private direct and indirect use; social use; and social option/nonuse of mangroves in Ghana. A survey of the literature was conducted to find studies that arrived at the values from all of these uses. These studies were from a number of locations in the Western Coast and Volta regions, where almost all of the mangroves in Ghana are currently found. If there were no studies available for a particular use of mangroves in Ghana, the values were arrived at by using data obtained from similar locations elsewhere. Since these studies were done in different years, all of the values were adjusted to 2020 PPP$, using inflation data in Ghana and the PPP$ conversion factor in order to compare these values on a similar basis. The results were reported as a mean value per hectare, along with the range of values found in those studies.

The mean value of private direct use of mangroves, mainly for timber and fuelwood, was calculated by using the quantity of mangroves harvested and their market price. The mean value was found to be $2,498 per hectare (ha), ranging from $811–$5,568. Private indirect use arose mainly from fisheries, the hunting of animals, and tourism. Using the quantity of fish harvested and their market price, the mean value of fisheries amounted to $719 per hectare ($402–$940). The hunting value was $82 per hectare, derived from only one study, based on the quantity of wildlife and its market price. The mean value for tourism was $46 per hectare ($45–$46), based on actual revenue generated.

Three social-use values of mangroves were assessed: carbon sequestration, flood protection, and water purification. The mean carbon sequestration value of $480 per hectare ($380–$500) was based on allometric studies to assess the carbon content in mangroves and the price of carbon. However, since no studies could be found in Ghana for flood protection and water purification, the mean flood protection value of $1,120 per hectare ($1,120–$1,370), and the mean water purification value of $327 ($151–$504) were based on studies done at locations outside of Ghana. **Biodiversity benefits were estimated as a social option**, and **nonuse value based on a willingness to pay approach**. The mean value found for nonuse was $1,281 ($911–$$1,651).

The cost of planting was based on 2 x 2-meter spacing for mangrove plantings. The mean cost of planting was found to be $2,528 ($1,760–$3,825), with an annual maintenance cost of $72 per hectare. Using these costs, the **private direct benefits** show a positive net present value (NPV) per hectare of $15,860, with a benefit cost ratio (BCR) of 5.7. With the inclusion of **indirect private benefits** from fisheries, the NPV per hectare increases to $21,398, with a BCR of 7.7. Once all of the **social-use values** are factored in, the NPV increases to $33,996, with a BCR of 12.2.

Two important findings emerge from this study. First, the sum of the benefits from private indirect use, social use, and social option/nonuse that occurs from the presence of mangroves far outweighs the private direct-use benefits. This suggests that the use of incentives and disincentives to discourage the unsustainable exploitation of mangroves that occurs mainly for direct use would lead to net social benefits. **Second, the large NPVs and BCRs that could be realized from planting mangroves makes a clear case for launching an immediate drive to plant mangroves on a war footing in all of the lands that are now barren, but are suitable for growing mangroves.**

CHAPTER 1.
INTRODUCTION

A significant share of Ghana's economy is dependent on its coastal zone; more than a quarter of the population resides there, and it accounts for nearly 80 percent of the country's industrial establishment (WEF 2015). Oil and gas production, port operations, and the generation of hydro and thermal electricity are some of the important industrial activities found in this area. This area also contributes to the overall economic activity of the country through coastal agriculture and fisheries. **The health of the coastal areas is therefore of vital importance for the country's economy.**

In recent times, increased pressure on the ecosystem of the coastal areas is posing a major threat to the population as well as the economy of Ghana. However, the extent of the problem differs depending on the location. The coastal zone in Ghana can be divided into three broad sections: the western, central, and eastern zones. All three sections have been facing the threat of erosion to varying degrees. The eastern section, which is influenced by the Volta Delta system, has been identified as the most vulnerable (WEF 2015).

Oil and gas production in the western section of the country has resulted in increased migration of people to that area, which has created increased stress on the coastal environment, along with changes in the coastal ecology systems. One major impact has been the destruction of vegetation like mangrove swamps, which exacerbates damage to the ecosystem. The mining of precious minerals along portions of the coast is also destroying the equilibrium of the beach system, and either initiating or intensifying erosion. Sand mining, which is banned but is still practiced along the entire coast for construction purposes, is also having a negative effect (WEF 2015).

The vulnerability of the coastal zone is expected to increase significantly as a result of climate change and the associated sea-level rise. Sea-level rise increases the direct inundation of low-lying areas, facilitates the rapid erosion of soft shores, and increases offshore loss of sediment as well as flooding. It is estimated that a one-meter increase in sea level will inundate a significant portion of the Volta Delta system in the eastern section of the country.

Management of the coastal ecosystem in Ghana, including the prevention of coastal erosion, is mostly reactive, site-specific, and usually involves using difficult engineering approaches (WEF 2015). These projects involve a combination of groynes and revetment. Groynes is a form of coastal protection in which barriers are built into the sea to prevent erosion. They essentially trap the sand and stop it from moving too far from the coast. Concrete or wooden structures known as revetments have also been built to act as a barrier against the waves in an attempt to stop the effects of coastal erosion. The revetments absorb the energy of the waves, and prevent the cliffs from eroding. While they stabilize the shoreline at the protected section, they may increase erosion elsewhere.

The current approaches adopted by the government for protecting its coastal ecosystems are unsustainable, and environmentally unfriendly. Future projections of erosion along the coast of Ghana indicate that the present coastal buffer zones may be completely eroded by 2100. Also, between 2052 and 2082, it is projected that coastal erosion will affect important landmarks such as the Christiansburg Castle, Ghana's Independence Square, and the Densu Ramser site in Accra – all of which are all located within the coastal zone (WEF 2015). In addition, site-specific interventions are having knock-on effects in most cases. Thus the construction of the Keta sea defense, using a combination of groynes and revetments, has led to increased coastal erosion on the downdrift coast, toward the Ghana–Togo border, by over 50 percent (World Bank 2017).

There is an urgent need to develop a comprehensive coastal policy for managing the coastal ecosystem; and mangroves present a cost-effective solution to the problem. They can provide the opportunity to create policy that incorporates strategies for tackling coastal management problems using the "green" concept of working ***with*** nature, not against it. Protecting the sustainability of the existing mangrove forests, and developing new mangrove swamps in suitable areas could be an important part of a green strategy. However, the use of mangroves as a policy intervention will have to be cost-effective; a detailed cost-benefit analysis can help in creating one.

Ghana's mangrove ecosystems are tremendously valuable; they provide carbon sequestration; protection from storms, floods, and erosion; timber and nontimber forest products; the processing of waste and nutrient pollution; support for aquaculture and agriculture; and habitats for both aquatic and terrestrial species. A thorough estimation of the potential benefits of mangroves can help determine the total overall net benefits that could be realized in Ghana, and can also help to identify the best areas to plant and maintain mangrove plantations.

The objectives of the current study are to:

1. Estimate the total economic value (TEV) of current mangrove plantations in Ghana by considering the whole range of potential benefits from mangroves;
2. Use those estimated values in economic cost-benefit analyses in order to determine the possible effects of replanting and/or creating additional mangrove plantations in suitable locations.

Section 2 of this report discusses the location, extent, and type of mangrove cover in Ghana. **Section 3** explains the methodology used, and the actual valuation of the various benefits that mangroves provide. **Section 4** discusses the costs that would be involved in the creation of new mangrove areas. **Section 5** concludes the report and proposes a way forward for the creation of new mangroves as well as ways to sustain the current area under mangroves.

CHAPTER 2.
MANGROVES IN GHANA

Mangrove swamps are structurally and functionally unique habitats restricted to intertidal and adjacent communities in tropical and subtropical regions. Mangrove species possess unique adaptations, including stilt roots and pneumatophores that allow the exchange of gases for their root tissues (Kauffman and Donato 2012). Their aerial root systems extend into intertidal and subtidal areas, where they provide stability for the otherwise soft sediment environment (Ellison and Farnsworth 1992). Indeed, mangroves are important habitats for many terrestrial and marine fauna, including several important commercial fish species (Aheto et al. 2014). Within the water column, mangrove roots are overgrown by epibionts such as tunicates, sponges, algae, and bivalves, with the spaces between their roots serving as shelter and food for motile fauna such as prawns, crabs, and fishes (Nagelkerken et al. 2008). Mangrove trees and canopies provide an important habitat for a wide range of species of birds, insects, mammals, and reptiles (Nagelkerken et al. 2008). Though they are restricted to coastlines, mangroves are one of the most productive coastal ecosystems, supporting a wide range of goods and services (Field et al. 1998). Humans have traditionally relied on mangrove-related products such as finfish, shellfish, firewood, timber, tannins, dyes, and medicinal products for their basic subsistence (Robertson 1988; Barbosa et al. 2001; Aheto 2011), which has probably contributed to the high level of degradation of mangrove ecosystems worldwide. It is noteworthy that among the major terrestrial land covers, the carbon storage potential of mangroves is the highest; yet mangrove ecosystem services are among the least investigated (Kauffman and Donato 2012).

In Ghana, mangroves are mainly limited to the beaches around lagoons on the west coast of the country, and bordering the lower reaches and delta of the Volta River. They are most developed on the west coast between Cote d'Ivoire and Cape Three Points. Six species of true mangrove are found in Ghana: *Acrostichum aureum; Avicennia germinans; Conocarpus erectus; Laguncularia racemose; Rhizophora harrisonii;* and *Rhizophora racemose*. Open lagoons are often dominated by *Rhizophora*, while closed lagoons, which have elevated salinity, contain *Avicennia germinans, Conocarpus erectus, Laguncularia racemose,* and *Acrostichum aureum*. The mangrove swamps in Ghana are very restricted in area and distribution, and they rarely develop beyond the thicket stage. *Laguncularia racemosa* and *Rhizophora racemosa* are found on the seaward side of lagoons in saline conditions. *Avicennia germinans* (syn *A. nitida*) occurs on the landward side of the swamps.

The mangrove stands in most areas are secondary growth, with degraded faunal composition due to intensive use of the mangrove for fuelwood to smoke fish and extract salt. *Avicennia germinans* is exploited for its bark, which is used for tanning fishing nets, and as firewood for local use. Mangrove wood is also used for construction. Mangrove lands have been reclaimed for both agricultural uses and urbanization, and they are threatened by oil pollution. As in many other parts of the world, short-term development needs are undermining long-term mangrove health and survival.

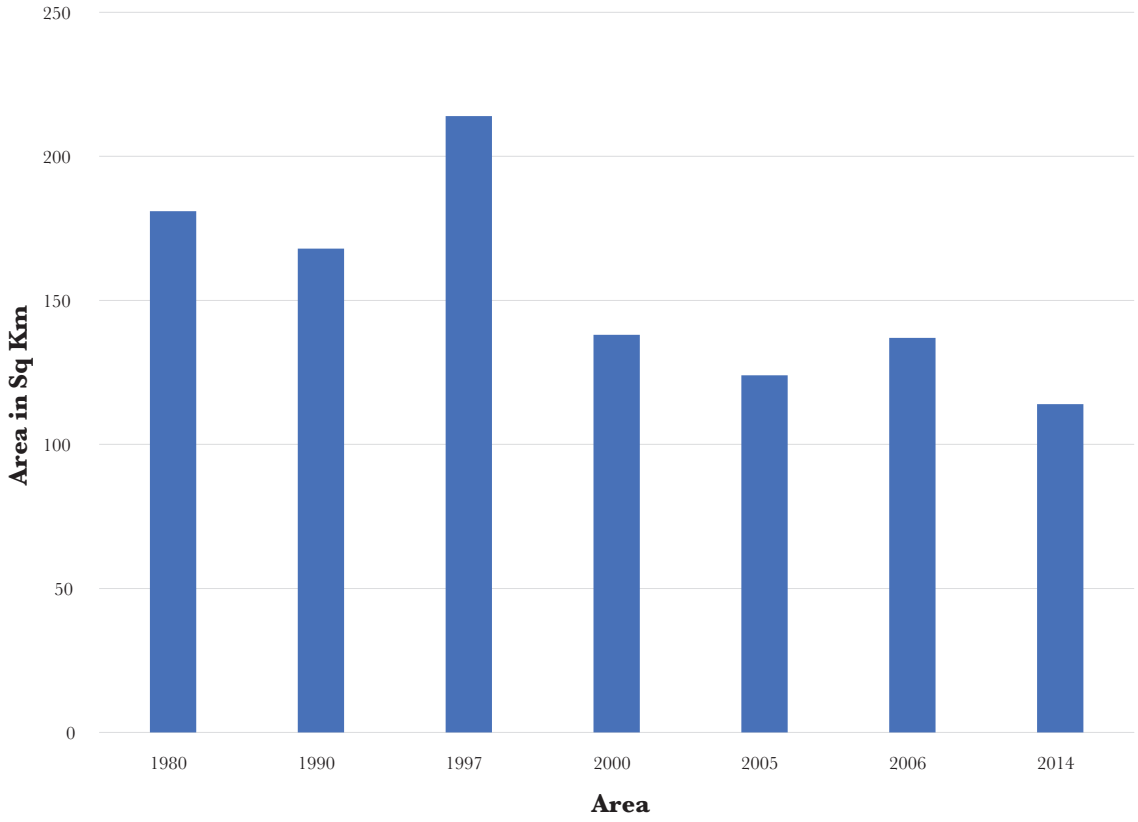
A number of local studies in Ghana have examined changes in the mangrove area coverage in specific small habitats; but only one large study has looked at changes in the overall Volta region. Most studies show a decline in mangrove areas, with only one study showing an increase, where extensive mangrove restoration had taken place (Yevugah 2017). The study encompassing the Volta region has shown a steady decrease in mangrove area, from 93.9 sq km in 1991 to 87.7 in 2002, and 63.7 in 2014 (Myers 2016).

A few local studies have also attempted to determine the quality of the mangrove cover in specific habitats by identifying the areas as intact, partially degraded, or fully degraded (Asante and Jengre 2012; Yevugah 2017). Some studies have also examined the types of mangrove species found in areas with mangroves (Dali 2020; Nortey et al. 2011). However, comprehensive, reliable, and detailed data for the whole country is lacking. The current complete country data for Ghana only provides an overall estimate of mangrove cover, with little detail. These data are mostly based on satellite images, with little ground validation of the data. The regional study in the Volta region using satellite images demonstrated the difficulty of correctly differentiating mangroves from other mangrove-related species, which often replace mangroves after the mangroves have been cut for timber and fuelwood (Myers 2016).

Based on the best available data, between 1980 and 2006 the mangrove area in Ghana fell from 181 to 137 sq km, a loss of 24 percent (UNEP 2007; Ajonina et al. 2008). Accounting for the further loss of mangrove areas in the Volta region between 2002 and 2014, these areas have been reduced even further, to 114 sq $3 km in 2014, a loss of 33 percent from 1980 (Myers 2016). Going by these trends, it is probable that the current area under mangroves may even be lower (Figure 1). While the decrease in mangrove cover in such data generally matches the ground realities of increasing the unsustainable harvesting of mangroves, the actual numbers require greater validation. The available data also does not distinguish between the various mangrove species on the ground; this is an important requirement when estimating the biomass in mangroves, since it can differ from species to species. With advances in satellite imagery that can provide more granularity of data concerning vegetation coverage on the ground, and other improved technical capabilities for differentiating each species, it is becoming increasingly feasible to develop such detailed data. Some recent studies conducted in other countries have been able to determine the composition of mangrove forests using red-edge spectral bands and chlorophyll absorption information from AVIRIS-NG and Sentinel-2 data.[1] The use of such techniques in the analysis of mangrove cover in Ghana can increase the accuracy and usefulness of these area estimations.

[1] https://www.researchgate.net/publication/351749539_Species-Level_Classification_and_Mapping_of_a_Mangrove_Forest_Using_Random_Forest-Utilisation_of_AVIRIS-NG_and_Sentinel_Data

FIGURE 1: AREA OF MANGROVES IN GHANA (IN SQ KM)



2.1. COMMON MANGROVE SPECIES FOUND IN GHANA

Six true mangrove species are found in Ghana (Tomlinson 1986). These are *Avicennia germinans* (Black Mangrove); *Laguncularia racemosa* (White Mangrove); *Conocarpus erectus* (Buttonwood); *Acrostichum aureum* (Golden Leather Fern); *Rhizophora racemosa* (Red Mangrove); and *Rhizophora harrisonii* (Red Mangrove). The characteristics, occurrence, and method of propagation for each of them is described in Table 1.

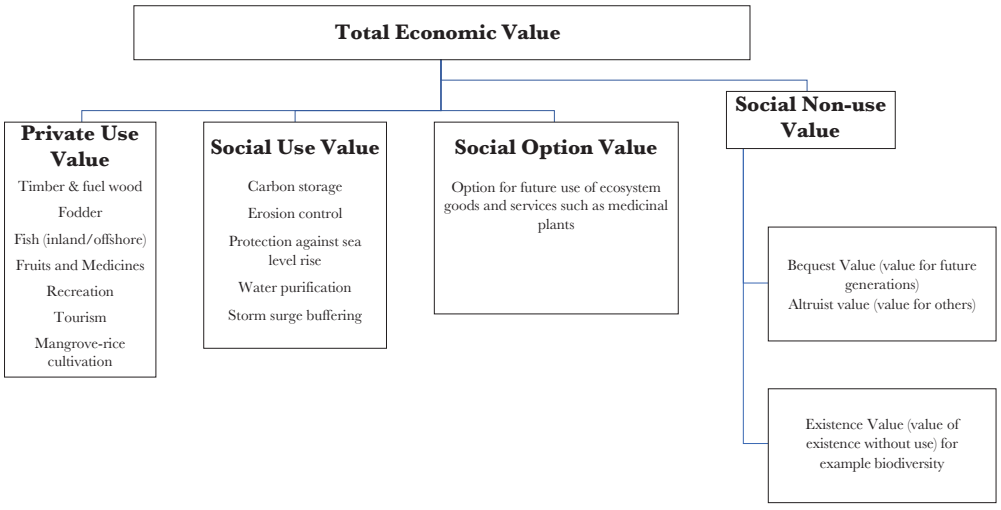
TABLE 1: COMMON MANGROVE SPECIES IN GHANA

Mangrove Species	Characteristic	Occurrence	Propagation
Avicennia germinans (Black Mangrove)	Develops finger-like projections, called pneumatophores, which protrude from the soil around the trunk (Tan 2001).	This species occurs at higher inland elevations than the red mangrove.	Reproduces by vivipary, with sprouting seeds that drop into the soft bottom around the base of the trees. The seeds can also be transported by currents and tixdes to other suitable locations (Florida Keys NMS 2006).
Lagunculari racemosa (White Mangrove)	Does not develop visible aerial roots; has elliptical light yellow-green leaves.	Occurs at even higher elevations farther upland than either the red or black mangroves.	Sprouting seeds drop into the soft bottom around the base of the trees. The seeds can also be transported by currents and tides to other suitable locations.
Conocarpus erectus (Buttonwood)	Belongs to the same family as the white mangrove, but has a different appearance, with dense, rounded flowerheads that grow in a branched cluster, and purplish-green, round, conelike fruit.	Grows in brackish areas and alkaline soils, and thrives in the broken shade and wet soils of hammocks.	The seed heads burst when they are ripe, and the seeds are dispersed by water.
Acrostichum aureum (Golden Leather Fern)	Does not have any aerial roots; instead it has fibrous, fern-like roots. It can grow up to 1.5 meters high, and have leaves that can be up to 1 meter long and 4 centimeters wide.	Grows in swamps and mangrove forests, salt marshes, and on river banks, and is tolerant of raised salinity levels.	Mature fronds become sporophyllous, diffuse spoprangia at the abaxial surface; mixed sporangia on both sides of the mid-vein, brown sporangia- stalked, upper globose (Kathiresan 2010).
Rhizophora harrisonii (Red Mangrove)	A hybrid of *R. mangle* and *R. racemosa*, it shares morphological characteristics with both species, and is recognized by FAO as a distinct species.	Mostly found in the estuaries of river systems with more continuous freshwater flows (Duke 2006).	Creates a propagule that is in reality a living tree; a fully-grown propagule on the mangrove is capable of rooting and producing a new tree.
Rhizophora racemosa (Red Mangrove)	Grows up to 30 meters (100 ft) tall, often with aerial stilt roots; in more marginal habitats this species is shorter, more branched, and scrubby. The leaves grow in opposite pairs, each pair with two interlocking stipules. The leaves are simple and entire, with elliptical hairless blades and slightly down-rolled margins.	When new mudflats are formed, seagrasses are the first plants that grow on the mud, with *Rhizophora racemosa*, a pioneering species, being the first mangrove to appear. It primarily occurs in the open lagoon systems in areas along the coastlines (Duke 2006; WWF 2001).	The fruit produces propagules which may fall into the water and be dispersed by wind and currents.

CHAPTER 3.
ECONOMIC BENEFITS FROM MANGROVES

Mangroves provide many direct-use benefits in the form of timber, fuelwood, animal fodder, fuel for smoking (curing) fish, medicines, etc. A number of other indirect benefits, including fisheries, recreational uses, and tourism are also made possible by the existence of mangroves. However, most of these constitute **private benefits** for the people who live in the immediate proximity of the mangrove plantations; this does not fully reflect the total economic value (TEV) of mangroves. To arrive at the TEV, we need to account for the **social benefits** arising from mangroves: for example, carbon storage, coastal erosion control, protection against sea-level rise, water purification, and storm surge and swell buffering; as well as **social option values** and **social nonuse values** (Figure 2).

FIGURE 2: TOTAL ECONOMIC VALUE (TEV) OVERVIEW OF THE ESTIMATION PROCESS



The overall social benefits that can be realized from mangroves can exceed the total private benefits, some of which (like carbon sequestration) can also lead to global benefits. To determine the true economic benefits from mangrove plantations, all of the private and social benefits have to be evaluated and accounted for. However, since many of the outcomes that fall under the category of social benefits cannot be traded in a market, there is often no ready market price that can be used to monetize these benefits. Therefore, when analyzing the economic benefits of mangrove plantation projects, alternative valuation methods have to be employed in order to give a more complete picture.

The benefits derived from mangrove plantations and/or the costs of planting and maintaining them are often location- as well as context-specific. The present study developed a methodology for estimating the full benefits that could be received from mangrove plantations in Ghana and used that to determine the economic value from such activity. These data, along with the costs required for planting mangroves, were then used to determine whether mangrove afforestation projects are economically justifiable. This method can help demonstrate how these procedures can be applied in general, when establishing priorities among various adaptation projects that all have significant benefits.

3.1. PRIVATE-USE VALUE

3.1.1. DIRECT PRODUCTS

Mangrove forests provide a number of useful products—fuelwood, charcoal, timber, poles, honey, wax, fruits, medicinal plants, *akpeteshi* distilling, etc. The benefits from each species of mangrove present in Ghana, as found in the literature, for direct use and for medicinal use are listed in Table 2.

However, not of all of these uses can be realized from the types of mangroves found in Ghana. The most common uses of mangroves in Ghana are timber and fuelwood for smoking fish, and domestic fuel: a number of studies in various locations in Ghana have tried to determine the monetary value of these uses (studies referenced under table 3). There is some anecdotal evidence about its medicinal use, but there is no actual available data. Moreover, medicinal use may be declining over time, with the greater availability of conventional modern medicine in the country. There is also some reported use as tannin for staining, but there is very little accurate data about the quantity of such use.

Table 3 lists the direct private-use value per hectare in a number of locations in Ghana in the Western Coast and Volta regions, where currently almost all of the mangroves in Ghana are found. Since these studies were done in different time periods, and the rate of inflation has been quite high in Ghana for the last few years, all of the reported results are converted to 2020 valuations using the annual inflation rate in Ghana during this period. These results were then converted into PPP$ using the purchasing power parity for Ghana in 2020. The valuation of total use as wood per hectare ranged between $811 and $5,568, with fuelwood being the largest share in such use. The valuation also shows an increasing trend over the years, mainly from the likely increase in prices for mangrove wood over time, which exceeded the average inflation rate in the overall economy.

TABLE 2: PRIVATE DIRECT-USE VALUE OF MANGROVES PER HECTARE IN 2020 PPP$

	West Coast Y2004	Volta: Y2009	West Coast: Y2011	Volta: Y2013
Timber	$ 94	$ 207	N/A	Only combined total use data
Fuelwood (Domestic Use and Fish- Smoking)	$ 717	$ 621	$ 5,568	Only combined total use data
Total Use as Wood	$ 811	$ 828	$ 5,568	$ 2,783

Sources: For West Coast 2004 (Aheto 2011); for Volta 2009 (Gordon et al. 2009); for West Coast 2011 (Ajonina 2011); and for Volta 2013 (Aheto 2011).

3.1.2. INDIRECT VALUE OBTAINED FROM MANGROVE PLANTATIONS

Mangroves make possible a number of benefits, such as fisheries and the hunting of animals and birds; they also provide opportunities for developing tourism. The biggest economic benefits arise from the fishery sector. The water bodies of mangroves are used as spawning, hatching, nursery, and foraging grounds by a variety of fish, crab, shrimp, mollusks, and other aquatic creatures. They spend a portion of their lifecycles in the mangrove forests and later move on to the sea. It has been found that when mangrove forests are added to the coast, the fish population of nearby areas tends to increase.

A number of crab, fish, and black snail species are found in the mangroves in Ghana. One study of the Lower Volta mangrove swamps encountered 38 finfish and 14 shellfish species (Dankwa and Gordon, 2002).[2] Areas with more extensive mangrove cover were found to have greater species diversity than areas with sparse or no mangrove vegetation. The size and frequency distribution of all the species considered indicated a higher proportion of juveniles in the catch, emphasizing the nursery role of the study area.

[2] The most abundant finfish species were *Gerres melanopterus* (20.2 percent); *Clarias anguillaris* (18.7 percent); *Liza falcipinnis* (9.7 percent); *Mugil curema* (9.6 percent); and *Sarotherodon melanothero* (8.5 percent) of the total catch.

TABLE 3: COMMON DIRECT USES OF MANGROVES

Species	Overall Direct Use	Medicinal Use
Avicennia germinans (Black Mangrove)	The cotyledons of the seed are eaten during famines, but only after careful preparation to remove toxic compounds. The leaves and roots are used to prepare a vegetable salt.	**Leaves:** Applied as an enema to treat piles. An extract of leafy twigs showed cytotoxic activity in several human cancer cell lines. The stems and leaves are combined with a smaller amount of *Rhabdadenia biflora* and *Nicotiana tabacum* to make a soothing remedy for stingray wounds. **Bark:** Powdered bark can be mixed with palm oil for treatment of lice, ringworm, and mange; or added to a bath in order to promote childbirth. The bark resin is used in traditional medicine to treat tumors, diarrhea, hemorrhage, hemorrhoids, rheumatism, swelling, wounds, and sore throats. Roots: Used as an aphrodisiac, or as a decoction to treat intestinal problems.
Laguncularia racemosa (White Mangrove)	The bark and leaves produce a tannin and a brown dye of good quality, but not in quantities that are economically interesting. The bark is used to treat fishing nets for longer preservation. Sometimes used as animal fodder. The flowers are said to be useful in honey production, and in Guinea Bissau the fruits are eaten. The wood is heavy, hard, strong and close-grained; it is mainly used for firewood, rarely for construction or wooden utensils.	Historically, the high tannin content in the bark was used as a tonic to treat fevers, skin wounds, ulcers, dysentery, and scurvy, and to prevent tumors. A bark infusion is used as an astringent, tonic, and folk remedy for dysentery, aphthae, fever, and scurvy. It is also attributed some antitumor activity.
Conocarpus erectus (Buttonwood)	The heavy wood (specific gravity 1–0) is durable and takes a fine polish. Durable in water, it is used for barges, boats, and maritime construction. Though susceptible to dry-wood termites, it is also used for crossties, fences, and turnery. Describing it as keeping well underground and in salt water, Irvine (1961) notes that it can be used for piling and firewood. The bark has been used for tanning leather. Sometimes introduced as an ornamental evergreen.	**Leaves**: Decoction used as a febrifuge. **Latex**: Applied to cuts to stop bleeding. **Roots**: Ground and boiled as a cure for catarrh**.** **Bark**: Used in the treatment of gonorrhea. A folk remedy for anemia, catarrh, conjunctivitis, diabetes, diarrhea, fever, gonorrhea, headache, hemorrhage, orchitis, prickly heat, swelling, and syphilis.
Acrostichum aureum (Golden Leather Fern)	Young shoots are eaten as a vegetable. The firm, dried, parchment-like leaves are stitched together and used as thatching material in the place of straw, as the roof lasts longer with much less risk of fire. It has potential as an ornamental plant because of its handsome leathery leaves, and because it can be grown in pots.	Rhizomes are used for the healing of stubborn ulcers. Leaves are used topically as emollient. Medicinally, the pounded or grated leaves and rhizomes are applied as a paste to wounds, ulcers, and boils, and are used against worms.
Rhizophora harrisonii (Red Mangrove)	Similar to other Rhizophora species.	Similar to other Rhizophora species.
Rhizophora racemosa (Red Mangrove)	Used for construction poles and firewood on a limited scale. The smoke has antimicrobial properties and is also used for smoking meat.	**Roots:** Used with palm oil as an ointment for boils. **Bark:** Extract is used for fungal infections of the skin; treatment of diarrhea and dysentery in children; leprosy, and sore throat.

Many animals, including monkeys, antelopes, rats, and grasscutters constitute important wildlife species found in mangroves. The mangroves also provide a habitat for a number of bird species. These animals and birds are caught by local inhabitants and are used as a source of food. The presence of these animals and birds, as well as the vegetation, also help tourism, since they attract visitors to these locations.

The ecosystem of a mangrove forest is completely different from the ecosystems in other areas of Ghana, and is therefore attractive to visitors. There are opportunities for recreational fishing, bird watching, and boating, or simply touring the area on boardwalks. The Ghana Wildlife Society (GWS) has been playing a critical conservation role in the area by promoting small-scale development projects that protect biodiversity while enhancing the economy around the Amanzule wetlands, which are covered with mangroves. To promote tourism, they have built walkways and provided boats to facilitate viewing the plant and animal species in the reserve.

The recreational benefits of mangroves are very little exploited in Ghana at present. However, such potential can be estimated using a travel cost method based on the estimation of transport costs to and from the recreational area as well as all additional expenses (food, lodging, transport, tickets, etc.), plus the opportunity cost of total time spent by the visitors for the whole trip.

The value of the increased recreational opportunities (V) for a single visit is given by:

$$V = ((T \times w) + (D \times v) + Ca) \times Va$$

Where:

T = travel time (in hours)

w = average wage rate (SAR/hour)

D = distance (in km)

v = marginal vehicle operating costs

Ca = cost of admission to asset

Va = average number of visits per year

Table 4 lists the current valuation of these indirect benefits in a number of locations in Ghana based on several studies. Since these studies were done in different years, all of the values have been adjusted to 2020 PPP$ using inflation data in Ghana and the PPP$ conversion factor. The fishery benefits per hectare ranged from $402 to $940, with benefits on the West Coast being greater than in the Volta region. Only one study on the West Coast computed the benefits from hunting animals and birds, while two studies, both on the West Coast, found benefits from tourism. However, the tourism data revealed wide variations from year to year, with decreasing revenue possibly due to inadequate infrastructure. To determine potential tourism revenue, the highest revenue figure was used in the benefit determination from both studies.

TABLE 4: PRIVATE INDIRECT-USE VALUE OF MANGROVES PER HECTARE IN PPP$ IN 2020

	West Coast: Y2004	Volta: Y2009	West Coast: Y2011	West Coast: Y2018
Fisheries	$ 940	$ 402		$ 814
Hunting	$ 82	NA	NA	NA
Tourism	NA	NA	$ 45	$46

Sources: For West Coast 2004 (Aheto 2011); for Volta 2009 (Gordon 2009); for West Coast 2011 (Ajonina 2011); for West Coast 2018 (Jonah 2020)

Mangroves also enable a large share of the fish catch in the coastal areas and the ocean by providing vital nursery facilities. Without the presence of mangroves these fishes would no longer be able to reproduce, and wouldn't be sustained. The annual fish catch in Ghana was 327,457 tons in 2016, of which inland catch was 87,816 tons; the remaining was in coastal areas and the ocean. Large pelagics (tuna, skipjacks, etc.) do not use mangroves as nurseries. It is estimated that nearly 70 percent of the rest—small pelagics like

sardinellas, anchovies, chub mackerels, etc.; demersal fish (breams, carangids, snappers, groupers, etc.); and shellfish (shrimps and lobsters) use mangroves for spawning, hatching, nurseries, and foraging grounds.

The economic valuation of the annual nursery services for fish that mangroves provide is based on the net valuation of the fishery output after subtracting the production, transportation, and handling costs. A survey of small pelagic fish prices in 2018 showed an average price of 2.74 cedi/kilogram, of which equipment, transportation, and handling costs accounted for around 40 percent of the price (Jonah 2020). Based on the fish catch that is dependent upon mangroves and the average price, the total net value of the annual fish catch was found to be $203.7 million (in 2020 PPP$). Based on the mangrove cover of 11,400 hectares (the latest data available), the annual value addition from nursey services for fish was found to be 10,719 PPP$ per hectare.

3.1.3. INDIRECT ECONOMIC BENEFITS

Mangrove forests provide a number of indirect benefits, including carbon sequestration, protecting the coasts from erosion, flooding from storm-induced swells, problems arising from prospective sea-level rise, and water purification. A number of other benefits, such as increased biodiversity, purification of contaminated water, tourism and recreation, and health benefits are also associated with mangroves. Each of these benefits has been estimated based on local data.

Benefits of Carbon Sequestration

Mangroves are very good for carbon sequestration since they store carbon material (CM) not only in the above-ground biomass (trunks, branches, trees, twigs, etc.) but also in the roots and soil. In fact, with mangroves a larger share of carbon is stored underground than above-ground (Alongi 2014). The soil in the mangroves is also rich in CM, since the anoxic condition of the mangrove floor prevents carbon (C) combining with oxygen (O_2) in the air to form carbon dioxide (CO_2) and then being released into the atmosphere.

There are five areas where carbon materials are stored in mangroves:

1. Above-ground biomass (trunk, branches, leaves, etc.)
2. Underground biomass (living roots)
3. Aerial roots
4. Fallen leaves, branches, twigs, etc.
5. Dead roots

A number of studies in Ghana have made use of the standard procedure of using an allometric function to estimate the above-ground biomass stored in the trunks, branches, and leaves in plants that express it as a function of the plant's height and diameter at breast height (DBH) (Abohassan et al. 2012). The following allometric function is usually used for such analysis:

$$\text{Biomass} = \alpha + \beta_1 \text{Ht} + \beta_2 \text{DBH} + \varepsilon$$

Where α is the intercept, β_1 and β_2 represent regression coefficients for height (Ht) and DBH for respectively, and ε stands for the residual.

Such surveys are based on data from selected plots from the survey area, and then extrapolating the results to the whole area. Typically, the mangrove forest inventory would use three subplots in each location, with each subplot having either a 2- or 3-meter radius. The plots would be randomly laid out using a stratified random sampling. In the first stage, the area under mangroves is divided into strata of equal size, covering the whole area. In the second stage, a representative number of sample plots would be picked randomly from each stratum.

The survey sample size is determined based on the variability of biomass within the samples and the precision level required by the methodology (an allowed 10 percent error). In other words, the sampling strategy aims to achieve an error with a mean value of 10 percent or less, thus with a 90 percent level of statistical confidence that the claimed amount of carbon sequestered is the true amount.

During data collection, the following parameters are assessed and/or measured:

- Species code
- Size: Classification between trees and saplings.
- DBH: Diameter at breast height (1.3). (Only measured in trees.)
- D_{30}: Diameter of stem at 30 centimeters above ground level. (Only measured in saplings.)
- Total Height: Total height of the tree or sapling.

Once the total ground biomass per unit of land is determined, the carbon sequestration can be computed using information about the carbon content of the biomass. Since the amount of sequestration differs among various species of mangroves, the carbon content in the biomass per unit of the species encountered has to be separately estimated. This factor is then applied to determine the carbon content of the biomass found in the study.

The calculation method is as follows:

$$BM/Hectare = (a + \beta_1 Ht + \beta_2 DBH) * (1+BGF) * TD$$

Where:

BM/Hectare = Biomass per hectare

BGF = Below ground biomass factor as a share of above ground biomass

TD = Mangrove tree density per hectare

CC = Carbon content per unit of biomass

A number of studies have determined the biomass in various locations in Ghana in recent years using the procedure described. However, most of these studies were done on the West Coast, with only one study being done in the Volta region. Since *R. mangle*, *A. germinas*, and *L. racemose* are the predominant mangrove species found in Ghana, most studies report data on DBH and height for these three species of mangroves separately (Table 5). The DBH data for all three species generally ranged between 2.3–4.1 cm; only one study reported a much higher number (8–11 cm), presumably because of the presence of very old trees in that location. It may therefore be treated as an outlier. Among the three species, on average the *R. mangle* trees were the tallest in height (2.9–5.2 meters) and the *L. racemose* the shortest (2.3–3.8 m) with the height of *A. germinus* (2.7–4.4 m) lying in between.

TABLE 5: AVERAGE DBH AND HEIGHT OF MANGROVES FOUND IN VARIOUS GHANAIAN HABITATS

R. mangle		*A. germinas*		*L. racemosa*		
DBH cm	**Height m**	**DBH cm**	**Height m**	**DBH cm**	**Height m**	**Year**
3.5	4.5	3.2	3.2	2.9	2.9	2018
2.9	4.3	4.1	4.4	3.3	3.8	2018
3	3	1.3	1.7	2.5	2.5	2011
2.8	2.8	3.1	3.1	3	3	2011
2.9	2.9	3	2.7	2.7	2.3	2015
11	8.2	8	5.8	4.1	3.7	2015
3	5.2	2.9	3.1	2.3	2.3	2010

Sources: Dali 2020; Nortey et al. 2016 ; Adotey 2015 ; Aheto et al. 2011.

TABLE 6: AVERAGE CARBON STORAGE (TON PER HECTARE) IN MANGROVES FOUND IN VARIOUS GHANAIAN HABITATS

Above ground Carbon	Below ground Carbon	Soil Carbons	Total	Year	Region
184			184	2011	WC
114	23		137	2012	WC
1467	189		1656	2016	WC
107	48	311	466	2015	WC
3771	1193	352	5316	2015	WC
100			100	2014	Volta
93[3]		3872	3962	2018	WC

Sources: Ajonina 2011; Asante and Jengre 2012; Yevugah 2017; Adotey 2015; Myers 2016; Jonah 2020.

The carbon content found in mangroves per hectare in the chosen study locations showed large variations mainly because of the condition of the plantations (Table 6). All of the studies reported on the above-ground carbon, and a majority of them also reported on the underground carbon stored in roots. However, only three of the studies reported on the carbon trapped in the soil. Inclusion of soil carbon in the estimation for carbon storage in mangroves is important, since unlike normal soil, the decomposition of such carbon is much slower in mangrove plantations; this is because the soil remains submerged most of the time. As a result, the carbon stored in such soil over time can often exceed the carbon stored in the mangrove plants.

The above-ground carbon storage of 93–184 tons per hectare found in these studies mostly represents younger mangroves (less than 10 years old), while the greater amounts of carbon storage were found in areas with pristine, very old mangroves. Assuming an average growth period of 10 years, these data reveal that mangrove plantations can sequester between 9 and 18 tons of carbon per hectare per year, with an average of 14 tons. Additional carbon storage occurs as litter falls from the plants that remain in the soil. A study in two locations in Ghana found the annual carbon addition from litter fall to be around 10 tons per hectare. The estimates indicate an average total annual carbon sequestration from existing mangroves found in a typical mangrove cover in Ghana to be around 24 tons per hectare.

The annual economic value addition from carbon sequestration from each hectare of mangroves in Ghana is monetized using the shadow price of carbon. The social cost of carbon is highly country-specific; current estimates for Ghana suggest a price of $1 per ton.[4] However, as the international trading of such carbon is becoming increasingly feasible, the social cost of carbon in Ghana is based on the price it can command in that market if the carbon reduction is traded. The global weighted average price of carbon has been variously estimated to be around $20 per ton in 2020.[5] This suggests an annual economic value addition of $480 from the 24 tons of carbon sequestered in each hectare of mangroves in Ghana.

In other words:

> *The Economic Value of Carbon Sequestration from Mangrove = Carbon Stock Trapped in Mangrove x the Shadow Price of Carbon.*

[3] Combined above and below ground biomass
[4] https://www.nature.com/articles/s41558-018-0282-y
[5] https://carboncreditcapital.com/value-of-carbon-market-update-2020/

Protection from Coastal Erosion, Coastal Floods, and Sea-Level Rise

The presence of mangroves along the coasts plays an important role in minimizing the damages from coastal erosion and flooding caused by storm swells. When waves and water navigate through the forests during a storm-induced swell event, the dense forests of mangroves, with their trunks, aerial roots, and low-hanging branches, produce friction with the incoming water. The result is wave attenuation and reduced water velocity, which limits inland water intrusion and damage to infrastructure. Mangroves also reduce the movement of debris during extreme events.

Mangrove forests are likely to provide better protection from sea-level rise in coastal areas resulting from climate change than fixed manmade engineering structures meant to protect the shoreline, since mangrove forests will naturally experience vertical accretion over time. Thus, with the expected sea-level rise, manmade engineering structures will become progressively less effective over time, while mangrove forests should be able to maintain their relative position in relation to the sea level over time, provided sufficient sediment is available. Recent evidence suggests that mangrove surfaces are keeping pace with rising sea level in a number of locations (McIvor et al. 2013).

Studies have found that with each kilometer of mangroves, swell height could be reduced by 5 to 50 centimeters (McIvor et al. 2012). The effectiveness depends on the geomorphological conditions of the sites, the plant species, and the density of the forests. Mangroves on their own cannot completely protect vulnerable communities from flooding caused by storm-induced swells. However, they can work in conjunction with complementary engineering infrastructure. Swell attenuation by mangroves should allow for a lower level of the investment needed in protective engineering infrastructure by allowing embankments of lower height and width to be built, saving a substantial amount in construction costs. In addition, the presence of mangroves in front of the infrastructure can reduce the maintenance cost of the infrastructure.

A separate project to estimate the physical benefits of the decreased coastal erosion, and reduction of flooding that is provided by mangroves at select coastal locations in Ghana is underway at present. However, the actual data from the project will take some time and may not be available by the time this report is finalized. The current estimation will therefore use data extrapolated from studies done elsewhere, making allowances for local characteristics of the Ghanaian coast. These estimates can be updated later with actual data for the Ghanaian coast once these become available.

Valuation of the protective services provided by mangroves can be done in two ways: by the replacement method, and by the avoided damage cost method. If the protective service of the mangrove forests can be replaced by installing breakwaters or any other engineering structure, the cost of installing that engineering structure is treated as the economic value of the erosion protection service of the mangroves. The other way is to calculate the economic damages that might have occurred in the absence of the mangrove forests.

Valuation of the protection provided by mangroves based on avoidance of damage has been estimated in a number of countries around the world. These estimates range between $ 1,120 – 1,369 per hectare (Barbier 2007; Estoque et al. 2018). The lower end of these estimates may be more appropriate for use in benefits estimation in Ghana, given the average income levels of the countries included in the studies.

Biodiversity Benefits

Mangrove ecosystems and their associated wetlands support a wide array of biodiversity in Ghana by serving as a habitat for high concentrations of birds, mammals, reptiles, amphibians, fish, and invertebrate species. The biological diversity on the coastal shelf of Ghana depends on the input of organic matter and detritus from the coastal mangroves (Shalovenkov 2000). A great number of seabirds use the mangrove forests for feeding, reproduction, and shelter (Sagno 2005). A number of endangered species also depend on these wetland ecosystems for their

survival. The preservation of these mangrove ecosystems through the sustainable use of resources is therefore vital for protecting the biodiversity found in Ghana.

Only a limited share of the area identified as mangrove forests in Ghana falls within designated protected areas. Designating wetlands as protected areas based on the principles laid down under the Ramsar Convention, and implementing them fully is important for preserving the unique character that supports biodiversity around such areas. This would involve following the established rules for preventing unsustainable use of wetlands that puts pressure on the survival of the ecosystem. However, since the designation as a protected area would curb some of the practices currently followed in harvesting resources, the communities around the protected areas may face reduction in their income-generating activities from these areas.

The economic benefit from preservation of the mangrove ecosystem in Ghana can be determined indirectly by using the Willingness to Pay (WTP) approach. The WTP would be based on how much reduction in income the communities around the mangrove areas are willing to accept if the area is designated as a protected area. This would be a way of determining how much value these communities assign to protecting the biodiversity associated with mangrove areas that would be a proxy of the benefits provided to these areas by preserving biodiversity.

In other words:

> *The Economic Value of Protection of Biodiversity Resulting from Mangrove = Willingness to Accept Income Reduction if the Area is Designated as a Protected Area.*

The WTP approach, based on a survey, was used to determine the biodiversity benefits in two habitats in Ghana, both on the Western coast. One study, conducted in 2004, revealed an average per-hectare valuation of $911 when valued in 2000 PPP$ (Aheto 2011). The other study, completed in 2018, when valued in 2020 PPP$ revealed a valuation of $1,651 per hectare (Jonah 2020). However these values, based on WTP, often underestimate their true value, since all of the relevant information about the benefits that biodiversity can provide may not be available to the survey respondents.

Water Purification Benefits

Mangroves provide natural water purification services. Excess nutrients present in the water are removed and broken down, which results in better-quality water. Laboratory experiments also show high removal rates of nitrogen and phosphorus from both organic and inorganic nutrient-rich wastewater (Shimoda et al. 2009) in a mangrove environment. Mangroves are also known for removing harmful materials from wastewater and transforming toxic pollutants to less harmful materials.

The benefits of the water purification service of mangroves in Ghana was estimated using an alternative cost approach found in water purification studies done elsewhere. Essentially, the estimates are based on the cost incurred for performing similar filtering services in a typical treatment plant. Using this method Lal (1990) found that the monetary value of the water purification services of mangroves is equivalent to $5,820 hectares/year. However, with technological improvements, the cost of such filtering services in treatment plants have come down over the past 30 years; therefore, current values are likely to be much lower.

Another way of valuing the benefits of water purification performed by mangroves is based on the property of removal of salinity from sea water. Mangroves are facultative halophytes and are known for their special ultrafiltration system, which can filter approximately 90 percent of sodium ions from the surrounding seawater through the roots.[6] However, the efficiency found in these studies is based on a laboratory setting; in natural conditions the actual performance may be much lower. The cost of similar salt filtration in desalinization plants can be used to determine the monetary benefits arising from water purification by mangroves.

[6] https://www.nature.com/articles/srep20426

In other words:

> *The Economic Value of Water Purification from Mangrove = Cost of Performing Similar Filtering Services in a Typical Treatment Plant.*

The cost of converting sea water into brackish water is used to determine the water purification benefits from mangroves. The current cost of the desalinization of sea water is around $3 per 1,000 gallons, while that of brackish water is $1.09. The volume of water purified by mangroves per hectare annually was estimated using an average root height of 50 centimeters, and a conservative 6 to 20 percent efficiency based on location because of the constant flow of sea water around mangroves. Based on these assumptions, the water purification benefits from each hectare of mangroves ranges from $151 to $504.

Total Benefits from Mangroves

The valuation of benefits derived from mangroves in Ghana clearly reveals that the private-use direct benefits are only a small fraction of the total economic benefits mangroves provide (Table 7). The total private direct benefits are also much smaller than the private indirect benefit from the fisheries sector.

Once the social-use benefit from mangroves is included in the overall benefits, a much stronger case can be made for the preservation and creation of new mangroves in areas suitable for such growth. The social use values presented are generally on the conservative side, and do not fully account for all possible values. Even with these limitations, the overall value, including social values, far exceeds the private use benefits.

TABLE 7: TOTAL BENEFITS FROM MANGROVES IN GHANA PER HECTARE IN 2020 PPP$

Annual Total Benefits	Mean Value	Range: Min-Max
Private Direct Use		
Timber	$ 151	$94 – $207
Fuelwood (Domestic and Fish-Smoking	$ 2,422	$621 – $5,568
Total Wood	$ 2,498	$811 – $5,568
Private Indirect Use		
Fisheries	$719	$402 – $940
Hunting	$82	Only one value
Tourism	$46	$45 – $46
Social Use		
Carbon Sequestration	$480	$380 – $500
Flood Protection	$1,120	$1,120 – $1,370
Water Purification	$327	$151 – $504
Social Option and Nonuse		
Biodiversity	$1,281	$911 – $1,651

CHAPTER 4.
ECONOMIC COST ESTIMATIONS OF THE AFFORESTATION PROGRAM

The total cost of mangrove plantation in Ghana will involve an initial one-time cost of planting, plus the cost of maintenance, which will be estimated on an annual basis. The planting cost of mangroves per unit of land will differ depending upon whether these are plantations in new areas (including totally degraded land), or rehabilitation measures in existing, partially degraded mangrove forests. However, in both cases the cost will consist of the labor and materials needed to plant mangroves, assuming that the plantations will be done on public land and no land acquisition costs would be incurred.

The annual maintenance cost of mangroves, including rotational thinning and selective/final felling will involve both labor and material costs. These will be estimated based on the typical manpower needed in Ghana for forest maintenance per unit of land, and the prevailing wage rates. The material costs for annual maintenance will be estimated as a percentage of the labor costs, as these costs are likely to be minimal.

4.1. COST-BENEFIT ANALYSIS AND ESTIMATION OF NET PRESENT VALUE AND INTERNAL RATE OF RETURN

The cost of planting will be based on 2 x 2-meter spacing for the plantings. Three data sources for the cost of planting were found in Ghana: one on the West Coast, and the other two in the Volta region. The cost of initial planting in the first year (2013) was found to be $1,760 per hectare after extrapolation to 2020 PPP$ (Aheto et al 2016). The second cost, from 2018, was found to be $3,825 per hectare after extrapolation to 2020 PPP$ (Denis Aheto (Personal communication) March 14, 2020). A recent cost estimate of $2,000 per hectare was also reported for the Songar Ramsar site.[7] To ensure that the plants are protected and continue to grow, annual maintenance costs, mostly in terms of labor costs, was found to be $72 per hectare in 2020 PPP$.

[7] C. Gordon, personal communication, November 4, 2021

The NPV from each hectare of new plantation is estimated using the following formula over a 20 year period:

$$NPV = \sum_{t=1}^{T} \frac{NPt}{(1+r)^t}$$

where NPV is the net present value; NPt is the net profit at time t; r is the discount rate, and T is the project lifespan. In addition, a benefit cost ratio (BCR) is estimated based on a ratio of NPV of benefits and the cost based on these values

Assuming that the annual benefits start accruing ten years after planting, over a 20 year period, the private direct benefits show a positive NPV per hectare of $15,860, with a BCR of 5.7. Using the minimum and maximum values the NPV per hectare ranges between $4,831 and $35,931, with a BCR between 1.7 and 12.9. With inclusion of private indirect benefits from fisheries, the NPV per hectare increases to $21,398, with a BCR of 7.7. Once the social use values are factored in, the NPV increases to $33,996 with a BCR of 12.2. These reveal the large benefits that can occur with investment in planting mangroves in Ghana.

CHAPTER 5.
CONCLUSION

The findings from this study can help formulate policies that will enhance social welfare through not only preserving the existing mangrove areas, but also developing new mangroves in lands that are now barren but are suitable for growing mangroves. Preserving the current mangrove areas will be welfare-enhancing, since the sum of benefits from private indirect use, social use, and social option/nonuse that mangroves provide far outweighs the private direct-use benefits. This suggests that policies that provide incentives and disincentives to discourage the unsustainable exploitation of mangroves would lead to net social benefits. These incentives and disincentives can take many forms, from the use of regulations to ban the unsustainable cutting of mangroves to economic interventions like imposing taxes on mangrove products, or providing subsidies to encourage the use of substitutes for them.

Mangroves in Ghana provide many monetary benefits; even the direct private benefits clearly outweigh the costs of creating and maintaining them in most areas that are now barren but suitable for mangroves. In areas that have been cleared of mangroves for alternative uses like salt production or urban use, where mangrove restoration may not be feasible , the benefits from planting new mangroves can often be comparable to the benefits from the other uses once we monetize the private indirect and social use benefits. Identifying the locations that will provide the best prospects for the biggest return on investment calls for a detailed analysis of the benefits to be gained from investing in mangroves, using the methodology proposed for each type of benefit. However, an accurate, region-specific analysis of the net benefits in each area will require the collection of data specific to each region in Ghana, since the types of mangroves, and their spread, often differ across regions.

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GPS Global Program on Sustainability

WACA West Africa Coastal Areas Management Program

NDF Nordic Development Fund

PROBLUE

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TECHNICAL REPORT

UNDERSTANDING THE NEXUS OF MANGROVES AND WOMEN IN GHANA

Photo credit: N. A. Anokye

MARCH 2023

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ACKNOWLEDGEMENTS

This report was prepared by Nana Amma Anokye and Harriet M. D. Potakey (Consultants) under the supervision of Susmita Dasgupta (Lead Environment Economist), and Juan Jose Miranda (Senior Environmental Economist), under the guidance of Maria Sarraf (Practice Manager) and Sanjay Srivastava (Prantice Manager). The report was prepared under the World Bank's West Africa Coastal Areas (WACA) management program. The team would like to acknowledge the financial support provided by the Global Program on Sustainability (GPS) and Wealth Accounting and the Valuation of Ecosystem Services (WAVES), and PROBLUE Trust Funds. PROBLUE is an umbrella trust fund that supports a sustainable and integrated development of marine and coastal resources in healthy oceans.

ABBREVIATIONS AND ACRONYMS

CBO	Community Based Organization
CSLP	Coastal Sustainable Land Project
CWMC	Coastal and Wetlands Management Committee
DAA	Development Action Association
DOPA	Densu Oyster Picking Association
EPA	Environmental Protection Agency
FC	Forestry Commission
FGD	Focus group discussion
IUCN	International Union of Conservation of Nature
NGO	Nongovernmental organization
REDO	Resource and Environmental Development Organization
ResIP	Resilience Investment Project
SFMP	Sustainable Fisheries Management Project
SwS	Seawater Solutions Ghana
TDI	The Development Institute
ToR	Terms of Reference
UNEP	United Nations Environmental Programme
USAID	United States Agency for International Development
WACA	West Africa Coastal Areas
WLD	Wildlife Division

EXECUTIVE SUMMARY

The main objective of this study was to assist understanding of the nexus between mangrove cultivation and restoration, and women in coastal Ghana by covering two broad areas:

1. Women's use of mangroves; and
2. Women's role in conservation and restoration of mangroves.

Both desk and field studies were conducted. The field study used purposive sampling technique to select two localities: one in the Densu Delta Wetland (Tsokomey and Bortianor) in the Greater Accra region, the other in the Anloga district (Anloga, Anyanui, Gblipke and Atorkor) in the Volta region. **Densu Delta was chosen for study because of the presence of a women's group that is involved in mangrove-centric activities, as well as a conservation/restoration project. Anloga district was chosen because it has a vast expanse of mangrove forest, and a major mangrove wood market at Anyanui.**

The people we interviewed were selected using purposive and snowball sampling techniques. They included relevant mangrove-centric stakeholders such as women's groups; key local and institutional informants; opinion leaders; nongovernmental organizations (NGOs); and community-based organizations (CBOs), as well as individuals from the communities.

Face-to-face interviews with individuals and key informants; two consultations with experts; and focus group discussions (FGDs) were used to gather the data. Observations of some of the mangroves and mangrove-centric activities around the Densu Delta, and around Angor Lagoon were made via boat trips.

The data collected were analyzed descriptively according to themes based on the scope and content of the study. These themes included the state of the mangroves; mangrove-centric activities engaged in by women; mangrove-centric products; and women's dependency on those products for primary, secondary, subsistence, and commercial uses. The demographic and socioeconomic characteristics of women engaged in mangrove-centric activities and conservation and restoration projects, were also covered. Membership in women's groups and CBOs; the seasonality of the mangrove-centric activities; the willingness of women to consider changing to alternative sources of income; and issues concerning the conservation and restoration of mangroves were also studied.

The main findings of this study indicate that mangroves in Ghana are very limited in distribution and area: they occur in estuaries and lagoons across the Volta, Greater Accra, Central, and Western regions. The Western and Volta regions have extensive mangroves; between the Western and Volta regions, patchy mangroves associated with lagoons and estuaries are found in a few places.

Mangrove-centric activities and products include: the cultivation of mangroves; timber logging for construction; mangrove fuelwood harvesting for fish-smoking and domestic purposes; and the harvesting of mollusks and oysters, fish (tilapia), crab, periwinkles, and herbs. The Volta region, where mangrove is the dominant species of harvested fuelwood, has a commercial mangrove market center.

Most of the literature on mangrove-centric activities in Ghana does not separate the tasks of women from men. Both genders were engaged in mangrove-centric activities to varying degrees, depending on the specific product and the location. Women engaged more than men in oyster harvesting, however, at Anyanui, the women were involved in full-time harvesting and selling of fuelwood.

Most mangrove users depend on the mangroves for both subsistence and commercial purposes. However, in Anyanui, the use of mangrove is purely commercial, and is the people's primary source of income.

A high percentage of women in mangrove-centric activities are within the ages of the active labor force (i.e. 20 to 60 years of age). The elderly women (those above forty) are more involved in fish smoking. The marital status of the women varied: married, single, widowed, and women with or without children were all included. The household income of women involved in mangrove-centric activities is generally low, as is their level of education; the majority have had only basic education.[1] Mangrove resource users who live outside the Volta region are mainly migrants originating from the Volta region, while those who live within the region are indigenes.

Mangrove harvesting is a year-round activity but both fish smoking and wood harvesting peak when the fishing picks up during the bumper season. There are only limited opportunities for alternative livelihoods for the majority of women involved in mangrove-centric activities. Some were willing to consider alternative means of livelihood but others were hard-core mangrove users, particularly in the Volta region, where they perceive the mangroves to be in abundance.

There is no legislation on sustainable mangrove use and conservation; however, there were some bylaws enacted by the Anloga District Assembly. Previous conservation/restoration interventions have been spearheaded by NGOs. In the Densu Delta a restoration project was initiated at the local level by Development Action Association (DAA), an NGO. In the Anloga district NGOs collaborate with the Anloga Wildlife Division (WLD) of the Forestry Commission (FC). Women have been involved in mangrove restoration projects, raising seedlings in nurseries and planting them on degraded lands.

Mangrove-centric activities in Ghana include the cultivation of mangroves; timber logging for construction; mangrove fuelwood harvesting for fish-smoking and domestic purposes; and the harvesting of mollusks and oysters, fish (tilapia), crabs, periwinkles, and herbs. Within the study areas the main activities were oyster picking and harvesting, fishing, and mangrove harvesting. These activities were engaged in by both women and men but women dominate in oyster picking and harvesting, and mangrove harvesting. These activities serve as both commercial and subsistence resource, as well as a primary source of income; hence they form a major source of livelihood for these communities.

Mangroves are under threat of being degraded. In the Anloga district the depletion has been gradual; it is more degraded in the Densu Delta. In spite of the general dwindling of mangrove products in the Anloga district, the dependency of the women on this resource is still high because they have limited alternatives; also,

[1] Basic education is from first to ninth grade. It is for children between 6 and 15 years old (primary and junior high).

mangrove-centric related activities are their only known occupation. The women in the Densu Delta are more willing to consider other livelihood alternatives than in the Anloga district. There have been some conservation/ restoration interventions involving women who are involved in mangrove-centric activities. In general, the participation of women in mangrove restoration projects in the study areas (Densu Delta and Anloga district) is location-specific. Land acquisition has been a major challenge for the district assembly and NGO restoration projects.

This study recommends that:

» The use of mangrove-centric products be regulated through sensitization and public education on the importance of sustainable use.

» The rules and regulations concerning sustainable mangrove use should be widely promulgated and enforced.

» To reduce the dependency on mangrove-related products, the people need alternative livelihoods. There is an urgent need for training, and the provision of start-up capital.

» Rather than just focusing on activities that have immediate economic benefits, sustainable, beneficial roles for the communities, including women in mangrove restoration projects, should be identified.

In order to capture holistic dynamics of the women-mangrove nexus in Ghana, further research covering the remaining coastal regions (Central and Western) is needed.

CHAPTER 1.
INTRODUCTION

1.1. BACKGROUND

This report was done in fulfillment of a major requirement detailed in the terms of reference (ToR) of the consultancy agreement between the authors[2] and the Resilience Investment Project (ResIP) of the World Bank. ResIP Part II aims to strengthen the resilience of targeted communities and areas in coastal West Africa. In Ghana, part of the purpose is to support, among other activities, the protection and restoration of mangrove habitats that serve as a protective asset against coastal floods, as well as other nature-based solutions that support the project objectives.

There seems to be a scarcity of organized knowledge of how women benefit from mangroves, and what role they play in the conservation and restoration of them in West African coastal areas. The ToR specifying the scope and content of this study charged us with undertaking a desk study; an empirical study that included developing and field testing of research instruments; and drawing connections between the learnings gained from the desk study as well as from the empirical studies.

The scope and content of the study, as spelled out in the ToR, was to:

1. Compile a comprehensive list of mangrove-centric activities of women in the coastal areas of Ghana;
2. Determine whether women are using mangrove products for household consumption, or are selling the products in the market;
3. If women are using mangrove products for household consumption, understanding whether the household demand for the product(s) is being fully met;
4. If women are using mangrove products for selling in the market, understanding the role of mangroves as their primary or secondary source of income;
5. Understand the characteristics of women who rely on mangroves for their livelihood;
6. Understand the time activity patterns of women who rely on mangroves;
7. Understand the willingness of women to switch to alternatives for mangrove products;
8. Understand the roles of women in the conservation, afforestation, and rehabilitation of mangroves;

[2] N. A. Anokye and H. M. D. Potakey (researchers).

9. Understand the specific activities women undertake to conserve mangroves;
10. Understand whether their engagement in the conservation of mangroves is full-time or part-time;
11. Understand the characteristics of women who take part in the conservation of mangroves;
12. Understand any problems or issues women face in the conservation of mangroves;
13. Understand whether women have any formal representation in women self-help groups and community based groups.

The main objective of the study was to assist in understanding the nexus of mangroves and women in Ghana, by examining how women benefit from mangroves and what role they play in the conservation and restoration of mangroves in coastal Ghana.

The report presented here is based on both desk and empirical (field) studies on how women relate to mangroves in terms of their reliance on mangroves and mangrove-centric activities and products, as well as the role they play in conserving and restoring mangroves to ensure their sustainability. As part of the consultancy, research instruments were developed and tested in the field for future use to solicit information from stakeholders in the use, conservation, and restoration of mangroves.

The report is divided into four main sections. **Section 1** provides the background and methods used to carry out the study. **Section 2** presents the situation in Ghana at the national level, and is drawn mainly from the literature review and from consultations with experts. Section 3 focuses on learnings and findings from the field at the local level, and relates them to learnings from the national level. Section 4 concludes the study and provides recommendations.

1.2. METHODS

The empirical study, including the field testing of research instruments, was preceded by a literature review.

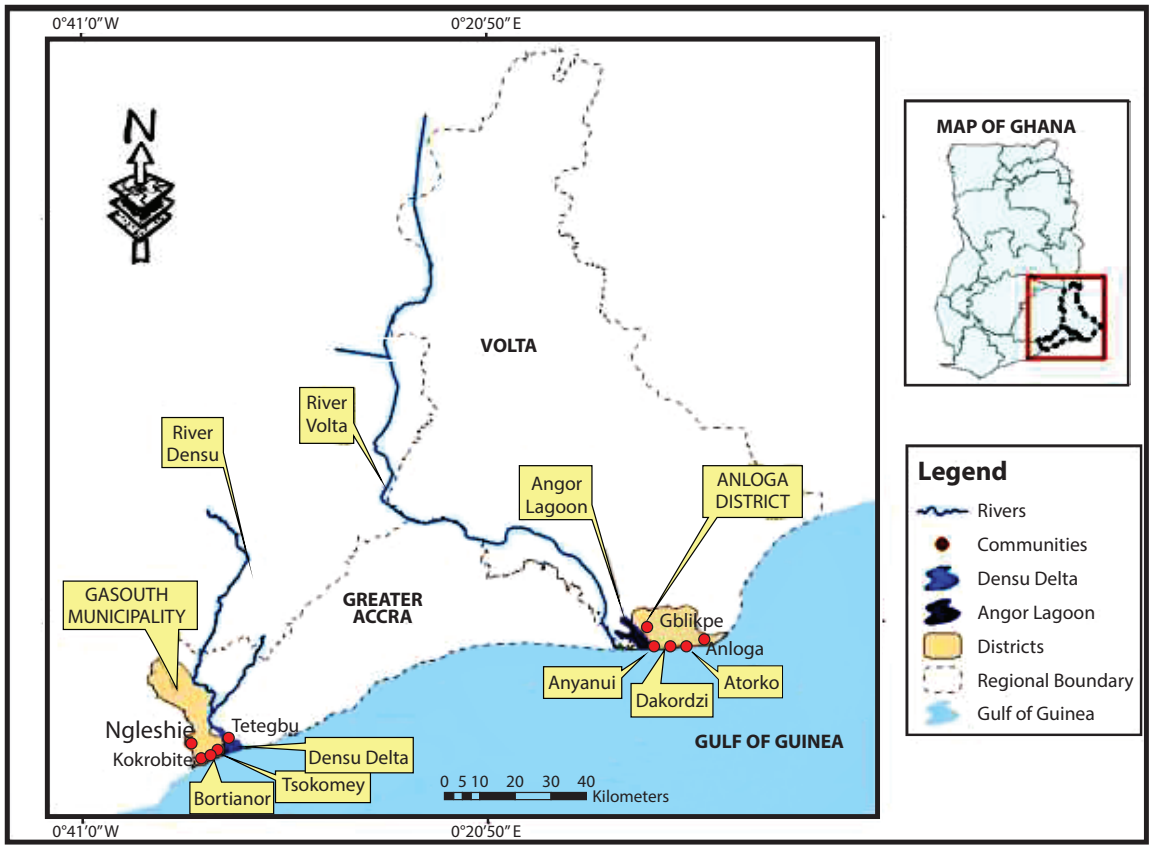
1.2.1. STUDY AREAS

The fieldwork was carried out in two main locations, which were chosen for their particular dynamics and time constraints. The areas were the Densu Delta Wetland (Tsokomey and Bortianor), in the Ga South municipality of the Greater Accra region[3]; and the Anloga district (Anloga, Anyanui, Gblipke, and Atorkor) in the Volta region. Densu Delta was chosen because of the presence of a women's group that is involved in mangrove-centric activities, as well as a conservation/restoration project.

The Anloga district[4] has a vast expanse of mangrove forest, and a major mangrove wood market at Anyanui. The district is located east of the Volta estuary. Anyanui, around where the second field-testing took place, is a coastal town in the newly formed Anloga district, along the east coast of Ghana. Anyanui borders the eastern side of the Volta estuary and shares part of the Angor Lagoon (see Figure 1).

[3] The Municipal Assembly is one of the newly created assemblies in the Greater Accra region. It was inaugurated in March 2018.
[4] The Anloga district was carved out of the Keta Municipal Assembly in 2018 and established in February 2019.

FIGURE 1: MAP OF SOUTHEAST GHANA SHOWING GA SOUTH MUNICIPALITY AND THE ANLOGA DISTRICT



Source: Department of Geography and Regional Planning, University of Cape Coast (January 2022)

1.2.2. SELECTION OF RESPONDENTS

The study targeted relevant mangrove-centric stakeholders like women's groups, individuals, key local and institutional informants, opinion leaders, nongovernmental organizations (NGOs), and community-based organizations (CBOs). Qualitative sampling procedures were employed, using nonprobability sampling techniques. Respondents were selected using purposive sampling technique,[5] and interviewed because they had direct and/or indirect bearing on the subject matter and could provide relevant information. Snowball sampling technique was used in some circumstances.[6]

Key informants from institutions that have bearing on mangrove-centric activities and products, and/or mangrove conservation and restoration, and that are involved with women were selected.

» The **development planning officers of the district assemblies** of the study areas were selected because they are in charge of all development issues and planning in the districts.

» The **executive director and the manager of the Fisheries Training Center** of the only nongovernmental organization (NGO) in the Densu Delta — the Development Action Association

[5] Purposive sampling technique is a "nonprobability sampling technique in which [people or] units are selected because they have characteristics that are needed in the sample." (Nikolopoulou, K. 2022).

[6] "Snowball sampling technique is a nonprobability sampling technique where new … [respondents are recommended or selected by other respondents] to form part of the sample." (Nikolopoulou, K. 2022).

(DAA) — which spearheaded a mangrove restoration program and also has a women's group involved in mangrove-centric activities.

» The **project officer for Seawater Solutions Ghana (SwS)**, a company with the largest mangrove nursery, which also engages women in managing the nursery and mangrove restoration, who is also the director of a local NGO (Keta Ramsar Centre) that engages women and young people in the planting of mangroves.

» **The principal manager of the Wildlife Division (WLD) of the Forestry Commission (FC) was also selected.** (He is also the manager in charge of the Keta Lagoon Complex Ramsar Site.) The WLD of the FC has habitat restoration as one of its core mandates, and one of its management practices is the restoration of mangroves; it also engages community members, including women, in restoration programs. All NGOs involved in the conservation and restoration of mangroves must collaborate with the WLD.

The **key local informants** were also selected using purposive sampling technique; they were leaders of CBOs that have bearing on mangrove-centric activities and products, mangrove conservation and restoration, and the involvement of women. These informants were:

» The local president of Densu Oyster Picking Association (DOPA);

» The chairperson of the Mangrove Planters Association;

» The district chairperson of the Coastal and Wetlands Management Committee (CWMC) for Anloga;

» The local (Anyanui) chairperson of the CWMC;

» A member of the CWMC; and

» The chief (traditional leader) of Anyanui. (Anyanui is known for its extensive mangrove forest and is a commercial town for mangroves and the mangrove wood market).

The participants for the focus group discussions (FGDs) and the individual respondents selected were all women in mangrove-centric activities.[7]

1.2.3. FIELDWORK /DATA COLLECTION

Our fieldwork started with reconnaissance visits to some key experts at the University of Ghana and the University of Cape Coast, to gain firsthand information and an overview of the problem under study. This also gave us some guidance (complemented by the literature we had reviewed) as to where to carry out the fieldwork.

The reconnaissance was done in four days in July and September 2021. Fieldwork and testing were done in the months of September, October, and November 2021: three days in the Densu Delta and three days in the Anloga district. Another two days in November 2021 were spent in Anloga district to mop up the data we had gathered, since some respondents could not be reached on the earlier trip. This also helped us to triangulate the data we had gathered.

[7] The members of DOPA were mainly women oyster pickers in the Densu Delta; 12 of them (per the FGD requirement of 6-12 participants) were selected as participants of one FGD. Four others were selected as individual respondents. Eleven women engaged by SwS in raising mangrove seedlings were selected as FGD participants in the Anloga district. Those who had established their own mangrove nurseries were selected as individual respondents. A woman involved in mangrove fuelwood harvesting and selling, and who was prepared to cooperate was selected at the mangrove market. With the assistance of WLD, other women involved in mangrove-centric activities were selected using Snowball. Six of them were grouped for an FGD, and two were interviewed as individual respondents.

Face-to-face interviews with individuals and key informants, and FGDs with the groups were used to gather the data. The interactions involved were:

» Consultation with two (2) experts;

» Interviews with five (5) institutional key informants — three (3) from Ga South municipal/Densu Delta and two (2) from Anloga district;

» Interviews with seven (7) local key informants — one (1) from Ga South municipal/Densu Delta and six (6) from Anloga district;

» Interviews with ten (10) individuals engaged in mangrove-centric activities — four (4) from Ga South municipal/Densu Delta, and six (6) from Anloga district; three (3) FGDs — one (1) from Ga South municipal/Densu Delta and two (2) from Anloga district.

In all, 24 interviews using interview guides and three FGDs, using FGD discussion guide, were held,[8] as well as two consultations with experts.

Two boat trips were made to observe some of the mangroves and mangrove-centric activities in the Densu Delta, and Angor Lagoon. Some of the communities we visited could most easily be reached by boat (see Photos 1–2).

PHOTO 1: SETTING OFF IN A CANOE WITH DOPA MEMBERS, TO OBSERVE DOPA'S REPLANTED MANGROVE AND OTHER ACTIVITIES, DENSU DELTA

Source: Fieldwork September 2021. (Photo credit: N. A. Anokye)

[8] The interview guides and FGD guide were the research instruments used to collect data during the fieldwork from individuals and FGDs respectively and also guide the interview and discussion respectively. These research instruments were developed by us (the researchers).

PHOTO 2: RESEARCHERS BOARDING CANOE AT ANYANUI LANDING BAY

Source: Fieldwork October 2021. (Photo credit: E. Quaye)

The interviews were recorded, and field notes taken, to augment the data gathering. In some cases interviews and FDGs were done through an interpreter (Photos 3 and 4).

PHOTO 3: RESEARCHERS INTERVIEWING INDIVIDUAL RESPONDENTS AT ANLOGA

Source: Fieldwork November 2021. (Photo credit: E. Quaye)

Where possible, pictures were also taken to confirm the accuracy of the information that was gathered.

PHOTO 4: RESEARCHER TAKING PICTURES OF DIFFERENT MANGROVE SPECIES

Source: Fieldwork October 2021. (Photo credit: N. A. Anokye)

PHOTO 5: RESEARCHERS OBSERVE THE MANGROVE NURSERY OF THE WILDLIFE DIVISION WITH THE STAFF OF GHANA WILDLIFE DIVISION, ANLOGA

Source: Fieldwork October 2021. (Photo credit: E. Quaye)

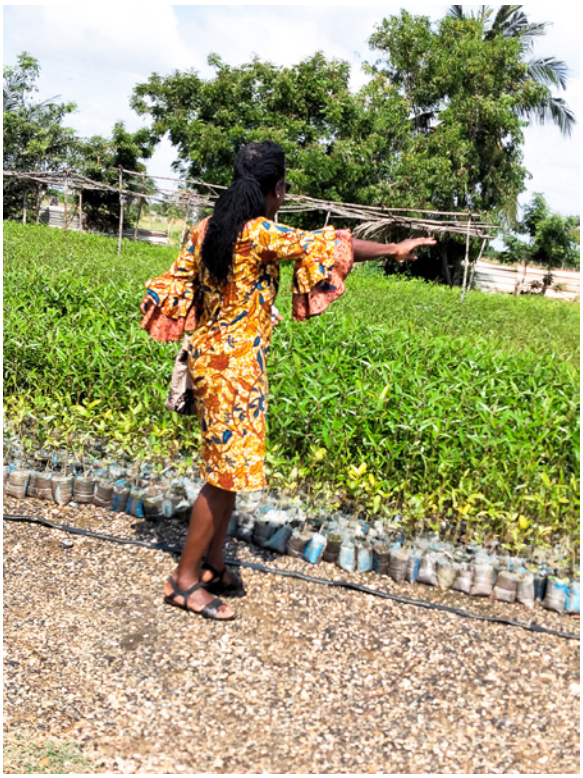


PHOTO 6: RESEARCHERS OBSERVING SECTIONS OF THE SwS MANGROVE NURSERY AT ATORKOR

Source: Fieldwork November 2021. (Photo credit: E. Quaye)

1.2.4. DATA ANALYSIS

The data we gathered was then transcribed and analyzed according to seven specific themes (see Section 3 for details). The results were discussed in relation to the themes covered under literature review at the national level that is detailed in Section 2.

1.2.5. ETHICAL ISSUES

Consent and permission were sought from the participants and their leaders. In the Densu Delta, permission was also sought from the executive director of the DAA and DOPA to interview the members of their women's group. The consent of the individuals was also sought, after explaining the purpose of the interview and making it clear that the interviewees were free to stop the interview if they felt uncomfortable about the issues under discussion.

In Anyanui, following traditional custom, permission had to be sought from the Chief before access into the community could be allowed. Permission from the Ramsar Site Manager/Principal Manager of the Wildlife Division (WLD) of the Forestry Commission (FC) also had to be given before access onto the Angor Lagoon was allowed. Special codes were used to identify the respondents, to allow for anonymity of their responses. Recording and photographs were taken by us only with consent.

1.2.6. LIMITATIONS

The timing of the fieldwork coincided with the rainy season, and the opening of the Weija Dam, which empties into the Densu Delta. Therefore, we were unable to witness many of the typical activities in action.

CHAPTER 2.
OVERVIEW: NATIONAL LEVEL

This section provides an overview of women in mangroves at the national level, beginning with the state of the mangroves.

2.1. STATE OF THE MANGROVES IN GHANA

Mangroves in Ghana are very limited in distribution and area, occurring in estuaries and lagoons (Agyeman, Akpalu and Kyereh 2007). The total mangrove area is somewhere between 100 square kilometers (km^2) (Ntyam 2014) and 140 km^2 (Ajonina, Agardy, Lau, Agbogah and Gormey 2014). About 550 km of the coastline has lagoons and estuaries that are associated with narrow and patchy mangrove vegetation (Armah et al. 2016).

Mangroves are found around large lagoons on the coast of the Western region between Cote d'Ivoire and Cape Three Points (Sackey, Kpikpi, and Imoro 2011; UNEP 2007; Aheto, Owusu, & Obodai 2011; Ntyam 2014; Armah et al. 2016). Specifically within the Greater Amanzule region.[9] The Greater Amanzule covers wetlands from the Cote d'Ivoire border to Ankobra River (that is, Half Assini in the Jomoro district to halfway into the Ellembelle district). Other locations are found in Axim in the Nzema East, and Princess Town in the Ahanta West districts (Ajonina et al. 2014) and the Shama district.

The second place where extensive mangroves can be found is the lower reaches and the "main" estuary of the Volta River (UNEP 2007; Ntyam 2014; Ajonina et al. 2014), and around Anyanui, where a new estuary was created in the middle of 2021 when the sea washed away a piece of land between the sea and the Angor Lagoon (see details in Section 3.1). Anyanui even has a mangrove wood market on Tuesdays and Wednesdays.

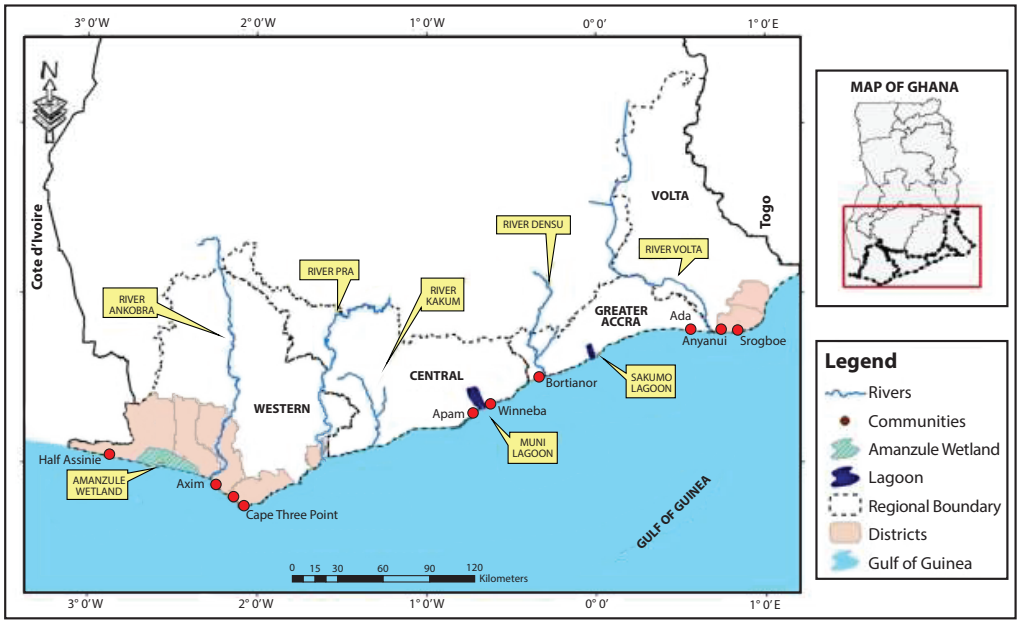
Anyanui engages in mangrove farming: according to conversations with Experts 1 and 2, the trees take twelve to fifteen years to mature and be harvested for sale. The Keta and Anloga districts in the Volta region are the districts with the greatest amount of mangrove coverage in Ghana (see Section 3.1). Between the Western and Volta regions there are patchy mangroves associated with lagoons and estuaries, dotted at a few places such as Apam, Muni Lagoon, and Winneba in the Central Region; Sakumo Lagoon; and Bortianor, Ada, and Sroegbe along the east coast (Nunoo and Agyekumhene 2014; Dali 2020)[10] (see Figure 2). According to Nunoo and Agyekumhene (2014), however, the

[9] Conversations with Expert 1 (Cape Coast) and Expert 2 (Accra) July 2021.
[10] See also conversation with Expert 2 (Accra) July 2021.

Volta region, in terms of spatial distribution, has the most extensive and numerous stands of mangroves, followed by the Western, Greater Accra, and Central regions (see Section 3.1).

There are three main genera of mangrove vegetation in Ghana, belonging to three families: they are the *Rhizophora* (*Rhizophoraceae*), *Avicennia* (*Avicenniaceae*), and *Laguncularia* (*Combretaceae*) (see Section 3.1). The existing species are *Rhizophora racemosa*, *R. mangle*, *R. harrisonii*, *Avicennia germinans*, and *Laguncularia racemosa* (Nunoo and Agyekumhene, 2014).

FIGURE 2: MAP OF COASTAL GHANA



Source: Department of Geography and Regional Planning, University of Cape Coast (January 2022)

2.2. MANGROVE-CENTRIC ACTIVITIES IN GHANA

Mangrove-centric activities in Ghana include: the cultivation of mangroves, timber logging for construction purposes, the harvesting of mangrove fuelwood for fish smoking and domestic purposes, the harvesting of mollusks and oysters, fish (tilapia), and crab, periwinkles, and herbs (Armah et al. 2016; USFS-IP 2018; Dali 2020).[11] These activities are also engaged in at the local level in the study areas (see Sections 3.4.1 and 3.4.3).

According to Darko Obiri, Owusu-Afriyie, Kwarteng and Nutakor (2015), fuelwood producers usually harvest more than one type of tree species for sale, except in the Volta region, where mangrove is the dominant species harvested. This was confirmed at the local level around the Angor Lagoon, where harvested mangrove wood is sorted out into fuelwood (see Section 3.4.3). The *Rhizophora mangle* and *Laguncularia racemosa* species (locally called Atra and Amuti respectively) ranked third, after *Albizia zygia* and *Celtis mildbraedii* (locally referred to as Okoro and Esa) among the types of fuelwood harvested for sale across the Greater Accra, Central, Volta, Western, and Eastern regions. The study by Darko Obiri et al. (2015), which was done along

[11] Expert 1(Cape Coast) and Expert 2 (Accra) July 2021.

the coast of Ghana, indicated that fuelwood is the main source of fuel used by almost all fish smokers along the coast. Mangrove fuelwood is preferable to other types of fuelwood because it enhances the color and taste of the fish; lasts long in the fire; dries and hardens fish faster; preserves fish for long; is easily available; and is easy to light (Darko Obiri et al. 2015). In the Western region, in the Amanzule mangrove complex, mangrove-centric activities are shellfish (such as oysters), tilapia, and crab harvesting. There is also harvesting of honey from beehives. Freshly cut mangroves are used for smoking fish.[12] In the Kakum mangrove forest more people were involved in fishery than tree harvesting; however, at the Pra mangrove forest more people exploited forest products than fish products, while a small proportion exploited both (Dali 2020).

Due to its water-resistant nature, mangrove roots are used to build houses in some places along the coast, for example Anyanui in the Volta region and Adakope in the Western region. *Rhizophora* is the most durable mangrove species for construction, hence it is a preferred choice. The mangrove roots are also used to produce charcoal in Winneba, in the Central region (Nunoo and Agyekumhene 2014; Dali 2020).

2.3. MANGROVE-CENTRIC ACTIVITIES OF WOMEN IN GHANA

Most of the literature on mangrove-centric activities in Ghana does not separate the tasks of women and men. Both genders are engaged in mangrove-centric activities to varying degrees, depending on the specific mangrove product and location. The Densu Delta has a purely women- dominated activity of oyster harvesting.[13] In the Kakum mangrove forest area, a study by Dali (2020) revealed that a greater number of men harvested fish than women, while more women harvested forest resources. Hence, in terms of forest resources women dominated. However, at the Pra mangrove area, the opposite was observed. Men mostly harvested forest resources, while women mostly harvested fish.

More females harvested *Avicennia* mangrove fuelwood than males; however, males dominated the harvesting of *Rhizophora*. When compared to *Rhizophora*, *Avicennia* is readily available, easy to harvest, and does not cause any bodily injury to the harvester. Hence, *Avicennia* is the preferred choice for women in the Kakum and Pra mangrove forest (Dali 2020).

At Anyanui, there seems to be a division of roles by gender. The men harvest the mangrove, and their spouses (women) gather and arrange them in canoes for onward transportation and sale in the market.[14] If the women are new to the mangrove business, both the men and women determine the price, after which the women engage in the selling. After the women have gained experience in pricing, they are able to determine the price by themselves. Generally, across the nation, fuelwood harvesting is done on a part-time basis, in addition to fish smoking. At Anyanui, however, the women are involved in full-time harvesting and selling of fuelwood.[15]

2.4. MANGROVE PRODUCTS (DOMESTIC/COMMERCIAL PURPOSES; PRIMARY/ SECONDARY SOURCES OF INCOME)

Most mangrove users depend on mangroves for both subsistence and commercial purposes. Usually the small branches of fuelwood that will not bring a good price

[12] Conversation with Expert 1 (Cape Coast) July 2021.
[13] Conversation with Expert 2 (Accra) July 2021.
[14] Ibid.
[15] Ibid.

are used for home consumption.[16] However, in Anyanui, mangrove products are purely commercial, and are the primary source of income for the people. Mangrove wood is cultivated by families who own land along the Volta River and is sold mainly for income. Both women and men are involved along the mangrove market chain.[17] Those who do not own their own land lease land from landowners. Others buy mangrove plantations, harvest, and sell.

Mangrove farming has been the only source of income for some families for years (Nunoo and Agyekumhene 2014). In our research, dependency on mangroves as a primary source of income was revealed at the local level as well in the Anloga district (see Sections 3.4.4 and 3.5). Shellfish harvesting and farming are their secondary sources of income.

In other places, mangrove-centric activities are secondary sources of income.[18] In the Kakum and Pra mangrove area, people of all ages depend on mangrove products as a source of income: most of these users were engaged in schooling, farming, and trading, and they used mangrove resource harvesting as a part-time occupation (Dali 2020).

Along the coast it is generally believed that fish smoked with mangrove fuelwood (especially *Rhizophora)* tasted better than fish smoked with other kinds of fuelwood. The fish smoked with mangrove fuelwood fetches more money because it tastes better and can be preserved for a longer time.[19] In the past, fishermen strengthened their fishing nets by soaking the nets in the sap of the mangroves. After delivering babies, women also use the steam from boiled mangrove leaves for postnatal healing — for home consumption.[20]

2.5. DEMOGRAPHIC AND SOCIOECONOMIC CHARACTERISTICS OF WOMEN ENGAGED IN MANGROVE-CENTRIC ACTIVITIES

Women with livelihoods tied to fishing are involved with mangrove-centric activities. These include fishmongers, who are mainly fish smokers. The elderly women (those above 40) are more involved in fish smoking, with younger ones assisting them.[21] However, a study by Agbekpornu, Ennin, Issah, Pappoe and Yeboah (2021) showed that women who were involved in oyster harvesting along the Densu Delta ranged from 18 to 68 years.[22] Our study at the local level (see Section 3.3) showed that the age of the women in oyster picking ranged from 21 to 44 years.

The marital status of women involved in mangrove-centric activities is varied. Some are married, some are single, and others are widowed.[23] According to Agbekpornu et al., (2021) most of the women oyster harvesters at the Densu Delta were married. A key informant in the Densu Delta confirmed that most of the women oyster harvesters are married (see Section 3.3).

The household income of women in mangrove-centric activities is generally low.[24] The low household income of the women was also observed at the local level in the two study areas (see Section 3.3). The study by Agbekpornu et al. (2021) at the Densu Delta revealed

[16] Ibid.
[17] Conversations with Experts 1 (Cape Coast) and 2 (Accra) July 2021.
[18] Conversation with Expert 1(Cape Coast) July 2021.
[19] Conversations with Experts 1 (Cape Coast) and 2 (Accra) July 2021.
[20] Conversation with Expert 2 (Accra) July 2021.
[21] Conversation with Expert 1 (Cape Coast) July 2020.
[22] The study showed that a high percentage of women oyster harvesters from Bortianor were within the ages of the active labor force (from 20 to 60 years). Those in Tsokomey were from 21 to 50 years old. In Tetegu they were from 21 to 30 years.
[23] Conversation with Expert 2 (Accra) July 2021.
[24] Ibid

that the proportion of income the women made from oyster harvesting, out of the total household income for the seven-month harvesting period, ranged from 2–100 percent. Oyster harvesting was not the major employment: most of these women were involved in petty trading and fish processing.

The level of education of women in mangrove-centric activities is very low; however, some of them are very intelligent and are able to do water quality analysis.[25] A greater proportion of the respondents of the study by Agbekpornu et al. (2021) (69 percent) have had only basic-level education, while 27 percent of them have had no formal education at all. The local-level study showed similar findings where most of the respondents had just a basic-level education (see Section 3.3).

A study by Dali (2020) revealed that mangrove resource users were mainly migrants. Agbekpornu et al. (2021) also indicated that about 79 percent of the oyster harvester respondents were migrants, and that the natives were not much involved in oyster harvesting. This is different from what occurs in the Anloga district. There, the local-level study indicated that almost all of those engaged in mangrove-centric activities were Ewes who were natives of the Volta region (see Section 3.3). At the Densu Delta, however, the women are mostly Ewe migrants, who have lived in the communities for a long time: 40 years or more.[26]

The work of Agbekpornu et al. (2021) showed that women benefit from restoration projects. For example, oyster harvesters and the oyster pickers association benefited from receiving training in mangrove restoration through replanting and nursery management to improve oyster habitats, as well as training in areas such as processing and hygienic packaging of oysters. Other areas of training included testing of water quality, salinity, temperature, turbidity, and pH.

2.6. SEASONALITY OF MANGROVE-CENTRIC ACTIVITIES BY WOMEN

Wood harvesting is done all year round on a part-time basis, along with fish smoking; and generally in Ghana, this is done by women. However, bumper fuelwood harvesting is linked to a bumper fishing season because mangrove fuelwood is used to smoke the fish. Both fish smoking and wood harvesting peak when fishing picks up during the bumper season (July to September), and then they go down in the lean fishing season. In Anyanui, people buy plenty of mangrove fuelwood and store it in the lean season: then they sell it during the bumper fishing season because the price of mangrove shoots up during the bumper season. Since the mangroves are planted at different times during the year from plot to plot on rotational basis at Anyanui, the mangroves also mature at different times throughout the year. Therefore, year-round mangrove farmers are able to harvest from plot to plot.[27] The year-round harvesting of mangroves was confirmed during the fieldwork we conducted in the Anloga district (see Section 3.4.5).

2.7. WILLINGNESS OF WOMEN TO SWITCH TO ALTERNATIVE PRODUCTS OR LIVELIHOODS

There are only limited opportunities for alternative livelihoods for the majority of women currently engaged in mangrove-centric activities. Some women would be willing to stop if they could secure other means of livelihood but

[25] Ibid.
[26] Conversation with Expert 2 (Accra) July 2021.
[27] Conversations with Experts 1 (Cape Coast) & 2 (Accra) July 2021.

others are "hard-core" mangrove users. In the Kakum and Pra mangrove areas in the Central and Western regions, most women resisted the idea of alternative use of the mangrove forest area stating that alternative use of the forests would lead to loss of their livelihoods (Dali 2020). They wanted the continuous existence of the mangrove forests as well as its use. A similar finding was revealed at the local level in the Anloga district (see Section 3.5).

Some users have switched to alternative sources of livelihood, supported by various NGOs. One of the experts we consulted regarding a project in Winneba in the Central region indicated that women would be willing to switch from mangrove-centric activities if and when they have alternatives.

> *To assist them switch from mangrove-centric activities we first built their capacities to enhance their livelihoods. We provided alternative livelihoods such as soapmaking, animal (grasscutter) rearing. They were also provided with a revolving fund at low interest rate to sustain their alternative livelihoods. In the past, we trained them on tree planting on their lands. Then we engaged the communities to protect the mangroves. Once they had alternatives their attitudes changed.*[28]

2.8. CONSERVATION AND RESTORATION OF MANGROVES

Several divisions and organizations are responsible for the management and conservation of mangroves in Ghana (Armah et al. 2016). However, efforts made for conservation and sustainable use are usually championed by development and civil society organizations (Asante, Acheampong, Boateng and Adda 2017). Hence, NGOs and community-based organizations (CBOs) are the main initiators of reforestation projects in Ghana (Armah et al. 2016). In the Densu Delta, at the local level the restoration project was initiated by the Development Action Association (DAA), an NGO. And in the Anloga district NGOs have started to collaborate with the Anloga Wildlife Division (WLD) of the Forestry Commission (FC) (see Section 3.6.1 and 3.6.2). Generally the communities and individuals that own the land control the resource.

According to Derkyi (2007) there seems to be a generally poor understanding of the values and functions of mangroves and wetland ecosystems in Ghana. Therefore, mangrove forests are often considered as degraded and worthless areas that have to be exploited for productive uses. This has been the conventional view of mangroves. Seven years after Derkyi's 2007 finding, Sustainable Fisheries Management Project (SFMP) (2014) wrote:

> *Under a US government presidential Feed the Future Initiative, the USAID/Ghana Sustainable Fisheries Management Project — SFMP — supported Sanwoma to embark on a study tour to another local community where sustainable mangrove harvesting is practiced. Before the study tour, some community members did not even know that mangroves could be replanted after harvesting. Aside from the direct economic benefit from wood harvests, the community was unaware of other benefits of the mangrove forests — especially for a community that was battling with erosion of the shoreline, made worse by the loss of mangroves.*

The chief of Sanwoma was reported to have said the following:

> *I had good resource at my disposal and didn't know its worth. I now have a high sense of pride, knowing that this management activity will provide for posterity. (SFMP 2014: 1).*

The Sanwoma story was also confirmed by Oppong-Ansah (2018). He showed that a local NGO, Hen Mpoano, was supported by the USAID-Ghana SFMP to educate the community about the benefits of the mangrove forests (see Section 3.6.1).

[28] Expert 2 (Accra) July 2021.

Though the conventional view of mangroves is gradually changing due to education and sensitization by NGOs, it still exists in some areas in Ghana. A study by Nunoo and Agyekumhene (2014) revealed that fuelwood harvesting for fish smoking is the number-one threat to the mangroves along the entire coast of Ghana. It is only in the Volta region that harvested mangroves are replanted after 12–15 years, for economic reasons (Armah et al. 2016).

There have been several mangrove conservation projects and programs undertaken in the coastal regions of Ghana through the efforts of NGOs and local initiatives. The following are some of them:

Central Region: Community Restoration in Ghana Project sponsored by Resource and Environmental Development Organization (REDO), located in Winneba, 1997–2000. (Armah et al. 2016).[29] Winneba has bylaws to protect trees along rivers. The project-trained beneficiaries were given wood seedlings, participated in woodlot establishment and practised rotational harvesting.[30]

Volta Region: The Lower Volta Mangrove Project Phase 1 focused on assessing environmental, economic, and social factors with the Ghana Wildlife Division (GWD) and the Environmental Protection Agency (EPA) 1996–1997 at Ada and Anyanui (Armah et al. 2016).

Western Region: Community Restoration in Ghana project by REDO from 1997 to 2000, located at Shama Princess Town (Armah et al. 2016). There is also the Greater Amanzule management project.[31] In the Western Region all chiefs were in support of protecting the mangroves. And the NGO Hen Mpoano was involved with Coastal Sustainable Land Project.[32]

With assistance from the USAID/Ghana SFMP, Sanwoma, led by their chief, embarked on a restoration project. The community is using bylaws to check indiscriminate mangrove harvesting. (SFMP 2014).

The Coastal Sustainable Land Project, together with key stakeholders, has initiated mangrove restoration projects at Yabiw, Anlo Beach, and Krobo in the Shama district, and Akwidai in the Ahanta-West district (SFMP 2014). Members of a volunteer group were trained to oversee and manage the restored mangrove areas (SFMP 2014).

Greater Accra Region: At Tsokomey there was a mangrove restoration project from 2016 to 2018 implemented by an NGO, the Development Action Association (DAA), which was sponsored by SFMP and USAID. The project involved oyster habitat manipulation.[33] The members of the Densu Oyster Pickers Association (DOPA), who are mainly women, nursed and transplanted the mangroves. They also manage the replanted mangroves (see Section 3.6.1).

Aheto, Kankam, Okyere, Mensah, Osman, Jonah, and Mensah (2017) observed in a study at the catchment area of the Volta that livelihoods and economic benefits are the main factors that encourage local stakeholders to participate in mangrove restoration programs. The study also showed that if customary laws are imposed and institutional arrangements are put in place to deal with mangrove destruction and rejuvenation rates, mangrove products can be used sustainably, rehabilitated, and managed. These researchers also mentioned the fact that the few livelihood alternatives are the major reason for the exploitation of mangrove products.

[29] Conversation with Expert 2 (Accra) July 2021.
[30] Ibid.
[31] Ibid.
[32] Ibid.
[33] Ibid.

2.9. ACTIVITIES OF WOMEN IN THE CONSERVATION, REHABILITATION, AND/OR RESTORATION OF MANGROVES

Women have been involved in mangrove restoration projects like the planting of seedlings.[34] Specifically, women collected seeds for establishing the mangrove nursery in Sanwoma. Oppong-Ansah (2018) observed that in Sanwoma, women who were involved in mangrove restoration saw the effect that the clean air that resulted had in reducing airborne diseases in the community. The women were happy doing this because they knew that it would give them more fuelwood for home consumption (Oppong-Ansah 2018). The women also put seedlings in the holes dug by their husbands, and covered the sides with soil during transplanting. This happened at the two study areas (local level) as well, where men dug the holes and the women put in the seedlings and covered the sides with soil (see Section 3.6.1).

Other mangrove restoration projects that women were involved in included a project at Muni Lagoon in Winneba. In this project women brought food to the men as the men planted the mangroves. The women also brought seedlings for the men to plant.[35]

In the Densu Delta, Tsokomey, under a project called the Sustainable Fisheries Management Project funded by USAID and spearheaded by DAA, a women's group involved in oyster harvesting have also been engaged in mangrove restoration. The DAA has branches in all the coastal communities (for example, Apam) helping women in fisheries. The branch at Tsokomey is peculiar because of the relationship these women have with mangroves. They restored mangroves as part of their project. However, the main project was to enhance oyster production; because the oysters are associated with the mangroves, restoration of the mangroves was necessary in order to ensure the sustenance of the oysters. The mangroves there are very young, and restoration is picking up.[36]

2.10. DEMOGRAPHIC AND SOCIOECONOMIC CHARACTERISTICS OF WOMEN INVOLVED IN THE CONSERVATION OF MANGROVES

On average, the women engaged in mangrove restoration activities are younger than women in mangrove-centric activities in general (usually 30–40 years old).[37] Their marital status is varied; they are single, married, widowed, and/or divorced, with or without children. Most of them have lived in their communities for a long time; 40 years or more. The household income of these women is low. Their level of education is also very low. However, some of them are very intelligent.[38] For example, Expert 2 offered that they had been able to train the Tsokomey women to analyze their own water samples.

[34] Ibid.
[35] Ibid.
[36] Conversation with Expert 2 (Accra) July 2021.
[37] Ibid.
[38] Ibid.

2.11. CHALLENGES FACED BY WOMEN IN THE CONSERVATION OF MANGROVES

The first two challenges were found to be faced specifically by women, while the others are challenges experienced by both genders.

2.11.1. CHALLENGES FOR WOMEN

» Financing becomes a challenge for the women when they stop harvesting mangroves (which is an income-making activity).

» When mangrove nurseries are sited at a distance from where replanting is done, it becomes difficult to convey the seedlings by wading through the mud to the site of replanting. (USFS-IP 2018). Usually it is women who are transporting the seedlings to the men, who then do the planting.

2.11.2. CHALLENGES FOR EVERYONE

» The institutions responsible for the management of wetlands are weak (USFS-IP 2018).

» There are bylaws governing the wetland areas in Shama and Akwidai area but they are not being enforced. The observation is that community members are not aware of the bylaws (USFS-IP 2018). This was also observed in the Anloga district (see Section 3.9).

» Difficulty in predicting high tidal water can lead to planted mangroves being destroyed if they are covered with water for more than three days (USFS-IP 2018).

» In Winneba, Woarabeba, and Ensuakyiri, the lack of alternative livelihoods was a big problem.[39]

» It has been argued that governance issues regarding land rights in mangrove conservation and rehabilitation are often overlooked, resulting in failure to enhance the conservation and sustainable usage of mangroves. This happened in the Songor Ramsar site, where mangrove ownership is organized by community, clan, or family, and in the Keta Lagoon Complex Ramsar site (Asante et al. 2017; USFS-IP 2018).

[39] Conservation with Expert 2 (Accra) July 2021.

CHAPTER 3.
WOMEN IN MANGROVES AT THE LOCAL LEVEL

This section discusses findings from the field on women involved in mangrove-centric activities and products; and mangrove conservation and restoration at the local level from two coastal wetland districts.[40] It also draws connections between the local findings and the findings on the national level.

This section of the report is divided into ten subsections, based on the tasks involved.

3.1. STATE OF MANGROVES

Generally the state of mangroves in the Densu Delta wetland is degraded but it has shown some improvement over the past five years due to an intervention by the Development Action Association (DAA). According to Densu Delta institutional key informant 2 (September 2021), the mangroves in the Densu Delta wetland were depleting because people were harvesting them without knowing their importance. However, Densu Delta institutional key informant 1 (September 2021) believed that the state of mangroves within the Ga South municipality, specifically in the Densu Delta wetland, has improved since 2016. Before 2016 the mangroves in the district had degraded (see Photo 7). The mangroves were becoming depleted as a result of cutting the trees for *atidja* (see Photo 8), which is a practice by fishermen in which they leave tree branches and leaves in the lakes or lagoons as bait to attract fish (Anokye 2013).

[40] Ga South municipality and Anloga district.

PHOTO 7: PORTION OF DEPLETED MANGROVE AT THE DENSU DELTA WETLAND

Source: Fieldwork September 2021. (Photo credit: E. Quaye)

> *Fishermen from the surrounding communities cut the mangroves for 'atidja' to trap fish. This in turn depleted the oysters in the Densu Delta wetland. There used to be oysters in the lagoon but got depleted. The fish is also getting depleted.*[41]

PHOTO 8: ATIDJA IN THE DENSU RIVER

Source: Fieldwork September 2021. (Photo credit: E. Quaye)

[41] Densu Delta institutional key informant 1 (Kokrobite) September 2021.

With the support of the Sustainable Fisheries Management Project (SFMP), DAA restored the mangroves by replanting them with the help of oyster pickers, who wanted to boost oyster production (see Photo 9). There were also unrestored portions of the Densu Delta wetland, which is community-owned. Other places had DAA and DOPA-replanted mangroves interspersed with community mangroves (Photo 10). They replanted red mangroves in such places to distinguish their mangroves from the community ones.

The Anloga district has a comparatively extensive stretch of mangrove swamps along the Angor Lagoon. According to findings at the national level, the Anloga and Keta districts in the Volta region are the districts with the highest mangrove coverage in Ghana (see Section 2.1). The 530-square kilometer wetland was designated as a Ramsar site in 1992. Anloga institutional key informant 2 (October 2021) noted that there is a vast forest of mangroves stretching across several acres of land in the Anloga district.

PHOTO 9: DAA AND DOPA-REPLANTED MANGROVES ALONG THE DENSU DELTA

Source: Fieldwork September 2021. (Photo credit: E. Quaye)

In fact Nunoo and Agyekumhene (2014) indicated that the Volta region, in terms of spatial distribution, has the most extensive and numerous stands of mangroves in Ghana (see Section 2.1). The amount of land planted in mangroves has been reduced in the past two years, since the district was established. There used to be a large area of mangroves on the left, going from Dzita township towards Anyanui, however, sections of the mangrove forest had to be cut down for security reasons: it was on record that people were taking advantage of the thick mangrove forest to kill, rape, and kidnap, so the security services came in to cut down all the mangroves in that area.

There has been a gradual degradation of the mangrove in the Anloga district.

> *The mangrove in the district has degraded over the past 20 years due to the high rate of harvesting. The sizes of mangrove stems are becoming smaller and smaller. There is overdependence, they do not allow the products to fully mature before harvesting. For the mangroves, the sediments or original soils after cutting do not properly support the regrowth unless they are planted on fresh lands.*[42]

[42] Anloga district institutional key informant 1 (Anloga) October 2021.

PHOTO 10: DAA AND DOPA-REPLANTED MANGROVES INTERSPERSED WITH COMMUNITY MANGROVES ALONG THE DENSU DELTA

Source: Fieldwork September 2021. (Photo credit: E. Quaye)

This interviewee also confirmed that the mangroves are being reduced due to regular harvesting; this is depleting as well as the oysters. There seems to be no strong consensus among individual observers as to whether or not the mangroves are depleting.[43]

Individual respondent 1 (October 2021) also reported that:

> *There is more harvesting and more planting of mangrove for fuelwood and construction now than some years back.*

However, Anloga district institutional key informant 2 (October 2021) commented:

> *They don't plant the mangroves; they (the mangroves) spring up by themselves.*

The reasons given for the degradation are that people are harvesting but are not planting,[44] and even for those who are planting, the soil has become hard, so the mangroves are not able to grow well. According to

[43] Individual respondents agreed that the size (diameter) of the mangroves they are harvesting is smaller than what they were harvesting ten to twenty years ago. Anloga district individual respondent 2 stated that for the 30 years during which she has been harvesting and planting mangroves she has realized that the mangrove is depleting; however, Anloga district individual respondent 3 disagreed. She said it has not been depleting over the 35 years that she has been harvesting and planting. According to two other Anloga district individual respondents, 4 and 5 the mangrove is depleting; and two other Anloga individual respondents 1 and 6 were of the view that it is not depleting because they plant as they harvest, since it is their source of income. (October and November 2021).

[44] Anloga district individual respondent 4 (Atorkor) November 2021.

Anloga district local key informant 5 (October 2021), the overexploitation of mangroves is mostly within the buffer zones. He complained:

Within the buffer zone, laws do not work because communities are interspersed or are embedded within the areas…Even though the areas are supposed to be under protection and of a 'no-go area'.

PHOTO 11: MANGROVE TREES BORDERING THE ANGOR LAGOON

Source: Fieldwork October 2021. (Photo credits: N. A. Anokye and H. M. D. Potakey)

In general the district has a very good stand of mangroves that includes all three genera found in Ghana — red (*Rhizophora)*, white (*Laguncularia)*, and black (*Avicennia)* — but the red dominates (see Section 2.1, and Photo 11). However, there are also portions of depleted mangroves (Photo 12).

According to Anloga district local key informant 2 (October 2021), mangroves thrive better in soft mud than in loamy soils.[45] One forestry assistant, and also Anloga district individual respondent 2, explained that the mangroves do well in soft soils. However, after several cycles of harvesting and replanting, the soil gets hardened and no longer supports growth. The mangroves that manage to grow on such hardened soil cannot grow very big, no matter how many years they are left to grow.

Portions of the land that has hardened have been taken over by *Acrostichum danaeifolium*, commonly known as the giant leather fern, which is a grass from the fern family (see Photo 13). This fern competes with the mangrove and eventually takes over.

PHOTO 12: DEPLETED MANGROVE LAND ALONG ANGOR LAGOON

Source: Fieldwork October 2021. (Photo credit: N. A. Anokye)

> *Somewhere in June-July 2021 the sea washed away the land between the sea and the Angor Lagoon, creating another estuary. The lagoon had been a closed lagoon then. This has changed the hydrology of the lagoon (see Photo 14).*[46]
>
> *…the sea now flows into the lagoon, creating shocks for the freshwater fish in the lagoon. This has reduced the quantity of big freshwater fish. Most freshwater fish died when the sea joined the lagoon. The inflow of the sea water increases the salinity of the lagoon water which is not so good for the freshwater fish.*[47]

Most of the freshwater fish died when the sea joined the lagoon; the dead fish were seen floating in the lagoon for days afterward.

[45] This was confirmed by Anloga district local key informant 3 (Gblikpe) October 2022, and individual respondents 2 (Anloga) and 6 (Atorkor) November 2022.
[46] Anloga district institutional key informant 1 (Anloga) October 2021.
[47] Anloga district local key informant 3 (Gblikpe) October 2021.

PHOTO 13: THE LEATHER FERN HAS TAKEN OVER MANGROVE LAND BETWEEN ANYANUI AND GBLIKPE ALONG THE ANGOR LAGOON

Source: Fieldwork October 2021. (Photo credit: H. M. D. Potakey)

PHOTO 14: THE NEW ESTUARY, WHERE THE SEA HAS WASHED OFF THE LAND AND JOINED THE ANGOR LAGOON

Source: Fieldwork October 2021. (Photo credit: N. A. Anokye)

The inflow of the sea brought in a lot of sand/silt and therefore reduced the quantity of fish in the lagoon. The spillage of the dam at Akosombo and Sogakope upstream brings in freshwater, which is good for the fish. However, the lagoon needs dredging to give way to fishing.[48]

3.2. MANGROVE OWNERSHIP REGIME

The Densu Delta wetland is a stool land, owned by the Ga stool.[49] Clans and families are the real owners but the Densu Focus Group Discussion (September 2021) revealed that some lands are owned by individuals. The wild mangroves (not the replanted ones) are available for community use, however, access and exploitation is controlled by the traditional authorities. Some portions serve as sacred groves for the chiefs and the elders of the traditional authorities. Access to and exploitation of the replanted mangroves is controlled by the Densu Oyster Pickers Association (DOPA). The Development Action Association (DAA) sought permission from the traditional authorities, the landlords, before land was released to them for their restoration project. Access to the oysters is open; the pickers hire boats or canoes and go and collect the oysters from the riverbed.

Unlike in the Densu Delta, in the Anloga district, the land belongs to individuals, families, and clans. The owners allow the harvesters to plant the mangroves and then sell them back to them when they have matured, on various agreement terms of sharecropping. In some instances individual landowners hire other individuals to cultivate the mangroves and sell them to the people who cultivated them. One staff member of the Wildlife Division explained that the majority of landowners do not have the skills for cultivating and harvesting the mangroves. Others do cultivate the mangroves on their family lands. One respondent plants and harvests mangroves on her grandfather's land, which belongs to her and the other grandchildren.[50]

3.3. DEMOGRAPHIC AND SOCIOECONOMIC CHARACTERISTICS OF WOMEN IN MANGROVE-CENTRIC ACTIVITIES

This subsection of the report focuses on the demographic and socioeconomic characteristics of women in mangrove-centric activities at the local level (see summary in Table 1).

The women engaged in mangrove-related activities in the Densu Delta at Tsokomey and Bortianor in the Greater Accra region range between 21 and 70 years old. Those involved in oyster picking are between the ages of 21 and 44 years.[51] The individuals interviewed were between 31 and 37 years. An earlier study by Agbekpornu et al. (2021) showed that women who were into oyster harvesting along the Densu Delta ranged from 18 to 68 years. A high percentage of women oyster harvesters from Bortianor, Tsokomey and Tetegbu were between 21 and 50 (see Section 2.5).

The range in the ages of fuelwood harvesters is from less than 14 to 60 years along the Angor Lagoon. Anloga district individual respondent 1 is a 66 year-old woman who is involved in almost all the activities along the fuelwood value chain (planting mangroves, harvesting, sorting, arranging, and selling) at the Anyanui market.

[48] According to Anloga district local key informant 3 (Gblikpe). October 2021.
[49] The stool is the seat of the chief. Ownership of some lands in Ghana is vested in stools and the chief is the custodian of stool lands. (Anokye 2013).
[50] Anloga district individual respondent 2 (Anloga). November 2021.
[51] Densu Delta FGD (Tsokomey) September 2021. (However, Densu Delta local key informant 1 (Tsokomey September 2021) puts their ages between 20 and 60).

Two other respondents who are also mangrove harvesters are 50 and 57 years old.[52] The other individual respondents who have been raising mangrove seedlings (nurseries) are 30, 41, and 42 years respectively.[53] Most of the women respondents are in their late 40s. Children are also involved in crab harvesting in the Anloga district. They normally go to the lagoon to set the crab traps. Children less than 10 years old are engaged in making crab traps[54] (see Photo 15, See Table 1).

PHOTO 15: DRYING OF CRAB TRAPS ON THE ANGOR LAGOON

Source: Fieldwork October 2021. (Photo credit: N. A. Anokye)

The highest level of formal education attained by the oyster pickers at the Densu Delta is the secondary level (twelfth grade). Others have up to the basic level (ninth grade), while some have not had any formal education at all.[55] The four oyster pickers interviewed at the Densu Delta have up to the secondary level of education. This corroborates the study of Agbekpornu et al. (2021), which showed that a greater proportion of their respondents (69 percent) have had basic level education, while 27 percent have had no formal education (see Section 2.5). The formal educational level of the women in mangrove-centric activities along the Angor Lagoon ranges from primary to secondary.[56] All the respondents from the Anloga district have at least primary education. Even the oldest, the 66-year-old woman has had a basic education. Some are school dropouts.

> *Due to financial difficulties some drop out of school and go into mangrove harvesting, which they are paid GHC30 (US$4.95) a day.*[57]

[52] Anloga district individual respondents 2 and 3 (Anloga) November 2021.
[53] Anloga district individual respondents 4, 5 and 6 (Atorkor) November 2021.
[54] Anloga district institutional key informant 1 (Anloga October 2021). Anloga district institutional key informant 2 (Anloga October 2021) explained that those involved in the planting and harvesting of mangroves are between 40 and 60.
[55] Basic education is from first to ninth grade. Primary education is from first to sixth grade, while secondary education is from seventh to twelfth grade.
[56] Ibid.
[57] According to Anloga district local key informant 2 (Anyanui) October 2021.

TABLE 1: DEMOGRAPHIC AND SOCIOECONOMIC CHARACTERISTICS OF WOMEN IN MANGROVE-CENTRIC ACTIVITIES

Characteristicst	Densu Delta	Anloga district
Age (years)	21–70	
Oyster & periwinkle picking	21–44	More than10
Fuelwood harvesting		Less than 14–60
Making & setting of crab traps		Less than 10 and above
Mangrove planters and harvesters		40–60
Raising mangrove seedlings (nurseries)		30–42
Level of Formal Education	No formal education to Secondary (High school) level	Primary to secondary
Ethnic Group	Gas, Ewes, Fantes	Ewes
Indigenes	Gas	Ewes
Migrants	Ewes (majority)	None
Marital Status	Single, married, widowed	Single, married
Religion	Christians & Muslims (majority), traditionalists	Traditionalists (majority), Christians, Muslims
Income Level	Low	Low
Number of Children	3–7	1–5
Number of Children in School	3–4	3 on the average
Household Size (includes dependents)	5–17; 6 on the average	4–12

Source: Interviews and FGDs (Densu Delta and Anloga district September, October and November 2021)

The Densu oyster pickers are Gas, Ewes, and Fantes. The Fantes are in the minority. The land is Ga land, so the Gas are indigenes and the Ewes are settlers, though the Ewes have been there for many years; their great grandparents came to settle there from the Volta region. The current generation, both indigenes and settlers, were born and bred there. This was confirmed by the local president of DOPA.

The Ga oyster pickers are at Bortianor, while the Ewes are at Tsokomey. There are more Ewes (migrant) than native (Ga) oyster pickers. This finding supports Agbekpornu et al. (2021), who indicated that about 79 percent of their oyster harvester respondents along the Densu Delta were migrants, and that the natives were not very involved in oyster harvesting (see Section 2.5). One has to bear in mind that the DOPA group, is a mixture of Ga indigenes and Ewe settlers. The Densu oyster pickers have lived in their current community since birth.

> *Though migrants, the women have lived in their communities for a long time - as long as 40 years or more.*[58]

The oyster pickers along the Densu Delta are in just three communities: Bortianor, Tsokomey, and Tetegbu. However, there are oyster harvesters in all of the communities bordering the Angor Lagoon.

[58] Conversation with Expert 2 (Accra) July 2021.

The women involved in mangrove-centric activities along the Angor Lagoon are mostly Ewes and indigenes who have resided in their communities for a long time, more than 20 years. All of the participants in the two FGDs, as well as the six individuals interviewed in the Anloga district are Ewes: there are hardly any migrants engaged in any of the mangrove-centric activities in the Volta region. The studies of Dali (2020) and Agbekpornu et al. (2021) revealed that the mangrove resource users are mainly migrants, however, this does not hold true in the Volta region (see Section 2.5). This could be due to the fact that those previous studies were conducted outside of the Volta region, which seems to be a source of people with mangrove-centric activity know-hows. Unlike in the Densu Delta, the women in mangrove-centric activities in the Anloga district are indigenes of their localities. Some of them have lived in their present localities since birth.[59] The other three individual respondents have lived in their present localities for 6, 21, and 30 years.

Dendu Delta FGD revealed that the majority of the women were single parents but there were also married women and widows among them.[60] However, the local president of DOPA said most of them were married. This conforms to the findings of Agbekpornu et al. (2021), which also revealed that the women oyster harvesters at the Densu Delta were married (see Section 2.5). The four individual oyster pickers we interviewed were all married. The women in mangrove-centric activities along the Angor Lagoon had varied marital status but most were single parents.[61] All six participants of Anloga district FGD 1 were single except one;[62] and three out of the eleven Anloga district FGD 2 participants were single; the rest were married.[63]

The religious affiliation of the women oyster pickers in the Densu Delta varied. There were Christians, Muslims, and traditionalists but Muslims and Christians dominated, according to the local president of DOPA. The religious affiliation of the women in mangrove-centric activities along the Angor Lagoon also varied but the majority of them were traditionalists. A few were Christians and Muslims.[64] However, the individual respondents and Anloga district FGD 1 participants were all Christians, except two who were traditionalists.

The women in mangrove-related activities along the Densu Delta were of the lower income class. According to Densu Delta institutional key informant 1, these women struggle to make ends meet: there have been times she has had to intervene in their private lives in order to help them. The situation was the same along the Angor Lagoon; the low income level of the women there was also confirmed in our conversation with Expert 2 (July 2021) (see Section 2.5). Only two of the FGD participants (one each from the two FGDs in the Anloga district) were of the medium-income class, and they were fishmongers.

The household size of the women oyster pickers along the Densu Delta ranged between five and seventeen[65] but the local president of DOPA said their average household size was around five or six. The number of children the women had was between three and seven. This means that the women were living with not only their nuclear families but with other relatives as well. The number of children in school was between three and four. The younger women had almost all of their children in school. Some of them indicated during the FGD that some of their children had finished school and were on their own.

[59] Anloga district individual respondents 1 (Anyanui October 2021), 2 (Anloga), and 5 (Atorkor), and all the participants of Anloga district FGD 1 (Anloga) except two. November 2021.
[60] Densu Delta FGD (Tsokomey) September 2021.
[61] According to Anloga district institutional key informant 1 (Anloga October 2021), however, five of the six individual respondents were married; the other was divorced.
[62] Anloga district FGD 1 (Anloga) November 2021.
[63] Anloga district FGD 2 (Atorkor) November 2021.
[64] According to Anloga district institutional key informant 1, Anloga district local key informant 4 and Anloga district institutional key informant 6.
[65] Densu delta FGD (Tsokomey) September, 2021.

In the Anloga district the average household size, was four; and some of the women also have other dependents.[66] There seemed to be a lot of variation in the household sizes. Household size ranged between four and nine for the participants of Anloga district FGD 1. The interview with Anloga district local key informant 2 revealed that members of the Mangrove Planters Association have a household size ranging between four and eight. For the individual respondents, the household size ranged between five and twelve.

The number of children and dependents also varied. The number of children of the FGD participants and the individual respondents ranged from one to five; on the average three were in school. The number of dependents averaged seven. Household size ranged from 2–12. With the children of the members of the Mangrove Planters Association, some were in school, some had completed school, and due to the limited financial resources of their parents some were not in school, even though they were of school-going age.

3.4. MANGROVE-CENTRIC PRODUCTS AND ACTIVITIES

The mangrove-centric activities in the study areas include oyster picking, basket fishing (for tilapia and shrimp), crab harvesting, raising mangrove seedlings in nurseries, and mangrove harvesting for fuelwood, construction purposes, and *atidja* (see Photo 8).

3.4.1. OYSTER, PERIWINKLE, AND CRAB HARVESTING AND FISHING

Oysters in the Densu Delta are picked from the river or lagoon bed. Oyster picking is the main livelihood of the oyster pickers.

> *Oyster picking and fishing are their main source of livelihood. The environment provided by the mangrove allows for the growth of the oyster and they make their livelihood out of that.*[67]

The women are engaged more than men in oyster picking and basket fishing. Photo 16 is a picture of oyster shells from the Densu River. Photo 17 is a picture of fish harvested by basket fishing. Photos 18 and 19 portray crab harvesting.

[66] According to Anloga district institutional key informant 1 (Anloga) October 2021.
[67] Densu Delta institutional key informant 2 (Ngleshie) September 2021.

PHOTO 16: OYSTER SHELLS AT TSOKOMEY

Source: Fieldwork September 2021. (Photo credit: N. A. Anokye)

PHOTO 17: WOMEN CLEANING FISH HARVESTED BY BASKET FISHING AT TSOKOMEY

PHOTO 18: FISH TRAP IN THE DENSU RIVER

Source: Fieldwork September 2021. (Photo credit: E. Quaye)

PHOTO 19: CRAB STICKING TO MANGROVE, DENSU RIVER

Along the Angor Lagoon the mangrove-centric activities include oyster, periwinkle, and crab harvesting and fishing. Photos 20 and 21 are pictures of the periwinkles and oyster shells that are used to strengthen the foundations of mud houses. In the Angor Lagoon, unlike in the Densu Delta, the oysters stick to the roots of the mangroves (see Photos 22 and 23). They are harvested by cutting the mangrove roots on which they are stuck. Both women and men engage in these activities but the oyster picking is mainly done by the women (see Photo 24). Some children are also involved, especially with crab harvesting in the Anloga district. They normally go to the lagoon to set the crab traps.

> *Mangrove-related activities are done by men, women and children, so you see men, you see women and you see children under 18 engaged in the activity either crab harvesting or picking of oysters, fishing and all that.*[68]

Their engagement in these activities has been over ten years.

PHOTO 20: PERIWINKLES HARVESTED AT GBLIKPE

Source: Fieldwork October 2021. (Photo credit: N. A. Anokye)

PHOTO 21: OYSTER SHELLS AS PART OF THE FOUNDATION OF A MUD HOUSE AT GBLIKPE

[68] Anloga district institutional key informant 1 (Anloga) October 2021.

PHOTO 22: OYSTERS STICKING TO MANGROVE ROOT

Source: Fieldwork October 2021. (Photo credit: E. Quaye)

PHOTO 23: FRESHLY HARVESTED OYSTERS FROM ANGOR LAGOON

PHOTO 24: WOMAN HARVESTING OYSTERS FROM ANGOR LAGOON

Source: Fieldwork October 2021. (Photo credit: E. Quaye)

For processing, the oysters are steamed or boiled; then they are sold both in the Densu Delta and in the communities around the Angor Lagoon. They are cooked until the shells open up; then the processors use knives to remove the oysters from the shells. The women arrange them on trays for the children to sell within the communities. In the Densu Delta some also sell them on market days and along the roadside. Some of the respondents provided additional insight:

> *We boil part. Due to the time and energy consuming nature of the processing of oysters, we only do the initial boiling.*[69]

> *… Some re-cook them by frying after boiling; others too eat them without further cooking.*[70]

Some of the products are sold on the market:

> *As tomorrow is market day, we have run out of stock because some sellers have come for all our harvested oysters to sell at the Anyanui market tomorrow.*[71]

Periwinkles can be sold and exported to other regions without being processed because of their long shelf life:

> *Periwinkles are sold directly to buyers without processing …. they are in higher demand than oysters, they are sent to the Eastern region (which is far away) due to their longer shelf life.*[72]

3.4.2. RAISING MANGROVE SEEDLINGS IN NURSERIES

Picking mangrove seeds and seedlings, and establishing mangrove nurseries are also activities engaged in by individuals, as well as one group in the Anloga district. They were trained by Seawater Solutions Ghana (SwS) on how to raise mangrove seedlings at its premises at Atorkor, near Anloga. The group, which consists of 48 women and men, with women outnumbering the men, collects mangrove seeds and seedlings for SwS. SwS engages the group in preparing seedling bags, filling them with soil, sowing the mangrove seeds, and caring for the seedlings by watering them before and after germination. The group also picks weeds around the seedlings, replaces the dead ones, and generally nurtures the seeds to the point where they are mature enough for replanting in the fields (Photos 25 to 28).

[69] Densu Delta individual respondent 2 (Tsokomey) September 2021.
[70] Densu Delta individual respondent 1 (Tsokomey) September 2021).
[71] Anloga district local key informant 2 (Gblikpe) October 2021).
[72] Ibid.

PHOTO 25: WOMEN FILLING SEEDLING BAGS WITH SOIL

Source: Fieldwork November 2021. (Photo credit: H. M. D. Potakey)

PHOTO 26: WOMAN PICKING UP FILLED SEEDLING BAGS

PHOTO 27: WOMAN SOWING MANGROVE SEEDS AT SwS PREMISES

Source: Fieldwork November 2021. (Photo credit: H. M. D. Potakey)

PHOTO 28: GROWING MANGROVE SEEDLINGS AT SwS PREMISES

At the time of data collection, SwS had about 250,000 seedlings.[73] (Photo 29). SwS encouraged the group members to raise their own (white) mangrove seedlings in their community, Dakordzi. SwS in turn buys the seedlings for replanting onto the field. There are some women in Anloga district that the Wildlife Division (WLD) of the Forestry Commission (FC) sometimes engages to pick seeds and young seedlings, and also to help with the planting.[74]

PHOTO 29: SECTION OF SwS MANGROVE NURSERY, ATORKOR

Source: Fieldwork November 2021. (Photo credit: N. A. Anokye)

3.4.3. MANGROVE HARVESTING

Mangrove harvesting seems to be the most dominant activity, especially along the Angor Lagoon. It is done by both men and women (see Photos 30 and 31). Some individuals buy mangrove plantations from land/mangrove owners and harvest them. Others are hired to harvest, while still others harvest the mangroves on their own, or on family land.

[73] Anloga district local key informant 5 (Atorkor) November 2021.
[74] Anloga district institutional key informant 1;and Anloga district individual respondent 2 (Anloga) November 2021.

PHOTO 30: WOMAN AND MAN HARVESTING MANGROVES ALONG THE ANGOR LAGOON

Source: Fieldwork November 2021. (Photo credit: N. A. Ano*kye)*

PHOTO 31: HARVESTED MANGROVES BY ANGOR LAGOON WAITING TO BE TRANSPORTED BY BOAT TO THE MARKET

Source: Fieldwork October 2021. (Photo credit: N. A. Anokye)

After harvesting the mangroves, initial sorting is done at the harvesting site; then they are transported to the landing bay, which doubles as a market at Anyanui. The transportation of mangroves is dominated by men. At the landing bay/market several activities along the mangrove value chain take place. Further sorting into different sizes is carried out at the landing bay by women (Photos 32 to 37).

Mangrove harvesting is a process. After harvesting you have to sort; women also take part in the harvesting but sorting into various categories is done by the women. About 70 percent of those who do the sorting are women.[75]

Anloga district institutional key informants 1 and 2 (October 2021) indicated that people harvest mangrove for fuelwood and construction. The bigger ones are sorted out for building purposes, and the small ones for fuelwood. This finding confirms Darko Obiri et al.'s (2015) assertion that in the Volta region mangrove is the dominant species that is harvested for fuelwood (see Section 2.2).

PHOTO 32: MANGROVE FUELWOOD SORTED, GROUPED, AND TIED, WAITING FOR THE NEXT DAY'S MARKET

Source: Fieldwork October 2021. (Photo credit: N. A. Anokye)

[75] Anloga district local key informant 1 (Anyanui) October 2021.

PHOTO 33: WOMEN SORTING AND ARRANGING MANGROVE INTO DIFFERENT SIZES AND TYING IT AT LANDING BAY/MARKET, ANYANUI

Source: Fieldwork October 2021. (Photo credit: N. A. Anokye)

PHOTO 34: WOMEN SORTING MANGROVE INTO DIFFERENT SIZES, ARRANGING, AND TYING AT LANDING BAY/MARKET, ANYANUI

Source: Fieldwork October 2021. (Photo credit: N. A. Anokye)

PHOTO 35: BUNDLES OF YOUNG MANGROVE ROOTS USED FOR ROPES

Source: Fieldwork October 2021. (Photo credit: N. A.Anokye)

PHOTO 36: SPLIT MANGROVE ROPES FOR TYING

PHOTO 37: DIFFERENT SIZES OF MANGROVES

Source: Fieldwork October 2021. (Photo credit: N. A. Anokye)

Buyers come with trucks to the Anyanui mangrove market; then they buy the mangrove wood and transport them to other places in the country (see Photo 38). The loading of the wood onto the trucks is done by men.

PHOTO 38: LOADING OF MANGROVE WOOD ONTO VARIOUS VEHICLES AT ANYANUI MANGROVE MARKET

Source: Fieldwork October 2021. (Photo credit: N. A. Anokye)

Some of the allied activities, for example transport and tourism, are also associated with the mangroves. Some of the indigenes organize tours for tourists to travel by boat around the extensive mangroves on the Angor Lagoon.

> *You'll also see some hotels on the bank of the lagoon, so that's where the tourism comes in. You see some tour operators as well.*[76]

The findings on the types of mangrove-centric activities at the local level in our two study areas are consistent with the findings of Armah et al. 2016; USFS-IP 2018; Dali 2020; and Experts 1 and 2 2021 in Ghana (see Section 2.2). Women are engaged in all of the activities along the mangrove value chain (planting, harvesting, transporting, processing, and selling); and these activities have been going on for over 10 years.

3.4.4. PURPOSES FOR ENGAGING IN MANGROVE-CENTRIC ACTIVITIES

The main purpose for engaging in mangrove-centric activities is for income (commercial) and also for at-home consumption, to improve diet:

> *… for over 10 years now, we've been harvesting the oysters and selling them. We also keep some at home since it is delicious.*[77]

> *I have been selling for over 10 years and we also keep some at home and consume.*[78]

> *They (community members) have been doing it for over 30 years for both household consumption and commercial purposes … there are people who earn all*

[76] Anloga institutional key informant 1 (Anloga) October 202).
[77] Densu Delta FGD (Tsokomey) September 2021.
[78] Densu Delta individual respondent 3 (Tsokomey) September 2021.

their money from it and what they do is to harvest mangroves for sale. Others also earn money by being hired by the owners of the mangroves and get paid at 30 cedis per day.[79]

In the past the oysters were mainly used for household consumption, and they fully met household demands but in recent times most of the demand is not being met. The harvested oysters contribute to only between 10 and 40 percent of household demand. One respondent explained:

It does not meet our household demand … but better during peak season.[80]

People sometimes have to augment their diets with other things, such as backyard poultry, to meet their nutritional need for protein.

Most of the respondents indicated that the mangrove-centric activities have been their primary source of income for over ten years. A few, especially the men, have oyster harvesting as their secondary source of income but it is the primary source of income for women in the Densu Delta. However, they do not fully depend on the oyster picking. They also engage in basket fishing as a secondary source of income; this is done during the lean and closed oyster seasons, and during the rainy season, or when the Weija Dam is open and the lagoon gets flooded. Some of the women sell processed foods, and others go into the processing of sea fish. Others do porterage: carrying loads of fish from the beach to the processing sites for a fee.

In the Anloga district, mangrove harvesting is women's primary source of income, and harvesting oysters and periwinkles is their secondary source. Since the mangroves take a long time (10 to 15 years) to mature, they fill in the period of waiting with harvesting oysters and periwinkles. These findings are consistent with Nunoo and Agyekumhene's (2014) findings that mangroves are a primary source of income (see Section 2.4).

However, in Dakordzi, fishing seems to be the primary source of income. Engagement in raising mangrove seedlings in nurseries is quite recent; it only began in June 2021 through the intervention of SwS. Women prefer raising mangrove seedlings in nurseries to fishing, even though their main work is fishing because they are able to generate more income that way. Vegetable farming is their secondary source of income, along with backyard poultry and fish farming to supplement their income.

3.4.5. SEASONALITY AND TIME ACTIVITY PATTERNS

Oyster harvesting in the Densu Delta is performed seasonally: the peak season is between April and August, and the lean season is from September to October. Over the past three to four years a closed season from November to April has been introduced by DAA in the Densu Delta.

The seasons changed over the years. The lean season was replaced by the closed season about three years ago. Five years ago there was no closed season. The closed season is linked to the opening of the Weija Dam. The closed season has been official since about 3–4 years.[81]

A local key informant added that:

….. the activity (oyster harvesting) was performed all year round in the past years but it is seasonal now, not all year round because there is a closed season. Previously there were no closed seasons but now we have it.[82]

DAA informs the Municipal Planning Coordinating Committee of the Ga South Municipal Assembly, which includes a DAA staff member, about the closed season for

[79] Anloga district institutional key informant 1 (Anloga) October 2021.
[80] Densu Delta individual respondent 2 (Tsokomey) September 2021.
[81] Densu Delta individual respondent 2 (Tsokomey) September 2021.
[82] Densu Delta local key informant 1 (Tsokomey) September 2021.

oyster picking. The end of the closed season is marked by the opening of the Densu Delta for the harvesting of oysters; there is a celebration to which DAA invites the Ga South Municipal Assembly, traditional leaders (chiefs and fetish priests),[83] and others.[84]

The time of day the activities are engaged in varies but they mainly take place during the day, for safety reasons. In the Densu Delta oyster picking is done every other day because of its tedious nature. The activities are engaged in all day but not in the evenings. The time of the day depends on the tide: low tide is preferable. The harvesters go out very early in the morning, between 6 and 9 am; then they return and go again at 2 pm. Basket fishing is often done at night.

In the Anloga district, mangrove, oyster, and fish harvesting is done throughout the year but seasonally for periwinkles. Experts 1 and 2 (July 2021) have confirmed the year-round harvesting of mangroves in Anyanui (see Section 2.6). The periwinkles cannot be picked during the rainy season when the lagoon is full. The oysters used to be seasonal but due to the recently created estuary by the erosion of sea sand, more seawater has been entering the lagoon, making the water more conducive for oysters; so now they are always available and they are getting much bigger. One respondent noted:

> *Oysters are always there. The oysters here attach themselves to the branched roots of the mangrove… and now that the sea has created an estuary, more saline water is entering the lagoon, making it more favorable for the oysters, so they are always there.*[85]

Another interviewee commented:

> *The oyster picking is usually seasonal but now that we have climate change, there is some change in the season. We expect fish around this time in abundance and now that the sea has merged with the lagoon, the hydrology of the whole place has changed. The kinds of fish we expect now are not present but the oysters are available. As for the harvesting of mangroves, it is throughout the year. The fishing too is throughout the year.*[86]

Oyster harvesting is done every day during low tide, and during daytime hours. The planting of mangroves is done only when there are degraded areas.

3.5. MANGROVE DEPENDENCY AND WILLINGNESS TO SWITCH TO LIVELIHOOD ALTERNATIVES

Dependency on mangrove-centric products over the years has varied. For some users, it has been reduced; for others it has remained the same, or even increased. In Anyanui and its environs, dependency on the mangroves is high. Anloga district institutional key informant 1 commented that the people feed basically on the resources from the lagoon such as crab, fish, and fuelwood. This comment supports Nunoo and Agyekumhene's (2014) observation that mangroves have been a major source of income for families over the years (see Section 2.4). Anloga district institutional key informant 1 added that because the communities are overexploiting the resources, they are quickly becoming depleted. According to him, some people believe that because the mangroves regrow themselves, they can never become extinct but the reality is that the soils are becoming harder, and is compromising the ability of the new mangroves to grow tall.[87]

In the Densu Delta, the population has been increasing due to inflows of migrants and high birth rates; according to one interviewee, this does not affect mangrove-centric activities:

[83] Fetish priest is traditional religious leader.
[84] According to Densu Delta institutional key informant 3 (on phone) December 2021.
[85] Anloga district local key informant 2 (Gblikpe) October 2021.
[86] Anloga district institutional key informant 1 (Anloga) October 2021.
[87] Ibid

Mangrove-centric activities are not being affected that much. Not all the people are in mangrove-centric activities; again the younger ones are going to school, more of the youth too are getting into craftsmanship apprenticeship rather than mangrove-related activities.[88]

Other respondents feel that dependency on mangrove-centric products has increased due to the high birth rate and migration; still others believe that dependency has increased because there are no livelihood alternatives.

There is no other livelihood, it's our ancestral profession handed down to us through generations as our source of livelihood. We cannot deprive others who depend on it for their livelihoods.[89]

In the Densu Delta there have been changes in the quantities and volume of mangrove products being harvested or sold over the years. While some have experienced decreases in the harvest over the years, others have reported increases over the past five years but a decrease within the past six to ten years.

Before then, there were lots of mangroves but they have been cut so the oysters no longer attach to the mangrove roots but in the mud. Now there is a lot of mud in the lagoon, making the cultivation and harvesting of mangrove difficult and painstaking.[90]

Another responded commented:

The sizes of oysters are no longer increasing due to the depletion; I spend so much time, about 6 hours in the water but pick only small ones which I eventually throw back into the water. Men have other activities to augment their livelihood, so they don't waste time on this tedious process.[91]

Those who observed a positive change attributed it to greater awareness of how to manage the environment for oysters, and also the DAA/DOPA reforestation project.

In Anyanui and its environs, those engaged in mangrove-centric products have experienced increased quantities in the amount of products harvested. The demand for periwinkles is high. For mangroves, supply outweighs demand, so to avoid a glut, the Anlo and Tongu women who engage in selling mangroves take turns on market days.

Currently the supply of mangrove is so much that we the sellers have split ourselves into two groups and take turns on market days. The Anlos come on Wednesdays and we the Tongus come on Tuesdays.[92]

Some of the women are willing to change from mangrove-centric livelihoods to others that are not mangrove-centric, or to add other alternatives to their mangrove-centric activities. The Anloga district FGD 1 participants are all willing to change to other livelihoods, because the quantity of fish smoked has gone down with the associated decline in the demand for mangrove fuel. They attribute the low fish catch to disregard for certain taboos within their communities, such as no child delivery and abortion.[93] This has led to the tidal waves becoming very rough and wiping communities away. Some people believe that this is a case of divine retribution.

Most of the inhabitants of the land have become Christians, hence traditionalists have drastically reduced in number; therefore the regular sacrifice done to appease the gods has also been reduced. Due to the inconsistency of the annual sacrifice the sea gods have decided to punish the people through low catch of fish.[94]

[88] Densu Delta individual respondent 1 (Tsokomey) September 2021.
[89] Densu Delta individual respondent 2 (Tsokomey) September 2021.
[90] Densu Delta individual respondent 1 (Tsokomey) September 2021.
[91] Densu Delta individual respondent 3 (Tsokomey) September 2021.
[92] Anloga district individual respondent 1 (Anyanui) October 2021.
[93] Women are supposed to move out of the community to deliver their babies and come back after delivery.
[94] Anloga district FGD 1 (Anloga) November 2021.

Those who are willing to change to other livelihood alternatives have indicated that they would be interested in anything that will fetch them money; for example start-up capital to go into minor investments such as soapmaking, pastries, vegetable farming, fish processing, and artisanal jobs such as auto mechanic. Some suggested livelihood alternatives such as tie-dye, fabric making, dressmaking, baking, and beekeeping, among others. Anloga district FGD 1 and 2 suggested alternatives that included petty trading in clothes, footwear, plasticware, sachet drinking water[95] and foodstuffs; poultry farming; animal husbandry; and auto spraying.

The Densu Delta FGD participants also mentioned start-up capital:

> *Oyster picking is a difficult job. We need start-up capital to change to other alternatives. One of us is a traditional birth attendant but needs recognition because she doesn't have any formal education.*

Densu Delta Institutional key informant 2 seconded this opinion:

> *Oyster picking is not an easy job therefore they may be willing to move to other jobs if the need be.*

The Anloga district FGD 2 members prefer mangrove nursery work to their fishing activities since it generates more income according to them.

While some are willing to change to other livelihood alternatives due to dwindling products over the years, a few are not willing to change, particularly in Anyanui, where they perceive the mangroves as never going extinct. They say that this is the profession they were born into, and the only job for which they have the skills. One respondent said:

> *…we are not willing to change to alternative livelihoods; we are okay with the fuelwood harvesting. We get sales from it and we keep replanting so it's always available and hence no need to change to other livelihoods. The mangroves will never finish.*[96]

For one respondent in Anloga, diverting from mangrove-centric activity was not likely because the mangrove plantation belongs to her and her husband: she said that if she wanted to stop and her husband did not permit it she would not be able to divert. However, if he agreed then she would be able to change to another alternative.[97]

The unwillingness to change to alternative livelihoods is similar to what Dali (2020) found; her findings revealed that mangrove users in Kakum and Pra were unwilling to change to other alternatives (see Section 2.7).

In the short term, the Anloga District Assembly plans to train people on alternative livelihoods such as beekeeping, soapmaking, dressmaking, and aquaculture. Anloga district institutional key informant 2 (October 2021) commented that:

> *It will be a disaster if we take away their livelihoods without replacing them with other livelihoods.*

The Anloga District Assembly is partnering with the Agriculture Department to introduce the use of low energy stoves for fish smoking to the community. According to the district development planning officer, this would reduce the amount of wood that is harvested. The Assembly also wants to scale up aquaculture in the district as this could provide an alternative livelihood for the people.

Anloga district institutional key informant 1 (October 2021) reported what WLD of FC is doing to ensure sustainability of the mangroves:

[95] Sachet drinking water is pre-filtered water or sanitized water in plastic, heat sealed bags.
[96] Anloga district individual respondent 1 (Anyanui) October 2021.
[97] Anloga district individual respondent 3(Atokor) November 2021.

We are now trying to liaise with some NGOs to come to the aid of the people. They can get a few locals and put them into apprenticeships and also get them some sources of income like soapmaking, tie-dye; something that can get them money; and also to establish woodlots.

WLD of FC is also trying to plant other trees (for example, acacia) so that the people can harvest them instead of the mangroves. According to Anloga district institutional key informant 1 (October 2021), the mangroves are mostly used by the fishmongers. Most of them are not near the assembling places of the mangrove fuelwood. They are at Keta and Anloga. Some also go to Anyanui, to buy and transport the fuelwood to places like Brekuso, toward Aflao, and use them.

3.6. CONSERVATION AND RESTORATION OF MANGROVES

3.6.1. NGO INTERVENTIONS, AND ACTIVITIES OF WOMEN IN CONSERVATION AND RESTORATION

Mangrove conservation and restoration interventions have been spearheaded by NGOs in Ghana (Armah et al. 2016) (see Section 2.8). A similar observation was made from the field. The Densu Delta benefited from an intervention by an NGO, the Development Action Association (DAA). DAA is a farmer-based NGO involved in fish processing, livestock rearing, cassava processing, vegetable production, and advocacy. Its objectives are to promote food security; reduce hunger and poverty; and encourage women to be independent. DAA has both farmer and fishery groups. In all it had 74 groups in the Central, Eastern, Oti, Volta, and Greater Accra regions. Most of the group (about 98 percent) is women. The few men are also doing fish processing with their wives.

At the Densu Delta wetlands, DAA, with the support of the Sustainable Fisheries Management Project (SFMP), restored the mangroves by replanting them, working with the oyster pickers. This restoration project was sponsored by SFMP and USAID for three years (2016–2018). Through this project individual oyster pickers who were beneficiaries of the project came together to form the association called Densu Oyster Pickers Association (DOPA), to manage the replanted mangroves. There are five communities in the Densu Delta wetland: Oblogo, Aplaku, Tsokomey, Bortianor, and Tetegbu. The oyster group members are from three of those communities — Tsokomey, Bortianor, and Tetegbu — which are not far from the project site. They nursed and planted 50 acres of red mangroves (see Photos 39 to 41). There is still more land for planting, and DAA is searching for funds to do the planting. The focus group discussion held at Tsokomey in September 2021 confirmed all of these. The DOPA members, mainly women, did the transplanting.

All of the young DOPA members who are involved in oyster picking and basket fishing were also involved in a mangrove restoration project. These women, together with the few men in the group, raised a mangrove nursery in 2016. They transported the mangrove seedlings in a boat to the planting sites and planted them. They put the seedlings in holes they themselves had dug, and covered the sides with soil. According to a male respondent the men raised the fencing. The planting was done all day long but only occasionally. It took about 10 minutes by boat to get to the project/planting sites.

As part of this project, the DOPA members were trained in oyster ecology and biology about suitable habitats for oysters (salinity, pH, etc.). According to Densu Delta institutional key informant 3 (September 2021), the members applied the knowledge they had gained. Some of the members were picked and trained to collect data on water quality for three months to know whether the water was conducive for oysters.

PHOTO 39: PORTION OF DOPA PLANTED MANGROVES ALONG THE DENSU DELTA

Source: Fieldwork September 2021. (Photo credit: E. Quaye)

This intervention has been sustained through comanagement with DOPA, the traditional authorities, and the Ga South Municipal Assembly.[98] Both Densu Delta local key informant 1 and Densu Delta institutional key informant 2 confirmed this, and added that the municipal assembly always participates in DAA's meetings. Densu Delta local key informant 1 did express regret that the assembly does not play any significant role in the conservation of the mangroves. He added, though, that there is a committee, which a staff of DAA is a member of.

In the Anloga district a few NGOs have started collaborating with the Wildlife Division (WLD) of the Forestry Commission (FC) on restoration programs and projects. The Development Institute (TDI) is one of these collaborative NGOs. It has established a community-based organization (CBO) called the Mangrove Planters Association. The members are women and men along the Angor Lagoon near Gblipke whose aim is to plant mangroves both as a group and as individuals. The chairperson of the group is a woman, and the women in the group perform the same activities as the men. The WLD of FC supplies TDI with mangrove seedlings and also partners with it in undertaking restoration programs. Photos 42 and 43 show members of the Mangrove Planters Association in a restoration program that was sponsored and organized by TDI in collaboration with WLD of FC in November, 2021. Our finding agrees with the finding at the national level: women conveyed the seedlings and planted them as the men dug the holes (see Section 2.9).

[98] Densu Delta institutional key informant 1 (Kokrobite) September 2021.

PHOTO 40: ANOTHER PORTION OF DOPA PLANTED MANGROVES ALONG THE DENSU DELTA

Source: Fieldwork September 2021. (Photo credit: E. Quaye)

PHOTO 41: AANOTHER PORTION OF DOPA PLANTED MANGROVES ALONG THE DENSU DELTAELTA

Source: Fieldwork September 2021. (Photo credit: E. Quaye)

PHOTO 42: WOMEN PUTTING SEEDLINGS IN DUG HOLES

Source and photo credit: Ocloo-Tetteh, WLD of FC November 2021

PHOTO 43: MAN DIGGING HOLES, WOMEN PUTTING SEEDLINGS IN DUG HOLES

Source and photo credit: Ocloo-Tetteh, WLD of FC November 2021

Seawater Solutions Ghana (SwS) collaborates with WLD of FC in mangrove restoration programs. Photos 69 and 70 show some of the restoration activities SwS organized and sponsored in September, 2021, working with WLD of FC. They engaged Fiaxor community members in planting mangrove seedlings. SwS engages some of the members of the group that it had trained in raising nursery in the mangrove replanting or restoration programs. Arocha, an NGO, has also started collaborating with WLD of FC.

The International Union of Conservation of Nature (IUCN) has awarded two projects in the Anloga district; one to Arocha, for the creation of alternative livelihoods for the fringe communities that have been depending on the mangroves. The other has been awarded to Kwame Nkrumah University of Science and Technology, to study the hydrological condition of the mangroves.

World Mangrove Day, July 26, 2021, was launched in Anyanui. The WLD of FC, in collaboration with TDI and IUCN, organized and commemorated the day at Anyanui to sensitize the communities to the importance of mangroves (see Photo 44). The day was focused on advocacy and education on replanting and sustainable harvesting. As one of the core practices, the people were asked to leave some buffer habitat restoration.[99]

PHOTO 44: COMMEMORATION OF WORLD MANGROVE DAY, ANYANUI

Source and photo credit: Ocloo-Tetteh, WLD of FC September 2021

There is also a community group formed by a local NGO, Keta Ramsar Centre. Members are women and young people, and they engage in planting mangroves. The Keta Ramsar Centre also educates the people and chiefs on the importance of mangroves in the ecosystem, so as to allow planting within their communities. This happens at the national level as well (see Section 2.8 Conservation and Restoration of Mangroves), where Oppong-Ansah (2018) reported that a local NGO, Hen Mpoano, was supported by the USAID-Ghana SFMP to educate communities about the benefits of the mangrove forests.

3.6.2. CONSERVATION PRACTICES

Conservation culture among the people of Anloga district is laudable because harvesting of mangroves is their primary source of income. Some have taken the replanting so seriously that they are even going beyond the regulations on tree planting. Anloga district institutional key informant 2 (October 2021) remarked that there is a bylaw that says when you cut one tree you plant one tree, and the communities are doing well with this practice. He emphasized:

[99] The communities were asked to replant mangroves in the degraded buffer zones to protected the replanted mangroves from negative external pressures..

Having gone round to the various communities during an impact assessment, they have even gone beyond the bylaw by not replacing with one but replacing with two when they cut one tree. The people at Dzita and Aynanui Area council, to be specific, have placed measures that when they cut one, they would plant two.

Anloga district individual respondent 1 (October 2021) also affirmed that when they harvest the trees, they also replant. However, according to Anloga district institutional key informant 1, some people claim they have planted mangroves after harvesting but have not actually done it. Some of the mangrove plants grow naturally but according to some of the respondents, they do not grow well because they are not properly spaced. They usually clump together, hence the stems are very small.

WLD of FC in Anloga educates the public periodically and advises them that they should always leave some mangroves during harvesting as a buffer so that the fishes can breed there. Habitat restoration is one of the core mandates of WLD of FC; because one of its management practices is restoration of the mangroves. The WLD of FC provides the communities with seedlings to plant, and it embarks on restoration projects when it obtains funds. It occasionally undertakes afforestation projects and involves community members, including women. Anloga district individual respondent 2 indicated that she had been engaged in WLD of FC restoration projects for about four years. Some of these restored mangroves are at Dornogbor near Anloga, and Salo in the Anloga district. The WLD of FC sought consent of the landowners prior to any replanting that it did.

WLD of FC plans to establish more woodlots, for example with acacia trees, so that acacia can be used as fuelwood instead of mangrove. To encourage community members to establish woodlots, WLD of FC gives them fruit tree seedlings. WLD of FC has nurseries for red, white and black mangroves (see Photos 45 and 46), as well as woodlots.

The Anloga District Assembly has a high stake in the restoration of mangroves. In their development plan they have concerns about mangrove restoration.

We have a four-year plan of mangrove restoration. We have in the plan, the need to educate the public about the importance of mangroves.

In the medium term the Assembly hopes to acquire land banks so that they can go into mangrove plantation and ensure proper monitoring and sustainability of the mangroves within those areas. In this regard the land will not be in the hands of individuals who will harvest the trees unsustainably.

PHOTO 45: PORTION OF MANGROVE AND OTHER WOODLOT NURSERY OF THE WILDLIFE DIVISION IN ANLOGA

Source: Fieldwork October 2021. (Photo credit: N. A. Anokye)

PHOTO 46: PORTION OF NURSERY SHOWING RED MANGROVE AND PAWPAW SEEDLINGS, ANLOGA

Source: Fieldwork October 2021. (Photo credit H. M. D. Potakey)

3.6.3. CHALLENGES WITH THE CONSERVATION AND RESTORATION OF MANGROVES

The challenges facing restoration programs and projects in our two study areas are listed below:

» One of the main challenges the DAA/DOPA faced with the restoration project in the Densu Delta was with fishermen, who were difficult to work with because of their *atidja*.[100] The group initially faced some stiff opposition from local fishermen because they feared that the restoration project could deprive them of the *atidja* that they use in trapping the fish.[101]

» In the Densu Delta, DAA/DOPA has land available to plant more mangroves but they lack funding. The following quotes also indicate lack of funds for restoration projects and for training people in alternative livelihoods in the Volta region:

The Wildlife Division lacks funds to hire planters. These planters have to be paid before they do the planting. Most funds meant for restoration go to NGOs. State funds allocated to Forestry Commission are used for other activities, such as ecological monitoring of birds and turtles.[102]

There is a lack of funds to train people in alternative livelihoods for them to stop depending on mangroves. The Anloga District Assembly is in debt already.[103]

» The Anloga District Assembly faces the challenge of accessing land for mangrove plantation because of the ownership regime in this area, where lands are owned by individuals and families. The landowners are not ready to release land.

On access to land, for instance, there is a settlement that had to be relocated because the sea had taken over the settlement. The resettlement land that we had too; there are plans to even take the land from us.[104]

» Nonadherence to bylaws is also a challenge in the Anloga district.

There are challenges with enforcement as some of the community members do not adhere to the bylaw of cut-one-plant-one tree. They don't respect the bylaw so they go in the night and cut down the mangrove trees and they do not plant.[105]

» The Wildlife Division in Anloga has insufficient staff. It has only six staff managing 530 km^2 of the wetland.

» Logistical constraints are among the other challenges regarding mangrove restoration progams and projects. The Wildlife Division in Anloga has to rent boats for their monitoring activities. In the Densu Delta, DAA/DOPA also had difficulties in getting boats to go to the project sites. They had to hire boats all the time.

» The Mangrove Planters Association in Gblikpe has the challenge of low patronage of their members in their mangrove planting activity. Most of the time the members are in a hurry to go back to their selling business to earn their daily income.

The planting exercise takes time, almost the entire day … the members therefore are reluctant to spend the whole day without any earnings … what will they use to feed their families if they spend the whole day on planting?[106]

[100] Densu Delta institutional key informant 1 (Kokrobite) September 2021.
[101] The fishermen continue to have access to the community owned mangroves for the *atidja* and not the DAA/DOPA planted mangroves.
[102] Anloga district institutional key informant 1 (Anloga) October, 2021.
[103] Anloga district institutional key informant 2 (Anloga) October 2021.
[104] Ibid.
[105] Ibid.
[106] Anloga district local key informant 2 (Gblikpe) October 2021.

» In Dakordzi, initially individual mangrove nursery owners had strong interest in the nursery but their enthusiasm has weakened, because the monies that were supposed to be paid to them by the NGO have not been paid. The seedlings are ready for transplanting but they are not being bought by the NGO as arranged. The owners feel they are wasting their resources as they have to nurse the seedlings until they are bought by the NGO. The NGO is searching for fields where it can transplant the seedlings before it buys the seedlings. The land issues go with a lot of delay due to the long process of gaining permission for use of the land. The heads of the clans are not easily accessible.

3.6.4. DEMOGRAPHIC AND SOCIOECONOMIC CHARACTERISTICS OF WOMEN ENGAGED IN MANGROVE CONSERVATION AND RESTORATION

The women engaged in mangrove conservation/restoration along the Densu Delta are the DOPA women. Their characteristics are discussed in Section 3.3. However, the women in conservation/restoration planting mangroves along the Angor Lagoon are women who belong to the Mangrove Planters Association. They are Ewes, and natives of the area who have resided in their current communities since their birth. Their highest level of formal education attained is the basic level. Some of them are married and others are single. They are traditionalists and Christians and belong to the low-income class. This corroborates with what Expert 2 attested:

> *… most of them have lived in their communities for a long time - as long as 40 years or more. Household income of these women is low. Their level of education is also very low and they have varied marital status.*[107]

Other individual respondents who indicated that they have been involved in restoration programs along the Angor Lagoon are aged 41, 42 and 57 years; they have a basic level of education; two are married and the other is divorced. They are Ewes and indigenes; Christians; and are from low-income households. They have an average of three children, typically with all three in school; the average household size is five, with four dependents (see Table 2 for summary).

TABLE 2: DEMOGRAPHIC AND SOCIOECONOMIC CHARACTERISTICS OF WOMEN IN MANGROVE CONSERVATION AND RESTORATION

Characteristics	Densu Delta	Anloga district
Age (years)	21–44	41–57
Level of Formal Education	No formal education to Secondary (High school) level	Basic level (primary and junior high)
Ethnic Group	Gas, Ewes	Ewes
Indigenes	Gas	Ewes
Migrants	Ewes (majority)	None
Marital Status	Single, married, widowed	Single, married, divorced
Religion	Christians & Muslims (majority), traditionalists	Christians, traditionalists
Income Level	Low	Low

[107] Conversation with Expert 2 (Accra) July 2021.

Characteristics	Densu Delta	Anloga district
Number of Children	3–7	3 on the average
Number of Children in School	3–4	3 on the average
Household Size (includes dependents)	5–17; 6 on the average	5 on the average

Source: Interviews and FGDs (Densu Delta and Anloga district September, October and November 2021)

3.7. MEMBERSHIP IN COMMUNITY GROUPS

3.7.1. GROUP DYNAMICS

Some of the DOPA women oyster pickers along the Densu Delta are members of other community groups, such as those described in this subsection.

One example is **Village Savings and Loans**. The treasurer and secretary of this group, and the other members, are women oyster pickers and members of DOPA. The aim of this group is to promote savings among the members; make loans available to them; and support members, particularly in times of bereavement. The aim of the women in joining the group is to be able to save money and also to access loans.

One individual respondent (an oyster picker) was a member of a community group called **Dughaza Self Help** for two years. The group was in existence for over ten years. It collapsed and was revived. She joined the group for welfare purposes, and for savings and loans. She was able to voice her interests and concerns, and to mobilize members to send their grievances to the group leaders while she was with the group.

There are few community-based groups in the communities in the Anloga district: this is because the people like to do things individually.[108] The Mangrove Planters Association is a group of both men and women. Though the men outnumber the women, the chairperson is a woman. Asked how she became the chairperson, she responded:

> *I was chosen as the leader of the group because during the sensitization and training by the NGO (TDI), I was identified as being assertive and having the knowledge and a lot of experience with the oyster and mangroves.*[109]

The aim of this group is to plant mangroves as a group and as individuals. The women are able to voice their interests and concerns. The women are free to speak, as the chairperson explained:

> *Everybody is free to express his or her concerns. Imagine I, a female, being the leader of a group that has some males, means a lot, no intimidation, yes, the women are free to express themselves.*[110]

However, the group's voice is limited to being heard only at the community level.

[108] Anloga district institutional key informant 2 (Anloga) October 2021.
[109] Anloga district local key informant 2 (Gblikpe) October 2021.
[110] Ibid.

The community members that SwS engages to work in its mangrove nursery at Atorkor, are involved in the collection of mangrove seeds and seedlings, making seedling bags, raising seedlings, and planting them in degraded areas.

Anloga district individual respondent 4 has been a member of the **Agbadza dancing group**, which consists of both men and women, for three years. Her aim of joining the group is to have a befitting burial when she dies; the group performs dances at the funerals of its members. Members contribute GH₵1.00 each per gathering. She is able to present her interests and concerns in the group.

One respondent is a **choir leader in her church group**. Two individuals and participants of the Anloga district FGDs belong to church groups that consist of both women and men in their respective churches. Their aim is to worship God. One respondent added that it is also to receive support in a time of bereavement. Only one participant of Anloga district FGD 2 belongs to a social group; the rest do not due to financial constraints.[111] However, participants of Anloga district FGD 1 are also members of various social groups; these are **Kugbeta, Vovoli, Wonder Welfare Group, and Control Welfare Society**. Some have been members for over 20 years; others have been members for just one or two years. Their aim in joining the social groups is to have befitting burials and funerals when they die. One participant said:

> *The group will have funeral cloths branded in the dead member's name and a very beautiful coffin.*[112]

They are able to voice their concerns and interests in the church groups. However, they are not able to do so in the social groups that they join. This is because the church welcomes everyone, no matter ones socioeconomic status but they feel intimidated in the social groups because of their low economic status. The church groups are able to influence decisions in the church and also promote their interests. The social groups are also able to influence decisions at the community and district levels.[113]

3.7.2. CHALLENGES FACED IN THE GROUPS

Village Savings and Loans Group The main challenge that confronts the women in this group is that they find it difficult to save any money, since their income level is so low. Their situation is worse during the closed season of oyster picking. Some women have dropped out of the group as a result. Another challenge is the difficulty in mobilizing members because they demand money to replace their time spent at meetings.

Mangrove Planters Association The main challenge for these members is transportation; difficulty in getting boats for them to go around picking seeds, and taking seedlings to the planting sites.

Agbadza group Here the challenge is the lateness of members to group meetings. Their reason for the lateness is that they have to look for funds to pay their contribution at the meetings. The social groups generally face the problem of lateness among members.

The **church groups** are not able to commit to the decisions that have been made, and some church group members are not able to contribute to support members' welfare. There are also petty quarrels in some of the church groups.

3.8. WOMEN'S GROUP AND MEMBERSHIP

As mentioned above, the Densu Oyster Pickers Association (DOPA), is one of the DAA groups who were beneficiaries of a restoration project that came together to manage the replanted mangrove along the Densu Delta (see Section 3.6.1). The DOPA members are mainly women, with a few men. The group had been in existence for four years at the time of data collection in September 2021. The aim of DOPA is to sustain oyster harvesting by protecting and building the Densu Delta. One individual

[111] One has to make financial contributions as a group member.
[112] Anloga district FGD 1 (Anloga), November 2021.
[113] Community level is the local level. District level is higher than the local or community level but lower than national level.

respondent said that she had joined DOPA, like some of the others, to learn how to manage the oysters. This individual respondent said that she feels free to say whatever she wants to say. Densu Delta institutional key informant 1 also confirmed that the women are able to voice their interests and concerns in the group. She added that:

> … *they push their ideas at meetings and claim what is theirs. The group is able to influence decisions at high levels, as high as the national level. They once faced the Minister of Fisheries.*[114]

Some women's groups are church groups. One participant of the Densu FGD has joined a women's self-help group called **Tsokomey Deawowo,** which is a church group. One respondent in the Anloga district has been a member of church women's welfare group for 18 years. Her reason for joining was to have support when bereaved. According to Anloga district institutional key informant 2, there are a few women's groups but they are involved in other things that are not related to mangroves.

3.9. RULES AND REGULATIONS

According to Densu Delta institutional key informant 2 (September 2021), the Ga South Municipal Assembly seems to have no bylaws on the use of mangroves, since the mangroves are not considered to be important. In the Densu Delta wetland there seem to be some rules and regulations concerning mangrove-centric activities, and the harvesting of mangrove products under their restoration project. The rules are set by DAA and DOPA, and are implemented and enforced by the management committee, which consists of DOPA members from the three oyster-picking communities (Bortianor, Tsokomey and Tetegbu).[115] These rules ban the harvesting of mangroves that have been planted or restored by DAA/DOPA. They may be harvested after ten years from 2016 since they serve as attachment for the oysters.[116] Densu Delta institutional key informant 1 (September 2021) explained that:

> … *the community realized that we planted the mangroves and that they are not theirs so they can't harvest them. They do not cut it because we have gone into comanagement with the community.*

The Densu FGD revealed that the community has adapted the DOPA rules; they now harvest the community-owned mangrove every other six months. One individual respondent confirmed this:

> …. *the communities in the Densu Delta wetland, upon seeing how healthy the DAA/DOPA restored mangroves are have adapted the DAA/DOPA rules and they harvest the community-owned mangroves every other six months.*

DAA/DOPA has also instituted a closed season for oyster harvesting, from November to April. They also have bylaws that ban the harvesting of small oysters.

There are bylaws regarding the collection of periwinkle within the Anloga district. Collection is prohibited on certain days — for example a day before Anlo market days. Anlo market days are rotational, so the prohibited days are not fixed.[117] These are set and enforced by the traditional authorities. Anloga district institutional key informant 1 (October 2021) indicated that there are neither rules, regulations nor bylaws that protect the mangroves, nor that govern the harvesting of mangroves.

> *There is no bylaw, but since mangrove harvesting is a major business the harvesters replant so they will have some to harvest in the future.*[118]

However, Anloga district institutional key informant 2 (October 2021) indicated that:

[114] Densu Delta institutional key informant 1 (Kokrobite) September 2021.
[115] Densu Delta institutional key informant 3 (on phone) December 2021.
[116] Densu Delta FGD; Densu Delta local key informant 1; Densu Delta individual respondent 1 (Tsokomey) September 2021.
[117] Anloga district local key informant 2 (Gblikpe) October 2021.
[118] Anloga district local key informant 5 (Anyanui) October 2021.

The Assembly has a bylaw that regulates human activities in space. As part of issues in the bylaw, there is an element on cutting of trees. There is a clause that says that when you cut one tree you have to plant one tree … this could be stretched to include mangrove trees.

There are some bylaws but it seems that some of the people are not aware of them. A similar observation was made by USFS-IP (2018) when they realized that community members were not aware of the bylaws governing wetland areas in the Shama and Akwidai areas (see Section 2.11).

3.10. SUGGESTIONS BY RESPONDENTS

The respondents made several suggestions that would improve the health of the mangroves, they are listed here:

Suggestions from the Densu Delta:

» To reduce the dependency on mangrove-related products there should be training of oyster pickers in alternative livelihoods like soapmaking, baking (bread, biscuits). There could be training of trainers who in turn could train the pickers in these alternate trades.

» The respondents suggested planting more mangroves, since there is land available for that. They are asking for mangrove seedlings to plant.

» A member of DOPA suggested intensive guarding of the mangroves.

» Densu Delta institutional key informant 1 (September 2021), and a member of DOPA suggested comanagement between the communities, the district assembly and the NGO (DAA).

» Densu Delta institutional key informant 2 (September 2021) suggested educating community members so that they will stop cutting the mangrove for fuelwood.

» Densu Delta institutional key informant 2 (September 2021) suggested that the Assembly's involvement should go beyond attending meetings of the DAA and support by funding. He added that the Assembly should invite some members of the women's group, the chairperson or any other person from the group, to the Environmental Health Subcommittee meetings so that the Assembly will come to understand their challenges and what they could do to help. According to this interviewee, the Environmental Health Unit does community engagements, and could factor in the issues of mangrove conservation.

» The DOPA members need market outlets for processed and packaged oysters. They have acquired training in the processing and packaging of oysters but there are no market outlets for them.

Suggestions from Anloga District:

- Mangroves should be planted in soft muddy areas, since they strive better in muddy soil.
» Mangroves should be planted with enough spacing between the seedlings.

» Planters should be encouraged to plant black and white mangroves because they attract honey-making bees; also, the seeds of the black mangrove have a pleasant scent.

» Setting fires in the mangrove forest should be avoided because bushfires burn the replanted mangroves.

» There should be a way of controlling the caterpillars which invade the mangroves.

» The fringes of the mangrove forest should not be harvested; they should be left as a buffer zone to serve as breeding grounds for fish.

- The government must implement buffer zone laws to ensure that the mangrove harvesting is sustainable.

» Encourage fish smokers to use "smart stoves," which use less fuelwood to smoke fish.

• The use of the neem tree as fuelwood should be encouraged, since it also enhances the taste of the smoked fish and has the same preservative attributes of mangrove fuelwood. Therefore we should have a neem tree woodlot.

» Women should be trained into other ventures, like soapmaking and baking, to reduce dependency on the mangrove.

» Preference should be given to vulnerable female single parents who pick mangrove seeds and seedlings for the Wildlife Division whenever there is training or support.

» The people should be sensitized to the importance of planting after harvesting, and waiting until the new plants mature before harvesting them.

CHAPTER 4.
CONCLUSIONS AND RECOMMENDATIONS

4.1. CONCLUSIONS

The conclusions for this study emanate from the key findings from both the literature review and the empirical study. Mangrove-centric activities in Ghana include: the cultivation of mangroves; timber logging for construction; mangrove fuelwood harvesting for fish smoking and domestic purposes; and the harvesting of mollusks and oysters, fish (tilapia), crabs, periwinkles, and herbs.

Both genders are engaged in mangrove-centric activities to varying degrees, depending on the specific product and location. Therefore the type of mangrove-centric activity engaged in by women is product and location-specific. The main activities within the study areas are oyster picking and harvesting, fishing, and mangrove harvesting. The activities are engaged in by both women and men but women dominate in oyster picking and harvesting. The women in the Densu Delta are engaged mainly in oyster picking, while in the Anloga district they are involved in both oyster and mangrove wood harvesting. Mangrove as fuelwood is very important in the coastal regions of Ghana. The mangrove species, *Rhizophora mangle* and *Laguncularia racemosa* ranked third, after *Albizia zygia* and *Celtis mildbraedii,* among the types of fuelwood harvested for sale across the coastal regions.

Activities along the mangrove wood value chain (harvesting, sorting, arranging, tying and selling) are major livelihood activities in Anyanui and its environs. They serve as the primary source of income for the people, and hence form a major livelihood for the communities living in the mangrove areas along the coast of the Volta region. The oysters are used for both commercial and home consumption in both the Densu Delta and Anloga district.

The coastal areas of the Volta region are occupied by wetlands; the Ewes, who are the natives of these areas, are involved in wetland-related activities. They are born into them and thus they develop or acquire the skills needed to carry out mangrove-centric activities. They are very skilled in these activities; hence it is their main occupation. This explains why in the Volta region wetland, mangrove-centric activities are carried out by the natives (Ewes) but outside the Volta region (for example, in the Densu Delta) these activities are carried out mainly by Ewes who have migrated there.

Generally speaking, mangroves in both study areas have been degrading. In the Densu Delta they have been depleted even though the intervention of an NGO (DAA) has improved the state of the mangroves a bit. Degradation of the mangroves in the Anloga district has been gradual. In both places there is a need to increase the pace of restoration and conservation. The cycle of harvesting and replanting, which hardens the soil, has to be addressed.

In spite of the general dwindling of the mangrove products in the Anloga district, the dependency of the women on the mangroves is still high, because they have limited alternatives. Furthermore, mangrove-centric activities are their only known occupation. Comparatively, the women in the Densu Delta are more willing to adopt other livelihood alternatives. There have been some conservation/restoration interventions involving women who are involved in mangrove-centric activities. In general, the participation of women in mangrove restoration projects in the study areas is location-specific.

Chiefs and clans or families own land in the Ga South district, while individuals and families own land in the Anloga district; this has implications for acquiring land for restoration projects, since consent has to be sought from the landowners whether they are individuals, families, or chiefs. The main challenges with restoration projects have to do with the acquisition of land for planting by Anloga District Assembly and SwS; and resource constraint encountered by state institutions such as WLD of FC and the Anloga District Assembly.

4.2. RECOMMENDATIONS

Our recommendations are based on the key findings from our literature review (at the national level) and our field studies (at the local level) on how to support the protection and restoration of mangrove habitats in Ghana.

» The use of mangrove-centric products needs to be regulated through sensitization and education of the public regarding the importance of sustainability.

» The rules and regulations concerning mangrove usage should be widely promulgated and enforced.

» To reduce the dependency on mangrove-related products there is an urgent need to provide alternative livelihoods. This should be tied to training and the provision of start-up capital.

» Sustainable, beneficial roles for whole communities, including women, in mangrove restoration projects should be identified; rather than roles with only immediate economic benefits.

» Additional research should be carried out in the Western, and Central coastal regions in order to establish generally the nature of women's participation in mangrove-centric activities and mangrove restoration projects in Ghana.

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GLOSSARY

Accra	Capital city of Greater Accra region and Ghana.
Amuti	Local name for *Laguncularia racemosa.*
Angor Lagoon	The Angor Lagoon connects the Keta Lagoon (a coastal Ramsar site) to the Volta River. It is at the coast of Volta region.
Anloga	Capital town of Anloga district.
Anloga district	It is in the Volta region.
Anlos	They are a group of Ewes in the Anloga district. They alternate with the Tongus in bringing their mangrove wood to the Anyanui market.
Anyanui	A town in the Anloga district in the Volta region. It has a big mangrove wood market
Atidja	A practice by fishermen in which they leave tree branches, twigs and leaves in the lakes or lagoons as bait to attract fish.
Atorkor	A community in Anloga district.
Atra	Local name for *Rhizophora mangle.*
Basic education	From first to ninth grade. It is for children between 6 and 15 years (primary and junior high).
Bortianor	A community located in the Densu Delta Wetland.
Cape Coast	Capital city of the Central region.
Closed season	Closure of the water body (Densu Delta) — Oyster picking is not allowed in the water.
Dakordzi	A community in Anloga district.
Densu Delta	It is at the west coast of the Greater Accra region.
Esa	Local name for *Celtis mildbraedii.*

Ewe	Ewe is a tribe in the Volta region. The Ewes originate from the Volta region.
Fetish priest	Traditional religious leader.
Ga	Ga is a tribe in the Greater Accra region. The Gas originate from the Greater Accra region.
Gblipke	A community in Anloga district.
Greater Accra region	It is one of the coastal administrative regions in eastern part of Ghana.
Okoro	Local name for *Albizia zygia.*
Primary education	From first to sixth grade. It is for children between 6 and 12 years. The first six years of basic education.
Purposive sampling technique	It is "a group of nonprobability sampling techniques in which [people or] units are selected because they have characteristics that are needed in the sample,… [i.e.] units are selected 'on purpose'." Nikolopoulou, K. 2022.
Sachet drinking water	Filtered water or sanitized water in plastic, heat sealed bags.
Secondary education	From seventh to twelfth grade. It is for children between 16 and 18 years (junior high and senior high).
Snowball sampling technique	"Snowball sampling is a nonprobability sampling technique where new ... [respondents are recommended or selected by other respondents] to form part of the sample." Nikolopoulou, K. 2022.
Stool	The stool is the seat of the chief. Ownership of some lands in Ghana is vested in stools and the chief is the custodian of stool lands.
Tongus	They are another group of Ewes living on the other side of the Volta River. They alternate with the Anlos in bringing their mangrove wood to the Anyanui market.
Tsokomey	A community located in the Densu Delta Wetland.
Volta region	It is one of the coastal administrative regions in the extreme east of Ghana.

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GPS Global Program on Sustainability

WACA West Africa Coastal Areas Management Program

NDF Nordic Development Fund

PROBLUE

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TECHNICAL REPORT

UNDERSTANDING THE NEXUS OF MANGROVES AND WOMEN IN GUINEA-CONAKRY

Photo credit: Yalikhan Camara

MARCH 2023

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FOREWORD

Guinea, a developing country with immense natural resources and geographical scope, is currently one of the countries most at risk from environmental degradation, whose repercussions on the living conditions of poor and vulnerable populations are manifested in socioeconomic imbalances.

In order to better understand the relationship between mangroves and women in the Republic of Guinea, the West Africa Coastal Areas (WACA) Program - Resilience Investment Project (ResIP) initiated this analysis of the role of women in the use and rehabilitation of mangroves in West African countries in general, and in Guinea in particular.

Faced with the enormous challenge of reversing the trend of soil and subsoil erosion, flooding, and pollution in coastal regions, this study addresses issues related to the conservation and/or restoration of an endemic species that has become a world asset—the mangrove—because of its ecological and ecosystemic importance. In addition to the diagnosis conducted, the study also proposes solutions to deepen the dialogue between coastal countries and technical and financial partners.

The study allowed for a better understanding of the link between the mangroves and Guinean women through research and field surveys on the selected sites, namely, Kaback, Kanfarandé, and Kamsar. It also generated innovative data to help build capacity and knowledge to save the mangroves along the coastline.

It aims to generate data to help strengthen the knowledge of both government and nongovernment actors to better manage issues pertaining to the relationship between mangroves and women and the livelihoods of communities dependent on mangrove products. It will also enable the government to adopt specific measures to provide appropriate solutions to these communities and strengthen their resilience in a sustainable manner, given that the study has helped shed light on the extreme vulnerability of women living in coastal areas and their heavy dependence on mangrove products.

Lastly, this study has generated innovative data to help build capacity and knowledge to save mangroves and restore degraded areas, while proposing appropriate solutions to these communities to reduce their dependence and strengthen their resilience on a sustainable basis.

ABBREVIATIONS AND ACRONYMS

CBG	Compagnie des Bauxites de Guinée
DPEDD	Prefectural Directorate of the Environment and Sustainable Development
DPEDD	Prefectural Directorate of the Environment and Sustainable Development
EIG	Economic Interest Group
GAC	Global Alumina Corporation
IGA	Income-Generating Activity
MEDD	Ministry of the Environment and Sustainable Development
MPA	Marine Protected Areas
MPEM	Ministry of Fisheries and Maritime Economy
MSI	Mouvement Sauvons nos Iles
NGO	Non-governmental organization
OGM	Maritime Guinea Observatory
OGUI	Guinean Timber Board
PDL	Local Development Plan
PMA	Protected Marine Area
PRAO	West Africa Regional Fisheries Project
PRCM	Regional Partnership for Coastal and Marine Conservation
PREM	Partenariat Recherches Environnement Médias
RC	Rural Commune
ResIP	Resilience Investment Project
SDAM	Mangrove Development Master Plan
SDAM	Mangrove Development Master Plan
SPFF	Forest and Wildlife Prefectural Division
TFPs	Technical and Financial Partners
WACA	West Africa Coastal Areas

EXECUTIVE SUMMARY

This report focuses on the results of the study on the relationship between mangroves and women in the Republic of Guinea, funded by the World Bank under the West Africa Coastal Areas (WACA) Program - Resilience Investment Project (ResIP). This program was established in April 2018 by the World Bank to build resilience in targeted communities and areas in the West African coastal zone. The goal of this program is to gain a structural understanding of the benefits derived from mangrove products by women and the role they play in mangrove conservation.

The context and objectives of the study favored the use of an approach based on four basic methods for collecting information in qualitative research, namely, an interview with 10 key informants from the decentralized services of the Ministry of the Environment and Sustainable Development (environmental agents, water and forests, coastal management center, NGOs, and so forth) in the prefectures of Boké and Forécariah; and interviews with 20 local elected officials in the prefectures of Forécariah and Boké (district chiefs, elders, members of the assembly and leaders of community organizations or civil society), and semistructured individual interviews with 64 rural households in the districts of the three subprefectures of Kaback, Kanfarandé, and Forécariah. Several complementary tools were used, including interviews with institutional stakeholders in Conakry, focus groups, and an observation study to gain a better understanding of the relationship between women and mangroves in the Republic of Guinea.

THE RELATIONSHIP BETWEEN WOMEN AND MANGROVES – PERCEPTIONS, INTERVIEWS, BELIEFS, AND PRACTICES OF RURAL HOUSEHOLDS IN KABACK, KANFARANDE, AND KAMSAR

The report states that 35 percent of women in rural households interviewed in the districts of Bossimiyah, Seydouyah, Matakan, Bolimanda, Youlayen (Kaback); Kanof, Kankouf, Tesken (Kanfarandé); and Taigbé and Taidi (Kamsar) say that the mangrove forest is currently depleted because of the advance of the sea toward the mainland and the construction of roadsteads by mining companies. About 65 percent of the women interviewed believe that the number of people who are dependent on mangrove forest products has increased. This degradation of the environment is essentially due to human activities.

Among the human activities responsible for the degradation of the mangrove ecosystem, logging (cutting mangrove wood) for construction, cooking, and sale is the most important; fish smoking, which requires copious quantities of fuelwood, and traditional salt production are of secondary significance. Of the respondents of both sexes, 85 percent believe that

mangrove wood harvesting is the main cause of mangrove degradation, while 15 percent point to oyster picking and rice cultivation as explanatory factors of mangrove depletion.

For women directly linked to the mangrove, this degradation is manifested by the decrease in socioeconomic profitability for women fish smokers (as a result of the destruction of young fish habitats) and women oyster pickers. For rice farmers facing coastal erosion, this is due to the loss of cultivable or arable land caused by the increase in salinity. The only alternative for these vulnerable people is to help them shift to other income-generating activities such as small-scale trade, market gardening, the establishment of economic interest groups, and the financing of microprojects.

The majority of the women interviewed in the three localities have had no education. Eighty-four percent of the women interviewed stated that they had an intellectual disability, that is, they had not received any formal education, while 10 percent had completed basic education, or primary school, and 6 percent had received a high school education. In terms of age groups, 35 percent of the women interviewed are 20 to 35 years old; 37 percent are between 35 and 46 years, and 28 percent are 46 years or more.

The women who depend on mangrove products are Indigenous and affirm that they cannot abandon this resource unless the governments makes available to them new techniques that will allow them to meet their needs through income-generating activities (IGAs) and other alternative activities adapted to their environment and way of life. These include general trade, or small business (stores), funding for microprojects (agriculture, African textiles), among others. Products derived from harvesting mangrove are intended primarily for the domestic consumption of households and for sale.

The survey respondents are aware of the loss and degradation of mangrove areas, which affect the socioeconomic activities of the dependent populations.

In addition, 84 percent of women in the three localities visited said that they had never experienced mangrove restoration or rehabilitation projects in their locality, while 13 percent affirmed that there have been such projects in the past but that they were short-lived. These mangrove restoration efforts have mainly concerned reforestation and the prohibition of wood cutting in some places.

In some areas, the mangrove is conserved by the community through various approaches, but with no restrictions on access. Ninety percent of the women interviewed said that access to the mangroves is open to local residents, while 10 percent said that they are family-owned, and access is controlled.

Salt production, market gardening, and rice growing are seasonal, while fish smoking and logging are annual activities.

Overall, the study shows that women use mangrove products for household survival needs, despite the fact that they do not have the means to restore the mangroves and are, in fact, exerting considerable pressure on these mangroves. We are witnessing an antagonism between livelihood and conservation needs. In particular, it is the relationship of dependence between factors related to socioeconomic needs and environmental degradation that explains this situation. In terms of conservation, households are dealing with a lack of means to participate in the diversification of activities or in the monitoring of the mangroves.

The employees of the decentralized government services who were interviewed confirmed that the government, through its Ministry of the Environment and Sustainable Development (MEDD) and the Ministry of Fisheries and Maritime Economy (MPEM), has representatives in the three subprefectures covered by the study. The nature conservationists represented by the forestry agents are mandated to monitor the coastal zones against poaching and environmental destruction in all its forms, but they lack equipment and adequate techniques to provide a quality service.

Since the mangrove areas are not under high surveillance, loggers have adopted a new clever mangrove harvesting technique: they harvest wood deep inside the mangrove (the interior) and leave the exterior to nature. At a glance, the mangrove appears to be flourishing and reflects a beautiful and preserved natural landscape; however, when one ventures into the interior, the damage is visible.

INTRODUCTION

As part of the implementation of the activities of the West Africa Coastal Areas (WACA) Program - Resilience Investment Project (ResIP), established in April 2018 by the World Bank to build resilience in communities and targeted areas in the West African coastal zone, investments in green and climate-resilient infrastructure are planned, particularly in mangrove management and restoration.

Indeed, the objective of ResIP is to reduce the exposure of households in targeted coastal areas to erosion, flooding, and pollution, and to strengthen regional integration in policy, regulation, coastal observation, and coordinated cross-border action.

This document presents the results of analytical studies related to the role of women in the use and rehabilitation of mangroves in the Republic of Guinea.

Specifically, the surface area of mangroves in the Republic of Guinea continues to decrease. In 1956, they occupied 350,000 hectares, compared to 250,000 hectares some 40 years later, according to a study conducted by the Mangrove Development Master Plan (SDAM) in 2000.

This clearing is due to the development of agricultural activities, particularly rice cultivation, and the commercial exploitation of wood. In addition, many people cut wood freely to use as fuel: they use it as a source of domestic energy, for smoking fish or for salt production, as traditionally done in the mangrove areas. With the traditional technique, it is necessary to burn three kilos of wood to obtain one kilo of salt.

The exploitation is thus very localized. The old stands of reproductive individual trees and the young formations are spared.

In most cases, the situation is variable, with intensive harvesting localized downstream of the estuary, with upstream formations being minimally utilized to date. Downstream, the main channel and the coastline are currently being eroded, which is having a significant impact on the dynamics of *Rhizophora* stands. Elsewhere, regeneration seems to be occurring in the inner channels of the Sakama islands. The combination of natural processes and logging may pose a threat to the formations. Nevertheless, as hydrosedimentary dynamics are impossible to predict, only a precautionary principle would be appropriate here (Maritime Guinea Observatory (OGM), Progress Report, May 2005, pp. 98-99).

A comprehensive understanding of the potential of mangroves for coastal protection and other co-benefits not available in WACA will help afforestation and mangrove restoration programs to optimize the following:

1. Their coastal protection function;
2. Their climate change mitigation function; and
3. Their contributions to nature-based livelihoods.

This knowledge will also help the private sector identify cost-effective investment opportunities to address complex development challenges in the coastal region.

PART ONE:
CONCEPTUAL FRAMEWORK

The conceptual framework for the baseline study of the relationship between mangroves and women in the Republic of Guinea is based on the compilation and use of scientific studies and research that have been conducted in the targeted coastal and marine areas.

To achieve the objectives of the study, the methodological approach was based on consultation of the results of scientific research in all official national documents on mangroves, specifically on the roles that women play in the use or rehabilitation of mangrove products. Also included were reports on the activities of scientific research institutions, reports on projects financed by technical and financial partners, reports on the impacts on the environment caused by climate change in the Republic of Guinea, and others.

Finally, the results of the literature review corroborated the findings of the field surveys based on the questionnaires developed and validated by the reviewers.

This baseline study is organized around the following research questions identified in the TRD:

1. Which mangrove-centered activities (fish smoking, salt production, oyster picking, etc.) are performed by women in the coastal areas of Guinea-Conakry?
2. Do women use mangrove products for domestic consumption or sell the products on the market?
3. Is household demand fully met by mangrove products?
4. What is the role of mangroves as a primary or secondary source of income for women?
5. What are the characteristics of women who depend on mangroves for their livelihoods (location, age, education, household income, etc.)?
6. What are the seasonal activities of women who depend on the mangroves?
7. What is the extent of women's willingness to switch to alternatives to mangrove products?
8. What are the specific activities that women undertake for mangrove conservation and what roles do they play in conservation, afforestation, and rehabilitation.
9. Is their involvement in mangrove conservation full-time or part-time?
10. What are the characteristics of women involved in mangrove conservation (location, age, education, household income, etc.)?

11. What problems or issues do women face in mangrove conservation?
12. Do women have formal representation or a women's economic interest group (EIG) to voice their interests and concerns?

Based on these questions and field research, we have identified:

» The activities of women who depend on mangrove products, with particular emphasis on their vulnerability;
» The environmental impact on the uncontrolled cutting of mangrove products, considering the gender dimension (including women and youth and other vulnerable groups) in terms of the use of products;
» The environmental risks and their possible impacts on the coastal zones.

I. THE ISSUE

Maritime Guinea is made up of three quite different ecosystems. Each one has its own characteristics and specific morphodynamic functioning, and therefore its own potential and own development constraints.

However, the extent of the interactions that link the tidal marshes to the mangrove swamps at the foothills on the one hand, and to the continental shelf on the other, suggests that these three ecological units constitute a complex system within which each is highly dependent on the others for biophysical and developmental reasons (OGM, Final Summary Report, 2006).

For island and coastal sites, *Rhizophora racemosa* and *R. harrisonii* are the most widely used plant species after oil palm (*Elaeis guineensis*). It is the primary wood material for shoring and framing and the primary fuel for domestic energy and salt and fish smoking (OGM, Final Summary Report, 2006).

The regions of Maritime Guinea are entirely devoted to activities such as fishing, agriculture, arboriculture, rice cultivation, and salt production, while Lower Guinea is primarily a grain producer.

Rice cultivation is the main agricultural activity in Lower Guinea and rice is the country's primary staple food. It covers more than half of the country's cultivated area. Guinea is one of the main rice-producing countries in Africa, although it still cannot meet the basic needs of its population.

Rice growing, which is the most characteristic activity along this coastline, is now an important economic issue for Maritime Guinea. For this reason, the expertise of the Baga rice farmers living north of Conakry (Paulme, 1957; Bouju, 1994 a and b) and of the Balanta (Embaldo, 1990), from whom the Baga undoubtedly drew inspiration in developing their rice-growing technique, is rightly emphasized.

Mangrove rice, called "*Bora Malé*" in Susu ("mud rice"), is a rainfed, non-irrigated rice crop developed in Maritime Guinea on the plains and islands of the lower estuaries that are subject to flooding by high tides. It plays a key role in agricultural production, hence the importance of this sector in coastal areas.

However, despite all the services from which humans benefit in the coastal zones, the mangrove forest today faces a multitude of problems that have caused its degradation. In order to restore this ecosystem, an in-depth study has become necessary to understand the link between humans and their environment and, more particularly, the link between women and the mangrove and the role they play in its preservation.

II. OBJECTIVES OF THE STUDY

GENERAL OBJECTIVE

The objective of this study is to gain a structural understanding of the benefits derived from mangrove products by women and the role they play in mangrove conservation. It will allow us to understand the relationship between the mangrove and Guinean women through research and field surveys on the sites selected for the study, namely Kaback, Kanfarandé, and Kamsar. The study will also enable us to generate innovative data to help build the capacity and knowledge needed to protect mangroves on the Guinean coast and to identify specific measures to provide solutions to these communities and strengthen their resilience in a sustainable manner.

SPECIFIC OBJECTIVES

To achieve the overall objectives, the specific objectives are as follows:

- Compile a comprehensive list of mangrove-centered activities conducted by women in the coastal areas of Guinea-Conakry;
- Determine whether women use mangrove products for home consumption or sell the products in the market.
- Analyze women's roles in mangrove conservation, reforestation, and rehabilitation.

III. ORGANIZATION OF THE ELEMENTS OF THE STUDY

In response to the situation of soil degradation caused by salinization affecting the land and the uncontrolled cutting of mangroves, the World Bank has invested in the restoration of these lands by seeking to gain a better understanding of the causes of degradation and their impacts in order to plan its interventions more effectively. This platform was created to attract expertise and funding and to deepen the dialogue between countries and technical and financial partners.

Under the ResIP, each country has allocated funds to make investments in green and climate-resilient infrastructure and, in particular, in the management and restoration of mangroves. Mangrove forests are increasingly being recommended as part of broader coastal management strategies, as mangroves can significantly reduce the vulnerability of coastal areas. It is to this end that the study of the relationship between mangroves and women and the role they play in their conservation and rehabilitation in the three targeted subprefectures was initiated, thereby providing a broader vision that will promote the protection and restoration of mangrove habitats and provide a database to build a response strategy to address the impacts of climate change on mangroves.

The study was based on the following:

1. Mangrove-centered socioeconomic activities of women in Guinea;
2. Analysis of the use of mangrove products in domestic consumption or sale on the market;
3. Analysis of women's roles in mangrove conservation, afforestation, and rehabilitation in Guinea;
4. Lessons learned about the relationship between women and mangroves in Guinea.

The main finding from the literature review is the very fragmentary nature of studies on the relationship between women and mangroves and its limited recognition in public documents and government policies. However, Guinea is not an exception among countries in coastal areas that are undergoing natural upheavals such as flooding, coastal erosion, and other large-scale environmental impacts. A series of floods in seasonal rice-growing areas have been observed in Kaback, for example, as well as in other sites.

PART TWO:
METHODOLOGICAL FRAMEWORK

IV. BRIEF INTRODUCTION TO LOWER GUINEA AND THE STUDY AREAS

The Republic of Guinea is a coastal country located in West Africa, with a surface area of 245,857 km². Its population was 12 million at the last census, conducted in 2014. Population projections show the rapid growth rate of the population, which is expected to reach about 16 million by 2030, 20 million by 2040, and 25 million by 2050. As elsewhere in Africa, one of the striking characteristics of its population is its youth.

Maritime Guinea or Lower Guinea, which is the subject of this study through the three target areas, is a low-lying coastal region. The climate is sub-Guinean. Rainfall often exceeds 2,000 mm annually. This region is characterized by mangroves, which cover 18 percent of the national territory. Economic activities are mainly based on rainfed rice cultivation, fishing, fruit growing, industry, mining, services, etc.

The region is home to 30 percent of the Guinean people. The population is mainly concentrated in the capital, Conakry, which is also the main place of settlement for internal migrants and immigrants, mainly from the West African subregion.

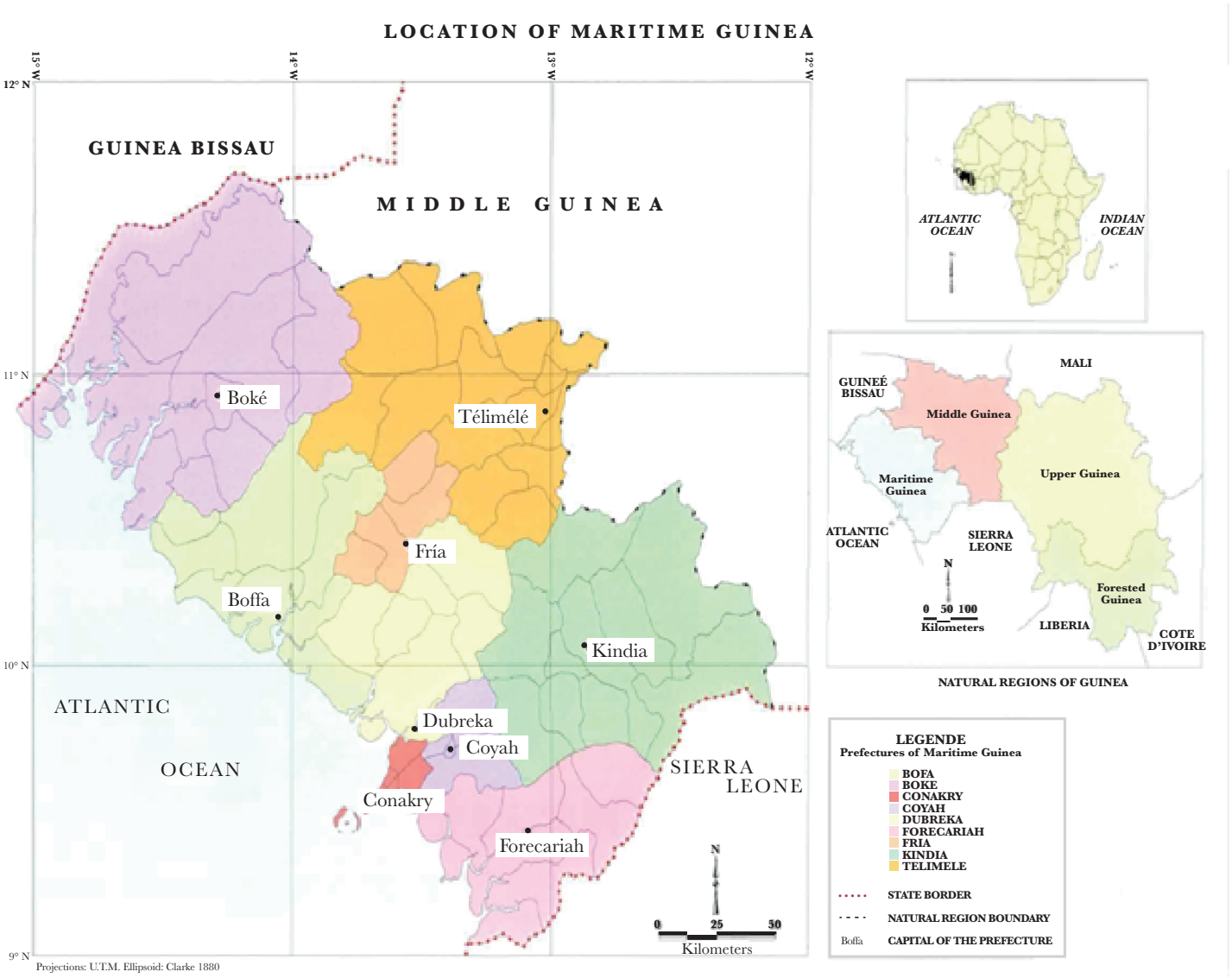
Maritime Guinea brings together three highly differentiated ecosystems. Each one has specific characteristics and morphodynamic functioning, and thus its own development potential and constraints. However, the extent of the interactions that link the tidal marshes to the mangrove swamps at the foothills on the one hand, and to the continental shelf on the other, suggests that these three ecological units should be considered as constituting a complex system within which each is heavily dependent on the others for biophysical and development reasons.

Indeed, with the exception of the highlands and slopes, which exclusively play the key role of sediment production, the ecological complex is essentially built around hydrological flows. They allow the circulation and transfer of mineral and organic elements from one ecological unit to another, maintaining the productive potential of the mangrove soils by sedimentary contributions conveyed by agitation and marine

currents, and enriching coastal waters by terrigenous contributions from floods. As we have noted, the most original ecosystem and the one that offers the greatest diversity of resources is the mangrove. It cannot be considered to be uniform. Under an apparent monotony, it is a real mosaic of microenvironments that is at the origin of multiple interfaces.

It is the abundance of these interfaces that generates considerable biodiversity and productivity in a relatively small area. The distinctive characteristics and dynamics mentioned above prevent the mangrove ecosystem of the Guinean coast from being seen as a simple interface between ocean and continent. Its spatial extension and the specificity of the ecological conditions that characterize it and that have led to a specialization of its flora and fauna, make the mangrove an ecological unit in its own right. The interpenetration of the ecological units linked to the climatic hydrosedimentary variations has produced a mosaic of microenvironments with diversified potential (Mangrove Observatory, Atlas Infographique de la Guinée Maritime, 2001).

FIGURE 1: MAP OF LOWER GUINEA



Source: Atlas Infographique de la Guinée Maritime

1. SUBPREFECTURE OF KABACK

1.1. **Geographic location of Kaback:** The Rural Commune (RC) of Kaback is an island located 60 km from the capital of the prefecture of Forécariah between 09°16 and 09°24 north latitude and 13°19 and 13°25 west longitude at an altitude of 47 m above sea level.
The Kaback RC is located at the center of a delta formed by the Soumbouyah, Moribay, Kissis-kissi, and Méllakoré rivers. This delta is mostly composed of the islands of Kakonia, Kaback, and Tana.

1.2. **Human environment:** The RC has 27,362 inhabitants over an area of 116.2 km², divided into eight districts, 32 sectors, and 64 hamlets. The average size of a family is seven people. The population of the Kaback RC is essentially composed of Susu. The Peulh, who engage in small-scale trade, are welcomed and housed by the local population. The dominant language is Susu. Also present are the Téminè, the Baga, and the Malinké people. The Kaback RC has eight districts.

1.3. **Climate:** It has a tropical climate with oceanic influences, known as the Maritime Guinean tropical climate.

1.4. **Soil:** Alluvial fluvio-marine soils.

1.5. **Hydrography:** The RC has a hydrographic network made up of rivers and the Kenèndé, Khouloundé, and Gbérébounyi basins, all of which have a regular pattern and flow into the sea.

1.6. **Vegetation:** The island of Kaback is almost entirely made up of coastal plains; they include three swampy forests located in the mangrove hinterland in which the water table, having no impact in the dry season, still provides constantly moist soil. These are the forests of Kèka, Karangbani, and Filitagui.

1.7. **Wildlife:** Wildlife would have been abundant and varied a few decades ago. But as their refuge, namely the forest formations, have become increasingly depleted, the animals have become scarcer. We can note, however, the presence of various primates, such as duikers, agouti, and squirrels. The aquatic fauna remains abundant in spite of the strong pressures to which it is subjected (Source: Kaback PDL, 2015-2019).

2. SUBPREFECTURE OF KANFARANDÉ

2.1. **Geographic location:** The RC of Kanfarandé has the distinction of being made up of several islands and a section that is entirely on the mainland, making it a unique region in the Republic of Guinea.
Formed by 15 districts, seven of which are on the islands, the Kanfarandé RC covers an area of 1,725 km². It derives its distinctiveness from the Tristao islands, composed of a group of islands and islets that extend to several marine environments up to the border with Guinea-Bissau.
The 15 districts of Kanfarandé are fairly homogeneous in size, with the exception of Koukouba district, which at 161 km² represents 14 percent of the territory of the RC. This size is undoubtedly related to the physical specificity of this district.
Only the Kambilam district is entirely on the mainland, with no tidal areas. It is also in this district that the largest sector of Kanfarandé is located: the Bissitè sector, covering 64 km². This is the most isolated sector in the RC, because this sector has few cultivable areas and lacks the amphibian component, thus reducing the diversity of agroecological features and making it less attractive to the population.
Kanfarandé is one of the largest RCs in Maritime Guinea, but it is also one of the most heterogeneous because it is fragmented into multiple small islands that are all sectors. This subprefecture faces many problems related to

its particular nature. The island areas of the RC are often less isolated than the few mainland areas because of the absence or inadequacy of communication infrastructure.

2.2. **Climate:** It has a tropical coastal climate with two distinct alternating seasons: a dry season that is becoming progressively longer, from November to May, and the rainy season from June to October.

The rainfall toward the coast amounts to 3,000 mm annually. Temperatures vary widely and in March, April, and May, temperatures climb to 40 °C and above. In November and January, the average is lower, at 20 °C.

The atmospheric humidity is high, averaging between 60 and 80 percent. The monsoon is the dominant wind coming from the sea, while the harmattan blows from the continent toward the sea. However, it has very remarkable effects (cold nights, dry and hot winds during the day).

2.3. **Terrain:** The terrain of the RC of Kanfarandé is slightly rugged. From the sea to the mainland, there are vast mangrove lowlands, hinterland mangroves, and relatively fertile shallows.

2.4. **Vegetation:** The low population density and extensive size of the Kanfarandé RC explain the existence of large areas of forest and savanna. In some areas, there are several stands of dry and humid forests. These areas also include locations that are worthy of note owing to their unusual character within the RC, such as the areas of Katfoura and Tchangban and the bird island of Alcatraz, to name a few.

2.5. **Like the other RCs, Kanfarandé comprises mainly two distinct types of forest formations:**

» **The mangrove formation:** it covers the entire coastline and is fully exploited by woodcutters, fish smokers, salt extractors, oyster pickers, and other users for domestic purposes. It is also the spawning ground of halieutic species (fish and others) and a transition area for migratory birds.

» **The forest formations:** composed essentially of shrub and grassy savanna, these types of formations are favorable to the species of *parinari exelsa*, *haroungana madagascariensis*, *uvaru* chamae, *combretum*, *diopiros heudeloti*, and others. It is noteworthy that this zone is subject to bush fires caused by herders and farmers. The lack of appropriate techniques means that every year hectares of forest go up in smoke.

2.6. **Hydrography:** Inlets, estuaries such as the Rio Campony, Rio Baranba, and Rio Nunez, and water bodies (the Tonkima, the Boffadar marsh creeks, and the Dobaly marsh creeks) form the hydrographic network of the Kanfarandé RC.

Large estuaries carve out this coastline and divide up the RC between the border and the Rio Nunez. Farther south, the Rio Campony separates the four isolated districts of Kapkin, Kasmack, Kadignet, and Katfoura from the large group of islands and peninsulas in the south.

The large group of Kanfarandé districts is located between the Rio Kogon to the north and the Rio Nunez to the south and is crossed by a very dense network of tidal channels, the two main ones being the Tonkima and Boffadar marsh creeks.

2.7. **Population:** The Kanfarandé RC has a population of more than 21,796 inhabitants spread over two distinct zones (the islands and the mainland) with a total area of 1,725 km^2. It is one of the largest RCs in Maritime Guinea. The population of the Kanfarandé RC is certainly one of the oldest on the Guinean coast. While the population is still small, it is made up of distinct ethnic groups according to their geographical location: there are the Nalu, Balanta, and Baga in the island zone, and the Landouma, Diakanké, Diola Peuhl, Susu, and the Nalu in the mainland part of the RC.

Kanfarandé is the most northerly of the Guinean coastal RCs, bordering Guinea-Bissau to the northwest, and bounded by the RCs of Sansalé to the north, Tanènè to the northeast, Kolabouyi to the east, and Kamsar to the southeast.

2.8. **People's occupations:** The main productive activities in the Kanfarandé RC are fishing, agriculture, livestock production, palm oil extraction, traditional salt extraction, poultry farming, and small-scale trade.

2.9. **Fishing:** It should be noted that because of its position in relation to the sea, Kanfarandé is an important part of the Guinean coastline, where intensive artisanal and industrial fishing activities are carried out. Owing to these abundant and rich halieutic resources, the fishing sector is by far the most profitable activity for the people. The Kanfarandé RC offers immense fishing potential, thanks to the Atlantic Ocean and the inlets that facilitate the reproduction and proliferation of numerous fish species.

Fishing has become a source of employment and labor, owing to the various production chains involved (fishers, fishmongers, smokers, buyers, etc.).

Various materials are used, according to the types of fishing. Generally, there are dugout canoes and pampas (type of boat), nets with different mesh sizes depending on the type of fish to be caught, hooks, and so on.

Artisanal fishing is practiced in the open sea and in estuaries, inlets, and channels.

2.10. **Agriculture:** Agriculture is one of the main economic activities in Kanfarandé RC; it employs the largest proportion of the active workforce. This essential activity is strongly influenced by the different landforms and the habits of the farmers, depending on the ethnic group. Despite the diversity of zones and ethnic groups, a large part of the population engages in this activity, although it remains subsistence agriculture.

The farming system is predominantly rice cultivation. Flooded rice cultivation in the mangrove is the most productive in the region and is practiced mainly by the Nalu, Baga, and Balanta. Rice cultivation is closely followed by the growing of cashew nuts, peanuts, fonio, cassava, and maize. Fruit crops are not well developed. Fruits such as mangoes, coconuts, kola nuts, oranges, and bananas are grown. Acajou ("cashew") cultivation is developing at an increasing rate.

In this RC, two production systems corresponding to the following morphological units are practiced by the people:

- **The coastal plain (mangrove):** an excellent area for flooded rice cultivation based on transplanting; this is the preferred area of the Nalu, Baga, Balanta, and Djola. The biggest production of rice in the area comes from this section;
- **The transition zone (mangrove-plain):** Slash-and-burn agriculture is practiced in this zone where the Peulhs, Landouma, Diakhanké, and Nalu are found. The main crops in this zone are cashew nuts, fonio, corn, groundnuts, hillside rice, and cassava.

It should be noted that crop yields on the hillsides are often exceptionally low (500 to 800 kg per ha for rice, and 300 to 500 kg per ha for other crops).

2.11. **Livestock:** Although agriculture and fishing are the main economic activities, livestock farming is no less important in social and economic terms.

The livestock population is mainly composed of cattle, sheep, goats, pigs, and poultry. Despite the abundance of plains and grazing areas, livestock farming remains poorly developed, most likely because of the isolation of the area, which makes it difficult, if not impossible, to sell livestock products and by-products, and also because of the geographic location of the RC, where a large part of the land is located on the islands. Second, pig farming is an activity practiced exclusively by the Balanta. Indeed, the pig is an important part

of the Balanta culture, especially during funerals, initiations, and field work. Pig rearing is based on seasonal migration.

2.12. **Extraction of palm oil:** This activity is practiced by all ethnic groups, mainly by women, in order to meet their consumption needs at the weekly markets. Income is generally low, given the remoteness of the settlements and the time spent using methods that are, for the most part, rudimentary. The income is generally used to maintain the balance between agricultural, fishery, and livestock products in households.

2.13. **Traditional salt extraction:** once practiced solely by the Baga and Nalu, this activity is now practiced by all the ethnic groups of the RC on the islands and on the mainland. Salt extraction balances the budget of many households. It enables some women to cover their expenses independently. In terms of local consumption, needs are largely met on the coast and in many of the surrounding subprefectures. Salt is also used for smoking fish on the islands.

2.14. **Commerce:** This activity is not developed on the mainland of the RC. It is practiced on a large scale in the islands where traders, generally the Peulh, are based in the fishermen's camps. At this level, bartering or the exchange of products for money is practiced (Source: Kanfarandé PDL, 2017).

3. SUBPREFECTURE OF KAMSAR

3.1. **Geographic location:** Located 35 km southwest of the prefecture of Boké, the RC of Kamsar is bordered to the north by the Rio Nunez and the subprefecture of Kanfarandé, to the south by the subprefecture of Bintimodia, to the east by the subprefecture of Kolaboui, and to the west by the Atlantic Ocean. It covers an area of 472 km².

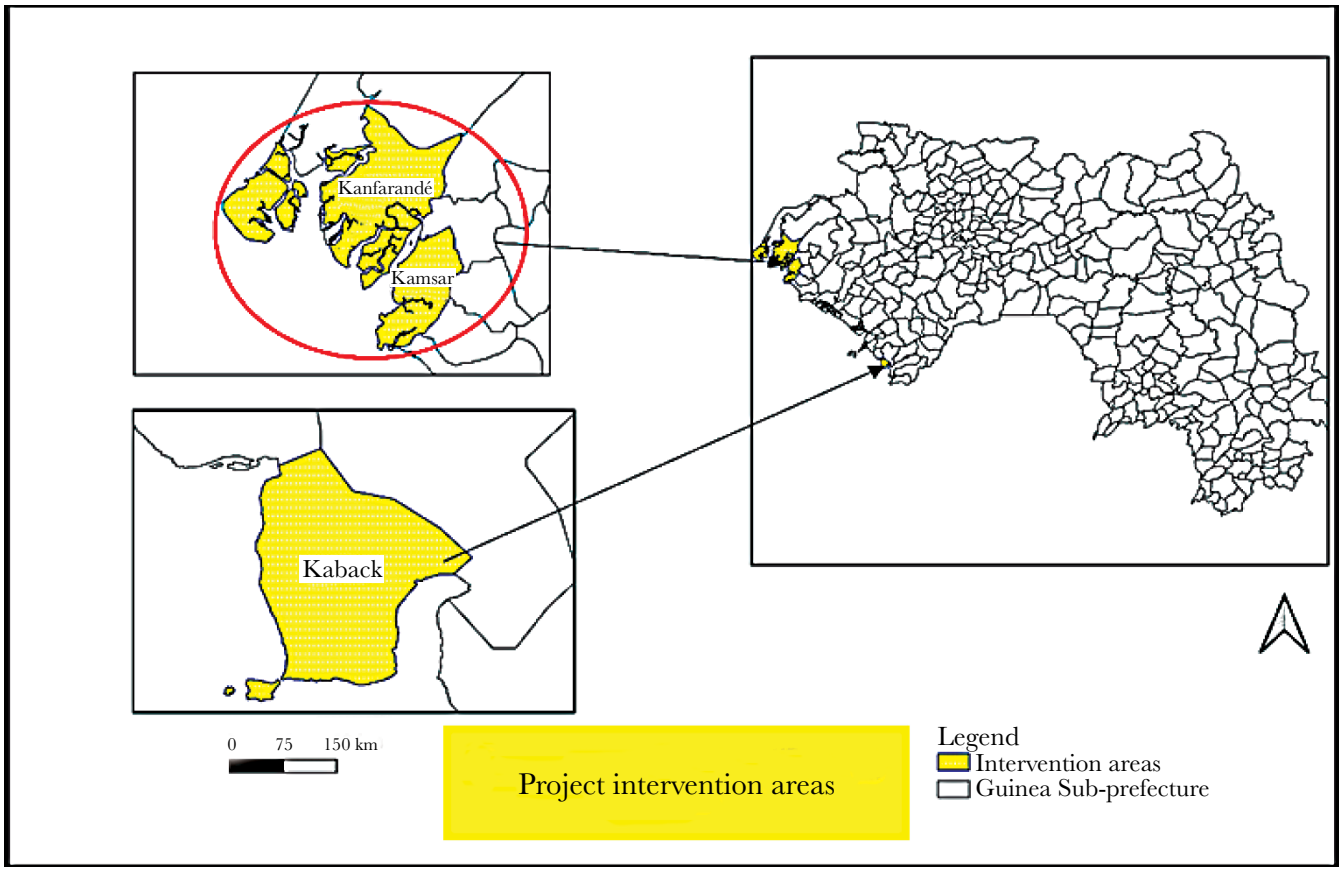
3.2. **Climate:** The subprefecture of Kamsar on the Atlantic coast has a climate dominated by sea winds and has two alternating seasons: a rainy season from June to November and a dry season in December.

3.3. **Terrain and hydrography:** In Kamsar, there is a coastal plain about 50 km wide. Numerous rivers (*rios* in Portuguese) irrigate this plain before flowing into the sea. These *rios* are navigable in all seasons.

3.4. **Vegetation:** The vegetation is dominated by the mangrove, with mangrove trees 5 to 10 m high. Palm and coconut trees also grow in this area.

3.5. **Population:** The subprefecture has a population of well over 360,000 inhabitants and is part of the Boké prefecture. Originally a small fishing village, it is now a town in northwestern Guinea located about 3.5 hours north of Conakry on the Rio Nunez estuary of the Atlantic Ocean. It is an industrial center for the Compagnie des Bauxites de Guinée (CBG), with a rail connection to the nearby Sangarédi plateau, which is one of the world's largest bauxite reserves. It covers an area of 472 km².

FIGURE 2: MAP OF STUDY AREAS



Source: Gadmin

V. METHODOLOGY AND RESULTS OF THE STUDY

The methodology used in this work is based on three elements: the collection of information, the processing and analysis of data, and the drafting of the final document.

1. LOCATION OF THE STUDY AREAS AND SELECTION OF DISTRICTS

Within the three areas of study, a number of criteria for mangrove-centered activities in the estuary zones were established.

In Kaback, the districts of Bolimanda, Seydouyah, Matakan, Bossimiyah, and the Kenendé sector were selected. These districts were selected on the basis of the level of women's activities in the mangrove.

In Kanfarandé, we selected Kanof, Kankouf, and Tesken, a sector of the Kanfarandé Centre district, because of the mangrove coastal zone and the life of the islanders, which offered the prospect of studying activities focused on the mangroves and women.

In Kamsar, Taigbé and Taidi were also chosen for the same reasons: to observe the island communities in their daily life.

The charts contain information on mangrove-centered activities, socioeconomic life, demographic characteristics, policy rules and regulations on the mangrove, among others.

2. DATA COLLECTION

This was the first phase of the project, which consisted of a review of the literature and lessons learned from national and institutional activities, through field visits, administration of questionnaires and interview guides, data collection, sample analysis, and photography of impacted areas.

The methodology was therefore as follows:

» The documentation was the starting point and the most essential part of this work, in that it allowed for a better understanding of the objective of the study and a more accurate picture of the area. Thus, various works and websites dealing with the link between mangroves and women and the benefits they derive from using these products were consulted. The study was based on consultations and leveraging the findings contained in official documents on mangroves, with a focus on the role of women in the Republic of Guinea. We consulted and used mainly (i) policy and strategy documents on mangrove management from the Ministry of the Environment, (ii) activity reports from scientific research institutions, (iii) final reports from projects financed by Technical and Financial Partners (TFPs), and (iv) reports on environmental and social impact studies conducted in the coastal zone.

» The field visits consisted of visiting the three sites selected for the study, mainly in the districts bordering the estuary, to identify the sites where mangrove-centered activities are more visible. The questionnaires were administered during the visits in the 10 neighboring districts spread over the three study areas.

» The questionnaires targeted 150 people distributed as follows at each site: 10 oyster pickers, 10 salt producers, 10 fish smokers, 10 palm oil producers, four rice farmers, two mangrove wood sellers, one agent from the environmental service, one agent from the coastal management center, one NGO agent, and an elected official from the commune, for a total of 50 people per study site. However, these targets were not met, owing to the reluctance of respondents to answer questions and the timing of some activities, such as palm oil and black soap production, which had not yet begun.

» The household questionnaires included individual forms on mangrove-centered socioeconomic activities and were administered to 28 households in the subprefecture of Kanfarandé Centre, specifically in the districts of Kanof, Kankouf, and Tesken; 12 households in the subprefecture of Kamsar, district and sector of Taigbé and Taidi; and 24 households in the subprefecture of Kaback, districts of Bolimanda, Bossimayah, Matakan, and Seydouyah. Thus, with 5 to 10 questionnaires per district, we were able to collect information on the link between women and the mangrove and the benefits they derive from it through their activities, the roles they play in its conservation and/or restoration, and the causes and consequences of its degradation or disappearance, among other things.

» This was followed by the introduction of an interview guide for local informants, including district chiefs, elders, members of the assembly and leaders of community organizations, and the prefectural directors of the decentralized services of the Ministry of the Environment. Thus, 20 local informants were interviewed in the three study areas; seven prefectural directors of the three sites; and two NGOs.

» In addition, five focus groups were formed and six observational interviews were conducted in the three study areas.

» With the help of a digital camera and a cartography expert, photographs were taken in the three study areas and in the districts whose geographical coordinates were recorded with Earth software.

» Lastly, the collection of various data analysis samples in areas with low, medium, or severe degradation.

» The household survey was conducted from January 25 to February 4, 2022. The main sites for the survey were Kamsar, Kanfarandé, and Kaback (Lower Guinea).

3. PROCESSING AND INTERPRETATION OF QUESTIONNAIRES

The relationship between mangroves and women cannot be addressed without considering the dependence of women on this environment, which is a source of income and household subsistence. Without their involvement, we would not understand their reasons for using the products of the ecosystem; hence the need to seek their opinions on the various activities they carry out in this environment and their impacts on the environment. Thus, questionnaires were administered to the majority of this vulnerable group in the three study areas of Kaback, Kanfarandé, and Kamsar.

These questionnaires targeted households whose subsistence activities depended on mangrove products.

Pirogue (narrow canoe) trips were made to observe mangroves and mangrove-centered activities in all 10 districts of the three study areas. Some districts visited were only reachable by pirogue.

PHOTOS 1–23. PHOTOGRAPHS TAKEN DURING THE FIELD VISITS IN THE THREE STUDY AREAS

Photo 1. Raising awareness about mangroves in Tesken

Photo 2. Family photo in Tesken mangrove.

Photo 3. Scraping of salt brine powder in Kanof.

Photo 4. Collection of salty soil from a *tanne* (salty lands) by Kankouf women.

Photos 5, 6. Wood on Kankouf landing bay for sale and salt bagged last year.

Photo 7. Women working up to 22 hours a day in Tesken.

Photo 8. Funnel for filtering brine in Tesken.

Photo 9. Mangrove wood cut in the mangrove.


Photos 10, 11. Market gardening in Kanfarandé Centre.


Photos 12, 13. Oysters hanging on mangrove root and shells in Kankouf.


Photos 14, 15. Fish smoking facility in Kanfarandé Centre.

Photos 16, 17. Access bridge to Taigbé in the Kamsar area. Pirogue sunk in the mud in Taigbé.

Photos 18, 19. Smoking at home in Taigbé.

Photo 20. Traditional salt preparation site in Taigbé.

Photo 21. Reddish mangrove leaves affected by bauxite residues.


Photos 22, 23. Hectares of rice fields in Taigbé.

The following information was obtained from the results of the survey.

4. PROCESSING AND INTERPRETATION OF THE RESULTS OF THE SURVEY OF KABACK, KANFARANDÉ, AND KAMSAR

❖ COMPONENT ON THE SEMISTRUCTURED QUALITATIVE SURVEY

SITE 1: KABACK

1. Mangrove-centered activities in Kaback

Mangrove-centered activities in the Kaback area include fishing, smoking, oyster picking, logging for the construction of fishing canoes and for domestic purposes, salt production, rice farming, red oil production, black soap production, shrimp fishing, and bread ovens, according to the Prefectural Director of the Environment and Sustainable Development (DPEDD). All of these activities are practiced in the coastal areas of the Republic of Guinea, particularly in the Kaback area.

Rhizophora racemosa and *R. harrisonii* are the most widely used plant species and constitute the primary fuel for smoking fish to enhance its taste, for domestic energy, and for salt production. There is a real disparity between wood harvesting and the potential of each of the logging sectors; as a result, mangrove wood resources are dwindling under the pressure of logging.

Traditional fish smoking techniques rely on the use of intense and prolonged heat that dehydrates the fish by about 70 percent of its weight. This operation fills the fish with antiseptic substances in the smoke and gives it an appreciable taste. This activity is often carried out by women. According to artisanal fishing statistics, nearly 26,000 metric tons of fresh fish are caught each year, and it is estimated that 80 percent of the fish is smoked, and that 90 percent of the wood used for smoking is taken from the mangrove. At this rate, the consumption of wood risks accelerating the disappearance of the woody capital of the mangrove. The "*koumbousi*" type of smoking uses on average 2.85 kg of wood per kg of fish. The "*banda*" type uses 3.10 kg of wood for each kg of fish and is the most popular (Maadjou BAH, National CBD Focal Point) SD.

In the Kaback area, artisanal fishing is more advanced than all other activities, but it is practiced only by men, and the types of fish caught are machoiron, *Ethmalosa fimbriata* (bonga), *Arius spp* (machoiron), *Sardinella maderensis* and *Sardinella aurita* (sardinella), and *Sphyraena barracuda* (barracuda). Women in the mangrove fish mainly for tilapia, crabs, and oysters.

2. Mangrove-centered activities of women in Kaback

Mangrove-centered activities of women in Kaback include fish smoking, logging (cutting and selling mangrove wood), harvesting mangrove fuelwood for domestic purposes, salt extraction, rice cultivation or lowland rice cultivation, market gardening, and oyster picking; women most often practice these activities to provide for their families. The commercial exploitation of wood is now an emerging activity in Kaback. The mangrove forest is an essential energy resource for the development of new economic opportunities. Also, owing to the lack of modern smoking centers, many women smoke their fish at home using machoiron, tilapia, *Ethmalosa fimbriata* (bonga), and other types of fish.

The women, however, cut mangrove wood for commercial and domestic purposes, and at times face enormous difficulties such as physical injury during the harvesting of the wood. The men are more involved in fishing and rice cultivation, and they sometimes engage in logging for the manufacture of boats using *Rhizophora*, which is considered to be a resistant wood. There seems to be a division of roles between the sexes.

The activities practiced by both men and women are often rice cultivation or the cultivation of lowland rice, called *Bora Maâlé* in the Susu language, and market gardening. The men plow to prepare the land and build dikes. The women plant the rice nurseries. The men are also involved in salt production and building the *tanké* (type of filter).

Of the women interviewed in Kaback, 46 percent engage in smoking fish, 25 percent in logging (cutting mangrove wood), 8 percent in rice cultivation, 8 percent in oyster picking, 8 percent in salt extraction, and 5 percent in market gardening. However, since these activities are highly dependent on mangrove wood, the uncontrolled harvesting of mangrove wood remains the main activity of women in the coastal areas of Kaback.

In addition, the biggest problem in the Kaback area is the rise in salinity in the rice plains, which has led to a decline in the profitability of rice-growing operations. Communities are faced with the depletion of uncultivable soil because of the salinity level. This is reflected in the responses of the women interviewed: the number of people dependent on mangrove products has increased by 71 percent, while activities in the mangroves fell by just 29 percent.

It should be noted that logging remains the main economic activity of the rural communities in the coastal areas visited in Kaback. *Rhizophora racemosa* is mainly cut for sale as wood for smoking fish. Also, bakers use it for baking bread, salt producers for cooking, soap making, and the production of red oil during cooking.

Rice cultivation in the lowlands and market gardening are often intended for household consumption, depending on the harvest; since all these products are grown extensively in the rainy season, agricultural production depends largely on rainfall. For this very reason, rice and market gardening cannot be considered stable economic activities.

In addition to logging, the most important economic activities practiced by the women of Kaback are fish smoking, rice farming and salt extraction. These activities are a means of spreading risk in the household budget. Oyster picking is mainly for domestic consumption. According to one female oyster picker, "a basin of oysters after drying can yield 3 kilos of oysters."

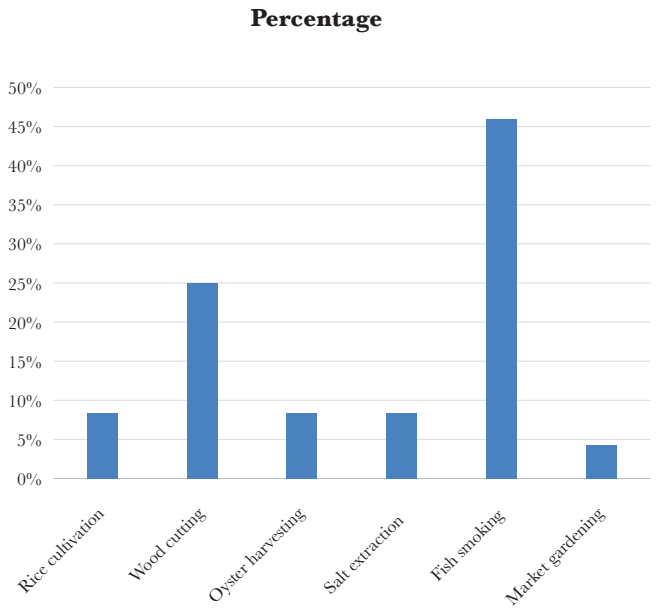
On the islands and in the coastal area, fishing is considered a primary economic activity for men. Large-scale fishing is carried out using motorized canoes in the coastal area, while in the islands with limited access to the market, artisanal fishing and processing of fish products are practiced.

In general, the harvesting of mangrove wood for sale is done throughout the day on a full-time basis, depending on the tides, and most women depend on these mangrove products for both subsistence and commercial purposes.

TABLE 1: MANGROVE-CENTERED ACTIVITIES IN KABACK

Activity	Percentage
Rice growing	8%
Wood harvesting	25%
Oyster picking	8%
Salt extraction	8%
Fish smoking	46%
Market gardening	5%
Total	100%

GRAPH 1: ACTIVITIES BY PERCENTAGE



3. Mangrove products for domestic consumption or commercial sale

In Kaback, only 20 percent of mangrove products are destined for family consumption, while 80 percent are marketed and sold in local markets for commercial income. Profits from mangrove products are often spent on food, clothing, schooling, and family health. Most women who produce mangrove products depend on them. *Rhizophora racemosa* wood is cut into small pieces by the women and piled up before being sold at the local market. A pile of three pieces (kg equivalent) of wood can cost GF 5,000, and buyers often come to collect it at the landing bay. Small branches of *Avicennia* are often used as fuelwood for domestic consumption.

A woman interviewed in the Kenendé sector of the Seydouyah district told us the following story: "*We have been in the mangroves since we were children, and we used to accompany our mothers in selling mangrove wood; today, it is our main activity and source of income. In the past, 20 years ago, the profits from mangrove products covered the primary and secondary needs of the family. I was able to pay for my children's education, clothing, food, and so on, but today there is a decline in products, and we are increasingly poor. The only way to survive is to turn to rice growing or market gardening, and there too the dikes have broken down and it is difficult for us to obtain 10 bags of rice in our fields because of the high level of salinity.*"

In the Kaback region, particularly in the Seydouyah district of the Kenendé sector, the women who cut mangrove wood do so for commercial purposes, and it is their main source of income. They are the ones who cut the wood and chop it up before reselling it. It is a full-time activity, and the harvesting of mangrove wood is organized according to the tides. The Kenendé sector is home to a mangrove wood market managed by women.

Photo 24. Mangrove wood piled up by women.

In the districts visited at the Kaback site, the secondary activities of women include harvesting oysters and making coconut oil, palm oil, and soap.

However, in the district of Matakang, fish smoking remains the main activity of women, followed by market gardening, small trade, and the sale of oyster cakes, among other things.

According to the president of the Matakang district, the mangrove belongs to the State and the Kaback community. Access is open in some places, such as in Kenendé, Bolimanda, and Bossimyah, but in Matakang the community has introduced, through the local authorities, a monitoring system and a ban on cutting mangroves. Access is therefore controlled in this community, but despite this restriction, women still enter the mangrove to harvest the wood.

4. Socioeconomic and demographic characteristics of the representative sample of Kaback women engaged in mangrove activities

Of the women interviewed, 43 percent are between 20 and 35 years of age; those between 35 and 45 years of age represent 28 percent, while 29 percent of these women are between the ages of 45 and 65 and over. Despite this diversity of ages, all of the women interviewed have been engaged in mangrove-centered activities for more than 20 years. The Susu ethnic group still represents the majority of Indigenous villagers.

Women between the ages of 20 and 35 are often involved in oyster harvesting, market gardening, mangrove wood cutting, and fish smoking. These are the youngest and most active, while those between 36 and 45 years of age are mainly involved in fish smoking, and sometimes in wood cutting and salt production. The women who smoke fish do not necessarily cut mangrove wood. The oldest women, aged 46 to 65 and over, are often the ones who practice market gardening and rice cultivation, salt production, or sometimes fish smoking. The younger women help them in their work.

The main activity of the women of Kaback is smoking fish, practiced by 46 percent of the women interviewed; mangrove wood cutting comes second, at 25 percent, while salt extraction accounts for 8 percent of the sample.

The majority of women respondents have no formal education. Some 80 percent say they have never studied, 12 percent have a high school education, and 8 percent have a basic education. Women respondents who are engaged in a mangrove activity are either married or widowed and have a high number of dependents. A local informant in Bolimanda district told us that a household may have as many as seven to eight dependent children.

The proportion of household income was considered 70 percent to 80 percent satisfactory 20 years ago and met the needs of the household, but today the household income is no longer adequate and is generally low: 60 percent of the women interviewed confirm that they have an average income that covers only 45 to 60 percent of the family's needs, while 40 percent state that their income is 30 to 40 percent too low. This decline in income in the mangroves is reflected in the degradation of the areas and anthropogenic pressures. It was noted in all the districts visited in the Kaback area that when fishing flourishes, the incomes of the fish smokers increase by 60 to 70 percent, whereas when the catches decrease, people are faced with serious livelihood challenges.

The Indigenous people of the Susu ethnic group carry out 38 percent of the activities in the mangrove, while only 22 percent are migrants who have settled in Kaback and are often involved in fishing and small-scale trade.

The study showed that the women of Kaback have not benefited from any mangrove restoration projects except in the district of Bossimiyah, where an NGO, **Mouvement Sauvons nos Iles (MSI)**, had initiated a mangrove rehabilitation project one year ago in degraded areas that are currently being regenerated.

5. Seasonal activities of women engaged in mangrove activities

Fish smoking and woodcutting are done annually by women on a full-time basis. The two activities complement each other and go hand in hand. Mangrove wood for smoking fish is purchased in quantity and stored in the smoking sheds. A pile of three pieces of wood can cost GF 5,000; the women can sell from GF 300,000 to GF 500,000 worth

of wood per day, depending on the needs of the buyers. People celebrating weddings and christenings prefer it to other fuelwood. Commonly called *kinsi* in Susu, the price soars during the rainy season because of the difficult access to mangroves during the lean season. In addition, salt production, oyster picking, commercial logging, soap making, rice cultivation, market gardening, and red oil and coconut production are practiced seasonally and part-time for domestic purposes.

CALENDAR OF SEASONAL ACTIVITIES BY MONTH

Category	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Women	Salt production, oyster harvesting, logging, soap making, palm oil				Rice growing, fish smoking			Rice growing, market gardening, fish smoking				
	Smoking and mangrove harvesting are practiced all year round.											
Men	Logging, fish preparation				Fishing, plowing fields, repairing dikes			Rice growing, fishing				
Both men and women	Logging, repairing of salt filters				Plowing and field preparation			Rice growing				

6. Willingness to switch to alternatives to mangrove products

The women who work with mangrove products have no other source of livelihood or income from alternatives; they depend solely on this environment. Most of the women interviewed said that they are now willing to switch to other alternatives if the resources are made available to them. They are determined to stop this activity because the benefits they receive from it do not cover 100 percent of their family's needs, and the opportunities for alternatives are often limited. They would like to practice general trade (chafing gear, sale of fishing equipment, and so on), training in income-generating trades, entrepreneurship, building modern smoking centers, as well as receive training in new smoking techniques, training in the production of solar salt, training in dyeing, creating community centers for women's empowerment (associations, women's groups, cooperatives, and so forth).

Eighty percent of the women interviewed in the Kaback area are seeking funding to create income-generating activities (IGAs) or economic interest groups (EIGs), or to set up market gardening activities or businesses in general. They are not abandoning fish smoking but are asking for the construction of modern ovens that consume less fuelwood, such as shorkor ovens. About 20 percent of the women interviewed say they are not quitting the activity (fish smoking), but rather are seeking to modernize their practices by building their capacity, but are determined to abandon mangrove wood cutting.

Notwithstanding the degradation of the rice fields, the women are calling for the rebuilding of the Kaback dikes. As the elder of the Bolimanda district told us, if the rice paddies are 100 percent operational, activities in the mangroves will cease concomitantly. Harvests are currently low in the rice paddies because of the high level of salinization, thereby exerting pressure on the mangroves.

7. Mangrove conservation and restoration

We had little information on mangrove conservation and restoration efforts. However, an NGO called "Mouvement Sauvons nos Iles" (MSI) had initiated a mangrove restoration project in the Bossimiyah district, where the barren areas were replanted one year ago. The women's role in this project was to water the mangrove nurseries and to assist in the reforestation of the plants with the men; the mangroves are very young and are currently in a regeneration phase.


Photos 25, 26. Regenerating mangrove trees in the district of Bossimiyah.

According to the district president, "*the efforts made by the Bossimiyah communities to monitor and ensure the proper management of the replanted mangroves are notable and are generally advocated by the sector chiefs of the surrounding communities through awareness campaigns. We conduct outreach campaigns during the lean seasons to help them understand the danger of mangrove cutting and the benefits that these products provide.*"

In the district of Matakang, the community itself, in collaboration with the president of the community's youth group, has set up committees known as mangrove monitoring brigades, on which women are represented, to provide protection. Their roles are to maintain the stability of the ecosystem by advising other women not to intrude on it.

Moreover, in the Matakang area, the cutting of mangroves is totally prohibited. According to the village elder, Mayor Ibrahima, "*we must protect our environment, especially since we are in an area submerged by the sea. The only protection for us is the mangroves (in Susu, worifiri) that surround us. Our role as village elders is to advise women and youth not to destroy our environment.*"

The study found that conservationists in the Kaback area are not well equipped and often face enormous problems in traveling to experience the realities of the mangrove forests; it also found that monitoring is limited to the landing bay of the mangrove forests.

8. Women's activities in mangrove conservation, rehabilitation, and/or restoration

A key section of the questionnaire focused on mangrove conservation efforts by women. In this section, we did not obtain much information on mangrove conservation projects, as the women interviewed said that they had never experienced mangrove restoration projects, except for one project in Bossimiyah district. The women involved in this project were located 500 m from the reforestation site. During the preparatory phase, they participated in decision-making and were responsible for watering the mangrove nurseries and assisting the men in reforesting the plants. They were regularly active and responsible for monitoring the reforested areas.

According to the Prefectural Director of the Environment and Sustainable Development (DPEDD), the population dependent on mangrove products is increasing, owing to the influx of migrants to Kaback. In the past, a RASK project led by Dr. Kandet Bangoura was undertaken, where the women of the locality created a mangrove forest on the coast. The role of the women in that project was to plant mangrove nurseries in barren areas in order to reforest and create new nurseries. Unfortunately, the project was discontinued.

During the study, we found that some women had adopted an adequate system or technique to conserve this environment. The women who pick oysters now scrape the

base of the mangrove trees, whereas before they used to cut the roots of the mangrove trees to extract the oysters. Also, women salt producers have remained in the same place each year to collect brine before starting the activity, whereas in the past they used to cut the *Avicennia* to allow the salt water to filter through each year in different areas.

Other households are faced with a lack of resources to participate in diversification activities or in the monitoring of mangroves; although they are aware that the mangrove is gradually being depleted, for lack of other resources they continue to venture out in search of a livelihood.

In the districts visited in Kaback, some women who harvest mangrove products claimed that the mangrove tree restores itself naturally. Therefore, according to them, mangroves can be restored and regenerated without human effort; however, they are willing to join an NGO or a mangrove restoration project.

9. Demographic and socioeconomic characteristics of women engaged in mangrove conservation

The women engaged in mangrove conservation activities are between 20 and 45 years of age, active and young, and are engaged in mangrove-centered activities. They are either married mothers or widows and have more than 20 dependents. Of the women interviewed, 90 percent are Indigenous, while the 10 percent considered to be migrants are women who have married Indigenous men and who have also been resident in the localities for more than 15 to 30 years. Their level of education is low.

10. Challenges faced by women in mangrove conservation

Most of the women interviewed said that they face financial challenges, and that mangroves are the only place where you can easily make money if you have the determination. The study also showed that the women who cut mangrove wood are willing to abandon this activity, which is extremely dangerous. Likewise, those who smoke fish want to improve smoking conditions through the shorkor ovens that the PRAO-GN project is building in Koukoudé; these are modern ovens that consume less fuelwood. With regard to salt extraction, the women are asking to be trained in the production of solar salt on tarpaulins.

As a woman interviewed in Bossimiyah told us, "We have let the mangrove regenerate, but we have problems with market gardening, as our plains are flooded by the sea. We are asking for help from the State and projects to help us build our dikes."

Some of the challenges they face are the following:

- Lack of means of subsistence and financial support to undertake an activity;
- Lack of support from women's associations;
- Repair of dikes to promote market gardening and rice growing;
- Lack of modern sheds for smoking;
- Lack of materials or inputs for market gardening activities;
- Difficulties in recovering money after the sale of smoked fish by the women of the group;
- Lack of training or capacity building in mangrove rehabilitation.

11. Composition of women's groups

The majority of the women interviewed belong to informal associations commonly called "*sèrè*." Ninety-eight percent of them belong to these groups, which function as revolving funds in the form of tontines. The advantage of belonging to one of these associations is that women can help each other and obtain a loan to start an activity; the loan is repayable at the end of the current month. This allows other members of the group to benefit in turn from loans.

As a result, these associations are generally informal and have no legal administrative documents; this is why members of these groups often encounter financial difficulties and/or are victims of embezzlement.

The important thing here is to help them set up an economic interest group that is recognized by the prefectural authorities. This will allow them to obtain external aid.

PHOTOS 27 TO 31. ACTIVITIES IN THE KABACK AREA

Photo 27. Matakang mangrove lowlands.

Photo 28. Depleted area, Bolimanda.

Photo 29. Interview in Youlayen,

Photos 30, 31. Oyster picker returning from the harvest in Kenendé.

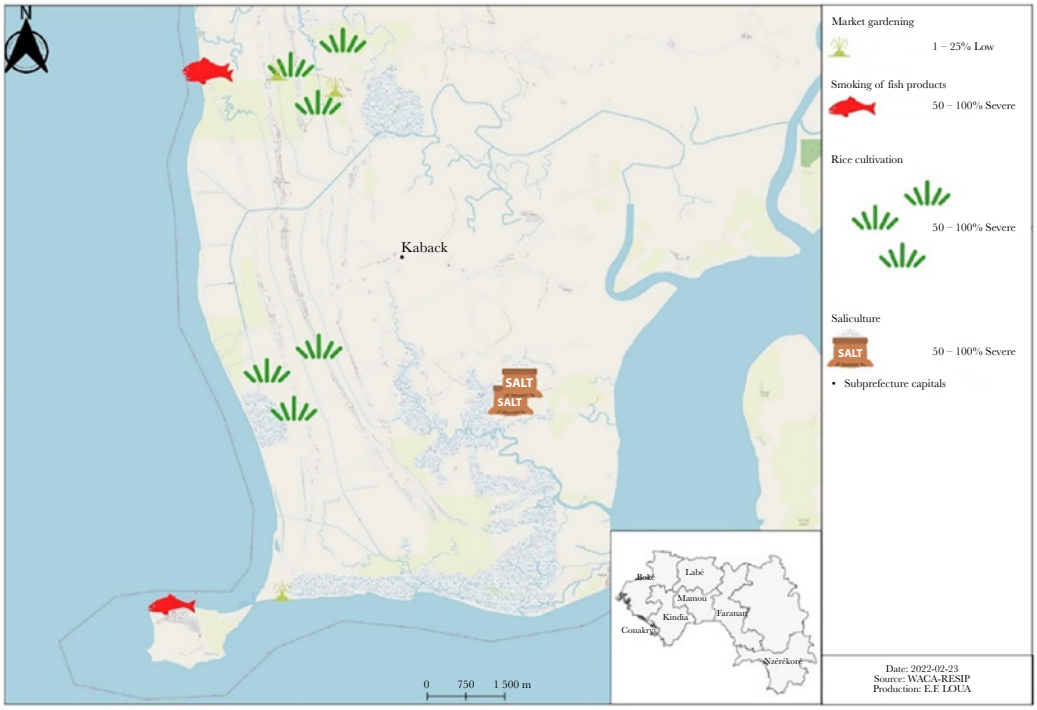
12. Mangroves under threat from activities in Kaback

The map reveals that rice farming and salt production pose a clear threat (50–100 percent), and that the rice-growing areas were once mangrove forests that have been replaced by rice paddies, as a result of high anthropogenic pressure from wood cutting. This in turn led to the advancement of the sea toward the mainland and the degradation of mangrove areas.

Protective dikes had been constructed to enable individuals to use flooded, degraded areas. However, according to a village elder, these dikes eventually failed.

Mangrove harvesting for fish smoking continues to pose the greatest threat to Kaback's mangrove habitat. It remains the flagship activity that has a significant impact on mangrove health and is the most practiced by both men and women.

FIGURE 3: RISK MAP - KABACK



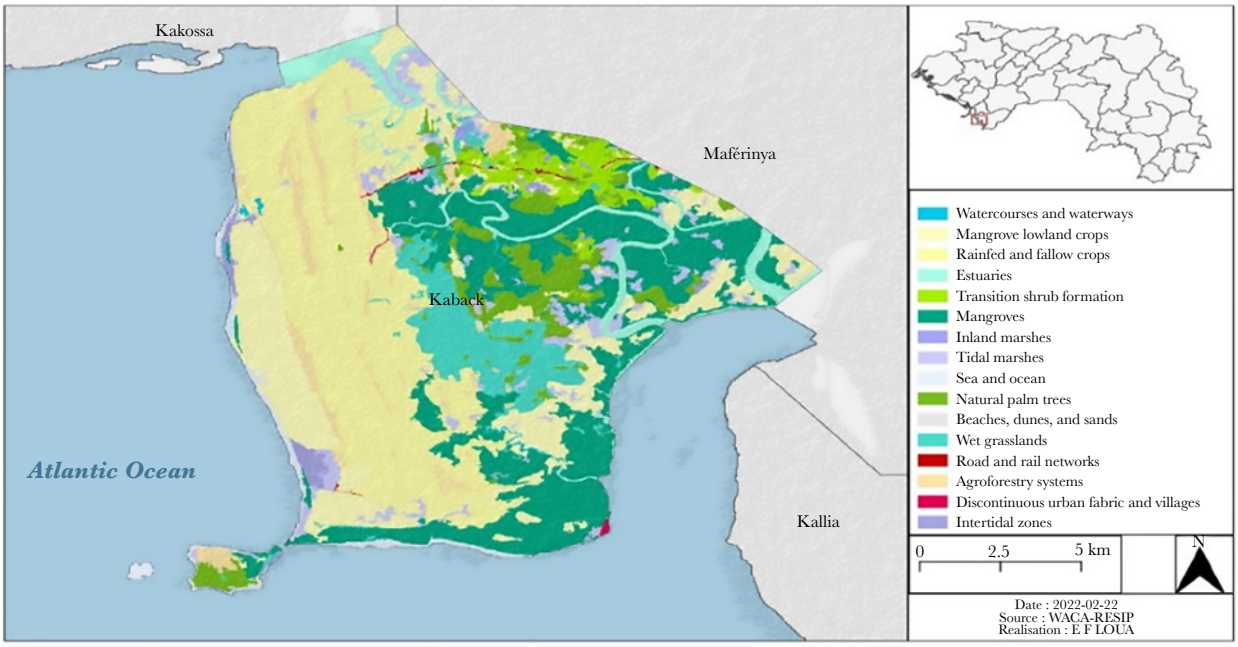
Source of the field study

13. Comparative land use map (2002–2022)

The comparison map for the period 2002–2022 shows a slight change in the current conditions in the Kaback area and provides us with a broader picture of changes over the past 20 years in human activities conducted in its environment.

In 2002, the marshes had not advanced much toward the mainland, there were vast mangrove lowland crop areas, and the mangrove forest was less degraded. A portion of the mangrove forest has been lost and replaced by fallow rainfed crops, and estuaries have been replaced by tidal marshes.

FIGURE 4: LAND USE (2002, KABACK)



Source: Spot héritage 2002

TABLE 2: SURFACE AREA AS A PERCENTAGE (2002, KABACK)

Area	Surface area in ha (2002)	Percentage
Watercourses and waterways	27.27	0%
Mangrove lowland crops	1,852.10	15%
Rainfed and fallow crops	3,520.52	29%
Estuaries	606.07	5%
Transition shrub formation	386.38	3%
Mangroves	**2,880.31**	**23%**
Inland marshes	43.36	0%
Tidal marshes	550.77	4%
Sea and ocean	216.40	2%
Natural palm trees	739.07	6%
Beaches, dunes, and sands	8.71	0%
Water bodies	2.34	0%
Wet grasslands	845.45	7%
Road and rail networks and associated spaces	24.33	0%
Agroforestry systems (combination of perennial crops and forest species)	491.42	4%
Discontinuous urban fabric and villages	8.91	0%
Intertidal zones	113.64	1%
Total	12,317.04	100%

GRAPH 2: PERCENTAGES (2002, KABACK)

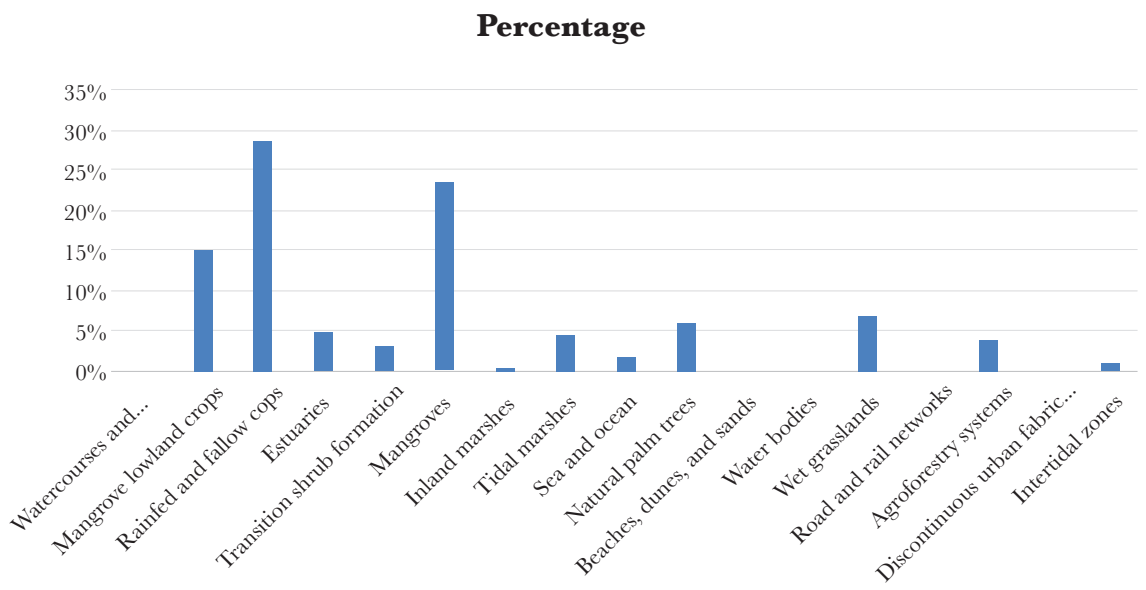
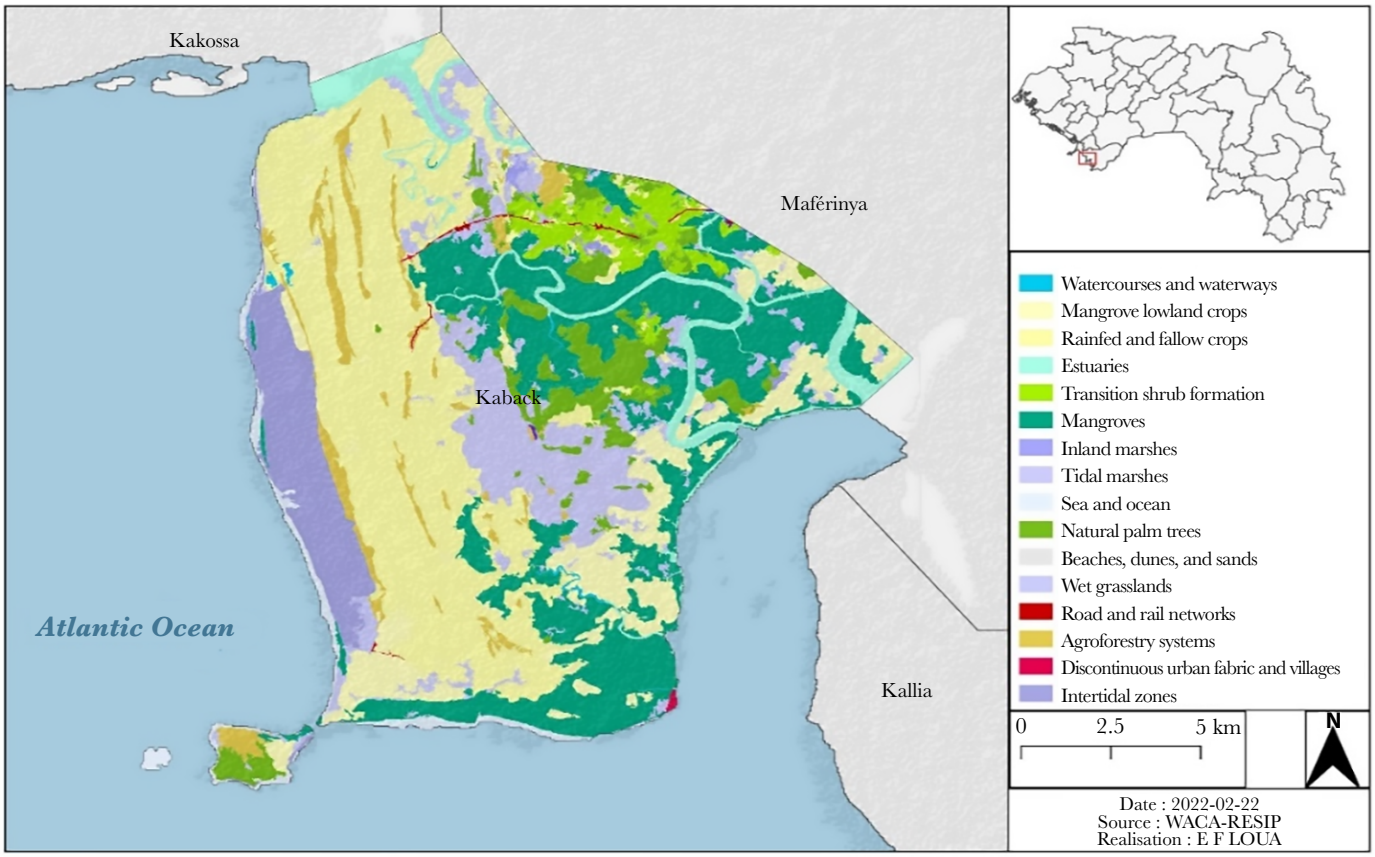


FIGURE 5: LAND USE (2022, KABACK)

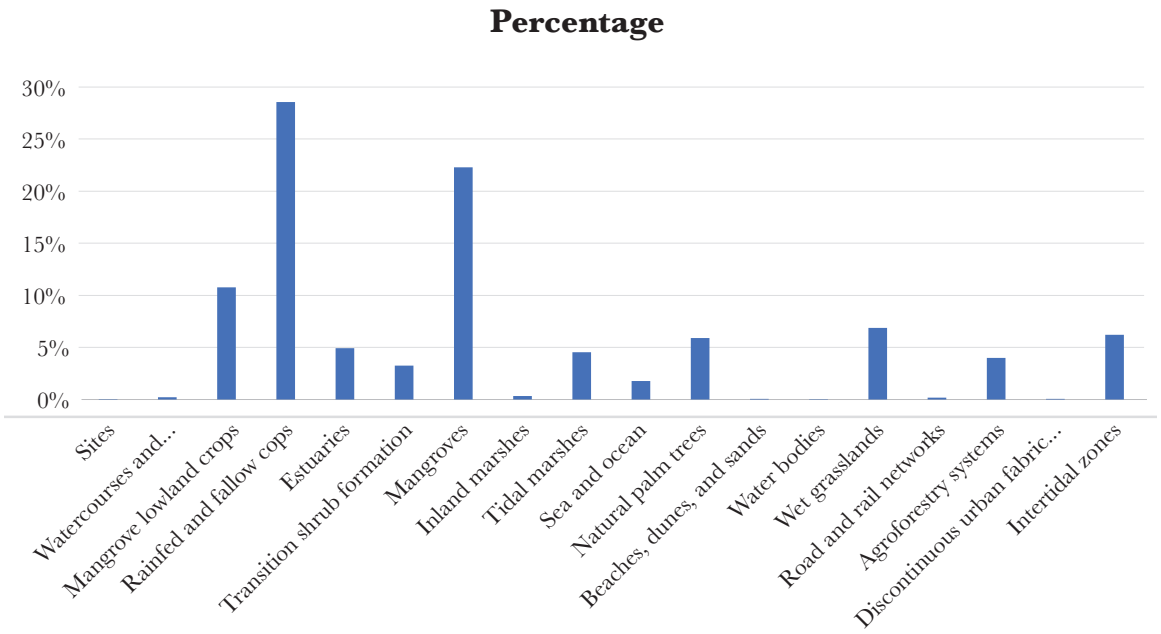


Source: Sentinel Imagery 2A, 2022

TABLE 3: SURFACE AREA AS A PERCENTAGE (2022, KABACK)

Area	Surface area in ha (2022)	Percentage
Sites	1.81	0%
Watercourses and waterways	27.27	0%
Mangrove lowland crops	1,327.81	11%
Rainfed and fallow crops	3,518.83	29%
Estuaries	606.07	5%
Transition shrub formation	399.65	3%
Mangroves	**2,745.41**	**22%**
Inland marshes	43.36	0%
Tidal marshes	557.20	5%
Sea and ocean	216.40	2%
Natural palm trees	725.68	6%
Beaches, dunes, and sands	8.71	0%
Water bodies	2.34	0%
Wet grasslands	845.45	7%
Road and rail networks and associated spaces	24.33	0%
Agroforestry systems (combination of perennial crops and forest species)	491.42	4%
Discontinuous urban fabric and villages	8.91	0%
Intertidal zones	766.39	6%
Total	12,317.037	100%

GRAPH 3: PERCENTAGES (2022, KABACK)

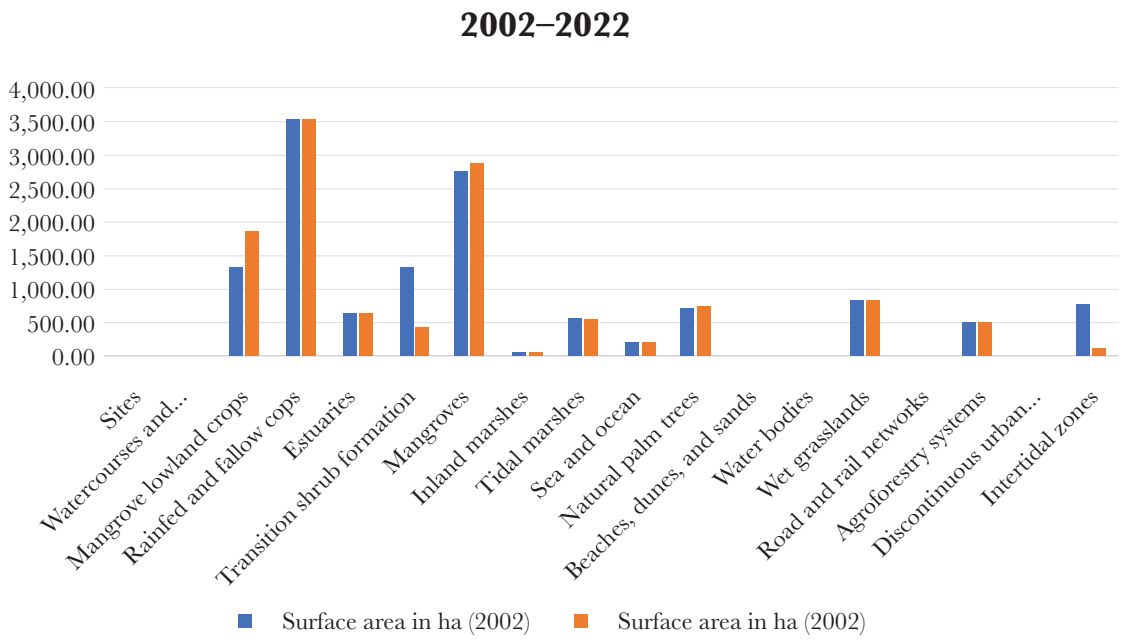


For more detail, see below the statistical table comparing the two maps for the Kaback area over the past 20 years.

TABLE 4: CHANGES BETWEEN 2002 AND 2022, KABACK

Area	Surface area in ha (2002)	% 2002	Surface area in ha (2022)	% 2022	Consumption and production flows
Sites	0.00	0%	1.81	0%	-1.81
Watercourses and waterways	27.27	0%	27.27	0%	0.00
Mangrove lowland crops	1,852.10	15%	1,327.81	11%	524.29
Rainfed and fallow crops	3,520.52	29%	3,518.83	29%	1.70
Estuaries	606.07	5%	606.07	5%	0.00
Transition shrub formation	386.38	3%	399.65	3%	-13.27
Mangroves	**2,880.31**	**23%**	**2,745.41**	**22%**	**134.89**
Inland marshes	43.36	0%	43.36	0%	0.00
Tidal marshes	550.77	4%	557.20	5%	-6.44
Sea and ocean	216.40	2%	216.40	2%	0.00
Natural palm trees	739.07	6%	725.68	6%	13.39
Beaches, dunes, and sands	8.71	0%	8.71	0%	0.00
Water bodies	2.34	0%	2.34	0%	0.00
Wet grasslands	845.45	7%	845.45	7%	0.00
Road and rail networks and associated spaces	24.33	0%	24.33	0%	0.00
Agroforestry systems (combination of perennial crops and forest species)	491.42	4%	491.42	4%	0.00
Discontinuous urban fabric and villages	8.91	0%	8.91	0%	0.00
Intertidal zones	113.64	1%	766.39	6%	-652.75
Total	12,317.04	100%	12,317.04	100%	0.00

GRAPH 4: COMPARISON BETWEEN 2002–2002, KABACK



SITE 2: KANFARANDÉ

1. Mangrove-centered activities in Kanfarandé

Mangrove-centered activities in the Kanfarandé area include fishing, fish smoking, market gardening, soap making, salt extraction, rice cultivation, mangrove honey production, and red oil extraction. Both men and women were engaged in the activities to varying degrees, depending on the product and the area inhabited. While men are typically more engaged in fishing, mangrove honey production, and rice farming than women, harvesting of mangrove products is generally dominated by women.

The main activity carried out by women in Kanfarandé is fish smoking, which is practiced by 28 percent of the women interviewed, followed by market gardening (21 percent), soap making (17 percent), salt extraction (14 percent), rice cultivation (14 percent), and oyster picking (6 percent) from the defined sample. Kanfarandé is located in the Marine Protected Areas (MPAs) of the Tristao/Alcatraz islands. It is therefore an excellent location for fishery resources, and attracts a large number of fishers to the area. For this reason, the main activity carried out by the women in Kanfarandé women is fish smoking. Trees are indiscriminately felled to provide fuel and service wood in Kanfarandé: users cut whatever, wherever and whenever they want, resulting in a real overexploitation of Rhizophora throughout the mangrove. Mangrove wood is also used for beams in building construction.

2. Activities carried out by women in the Kanfarandé mangrove

Women who harvest mangrove products in Kanfarandé are also fish smokers. During our study, we visited the smoking centers in Kanfarandé Centre and learned that traditional stoves use large quantities of wood. In addition, women in the forest area of Kanof district harvest the wood in this district, including significant harvesting of fresh mangrove wood. Upon our arrival in Kanof district, we saw the piles of freshly cut mangrove wood and realized that the group of poachers was actually made up of women. The harvest is often intended for sale to women who smoke fish. The main source of livelihood and income in the area is the mangrove. The harvest is often a full-time activity during peak season.

Women control the entire mangrove economy. The Kankouf district president said that women process fish products, collect oysters and shellfish, and cut fuelwood for cooking. This pressure on fuelwood and wood for fish smoking has led to the degradation of the areas.

Photos 32, 33. Landing bay for freshly cut mangrove wood in Kanof.

In Tesken district, salt production and oyster picking are more developed, but are less profitable secondary and seasonal activities practiced solely by women. A basin of freshly picked oysters can yield three kilograms of dried oysters. Oysters are often consumed in households and when the harvest is flourishing, they can get up to 10 kilograms of dried oysters and earn GF 25,000 for one kilogram and/or make and sell oyster cakes for GF 500 each. Profits earned are often insignificant.

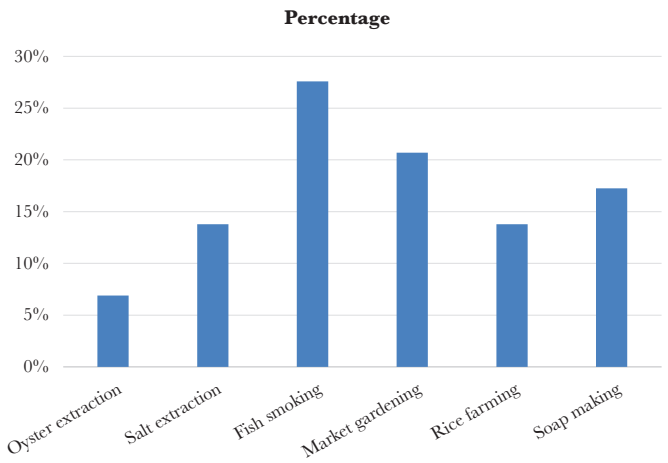
Photo 34. Oysters hanging from their habitat in Tesken. *Photo 35.* Oysters extracted from mangrove stands.

However, women are extremely interested in salt production. This activity is labor intensive and physically demanding for those who practice it. It provides income for women salt producers in Kanfarandé and mangrove salt is widely consumed and sold in all markets in Guinea and in neighboring countries.

TABLE 5: MANGROVE-CENTERED ACTIVITIES IN KANFARANDÉ

Activity	Percentage
Oyster extraction	6%
Salt extraction	14%
Fish smoking	28%
Market gardening	21%
Rice farming	14%
Soap making	17%
Total	100%

GRAPH 5: MANGROVE-CENTERED ACTIVITIES



3. Mangrove products for domestic/ commercial consumption or primary or secondary sources of income

Although women face problems when harvesting mangrove products, 80 percent of the crops are for commercial purposes, while only 20 percent are for domestic consumption. Most women are engaged in mangrove activities to meet the primary needs of the family; the mangrove is their main source of livelihood. Access to mangrove products remains open despite being controlled by forestry officers, and women who are often organized in groups, have access to these products throughout the day.

Participation in and dependence on mangrove-centered activities are no coincidence; these activities meet the essential needs of families.

The field study showed that women engaged in harvesting mangrove products are willing to switch to alternatives. However, owing to a lack of support and financial resources, they are forced to engage in mangrove activities.

4. Socioeconomic and demographic characteristics of women engaged in mangrove-centered activities in the Kanfarandé sample

Twelve percent of the women interviewed were between the ages of 20 and 35, 28 percent were between the ages of 35 and 45, and 60 percent were 45 and over. Despite this age diversity, all of the women interviewed had more than 20 years of experience in mangrove-centered activities and were all natives of the village and of the Nalu, Baga, and Susu ethnic groups; there was also a minority of ethnic Peulhs married to natives of the village.

The overwhelming majority of women interviewed in the Kanof, Kankouf, and Tesken districts have no education. Of a total of 28 women interviewed, 24 said they had never attended school, that is, 89 percent had no education. Only 11 percent report having a basic level of education.

All of the women engaged in mangrove product harvesting at the three sites visited were married; we also met a number of widows. Typically, in villages, women marry at a young age, between the ages of 15 and 18.

Women engaged in mangrove product harvesting are between the ages of 20 and 45. The youngest (between 20 and 35) pick the oysters and cut the mangrove wood, while the women in their 40s smoke the fish with assistance from the youngest women. Household income is currently low, whereas in the past the income earned by women engaged in mangrove-related activities could meet all basic family needs. According to one woman interviewed in Tesken, "*their income used to cover 90 to 100 percent of household needs in the past, but because of the increase in the population, the number of persons dependent on the mangroves has also increased. Now low-income households can only cover 30 percent of their needs while middle-income households are meeting 50 percent of their needs. We also have hectares of farmland, we just need the business capital to start market gardening activities.*" Today, 80 percent of the women interviewed have an average income that covers between

50 and 60 percent of needs, while 20 percent of women earn a low income that covers between 30 and 40 percent of needs.

Seventy-eight percent of mangrove-centered activities are carried out by indigenes, the majority of whom are Nalu, who indicated that no mangrove restoration project had been implemented in their locality. And in the three districts visited in Kanfarandé, oyster picking and the production of red oil and black soap are secondary sources of income, while salt production, wood harvesting, and fish smoking are the main sources of income.

5. Seasonal nature of the mangrove-centered activities of women in Kanfarandé

Salt production, oil collection, and palm oil and black soap production are seasonal activities that are practiced during the dry season (until February, when the first rains fall), while fish smoking and mangrove wood harvesting are year-round activities. The lean or dry seasons are devoted to salt production. During this period, women spend all day working full time late into the evening. The salt production process can take months— between three and four months.

Fish smoking decreases during the peak season but never stops; however, mangrove wood is more expensive in the market.

It should be noted that women who cut mangrove wood are not the same women who engage in fish smoking, but the wood and smoking complement each other. When fishing is flourishing, demand for wood to preserve fish is high and vice versa.

6. Women's willingness to switch to alternatives to mangrove products

Most women expressed a willingness to switch to alternatives such as financing to start microprojects, entrepreneurship training, etc., especially women engaged in wood harvesting and oyster pickers, if the resources are made available to them. However, women who smoke fish and produce salt, soap, and oil want to modernize and continue their activity.

They have requested the construction of modern stoves that use less wood, training in solar salt production, small business, etc. They see mangrove resources as a source of livelihood until they find alternative livelihoods and can leave the mangroves.

During the field visit we interviewed the supervisor of the NGO Tristao based in Kanfarandé Centre, who confirmed to us that he is involved in providing support to women with IEGs by helping them to better organize themselves and by financing their microprojects. The NGO is also involved in the reforestation of degraded areas through the planting of fast-growing trees and even mangrove restoration.

Photos 36, 37. Fast-growing tree nurseries in Kanfarandé.

Source: NGO TRISTAO

Women belonging to accredited groups often benefit from support and funding from the NGO Tristao. To date, the NGO has identified 33 registered women's groups working with them on the reforestation of endangered species and mangrove nurseries. The NGO also finances training in solar salt production for women salt producers and provides inputs to women. These groups are found in Kanfarandé Centre and on the islands.

An interview in Conakry with the Executive Director of the NGO Guinée Ecologie revealed that, in collaboration with the PRCM and PREM, mangrove conservation projects on the Tristao islands are being implemented.

In the Kanfarandé area, the study found that there are two NGOs working to restore mangroves.

7. Conservation and restoration of mangroves in the Kanfarandé area

The executive director of the NGO Guinée Ecologie told us about a project to mobilize local biodiversity conservation efforts in Touguissouri, which was implemented three years ago when women were engaged and represented in mangrove conservation. The NGO has been working for a year with its partners on another project "**Mangrove Conservation on the Tristao Islands.**" This project was close to the site and women were involved in the reforestation of mangroves and received training in solar salt production, fish smoking, and oyster picking. Degraded areas have been replanted with the help of women from Touguissouri and local authorities. Today, mangrove wood harvesting is prohibited on all Tristao islands and reforested areas are monitored by women and local authorities.
However, none of the three districts visited (Kanof, Kankouf and Tesken) had hosted a mangrove restoration project. Thanks solely to the NGO TRISTAO, the 33 women's groups in Kanfarandé Centre benefited from support through inputs for market gardening, fish smoking, and mangrove reforestation in degraded areas in Kanfarandé Centre.

During our interview with the Executive Director of the NGO Guinée Ecologie, he told us that the only way to get women to conserve mangroves is to help them adopt a new approach to save the mangrove ecosystem. He noted: "*They can't give up the mangroves, so we just need new technical approaches to convince them through awareness raising about the importance of this ecosystem.*"

8. Activities of women in the conservation, rehabilitation, and/or restoration of mangroves

Women were engaged in all the activities along the chain, right up to the reforestation of seedlings—from the preparation of terrain to the planting of seedlings. They also put seedlings in the holes and covered the base of the seedlings during transplanting, as shown in the images below.

Photos 38, 39. Women engaged in mangrove reforestation in Touguissori, Kanfarandé.

Photo 40. Reforested mangrove area in Touguissori.
Source: NGO Guinée écologie

Women in accredited groups were trained in smoking techniques, shellfish harvesting, market gardening, and oyster picking on the Tristao Islands. Oyster picking was practiced by more than 500 women belonging to a group all year round. Average catches are estimated at 25 kilograms per woman. The bulk of these catches is dried and intended for household consumption (80 percent) and commercial purposes (the remaining 20 percent).

9. Demographic and socioeconomic characteristics of women in mangrove conservation

Women engaged in mangrove conservation have a low educational level and are between 35 and 45 years old. They are usually married women and mothers. Most have always lived in the village while others who moved there because of marriage have been living in the localities for more than 15 years.

However, one woman in Tesken told us that women salt producers are often in debt. They obtain loans from associations known as "*sèrè*," or from merchants (youlè in the Susu language), which are used to prefinance the activity in the early stages of each salt production period. Loans are repaid after the sale of the products (salt), and they are often left with nothing.

10. Challenges faced by women in mangrove conservation

Coastal erosion and loss of arable land are challenges faced in mangrove conservation. Other challenges faced by women include:

» The presence of mining companies and their negative impacts on the islands caused by embankments that are moving the sea toward the mainland.
» Lack of financing or alternative sources of income to halt mangrove harvesting activities;
» Lack or inadequacy of mangrove restoration projects in the area;
» Insufficient government contribution to the conservation of coastal areas through its forestry officers.

11. Composition of the women's group

There is a plethora of women's associations in the Kanfarandé area. However, while membership in these women's associations means that you are free to develop on your own in your field of activity, when there are grants or types of support, women belonging to the same group work in synergy to achieve the fixed objective.

Often these women's associations are informal, commonly referred to as "*sèrè*" in the local language, which is an association of women of the same generation or age whose main objective is to help each other financially and socially in case of need.

In addition, women understood that in order to obtain financing or assistance, membership in a formal group is required, This is why women's groups and associations in Kanfarandé began to introduce administrative documents to formalize these organizations. They often need support and monitoring to structure their organization. In Kanfarandé, according to the supervisor of the NGO Tristao, [there are more than] 50 women's associations, but only 33 have been formally established. They join a group to obtain financial assistance, which is commonly referred to as tontine or a revolving fund.

12. Threat of mangrove-centered activities in Kanfarandé

Logging (cutting mangrove wood), oyster extraction, salt production, and soap making are clear threats (severe threat (50-100 percent) can be clearly observed on the map). The logging and sale of mangrove wood are practiced on all the islands visited, despite measures adopted by the authorities; this attests to the high percentage of women fish smokers and soap producers. These abovementioned activities use large quantities of wood, which demonstrates that a large number of people are dependent on mangrove products in the Kanfarandé area.

Traditional smoking techniques rely on intense and prolonged heat that dehydrates fish by about 70 percent of the weight of fresh fish. This operation fills the fish with antiseptic substances contained in the smoke and gives it a likeable taste. This activity is often carried out by women and 90 percent of the wood needed for smoking is taken from mangroves. Wood consumption at this rate is likely to accelerate the loss of mangrove wood capital.

Added to this is the presence of these mining companies that construct embankments that push the sea toward these islands. During our visit, we observed a large number of ships belonging to mining companies along the coast between Kanfarandé and Kamsar.

Photos 41, 42. Period of brine collection in mangrove lowlands.

Photo 43. Market gardening in the lowlands.

Photo 44. Traditional smoking.

Photo 45. Fields in fallow.

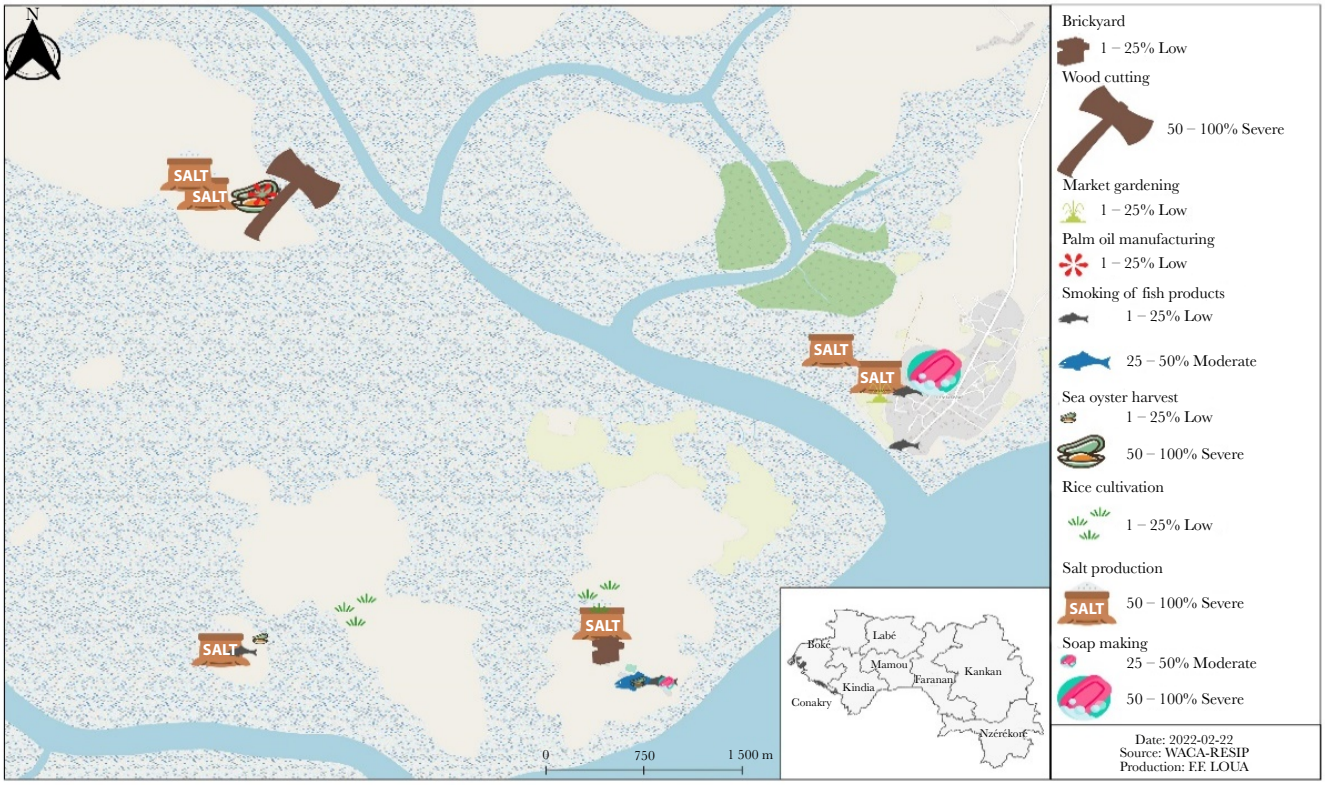
The harvesting of mangrove wood that is used to smoke fish remains the greatest threat to the mangrove habitat in Kanfarandé. It remains the flagship activity that has a greater impact on the health of mangroves and is widely practiced by both men and women.

13. Comparative land use map (2002–2022)

The comparison map for the period 2002 to 2022 shows a change in the current conditions in the Kanfarandé area and provides us with a broader picture of changes over this 20-year period in human activities conducted in its environment.

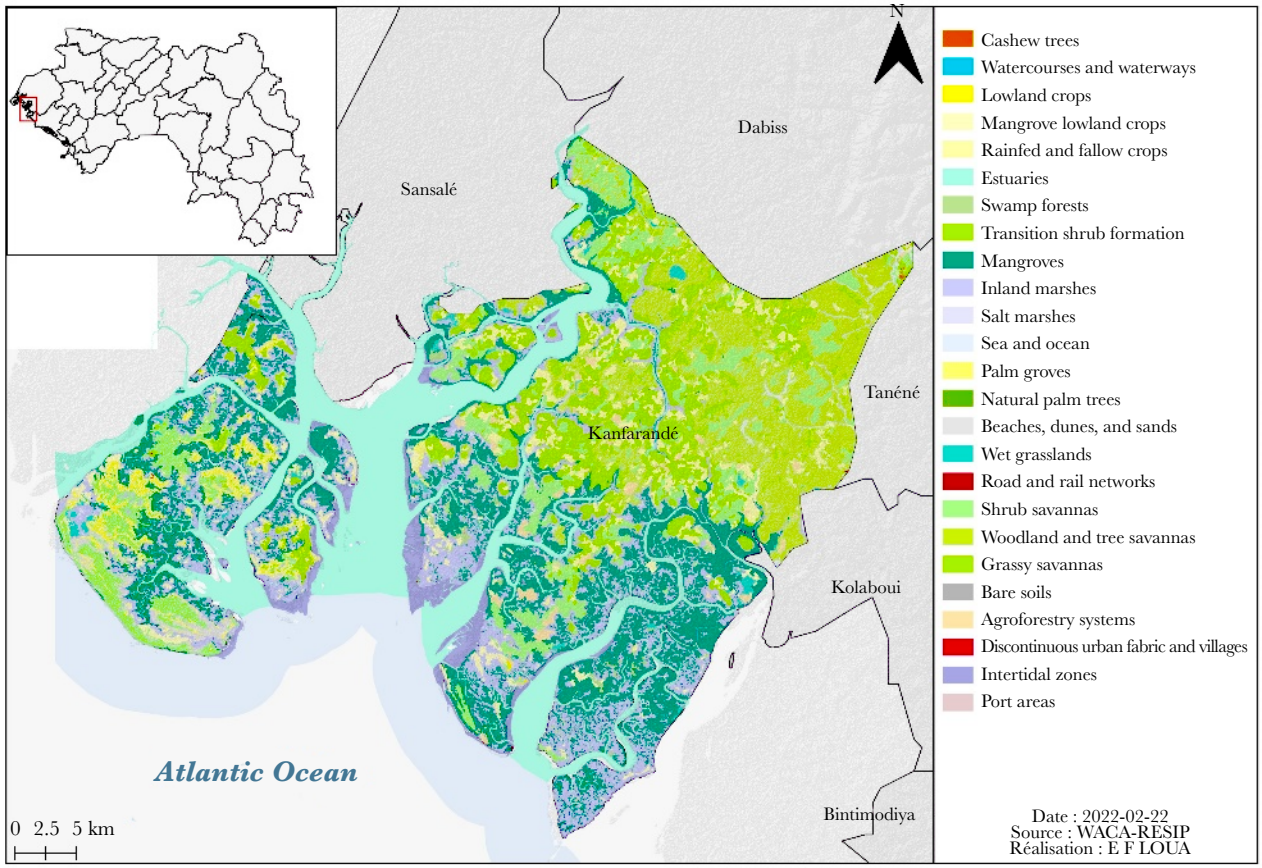
In 2002, the map shows cashew trees, water bodies, natural palm trees, and the road network. By 2022, these elements had almost disappeared and have been replaced by beaches, dunes, wet grassland, and shrub savannas. The mangrove forest continues to decline significantly in some places. If steps are not taken in time, the degradation caused by human activities will continue.

FIGURE 6: RISK MAP - KANFARANDÉ



Source of the field study

FIGURE 7: LAND USE (2002, KANFARANDÉ)



Source: Spot héritage 2002

TABLE 6: SURFACE AREA AS A PERCENTAGE (2002)

Area	Surface area in ha (2002)	Percentage
Cashew trees	23.682	0%
Watercourses and waterways	9,297.085	4%
Lowland crops	49.745	0%
Mangrove lowland crops	3,052.414	1%
Rainfed and fallow crops	6,562.678	3%
Estuaries	39,098.654	16%
Gallery forests	532.209	0%
Swamp forests	724.959	0%
Transition shrub formation	20,613.276	9%
Mangroves	**45,770.734**	**19%**
Tidal marshes	24,465.101	10%
Salt marshes	697.217	0%

Area	Surface area in ha (2002)	Percentage
Sea and ocean	32,434.321	13%
Palm groves	4,543.012	2%
Natural palm trees	7.013	0%
Beaches, dunes, and sands	1,281.260	1%
Water bodies	198.896	0%
Wet grasslands	1,577.724	1%
Road and rail networks and associated spaces	4.373	0%
Shrub savannas	17,386.573	7%
Woodland and tree savannas	22,400.409	9%
Grassy savannas	1,027.170	0%
Bare soils	4.551	0%
Agroforestry systems (combination of perennial crops and forest species)	1,730.711	1%
Continuous urban fabric	47.211	0%
Discontinuous urban fabric and villages	14.864	0%
Intertidal zones	6,903.008	3%
Port areas	6.777	0%
Total	240,455.627	100%

GRAPH 6: PERCENTAGES (2002)

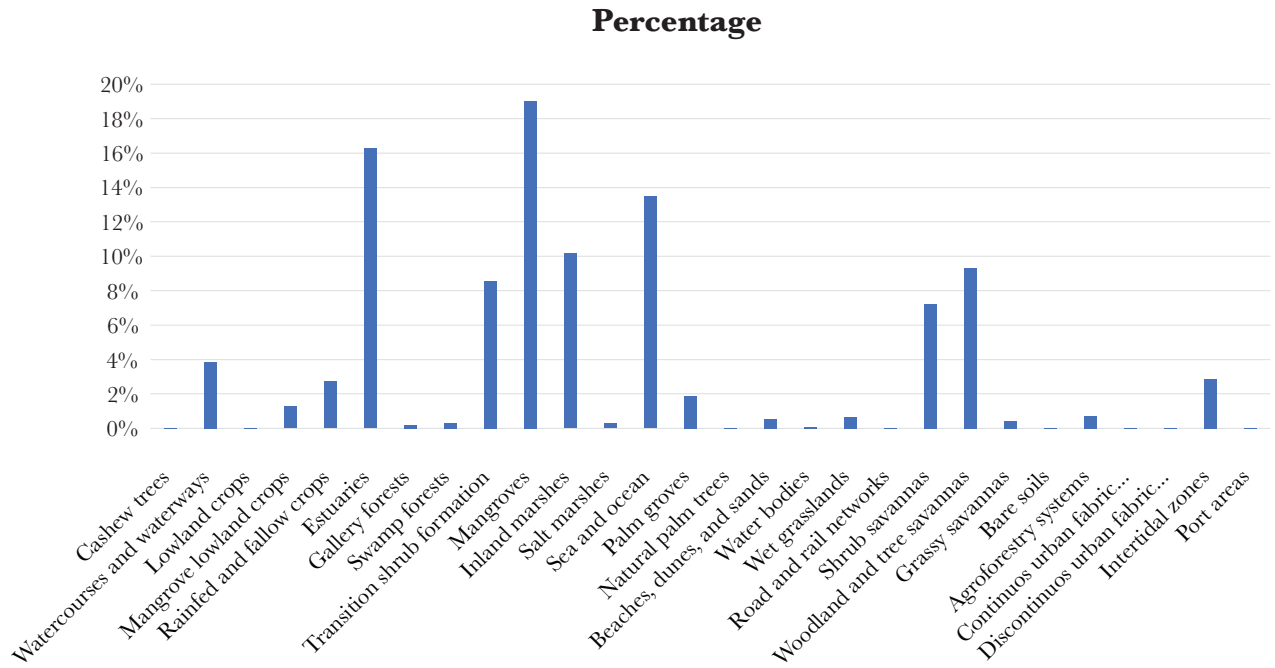
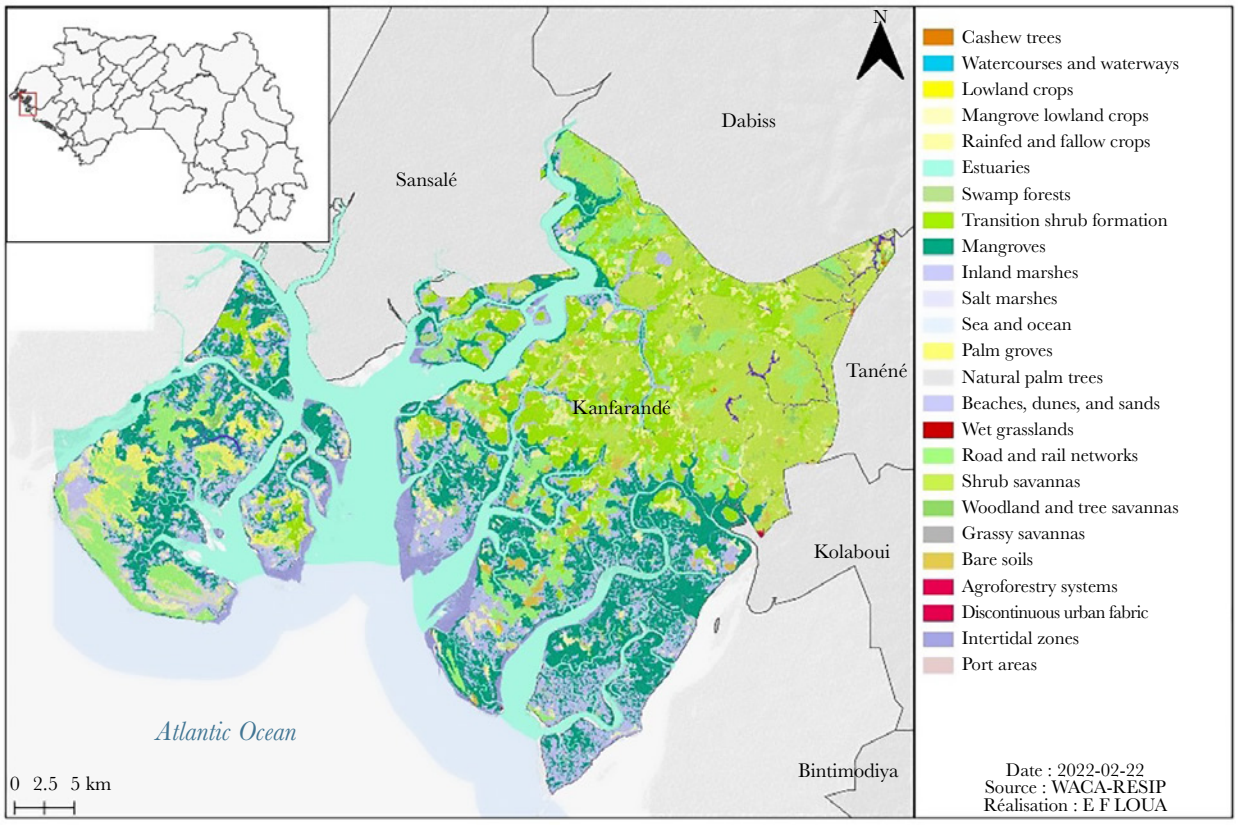


FIGURE 8: LAND USE (2022, KANFARANDÉ)



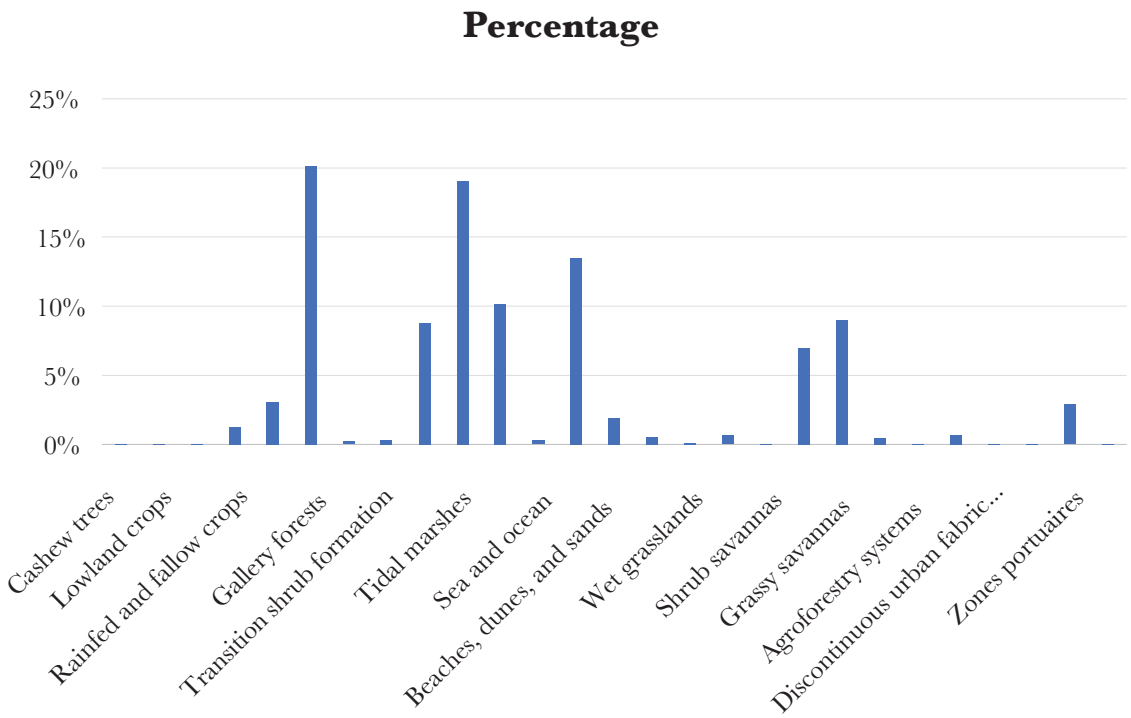
Source: Sentinel Imagery 2A, 2022

TABLE 7: SURFACE AREA AS A PERCENTAGE (2022, KANFARANDÉ)

Area	Surface area in ha (2022)	Percentage
Cashew trees	60.683	0%
Watercourses and waterways	37.428	0%
Lowland crops	49.745	0%
Mangrove lowland crops	3,064.308	1%
Rainfed and fallow crops	7,444.241	3%
Estuaries	48,358.311	20%
Gallery forests	532.209	0%
Swamp forests	724.959	0%
Transition shrub formation	21,138.275	9%
Mangroves	**45,758.840**	**19%**
Tidal marshes	24,465.101	10%
Salt marshes	697.217	0%
Sea and ocean	32,434.321	13%

Area	Surface area in ha (2022)	Percentage
Palm groves	4,543.012	2%
Beaches, dunes, and sands	1,281.260	1%
Water bodies	198.896	0%
Wet grasslands	1,577.724	1%
Road and rail networks and associated spaces	4.373	0%
Shrub savannas	16,764.452	7%
Woodland and tree savannas	21,587.858	9%
Grassy savannas	1,025.292	0%
Bare soils	4.551	0%
Agroforestry systems (combination of perennial crops and forest species)	1,730.711	1%
Continuous urban fabric	47.211	0%
Discontinuous urban fabric and villages	14.864	0%
Intertidal zones	6,903.008	3%
Port areas	6.777	0%
Total	240,455.627	100%

GRAPH 7: PERCENTAGES (2022)

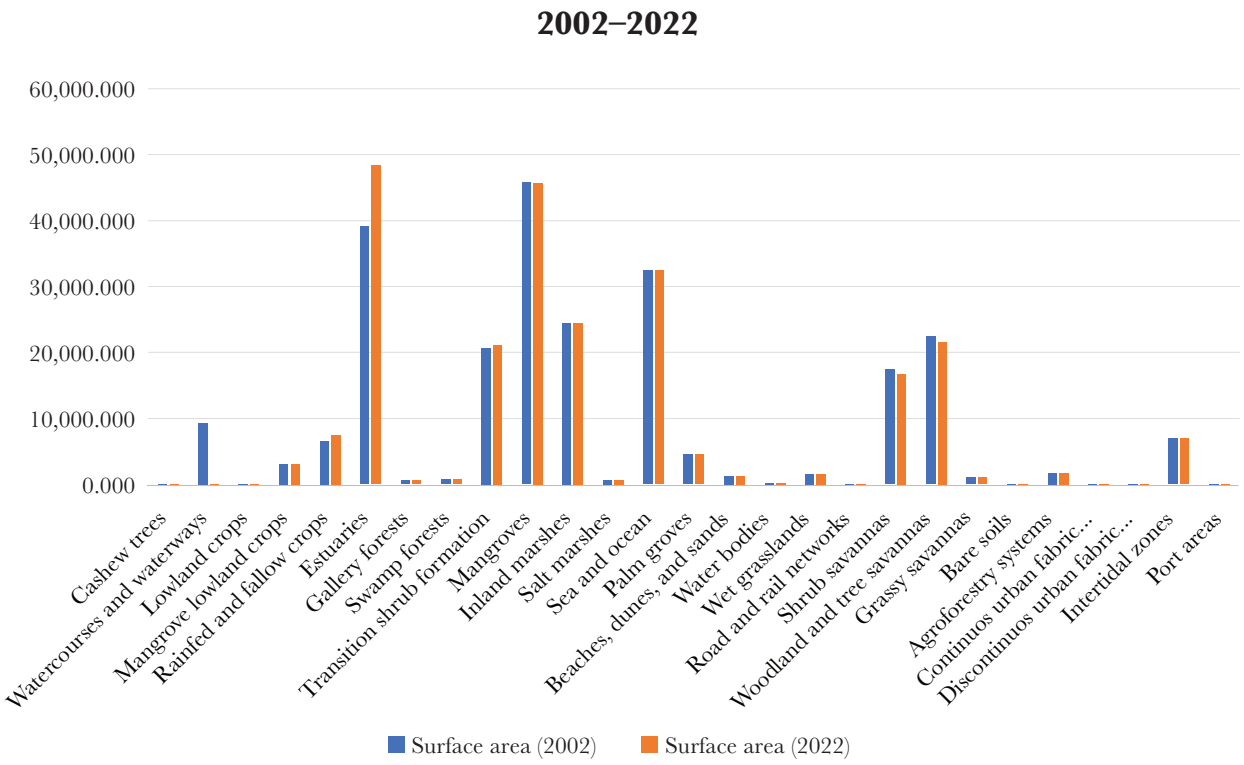


More specifically, the statistical table comparing the two maps provides a clearer and more precise picture of the changes over the past 20 years in the Kanfarandé area.

TABLE 8: CHANGES BETWEEN 2002 AND 2022, KANFARANDÉ

Area	Surface area (2002)	Surface area (2022)	Consumption and production flows
Cashew trees	23.682	60.683	-37.00
Watercourses and waterways	9,297.085	37.428	9,259.66
Lowland crops	49.745	49.745	0.00
Mangrove lowland crops	3,052.414	3,064.308	-11.89
Rainfed and fallow crops	6,562.678	7,444.241	-881.56
Estuaries	39,098.654	48,358.311	-9,259.66
Gallery forests	532.209	532.209	0.00
Swamp forests	724.959	724.959	0.00
Transition shrub formation	20,613.276	21,138.275	Δ25.00
Mangroves	**45,770.734**	**45,758.840**	**11.89**
Tidal marshes	24,465.101	24,465.101	0.00
Salt marshes	697.217	697.217	0.00
Sea and ocean	32,434.321	32,434.321	0.00
Palm groves	4,550.025	4,543.012	7.01
Beaches, dunes, and sands	1,281.260	1,281.260	0.00
Water bodies	198.896	198.896	0.00
Wet grasslands	1,577.724	1,577.724	0.00
Road and rail networks and associated spaces	4.373	4.373	0.00
Shrub savannas	17,386.573	16,764.452	622.12
Woodland and tree savannas	22,400.409	21,587.858	812.55
Grassy savannas	1,027.170	1,025.292	1.88
Bare soils	4.551	4.551	0.00
Agroforestry systems (combination of perennial crops and forest species)	1,730.711	1,730.711	0.00
Continuous urban fabric	47.211	47.211	0.00
Discontinuous urban fabric and villages	14.864	14.864	0.00
Intertidal zones	6,903.008	6,903.008	0.00
Port areas	6.777	6.777	0.00
Total	240,455.627	240,455.627	0.00

GRAPH 8: COMPARISON BETWEEN 2002 AND 2022



SITE 3: KAMSAR

1. Mangrove-centered activities in Kamsar

Mangrove-centered activities in the Kamsar area include salt production, fish smoking, rice farming, fishing, and oyster picking. While mangrove firewood harvesting for smoking and domestic use is established, harvesting of mangroves for sale is no longer being carried out on the two sites visited. The mangroves in the Kamsar area have deteriorated over the past 20 years, primarily as a result of anthropogenic pressure from excessive wood harvesting, the influx of migrants in search of well-being, and the advancement of the sea toward the mainland caused by embankments constructed by mining companies. Kamsar is an industrial port city.

Salt extraction areas were previously mangrove forests. As the sea advanced, the mangroves degraded, providing room for mangrove lowlands where women scrape the soil to obtain a brine powder when the tide is low. This powder is processed to obtain the salt. As traditional places are still in place in the islands, salt production requires large quantities of mangrove wood.

Furthermore, the degradation of Kamsar's mangroves could be explained by the non-rational exploitation of coastal areas by local communities and by the various economic operators (uncontrolled urbanization, tourism activities, and oil mining). Demographic pressure and the development of the tourism industry in the Kamsar area have led to the disappearance of certain species from the coastal forest of this area.

2. Mangrove-centered activities of women in Kamsar

Forty-two percent of the women interviewed in Kamsar engage in salt extraction, while 33 percent are involved in fish smoking, and 25 percent in rice farming. In general, activities are essentially gender-based, with the exception of fishing and sometimes rice farming, which requires a lot of physical strength and courage. Women are involved in all activities in the mangrove area.

The number of persons who are dependent on mangrove products increased to 58.33 percent, up from 41.67 percent.

There is no more wood to be harvested in Kamsar, as mining companies are operating in the area and there is a port area for bauxite extraction. Kamsar is extremely popular among migrants who come from the four regions of Guinea. Most Kamsar youth work with the mining companies while others practice fishing. Women who depend on mangrove products are more involved in fish farming, fish smoking, and rice cultivation.

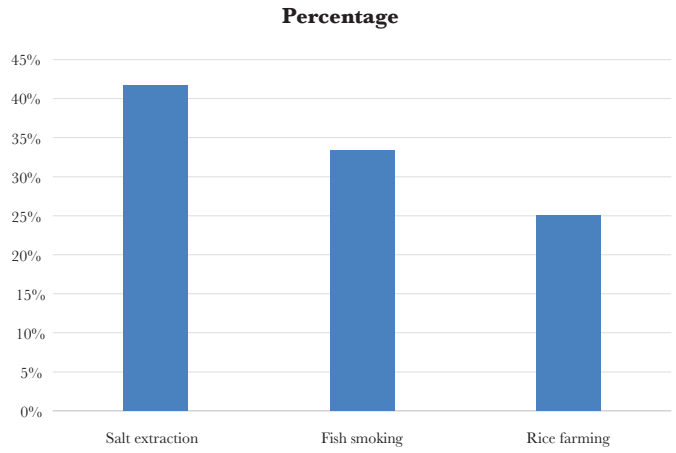
However, in the case of rice cultivation, men prepare the land by plowing and allowing water to flow between the dikes, while the women take the young rice plants from the rice nurseries and help the husbands with the marking out of the fields. Beside their husbands' fields, they develop the market garden fields where products are planted for sale and domestic consumption. At harvest time, men and women perform complementary tasks. Men cut the rice while women beat it. Women parboil the final product, 80 percent of which is sold on the weekly market, while households consume the rest. A small amount is kept and used as seed stock for the following year. Fuelwood harvesting is done on a part-time basis. Modern smoking centers equipped with FAO's FTT ovens are being built in Kamsar Centre and other subprefectures. The importance of this smoking activity is reflected in the establishment of several groups and associations of women fish smokers by the NGO *"Charente Maritime."*

In the Kamsar districts visited (Taigbé and Taidi sector), smoking is practiced at home by many women.

TABLE 9: MANGROVE-CENTERED ACTIVITIES OF WOMEN IN KAMSAR

Activity	Percentage
Salt extraction	42%
Fish smoking	33%
Rice farming	25%
Total	100%

GRAPH 9: PERCENTAGE OF MANGROVE-CENTERED ACTIVITIES IN KAMSAR



3. Mangrove products for domestic/ commercial consumption to earn income

Products derived from mangrove-centered activities in Kamsar are primarily for commercial consumption: 90 percent of the products are for commercial purposes while 10 percent are consumed by households, which depend on these products for subsistence. Fish smoking and rice cultivation are highly developed in the Kamsar area and are primary sources of income. Oyster harvesting, soap making, and oil production are considered secondary sources of income.

According to the sector chief, in the Taidi area closer to Kamsar, "*the embankments constructed by mining companies block the free flow of water, which no longer irrigates the other side of the saltflats (tannes), thereby leading to acidification and an increase in the normal salinity rate.*"

However, he indicated as well that natural factors such as climate change and reduced rainfall were also at play. In this large swampy area, *Rhizophora* has disappeared, unlike *Avicennia*, which thrives in some sections.


Photos 46, 47. Avicennia forest in Taigbé.

4. Socioeconomic and demographic characteristics of women engaged in mangrove-centered activities in the Kamsar sample

Women engaged in mangrove conservation are mostly Indigenous residents of the village, and range in age from 35 to 45 years old. Some 87 percent of the women interviewed earn a low income that covers 30 percent of their needs, while 10 percent of the respondents earn an average income that covers 50 percent of needs. Only 3 percent indicated that they earn a high income and these women are often fish smokers and salt producers.

Forty-two percent of the women interviewed were between the ages of 20 and 35, 33 percent were between 35 and 45, and 25 percent were 45 years and over. The majority of respondents had more than 20 years' experience in mangrove-centered activities and were all native to the village (100 percent Baga ethnic group). The study found that the women who engaged in mangrove activities were indigenes, while migrants, who were concentrated in the Kamsar Centre area, engage in small trade and buy processed fish for resale in the capital's major towns.

The main activity is salt extraction from the mangrove lowlands, which is practiced by 42 percent of the women interviewed, followed by fish smoking (33 percent), and rice cultivation (25 percent). As long as there is fishing, the need for smoking increases over time. Women depend first and foremost on mangroves to meet household subsistence needs. Women aged 45 and over often engage in fish smoking. The youngest are involved in salt production and oyster picking. The marital status of the women engaged in mangrove-centered activities varies: in general, they are all married, and some are widowed with dependent children. A household may have more than 15 to 20 persons. Ninety-nine percent of the sample of women interviewed have no education and only one percent indicated that they have a basic level.

According to an elder in Taigbé, "*when the rice harvest is poor, women turn to small trade in Kamsar Centre or purchase fish processed by their peers, which they often resell in the weekly market.*"

5. Seasonal nature of the activities of women engaged in mangrove activities

While smoking is done all year (or almost all year) round, slowing down only during the rainy season either because of bad weather or field work, salt is produced exclusively during the dry season. Wood for domestic consumption and fish smoking at home is harvested all year round. In Kamsar, women buy mangrove wood for smoking, but thanks to the FTT ovens, less wood is used for this process.

Farming in rice-growing areas throughout the year was confirmed during field studies in the two districts.

6. Women's willingness to switch to alternatives to mangrove products

In the Taigbé district and the Taidi sector, women who are dependent on mangrove products have expressed no interest in switching from smoking and salt production. They request support and capacity building in their fields of activity, while others request financial support to start a general trade business in Kamsar.

7. Conservation and restoration of mangroves in the Kamsar area

During the field visit, as part of the mangrove conservation and restoration effort, the two mining companies operating in the Kamsar area were identified: The Bauxite Company of Guinea (CBG) project [launched] two years ago, and another project by the Global Alumina Corporation (GAC) [launched] three years ago. According to the MEDD Department Head, the objective of these two projects was the implementation of the program of reforestation and rehabilitation of degraded areas of Taidi by the GAC.

8. Activities of women in the conservation, rehabilitation and/or restoration of mangroves

Specifically, women have been directly and indirectly involved in mangrove reforestation activities. According to the Prefectural Director of the Environment, women are at the center of all activities to be carried out in mangroves.

9. Demographic and socioeconomic characteristics of women engaged in mangrove conservation

Women engaged in mangrove conservation activities are married indigenes between the ages of 35 and 45 and often volunteer to participate in the activities.

10. Challenges faced by women in the conservation of mangroves

The challenges in Kamsar include:

» Advancement of the sea toward the mainland;
» Influx of migrants to Kamsar Centre;
» Lack of alternative financing for activities such as market gardening and rice farming;
» Lack of financing for women for IGAs.

11. Women's groups

There are women's self-help groups, as is the case in the other two areas studied.

12. Threat posed by mangrove-centered activities in Kamsar:

The map shows that salt extraction poses clear threats (severe threat (50-100 percent) can be clearly observed on the map). This activity is practiced everywhere on the Taigbé and Taidi islands, attesting to the high percentage of salt producers in the area. Wood harvesting in *Avicennia* mangroves is often triggered major land clearings for the creation of new salt ponds.

The field study period did not coincide with the salt production period; it did, however, coincide with the scraping of the land to obtain brine. This activity is expected to start in late February, but one woman explained the process to us, including how traditional salts are obtained.

Because of the high temperatures, the dry season promotes the formation of brine powder on the land surface. The strip of land that covers mangrove saltflats (tannes) has an extremely high salinity level. This land is scraped and stored in piles. The men build a funnel-shaped filter (tanké) using just dried mud, tall soft grass, and branches that form the frame. The soil is deposited in the filter and covered with water. The water absorbs the salt and is collected downstream of the funnel in a small ditch that is also made of dried mud.

Using a calabash, the brine is transferred into a flat-bottomed pot called a tank or "keg." It is brought to a boil and evaporates slowly, revealing the salt. Deposited on a drying area for a few days, the salt is then stored in "50kg bags" and sold in major markets in the city.

In addition, these companies also have negative impacts on the islands because of the embankments that have been constructed and have led to the advancement of the sea toward the continent.

PHOTOS 48–52: MANGROVE-CENTERED ACTIVITIES IN KAMSAR

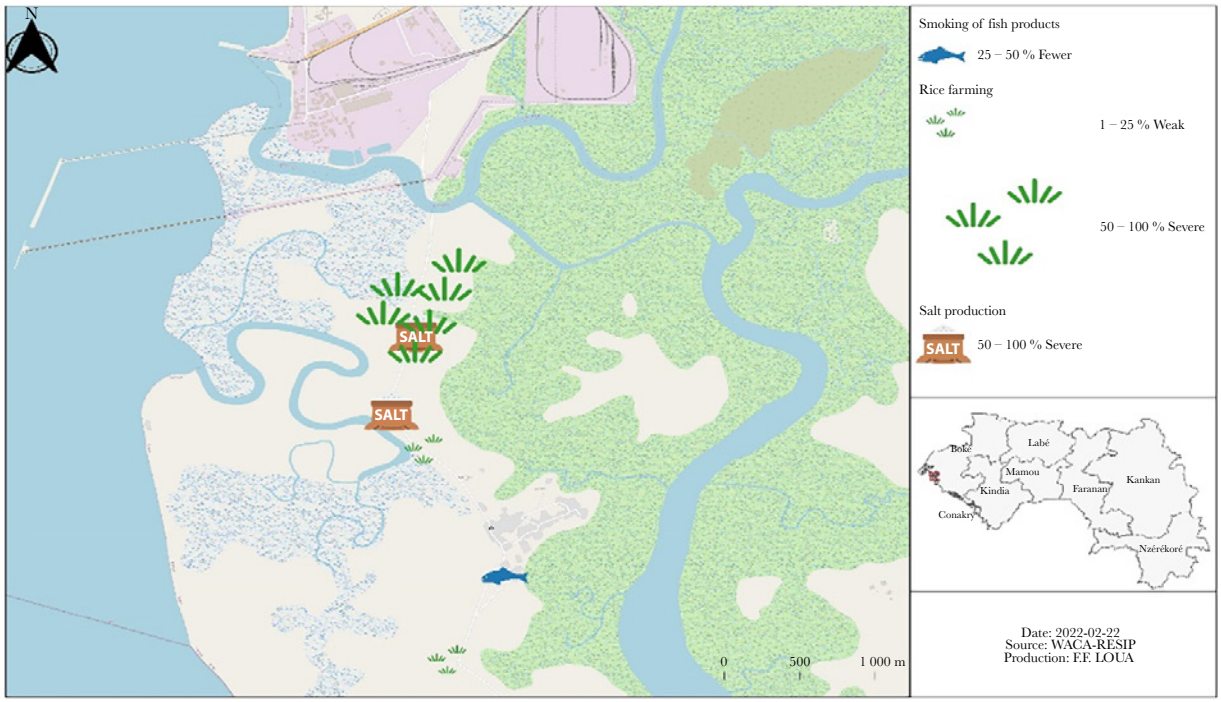
Photo 48. Brine filtering.

Photo 49. Mangrove lowlands in Taigbé.

Photos 50, 51. Traditional Banda for fish smoking.

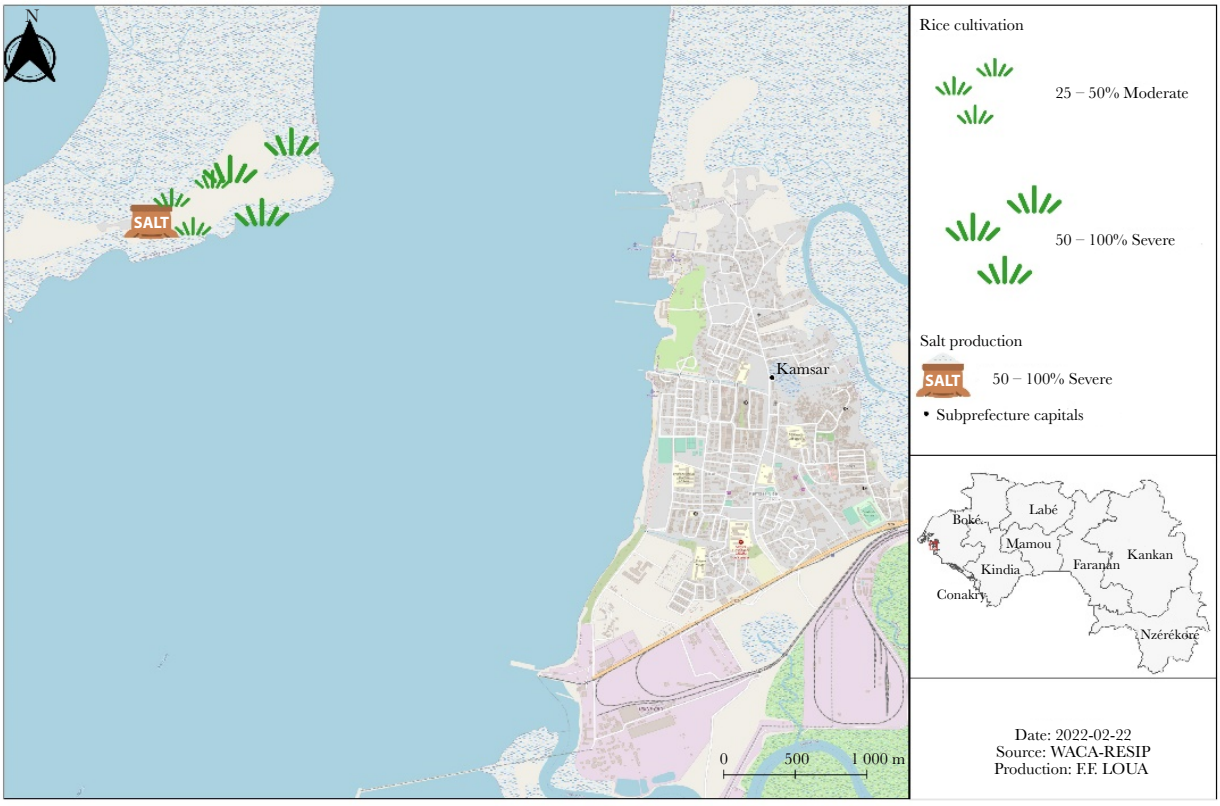
Photo 52. Rice paddy in Taigbé.

FIGURE 9: RISK MAP - TAIGBÉ



Source of field study

FIGURE 10: RISK MAP - TAIDI

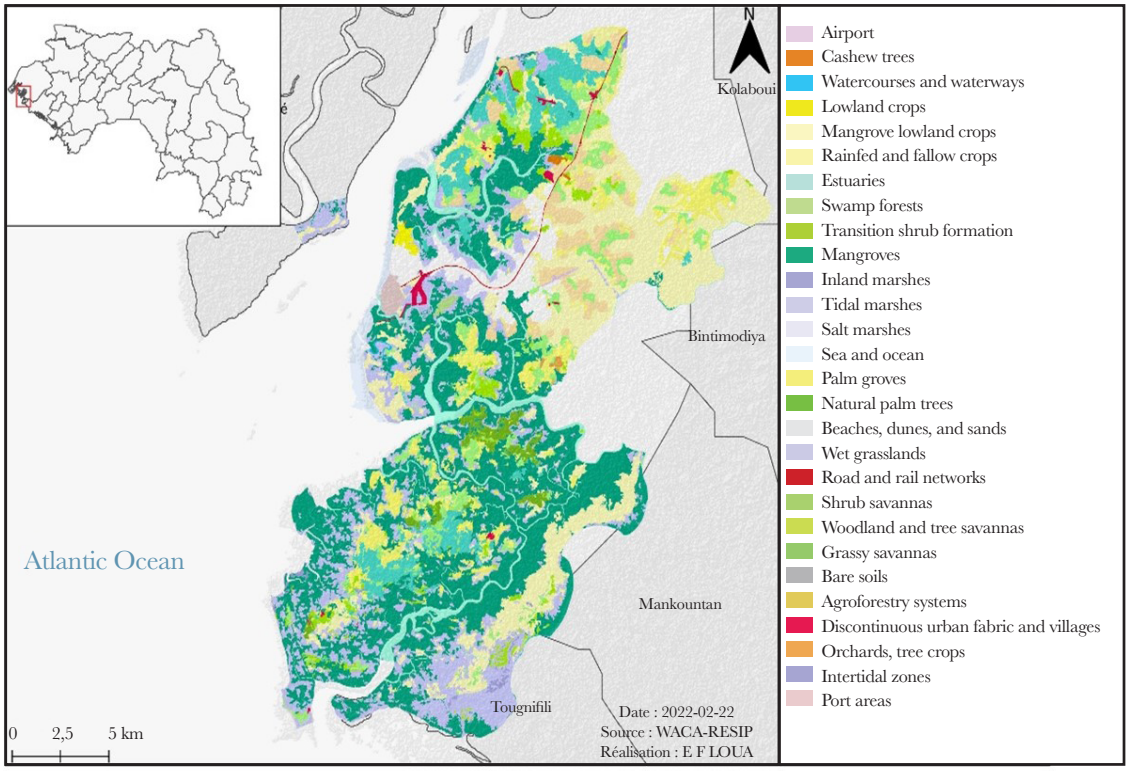


Source of field study

13. Comparative land use map 2002–2022

The comparison map for the period 2002 to 2022 shows a change in the current condition in the area over this 20-year period: the wet grassland changed, and by 2022 the landscape had been completely altered by human economic activity.

FIGURE 11: LAND USE (2002, KAMSAR)



Source: spot inheritance 2002

TABLE 10: SURFACE AREA AS A PERCENTAGE (2002)

Area	Surface area in ha 2022	Percentage
Airports	25.808	0%
Cashew trees	39.069	0%
Watercourses and waterways	59.378	0%
Lowland crops	131.030	0%
Mangrove lowland crops	6,867.579	12%
Rainfed and fallow crops	482.950	1%
Estuaries	1,635.684	3%
Swamp forests	57.110	0%
Transition shrub training	986.791	2%
Mangroves	**13,272.433**	**24%**
Inland marshes	24.482	0%

Area	Surface area in ha 2022	Percentage
Tidal marshes	6,049.425	11%
Salt marshes	20.996	0%
Sea and ocean	12,805.664	23%
Palm groves	3,022.588	5%
Natural palm trees	546.510	1%
Beaches, dunes, and sands	40.992	0%
Wet grasslands	2,400.846	4%
Road and rail networks and associated spaces	83.074	0%
Shrub savannas	2,705.157	5%
Woodland and tree savannas	3.235	0%
Grassy savannahs	51.784	0%
Bare soils	5.365	0%
Agroforestry systems (combination of perennial crops and forest species)	1,694.086	3%
Continuous urban fabric	1,634.545	3%
Discontinuous urban fabric and villages	184.188	0%
Orchards, tree crops	35.300	0%
Intertidal zones	272.095	0%
Port areas	180.970	0%
Total	55,319.134	100%

GRAPH 10: SURFACE AREA AS A PERCENTAGE (2002)

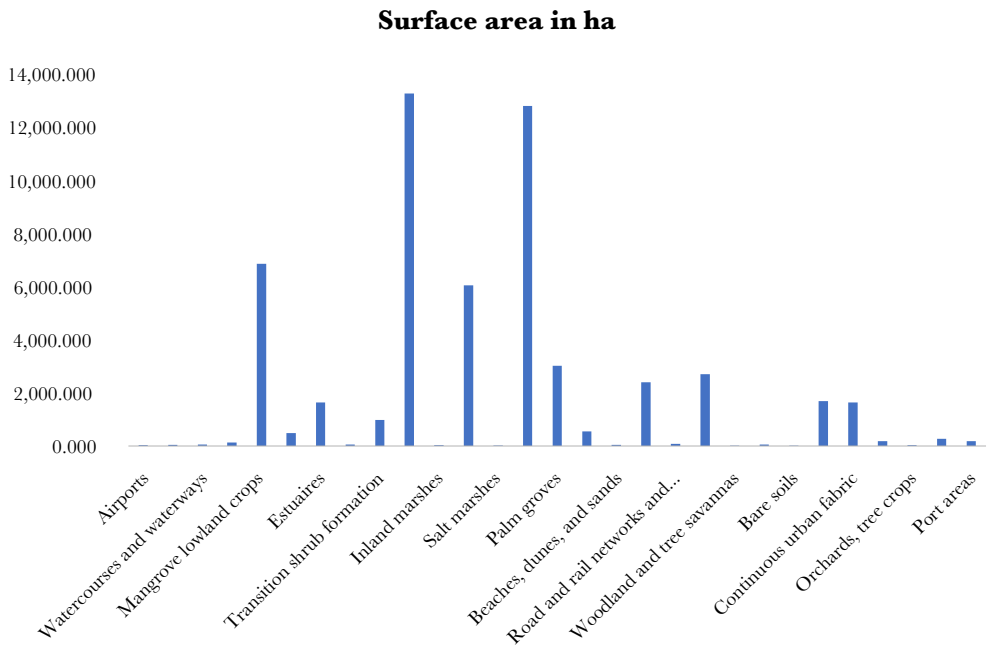
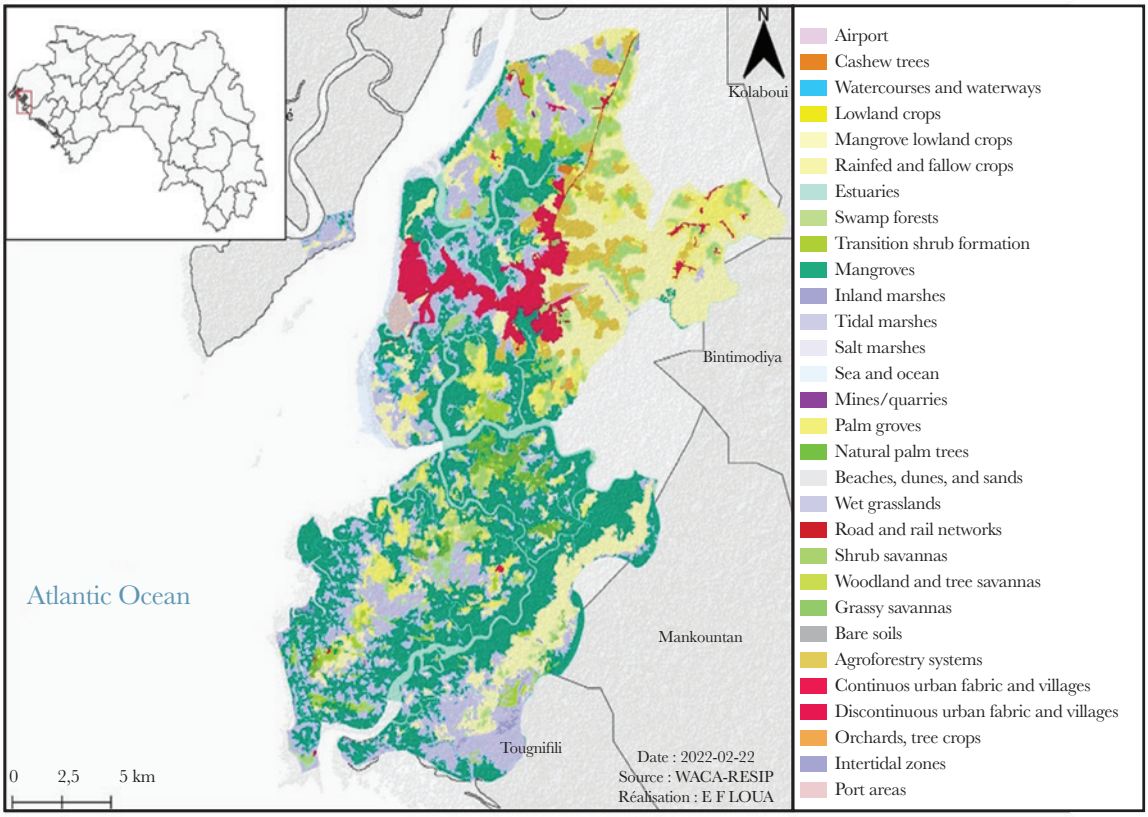


FIGURE 12: LAND USE (2022, KAMSAR)



Source: Sentinel Imagery 2A 2022

TABLE 11: SURFACE AREA AS A PERCENTAGE (2022)

Entity	Surface area in ha 2022	Percentage
Airports	25.808	0%
Cashew trees	39.069	0%
Watercourses and waterways	59.378	0%
Lowland crops	31.198	0%
Mangrove lowland crops	6,867.579	12%
Rainfed and fallow crops	556.895	1%
Estuaries	1,634.347	3%
Swamp forests	57.110	0%
Transition shrub training	914.284	2%
Mangroves	**13,263.787**	**24%**
Inland marshes	24.482	0%
Tidal marshes	6,049.425	11%
Salt marshes	20.996	0%

Entity	Surface area in ha 2022	Percentage
Sea and ocean	12,805.664	23%
Mines/quarries, extraction of materials	3.856	0%
Palm groves	3,018.195	5%
Natural palm trees	546.510	1%
Beaches, dunes, and sands	40.992	0%
Wet grasslands	2,400.846	4%
Road and rail networks and associated spaces	83.074	0%
Shrub savannas	2,686.911	5%
Woodland and tree savannas	3.235	0%
Grassy savannas	51.784	0%
Bare soils	5.365	0%
Agroforestry systems (combination of perennial crops and forest species)	1,694.086	3%
Continuous urban fabric	1,734.377	3%
Discontinuous urban fabric and villages	201.533	0%
Orchards, tree crops	35.300	0%
Intertidal zones	272.095	0%
Port areas	190.953	0%
Total	55,319.134	100%

GRAPH 11: SURFACE AREA AS A PERCENTAGE (2022)

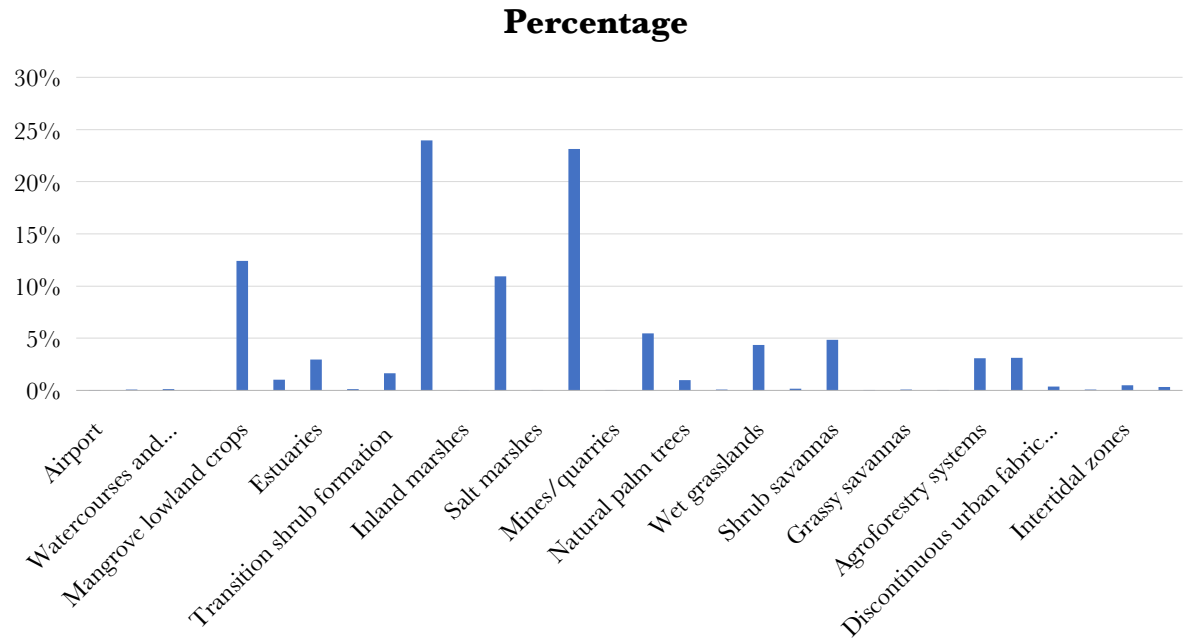
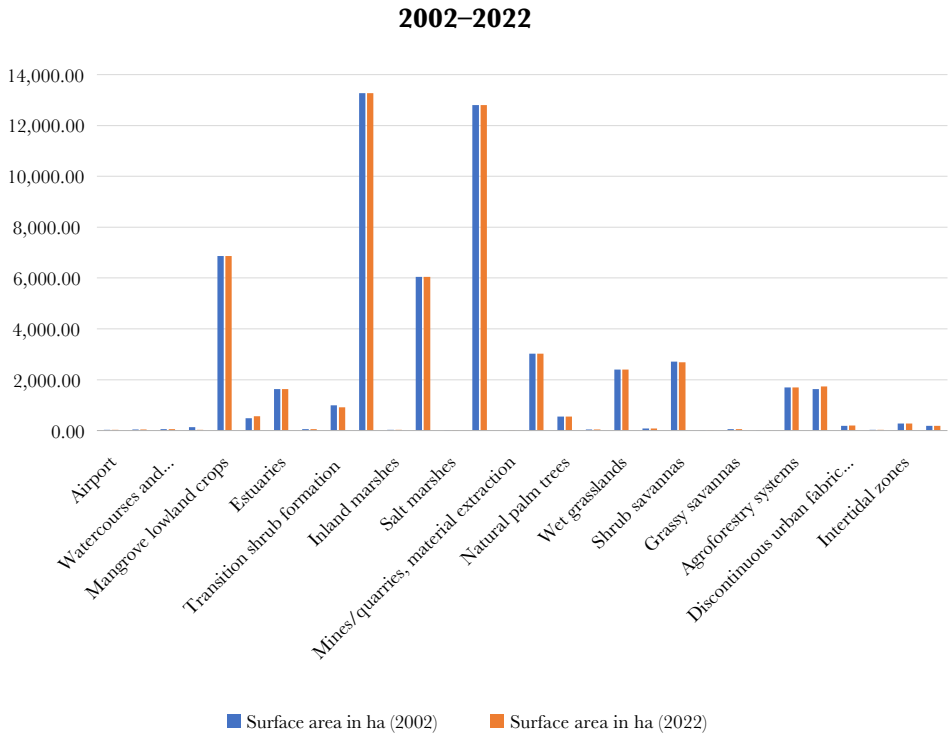


TABLE 12: COMPARISON BETWEEN 2002 AND 2022

Area	Surface area in ha (2002)	Surface area in ha (2022)	Consumption and production flows
Airports	25.81	25.81	0.00
Cashew trees	39.07	39.07	0.00
Watercourses and waterways	59.38	59.38	0.00
Lowland crops	131.03	31.20	99.83
Mangrove lowland crops	6,867.58	6,867.58	0.00
Rainfed and fallow crops	482.95	556.90	-73.95
Estuaries	1,635.68	1,634.35	1.34
Swamp forests	57.11	57.11	0.00
Transition shrub training	986.79	914.28	72.51
Mangroves	**13,272.43**	**13,263.79**	**8.65**
Inland marshes	24.48	24.48	0.00
Tidal marshes	6,049.43	6,049.43	0.00
Salt marshes	21.00	21.00	0.00
Sea and ocean	12,805.66	12,805.66	0.00
Mines/quarries, extraction of materials	0.00	3.86	-3.86
Palm groves	3,022.59	3,018.20	4.39
Natural palm trees	546.51	546.51	0.00
Beaches, dunes, and sands	40.99	40.99	0.00
Wet grasslands	2,400.85	2,400.85	0.00
Road and rail networks and associated spaces	83.07	83.07	0.00
Shrub savannas	2,705.16	2,686.91	18.25
Woodland and tree savannas	3.24	3.24	0.00
Grassy savannahs	51.78	51.78	0.00
Bare soils	5.37	5.37	0.00
Agroforestry systems (combination of perennial crops and forest species)	1,694.09	1,694.09	0.00
Continuous urban fabric	1,634.55	1,734.38	-99.83
Discontinuous urban fabric and villages	184.19	201.53	-17.35
Orchards, tree crops	35.30	35.30	0.00
Intertidal zones	272.10	272.10	0.00
Port areas	180.97	190.95	-9.98
Total	55,319.13	55,319.13	0.00

GRAPH 12: COMPARISON BETWEEN 2002 AND 2022



❖ COMPONENT ON THE SEMISTRUCTURED INDIVIDUAL INTERVIEW OF LOCAL INFORMANTS

This qualitative component was based primarily on the combination of three research tools: interviews with local informants, the focus group, and interviews with the institutional stakeholders and deconcentrated services of the Ministry of the Environment. The semistructured individual interviews of local informants were conducted to complement the household survey to further discuss the links between mangroves and women, based on the perceptions and perspectives of the local populations, while ensuring a diversity of profiles among the respondents: district chiefs, elders, presidents of youth groups, etc. Twenty semistructured individual interviews were conducted in the districts of the three study areas using an interview guide structured around a number of categories, including: profile, mangrove activities and products, socioeconomic characteristics of women engaged in mangrove-centered activities, the conservation, restoration, and/or rehabilitation of mangroves, the demographic characteristics of women, and policy rules and regulations.

TABLE 13: INTERVIEW OF KEY LOCAL INFORMANTS IN THE THREE STUDY AREAS

Study area	Individual interviews with local informants		
Sites	**Number of interviewers**	**Target**	**Total interviewed**
Kaback	5	Local informants	9
Kanfarandé	5		6
Kamsar	5		5

These interviews revealed that women who depend on mangrove-centered activities have no other sources of income and have almost never benefited from a mangrove restoration project or received support through income-generating activities. Mangrove sites face a

number of challenges in these environments. The general public nonetheless has free and unregulated access for personal use to 90 percent of these sites.

However, some sites have benefited from mangrove restoration projects such as the Kamsar area where the Global Alumina Corporation had in the past planted mangrove nurseries that never yielded good results because of the dumping of waste into the sea. In addition, 90 percent of the interviewees in Kamsar acknowledge that the establishment of mining companies had negative impacts on the islands, because of the construction of roadsteads to facilitate the transport of bauxite to large shipping vessels. For example, areas that served as rice paddies were flooded by sea water and remained unsustainable because of high salinity.

The NGO Tristao continues to finance reforestation projects for degraded sites in the Kanfarandé area with the establishment of fast-growing tree nurseries and provides training and coaching to women's groups, as well as support with income-generating activities. Support is also provided by the NGO Guinée Ecologie, which has been financing mangrove conservation projects on the Tristao islands for the past three to five years.

Photo 53. Interview in Bolimanda, Kaback.

❖ INTERVIEWS WITH KEY INFORMANTS FROM THE DECONCENTRATED GOVERNMENT SERVICES

Ten individual interviews of informants from the following deconcentrated services of the Ministry of the Environment and Sustainable Development (MEDD) were conducted in the three subprefectures in the study zone: Guinean Parks and Reserve Office (OGPR), Guinean Timber Board (OGUIB), Forest and Wildlife Prefectural Division (SPFF), the Prefectural Directorate of the Environment and Sustainable Development (DPEDD). The results of the interviews supplemented the results of the household surveys and provided information on the management of mangroves by the government.

These informants, who were targeted within and outside of Conakry, provided baseline information on the causes of the decline in mangrove areas, one of which is the lack of monitoring of the areas. Forestry officers based in these areas do not have adequate monitoring tools to effectively carry out their mission.

A forestry officer told me that he would not dare venture into the mangrove forest dressed in military attire, as he could be killed and dumped in the water by mangrove wood harvesters.

Furthermore, according to the information obtained from the survey of the deconcentrated government services, there were mangrove restoration and conservation projects in which women were involved and played an important role in the survival of the ecosystem. However, these same women are also engaged in salt production, smoking, and oyster picking on the same sites.

One hundred percent of the services surveyed confirm that mangroves are the sole source of income for women in these coastal areas and that they practice these activities for two reasons: to provide for their family and to earn a business income.

TABLE 14: INDIVIDUAL INTERVIEWS WITH DECONCENTRATED GOVERNMENT SERVICES

Study Area	Individual interviews with deconcentrated government services		
Sites	**Number of interviewers**	**Target**	**Total interviewed**
Conakry	2	Deconcentrated services	2
Kaback	5		2
Kanfarandé and Kamsar	5		6

These individual interviews were supplemented by focus groups and observation studies.

Photo 54. Focus group in Bossimiyah.

Photo 55. Observation in Taigbé.

❖ COMPONENT ON MANGROVE CONDITIONS IN THE THREE STUDY AREAS

The comparison tables for each study area clearly show that mangroves have decreased in area in some places and less so in others. The surface area in the Kaback area in 2002 was 2,880.31 hectares (23 percent), while in 2022 it decreased to 2,745.41 hectares (22 percent); consumption and production flows declined by 134.89 (Source: Sentinel Imagery 2A, 2022).

The mangrove surface area in the Kanfarandé area in 2002 was 45,770.734 hectares (19 percent), while in 2022 it had almost the same dimensions (45,758.840 hectares, still 19 percent); the consumption flow was 11.89 (Source: Sentinel Imagery 2A, 2022).

In Kamsar in 2002, the surface area of the mangroves was 13,272.433 hectares (24 percent); after 20 years it was 13,263.787 hectares (still 24 percent). The consumption flow is 8.65 percent (Source: Sentinel Imagery 2A, 2022).

In general, mangroves in the Kaback area have deteriorated over the past 20 years, while in Kanfarandé and Kamsar mangroves have shown some improvement over the same period, staying the course despite moderate harvesting. This was made possible through awareness raising among NGOs and mining companies.

Based on field findings and an analysis of the interview results, mangrove forests are gradually recovering in the Kanfarandé area, thanks to steps taken by the State and the

community to safeguard the mangrove forest. However, despite the rules and measures in place, harvesting is still being carried out within mangrove forests.

According to one respondent in Kanof, the authorities have been monitoring the coasts and banned mangrove wood harvesting more than three years ago. As a result, the regeneration of mangrove forests has been under way for some time.

Excessive harvesting has depleted mangrove forests in Kaback over the past 10 years and there are very few reforestation activities in the area. Given the current state of the area, communities have understood that if mangroves disappear, all vested interests will be lost. They have therefore understood the need to get involved in participatory, dynamic, and functional consultations that promote the introduction of community laws and rules that prohibit the destruction of mangroves and are validated by all users of mangrove products, the majority of whom are women who derive their income from these mangroves.

❖ COMPONENT ON THE MANGROVE OWNERSHIP REGIME IN THE THREE STUDY AREAS

The majority of respondents stated that mangrove ownership is community-based, with only a minority indicating that it was family-based. This is the case in the Bolimande district in Kaback subprefecture, where residential areas near mangroves are considered to be family property by landowners.

❖ RULES AND REGULATIONS

The rules and regulations are set out in the MEDD Environmental Code, the Forest Code, and the Fisheries Code, the articles of which govern the formal prohibition of logging in mangrove areas. These laws are defined by the State and implemented by its representatives in the deconcentrated services. Forestry and nature conservation officers are stationed in all subprefectures, but equipment and training are regrettably lacking.

Now, in light of the scarcity of fish in some areas and the decrease of mangroves, communities in coastal areas have understood the importance of this ecosystem. In the Matakang, Bolimanda, and Bossimiyah districts in Kaback, local authorities and presidents of youth groups formally prohibit mangrove wood harvesting. This is also the case in the Kanfarandé and Kamsar subprefectures. However, the illegal harvesting of mangrove and domestic wood for fish smoking at home continues.

In addition, women in the Kanfarandé and Kaback areas have introduced a rule prohibiting the cutting of mangrove roots for oyster picking. Now, the oyster are scraped off the roots. This is one way of conserving the mangroves.

❖ SUGGESTIONS FROM RESPONDENTS IN THE THREE STUDY AREAS

Suggestions for improving mangrove health in the three study areas were divided into two groups: the deconcentrated government services and key local informants as well as the women interviewed in the three study areas.

1. Deconcentrated government services
   - » Develop tools for mangrove management;
   - » Take into account the master plans for the implementation of laws and rules for coastal areas that will take into account mangroves;
   - » Support mangrove restoration and conservation initiatives;
   - » Inform and raise awareness among coastal communities about the importance of mangroves and the danger of its degradation;
   - » Reforest degraded mangrove sites;
   - » Involve administrative and commune-level authorities in the mangrove management process;
   - » Finance mangrove restoration projects;
   - » Strengthen surveillance by providing forest rangers with the appropriate resources.

2. Women engaged in mangrove activities:
   - » Reforest denuded areas;
   - » Finance income-generating activities and other alternative activities such as market gardening and oil and soap production;
   - » Provide assistance and support to women in implementing formal EIGs;
   - » Train oyster pickers and salt producers in the new modern techniques for oyster picking and solar salt production;
   - » Build shorkor stoves that use less fuelwood and train women in the use of this stove;
   - » Include women in the decision-making process for mangrove restoration and entrust them with the management of these mangroves;
   - » Train female leaders to raise awareness about the dangers of mangrove harvesting;
   - » Encourage the reforestation of fast-growing trees;
   - » Create community forests to meet fuelwood needs for domestic consumption.

VI. MANGROVE TYPOLOGY AND IDENTIFICATION OF POTENTIAL

Mangroves are halophytes that have developed special biological characteristics that enable them to tolerate the specific conditions in this environment (muddy soils, salt water, high amplitude tides). The *Avicennia germinans* species is found primarily along the coastline and in the mangrove hinterland. It has high salinity tolerance. On the banks of estuaries and marsh creeks, *Rhizophora mangle* (Tristao Islands), *Rhizophora mucronata*, and *Rhizophora mangle* (all along the coast) have developed a root system that forms arched stilts to ensure proper anchoring on the banks and good submersion conditions and lower salinity.

The *Laguncularia racemosa* sometimes shares the banks with *Rhizophora*. In the back of these forest formations, an area with halophytic grasses (salt marsh or grassy *tanne*) that are flooded only by high tide transitions to salt barrens (*tannes vifs*) that are occasionally inundated by freshwater high tides and vegetation from the plateau or freshwater flood areas (OGM, 2006).

In the Kanfarandé area, only the tallest stands that can be exploited on a large scale are threatened. This important operation is offset by the rapid formation of new stands in the numerous accretion areas. In the estuary of the Rio Nunez, the rising mudflats contribute to the sound growth of *Rhizophora* stands. This regeneration is evident in young, unexploited stands. It is therefore the logging activity, and not the stands, which is threatened in the medium term.

VII. DIFFICULTIES ENCOUNTERED DURING THE FIELD MISSION

Several challenges were encountered during the course of the field survey and the reduced time for consultation.

The first challenge was gaining access to the various sites, particularly Kanof, because of the lack of a quality canoe for the crossing from Kanfarandé Centre to Kanof.

Another challenge was the reluctance and refusal of the various persons we met to respond to our questions. They indicated that they had been interviewed several times by previous missions and that there had been no coordinated follow-up action. This was the case despite promises that have remained unfulfilled on the ground. They also indicated to us that they would rather have concrete action now than be subjected to series of questions.

Photos 56, 57. Canoe sunk in the mud at low tide.

VIII. CONCLUSION AND RECOMMENDATIONS

Most households and local government officials interviewed in the localities visited as well as the deconcentrated government services recognize that the mangroves in their locality have deteriorated over the past six to 10 years. Some attribute this deterioration to global climate change, while others point to the establishment of mining companies in areas conducive to the construction of ports for maritime transport that has triggered the advancement of the sea toward the mainland; and still others cite human activities. Survey data have highlighted the role of human activities in the disruption of mangrove health.

The islanders' circumstances, or even the marginalized living conditions on the islands caused by extreme poverty, necessitate a combination of activities to enable households to be self-sufficient and provide for their family. This is due in part to the fact that they are unable to meet their needs elsewhere because of a lack of means of transportation. It is a combination of all types of activities, producing all that is necessary to live in these areas; hence the different mangrove-centered activities.

All the women engaged in harvesting mangrove products in the three study areas expressed a willingness to shift to income-generating alternatives. They cited general trade (chafing gear, sale of fishing equipment, sales of telephones, clothing), training in income-generating trades, entrepreneurship, establishment of modern smoking centers as well as training in new smoking techniques, solar salt production, and dyeing, the establishment of community centers for women's empowerment (associations, women's groups, cooperatives, etc.).

RECOMMENDATIONS

» Strengthen NGO efforts to combat mangrove ecosystem degradation, particularly those led by women and young people through the development of economic interest groups to balance economic profitability with ecological sustainability through, for example, the afforestation of fast-growing trees, agroecological practices, gardening, village nurseries, community market gardening areas with technical support;

» Use other fuel sources such as butane or cooking gas for modern fish smoking to reduce wood consumption in traditional smoking;

» Build women's capacities in solar salt production, a non-labor intensive activity that does not require wood.

» Promote the emergence of IGAs among women and young people in the study areas relating to the promotion of green jobs or creation of green initiatives. Projects pertaining to plastic waste recycling, the development of soap making, the incorporation of training of dyers, the establishment of sewing training centers, and the social economy could thus serve as a model to demonstrate to women and young people the locally available potential and the socioeconomic opportunities that they can pursue without affecting the health of the mangroves.

» Implement programs and projects to combat the environmental degradation of mangrove ecosystems. Guinea has codes and legislation, strategic documents, and action plans pertaining to the environment and fisheries, but effective implementation is often the main obstacle.

» Strengthen the capacity of environmental actors and agents at the grassroots level and provide them with the tools needed equipment for strict enforcement of the laws and codes.

» With respect to human activities, more specifically the development of rice cultivation, the rehabilitation of mangrove rice paddies could be continued, by focusing on UNIVERSEL/ADAMA-type small-scale developments, in order to salvage abandoned rice ponds and improve the management of irrigation of plots, guaranteeing good harvests and sustainable harvesting practices.

» Create village forests such as fast-growing trees that will be used as production wood to replace mangrove wood, thereby protecting mangroves from excessive logging.

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TECHNICAL REPORT

WEST AFRICA COASTAL AREAS HIGH-LEVEL PLATFORM

BENEFITS OF MANGROVE AFFORESTATION AND RESTORATION PROGRAMS IN GUINEA-CONAKRY

MARCH 2023

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ACKNOWLEDGEMENTS

This report was prepared by Subhendu Roy (Consultant) under the supervision of Susmita Dasgupta (Lead Environment Economist), and Juan Jose Miranda (Senior Environmental Economist), under the guidance of Maria Sarraf (Practice Manager). The team would like to thank Olivier Rue and Jose Diego Hopkins Alfaro, for their valuable input. The report was prepared under the World Bank's West Africa Coastal Areas (WACA) management program. The team would like to acknowledge the financial support provided by the Global Program on Sustainability (GPS) and Wealth Accounting and the Valuation of Ecosystem Services (WAVES), and PROBLUE Trust Fund. PROBLUE is an umbrella trust fund that supports a sustainable and integrated development of marine and coastal resources in healthy oceans.

ACRONYMS AND ABBREVIATIONS

AGB	Above-Ground Biomass
BCR	Benefit-Cost Ratio
BGB	Below-Ground Biomass
CM	Carbon Material
CNSHB	National Center of Fishery Sciences of Boussoura
DBH	Diameter at Breast-High
DEM	Digital Elevation Model
GBD	Global Burden of Disease
GF	Guinean franc
GLAS	Geoscience Laser Altimeter System
LAI	Leaf Area Index
LSMS	Living Standard Measurement Survey
NPV	Net Present Value
PPP$	Purchasing Power Parity $
SRTM	Shuttle Radar Topography Mission
TEV	Total Economic Value
WTP	Willingness to Pay

All amounts in US dollars ($) unless otherwise stated

EXECUTIVE SUMMARY

Guinea's 300-kilometer coastline has extensive mangrove forest coverage that extends for more than 10 kilometers inland and the mangroves situated on the widest rivers can be found up to 40 kilometers inland from the coast. These mangrove areas not only support the gathering of timber and nontimber forest products; they also provide a myriad of ecosystem services such as carbon sequestration; protection from storms, floods, and erosion; the processing of waste and nutrient pollution; support for aquaculture and agriculture; and habitats for both aquatic and terrestrial species.

Recent estimates show that Guinea currently has a little over 2,000 square kilometers (sq km) of mangrove forests, down from 2,992 in 1980; this represents a loss of 32 percent, mainly due to the unsustainable harvesting of mangroves.[1] Such harvesting of mangroves for their direct benefits can result in the loss of mangrove areas and the associated ecosystem benefits, which can often exceed the direct benefits.

Understanding the full benefits that mangroves provide can help raise awareness of the need to preserve them for society. The full accounting of benefits from mangroves can also help to justify redeveloping mangroves in areas where such planting may be feasible. **The objectives of the current study are to estimate the total economic value (TEV) of current mangrove areas in Guinea, considering the whole range of benefits from mangroves; and to use those estimated values in economic cost-benefit analyses.**

This study focuses on private direct use, private indirect use, social use, social option and/or nonuse values, and private alternate use of mangroves. A survey of the literature was done to find studies conducted in Guinea that arrived at the estimated values from all of these uses. If no study was found for a particular use in Guinea, the values were arrived at using data obtained from similar locations elsewhere after making allowances for local characteristics of the Ghanaian coast. Since these studies were not all done in the same year, in order to compare the values on a similar basis, all values were adjusted to 2020 PPP$ using inflation data in Guinea and the PPP$ conversion factor. The results were reported as total value per year, as well as a mean value per hectare of mangroves.

The mean value of all of these uses were determined as follows:

- **Private direct use of mangroves, mainly as timber and fuelwood for domestic use and for salt production and the smoking of fish,** was determined using the quantity of mangroves harvested and their market price. The annual mean value was found to be $248 per hectare, with a total annual value of $52 million.

[1] Some of it is also due to increased urbanization, including the building of ports.

- **Private indirect use arises mainly from fisheries made possible by mangroves**. Using the quantity of fish harvested and their market price, the annual mean value of fisheries amounted to $1,119 per hectare, with a total annual value of $232 million.
- **Three social-use values of mangroves were assessed:** carbon sequestration, flood protection, and water purification. The mean **carbon sequestration** annual value of $221 per hectare, with a total value of $49 million was based on allometric studies to assess the carbon content in mangroves and the price of carbon. The mean **flood protection** value of $1,120 per hectare, with a total annual value of $232 million, was based on studies conducted in mangroves in other similar locations after making allowances for local characteristics of the Guinean coast, since no studies could be found in Guinea for flood protection. The annual mean **water purification** value, estimated as $151–$504, with a total annual value of $31–$105 million was also based on studies done at locations outside Guinea.
- **Biodiversity benefits** were estimated as a social option, and nonuse value was based on the willingness to pay (WTP) approach. The mean annual value was found to range between $911–$1651, with total annual value ranging between $189–$343 million.
- **The primary alternative use of land with mangroves over the years has been growing rice**. Using the market price of such rice and the quantity produced, the mean annual value was found to be $7,896 per hectare, with a total annual value of $616 million.

The cost of planting was based on 2 × 2-meter spacing for the mangroves. The mean cost was found to be $968 per hectare, with an annual maintenance cost of $72 per hectare. Using these costs, the **private direct benefits show a positive net present value (NPV) per hectare of $1,357, with a benefit-cost ratio (BCR) of 1.4**. With the inclusion of **private indirect benefits from fisheries, the NPV per hectare increases to $18,503, with a BCR of 19**. With the **social use values factored in, the NPV increases to $38,333, with a BCR of 39.**

Three important findings emerge from this study. First, the sum of the benefits from private indirect use, social use, and social option/nonuse that occurs from the presence of mangroves far outweighs the private direct-use benefits. This suggests that the use of incentives and disincentives to discourage the unsustainable exploitation of mangroves that mainly occurs for their direct use would lead to net social benefits. **Second, the large NPVs and BCRs from planting mangroves make a clear case for launching an immediate drive to plant mangroves on a war footing in all lands that are now barren but are suitable for growing mangroves**. Finally, the economic return from land that has been converted to grow rice is greater than all of the benefits listed from its use as mangroves; **restoring mangroves to such land would require a high level of subsidy on an annual basis, and may not be an economically feasible option.**

CHAPTER 1.
INTRODUCTION

The coast of Guinea is approximately 300 kilometers long and is home to 2 million people which is nearly 20 percent of the Guinean population. The coast is indented, with rias (drowned river valleys) that form inlets, tidal marshes, mangrove forests, and estuaries; and there are numerous offshore islands. The continental shelf of Guinea extends 300 kilometers along the coast, and covers an area of 47,400 square kilometers (sq km), making it the largest continental shelf in West Africa (UNEP 2007). Guinea's coastal and marine areas are characterized by the presence of still-preserved ecosystems, including large mangrove zones and rich natural-resource waters that are habitats for important plant and animal species, including the endangered West African manatee, pygmy hippos, a variety of Cetacea, and critically endangered migratory birds.

The country's coastal areas are subject to a number of environmental impacts arising from population growth and development within the country's key economic sectors (agriculture, fisheries, mining, and infrastructure). Rapid population growth has resulted in increased exploitation of coastal resources like mangroves and fisheries, many of which raise issues of sustainability. The clearing of mangroves for fuelwood and charcoal, timber, and salt extraction has resulted in mangrove degradation, and expansion of the port of Kamsar in the Bay of Sangaréya has resulted in the loss of 700,000 square meters (sq m) of mangroves. Fortunately, reforestation of the same area using the Rhizophora and Avicennia species was undertaken between 1993 and 1998 to help mitigate these effects (UNEP 2007). The processing and transport of bauxite[2] that takes place in the coastal zone has also affected the coastal ecosystem, although the extent of the impact has not been studied extensively.

The vulnerability of the coastal zone is also expected to increase significantly as a result of climate change and the associated sea-level rise. Sea-level rise will increase the direct inundation of low-lying areas, facilitate rapid erosion of the soft shores, and increase offshore loss of sediment as well as flooding. It is estimated that a 1-meter increase in sea level will inundate a significant portion of the coastal areas, causing major problems for mangrove rice cultivation.

[2] Guinea possesses between 25 and 30 percent of the world's reserves of bauxite. The three bauxite mines in Guinea produce 80 per cent of the country's export revenue.

Management of the coastal ecosystem in Guinea, including the prevention of coastal erosion, thus far has been mostly reactive, site-specific, and usually involves using hard engineering approaches. The engineering infrastructure currently in use in Guinea that is used to protect the shoreline and minimize flooding involves a combination of dikes, fixed protection spikes (stone or concrete), and bunds as well as soft engineering (beach-fill) methods. These gray infrastructures provide coastal protection by (i) decreasing the kinetic energy and destructive force of ocean waves; (ii) protecting against coastline erosion; (iii) protecting the socioeconomic infrastructure against destruction by water torrents; and (iv) protecting agricultural and residential areas from floods.

One area where a unique green solution has been practiced in Guinea is in the creation of mangrove bunds to protect rice cultivation. Currently more than 400 kilometers of mangrove rice bunds have been created to protect agricultural fields, mainly for rice cultivation. However, overexploitation of mangroves is posing a danger to these protective infrastructures; there is a need for proper planning in order to arrest the degradation of the mangrove cover.

There is an urgent need to develop a comprehensive coastal management policy for managing the coastal ecosystem; this policy should include the protection and rehabilitation of mangroves as an important component. Mangroves can help in creating policy that incorporates strategies to tackle problems in coastal management using the green concept of managing with nature and not against it. Sustainability of the existing mangrove forests, and developing new mangroves in areas suitable for them would be an important part in this green strategy. However, the use of mangroves as a policy intervention has to be cost-effective; a detailed cost-benefit analysis can help in creating such policy.

In addition to coastal protection from soil erosion, storms, and floods, Guinea's mangroves also provide a number of cobenefits, from the provision of timber and nontimber forest products to ecosystem services like carbon sequestration, the processing of waste and nutrient pollution, support for aquaculture, and habit ats for both aquatic and terrestrial species.

Another unique feature of mangrove areas in Guinea is mangrove rice cultivation, which is made possible by mangrove bunds that protect the land from flooding. A full estimation of these benefits can help in determining the net benefits that mangroves can provide. Quantifying the total benefits can also help identify prospective areas where the planting and maintenance of mangrove plantations can provide overall net benefits.

The objectives of the current study are to:

- **Estimate the total economic value of current mangrove plantations** in Guinea by considering the whole range of benefits that can be derived from mangroves; and
- **Use these estimated values in economic cost-benefit analyses to determine possible areas for replanting** and/or for the creation of additional mangrove plantations in suitable locations.

Section 2 of this report discusses the location, extent, and type of mangrove cover in Guinea. **Section 3** examines the various benefits that mangroves provide, and discusses the methodology that can be used to quantify each type of benefit. **Section 4** determines the cost involved in the creation of new mangrove areas. **Section 5** concludes the report and proposes a way forward for the creation of new mangroves, as well as ways to sustain the current area of land under mangroves.

CHAPTER 2.
MANGROVES IN GUINEA CONAKRY

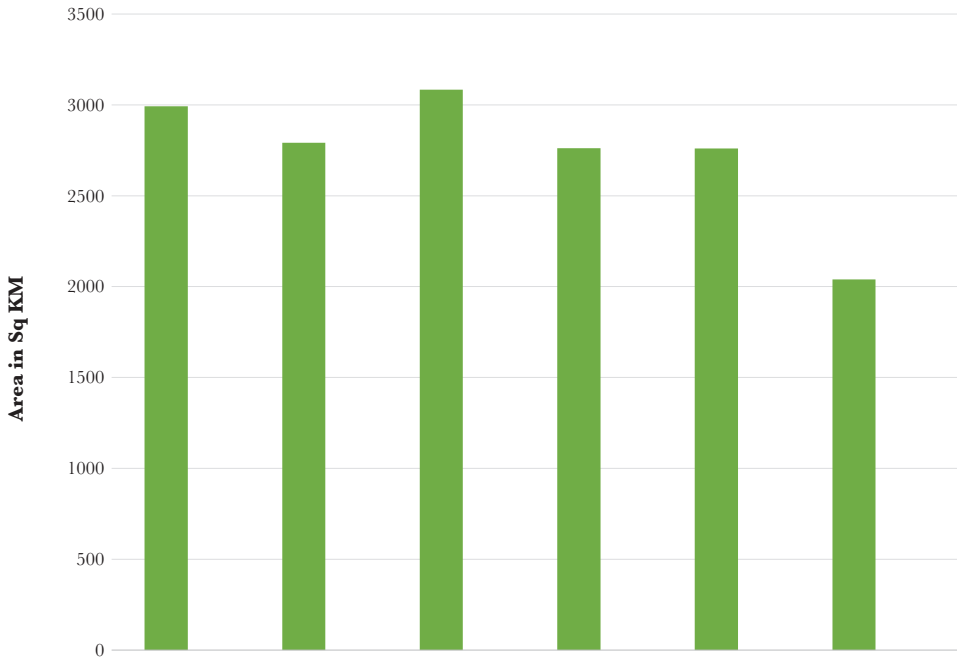
Mangroves are found along the length of the Guinean coast except for Cape Verga and Kaloum Island. The topography of the coastal area facilitates the deposition of sediment and submersion of the mouths of the rivers. There is a long tidal reach up the estuaries, which causes flooding of the rivers, leaving raised bars. It is here that mangroves can develop, within the bay of the estuary. Mangroves extend more than 10 kilometers inland and, along the widest rivers, they can be found up to 40 kilometers inland from the coast (Profile 2005).

The maximum possible area suitable for mangroves in Guinea, based on geomorphology, is estimated to be around 4,000 square kilometers (sq km).[3] Of these, approximately 1,300 square meters of land currently do not have any mangrove cover because these areas have been cleared for agriculture, for salt pans, or for increased urbanization, including the building of ports. Others are simply lying abandoned. The remaining 2,700 sq km currently under mangrove cover also faces various levels of degradation. A detailed analysis of the actual area of mangroves in Guinea over time, as found in the current literature, is presented in Appendix A.[4]

Estimates show that Guinea currently has a little over 2,000 sq km of mangrove forests, down from 4,000 in 1957.[5,6] Wide areas of mangroves have been cleared for agricultural use, salt pans, and for increased urbanization, including the building of ports. Between 1980 and 2006, it is estimated that the mangrove area in Guinea fell from 2,992 to 2,039 sq km, representing a loss of 32 percent, as shown in Figure 1 (UNEP 2007; Ajonina et al. 2008). A 2019 survey by NASA estimated the mangrove area to be 2,076 sq km. Estimates reveal that at present only about 1,000 sq km of this total area is in a good enough state that it could allow for commercial exploitation of mangroves if done on a sustainable basis.[7]

[3] Based on the conversion of an estimated 1,400 sq km of mangrove swamp being converted to rice fields, of which 620 sq km lay abandoned in 1993. (Spaulding 1997)
[4] The analysis is based on a report prepared by Dr. Oliver Ruë for the World Bank in 2020.
[5] Rouanet 1957, cited in Kaba, B. 2001.
[6] Diallo M. et al. 2019
[7] Ruë 1998

FIGURE 1: AREA OF MANGROVES IN GUINEA-CONAKRY (IN SQUARE KILOMETERS)



Source: (UNEP 2007; Ajonina et al. 2008; Sanderman et al. 2018)

In addition to mangroves being cut to support subsistence rural livelihoods and conversion to rice fields, sea-level rise and other climatic phenomena are also contributing toward mangrove degradation in Guinea. These occur through the loss of coastal and intertidal habitats, including changes in geomorphological processes, and the increased vulnerability of woody formations (UNDP 2019). Studies also reveal that sea-level rise is a major potential threat to mangrove ecosystems due to their sensitivity to the duration and frequency of flooding, and salinity levels that may exceed the physiological threshold of mangrove-specific tolerance. Additionally, the failure to maintain dikes built in previous decades, and the lack of planning and integration of climate risks in construction activities on the coast have contributed to the coastal zone's vulnerability to erosion, and have affected the mangroves.

Increases in the population and the development of urban centers, industry, and ports have also led to the conversion of lands; this changes drainage patterns, leads to conflicts over land use, and causes pollution. The discharge of domestic and industrial waste from land, ships, and aircraft threatens mangrove sustainability. Losses of mangrove areas have also been caused by the reclamation of land for agriculture, urbanization, and salt ponds. Currently the conversion of mangrove wetlands for solar salt production, and the expansion of towns and villages are major destructive threats to mangroves in Guinea (Armah 2006).

The estimation of the current economic benefit from mangroves in Guinea is based on the understanding that the 1,300 sq km of land cleared or converted, part of which is also currently lying abandoned, is unlikely to be brought back to mangrove cover in the near future. Therefore this valuation will focus on the remaining 2,700 sq km, and the actual estimation will include two approaches. The first will be based on the current state of the mangroves, assuming there is no further degradation. The other will examine what would happen if all of the current mangrove areas could be restored to normal health, since this would provide an idea of the true maximum natural capital potential of mangroves in Guinea.

2.1. COMMON MANGROVE SPECIES FOUND IN GUINEA

Seven species of true mangrove are found in Guinea: *Acrostichum aureum*, *Avicennia germinans*, *Conocarpus erectus*, *Laguncularia racemose*, *Rhizophora harrisonii*, *Rhizophora mangle*, and *Rhizophora racemose*. The species distribution of woody mangroves varies by location. *Avicennia* needs greater substrate stability, and is generally found in the shallows along the channels going inland, whereas *Rhizophora*, *Avicennia*, and *Laguncularia* prefer convex banks prone to high sedimentation. According to UNEP (2007) the nonwoody mangroves of Guinea tend to be located in degraded areas. In denuded areas, *Avicennia* and *Rhizophora* are found in mixed settlements along the banks of the channels. More developed "forest cathedrals" are found along the Konkouré River where there is fresh water from inland. *Avicennia germinans* and grassy species often colonize the deforested areas intended for rice growing. *Rhizophora racemosa* can reach 25 meters in height in Kakounsou and in the Bay of Sangaréya, but in other areas the trees seldom exceed 8 meters and are often much smaller. In the same zone, *Avicennia germinans* grows up to 15 meters, and Conocarpus erectus can also be found here (Profile 2005).

TABLE 1: COMMON MANGROVE SPECIES IN GUINEA

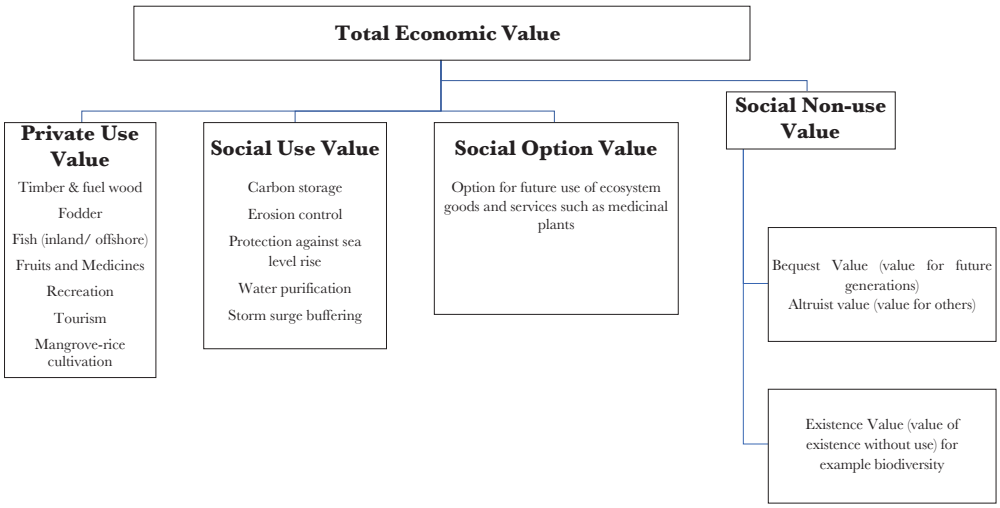
Mangrove species	Characteristic	Occurrence	Propagation
Avicennia germinans (Black Mangrove)	Develops finger-like projections, called pneumatophores, which protrude from the soil around the tree's trunk.	This species occurs at higher elevations inland than the red mangrove.	Reproduces by vivipary, with sprouting seeds that drop into the soft bottom around the base of the trees. The seeds can also be transported by currents and tides to other suitable locations.
Laguncularia racemosa (White Mangrove)	Does not develop visible aerial roots, and has elliptical light yellow-green leaves.	Occurs at even higher elevations farther upland than either the red or black mangroves.	Sprouting seeds that drop into the soft bottom around the base of the trees. The seeds can also be transported by currents and tides to other suitable locations.
Conocarpus erectus (Buttonwood)	Belongs to the same family as the white mangrove, but has a different appearance, with dense, rounded flowerheads that grow in a branched cluster, and purplish-green, round, conelike fruit.	Grows in brackish areas and alkaline soils, thriving in the broken shade and wet soils of hammocks.	The seed heads burst when ripe, and the seeds are dispersed by water.
Acrostichum aureum (Golden Leather Fern)	Does not have any aerial roots; instead has fibrous, fernlike roots. It can grow up to 1.5 meters high and have leaves that can be up to 1 meter long and 4 centimeters wide.	Grows in swamps and mangrove forests, salt marshes, and on river banks; is tolerant of raised salinity levels.	Mature fronds become sporophyllous, diffuse spoprangia at the abaxial surface, mixed sporangia on both sides of the mid-vein, brown sporangia stalked, upper globose.

Mangrove species	Characteristic	Occurrence	Propagation
Rhizophora harrisonii (Red Mangrove)	A hybrid of *R. mangle* and *R. racemosa*; shares morphological characteristics with both species and is recognized by FAO as a distinct species.	Mostly found in the estuaries of river systems with more continuous freshwater flows.	Creates a propagule that is in reality a living tree; a fully-grown propagule on the mangrove is capable of rooting and producing a new tree.
Rhizophora mangle (Red Mangrove)	Usually grows to 10–20 meters in height and has a 10–30 centimeter diameter at breast height (DBH); in some sites has been observed to exceed 40 meters in height and 70 centimeters DBH (Jimenez 1985).	Generally found growing along the water's edge.	Sprouting seeds that drop into the soft bottom around the base of the trees. The seeds can also be transported by currents and tides to other suitable locations. (Florida Keys NMS 2006; Law FRC-43).
Rhizophora racemosa (Red Mangrove)	Grows up to 30 meters (100 ft) tall, often with aerial stilt roots; in more marginal habitats is shorter, more branched, and scrubby. The leaves grow in opposite pairs, each pair with two interlocking stipules. The leaves are simple and entire, with elliptical hairless blades and slightly down-rolled margins.	When new mudflats are formed, seagrasses are the first plants that grow on the mud, with *Rhizophora racemosa*, a pioneering species, being the first mangrove to appear. It primarily occurs in the open lagoon systems in areas along the coastlines.	The fruit produces propagules that may fall into the water and be dispersed by wind and currents.

CHAPTER 3.
ESTIMATION OF THE ECONOMIC BENEFITS FROM MANGROVES

Mangroves provide many direct-use benefits in the form of timber, fuelwood, animal fodder, salt manufacturing, fish-smoking, medicines and so on. A number of other indirect benefits including fisheries, mangrove rice cultivation, recreational opportunities, and tourism are also made possible by the existence of mangroves. However, most of these constitute benefits only for the people who live in the immediate proximity of the mangrove plantations; they do not fully reflect the total economic value (TEV) of mangroves. In order to arrive at the TEV, we need to account for the social benefits arising from mangroves as well: carbon storage, coastal erosion control, protection against sea-level rise, water purification, storm surge and swell buffering. There are also social-option and social nonuse values (Figure 2).

FIGURE 2: TOTAL ECONOMIC VALUE (TEV) ESTIMATION PROCESS OVERVIEW



The overall social benefits from mangroves can exceed the total private benefits; and some of which (like carbon sequestration) can also lead to global benefits. To determine the true economic benefits from mangrove plantations, all such private and social benefits have to be evaluated and accounted for. However, since many of the outcomes under social benefits cannot be traded in a market, there is often no ready market price that can be used to monetize these benefits. Therefore, alternative valuation methods have to be employed in order to arrive at a complete estimation of all of the economic benefits.

The benefits from mangrove plantations and/or the costs of planting and maintaining them are often location- and context-specific. The present study has developed a methodology for estimating the full benefits from mangrove plantations in Guinea Conakry, and uses that methodology to determine which mangrove afforestation projects have economic justification based on the costs involved. This can help demonstrate how these procedures can be applied in general, while prioritizing among various adaptation projects, all of which have significant benefits. The type of benefits to be included in computing the total benefit of mangroves in Guinea, and the methodology to be used in the actual computation exercise of these benefits are explained in the following sections.

3.1. PRIVATE-USE VALUE

3.1.1. DIRECT BENEFITS

Mangrove forests can provide a number of useful products: fuelwood, charcoal, timber wood, honey, wax, fruits, medicinal plants, animal fodder, and *akpeteshi* distilling, among other things. The benefits from each species of mangrove present in Guinea, as found in the literature, are listed in Table 2.

TABLE 2: COMMON DIRECT USE OF MANGROVE SPECIES

Mangrove species	Overall Direct Use	Medicinal Use
Avicennia germinans (Black Mangrove)	The cotyledons of the seed are eaten during famines, but only after careful preparation to remove toxic compounds. The leaves and roots are used to prepare a vegetable salt.	**Leaves:** Applied as an enema to treat piles. An extract of leafy twigs showed cytotoxic activity in several human cancer cell lines. The stems and leaves are combined with a smaller amount of *Rhabdadenia biflora* and *Nicotiana tabacum* to make a soothing remedy for stingray wounds. **Bark:** Powdered bark mixed with palm oil for treatment of lice, ringworm, and mange; added to a bath in order to promote childbirth. The bark resin is used in traditional medicine to treat tumors, diarrhea, hemorrhage, hemorrhoids, rheumatism, swelling, wounds, and sore throat. **Roots:** Used as an aphrodisiac, and as a decoction to treat intestinal problems.
Laguncularia racemosa (White Mangrove)	The bark and leaves produce a tannin and a brown dye of good quality, but not in quantities that are economically interesting. The bark is used to treat fishing nets for longer preservation. Sometimes used as animal fodder. The flowers are said to be useful in honey production, and in Guinea Bissau the fruits are eaten. The wood is heavy, hard, strong, and close-grained; it is mainly used as firewood, rarely for construction or wooden utensils.	Historically the high tannin content in the bark was used as a tonic to treat fevers, skin wounds, ulcers, dysentery, and scurvy, and to prevent tumors. A bark infusion is used as an astringent, tonic, and folk remedy for dysentery, aphthae, fever, and scurvy. Some antitumor activity is also attributed to it.

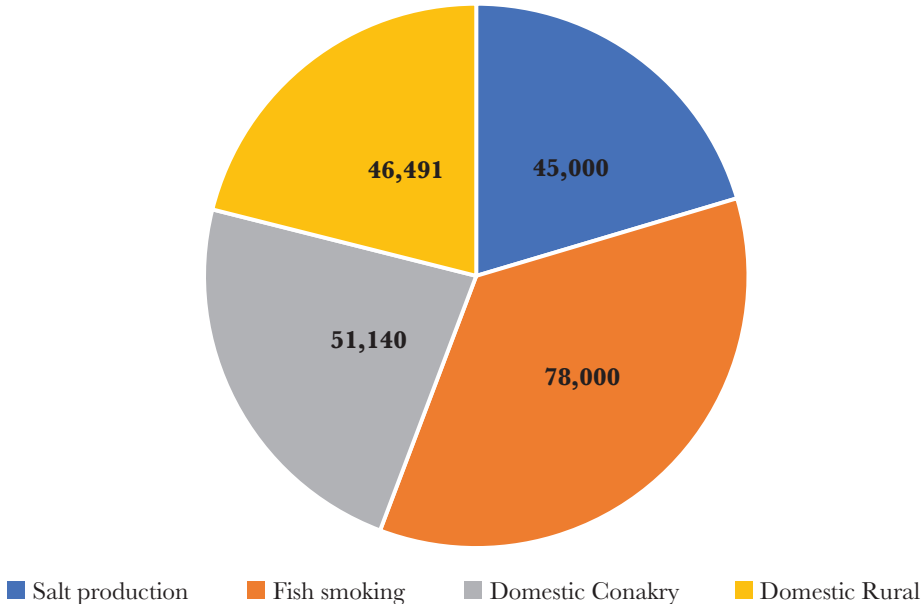
Mangrove species	Overall Direct Use	Medicinal Use
Conocarpus erectus (Buttonwood)	The heavy wood (sp. grav. 1-0) is durable and takes a fine polish. Durable in water, it is used for barges, boats, and maritime construction. Though susceptible to dry-wood termites, it is also used for crossties, fences, and turnery. Describing it as keeping well underground and in salt water, Irvine (1961) notes that it is used for piling and firewood. Bark has been used for tanning leather. Sometimes introduced as an ornamental evergreen.	**Leaves:** Decoction used as a febrifuge. Latex: Applied to cuts to stop bleeding. Roots**:** Ground and boiled as a cure for catarrh. Bark**:** Used in the treatment of gonorrhea. A folk remedy for anemia, catarrh, conjunctivitis, diabetes, diarrhea, fever, gonorrhea, headache, hemorrhage, orchitis, prickly heat, swelling, and syphilis.
Acrostichum aureum (Golden Leather Fern)	Young shoots are eaten as a vegetable. The firm, dried, parchment-like leaves are stitched together and used as thatching material in the place of straw-thatch, as the roof lasts longer with much less risk of fire. It has potential as an ornamental plant because of its handsome leathery leaves; and the plant can be grown in pots.	Rhizomes are used for the healing of stubborn ulcers. Leaves are used topically as an emollient. Medicinally, the pounded or grated leaves and rhizomes are applied as a paste to wounds, ulcers, and boils, and can be used against worms.
Rhizophora harrisonii (Red Mangrove)	Similar to other *Rhizophora* species.	Similar to other *Rhizophora* species.
Rhizophora mangle (Red Mangrove)	Used primarily for timber, building materials, fencing, firewood, charcoal, medicines, tannins for staining and leather-making, hunting, salt extraction, and as a habitat for commercial fisheries and aquaculture.	A folk remedy for angina, asthma, backache, boils, ciguatera, convulsions, diarrhea, dysentery, dyspepsia, and a host of other diseases. Bark extract can reduce gastric ulcers; it has antimicrobial and antioxidant properties.
Rhizophora racemosa (Red Mangrove)	Used for construction poles and firewood on a limited scale. The smoke has antimicrobial properties and is also used for smoking meat.	**Roots:** Used with palm oil as an ointment for boils. **Bark:** Extract used for fungal infections of the skin; treatment of diarrhea and dysentery in children; leprosy, sore throat.

However, only a few of these purposes are actually being used in Guinea; the rest of them can be considered as potential future uses. The most common use of mangroves in Guinea is as fuelwood and charcoal, especially for fish-smoking, since it imparts a unique color and flavor to the fish; and it is also used for salt production. Mangrove wood is also used for construction purposes, including the roofing of houses. The harvesting of wood from mangrove forests provides a major source of energy. Household consumption of firewood and charcoal in Guinea totalled more than 4.7 milliont in 1998, while the informal sector consumed nearly 0.18 million MT in 1996 (Samoura and Diallo 2003). A significant part of that use came from mangrove wood.

Current estimates indicate that approximately 220,000 MT of mangrove cuttings is in direct use each year for salt manufacturing, fish curing,

and as fuelwood and timber in Conakry and in rural areas of the country.[8] (Figure 3) However, the annual natural mangrove wood growth per year in the 1,000 sq km of commercially suitable area is only 80,000–150,000 MT, depending on the type of mangroves. This clearly demonstrates a reason for the loss of mangrove cover from overexploitation. However, it also shows that if all 2,700 sq km can be made commercially suitable, the annual sustainable yield would range from 210,000–410,000 MT, and could help to arrest the degradation of mangrove areas.

FIGURE 3: DIRECT USE OF MANGROVE (IN MT/YEAR) IN GUINEA



The valuation of the direct use of mangroves, using the local price of the end products when converted (using PPP adjusted $) is shown in Table 3.[9]

TABLE 3: TOTAL DIRECT USE VALUE

	Value PPP$M
Salt production	11.5
Fish-Smoking	19.9
Domestic, Conakry	8.3
Domestic, rural	11.8
Total	51.5

[8] The details of these uses are provided in Appendix B.
[9] Details in Appendix B.

Mangroves are known to provide medicinal uses for the population in a number of countries, but there is no substantive information about any such use in Guinea. Typically, these health benefits are estimated based on the reduction in mortality/morbidity either using the Global Burden of Disease (GBD) estimates within a country, or indirectly by the cost of medication saved. Future research is required to determine the amount of current use, as well as any future potential uses.

Annual Economic Value = Savings in traditional medicine costs, or the valuation of saved mortality/morbidity

3.1.2. INDIRECT BENEFITS

Inshore and Offshore Fisheries

The water bodies of mangroves are used as spawning, hatching, nursery, and foraging grounds by a number of fish, crab, shrimp, mollusks, and other aquatic creatures. They spend a portion of their lifecycle in the mangrove forests, and later move on to the sea. All of these marine creatures benefit from the presence of mangrove forests; it has been found that when mangrove forests are added to the coast, the fish population of the nearby areas tends to increase. Mangroves are estimated to provide habitats for the development of 70 percent of the fish caught in tropical and subtropical areas.[10] The loss of mangroves, therefore, also affects the livelihoods of local fisherfolk.

Guinea's waters contain significant resources associated with marine environments (shrimps, whitefish, small pelagics) that are relatively conducive to fisheries development(in terms of seasonal upwelling, river flow, and the like. Demersal resources include ground fish (sea bass, flounder, catfish, sea bream), cephalopods (mainly cuttle-fish), and shrimps. Pelagic resources (ethmalosa, sardinella, horse mackerel) also have considerable potential, and are mainly exploited by national operators in the artisanal subsector.

In the absence of mangroves, most of the marine fisheries in Guinea will not be sustainable. The contribution of mangroves to the fishery sector can be estimated using the value added by mangroves in the annual production of the sector. The total annual output in monetary terms can be calculated by taking into account the physical output and the price paid. The value added would be the net monetary value after subtracting the cost of fishing. The annual cost estimation includes both annualized fixed costs (vessels and other fishing gear) and variable costs (fuel, salaries for crew, repair and maintenance costs of vessels and gear, the cost of selling fish via auction, and fish handling and processing, for example, the purchase of ice).

Annual Economic Value Added = (Fish Yield/Year) × (Average price of fish/MT) − Cost of fishing/MT

The annual fishery output in Guinea in 2019 was a little over 350,000 tons, of which marine fisheries accounted for 289,544 tons (Fisheries Statistical Bulletin 2019). Of this amount**,** the annual coastal fish production was around 128,000 tons in 2019.[11] This consists mainly of demersal and pelagics; the output of cephalopods and shrimps are relatively lower. Among various types of fish, ethmalosis, captain royal, and various sardinellas account for nearly half of all of the fish captured.

The estimated annual value added by mangroves in the fishery sector is $232 million. This is based on a weighted average price of fish of $3,832 per ton. (The price of fish varies widely depending upon the type of fish, with a range of $1,121–$6,729 per ton).[12] The cost is based on the average cost of $1240 estimated for Africa, including all fixed and variable costs.

[10] https://www.greenclimate.fund/sites/default/files/document/21890-enhancing-resilience-guinea-s-coastal-rural-communities-coastal-erosion-due-climate-change.pdf
[11] See Appendix B for details.
[12] All values are PPP-adjusted.

Tourism and Recreational Benefits

The ecosystem of a mangrove forest is completely different from the ecosystems in other areas of Guinea, and therefore would be attractive to visitors. There are opportunities for recreational fishing, bird watching, boating to explore the forests, or simply touring the area on boardwalks. Experience from other countries that have benefitted from mangrove-based tourism can provide guidance about the types of possibilities that may exist.

The actual tourism potential in mangrove areas has not been explored very much in Guinea so far. The tourism sector overall is underdeveloped; building proper infrastructure and making suitable investments in facilities would be required in order to attract tourists. Any future plan for developing the tourist industry should include mangrove-based tourism. Anecdotal evidence reveals hidden potential that could be better exploited with proper planning and investment; this would also involve encouraging the private sector to enter into this economic activity (ECOREX 2012). We can see the potential in Guinea from what is already occurring in Ghana, which has a much smaller extent of wetlands, and less than a tenth of the area in mangrove forests compared to Guinea. In Ghana, to promote tourism with minimal impacts to the wetlands, walkways have been built, and boats provided from which visitors can view the plant and animal species in the reserves. As a result, the number of tourists has been increasing in Ghana since 2006, and it is more than 10,000 annually at present.

The potential recreational benefits of mangroves, once they are developed, can be estimated using a travel cost method based on all expenses to be spent in the recreational area (food, lodging, transport, tickets, etc.), plus the opportunity cost of total time spent by the visitors for the whole trip. Current market data for these costs will be used, along with the projected number of visitors based on sample surveys, to compute the total benefit.

The value of the increased recreational opportunities (V) for a single visitor is given by:

$$V = ((T \times w) + (D \times v) + F\&L + Ca) \times Va$$

Where:

T = travel time (in hours)
w = average wage rate (Guinea franc/hour)
D = distance (in km)
v = marginal vehicle operating costs
F&L = Food and Lodging expenses
Ca = cost of admission to asset
Va = average number of visits per year

Mangrove-Rice Cultivation

Rice farming on the coastal plains adjacent to the mangrove forests is a unique feature in Guinea, and in a few other neighboring countries in West Africa. Although rice farming on the coastal plains is made possible only due to the presence of adjacent mangrove bunds**,** it can't be strictly included in indirect benefits from mangroves since most of the land used for rice cultivation has been obtained over time by clearing erstwhile mangrove plantations. Therefore, it is treated as an alternative use value made possible by the crucial contribution that nearby mangrove areas provide.

Twenty-three percent of the national rice production in Guinea is from mangrove areas, and it provides livelihoods for more than 50,000 rice farmers, the majority of whom are women. Shifting to agriculture also occurs where salt inundation is low. Mangrove rice is a flood-fed crop requiring two flooding cycles, one with freshwater and one with saltwater.[13] (The saltwater is needed to eliminate weeds, regulate soil pH, and deposit organic matter and nutrients. Freshwater is necessary for soil desalination prior to cultivation, and maintenance of the water table throughout the cycle.)

In ideal conditions, mangrove rice farming produces higher yields than other rice farming techniques used in the interior of the

[13] https://www.greenclimate.fund/sites/default/files/document/21890-enhancing-resilience-guinea-s-coastal-rural-communities-coastal-erosion-due-climate-change.pdf

country. Annual mangrove rice production averages around 376,000 tonnes; it represents 16 percent of rice farmland in the country, and 23 percent of national production (Agence Française de Développement 2016). The value added in rice farming can be determined by accounting for the cost of such cultivation, including labor, fertilizer, seeds, and depreciation.

Annual Economic Value Added = (Rice Yield/Year) × (Average price of rice/MT) = Cultivation Cost

The estimated net annual value added from rice grown in 70,000 hectares of land devoted to mangrove rice cultivation is estimated to be $824 million.[14] This is based on a net annual mangrove rice production of 300,481 tons, and a price of $3,462 per ton,[15] after subtracting the average cost of rice cultivation.

3.1.3. SOCIAL BENEFITS

Mangrove forests can provide a number of social benefits: carbon sequestration, protecting the coasts from erosion and flooding from storm-induced swells, and problems arising from prospective sea-level rise. A number of other benefits, such as increased biodiversity, and purification of contaminated water are also often associated with mangroves. Each of these benefits are estimated based on local data.

Benefits from Carbon Sequestration

Mangroves are very good for carbon sequestration because they store carbon material (CM) not only in the above-ground biomass (trunks, branches, trees, twigs) but also in the roots and soils. In fact, in mangroves a larger share of carbon is stored below ground than above ground (Alongi 2015). The soil in the mangroves is also rich in CM because the anoxic condition of the mangrove floors retards carbon (C) from combining with oxygen (O_2) in the air to form carbon dioxide (CO_2); and then being released into the atmosphere.

While a few studies have estimated the extent of carbon sequestration in mangroves, using both above-ground and below-ground biomass in locations in neighbouring West African countries, such studies in Guinea are rare. The estimation for Guinea is therefore based on satellite-generated digital elevation model (DEM) data that has been validated using in situ field measurements in some countries in West Africa.

This study has calculated the economic valuation arising from carbon sequestration using the total mangrove coverage in Guinea. The valuation procedure involved a three-step process. The first step estimated biomass using an allometric function. In the second step, the carbon sequestration estimation was calculated using the carbon content per unit of biomass that is appropriate for the mangrove species involved. The economic value was then determined in the final valuation procedure, using the shadow price of carbon per MT applied to the carbon content in MT.

The biomass estimation takes into account the five following carbon storage areas in mangroves, along with carbon trapped in the soils around mangroves:

1. Above-ground biomass (trunk, branches, leaves, etc.)
2. Below-ground biomass (roots)
3. Aerial roots
4. Litter falls (leaves, branches, twigs, etc.)
5. Dead roots

The above-ground biomass (AGB) estimation for the whole of Guinea uses remotely-sensed satellite data that has been validated with in situ field measurements. This assessment is based on the mangrove dataset created by NASA for Guinea that includes distribution, biomass, and the canopy height of mangrove-forested wetlands. The data includes

[14] Details provided in Appendix D.
[15] All values are PPP-adjusted to 2020.

information about the total mangrove carbon stock (above- and below-ground biomass (BGB), and soil), based on the extent of mangrove coverage (Simrad et al. 2019).

The extent of biomass sequestered in mangroves varies with the mangrove species, but current satellite-derived data generally do not take this into account. The data developed by NASA that is used in the current study also does not distinguish the mangrove species in estimating the biomass. However, recent studies have been able to determine the species composition of a mangrove forest by using the red-edge spectral bands and chlorophyll absorption information from AVIRIS-NG and Sentinel-2 data.[16] The use of this technique in the estimation of mangrove biomass can in the future increase the accuracy of these estimations.

The mangrove dataset created by NASA was based on NASA's Shuttle Radar Topography Mission (SRTM) in 2000 digital elevation model (DEM) data, which was released globally in 2015. To identify mangrove ecotype areas and mask non-mangrove regions in the SRTM elevation dataset, a global mangrove extent map from Giri et al. (2011) was used. The canopy-height maps were generated using SRTM DEM data collected in February 2000, and lidar heights from the ICESat/GLAS Spaceborne Lidar mission. GLAS lidar altimetry data were collected globally from 2003 to 2009. A regression model was applied relating GLAS RH100 to SRTM elevation measurements to obtain a global map of maximum canopy height:

$$SRTMH_{max} = 1.697 \times HSRTM$$

where HSRTM represents the original SRTM DEM, and $SRTMH_{max}$ is the new maximum canopy height data set.

Field data was used by NASA to estimate forest structure attributes, basal area-weighted canopy height (H_{ba}), the height of the tallest tree (H_{max}), and above-ground biomass (AGB). The data was collected in field plots, using fixed or variable plot sizes. Within variable plots, trees were selected using a fixed-angle gauge. For each selected tree, the species was identified, and the diameter at breast height (DBH) and height were measured using a laser rangefinder or clinometer. Tree density (that is, the number of stems) was estimated for each plot, and expressed per unit area (in hectares).

For all sites, H_{ba} was calculated as:

$$H_{ba} = \sum_i(\pi r^2_i \times H_i)/\sum_i(\pi r^{2i})$$

where H_i and r_i are the height and radius at breast height of tree *i*, respectively, in meters.

In situ field data were used to derive stand-level allometry between AGB, H_{ba} and H_{max}. Models were generated between plot-level canopy height and plot-level AGB density, where height and AGB relationships were fitted to the regression model:

$$AGB = a \times H_x^b$$

where *Hx* can represent either *H*ba or *H*max.

Total above- and below-ground biomass, and carbon stock estimates for Guinea were generated by summing all of the corresponding pixels, while accounting for below-ground biomass and soil carbon. The total above-ground carbon stocks were calculated assuming a stoichiometric factor of 0.475 as the AGB conversion factor. Total root biomass was estimated as 27 percent of the AGB. (See Simrad et al. 2019 for more detail on the procedure followed by NASA.) A greater amount of carbon is stored in the soil in mangrove plantations since carbon remains trapped much longer in such submerged soil. However, the carbon trapped in the soil is not included in the analysis, since it is more difficult to estimate the extra carbon that is added to the soil as degraded land is restored.

Based on the carbon content found in the NASA study, the value of the carbon that would be sequestered in mangroves in Guinea if the 700 square kilometers of degraded land were restored would amount to $49 million, with an

[16] https://www.researchgate.net/publication/351749539_Species-Level_Classification_and_Mapping_of_a_Mangrove_Forest_Using_Random_Forest-Utilisation_of_AVIRIS-NG_and_Sentinel_Data

annual value addition of nearly $1.6 million from the natural growth in the existing mangrove plantations.[17] This is assuming that the carbon offset could be traded on the international market, and is based on the global weighted average price of carbon, which was variously estimated at around $20 per ton in 2020.[18] However, if the carbon offset were not traded, the valuation would be much lower, as current estimates for Guinea suggest a price of only $1 per ton for carbon.[19]

In other words:

> *Economic Value of Carbon Sequestration from Mangrove = Carbon Stock Trapped in Mangrove x Shadow Price of Carbon*

Protection from Coastal Erosion, Coastal Floods, and Sea-Level Rise

The vulnerability of the Guinean coast is mainly due to the fact that the West African coast has a strong sensitivity to erosion and coastal aggression caused by: **(i) the nature of the materials** (mobile sandy sediment, or highly altered and fractured rocks); **and (ii) sediment flows that remain limited** due to their capture at the river-mouth level, or their dispersal, which can be observed on coasts that are more predominantly structured in cape and creeks. This strong sensitivity to erosion is reinforced by climate-induced and human-driven mangrove forest degradation in the shoreline area (for example, the construction of port infrastructure by the mining industry).

The presence of mangroves along the coasts plays an important role in arresting coastal erosion and minimizing damages from coastal flooding, especially those caused by storm swells. When waves and water navigate through the forests during a storm-induced swell event, the dense forests of mangroves, with their trunks, aerial roots, and low-hanging branches produce friction with the incoming water. The result is wave attenuation and reduced water velocity, which limits inland water intrusion and damage to coastal infrastructure.

Mangrove forests also provide better protection from sea-level rise resulting from climate change, since unlike manmade fixed engineering structures that are meant to protect the shoreline, mangrove forests will naturally experience vertical accretion over time. Thus, over time manmade engineering structures will be progressively less effective, while mangrove forests should be able to maintain their relative position in relation to the sea level provided that sufficient sediment is available. Recent evidence suggests that mangrove surfaces are keeping pace with rising sea levels in a number of locations (McIvor et al. 2013).

Direct valuation of the erosion protection, flood mitigation, and impact reduction from sea-level rise that is made possible by mangroves can be calculated using the value of damage avoided. However, this valuation method requires detailed data about current coastal communities and coastal infrastructure near mangrove plantations, which is not readily available at present in Guinea. A separate project to estimate the physical damage protection provided by mangroves at select coastal locations in Guinea is currently underway. However, since the data from the project is not available yet, an indirect method of valuation using the replacement method was employed. Once the data from this project become available the indirect estimates of mangrove benefits can be updated with direct estimates .

Studies have found that with each kilometer of mangroves, ocean swell height could be reduced by 5 to 50 centimeters (McIvor et al. 2012). The effectiveness depends on the specific geomorphological conditions of the sites, the plant species, and the density of the mangrove forests. Mangroves cannot completely protect vulnerable communities from flooding caused by storm-induced swells. However, they can work in conjunction with, and can complement hard engineering infrastructure. Swell attenuation by mangroves should allow for a lower level of investment in protective

[17] See details in Appendix C.
[18] https://carboncreditcapital.com/value-of-carbon-market-update-2020/
[19] https://www.nature.com/articles/s41558-018-0282-y

engineering infrastructure by allowing barriers of lower height and width to be built, saving a substantial amount in construction costs. In addition, the presence of mangroves placed in front of the hard infrastructure can reduce the maintenance cost of the infrastructure.

More than 400 kilometers of mangrove rice protection bunds have been created in Guinea for the protection of agricultural and residential areas from floods. The presence of mangroves in these bunds have helped to not only minimize the use of other gray infrastructure, but also to reduce the height and width of the bunds needed to protect the rice fields. These mangrove bunds also protect the shoreline from erosion and have helped to minimize the need to reinforce and/or rehabilitate dikes and spikes designed to minimize impact on the shoreline from sea-level rise.

In the indirect computation of mangrove valuation, any reduction in the current costs of building/rehabilitating dikes, spikes, and bunds in Guinea can be considered as the economic value of the erosion protection, flood mitigation, and impact reduction from sea-level rise that mangroves provide. However, the cost of building infrastructure that could be reduced in order to determine the savings that can arise when mangroves partially or fully replace it is not readily available in Guinea. Therefore, we have used estimates done elsewhere to determine the economic value of mangroves in Guinea after making allowances for local characteristics of the Guinean coast.

In other words:

> *the Economic Value of Protection from Coastal Erosion, Coastal Floods, and Sea Level Rise provided from Mangrove = Savings in Hard Gray Infrastructure (mainly, dikes and spikes, and a reduction in bund height and width).*

The valuation of the protection provided by mangroves based on avoided expenditure on physical reclamation and replenishment approach has been estimated in a number of countries around the world: these estimates range from $1,120–1,369 per hectare (Barbier et al. 2011, Estoque et al. 2018). The lower end of these estimates may be more appropriate for use in estimating the benefits in Guinea, given the average income levels of the countries included in the studies. Accordingly, the annual value of protection from coastal erosion, coastal floods, and sea-level rise with an estimated mangrove cover of 207,600 hectares in Guinea amounts to $232.5 million.

Biodiversity Benefits

Mangrove ecosystems and their associated wetlands support a wide array of biodiversity in Guinea by serving as a habitat for high concentrations of birds, mammals, reptiles, amphibians, fish, and invertebrate species. The biological diversity on the coastal shelf of Guinea depends on the input of organic matter and detritus from the coastal mangroves (UNEP 2007). A great number of seabirds use the mangrove forests for feeding, reproduction, and shelter (UNEP 2007). A number of endangered species also depend for their survival on these wetland ecosystems. **Preservation of these mangrove ecosystems through the sustainable use of resources is therefore vital for protecting the country's biodiversity.**

Only a limited share of the area identified as mangrove forest in Guinea falls within designated protected areas. Guinea has four Ramsar sites that contain mangroves that were designated in 1992. These are: Iles Tristao, covering 850 square kilometers (sq km); Rio Kapatchez (200 sq km); Rio Pongo (300 sq km); and Konkouré (900 sq km). Designating wetlands as protected areas based on the principles laid down under the Ramsar Convention, and implementing them fully is important for preserving their unique character, which supports the biodiversity around these areas. This means following the rules laid down to prevent unsustainable use that puts pressure on the survival of the ecosystem. However, since designation as a protected area would curb some of the practices currently followed to harvest resources, the communities around the protected areas may face reduction in their income-generating activities from these areas.

The economic benefit from preservation of the mangrove ecosystem in Guinea can be determined indirectly using the Willingness to Pay (WTP) approach. The WTP is based on how much reduction in income the communities around the mangrove areas are willing to accept if the area is designated as a protected area. This provides a measure of how much value these communities assign to protecting the biodiversity associated with the mangrove areas that would be a proxy of the benefits provided these areas by preserving biodiversity.

This study had planned to conduct focus groups in the communities around the mangrove areas, followed by the distribution of a questionnaire aimed to measure local willingness to accept a loss in income if the area were to be designated as a protected area. However, due to COVID 19-related restrictions, the survey could not be conducted. The estimation is therefore based on the results from a similar study of two separate locations done in the neighboring country of Ghana, in the Cape Coast area.

In otherwords:

> *Economic Value of Protection of Biodiversity Resulting from Mangrove = Willingness to Accept Income Reduction if the Area is Designated as Protected Area.*

The WTP approach is based on a survey that was used to determine the biodiversity benefits in two habitats in Ghana, both on the western coast. One study, which was done in 2004, revealed an average per hectare valuation of $911 when valued at 2000 PPP$ (Aheto 2011). The other study, completed in 2018, when valued in 2020 PPP$ revealed a valuation of $1,651 per hectare (Jonah 2020). However, values based on WTP are often underestimated, since all of the relevant information concerning the benefits that biodiversity can provide may not be available to the survey respondents. Based on these numbers, the annual WTP to preserve the mangrove areas as a protected natural reserve with an estimated mangrove cover of 207,600 hectares in Guinea ranges from $189–$343 million.

Water Purification Benefits

Mangroves provide natural water purification services. Excess nutrients present in the water are removed and broken down, which results in better-quality water. Laboratory experiments also show high removal rates of nitrogen and phosphorus from both organic and inorganic nutrient-rich wastewater in a mangrove environment (Shimoda et al. 2009). Mangroves are also known for removing harmful materials from wastewater and transforming toxic pollutants to less harmful materials.

The benefits of water purification from mangroves in Guinea was estimated using an alternative cost approach. Essentially, these estimates are based on the cost incurred for performing similar filtering services in a typical treatment plant. Using this method, Lal (1990) found that the monetary value of water purification from mangroves is equivalent to $5,820/hectare/year. (However, with technological improvements, the cost of such filtering services in treatment plants has come down.)

Another way of valuing the benefits from water purification performed by mangroves is based on its property of removing salinity from sea water. Mangroves are facultative halophytes and are known for their special ultrafiltration system, which can filter approximately 90 percent of the sodium ions from the surrounding seawater through their roots.[20] However, the efficiency found in these studies is based on a laboratory setting; in natural conditions the actual performance may be much lower. The cost of similar salt filtration in desalinization plants can be used to determine the monetary benefits arising from water purification by mangroves.

[20] https://www.nature.com/articles/srep20426

In other words:

> *Economic Value of Water Purification from Mangrove = Cost of Performing Similar Filtering Services in a Typical Treatment plant.*

The cost of converting sea water into brackish water is used to determine the water purification benefits from mangroves. The current cost of desalinization of sea water is around $3 per 1000 gallons, while that of brackish water is $1.09 per 1,000 gallons.[21] The amount of water purified by mangroves per hectare annually was estimated using an average root height of 50 centimeters, and a conservative 6–20 percent efficiency based on location, because of the constant flow of sea water around mangroves. Based on these assumptions, the water purification benefits from each hectare of mangroves ranges between $151 and $504. Thus the annual water purification benefits from mangrove areas in Guinea, with its estimated mangrove cover of 207,600 hectares, ranges from $31,404,067 to $104,228,604.

Total Benefits from Mangroves

The valuation of benefits derived from mangroves in Guinea clearly reveals that the private-use direct benefits are only a small fraction of the total economic benefits mangroves can provide (Table 4). The total private direct benefits are also much smaller than the private indirect benefit from the fisheries sector. This study also shows why mangrove rice production is an attractive private benefit for farmers, since the benefits per hectare far exceed the private direct-use benefit they would otherwise get from mangroves in the same location.

Once the social-use benefit from mangroves is included in the overall benefits, a much stronger case can be made for preservation, and the creation of new mangroves in areas suitable for such growth. The social-use values presented are generally on the conservative side and do not fully account for all possible values. Even with these limitations, the overall value, including social values, far exceeds the private-use benefits.

TABLE 4: TOTAL BENEFITS FROM MANGROVES IN GUINEA

Annual Total Benefits	Value $M	Value $/Hectare
Private Direct Use		
Salt production	$12	$55
Fish smoking	$20	$96
Domestic, Conakry	$8	$40
Domestic, rural	$12	$57
Total Direct Use	$52	$248
Private Indirect Use		
Fisheries	$232	$1,119
Social Use		
Carbon Sequestration	$49	$221
Flood Protection	$232	$1,120
Water Purification	$31 - $105	$151 - $504
Social Option and Nonuse		
Biodiversity	$189 - $343	$911 - $1,651
Private Alternate Use		
Mangrove Rice	$616	$7,896

[21] https://www.advisian.com/en/global-perspectives/the-cost-of-desalination

CHAPTER 4.
ECONOMIC COST ESTIMATIONS OF THE AFFORESTATION PROGRAM

The total cost of mangrove plantation in Guinea will involve a one-time initial cost of planting plus the cost of maintenance, which will be estimated on an annual basis. The planting cost of mangroves per unit of land will differ depending upon whether these are plantations in new areas (including totally degraded land), or rehabilitation measures in existing partially-degraded mangrove forests. However, in both cases the cost will consist of the labor and materials needed for planting mangroves, assuming that the plantations will be done on public land, and that no land acquisition costs would be incurred.

The annual maintenance costs of mangroves, including rotational thinning and selective final felling, will involve both labor and material costs. These estimates are based on the typical amount of manpower needed in Guinea for forest maintenance per unit of land, and the prevailing wage rates. The material costs for annual maintenance is estimated as a percentage of the labor cost, as these costs are likely to be minimal.

The cost of planting with 2 x 2-meter spacing is estimated at $968 per hectare; and $1,815 with a 1x 1-meter spacing. This includes both the material and labor costs involved in the first year of the plantation. To ensure that the plants are protected and continue to grow, annual maintenance costs, mostly in terms of labor, are estimated at $72 per hectare. In the cost- benefit estimation for this study, we used the cost for 2 x 2-meter spacing.

4.1. COST-BENEFIT ANALYSIS AND ESTIMATION OF NET PRESENT VALUE AND INTERNAL RATE OF RETURN

The net present value (NPV) from each hectare of new plantations is estimated using the following formula over a twenty-year period:

$$NPV = \sum_{t=1}^{T} \frac{NPt}{(1+r)^t}$$

where NPV is the net present value; NPt is the net profit at time t; r is the discount rate; and T is the project lifespan. In addition, a benefit-cost ratio (BCR) is estimated based on the ratio of the NPV of benefits and the cost based on these values.

Assuming that the annual benefits start accruing ten years after planting, the private direct benefits show a positive NPV per hectare of $1,357, with a BCR of 1.4 over a twenty-year period, with a 3 percent discount rate. With inclusion of the private indirect benefits from fisheries, the NPV per hectare increases to $18,503, with a BCR of 19. Once the social-use values are factored in, the NPV increases to $38,333, with a BCR of 39. These reveal the large benefits that come with investment in planting mangroves in Guinea.

An additional NPV of $950 million can be created based on only private-direct use over a twenty-year period, with a 3 percent discount rate, by bringing the nearly 700 square kilometers of mangrove-suitable land that is currently barren or degraded back as pristine mangrove areas. If all of the other social benefits are also included, the NPV from such investment could be as high as $26.8 billion.

TABLE 5: NPV PER HECTARE, AND BCR FROM EXISTING MANGROVES

	NPV $/Hectare	BCR
Private Direct Benefit	$1357	1.4
All Private Benefits	$18,503	19
Private and Social Benefits	$38,333	39

CHAPTER 5.
CONCLUSION

Mangroves in Guinea provide many monetary benefits, and even the direct private benefits they provide clearly outweigh the costs of creating and maintaining them in most of the areas that are now barren but suitable for mangroves. In areas that have been cleared of mangroves for alternative uses like rice farming or urban use and may not be feasible for mangrove restoration, the benefits from mangroves can often be comparable to the benefits from other such uses once we monetize their private indirect and social-use benefits. To identify the locations that would provide the best return on investment in creating new mangroves, a detailed analysis of the benefits from mangroves, using the methodology proposed for each type of benefits, is needed. However, an accurate region-specific analysis of the net benefits in each area would require collecting data specific to each region in Guinea, since the types of mangroves and their spread often differ from region to region.

The benefit estimation in this study is based on the best local data available in Guinea and reveals a number of gaps in local data availability that may provide good areas for future research. First, the area estimates for mangroves currently do not clearly include species specific area coverage. With improvements in satellite technology, it is becoming increasingly feasible to determine these based on the satellite imagery data. Creating this mangrove species based coverage will help to more accurately determine the benefits from mangroves as the height and canopy cover differ across mangrove species. Second, some of the direct benefits like medicinal use are anecdotal and require more research to get a more accurate data estimates. Some other direct benefits like honey and tourism point towards possible future benefits that may still be untapped.

The biggest data gaps were found while estimating social benefits and option value benefits. One such area is carbon sequestration where, unlike in some of Guinea's neighboring countries, very few local on-the-ground estimates have been done. Regarding coastal protection, it is hoped that one current project in place in Guinea will help to collect suitable data for a location-specific estimate of benefits. There is also a need to carry out suitably structured surveys to determine the Willingness to Pay for mangrove preservation in order to more accurately determine such option value benefits.

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APPENDIX A.
ESTIMATION OF MANGROVE AREA IN GUINEA CONAKRY[22]

A survey of the current literature about the area coverage of mangroves in Guinea since 1951 reveals a number of issues. For example:

- The values provided are not, for the most part, accompanied by descriptions of the methodologies used (no calculation methods are provided), and rarely are there references provided from iconographic sources (topographic maps, aerial photographs, satellite images) or geomatics.
- The rounding nature of a number of the values supplied testifies to their imprecision.
- There is a repetition of values over time (from report to report), without citation of references, and without critical analysis of previous results.

In addition, what we have observed on reading various reports (mainly gray literature), which may be the source of some of the surface differences, are differences in the definition of the mangrove. Some of the definitions are:

- The tree formation seen in *Rhizophora* (the original Anglo-Saxon definition from the name of this tree),
- The entire tree layer (*Rhizophora, Avicennia, Laguncularia, Conocarpus*),
- All halophilic vegetation (vegetation that likes salt): tree, shrub, and herbaceous material
- All marshy surfaces that are liable to flooding by the sea (salt marshes);

The whole ecosystem integrating the hydrographic network, mud flats (*slikkes*), vegetated areas (*schorres*), and areas developed for growing rice or salt farming on salty substrate. Or 400,000 hectares (1951, 1974 ... 2018). Thus, estimates of mangrove areas and therefore deforestation rates may have been based on different spatial sets based on what the author of the calculation considers a reference area (for what he or she calls "mangrove"). These often do not distinguish between the types of mangrove plains taken into consideration.

One of the specificities of the mangrove areas of Guinea is the existence of three specific types of plains:

- **Estuarine plains.** These border the estuaries of the mouths of coastal rivers. They are very submersible, and are naturally occupied by *Rhizophora* mudflats (which are dominant).

[22] The contents in this Appendix is based on a report prepared by Olivier RUË in 2020 for the World Bank.

- **The seafront plains.** These are located in sectors further from the mouths of rivers. They are much less submersible than the estuarine plains, but with salty soils. They were originally occupied by *Avicennia*; since the 1950s they have been used for rice cultivation (the largest perimeters).
- **The back mangrove plains.** These are floodable (especially during winter). They are found in the transition between continental (non-salty) brackish and salty environments, and are partially colonized by hydrophytes with drainage constraints.

Some authors consider all of these plains in their calculation; others only consider estuarine areas with dominant *Rhizophora* (which are similar to the mangroves of Central Africa) because they are, in their natural state, submerged 50–70 percent of the time. Others include the dominant seafront plains or the rear mangrove plains in *Avicennia*, which are naturally submerged between 3 and 40 percent of the time. (Ruë 1998).

Considering these limitations, the following estimates can be found across time about the area coverage for mangroves in Guinea:

- IGN France Internationale, CIRAD, AFD ANASA: Agro-ecological zoning of the Republic of Guinea (2018–2020)[23]
  - 241,359 ha of maritime marshes (2015) including:
  - 141,953 ha of mangrove (2015)
  - 144,639 ha of mangrove (2005)
  - 99,406 ha (2015) and 99,677 ha (2005) of maritime wetlands
  - Loss of 2,686 ha of mangrove in 10 years between 2005 and 2015: either -1.9%/10 years, or 0.19%/year
- Diallo et al (2019)[24] use data from Rio Tinto (2012)
  - 279,100 ha of which
  - 203,600 ha of mangrove forest and 75,500 ha of brackish coastal marshes
  - 60,500 ha of floodplain rice fields
  - 30,500 ha of bare mud flats (slikkes) uses data from 2001 and from Altenburg (1989)
- Dolinguez F.[25] et al. (2018) after RUË (1995, 1998)
  - 270,000 ha of mangrove including 100,000 (almost a third) exploitable (wood)
- Green Climate Fund (2018)[26]:
  - 385,000 ha of mangrove (taken from Traoré et al. 2002).But according to the author "there is currently no official data that can accurately assess this area". About twenty cartographic estimates and measurements were carried out between 1950 and 2000, varying from single to double depending on the year and the study.
- Heral A.[27] (2016):
  - 385,000 ha of mangrove swamps (10% of mangrove swamp areas in West Africa from Senegal to Sierra Leone)
  - Of which 250,000 ha of forest areas and 120,000 to 140,000 ha cleared and developed into rice fields, saltworks, areas for smoking fish and oysters or others
- Ministry of the Environment, Water and Forests (2015)
  - Decrease in mangrove area -4.2% (without source or calculation method)

[23] https://www.ignfi.fr/fr/portfolio-item/zonage-agro-ecologique-guinee/
[24] Diallo M. et al (2019): model of criteria taking into account halieutic biodiversity in strategic port planning in Guinea - Vertigo - the electronic journal in environmental sciences, vol.19 n ° 3 - posted online on 30 dec . 2019.
[25] Dolinguez F. et al (2018): Twenty years of rice development in mangrove areas in Maritime Guinea - Technical note n ° 44 from Agence Francaise de Développement
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[27] Heral A. (2016): The traditional salt production activity in Guinean mangroves and the alternative by solar production - capitalization of the establishment and innovation (1992–2016)

- State of the environment report (2012) cited in Afrikimpact of 21/01/20
  - 250,000 ha of mangrove
  - Annual regression rate of 4.2%/year (secondary reference)

- National Environmental Policy (2011)
  - 250,000 ha of mangrove forests

- IUCN (2010)[28] :
  - 250,000 ha of mangrove forests (possibly from FAO 1998); the author indicates that in 2000 the area was about 330,000 ha but without indicating its source.
  - Reduction 1000 ha/year (-4% without calculation basis)

- IUCN (2007) MAOI
  - 437,000 ha so-called mangrove zone (in deep salty alluvial soils)
  - 250,000 ha of mangrove (350,000 ha in 1956 - without source)
  - Mangrove reduction 450 ha/year (-4% - without calculation basis)

- Bangoura I. (2004)[29] Information presented as part of the study for the assessment of global forest resources (FAO 2005)
  - 299,200 ha of mangrove area:
  - GTZ (2002)
  - 356,342ha of mangrove area
  - Water and paddy fields are not taken into account

- National Strategy and Action Plan on Biological Biodiversity (2001)
  - 250,000 ha of mangrove forests (reminder 400,000 ha in 1957 but probably reproduced from 1951 (ref. Known) but is it the only tree formation or the whole ecosystem?
  - 30,500 ha of bare mud flats (*slikkes*)
  - Mangrove reduction of 375 ha/year or 1%/year

- UNEP WCMC (2000): Landsat image interpretation as part of the World Mangrove Atlas initiative
  - 187,800 ha of mangrove

- RUË O[30]. (1995, 1998)
  - 270,000 ha of mangrove forests (ref. SDAM 1989) including
  - 100,000 ha of exploitable forest and exploited mixed areas with dominant Rhizophora
  - Decrease - 6000 ha/year in 1998, ie - 6%/year (compared to 100,000 ha of still exploitable forest); -12,000 ha/year in 2020 or 12%/year

- IUCN Hughes (1992)
  - 285,000 ha
  -
- SDAM (1989) Cartographic analysis at a scale of 1:700,000. The data come from aerial photographs from 1979–80 updated with Landsat MSS images 1984–1985–1986. CTFT/BDPA-SCET AGRI. 1989. Potentialities and Possibilities of Relaunching Forestry Activity: Regional and National Synthesis. 1:700,000. CTFT/BDPA-SCET AGRI
  - 385,000 ha of ecoystemic mangrove area (maritime marsh including channels, mud flats, tannes) including
  - 270,000 ha of mangrove forests
  - 120,000 ha cleared and/or converted into rice fields, saltworks, smoking area or other, including 70,000 ha abandoned, including 35,000 sterilized

- FAO[31] (1987)
  - 280,000 ha of mangrove forests

[28] IUCN (2010) Coastal Governance and Heritage
[29] FAO (2005) Global Forest Resources Assessment - Thematic Study on Mangroves in Guinea-
[30] RUË O. (1998): The development of the coast of Guinea - Memories of mangroves - ed. The Harmattan
[31] FAO (1987) Journal of the Forest Sector of Guinea

- Decrease - 6,000 ha/year exploited i.e. - 2%/year (compared to 280,000 ha)

- Bangoura I. (1980?) Reported in 2004
  - 299,200 ha of mangrove forest

- Republic of Guinea (Diallo K, 1974)
  - 400,000 ha of marshes including
  - 262,000 mangrove forest
  - 110,000 ha of plains suitable for rice cultivation

- Rouanet (1957)
  - 400,000 ha of mangrove (- without indication of measurement method) cited by Kaba (2001)

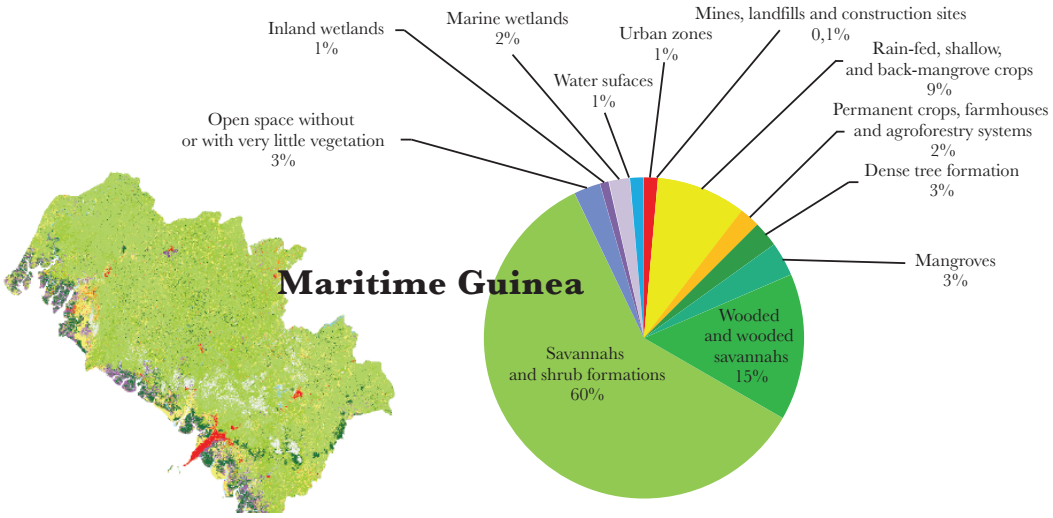
- Pre. R (1951) in The future of French Guinea
  - 400,000 ha of maritime marshes (this value includes the entire partially or totally submersible ecosystem, channels, mud flats, tannes, forest, coppice. In addition R.Pré, Governor of French Guinea dreamed of destroying the mangroves to replace them entirely in rice fields.) This measurement will often be repeated without planimetric verification.

TABLE A.1: AREA OF AGRO-ECOLOGICAL ZONES IN THE REPUBLIC FOUND BY GEOMATIC MEASUREMENT IN 2005 AND 2015

	S (ha) 2005	S (ha) 2015	2015 (%)	ΔCH	ΔCH (%)
Urban Zones	45,197	54,710	1.25%	9512.4	21.0
Mines, landfills and construction sites	3,947	5,117	0.12%	1170.8	29.7
Rain-fed, shallow, and back-mangrove crops	344,770	402,771	9.18%	58,001.0	16.8
Permanent crops, farmhouses and agroforestry systems	85,389	87,849	2.00%	2,459.5	2.9
Dense tree formation	118,744	117,656	2.68%	-1,087.6	-0.9
Mangroves	144,639	141,953	3.24%	-2,685.8	-1.9
Wooded and wooded savannahs	655,038	652,678	14.88%	-2,359.7	-0.4
Savannahs and shrub formations	2,676,488	2,611,352	59.52%	-65,136.0	-2.4
Open space without or with very little vegetation	119,598	119,603	2.73%	5.2	0.0
Inland Wetlands	34,695	34,517	0.79%	-178.4	-0.5
Marine wetlands	99,677	99,406	2.27%	-271.3	-0.3
Water surfaces	59,018	59,588	1.36%	569.9	1.0

Source:

FIGURE A.1: PERCENTAGE CHANGE OF AGRO-ECOLOGICAL ZONES IN THE REPUBLIC FOUND BY GEOMATIC MEASUREMENT BEWEEN 2005 AND 2015



Source:

The agroecological zoning work of the Republic of Guinea carried out by IGN F international, CIRAD and ANASA with *Agence France de Développement* funding over the past two years, on images from 2015 and 2005 constitutes the first rational geomatics work that distinguishes between mangroves and wetlands; but it is not differentiated by species. The results for the three regions, or three zones, as measured by Didier Bazzo on November 24, 2020 reveals the following data, which adds up to 200,000 hectares or 2,000 square kilometers.

TABLE A.2: AREA OF MANGROVES IN THREE ZONES IN GUINEA IN 2015

GB - Cap Verga border	Cap Verga - Kaloum	Kaloum - Frontière SL
90,000	74,000	36,000

MANGROVE EXPLOITATION AREA

A precise mapping (one of the few), at 1/20,000 scale, of natural formations, land use, development constraints, and the various levels of traditional interventions in the sector in Konkouré was carried out by the Mangrove Management pilot project in Sangaréah Bay (52,400 ha) between 1992 and 1995. It enabled a large-scale (detailed) inventory, but without differentiation of species, the proportions of specific forest and plant cover in one of the most beautiful mangrove massifs in Guinea. The results for area distributions were as follows:

- Productive woodlands 37.5 percent_
- Rear mangrove 34.1 percent
- Unproductive woodlands 22.9 percent
- Rice and salt fields 2.8 percent
- Wasteland and tannin 2.4 percent

This distribution showed that, in a sector considered to be one of the most beautiful and dynamic forested mangrove reserves in the country (the Konkouré Delta),

only 37.5 percent of the surface was occupied by a productive formation and therefore can be used rationally for commercial exploitation. **We can therefore deduce,** by applying this proportion to all of the main mangrove areas of Guinea in *Rhizophora*, **that of the 270,000 hectares of natural mangrove plant formations, we can only count on about 100,000 hectares (37.5 percent) for this type of commercial exploitation.**[32]

[32] Rio Nunez, Rio Pongo, Konkouré; Forécariah, Mellacorée (5 estuarine mangrove sectors with beautiful *Rhizophora*).

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APPENDIX B.
BENEFITS FROM PRODUCTS OBTAINED FROM MANGROVE PLANTATIONS

DIRECT BENEFITS

The overall direct use of mangrove wood is based on the following:

- The production of mangrove salt by cooking (ignigenic) varies between 10,000 and 20,000 tonnes/year. Guinea's needs are 78,000 tonnes/year at a rate of 6 kilograms (kg) per person per year. At the rate of 3 kg of *Avicennia* to produce 1 kg of salt,[33] the consumption of wood (*Avicennia*) amounts to an average of 45,000 tonnes/year.
- It takes 3 kg of *Rhizophora* to to smoke 1 kg of fish. Based on 26,000 tonnes of fish per year, the consumption of *Rhizophora* wood amounts to 78,000 tonnes/year.
- The consumption of mangrove wood in Conakry was estimated at 800,000 cubic meters (m^3) at a rate of 0.8 m^3 per inhabitant per year × 1,000,000 inhabitants) at the end of the 1980s and at 1,200,000 m^3 at the rate of 1,500,000 inhabitants at the end of the 1990s. In 2020, the population of Conakry stood at 1,938,000 inhabitants. Knowing that the individual consumption of wood energy amounts to approximately 0.8 m^3/year, the demand for wood (wooded savannah, shrub savannah, and mangrove) just for Conakry amounts to 1,550,400 m^3. This is converted to 51,140 tonnes using the average density of 0.032985 tonnes/m^3.

The SDAM (1989) provides the first estimate of the distribution of the different uses of mangrove wood over the whole of Lower Guinea. The usage breakdown is as follows:

- **Production of salt 22 percent**
- **Smoking fish 36 percent**
- **Domestic needs of Conakry 22 percent**
- **Rural domestic needs 20 percent**

The consumption of 45,000 tonnes for salt, 78,000 tonnes for smoking fish, and 51,140 for wood is very close to the proportion found earlier. We used that same proportion to estimate the consumption for rural domestic as 6,490 tonnes for total use of 220,630 tonnes per year (Table A.2).

[33] On the other hand, the production of solar mangrove salt (which does not consume wood) amounts to an average of 1,600 tonnes/year (over 15 years), although this technique has been introduced and popularized for almost 40 years.

Salt production and fish smoking uses mangrove as fuel wood. The use in Conakry and the rural areas is based on a comparison of wood harvesting in rural areas (Douprou) and in peri-urban areas (Dubréka) in 1994 (Ruë 1998). The comparison of the use of wood between Dubréka and the towns of Douprou showed that in 1994:

- The sale of wood represented 0 percent of revenue in Douprou against 73 percent in Dubréka.
- Smoking represented 47 percent of revenue in Douprou against 1 percent in Dubréka.
- Salt represented 38 percent of revenue in Douprou against 18 percent in Dubréka;
- Other mangrove activities represented 15 percent of revenue in Douprou against 8 percent in Dubréka.

It was assumed that rural areas mostly use mangrove for fuelwood; the proportion of wood used for Conakry was based on the ratio of use found in the town of Dubréka, a similar but smaller urban area for which survey data was available. The use of fuelwood as charcoal, was based on assuming a 40 percent reduction in volume when converting wood to charcoal.

We use this consumption data in tonnes, and the price per tonne, to determine the monetary value of mangrove use. The price data included both the average wholesale price and the retail price of wood and charcoal in local currency in 2000 in Guinea (Table B.1). However, we used the wholesale price in calculating the value of mangrove wood, since the retail value includes costs like handling and transportation as well. To arrive at the value in 2020, we applied the inflation rate between 2000 and 2020 in Guinea and finally expressed the value in PPP$, using the 2020 PPP conversion factor.[34] The valuation of each use is shown in Table B.2.

TABLE B.1: PRICE OF MANGROVE

Trade	Wood (gf/kg)	Charcoal (gf/kg)
Wholesale	20	65
Retail	40	130

From Wood Energy, Guinea 2000

TABLE B.2: TABLE B.2 MANGROVE USE

	Tonnes	Value in PPP$M
Salt production	45,000	11.5
Fish smoking	78,000	19.9
Domestic, Conakry	51,140	8.3
Domestic, rural	46,490	11.8
Total	220,630	51.5

[34] https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD?locations=GN

INDIRECT PRIVATE BENEFITS FROM FISHERIES

The information about fisheries in Guinea reveals the following:

- Species that are subservient to shallow water (up to 15–20 meters) are mainly coastal *scianidaes* such as *pseudotolithus sp* (boboe) and *ariidae* (jawbones), etc.
- The *ethmaloses* and flat *sardinellae*, which are pelagics that move in schools, make up nearly 50 percent of artisanal fishing.
- The *ethmaloses* are coastal and are fished all year round, while the sardinella is more related to upwelling (seasonal). Both reproduce under the mangrove and are therefore subject to the sedimented mangrove hydrosystem.They also represent a good proportion of the stomach contents of other coastal species.

"These fish are of paramount importance for the food security of Guinea because they are the most numerous ichthyological communities (*scianids*). Unlike in Senegal and Mauritania, where the biomass increases offshore due to oceanic upwelling, in Guinea the biomass increases toward the coast due to nutrients provided by coastal rivers and the productivity of mangroves. In Lower Guinea 80 percent of the fishery and forest resources are dependent on each other, and are ecologically associated.

A number of reports on annual fishery output exist. Our analysis is based on the report published by the National Center of Fishery Sciences of Boussoura (CNSHB), Ministry of Fisheries, Aquaculture, and Maritime Economy, Republic of Guinea. The total annual marine fish production in Guinea totalled 289,544 tonnes in 2019, of which pelagics accounted for 135,971 tonnes, and demersals for 152,395 tonnes.[35] A survey carried out at a number of important fishing locations found that the fishing was mainly at sea in Bongolon (88 percent) and Matakang (78 percent). In Koukoudé, on the other hand, there is a significant percentage of fishing activities on the coast (38.57 percent) and on the inlet (17 percent).[36] Based on these findings, we arrive at an annual coastal fishery output of 128,000 tonnes in Guinea. Of this, 70–80 percent of coastal fishing sustenance is dependent on the presence of mangroves.

The price of fish depends on the type of fish: this varies widely—from 5,000 GF/kg to more than 100,000 GF/kg—during 2019.[37] We use a weighted average price of 10,250 GF/kg in valuing the output. In PPP$ in 2020, this price translated to $3,832 per ton. However, this price includes the cost of fishing gear, and storage and transportation costs. To arrive at the net value of fish made possible by the presence of mangroves we subtracted $1,240 per ton in 2020 PPP$ based on the average cost of fishing in Guinea.[38] Assuming that 70 percent of the annual coastal catch of 128,000 tons is arising from the presence of mangroves, the value added from fisheries amounts to $232 million in 2020 PPP$.

[35] Fisheries Statistical Bulletin, 2019. Republic of Guinea. Ministry of Fisheries, Aquaculture, and Maritime Economy. National Center of Fishery Sciences of Boussoura (CNSHB)
[36] Living Standard Measurement Survey (LSMS) and fishing community study of fisheries comanagement sites, 2019. Ministry of Fisheries, Aquaculture, and Maritime Economy, Republic of Guinea..
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[38] https://academic.oup.com/icesjms/article/68/9/1996/668065

APPENDIX C.
SOCIAL BENEFITS FROM CARBON SEQUESTRATION

To arrive at the estimation of carbon sequestered in mangroves, the usual approach is to use an allometric function that requires estimating the height of the plants and the average diameter at breast height (DBH). Some functions also include leaf area index (LAI) as another parameter. However, such estimations in Guinea are not very common. A survey of the literature revealed only one study carried out in 2010 (Kovacs et al). In that study of the 10,442 hectares (ha) of mangroves in the country that have been mapped, approximately 30 percent were classified as riverine, dominated by tall *R. racemosa*. The remaining mangrove areas were dominated by dwarf mangroves, either *Rhizophora* or *A. germinans*. Biophysical parameter data collected from 56 transects varied considerably among the classes. For the tallest mangrove class, the mean values of height, DBH, estimated LAI, stem density, and basal area recorded were 13 meters, 15.1 centimeters, 4.3/838 stems/hectare (ha), and 25.9 m^2/ha, respectively. In contrast, for *A. germinans*, values of 3 meters, 4.6 centimeters, 1.5/2,877 stems/ha, and 6.0 m^2/ha were calculated.

In the absence of adequate ground-level data for various areas of the country, the only other alternative is to base such estimations on data derived from satellite imagery. However, only a few studies can be found that have computed the biomass in mangroves in Guinea. One study estimated the mangrove biomass in a number of countries in West Africa, including Guinea (Tang et al. 2019). It found an average canopy height of 7.8 meters, with an above-ground carbon density of 54.0–59.6 ton/hectare and below-ground carbon density of 20.5–22.7 ton/hectare.

A study done by NASA in 2020 specifically using satellite data for Guinea estimated the carbon biomass in mangroves in Guinea (see Table C.1). These findings indicated a slightly lower carbon density than that estimated by Tang et al. It also revealed the large amount of carbon sequestered in the soil of mangrove plantations.

TABLE C.1: TOTAL BIOMASS IN MANGROVE IN GUINEA

	2016	2017	2018	2019	2020
Total Above-Ground Biomass (Tg)	11.7	10.5	10.8	11.0	11.0
Total Below-Ground Biomass (Tg)	3.18	2.81	2.93	2.94	2.94
Total (Tg)	14.9	13.3	13.8	14.0	13.9
Total Biomass Carbon (Tg of C)	7.08	6.31	6.54	6.64	6.62
Area (sq km)	2,001	2,021	1,877	2,013	2,076
Biomass Carbon (Ton/Hectare)	35.38	31.21	34.82	32.97	31.88
Total Soil Organic Carbon (Tg of C)	48.56	48.29	46.24	49.34	48.83
Carbon Biomass in soil (Ton/Hectare)	242.66	238.96	246.36	245.09	235.22

Source: NASA 2020[39]

These show that each hectare of mangrove sequesters 31–35 tons of carbon in Guinea. If the 700 square kilometers of degraded mangrove is restored it would result in around 2.45 M ton of carbon sequestration. In addition, in each existing hectare of mangrove, each year an average of 2.4 Cum of biomass is added. So, given the current estimated mangrove cover in Guinea of a little over 2000 sq km, the natural growth of mangroves is helping to sequester 164.420 Ton of biomass (or 78,000 ton of carbon) per year.

The shadow price of carbon is based on estimates of the social cost of carbon in Guinea. This can be used in two ways. We can use the country-specific social cost of carbon as the shadow price. The other option is to base it on the price it could command in the international carbon market if that carbon reduction were to be traded.

The social cost of carbon is highly country-specific, and current estimates for Guinea suggest a price of $1 per ton.[40] On the contrary, the global weighted average price of carbon is much higher, and has been variously estimated to be around $20 per ton in 2020.[41]

Since international carbon trading is becoming quite easy, we have based our valuation of carbon sequestration in mangroves using the global weighted average price of carbon of $20 per ton. Using this figure, the economic value of restoring mangroves in the 700 sq km of degraded land would amount to $49 million. In addition, the economic value added from the annual natural increase in carbon sequestration in mangroves would add nearly $1.6 million every year.

[39] Simard, M., T. Fatoyinbo, C. Smetanka, V.H. Rivera-monroy, E. Castaneda-mova, N. Thomas, and T. Van der stocken. 2019. Global Mangrove Distribution, Aboveground Biomass, and Canopy Height. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1665 https://daac.ornl.gov/cgi-bin/dsviewer.pl?ds_id=1665

[40] https://www.nature.com/articles/s41558-018-0282-y

[41] https://carboncreditcapital.com/value-of-carbon-market-update-2020/

APPENDIX D.
MANGROVE RICE

Mangrove rice is currently grown in about 78,000 hectares of land in Guinea, as discussed in Appendix A. In 2019, the annual gross rice production was 353,946 tons, and there was a net annual mangrove rice production of 300,481 tons.[42] The average price realization for mangrove rice was 9262 GF per kg in 2019. Using inflation in Guinea terms of the 2020 PPP$, the price amounted to $3,462 per ton**.** However, to get the value added in rice production we have to subtract the cost of rice production.

The average input cost of rice cultivation is estimated to be 20.8 percent of total rice value on average, derived from a survey about the cultivation of mangrove rice.[43] An additional 20 percent was incurred as labor costs. Based on these, the annual value added in mangrove rice cultivation was estimated to be $616 million. Since rice is grown on around 78,000 hectares in Guinea, this translates to $7,896 per hectare.

[42] Agricultural Statistics Director, 2019. National Institute of Statistics, Republic of Guinea.
[43] General Report of the Agricultural Investigation. Agricultural Campaign 2014-15. Ministry of Agriculture, Republic of Guinea.

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