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Ecological baseline study and impact assessment for the development of the port of Ziguinchor, Senegal

A&W-report 2006

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Royal HaskoningDHV
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Front page
Great white egret in Casamance mangroves, photo by Erik Klop

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Contents

1 Introduction

1.1 Introduction

The city of Ziguinchor in southern Senegal is the main entry point to the Casamance Region for both people and cargo arriving from Dakar. Due to difficulties with the navigability of the river and port infrastructure, most of the transport is done by road, via Tambacounda. Alternatively, vehicles cross The Gambia, which involves additional costs and potential security problems. Many people therefore rely on the ferry that commutes twice a week between Dakar and Ziguinchor, but the facilities for cargo are limited.

In order to further open up the Casamance, a project has been initiated by the *Agence National des Affaires Maritimes* (ANAM) to facilitate maritime transport to Ziguinchor. ANAM is a governmental institute responsible for the development and maintenance of maritime infrastructure in Senegal. The project is co-financed by the Dutch facility for infrastructure development (ORIO).

The long-term objective of the project is to contribute to the development of the Casamance Region by improving access to markets through an improved transport infrastructure. More specifically, the goal of the project is to facilitate maritime transport in and out of the Casamance by improving access to the port of Ziguinchor. This goal is to be realised by the following project activities:

1) Dredging activities in the Casamance River to improve accessibility of the Port of Ziguinchor;
2) Construction and renovation activities at the commercial Port of Ziguinchor to improve and upgrade facilities, including the fuel import facilities;
3) Construction of a small quay at the small fishing port (Port de Boudody) to facilitate mooring of large pirogues;
4) Technical management support to optimize the organisation and efficiency of the port.

The Casamance River is the main artery of the Casamace estuary, which contains one of the largest stretches of mangroves in the country and is of great importance to the biodiversity of the region. The dredging works in the Casamance River and renovation activities at both the commercial port and fishing port may lead to temporary or permanent impacts on the ecology and ecosystem services of the area. According to the Environment Code that is part of Senegalese law, projects that are potentially harmful to the environment must be subjected to environmental assessment procedures. The potential environmental and socio-economic impacts that may arise from the project are therefore identified and assessed in an *Environmental and Social Impact Assessment* (ESIA). Such impacts may include, for example, effects on water quality, atmospheric pollution, or disturbance of habitats and wildlife.

In this report the potential impacts of the project on the terrestrial ecosystems and biodiversity in the study area are discussed. The scope of the ESIA is described in detail in the scoping report (de Wilde 2013). Impacts have been assessed using environmental baseline conditions as a point of departure.

Figure 1.1 The passenger ferry, which commutes twice a week between Dakar and Ziguinchor, on the Casamance River.

1.2 Project area

The project area is located in the western Casamance and is bounded by the city of Ziguinchor in the east and the Casamance River mouth in the west (figure 1.2). The project activities focus on the following areas:

A. Offshore dredging location
B. Carabane Island (Ile de Carabane)
C. Upstream of Carabane Island
D. Ziguinchor city

Dredging will take place in all four areas, although the dredging volumes differ significantly between these sites (with by far the largest volume in the offshore area). The renovation works at the commercial port and the construction of a new quay at the fishing port both take place in Ziguinchor. A detailed description of the project activities is given in chapter 2.

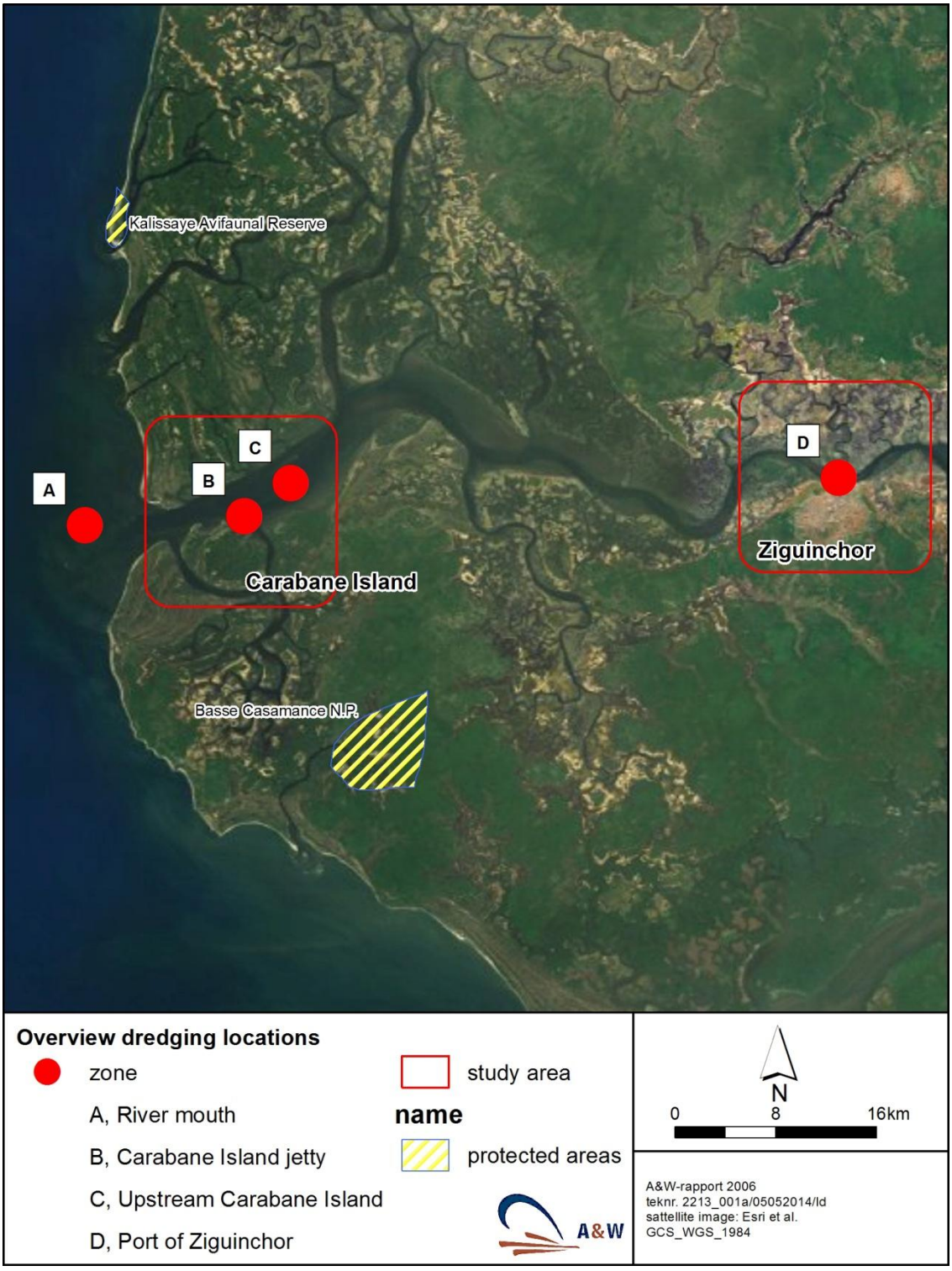

Figure 1.2 Location of the project sites (see text for details) and the study areas visited during the baseline studies. Protected areas are shaded in yellow.

2 Scope and methodology

This chapter gives a concise overview of the project activities and the methodology of the baseline studies and impact assessment. The project goals and the dredging works and other activities are described in detail by Royal HaskoningDHV (de Heer & de Jong 2013, de Wilde 2013). Below is a short summary of the main goals and project activities, based on these studies. The reader is referred to the aforementioned reports for more details.

2.1 Scope

This report presents an analysis of the potential positive and negative impacts of the proposed project activities on the terrestrial ecosystems and biodiversity in the study area. The scope of this impact assessment is limited to the project activities that are described below. Impacts on the marine ecosystem are described in a separate report by Royal HaskoningDHV and will not be considered here.

As described in the Introduction, the project consists of three main activities, i.e. dredging of the Casamance River, construction and renovation activities at the port of Ziguinchor, and the construction of a small quay at the fishing port. The locations of these project activities are depicted in figure 1.2.

Dredging
The dredging works do not cover the entire length of the Casamance River between Ziguinchor and the river mouth, but are concentrated in four areas:

1. The most important location is offshore, in the area of the submerged bars. The dredging volume in this area is by far the largest (1,214,730 m^3) of the three locations. Dredging depths range from 0 to 4.88 m, with an average depth of 1.59 m in an area of 762,700 m^2.
2. Small-scale dredging will be carried out at the jetty at Carabane Island. The total capital dredging volume at this site is around 10,000 m^3.
3. The dredging area upstream from Carabane Island is located 12 km from the river mouth. It is an area of 90,925 m^2 where limited dredging has to be carried out. The average dredging depth is about 0.96 m. The total capital dredging volume at this site is 87,265 m^3.
4. At the port of Ziguinchor, dredging will be carried out close to the quay wall. The dredging depths range from 0 to 2.1 m, with an average depth of 0.69 m. The area of dredging is 5,800 m and the total dredging volume is 3,981 m^3.

As formulated in the tentative dredging strategy (de Heer & de Jong 2013), dredging will be done by a *trailer suction hopper dredger* using a dredging pipe that is dragged over the sea bed. The dredged material is transported in the hopper to a disposal site. The capital dredging works are expected to last approximately 8–9 months, most of which will be spent in the offshore area. At the port of Ziguinchor the activities are very limited and will probably last no more than two weeks.

After the capital dredging works foreseen in 2015, maintenance dredging will be necessary every two years to maintain the channel profile and remove excessive infill.

Port development
The upgrade of the facilities at the commercial port of Ziguinchor involve 1) the renovation or expansion of a number of existing port buildings, and 2) the renovation of the fuel import facility. The existing fuel terminal has never been used and its facilities are in a dilapidated state. The current jetty with its (un-) loading facilities will need to be renovated and four new storage reservoirs will be constructed to store kerosene, petrol and heavy fuels. All renovations will take place in the existing port, so the project does not involve any expansion of the port area.

Fishing port
The fishing port (Port de Boudody) in Ziguinchor consists of a small jetty that is currently too small for large pirogues, which now have to dock near the commercial port. A small quay will be constructed, including a new jetty, immediately east of the existing jetty. The larger pirogues should be able to dock here. The dimensions of the new quay are roughly 115 × 70 m with a jetty of 36 m long. In addition to the new quay, the fish processing and cooling facilities will be transferred from the commercial port to the fishing port.

2.2 Methodology

Baseline studies
The starting point of the impact assessment is a two-week baseline study in March 2014, during which data on the ecological values of the area were collected. The baseline studies were limited to two areas, i.e. the mangroves and urban areas in and around Ziguinchor, and the area around Carabane Island (Ile de Carabane) (figure 1.2). Due to the limited time available, the baseline studies focused on those aspects of biodiversity that are easily surveyed (vegetation, diurnal vertebrates) and are good indicators of the state of the ecosystems in the area. For example, the presence of certain species will indicate whether or not habitats are degraded and what other species can be expected. The results from the baseline surveys have been supplemented by information from the literature and the results from other studies on mangrove ecosystems in the region (e.g. Zwarts *et al*. in prep.). The following parameters have been taken into account:

- Vegetation structure and habitat;
- Vegetation composition;
- Mammals;
- Birds, including the main heronries in Ziguinchor;
- Reptiles;
- Signs of human encroachment (e.g. presence of roads, villages, logging, hunting, cattle grazing etc.).

The vegetation and animals of the area were studied using plot counts. In total 20 sample plots were distributed over the area around Ziguinchor and Carabane Island (Appendix 2). Because of the importance of mangroves in the Casamance, all plots were located in mangrove areas. The plots were variable in size (100–6000 m^2; mean: 623 m^2), depending on what could be reliably surveyed by two observers given the height and density of the vegetation. The counts usually lasted 30 minutes (mean: 33 min), although a few plots took less (15 min) or more (60 min) time to complete.

In addition to the plot counts, data on the presence and abundance of birds and mammals were collected on an *ad hoc* basis and during a number of additional counts. All known roosting trees

of herons and cormorants in Ziguinchor were identified, mapped and checked for the presence of active nests. In addition, the daily movements between these roosts and the mangroves on the north bank were recorded during two morning counts and two evening counts of birds crossing the Casamance River. The morning counts started at sunrise (around 06:55 AM) and lasted one hour; the evening counts started at 18:00 PM and lasted until sunset (around 19:30). Finally, two river transects (6–9 km) were carried out in the main creeks around Ziguinchor, during which all riverine birds (mainly herons, kingfishers and waders) were counted.

The distribution and cover of mangroves in the study area was assessed using remote sensing data from UNEP-WCMC (http://data.unep-wcmc.org/datasets/21). This dataset offers the most recent (2011) and detailed overview of the global distribution of mangroves that is currently available. Details on the background and analysis of these data are given by Giri *et al*. (2011).

Assessment of impacts

The evaluation of potential ecological impacts is based on the baseline studies (see above) and good practice guidelines for environmental impact assessment (EIA) procedures. Most relevant in this case is Performance Standard 6 (Biodiversity Conservation and Sustainable Management of Living Natural Resources, effective January 2012) of the International Finance Corporation (IFC).

Potential impacts are rated on a scale ranging from negligible (no detectable impact) to major (serious impacts). The impact is determined by the sensitivity of a particular ecological value and the extent to which that value is affected by the project activities (table 2.1). The impact categories are as follows:

- Impacts are considered to be absent or negligible when the underlying baseline conditions (the ecological values and processes in the project area) will not be noticeably affected by the project activities, or when the impacts are indistinguishable from natural background variations.

- Minor impacts refer to effects that are detectable but usually short-term and localised. The underlying baseline conditions will not be significantly affected.

- Moderate impacts are clearly detectable and may extend to the area surrounding the project activity. These impacts involve loss or alteration of one or more of the key elements of the baseline conditions. However, moderate impacts may be reversible or subject to mitigation.

- Major impacts refer to widespread, long lasting and potentially irreversible changes in the baseline conditions. Mitigation is only possible through adaptations in the project design.

Table 2.1 Impact assessment rating matrix used to determine the impacts on terrestrial ecology. The impact is determined by the sensitivity of a particular ecological value and the extent to which that value is affected by the project activities.

	Effects				
Sensitivity	**Trivial**	**Minor**	**Moderate**	**Major**	**Extreme**
Very high	Moderate	Moderate	Major	Major	Major
High	Minor	Moderate	Moderate	Major	Major
Moderate	Minor	Minor	Moderate	Moderate	Major
Low	Negligible	Minor	Minor	Moderate	Moderate
Very low	Negligible	Negligible	Minor	Minor	Moderate

3 Baseline study

In this chapter the ecological value of the area around the port of Ziguinchor and the Casamance River is described. Based on a two-week field visit and data from the literature, the biodiversity and habitats present in the project area are described. The focus is on terrestrial (land-based) ecology as the marine ecology of the area will be described in a separate report.

3.1 Introduction

The Casamance estuary is, together with the Sine Saloum further north, one of the largest estuaries in Senegal. The area is characterised by a mosaic of mangroves, open mudflats and creeks ("*bolongs*") that are centered around the Casamance River. The total area of the estuary is around 3600 km^2, including open water (Hughes & Hughes 1992). The formation of the estuary began around 3500 BC, when the sea invaded the lower Casamance valley (Marius & Lucas 1991). The open bay became more sheltered due to the development of beach ridges, leading to the development of extensive mangrove swamps. The Casamance received its present form by around 500 AD (Marius & Lucas 1991).

The main water body is the Casamance River, which is not a true river originating inland, but rather an elongated inlet of the sea that reaches over 200 km inland. There are no major tributaries bringing in fresh water, and the input of fresh water is largely dependent on the rains in the wet season. Because of high evaporation rates that exceed the input of rainwater, the salinity of the river is higher than the seawater. Salinity levels increase with increasing distance from the river mouth, which is why the Casamance is often called an "inverse estuary" (Savenije & Pagès 1992, Saenger & Bellan 1995).

The Casamance has a tropical climate with a single rainy season from July to September. Annual rainfall is currently around 1100 mm, making it the wettest region within Senegal. Since the late 1960s, however, the amount of rain has decreased by roughly 400 mm and the rainy season has shortened from five to three months (Pagès *et al*. 1987, Marius & Lucas 1991). This decrease in precipitation has had major effects on the ecology of the area, such as rising salinity levels in the Casamance River and a decrease in mangrove cover (Saos *et al*. 1987, Marius & Lucas 1991). In addition, rice farming has become more difficult due to a decreased availability of fresh water, leading to higher salinity levels and the risk of soils turning acid (Bos *et al*. 2006).

3.2 Vegetation

Mangroves

Mangroves occur along the west coast of the African continent from Mauretania in the north to Angola in the south. West African mangrove forests cover approximately 1.5 million hectares, which is more than half of the total African mangrove area (Corcoran *et al*. 2007). The estuaries of the Sine Saloum and the Casamance contain the largest areas of mangrove in Senegal, with a total mangrove cover of around 1300 km^2 (Corcoran *et al*. 2007, Oyebade 2010).

Mangroves cover large parts of the study area west of Ziguinchor, in particular on the northern bank of the Casamance River where mangrove cover is higher than on the southern bank (Appendix 1). Near Ziguinchor, the band of mangroves on the north bank is about 4-6 km wide; further west, this increases to more than 20 km near Diouloulou. On the south bank, large

areas of mangroves are found at Carabane Island, the area south of Elinkine, and the area north of the Oussouye – Ziguinchor road. East of Ziguinchor, mangrove cover declines significantly (Debenay *et al*. 1989).

West African mangrove ecosystems are characterised by a relatively low botanical diversity, consisting mainly of the species *Rhizophora racemosa*, *Rhizophora mangle*, *Avicennia germinans*, *Laguncularia racemosa* and *Conocarpus erectus*. These species are distributed along a gradient of water depth, tidal fluctuation, salinity and soil conditions. *Rhizophora* occurs mainly at the outer edge in deeper water with significant intertidal fluctuations, whereas *Avicennia* is mostly found behind the *Rhizopohora* zone in drier, more saline conditions (see figures 3.1 – 3.4). *Laguncularia* grows higher in the intertidal zone, followed by *Conocarpus* in the most landward position where conditions are driest.

The mangroves in the Casamance are dominated by *Rhizophora racemosa* and *R. mangle* (red mangrove) and *Avicennia germinans* (black mangrove). *R. harrisonii* is also found, a species that is often regarded to be a hybrid between *racemosa* and *mangle*. The strip of mangroves bordering the Casamance River consists mainly of *R. racemosa*, whereas *R. mangle* is more dominant along shallower waters a little higher up the intertidal zone. Although *Rhizophora* can attain heights of 30 m, in the study area *R. racemosa* is usually well below 10 m high and *R. mangle* below 4 m. *Avicennia germinans* is dominant in the middle intertidal zone, where it can form pure stands that are usually low in height (<3 m). *Laguncularia* and *Conocarpus* occur throughout the area in low densities.

An important feature of the mangroves in the Casamance are the open mudflats or “tannes” (figures 3.3 and 3.4). These mudflats are generally bare, although salt-tolerant species such as *Sesuvium portulacastrum* and the grass *Paspalum vaginatum* are commonly found. The characteristic mosaic of mangroves and mudflats is shaped by a gradient in water level and salinity. In the low intertidal, salinity levels are mainly governed by the tidal fluctuations of the seawater. These conditions are suitable for *Rhizophora* and *Avicennia* mangroves. Higher up the gradient, inundation is rare and salinity levels can reach extremely high levels. These relatively arid and hypersaline conditions result in open flats that are largely void of vegetation. Salinity levels can rise even further during periods of drought when salt is accumulated in the soil and groundwater, and the expanse of bare flats in the Casamance has seen an increase since the 1970s due to decreasing rainfall and shortening of the rainy season (Pagès *et al*. 1987, Saos *et al*. 1987, Marius & Lucas 1991).

Woodland and scrub

The drier areas behind the mangrove zone and rice fields consist mainly of open woodland and degraded scrub habitats. The structure of these open woodlands is typical of the Guinea savanna zone of West Africa. The Guinea savanna is characterized by the coexistence of trees and grasses, the balance of which is principally governed by fire, moisture, nutrients and herbivory. In contrast to the drier Sudan savanna zone further north, rainfall is sufficiently high to support a closed tree cover. However, open grassy areas can be maintained by fire and grazing.

The tree layer reaches heights of 15 – 20 m and consists of species such as *Parinari excelsa*, *Dialium senegalense*, *Parinari macrophylla*, *Parkia biglobosa*, *Detarium senegalensis*, *Khaya senegalensis*, *Ceiba pentandra* etc.

Figure 3.1 Rhizophora racemosa trees bordering the water, clearly showing the typical stilt roots. Note the oysters that are attached to the roots, and the Western reef egret using the mangroves as a fishing post.

Figure 3.2 Dense mangrove forests on the north bank of the Casamance River north of Carabane Island.

Figure 3.3 Avicennia germinans shrubs bordering a mudflat or "tanne". These open mudflats are a characteristic feature of the mangroves in the Casamance.

Figure 3.4 A dried-out tanne, completely void of vegetation.

Artificial habitats
The Casamance is the main area for rice cultivation in Senegal, accounting for more than half the domestic rice production (Rigoulot 1979). The cultivation of rice takes place in the zone behind the mangroves, such as the area northwest of Ziguinchor. Average yields per hectare are low due to erratic rainfall and unfavourable soil conditions, most importantly the high salinity levels caused by salt water coming in from the estuary, or by capillary rise from deeper soil layers (Bos *et al*. 2006). In addition, when the waterlogged soils are drained, oxidation processes can lead to increased acidity of the soil (Bos *et al*. 2006).

The vegetation in urbanized areas is mostly degraded and mixed with cultivated species such as Mango trees (*Mangifera indica*). Conspicuous are the massive *Ceiba pentandra* trees that are found in towns and villages throughout the region. In Ziguinchor these trees are used as roosting and nesting trees by large numbers of cormorants, herons and ibises.

3.3 Mammals

Predators
The mangroves are home to African clawless otters (*Aonyx capensis*), a large species of otter that is widely distributed throughout Africa (Kingdon 1997). This species occurs in a variety of aquatic habitats in forest and savanna habitats, provided there is sufficient cover. They are mostly found in freshwater habitats, but also occur in estuaries and mangroves. The African clawless otter is not threatened and is listed as Least concern by the IUCN (2014).

During the baseline surveys, tracks of this species were found in the mangroves at Carabane Island. The size of the footprints and the absence of nails exclude the possibility of Spot-necked otter (*Lutra maculicollis*), a smaller species that is not known to occur in Senegal. No deposits of crushed crabshells or other food items were found during the baseline study, but these are difficult to find inside the dense mangrove habitat. The presence of African small-clawed otters in the Casamance is also shown by Pirotte (2007), who observed and photographed the species around Ile aux Oiseaux (Bird Island).

Marsh mongoose (*Atilax paludinosus*) were encountered on two occasions in the mangroves west and northwest of Ziguinchor, and footprints were found at several plots. This species is generally common and widespread in forested riparian habitats throughout sub-Saharan Africa (Estes 1991, Kingdon 1997). The multiple sightings and footprints encountered in a short timespan suggest that the Marsh mongoose is common in the area.

Several other species of small to medium-sized predators may occur in drier habitats in the study area, including African civet (*Civettictis civetta*), Egyptian mongoose (*Herpestes ichneumon*), Slender mongoose (*Herpestes sanguinea*), White-tailed mongoose (*Ichneumia albicauda*), Hausa genet (*Genetta thierryi*) and Common genet (*Genetta genetta*). None of these species was encountered during the baseline studies. However, many of these species are common and widely distributed throughout Africa.

Primates
Vervet monkeys (*Cercopithecus aethiops*) were encountered at Carabane Island. This widespread species probably occurs throughout the region in light wooded areas, dry scrub, mangroves and cultivated areas. Note that the Vervet monkeys in Senegal belong to the West African subspecies *sabaeus* (Green or Callithrix monkey) which is sometimes considered a full species, distinct from the Central and Eastern African (sub)species.

Open savannas in the wider area are used by Patas monkey (*Cercopithecus patas*), a terrestrial species typical of open grasslands of West and Central Africa. This species was not recorded during the baseline surveys but is reported to occur in the wider area by local people. The National Park of Basse Casamance is known to support populations of Campbell's monkeys (*Cercopithecus campbelli*) and Western red colobus (*Piliocolobus badius*). These species (especially the latter) are more tied to forest habitats and are not expected to occur in the study area.

Ungulates
No ungulates are found inside the mangroves, but the woodlands and thickets in the wider area may support species like Common duiker (*Sylvicapra grimmia*), Red-flanked duiker (*Cephalophus rufilatus*) and Bushbuck (*Tragelaphus scriptus*). None of these species was found during the baseline surveys. Red river hog (*Potamochoerus porcus*) is found inside moist forest in the National Park of Basse Casamance (see Vercammen *et al*. 1993) but this forest species is not expected to occur in the study area.

Other mammals
Several species of bats, rodents and other small mammals are likely to occur in the Casamance. The Straw-coloured fruit bat (*Eidolon helvum*) occurs widely in disturbed, urban areas throughout coastal West Africa, including Ziguinchor (Kock *et al*. 2002). This species is often found in very large and noisy colonies. Two fruit bats observed in Ziguinchor during the baseline studies probably referred to this species. However, no colonies of this species were observed in the area.

Species such as Scrub hare (*Lepus saxatilis*), Crested porcupine (*Hystrix cristata*) and various other (small) mammals are likely to occur in the wider area. However, these species are mostly found in open woodland habitats and less so (or not at all) in mangrove habitats. No information is available on the status or distribution of these species.

3.4 Birds

The mangroves provide valuable habitat to many bird species, and several studies have stressed the ornithological importance of West African coastal wetlands (e.g. Altenburg & Van Spanje 1989, Altenburg & Van der Kamp 1991, Bos *et al*. 2006, Zwarts *et al*. 2009). These birds include both resident species and migrants from Europe and other parts of Africa. The bird fauna in the mangroves of the Casamance is similar to other West African mangrove areas. During the baseline surveys, a total of 126 bird species were recorded in the mangroves and adjacent habitats (Appendix 4). Most mangrove birds are insectivores (sunbirds, warblers), fish-eating species (herons, kingfishers) and species that feed on macrobenthos such as crabs and other invertebrates (waders).

Mangroves and waterways
Birds use the mangroves as foraging habitat and for roosting. Similar to mangrove areas elsewhere in Africa, most bird species found in the mangroves of the Casamance have rather wide habitat preferences and are not restricted to mangrove habitat. No bird species in West Africa is exclusively mangrove-dependent (Nagelkerken *et al*. 2008), although mangroves are an important habitat for Brown sunbird (*Anthreptes gabonicus*). This species has a mainly coastal distribution, but also occurs in riverine thickets near fresh water.

The mangroves in the Casamance are mainly used by insectivores such as warblers and sunbirds, including high numbers of Beautiful sunbird, Senegal eremomela and European reed warbler. The latter species is a Palearctic migrant that breeds in Europe and spends the winter in West Africa. It was commonly recorded during the baseline surveys with 17 birds counted in 11 sampling plots, and singing individuals or the rasping alarm calls were heard on many occasions throughout the area. The high numbers recorded in the Casamance indicate that the area is an important wintering habitat for this species. Since the mangroves do not bear fruits that are edible to birds, seed- and fruit-eating birds are scarce and mainly occur at the inland side of the mangroves near other habitats (Altenburg & Van Spanje 1989).

The Casamance River and estuarine creeks (*bolongs*) are foraging habitat for a wide range of species, including aerial insectivores (swallows and bee-eaters) and a wide range of herons, cormorants, waders and terns that forage on fish or aquatic invertebrates. Twelve species of herons were observed during the baseline studies, including high numbers of Grey heron and Great white egret and smaller numbers of Purple and Goliath heron. Five species of terns were recorded along the Casamance River (Gull-billed, Royal, Caspian, Little and Sandwich tern). By far the commonest is Gull-billed tern, a species that feeds on *Uca tangeri* crabs. In addition to these species, the waterways are used by aerial insectivores such as swallows and bee-eaters that hawk insects over the water. Around Ziguinchor large numbers of Red-chested swallow forage over the river, joined by smaller numbers of Wire-tailed swallow.

Table 3.1 Numbers of birds counted during a river transect of 9.7 km length, along the main bolong north of Ziguinchor during high tide. Date: 09 March 2014, time: 16:45 – 18:12. Coordinates starting point: N 12.64350, W 16.26996; end point N 12.59745, W 16.26784.

Species	Number	Density per km river length
Pink-backed pelican	11	1,1
Great cormorant	6	0,6
Reed cormorant	24	2,5
Great white egret	16	1,6
Grey heron	4	0,4
Western reef egret	11	1,1
Yellow-billed stork	5	0,5
Sacred ibis	3	0,3
African spoonbill	3	0,3
African darter	8	0,8
Osprey	4	0,4
Grey plover	1	0,1
Whimbrel	14	1,4
Common redshank	21	2,2
Common greenshank	8	0,8
Curlew sandpiper	32	3,3
Royal tern	3	0,3
Caspian tern	2	0,2
Gull-billed tern	7	0,7
Pied kingfisher	13	1,3

During low tide, sandbanks in the Casamance River and the bolongs are used by waders, herons and other species for resting and foraging. West of Ziguinchor, many thousands of birds (mainly Common ringed plover and Curlew sandpiper, Greater flamingo, Whimbrel, Common

greenshank, Common redshank, Common sandpiper, Pied avocet, Bar-tailed godwit, Ruddy turnstone and Little tern) were observed on the large sandbank near Bird Island. The smaller muddy banks in the bolongs falling dry during low tide are used by various heron species (Grey heron, Great white egret, Western reef egret, Goliath heron), African darter, and waders (mainly Whimbrel, Common greenshank and Common redshank).

On the lower mudflats that are still regularly inundated, the soft mud provides excellent foraging habitat to waders and other birds. Western reef egret, Whimbrel, Common greenshank and Common redshank are commonly found on these mudflats. Other species that are regularly found are Pink-backed pelican, Yellow-billed stork, African spoonbill, Black-winged stilt and Curlew sandpiper. The tannes that have dried out are used by typical dry-country species such as Spur-winged plover, African wattled lapwing and Senegal thick-knee.

Woodland habitat

The open woodlands and scrub in the wider area are home to typical West African savanna species such as Western Grey Plantain-eater (very common in the area), Western Red-billed hornbill, Brown babbler, Yellow-billed shrike and several species of doves, starlings and seed-eaters. None of these species is currently listed as threatened and most of them are widely distributed throughout West Africa.

Urban areas

The town of Ziguinchor is home to commensal species as Hooded vulture, Yellow-billed kite, Common bulbul and Pied crow. Of ornithological importance are the massive *Ceiba pentandra* trees that are used as roosting and nesting trees by hundreds of Great cormorants, as well as Reed cormorants, Great white egrets and Sacred ibises. Over 40 colonies are known in the northern and western parts of Ziguinchor (Pirotte 2007; Appendix 3). The far majority of the roosting trees are *Ceibas*, although *Terminalia mantaly* (native to Madagascar), *Khaya senegalensis* and Baobabs (*Adansonia digitata*) are used as well. The locations of these trees are shown in Appendix 3.

The port area itself is of little use to birds. However, several *Ceiba pentandra* trees in the direct vicinity of the port area are used as roosting trees by cormorants and herons (Appendix 3). One roosting tree is located immediately next to the fuel tanks, but this tree contains no nests. The small mudflats east of the port and in front of the fuel import facilities are used by the usual herons and waders, whereas the jetty and other structures over the water are used as a roost by Red-chested and Wire-tailed swallows.

The mudflats in front of the fish port and fish market are used by small groups of Pink-backed pelican, Yellow-billed stork, Great and Reed cormorant, Western reef egret, Great white egret and larger numbers of Grey-headed gull, all of which are attracted to the fish discards.

Importance of the Casamance for migratory species

Of the 126 bird species recorded during the baseline surveys, around 25 species are migratory birds that breed in Europe and spend the winter in sub-Saharan Africa (see Appendix 4). Most of these migrant birds are various species of herons, waders, terns and passerines.

Particularly noteworthy are the high numbers of European reed warbler recorded during the baseline surveys. During the counts in the sample plots, a total of 17 birds were recorded in a total area of 1.25 ha, resulting in a density of roughly 14 birds/ha (including open mudflats). This is far higher than the density of 5.7 birds/ha in West African mangroves given by Altenburg & Van Spanje (1989), but only half of the density recently recorded in the Mansoa area in

Guinea-Bissau (Zwarts *et al*. in prep.). However, one should be careful to extrapolate the data from the study area as the proportion of mangrove cover and mudflats might not be representative of the entire Casamance.

Osprey was commonly recorded along the Casamance River and the bolongs. Although in Europe this species is mostly found in freshwater habitats, on their African wintering grounds they are often found in brackish and salt waters (Zwarts *et al*. 2009). During a river transect count (9,7 km) on the main bolong north of Ziguinchor, four Ospreys were counted (i.e. 0.4 birds per km river length).

As described above, large numbers of migrant waders make use of the sandbanks and mudflats in the Casamance River and bolongs. Whimbrel, Common greenshank and Common redshank are commonly found in the mangroves where they forage on open mudflats. The sandbanks that fall dry during low tide are used by these species plus large numbers of Common ringed plover and Curlew sandpiper, and smaller numbers of Kentish plover, Pied avocet, Bar-tailed godwit, Ruddy turnstone and Common sandpiper.

3.5 Other taxa

All three African species of crocodile occur or have occurred in Senegal (Thorbjarnarson 1992). The most widespread is the Nile crocodile (*Crocodylus niloticus*). This species was not observed during the baseline studies, but is known to occur in the mangroves of northwestern Guinea (pers. obs.). It is reported to occur in the Casamance by local fishermen, although in low densities. The Slender-snouted crocodile (*Crocodylus cataphractus*) used to be widely distributed throughout West Africa, but is probably extinct in Senegal (Shirley 2010). The third species, African dwarf crocodile (*Osteolaemus tetraspis*) might also be extinct or nearly extinct in Senegal (Eaton 2010). It is primarily a forest species and not likely to occur in the study area.

Except for the ubiquitous Common agama (*Agama agama*) and an unidentified snake, no terrestrial reptiles were observed during the baseline surveys. The following species are listed by Pirotte (2007) for the Casamance: Nile monitor (*Varanus niloticus*), African rock python (*Python sebae*), Black-necked spitting cobra (*Naja nigricollis*) and Green mamba (*Dendroaspis viridis*). The abundance of these species is unknown, although Nile monitor might be common (see Pirotte 2007). Green mamba is mostly a species of forests and woodlands and may not occur in the study area.

Amphibians are intolerant of saline conditions in the mangroves, but several species may occur in adjacent habitats. No information on amphibians in the study area is available.

3.6 Protected areas

Neither the Casamance River or any of the project sites is located within or adjacent to a protected area (see figure 1.2). The nearest protected area is the Basse Casamance National Park (50 km^2), which is located approximately 12 km southeast of Elinkin. The western part of this park is dominated by mangroves, with small patches of moist lowland forest and more extensive areas of secondary forests and savanna woodland in the central and eastern parts (Sournia & Dupuy 1990). The moist forests in the park are unique in Senegal and constitute the only remaining patch of tropical lowland forest in the country. This is reflected in the fauna of the park, which contains elements that are typical of the Upper Guinea rainforests such as Campbell's monkeys (*Cercopithecus campbelli*), Western red colobus (*Piliocolobus badius*), Yellow-backed duiker (*Cephalophus sylvicultor*) and Red river hog (*Potamochoerus porcus*).

These mammal species are not found in drier forests elsewhere in the Casamance. The national park is located at a distance of roughly 18 km from the nearest project site.

The Kalissaye Avifaunal reserve is a small reserve (16 ha) located north of the Casamance River on the shores of the Atlantic Ocean, approximately 15 km northwest of Carabane Island (figure 1.2). The reserve consists of three small islands (Iles de Kalissaye) and coastal dunes, shrub savanna and mangroves on the mainland. It is designated as an Important Bird Area (IBA) by BirdLife International, and harbours important breeding colonies of Royal and Caspian terns. Other animals reported to occur are Nile crocodile, West African manatee and various turtle species (MEPN 1997). Another reserve, the Kassel Reserve (90 ha) is located further north, roughly 5 km from Kafountine and over 30 km from the nearest project site.

Numerous Classified Forests (*forêts classées*) are located in the entire Casamance Region. These forests are managed mainly for timber production, soil protection or the conservation of particular vegetation types. Much of the area south of Ziguinchor is designated as Classified Forest (e.g. Forêt Classée de Djibélor, FC des Bayotes). In the Carabane Island area, the nearest Classified Forests are located south of Diembering and southeast of Kagnout (Forêts Classées de Guinom, Kaem, Diatem and Oukout). There are no Classified Forests within 3 km of any of the project sites.

4 Impact assessment

Based on the project activities (chapter 2) and results of the baseline study (chapter 3), in this chapter the potential ecological impacts of the port development in Ziguinchor and dredging activities in the Casamance River are discussed.

4.1 Introduction

The effects of the dredging activities and renovation works on the terrestrial environment can be manifold, and include direct effects (e.g. disturbance or habitat loss) and indirect effects such as changes in the abiotic environment or external pressure on protected areas.

An overview of the potential impacts of the various project activities is given in table 4.1. These impacts are often not clearly separable, as e.g. habitat loss can have immediate impacts on local biodiversity. In addition, some impacts may be only relevant during the operational phase, whereas others may be longer-lasting. In the sections below the different impacts will be discussed in more detail for each of the project components.

Table 4.1 Possible impacts on the terrestrial environment.

Aspect	**Potential impacts**
Habitat modification	Destruction (habitat loss) Degradation Fragmentation Damage to 'critical habitats' (see IFC Performance Standard 6)
Direct impacts on flora and fauna	Disturbance from noise, light and movements Accidental killing
Biodiversity	Reduction in species richness Changes in species composition Effects on 'key species', i.e. species that are threatened, endemic or have a limited geographic range
Changes in the abiotic environment	Turbidity Sedimentation Pollution
Protected areas	Area loss Disturbance External effects Human presence

4.2 Commercial port

The potential impacts of the construction and renovation activities at the port of Ziguinchor are limited to disturbance due to increased noise levels and the movement of people and machinery. The port area itself has an ecological value of nearly nil due to the near-absence of plants and animals. Ubiquitous commensal species like Yellow-billed kite and Pied crow are well-adapted to dynamic urban environments and will not be affected by the activities.

The most important ecological values around the port area are a number of roosting trees of herons and cormorants, and a small area of mudflats in the Casamance River. Several roosting trees are situated in the direct vicinity of the port area (Appendix 3). The renovation of the fuel import facility, including the replacement of the two old fuel tanks by four new ones, may result in disturbance or loss of the roosting tree that is situated right next to the existing tanks. This roost is small and does not contain any nests. Most of the important roosting trees are located further west and outside the disturbance zone of the port.

The small mudflat (<0.1 ha) in front of the fuel import facility is used by various waders and egrets, and swallows roost on the structures over the water (see previous chapter). These birds are likely to be disturbed by the renovation activities. However, numbers are small and there are ample alternative sites in the direct vicinity.

Every day, many hundreds of cormorants, herons and other birds fly over the port area in the morning and evening when travelling between their roosts in Ziguinchor and their foraging areas in the surrounding mangroves. These birds do not seem to be disturbed by the high levels of noise emission and the multitude of activities currently going on in the port area. Flight patterns are therefore not likely to be disturbed by the renovation activities.

Summarizing, because of the low ecological value and the current high level of disturbance that is characteristic of the port area, the additional disturbance as a result of the renovation activities is expected to be small. Although one roosting tree and the small mudflats near the fuel import facilities will probably be disturbed or lost, many alternative sites are available. The ecological impact is considered to be minor.

4.3 Fishing port

Land reclamation at the fishing port to construct a small quay will lead to the loss of a large part of the mudflat in front of the fish market (east of the existing jetty). This mudflat is now used by various birds that are attracted to the fish discards, such as Grey-headed gull, Pink-backed pelican, Yellow-billed stork, Great and Reed cormorant, Western reef egret and Great white egret (figure 4.1). All of these species are common and widely distributed in the area around Ziguinchor and the wider Casamance. Although the project will involve some minor habitat loss (<0.5 ha of mudflat), the impact on these species is probably negligible.

Disturbance during the renovation works might scare the birds away to other areas in the vicinity. Because of the availability of food, the bolder species will probably continue to use the area around the fish market, waiting for an easy meal. Overall, the ecological impact of the renovation works is considered to be minor.

4.4 Dredging

The negative effects of dredging on the marine environment have been described numerous times (e.g. Mestres *et al*. 2013). These impacts include changes in the physical environment (e.g. local bathymetry and sediment concentrations), chemical environment (e.g. sediment composition) and biological environment (e.g. composition of benthic communities). Less clear are the effects of dredging on the terrestrial environment. Such impacts may include disturbance of bankside flora and fauna, loss of habitat, and impacts due to the disposal of the spoil onto land. The various potential impacts are described in more detail below.

Figure 4.1 The mudflats in front of the fish market are used by various birds waiting for an easy meal. Shown here are Grey-headed gulls, Pink-backed pelicans, Great white egret and Yellow-billed stork.

Disturbance

The dredging works may result in disturbance of animals because of noise and light emission, movements and the presence of people. These disturbances often occur simultaneously and the effects may be impossible to separate in the field. Within the scope of the project, disturbance is mainly relevant to mangrove fauna (birds, mammals) and birds making use of the sandbanks and mudflats. During the European winter, migratory species such as various terns and waders forage and rest on the sandbanks that fall dry during low tide. Large sandbanks such as near Bird Island can accommodate thousands of birds, including large numbers of Curlew sandpiper, Common ringed plover, Whimbrel, Common greenshank, Common redshank and other species (see chapter 3). Disturbance of these birds can result in higher flight activity and energy expenditures, decreased foraging times, and even abandonment of these areas when disturbed frequently (Krijgsveld *et al*. 2008, Agness *et al*. 2013, Wymenga & Zwarts 2013). Evidently, disturbance of migratory species is not relevant during the European summer months, although local species (like some of the herons) are still present in this period.

The effects of disturbance due to noise, light, movements and the presence of people are limited to the area directly surrounding the dredging activities. The distance within which effects may occur depends on the level of noise and light emission at the source, the season, and the species concerned. Several studies have demonstrated that increased noise levels can lead to decreased densities of breeding birds, where disturbance usually takes place at noise levels higher than 40 – 50 dB(A) (Reijnen 1995, Garniel *et al*. 2007). However, the effects of noise disturbance are highly species-specific and vary according to the duration and frequency of disturbance, the habitat, season etc. Foraging waders are generally rather sensitive to disturbance and may take flight if the source of disturbance is within 100 – 200 meters (Krijgsveld *et al*. 2008). Diettrich & Koepff (1986) suggest a threshold distance of 500 m to avoid disturbance around high tide roosts. In this impact assessment a worst-case threshold distance of 500 m is used, meaning that no significant disturbance is expected beyond this distance.

By far the most extensive dredging works are carried out at the offshore site. Dredging at this site will take several months. Because of the distance from the land (>3 km), disturbance of terrestrial wildlife due to noise or movements can be ruled out.

The dredging works at the Carabane Island jetty are located at roughly 450 m from the nearest mangroves. The level of disturbance at this distance is considered to be minimal. The important sandbanks northeast of the island are all located at distances >500 m from the jetty. The dredging works in the Casamance River upstream of Carabane Island are located over 1000 m from the river banks or the nearest sandbank. Disturbance of terrestrial wildlife is not expected.

The dredging area at the port of Ziguinchor is located over 600 m from the nearest mangroves on the north bank, and roughly 450–500 m from a large mudflat that is exposed during low tide. This mudflat is used by herons and waders for foraging and resting. At this distance the level of disturbance from noise emission and ship movements is expected to be minimal. In addition, the activities are temporary (2 weeks) and the port area is also in the current situation heavily disturbed by ship movements and port activities. Given the short time frame and the current levels of disturbance around the port area, additional disturbance as a result of the dredging activities is likely to be minor.

Habitat loss

The dredging activities in the port area and Casamance River will not cause any direct loss of mangrove area, unless the dredged spoil is disposed onto land in mangrove areas. The potential impacts of onshore disposal will be discussed in the following section. Apart from this aspect, negative effects due to habitat loss can be ruled out.

Disposal of dredging material

In mangrove areas, the handling and management of the dredged material can have greater impacts than the dredging activities itself (Ohimain *et al*. 2010). The dredged material from the offshore site and near Carabane Island will be disposed offshore, over 25 nautical miles from the river mouth. The material should be disposed in an area where wave motion will not affect the sea bed and ocean currents are limited. This will ensure minimal spreading of the disposed material and minimal effects on the environment such as increases in turbidity levels (de Heer & de Jong 2013). Ecological impacts of offshore disposal on the terrestrial environment are not expected.

Offshore disposal is not feasible for the dredged sediments from the port area. This material is likely to be disposed in a deep section of the Casamance River. The exact location and duration of the disposal works are unknown, but given the small dredging volume, the duration is likely to be short. Impacts on the terrestrial environment due to disturbance are considered to be minor.

In case onshore disposal is considered, substantial negative ecological effects may arise, in particular when the dredged material is disposed into mangrove habitat. These effects include direct damage to the vegetation, smothering of the aerial roots of *Avicennia*, burial of mangrove seedlings, alteration of the topography and hydrology of the river bank, and acidification of the soil (Ohimain 2004, Corcoran *et al*. 2007). Accumulation of dredged material on the river bank will increase the height of the river bank, making it less prone to inundation. These changes in topography and hydrology make the river bank less suitable for mangroves and increase the risk of colonization by non-mangrove vegetation (Ohimain 2004). Onshore disposal or use of the dredged spoil as beach nourishment can also affect the chemical soil properties. When

mangrove soils are exposed to the air, oxidation of the pyrites in the soil can result in acidification due to the formation of sulphuric acid.

Summarizing, as long as the dredged materials are not disposed onto land, major impacts on the terrestrial environment are not likely. Offshore disposal is not expected to result in any impacts on the terrestrial ecosystem.

Sedimentation

Sedimentation is a natural process in mangrove habitats, and the roots of *Rhizophora* trees are known to slow down water velocity and promote sedimentation (Ellison 1999). Natural sedimentation rates in mangrove forests are roughly 0.5 to 1 cm per year (Ellison 1999). However, the deposition of sediment in mangrove areas may lead to degradation of the mangroves if a) sedimentation rates due to dredging (or the deposition of dredging material) exceed natural sedimentation rates, and b) if the aerial root systems of *Avicennia* get buried (Ellison 1999). The natural sedimentation rate at the port of Ziguinchor is estimated at roughly 5 cm per year (de Heer & de Jong 2013).

The effects of sediment accretion on the survival of *Rhizophora* and *Avicennia* seedlings were studied by Thampanya *et al*. (2002). Because of the length of the aerial roots, *Rhizophora* trees are less sensitive to sediment accretion than *Avicennia*. The pneumatophores of *Avicennia* are generally short (< 30 cm) and burial will result in death of the tree (Ellison 1999).

The effects of the dredging operations on sand transport rates and bed level changes are assessed using simulation models (de Heer & de Jong 2013). Sediment transport in the dredging areas is driven by tidal currents and wave action. In the offshore dredging area, the waves will redistribute the sand at the submerged bars around the navigation channel. Dredging will also affect sedimentation patterns in this area, but these impacts are probably small compared to the dynamics from natural geomorphological processes (waves, tidal forces). There are no impacts on terrestrial ecosystems. At the dredging site near Carabane Island, the dredging activities do not significantly alter current patterns in water velocity. Thus, any changes in sedimentation or infill rates are expected to be small (in the order of a few centimeters) and within the range of natural sedimentation processes.

The largest relative impact on current velocity is expected at the commercial port of Ziguinchor. At this site the dredging activities reduce the current velocity by 25% in the area directly around the quay. The impacts are limited to an area within c. 50 m of the quay wall. No impacts are expected on nearby sandbars or the mangrove-covered north bank.

Summarizing, the modeling study indicates that sand accumulation and bed level changes as a result of dredging are very localised and restricted to the dredging areas. Any changes in sedimentation rates in the mangrove areas are within the range of natural sedimentation rates. The impacts are thus considered to be negligible.

Water turbidity

Related to the sedimentation rates described above, the dredging activities will lead to a temporary increase in suspended sediment loads in the water column (turbidity). Generally, turbidity levels in the direct vicinity of the dredging site (near- and mid field effects) rise sharply, but the larger particles settle down quickly. The finer particles may stay suspended in the water column for some time, forming a sediment plume that can be transported away from the dredging site by water currents.

Increased water turbidity levels primarily affect the marine environment, leading to e.g. decreased primary production of phytoplankton and aquatic plants, and decreased visibility for a number of predatory species (e.g. Hao 2008, Erftemeijer *et al*. 2012). Potential impacts on the terrestrial environment are reduced visibility for fish-eating predators such as cormorants and terns, leading to reduced foraging success. For example, research in Guinea-Bissau showed that food intake rates of terns decreased with increasing water turbidity (Brenninkmeijer *et al*. 2002). Turbidity is likely to become a limiting factor only when the diving depths of these birds exceed water clarity levels (Arts & Meininger 1995). The African clawless otter hunts by mostly by touch and is considered to be rather tolerant of increased water turbidity (Somers *et al*. 1996).

In general the suspended sediment concentration in the estuary is not very high, ranging from 20 to 100 mg/l, depending on the location (the lowest values are most upstream) and moment within the tidal cycle (de Heer & de Jong 2013). Because of the small spatial scale and fast settlement of the larger particles, near-field effects (<200 m) will have no impact on the terrestrial environment. The concentration of fine particles in the water column may increase in a wider area. However, these particles will mostly settle down quickly when the dredging activities stop, so increased turbidity levels are largely limited to the dredging period. The concentrations of fine particles are expected to fall within the natural range of variation caused by waves and tidal movements. No negative impacts on the terrestrial environment, such as the foraging success of cormorants, terns or otters, are expected. Since there are no industrial activities close to the dredging sites, there is no risk of spreading contaminated sediment by the dredging works.

4.5 Long term impacts: increased boat traffic

The aim of the project is to facilitate increased boat traffic and the capacity for larger vessels to dock at the port of Ziguinchor. Current traffic flows are one vessel movement per day (i.e. the Dakar - Ziguinchor ferry), which is foreseen to increase to around three vessel movements per day.

Increased boat traffic can lead to disturbance of the mangroves and birds on sandbanks due to noise and visual disturbance. Frequent disturbance can impose energetic costs due to higher flight activity, or decreased use of valuable nesting or foraging habitat (e.g. Agness *et al*. 2013). Disturbance levels will depend on various factors, including the species concerned, season, the spatial dimensions of the sandbank, the frequency of vessel movements, vessel speed and proximity (e.g. Agness *et al*. 2013). Generally, large and slow-moving vessels result in less disturbance because the movements are more predictable. In addition, the larger vessels are confined to the fairway in the deepest part of the river, away from the riverbanks and sandbanks. Flush distances of waders reacting to water-based disturbance are usually 100 – 200 m, although some authors suggest higher threshold distances of 500 m (Diettrich & Koepff 1986, Rodgers & Schwikert 2002, Krijgsveld *et al*. 2008). As described before, in this impact assessment a worst-case threshold distance of 500 m is used.

Because of the depth requirements for boat traffic, the fairway in the Casamance River runs mostly away from the riverbanks or the sandbanks (see figure 16 in de Heer & de Jong 2013). River sections where the fairway is located rather close to the banks or sandbanks are the area north and east of Pointe St George (at km 20 and 30), at km 45, and the section close to Bird Island (between km 55 and 65). In particular the latter section is used during low tide by large numbers of wading birds (e.g. Greater flamingo, Common ringed plover, Curlew sandpiper,

Whimbrel, Common greenshank and Common redshank). The width of the navigable part of the river here measures no more than 450 – 500 m, meaning the vessels sail within a few hundred meters of the sandbank. Disturbance levels at this distance are likely to be small. Because of the width of the sandbank (>500 m) sufficient undisturbed foraging and resting areas will remain.

Although there will be a threefold increase in (large) vessel movements, traffic flows in the Casamance River after the dredging works will still be very low. Because of the position of the fairway in the deepest parts of the river, the sandbanks and mangroves in most areas will not be subjected to increased disturbance levels. Vessel movements during low tide may result in some disturbance in a few areas, especially the sandbanks near Bird Island. However, this disturbance is likely to be minimal compared to the disturbance caused by the frequent movements of small fishing boats (which are able to sail in shallower water close to the sandbank). The overall effect of disturbance due to increased vessel movements is considered to be minor.

Besides disturbance due to noise, light or movements, increased boat traffic can also lead to increased wave heights and rates of sedimentation transport and erosion, which may hamper mangrove seedling establishment (Balke *et al*. 2013). In the port area, vessels use their propeller with high power to manoeuvre close to the quay walls, resulting in erosion or resuspension of fine sediments (de Heer & de Jong 2013). A large sand bank is situated roughly 500 m to the north; because of this distance, any effects due to erosion or sediment accretion are likely to be small and within the range of natural sedimentation rates.

4.6 Risk of oil spills

Increased maritime traffic and industrial activities in Ziguinchor or the wider Casamance may increase the risk of accidental oil discharge into the ecosystem. Mangroves are vulnerable to oil spills because of their location at the water's edge, where oil is deposited by waves or tidal action. Here it can accumulate in roots and sediment (Duke *et al*. 1997, Santos *et al*. 2010).

Numerous studies have examined the effects of oil spills in mangrove ecosystems (e.g. Duke *et al*. 1997, Proffitt 1997, Lewis *et al*. 2011, Maia Santos *et al*. 2012). The impacts depend on many factors including the amount and type of oil that is spilled, the location, position in the intertidal zone, and exposure to waves and currents. Generally, highly refined oils tend to be more toxic than heavy oils but also contain more volatile compounds (e.g. naphtha, benzene) that evaporate quickly (Snedaker *et al*. 1997).

Oil spills can have serious effects on mangrove ecosystems. First, individual mangrove trees can be killed when the aerial roots get covered by oil, preventing the roots from exchanging oxygen. Mortality rates depend on the species and the extent to which the plants are covered by oil. Seedlings of *Rhizophora racemosa* and *R. mangle* have been reported to be relatively tolerant to oiling as long as less than a third or half of the plants get covered by oil (Touchette *et al*. 1992). Mortality rates are generally higher in *Avicennia* and *Laguncularia*.

Second, toxic fractions of the oil may penetrate the soil, causing long-term oil exposure to the mangroves (Touchette *et al*. 1992). This oil can damage cell membranes in the roots (IPIECA 1993). The effects of toxicity will gradually decrease in time because of dilution with rainwater or seawater, evaporation of the volatile compounds, and chemical changes ('weathering') that make the oil less toxic (IPIECA 1993). However, oil contaminants may still persist for several

decades in mangrove sediments (Duke *et al*. 1997). Mangrove stands are capable of recovery from oil spills, although this process may take 5–20 years (Burns *et al*. 1993). Recovery rates are generally higher in the fringe zone (bordering the water) where the mangroves and soils are washed daily by the tidal flow (Melville *et al*. 2009, Maia Santos *et al*. 2012).

Besides impacts on the mangrove flora, oil can affect associated animal species like crabs and various other benthic invertebrates. This will in turn also affect animals higher up the foodchain. Animals inhabiting the lower intertidal zone may recover relatively quickly if the oil residue is washed away by waves and tidal action (Melville *et al*. 2009).

Summarizing, oil spills can have potentially serious and long-lasting impacts on mangrove ecosystems. The magnitude and the spatial scale of impact depend on the amount and type of oil that is spilled. Industrial activities in the Casamance are mostly limited to Ziguinchor, and it is in this city where the risk of fuels leaking into the Casamance River is highest. Some of the small petrol stations for the fishing boats are located right next to the Casamance River and some fuel leakage is not unlikely, although the amounts will probably be small. Larger amounts of kerosene, petrol and heavy fuels will be stored at four new reservoirs at the commercial port, and handling these fuels may bring a risk of more substantial discharges into the environment. Any oil leaking into the river can be distributed quickly over a wider area due to tidal action. The impact is rated as moderate to major, depending on the amount of oil and the spatial scale over which the oil is distributed.

4.7 Summary of effects

Overall, the impacts of the various project activities on the terrestrial environment are considered to be negligible or of minor significance. Moderate or major impacts can be ruled out under normal circumstances, although oil spills could have major negative impacts on the ecosystem. An overview of the potential impacts for all project activities is given in table 4.1.

Table 4.1 Summary of impacts on the terrestrial environment.

	Potential impacts on terrestrial ecology			
Project activity	**Offshore site**	**Carabane Island**	**Commercial port**	**Fishing port**
Port renovation				
Disturbance	Negligible	Negligible	Minor	Negligible
Habitat loss	Negligible	Negligible	Minor	Negligible
Fishing port renovation				
Disturbance	Negligible	Negligible	Negligible	Minor
Habitat loss	Negligible	Negligible	Negligible	Minor
Dredging				
Disturbance	Negligible	Minor	Negligible	Negligible
Habitat loss	Negligible	Negligible	Negligible	Negligible
Disposal of spoil	Negligible	Negligible	Minor	Negligible
Sedimentation	Negligible	Negligible	Negligible	Negligible
Water turbidity	Negligible	Negligible	Negligible	Negligible
Increased boat traffic				
Disturbance	Minor (mainly near Bird Island)			
Sedimentation	Negligible			
Calamities				
Oil spills	Moderate to major (depending on scale)			

5 Conclusions

Under normal circumstances, the various project activities that are needed to facilitate maritime transport in and out of the Casamance do not result in substantial impacts on the terrestrial environment. Although the project will involve some minor disturbance and loss of a few small mudflats, these effects are very small and localised. However, the impact of accidental fuel discharge into the environment can be substantial.

Effects on protected areas
The project areas are not located in the direct vicinity of protected areas. Because of the distance to the Basse Casamance National Park (18 km), the Kalissaye Avifaunal Reserve (15 km) and the Kassel Reserve (>30 km), any negative impacts on these protected areas can be ruled out. The fishing port and commercial port of Ziguinchor are located within several kilometers of Classified Forests. These forests are not sensitive to disturbance, and because of the distance (>3 km) any negative effects resulting from the project activities can be ruled out.

Effects of dredging
Although the dredging activities can cause some disturbance, most dredging works are carried out at the offshore site where terrestrial impacts can be ruled out. The dredging works near Carabane Island and at the port of Ziguinchor are small-scale and do not lead to significant disturbance of the mangroves or roosting birds on the sandbanks. Under the condition that the dredged spoil is not disposed onto land in sensitive mangrove areas, impacts on the terrestrial environment are considered to be minor.

Effects from renovation works at the commercial port
Both the commercial port and the fishing port are heavily disturbed areas, and the renovation works do not lead to significant additional disturbance. The port area itself has an ecological value of nearly nil due to the near-absence of plants and animals. In the surrounding area, one roosting tree and the small mudflats near the fuel import facilities will probably be disturbed or lost due to the project activities. However, many alternative sites are available and the impact is considered to be minor.

Effects from construction works at the fishing port
The land reclamation area at the fishing port will result in some minor habitat loss of a mudflat, which is now being used by gulls, egrets and pelicans that scavenge for fish discards. In addition, disturbance during the renovation works might scare the birds away to other areas in the vicinity. All of these species are widely distributed throughout the area and the impact is considered to be minor.

Effects from increased boat traffic
The aim of the project is to facilitate increased boat traffic and the capacity for larger vessels to dock at the port of Ziguinchor. Increased boat traffic can lead to disturbance of the mangroves and birds on sandbanks due to noise and visual disturbance. Because of the position of the fairway in the deepest parts of the river, the sandbanks and mangroves in most areas will not be subjected to increased disturbance levels. However, vessel movements during low tide may result in some disturbance in a few areas, especially the sandbanks near Bird Island. This disturbance is likely to be minimal compared to the disturbance caused by the frequent movements of small fishing boats. The overall effect of disturbance due to increased vessel movements is considered to be minor.

Effects of oil spills

Accidental discharge of fuels into the Casamance Estuary can have substantial effects on the environment, including mortality of the mangroves and contamination of the sediment. The magnitude of impact depends primarily on the amount and type of oil that is spilled. Any accidental oil discharge is most likely to occur in Ziguinchor, for exampe at the new fuel storage tanks near the commercial port. Oil leaking into the Casamance River can be distributed quickly over a wider area due to currents and tidal action. Because of the potentially serious effects on the environment, the impact is rated as moderate to major, depending on the amount of oil and the spatial scale over which the oil is distributed.

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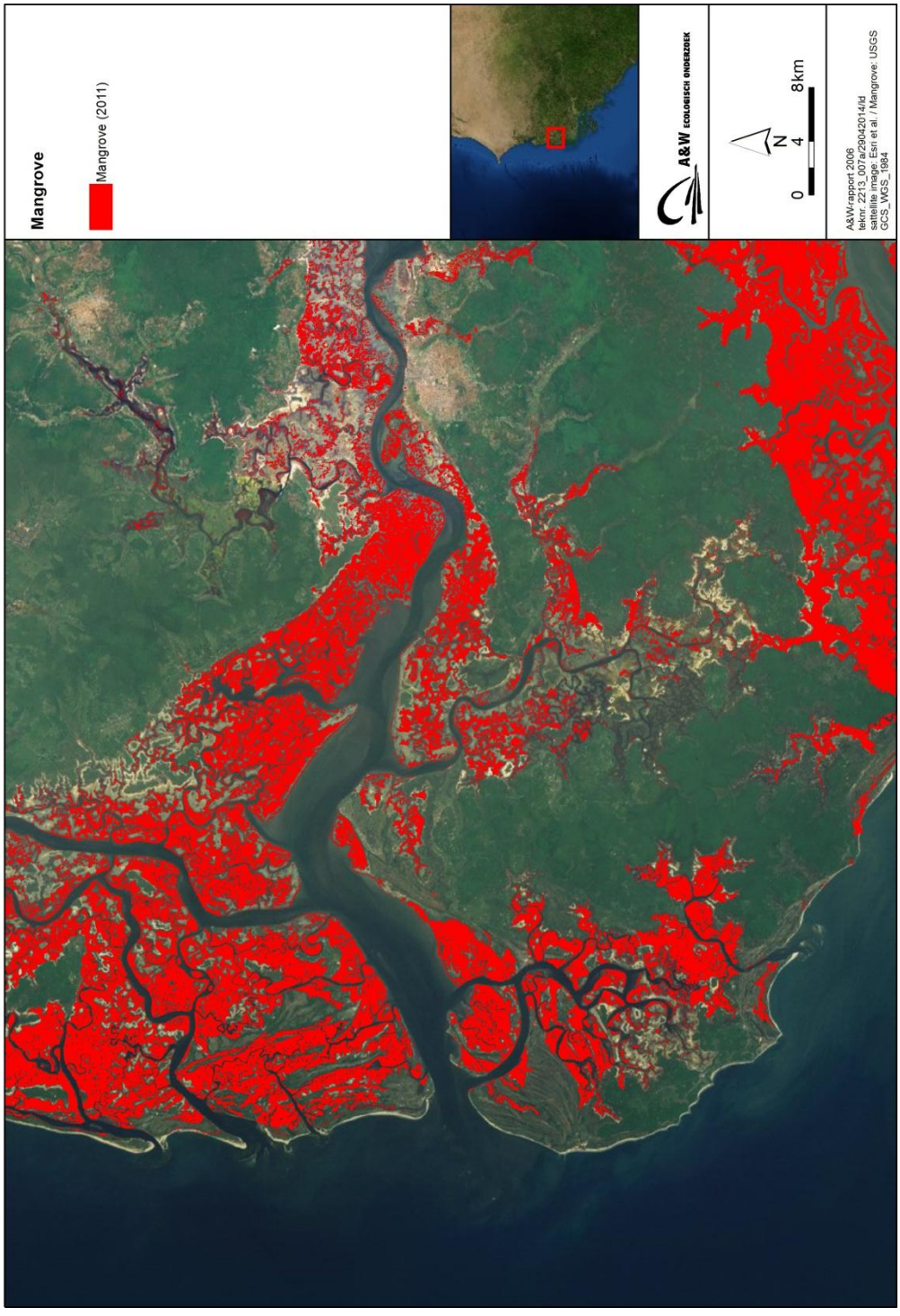
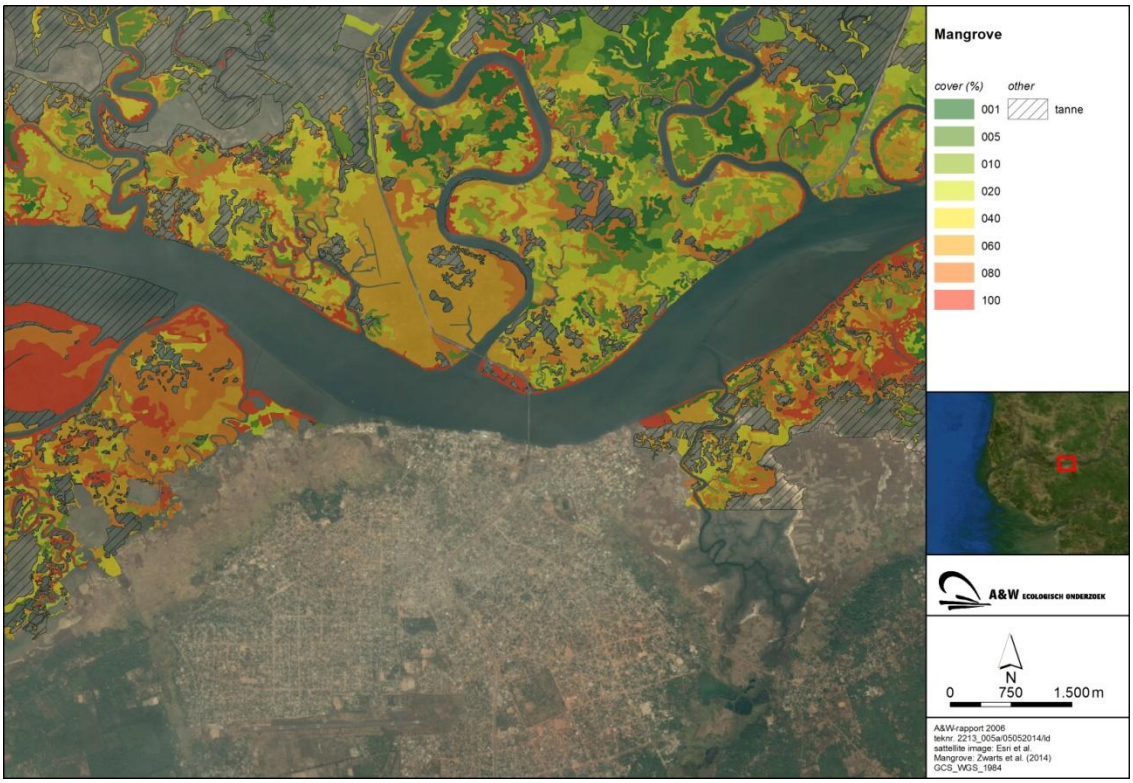
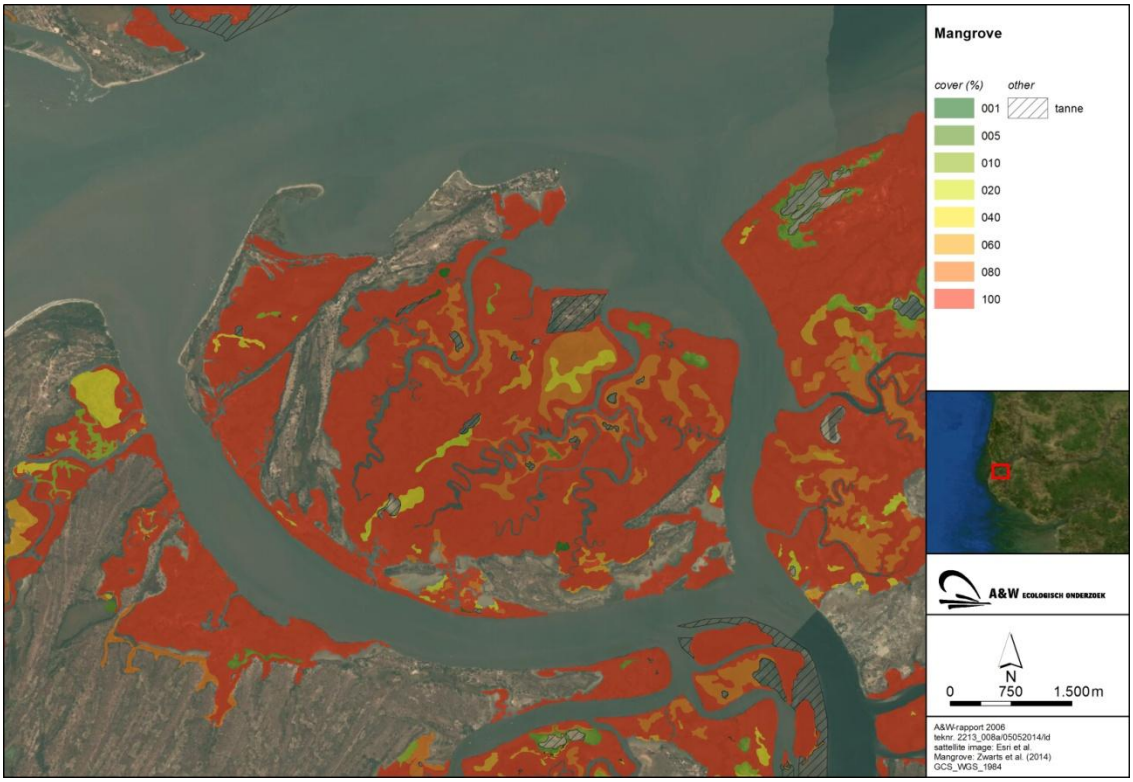
Appendix 1 Mangrove cover

The following maps show the distribution and cover of mangroves in the Casamance, from the river mouth in the west to the city of Ziguinchor in the east. Data on mangrove cover are based on remote sensing data from UNEP-WCMC (http://data.unep-wcmc.org/datasets/21). Details on the background and analysis of these data are given by Giri et al. (2011).





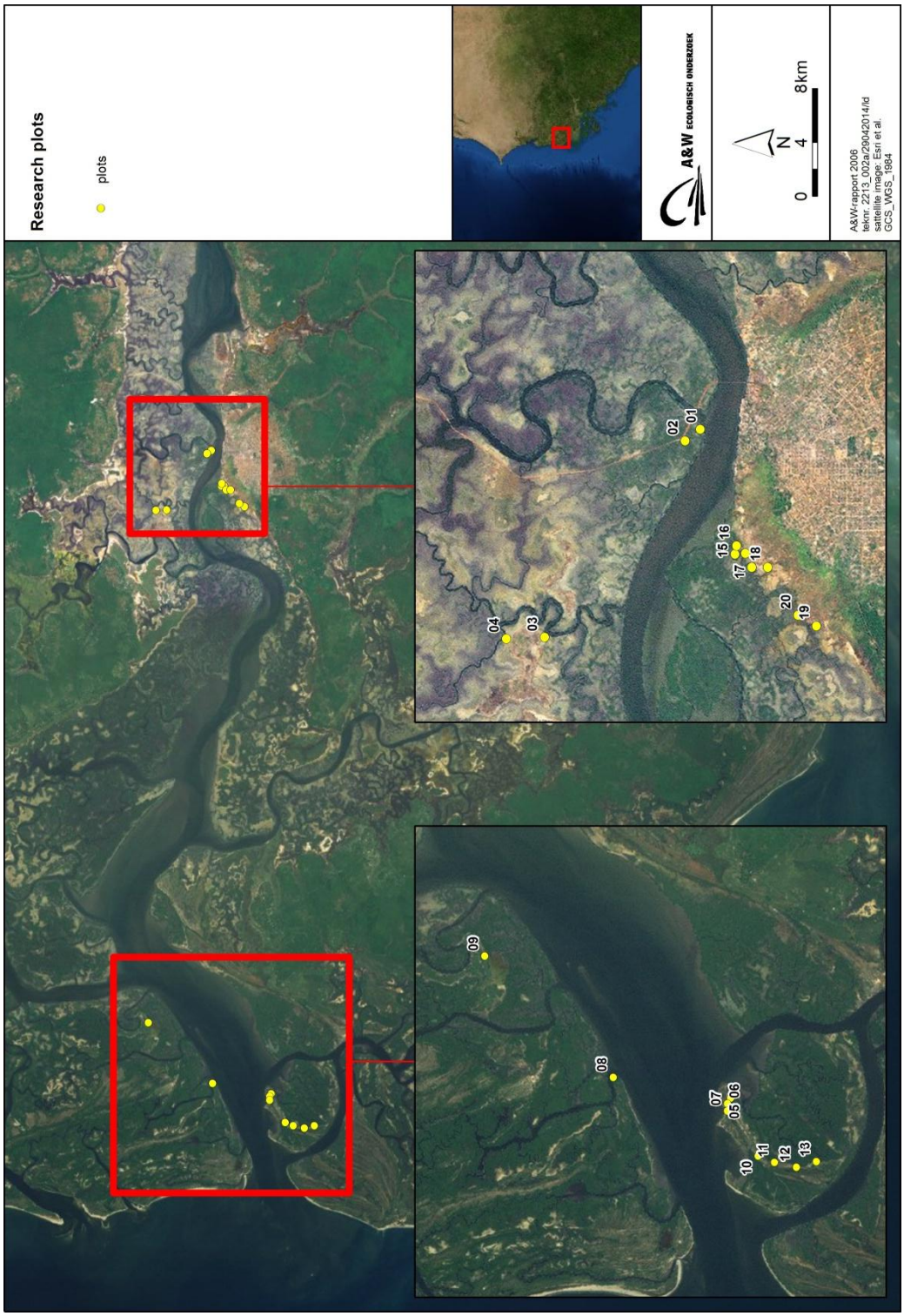
Mangrove cover around Ziguinchor.



Mangrove cover at Carabane Island.

Appendix 2 Research plots

The vegetation and animals of the area were studied using plot counts. In total 20 sample plots were distributed over the area around Ziguinchor and Carabane Island.



Appendix 3 Roosting trees Ziguinchor

The city of Ziguinchor is home to over 50 roosting trees (mostly Ceiba pentandra) that are used by large numbers of cormorants, herons and ibises.

Appendix 4 Status of birds in the study area

The table below lists all species recorded during the baseline surveys in March 2014. For each species the status and main habitat are given.

No.	Species	Status
1	Double-spurred Francolin (Francolinus bicalcaratus)	A few recorded in dry areas
2	Greater Flamingo (Phoenicopterus roseus)	>300 recorded on sand bank near Ile aux Oiseaux
3	Yellow-billed Stork (Mycteria ibis)	Fairly common in mangroves throughout
4	Great Cormorant (Phalacrocorax carbo)	Large numbers roosting in Ziguinchor
5	Long-tailed Cormorant (Phalacrocorax africanus)	Common on waterways throughout
6	African Darter (Anhinga rufa)	Low numbers along waterways throughout
7	Great White Pelican (Pelecanus onocrotalus)	A single bird flying over Casamance River on 16/3
8	Pink-backed Pelican (Pelecanus rufescens)	Small groups on various waterways
9	Hamerkop (Scopus umbretta)	Low numbers throughout
10	Gray Heron (Ardea cinerea)	Very common along waterways
11	Black-headed Heron (Ardea melanocephala)	Low numbers in dry areas
12	Goliath Heron (Ardea goliath)	Low numbers along major waterways
13	Purple Heron (Ardea purpurea)	One bird recorded
14	Great Egret (Ardea alba)	Very common
15	Little Egret (Egretta garzetta)	Low numbers
16	Western Reef-Heron (Egretta gularis)	Abundant in mangroves and on mudflats
17	Black Heron (Egretta ardesiaca)	A single bird at small pool in Ziguinchor, 16/3
18	Cattle Egret (Bubulcus ibis)	Low numbers on fields and around humans
19	Squacco Heron (Ardeola ralloides)	Low numbers
20	Striated Heron (Butorides striata)	Low numbers in mangroves
21	Black-crowned Night-Heron (Nycticorax nycticorax)	A single bird flying over Casamance River on 06/3
22	Sacred Ibis (Threskiornis aethiopicus)	Fairly common, roosting in Ziguinchor
23	African Spoonbill (Platalea alba)	Low numbers in mangroves
24	Osprey (Pandion haliaetus)	Fairly common along major waterways
25	Black Kite (Milvus migrans)	Abundant in towns
26	Palm-nut Vulture (Gypohierax angolensis)	Fairly common along waterways
27	Hooded Vulture (Necrosyrtes monachus)	Common in towns
28	Eurasian Marsh-Harrier (Circus aeruginosus)	Uncommon Palearctic migrant, open areas
29	Pallid Harrier (Circus macrourus)	A male over Carabane Island, 13/3
30	African Harrier-Hawk (Polyboroides typus)	Low numbers flying over Casamance River
31	African Hawk-Eagle (Aquila spilogaster)	One flying over Carabane Island, 13/3
32	Gray Kestrel (Falco ardosiaceus)	A few recorded in open woodland
33	Peregrine Falcon (Falco peregrinus)	A single bird flying over Casamance River, 14/3
34	Senegal Thick-knee (Burhinus senegalensis)	Two birds at dry tanne west of Ziguinchor, 08/3
35	Spur-winged Plover (Vanellus spinosus)	Fairly common on tannes and dry fields
36	Wattled Lapwing (Vanellus senegallus)	Low numbers on tannes and fields
37	Black-bellied Plover (Pluvialis squatarola)	Fairly common on mudflats and sandbanks
38	Kentish Plover (Charadrius alexandrinus)	A single bird on sandy flat, Carabane Island
39	Common Ringed Plover (Charadrius hiaticula)	Common on sandbanks and tannes
40	Eurasian Oystercatcher (Haematopus ostralegus)	A single bird on sandbank near Carabane Island
41	Black-winged Stilt (Himantopus himantopus)	Low numbers in mangroves
42	Pied Avocet (Recurvirostra avosetta)	A few on sandbank near Ile aux Oiseaux
43	Common Sandpiper (Actitis hypoleucos)	Low numbers on mudflats and river banks
44	Common Greenshank (Tringa nebularia)	Fairly common on wet mudflats in mangroves

45	Common Redshank (Tringa totanus)	Fairly common on wet mudflats in mangroves
46	Whimbrel (Numenius phaeopus)	Abundant on wet mudflats in mangroves
47	Eurasian Curlew (Numenius arquata)	Uncommon along Casamance River
48	Bar-tailed Godwit (Limosa lapponica)	A few on sandbank near Ile aux Oiseaux
49	Ruddy Turnstone (Arenaria interpres)	Low numbers along Casamance River
50	Curlew Sandpiper (Calidris ferruginea)	Common on sandbanks and tannes
51	Gray-hooded Gull (Chroicocephalus cirrocephalus)	Common near Ziguinchor fish port, coast
52	Black-headed Gull (Chroicocephalus ridibundus)	Coastal, a single bird at beach near Cap Skirring
53	Lesser Black-backed Gull (Larus fuscus)	Coastal, a few at beach near Cap Skirring
54	Little Tern (Sternula albifrons)	Low numbers along Casamance River
55	Gull-billed Tern (Gelochelidon nilotica)	Very common along waterways
56	Caspian Tern (Hydroprogne caspia)	Low numbers along major waterways
57	Royal Tern (Thalasseus maximus)	Low numbers along major waterways and coast
58	Common Tern (Sterna hirundo)	Coastal, one at beach near Cap Skirring
59	Sandwich Tern (Thalasseus sandvicensis)	Mainly coastal, single birds along Casamance River
60	Speckled Pigeon (Columba guinea)	Low numbers throughout
61	Mourning Collared-Dove (Streptopelia decipiens)	A few in dry areas
62	Red-eyed Dove (Streptopelia semitorquata)	Common in mangroves and fields
63	Vinaceous Dove (Streptopelia vinacea)	Common in towns and villages
64	Laughing Dove (Streptopelia senegalensis)	Common around villages
65	Black-billed Wood-Dove (Turtur abyssinicus)	Common in dry scrub
66	Namaqua Dove (Oena capensis)	A few in dry scrub
67	Rose-ringed Parakeet (Psittacula krameri)	Low numbers in open woodland throughout
68	Senegal Parrot (Poicephalus senegalus)	Fairly common in open woodland
69	Western Plantain-eater (Crinifer piscator)	Very common in open woodland
70	Senegal Coucal (Centropus senegalensis)	Fairly common in bush and mangroves
71	Barn owl (Tyto alba)	Heard at Carabane Island
72	Pallid Swift (Apus pallidus)	Commonly recorded throughout
73	Little Swift (Apus affinis)	Recorded only once, 15/3
74	African Palm-Swift (Cypsiurus parvus)	Common near oil palms
75	Malachite Kingfisher (Corythornis cristatus)	Fairly common along rivers and small creeks
76	Blue-breasted Kingfisher (Halcyon malimbica)	Low numbers in dense mangroves
77	Giant Kingfisher (Megaceryle maximus)	Low numbers along major waterways
78	Pied Kingfisher (Ceryle rudis)	Abundant along waterways
79	Little Bee-eater (Merops pusillus)	Low numbers in mangroves
80	White-throated Bee-eater (Merops albicollis)	Fairly common in mangroves and woodland
81	Blue-cheeked Bee-eater (Merops persicus)	Common in mangroves
82	Abyssinian Roller (Coracias abyssinicus)	A few in dry ricefields near Ziguinchor
83	Blue-bellied Roller (Coracias cyanogaster)	A few in woodland
84	Broad-billed Roller (Eurystomus glaucurus)	Low numbers, restricted to woodland habitats
85	Green wood-hoopoe (Phoeniculus purpureus)	Fairly common in mangroves and woodland
86	Western Red-billed Hornbill (Tockus kempi)	Fairly common in dry woodland and scrub
87	African Gray Hornbill (Tockus nasutus)	Low numbers in woodland
88	Bearded Barbet (Lybius dubius)	A single bird on Carabane Island, 13/3
89	Gray Woodpecker (Dendropicos goertae)	Fairly common in open woodland
90	Common Gonolek (Laniarius barbarus)	Fairly common in mangroves and thickets
91	Woodchat Shrike (Lanius senator)	A few in open habitats
92	Yellow-billed Shrike (Corvinella corvina)	Recorded once, Carabane Island 13/3
93	Fork-tailed Drongo (Dicrurus adsimilis)	A few in woodland habitats
94	Piapiac (Ptilostomus afer)	A few at Cap Skirring, 14/3

95	Pied Crow (Corvus albus)	Very common in towns
96	Crested Lark (Galerida cristata)	A few on dry tannes and fields
97	Red-chested Swallow (Hirundo lucida)	Abundant along Casamance River
98	Wire-tailed Swallow (Hirundo smithii)	Common along Casamance River
99	Common House-Martin (Delichon urbicum)	Low numbers
100	Common Bulbul (Pycnonotus barbatus)	Common in towns and villages, also mangroves
101	Northern Crombec (Sylvietta brachyura)	One bird in mangroves at Carabane Island, 11.3
102	Common Chiffchaff (Phylloscopus collybita)	Fairly common migrant in dry woodland
103	Eurasian Reed-Warbler (Acrocephalus scirpaceus)	Very common in mangroves
104	Black-necked Cisticola (Cisticola eximius)	A few in dry ricefields
105	Senegal Eremomela (Eremomela pusilla)	Common in mangroves and thickets
106	Blackcap Babbler (Turdoides reinwardtii)	A few in dense bush at Carabane Island
107	Brown Babbler (Turdoides plebejus)	Fairly common in woodland and scrub
108	Greater Blue-eared Glossy-Starling (Lamprotornis chalybaeus)	A few in Ziguinchor
109	Bronze-tailed Glossy-Starling (Lamprotornis chalcurus)	A few in woodland habitats
110	Long-tailed Glossy-Starling (Lamprotornis caudatus)	Common in dry woodland and scrub
111	Yellow-billed Oxpecker (Buphagus africanus)	Two at Carabane Island, 13/3
112	Beautiful Sunbird (Cinnyris pulchellus)	Abundant in mangroves and woodland
113	Western Yellow Wagtail (Motacilla flava)	A few near Cap Skirring, 14/3
114	White Wagtail (Motacilla alba)	A few in Ziguinchor and Cap Skirring
115	Yellow-fronted Canary (Serinus mozambicus)	Fairly common in mangroves and open woodland
116	Northern Gray-headed Sparrow (Passer griseus)	Common in villages
117	Little Weaver (Ploceus luteolus)	Low numbers in woodland habitats
118	Village Weaver (Ploceus cucullatus)	Abundant in towns and villages
119	Black-headed Weaver (Ploceus melanocephalus)	Low numbers in mangroves
120	Red-billed Quelea (Quelea quelea)	Erratic in dry ricefields
121	Orange Bishop (Euplectes franciscanus)	Very common in dry ricefields
122	Orange-cheeked Waxbill (Estrilda melpoda)	Fairly common around villages
123	Red-cheeked Cordonbleu (Uraeginthus bengalus)	Common around villages
124	Red-billed Firefinch (Lagonosticta senegala)	Common around villages
125	Bronze Mannikin (Spermestes cucullatus)	Common in scrub and around villages
126	Pin-tailed Whydah (Vidua macroura)	A few around villages and in dry woodland

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