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The status and ornithological significance of mangroves in West Africa

A&W-report 2047

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L. Zwarts
J. van der Kamp

Cover photograph
Mangroves along a creek, Rio de Junqueira, Quinara, Guinea-Bissau (25-8-2008; 13.697ºN, 15.401ºW).
Photo: Leo Zwarts

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Contents

1 Introduction

Mangrove are in decline, worldwide. The main threat, mainly in Asia, is the mariculture for which mangroves are converted into ponds to grow shrimp, prawn and fish. In West Africa, a large part of the mangroves has been turned into rice fields (Fig. 1), most already many centuries ago, but there is also a loss of mangroves due to the construction of roads and embankments, and by collection of fuel wood and charcoal. Moreover, millions of mangrove trees died off during the Great Drought, the dry years 1969-1993 when the rainfall in West Africa remained at an extremely low level.

This leaflet shows where mangroves are found in West Africa and gives an estimate of their surface per country. It describes the decline, but also the increase, of mangroves during the last 50 years in West Africa and pays special attention to the decline of mangroves during the Great Drought and their recovery after the rainfall improved since 1994. The leaflet also discusses to what degree mangroves are able to recolonize abandoned rice fields and what would be the best strategy to restore mangrove forests. Finally the report pays attention to a so far forgotten biological value of the West African mangroves as wintering area for millions of European birds feeding on insects.

This leaflet, of which there is also a French version, is based on a report (Zwarts 2014) and a scientific paper (Zwarts *et al.* 2014).

The study was financed by the Fondation MAVA.

Fig. 1. Mangrove forests and the rice fields within the mangrove zone of West Africa measure 8000 km^2 and 4000 km^2, respectively (Bos *et al.* 2007). The photo, taken from a low-flying small plane, shows the extensive mangrove zone with rice fields along the north bank of the Rio Cacheu (24-8-2008; 12.143ºN and 16.266ºW) .

Fig. 2. Scattered mangrove trees on the tidal flats and dense mangroves along tidal creeks in the Casamance. Date: 26-8-2008; 12.620ºN and 16.197ºW.

Fig. 3. Dense mangrove forests and bare tidal flats along the southern border of the Rio Grande de Buba, with Ilha de Bolama left at the horizon. Date: 25-8-2008; coordinates: 11.476°N and 15.413°W.

2 Mapping West African mangroves

The surface area of mangrove worldwide can be estimated at 15 million ha, of which 0.8 million ha is found in West Africa between Mauritania and Sierra Leone, nearly all between 14˚N (Saloum estuary in Senegal) and 7.5˚N (Sherbro Island in Sierra Leone). Within this range, the average rainfall varies between less than 700 and more than 3000 mm per year (Fig. 4). Fig. 4 does not show the small mangrove areas found in the outer estuary of the Senegal River and further north on the Banc d'Arguin in Mauritania.

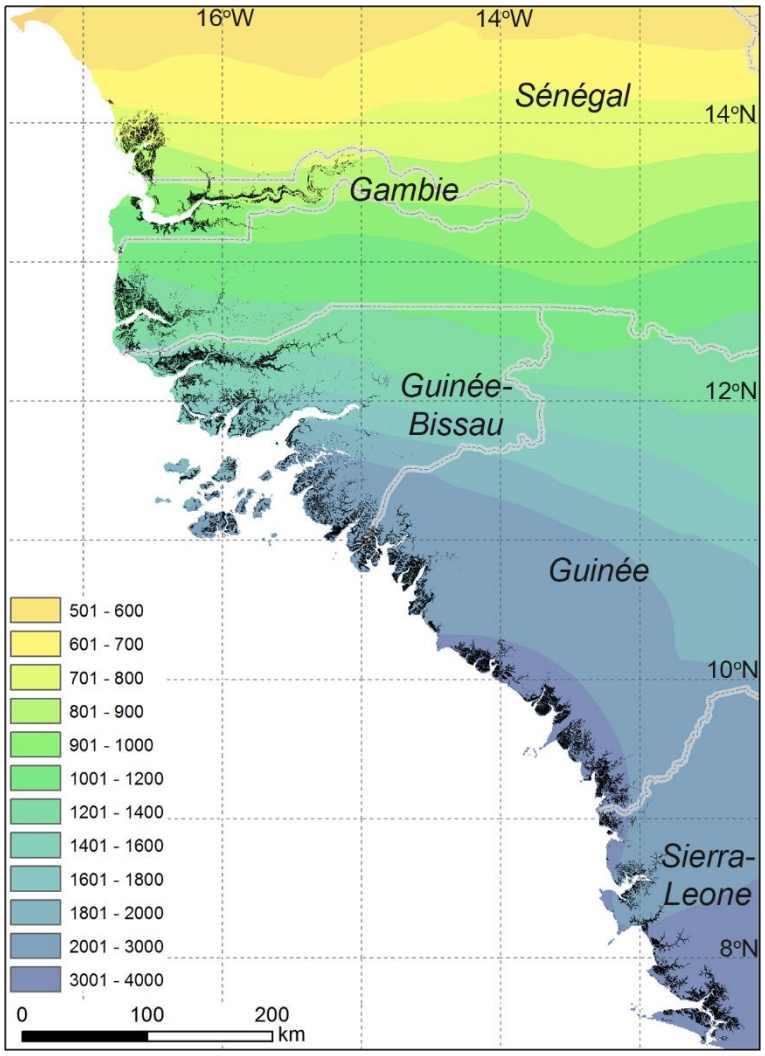


Fig. 4. The mangroves in West Africa (indicated in black) grow nearly everywhere along the coast between the Saloum (Senegal) and Sherbro Island (Sierra Leone), in large estuaries (e.g. Sine-Saloum) and further inland along the rivers (e.g. Gambia, Casamance, Rio Cacheu, Rio Geba, Rio Grande de Buba). The average annual rainfall increases from north to south by which the mangroves in Senegal grow in semi-arid and in Guinea-Conakry and Sierra Leone in very humid conditions. The few mangroves in Mauritania (not shown on the map) grow even in arid circumstances.

Three studies (Bos *et al*. 2006, Spalding *et al*. 2010, Giri *et al*. 2010) used satellite images from the Landsat archives, all from around 2000, to map the mangroves in West Africa. The data of Spalding and Giri have been made available by UNEP World Conservation Monitoring Centre (http://data.unep-wcmc.org/datasets). The three studies do not differ much regarding the total estimates of the mangroves in West Africa, between 7950 and 8400 km^2 (Table 1), but the differences are larger when country estimates are compared: the lowest estimate is 10% (Gambia) to 30% (Sierra Leone) below the highest estimate of the mangrove extent in a country (Table 1).

The differences in the estimates are due to problems with the interpretation of the remotely sensed images. It seems to be easy to recognize mangrove forests when one studies the high resolution satellite images on Google Earth (see Fig. 5) since on the seaside mangrove forests are surrounded by bare

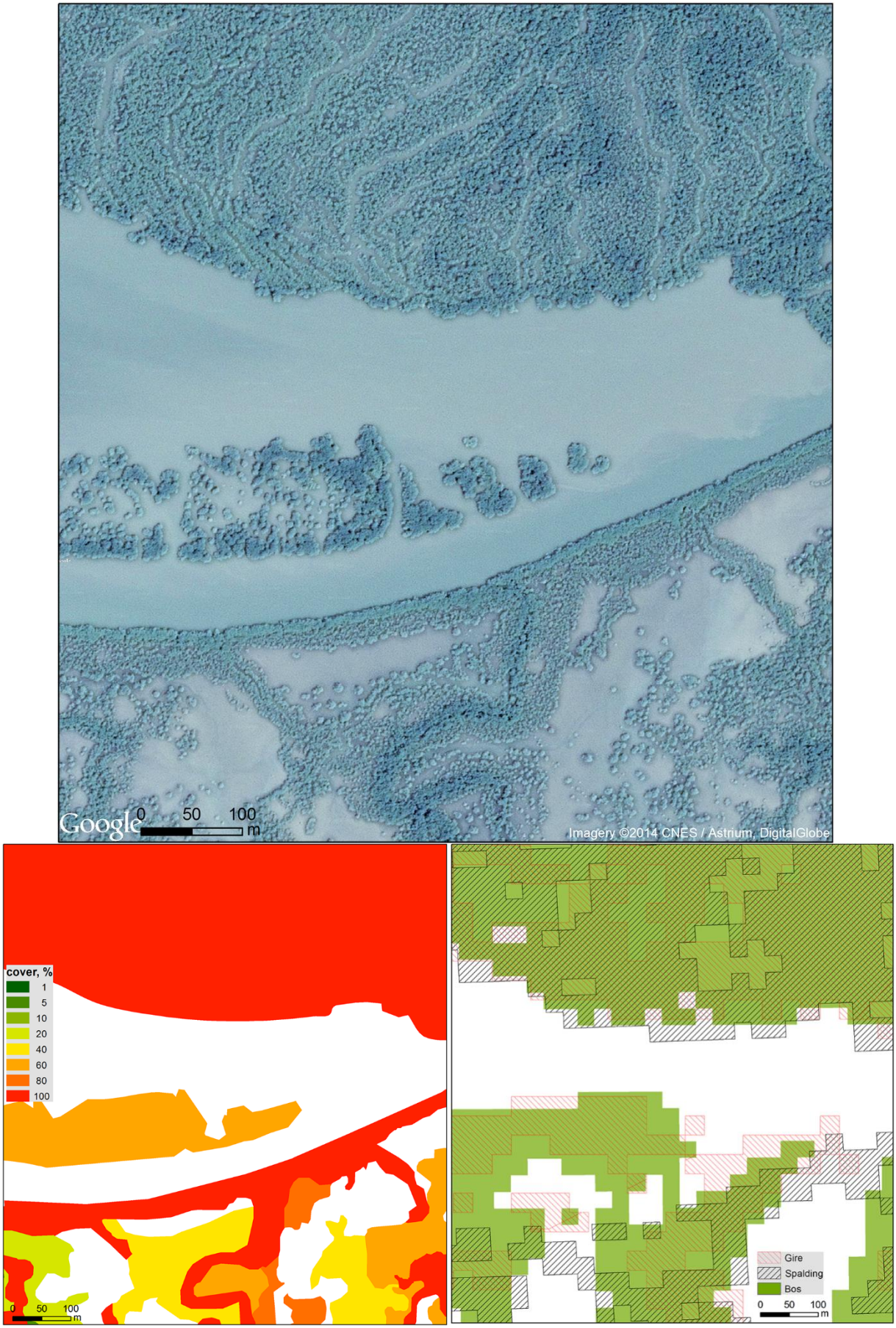


Fig. 5. Area (760x626m) with a high density of mangroves along the southern border of the Casamance, between UTM coordinates -1816900/140.027 (SW corner) and -1814140/1401852 (NE corner). Top: Google Earth image from 15-11-2013; bottom left: estimated mangrove cover using Google Earth; bottom right: mangrove cover according to Bos *et al.* (2006), Spalding *et al.* (2010) and Giri *et al* (2010).

intertidal flats or water (Fig. 2, 3) while on the landside there are rice fields (Fig. 1) or bare land with scattered scrubs and trees. Traditional remote sensing studies, however, distinguish mangrove forests by selecting specific spectral bands. To prevent missing mangroves, the selection criteria should be *less* strict, but on the other hand to prevent that forests are wrongly distinguished as mangroves, the criteria should be *more* strict. Each study made its own decision how to minimize both types of error. The three studies compared here could prevent evident errors, by using digital elevation data to eliminate areas recognized in their analysis as mangrove but situated in terrestrial areas.

A second problem is due to how mangrove cover is defined. To indicate a mangrove area is easy if all trees form together a closed canopy (Fig. 3), but how to deal with open areas in mangroves and with mangrove forests where the canopy is less dense (Fig. 2)? All three studies used satellite imagery with a 30 m spatial resolution. Thus open areas in mangrove forests of at least 30 x 30 m should be recognized as such, but what to do if the mangrove cover within a pixel varies between 1 and 100%? The studies give no details and also do not distinguish mangrove forests with different canopy covers. Fig. 5 gives as example the mapping by the three studies of a small area where the canopy cover differs locally. The closed forests and the large open areas are in all three studies correctly classified, but their maps differ where the mangrove trees form no closed canopy. As example, the mangrove vegetations in the three studies are given for the Saloum (Fig. 6).

Surface (km^2)	Bos	Giri	Spalding
Gambia	679	673	583
Senegal	1452	1226	1281
Guinea-Bissau	2521	2732	2982
Guinea-Conakry	2215	2359	2029
Sierra Leone	1085	1405	1049
TOTAL	7953	8396	7924

Table 1. The three country estimates of area covered by mangroves in 2000 according to Bos *et al.* (2006), Spalding *et al.* (2010) and Giri *et al.* (2010).

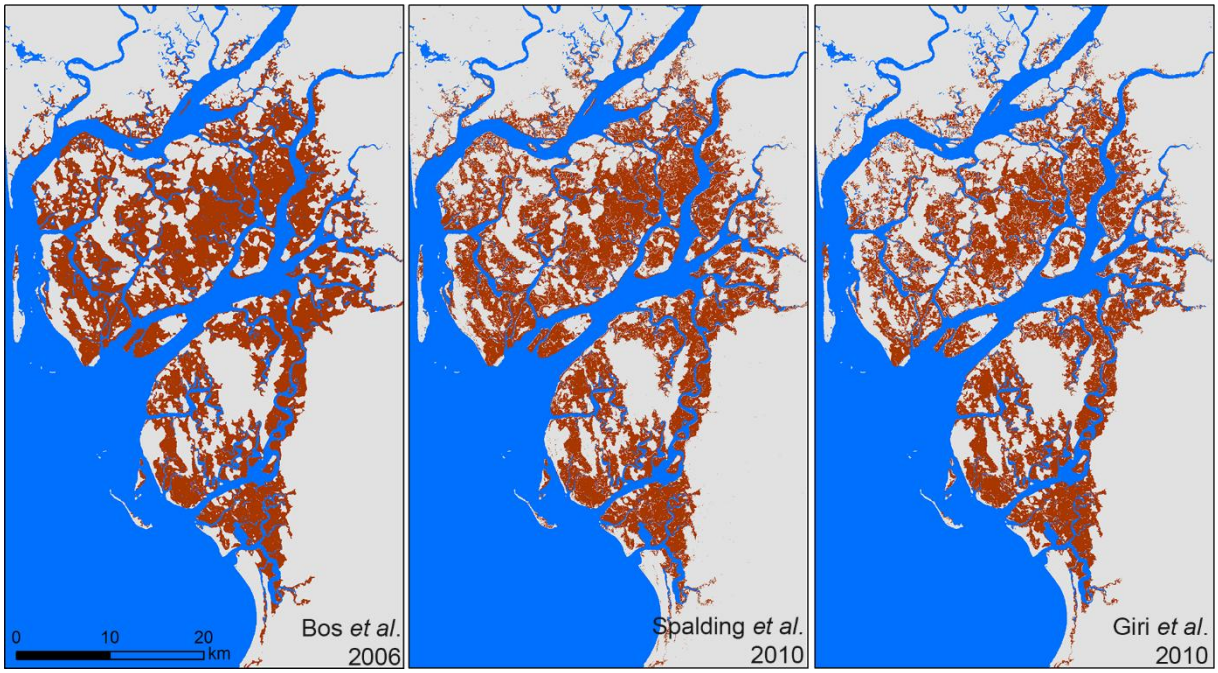


Fig. 6. The mangroves in the Saloum estuary around 2000 according to three studies, based on Landsat satellite images. At first glance, the three maps seems to be the same but Giri gives more open areas within the mangrove forests than Bos or Spalding (best visble in the NW part of the Saloum).

A systematic comparison of the maps produced by the three studies and Google Earth imagery (resolution 0.6-1.3 m) revealed that remote sensing studies based on a pixel size of 30x30m tend to overestimate areas with a low density of mangroves, but underestimate mangroves with a dense canopy. Since dense mangroves cover a larger surface than scattered mangroves, the total surface is slightly underestimated. Hence we expect that a remote sensing analysis based on high-resolution

satellite images with a resolution of 1 m would reveal a somewhat larger surface area of mangroves than the studies being done so far. Dense mangrove forests (Fig. 3) and areas with scattered mangrove trees (Fig. 2) are found all along the coast of West Africa, but large closed forests are found much more in Guinea-Bissau and further south, while large, open areas with some mangrove vegetation are common in Senegal, in the Saloum and along the Casamance River. Hence, mangroves in Senegal are more difficult to map than in Guinea-Bissau and further south.

Despite the just mentioned problems, the maps produced in the three studies do not differ much, as shown on country maps given on the next pages for Senegal, Guinea-Bissau, Guinea and Sierra Leone (Fig. 10). The differences becomes only apparent when the maps are studied in much more detail (Fig. 2, 6).

As can be seen on the aerial photographs (Figs. 1, 2, 3, 5, 7), the tree cover of mangrove is high along the tidal creeks and (much) less further from the creek. Sailing around between closed, impenetrable forests one may get the impression that the mangrove vegetation fully covers the intertidal zone, but the aerial photographs and high resolution satellite images show that behind the dense forests on the banks, the tree cover is less, often even turning into open areas, being bare or covered with a low saline vegetation. These open areas surrounded by mangrove forests, are known as tannes. Mangroves cannot grow there since the soil is hypersaline due to infrequent flooding and high evaporation.

The historical images in Google Earth enable everyone to check whether the mangrove cover has changed during the latest years, or not (which according to our expererience is usually the case in West Africa). Two examples are given. Fig. 7 shows the mangrove vegetation in the Casamance on four different dates between 2004 and 2010; the images can be compared to Fig. 5, showing the mangroves on 15-1-2013. There is not any change. Fig. 8 gives another example, again hardly with any difference. We carefully checked hundreds of sites for which historical imagary from the last 10 years are available and the conclusion remains that the mangrove vegetation is remarkably stable. Also when a comparison was made with aerial photographs and topographical maps from the last 60 years, the conclusion remains that the mangrove vegetation nearly everywhere in West Africa has not changed much, except in the northern estuarries (see next chapter).

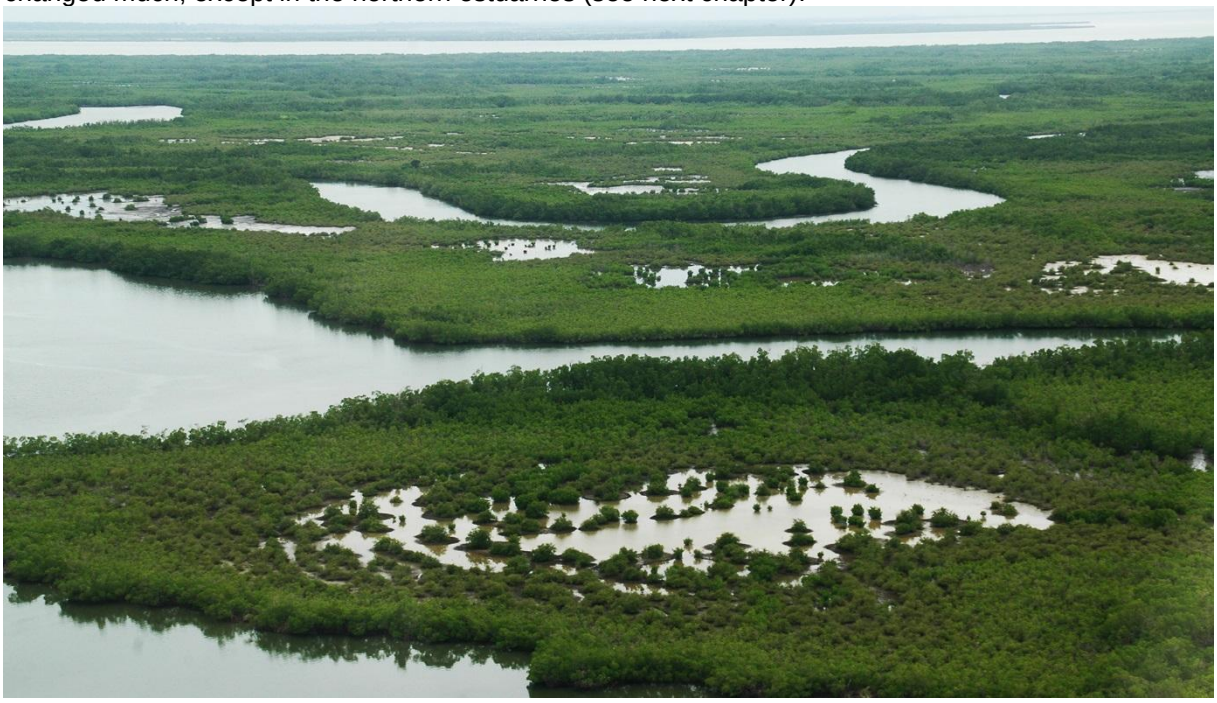


Fig. 7. Dense mangrove forests along the tidal creeks turning into open areas further from the creeks. Date 26-8-2008; coordinates 12.706˚N and 16.493˚W.

Fig. 10 (on page 8-15). The mangroves in Senegal and Gambia, Guinea-Bissau, Guinee and Sierra Leone around 2000 according to three studies, based on Landsat satellite images (reserves marked green).

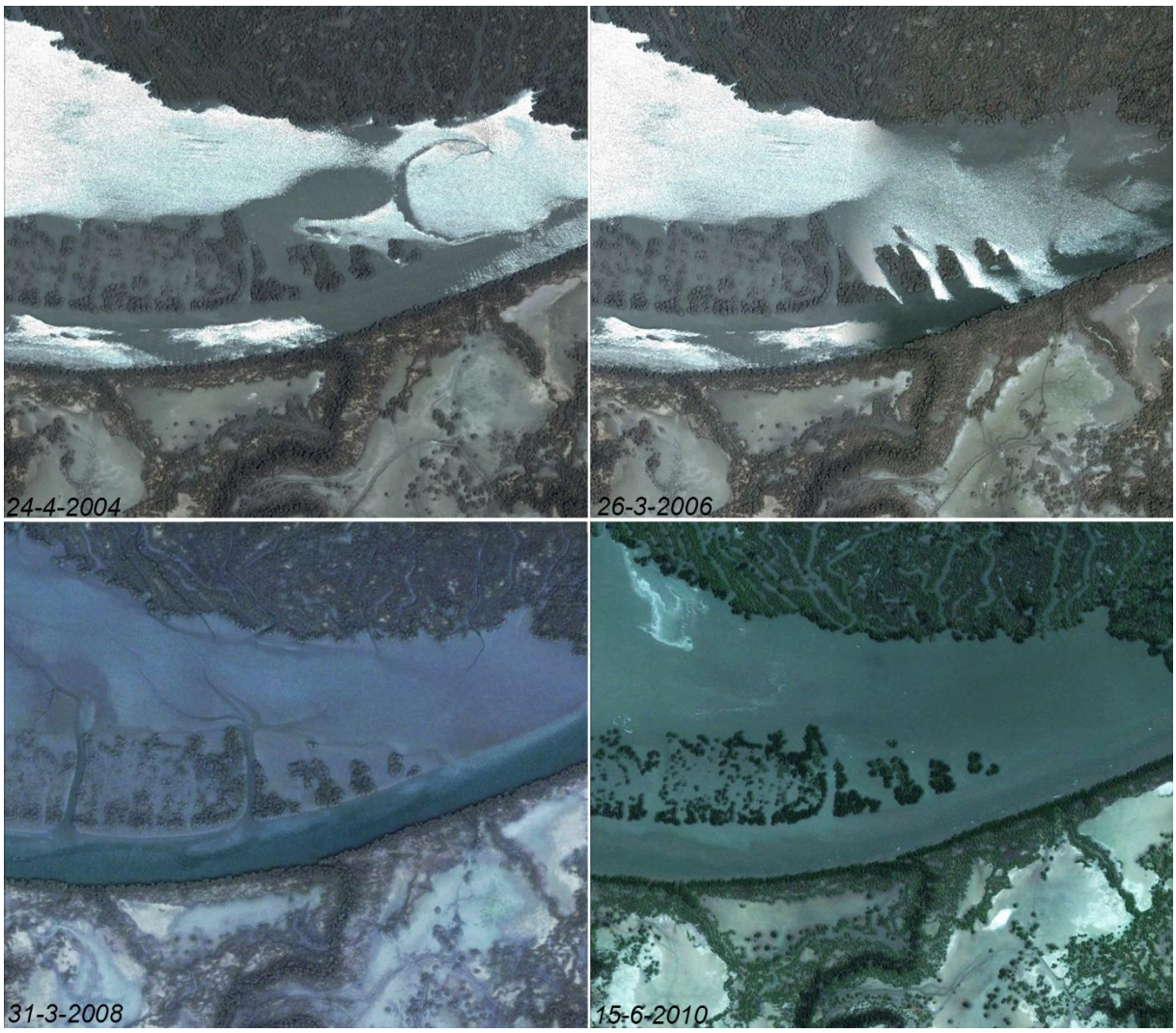
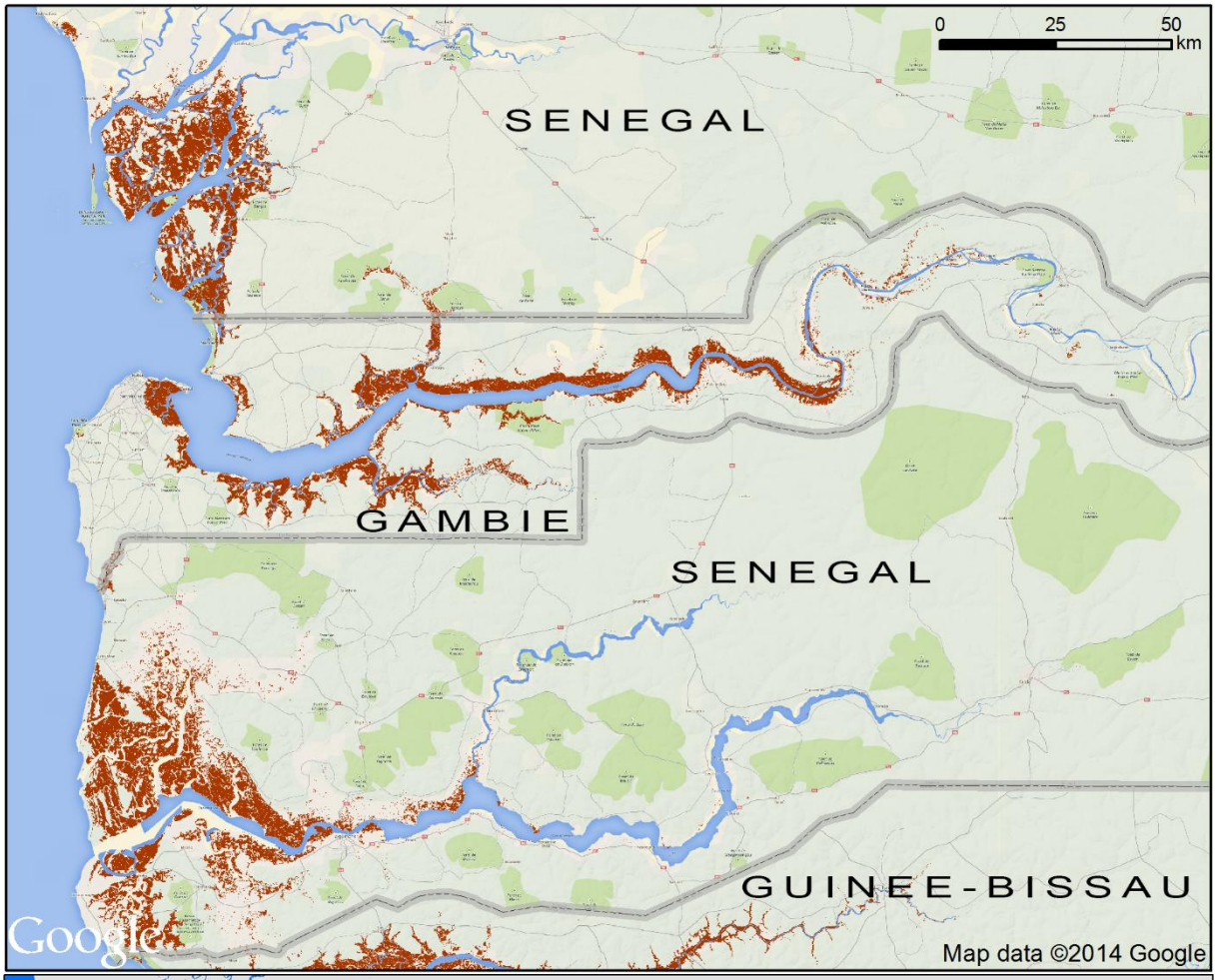


Fig. 8. Google Earth images of the area shown in Fig. 5 at four different dates between 2004 and 2010 to demonstrate that nothing has changed between 2004 and 2010.

Fig. 9. Google Earth image zoomed in more than Fig.7, showing the same area (210 x 410m) in the western Casamance for two different dates. No tree has disappeared during eight years in the upper part of the image, but some in the lower part. Note that the former dikes of abandoned rice fields are still visible.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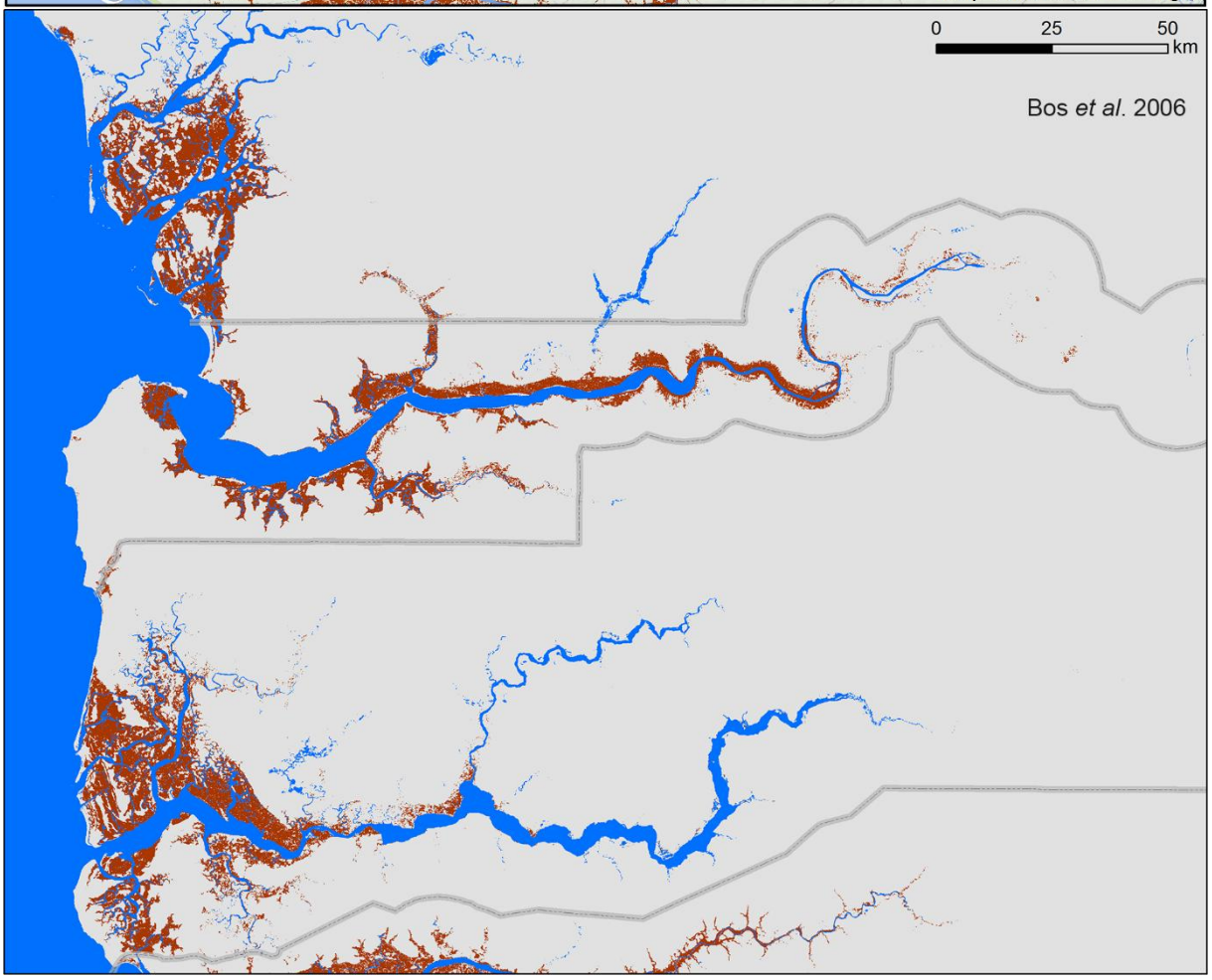
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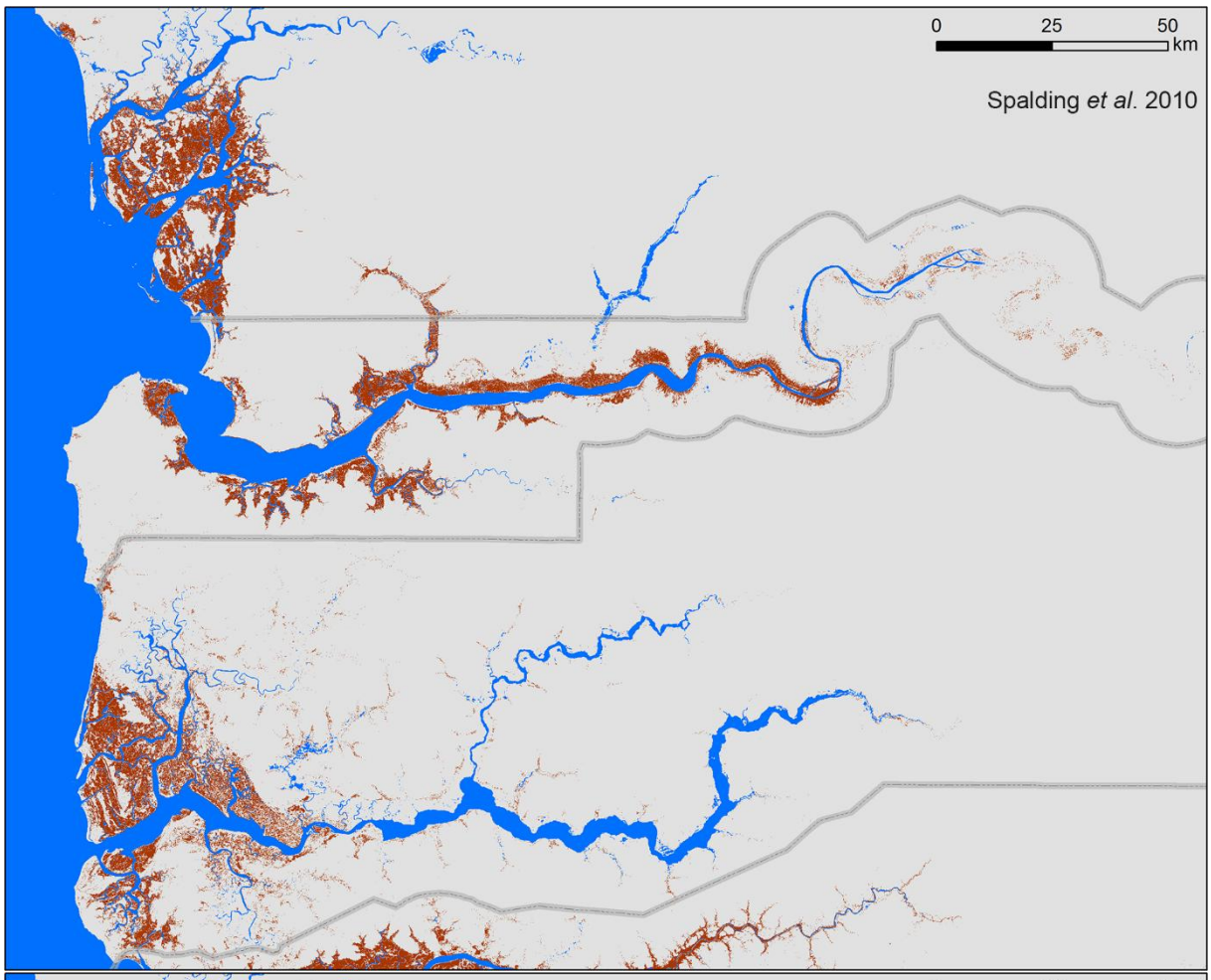
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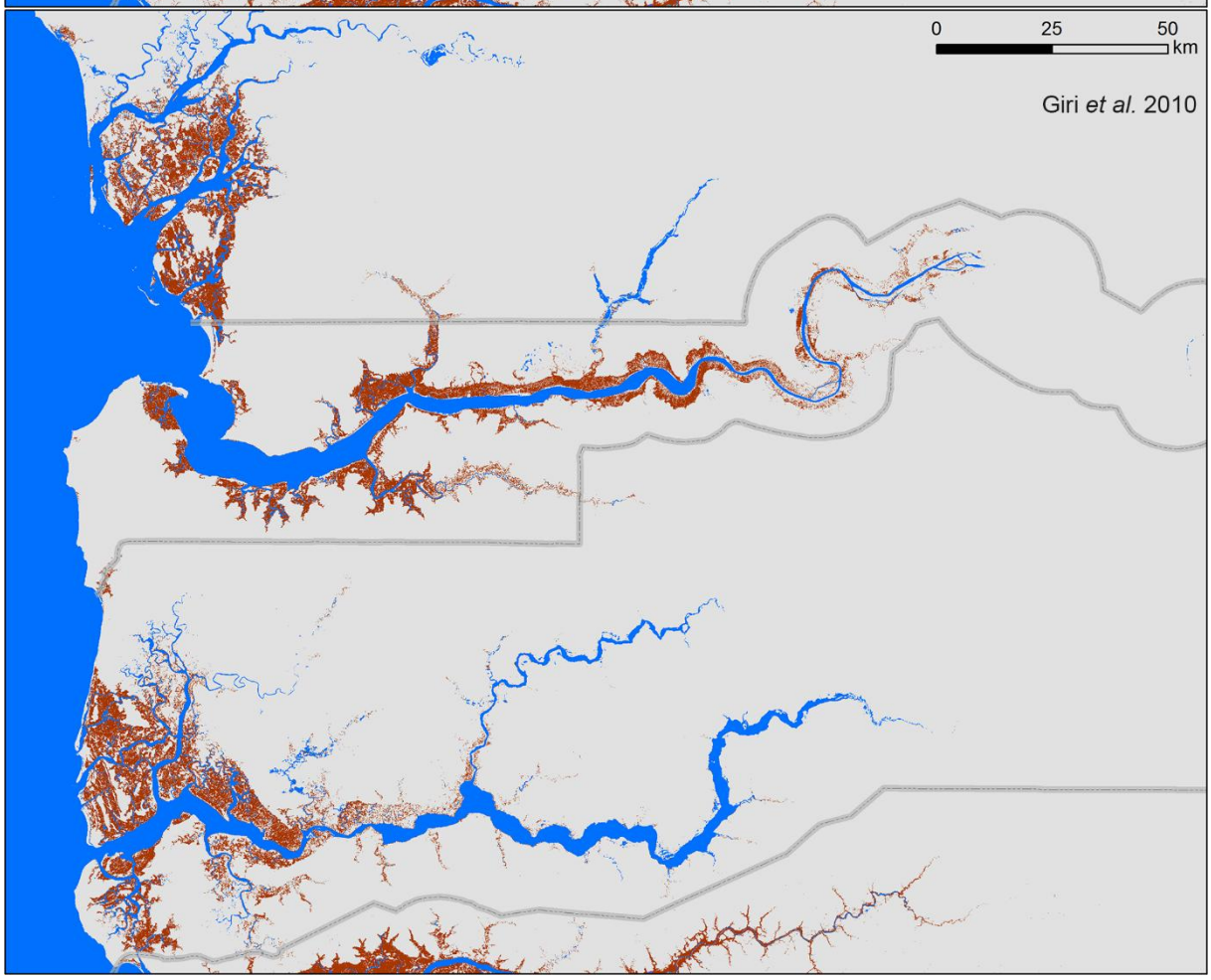
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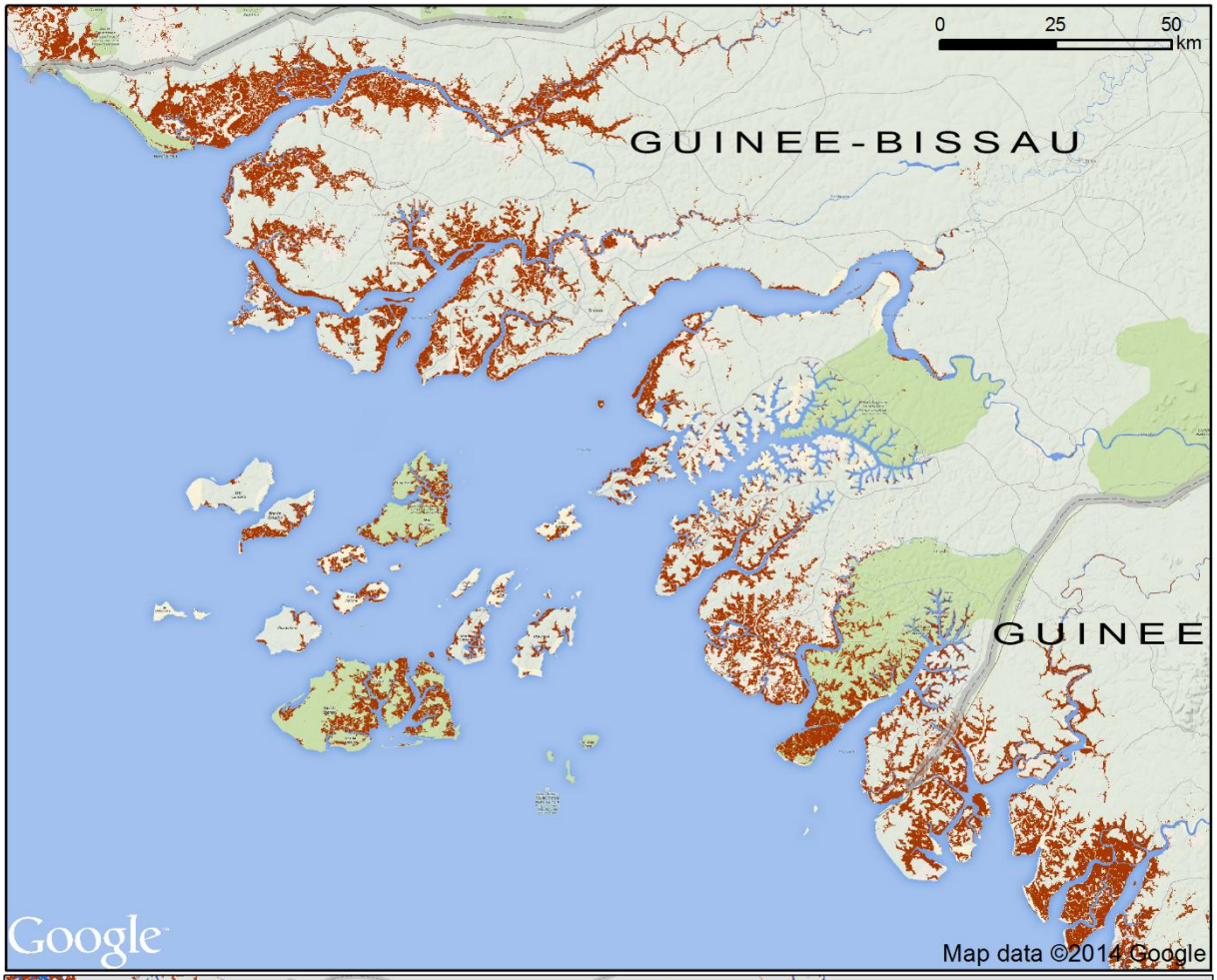
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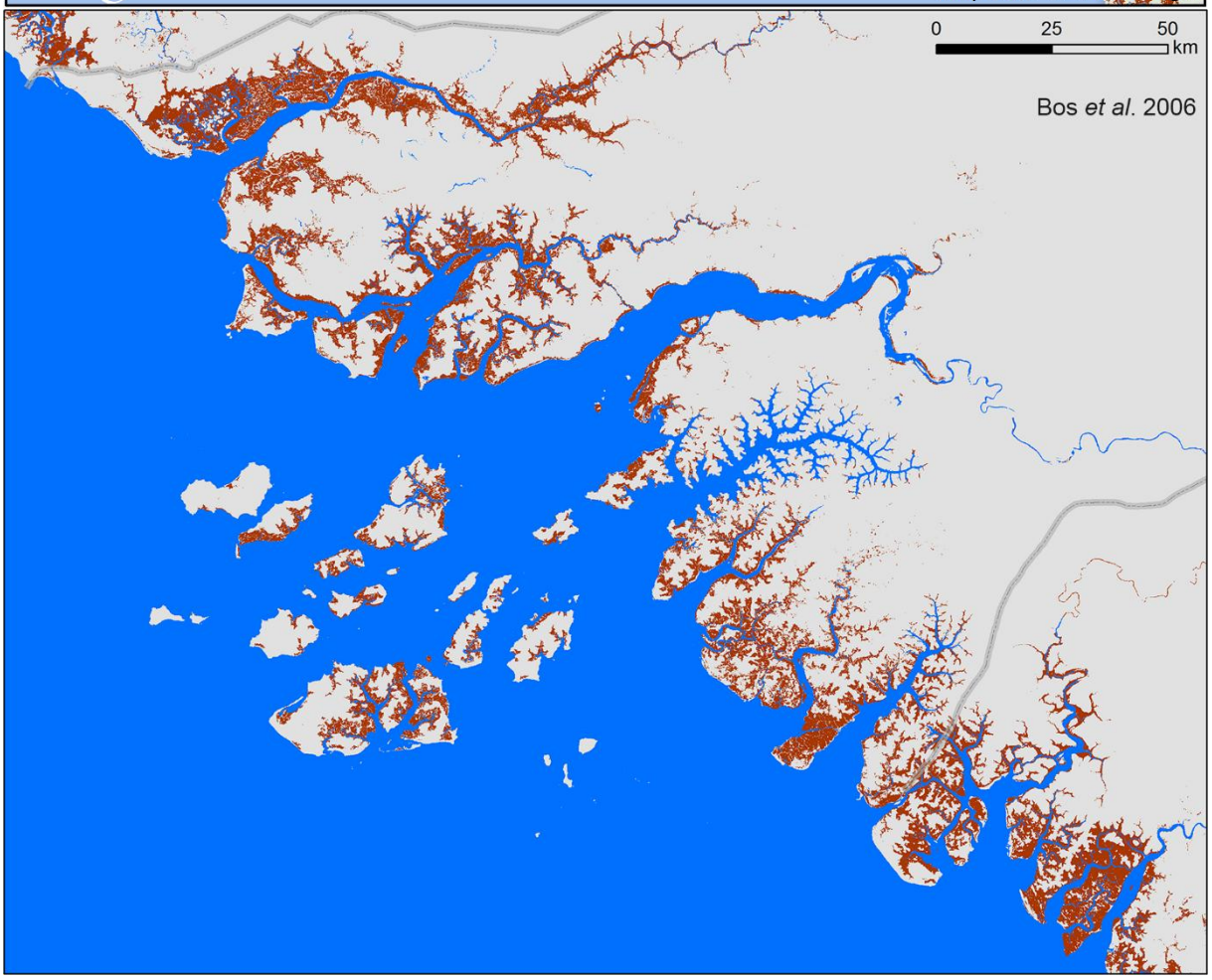
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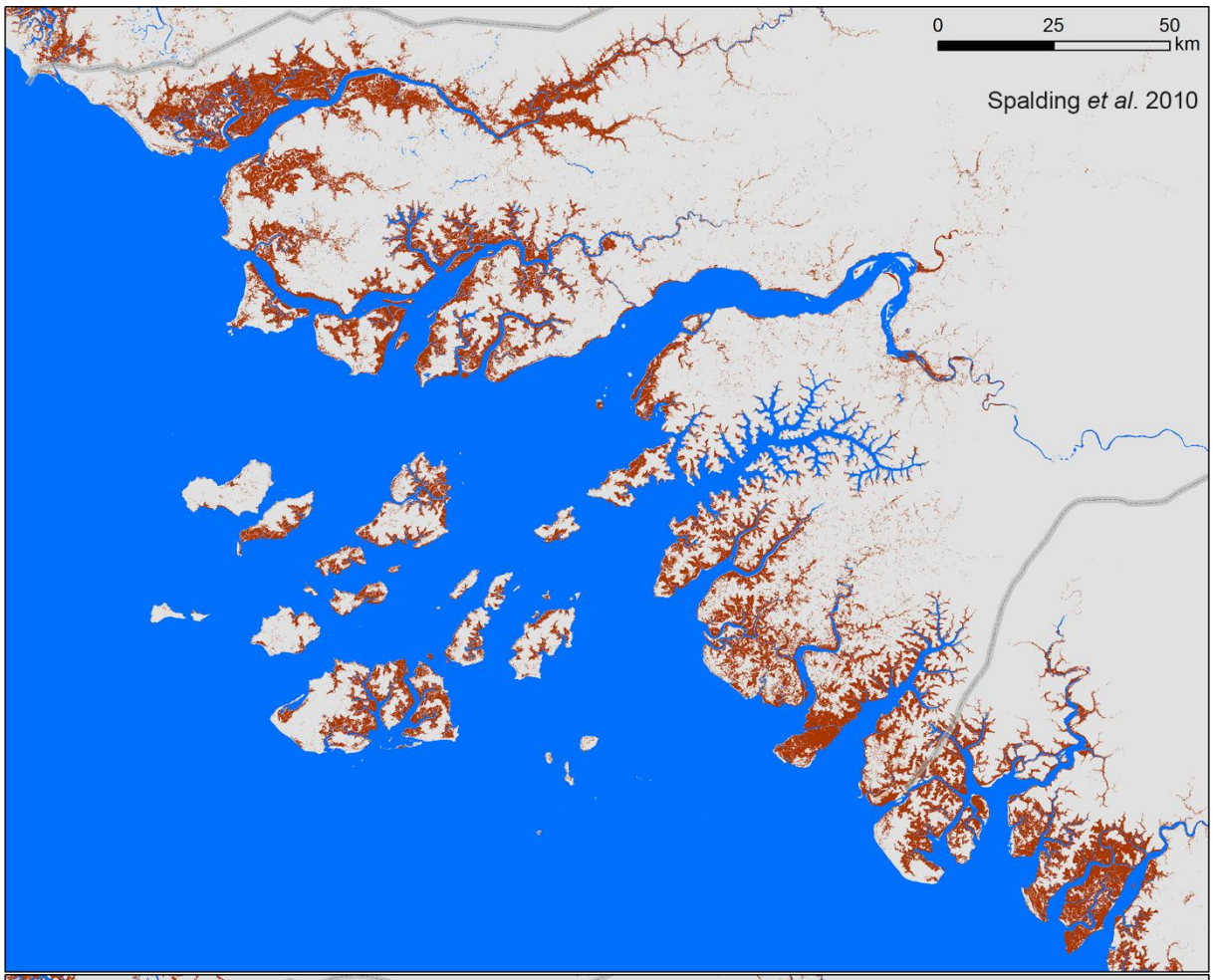
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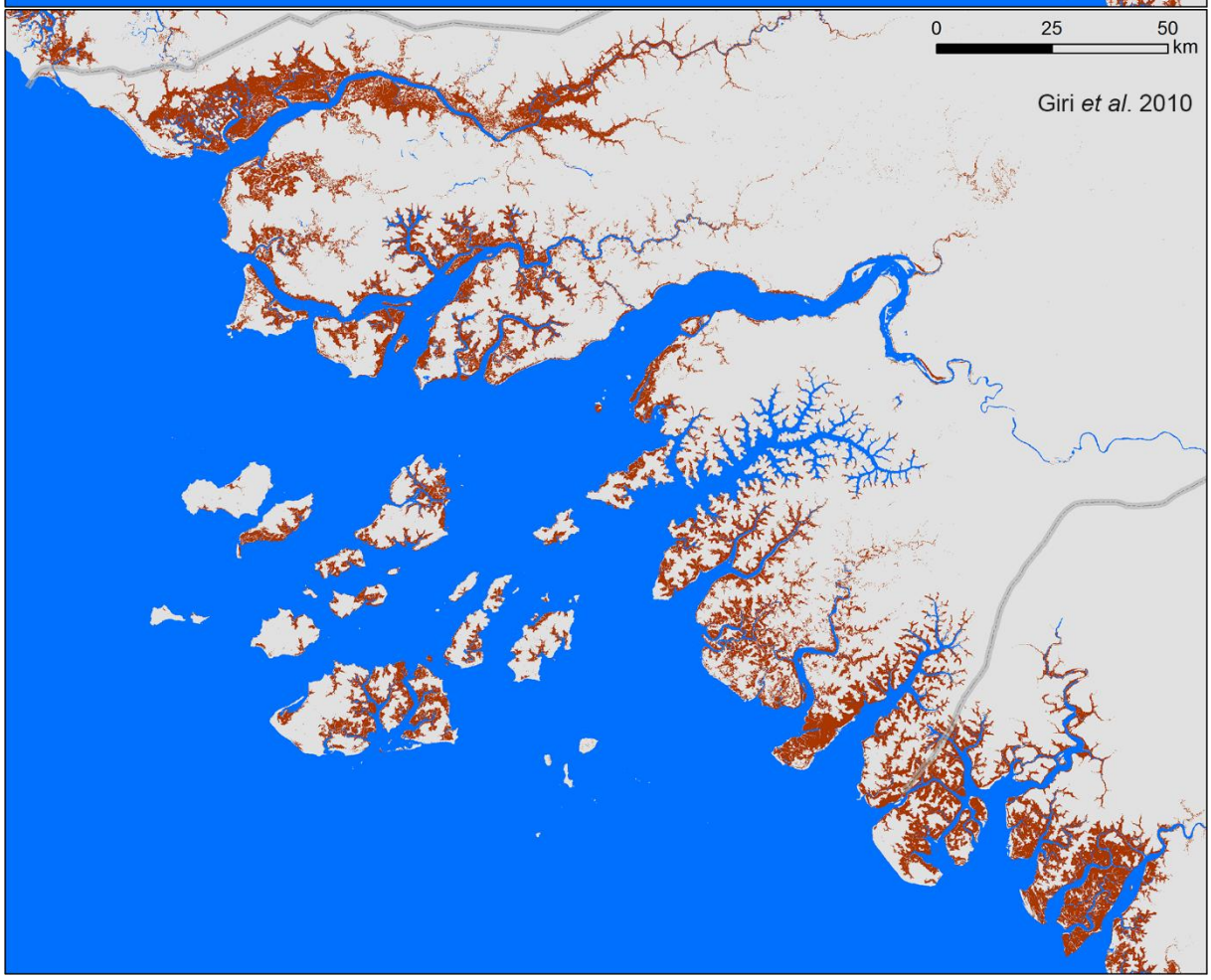
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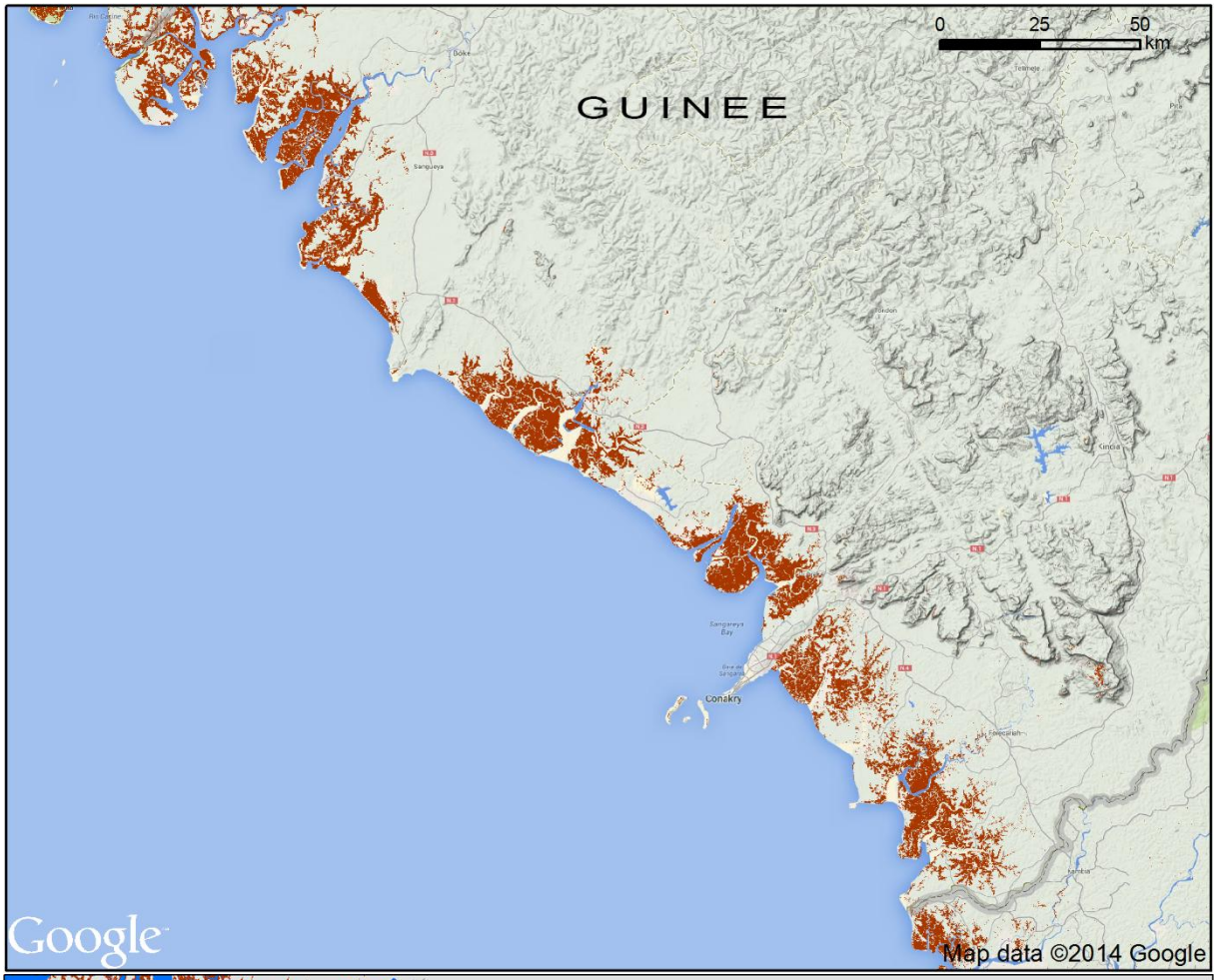
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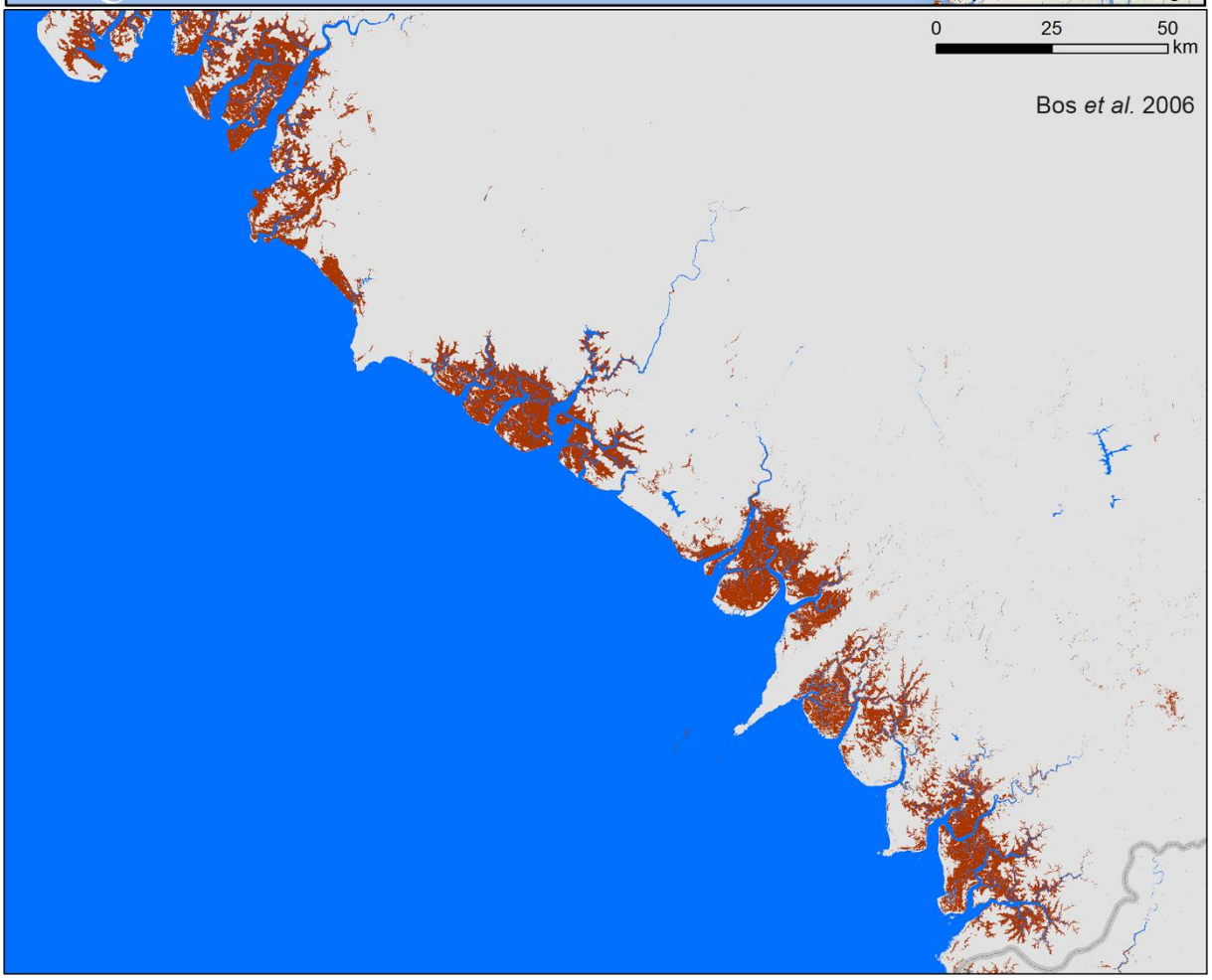
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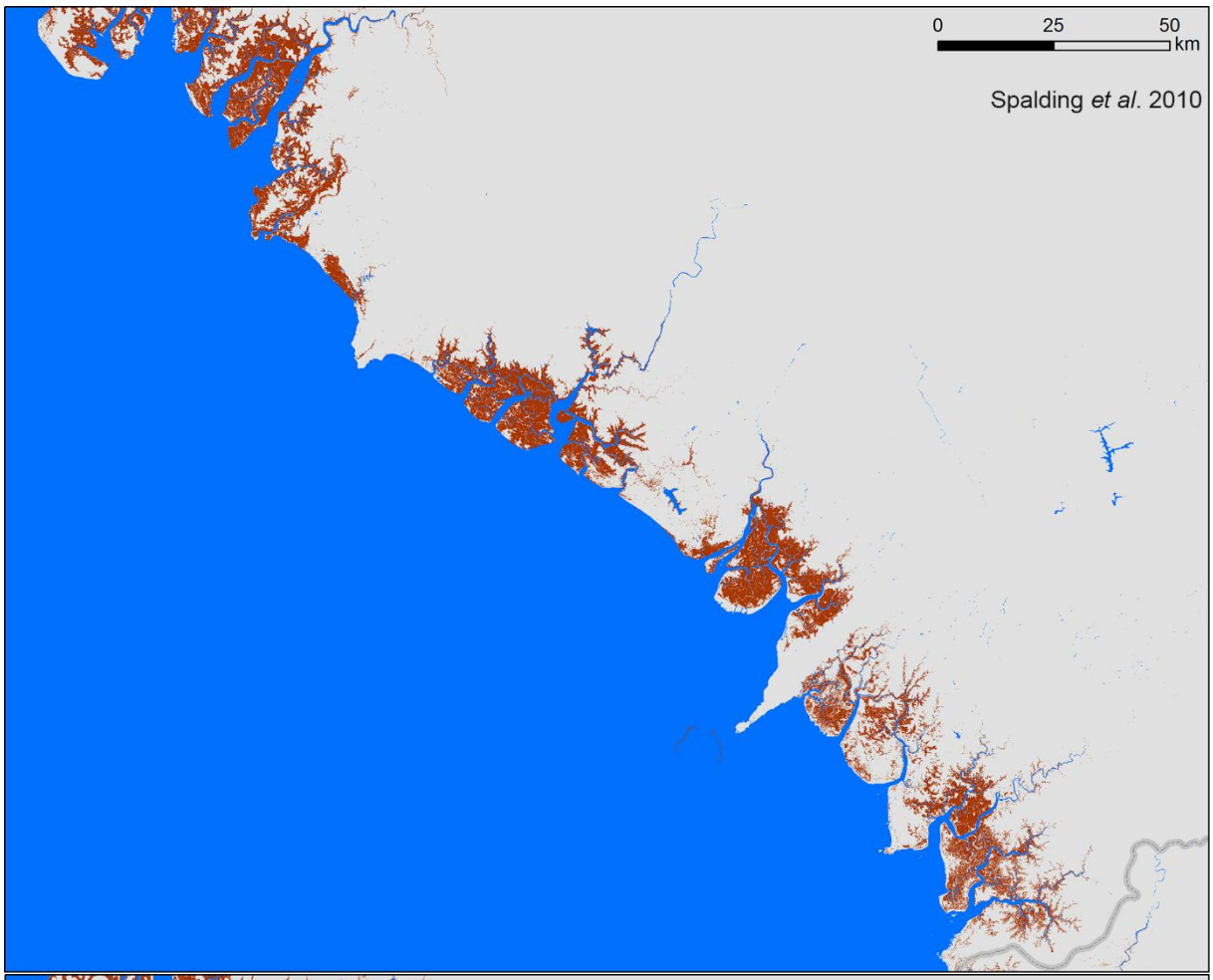
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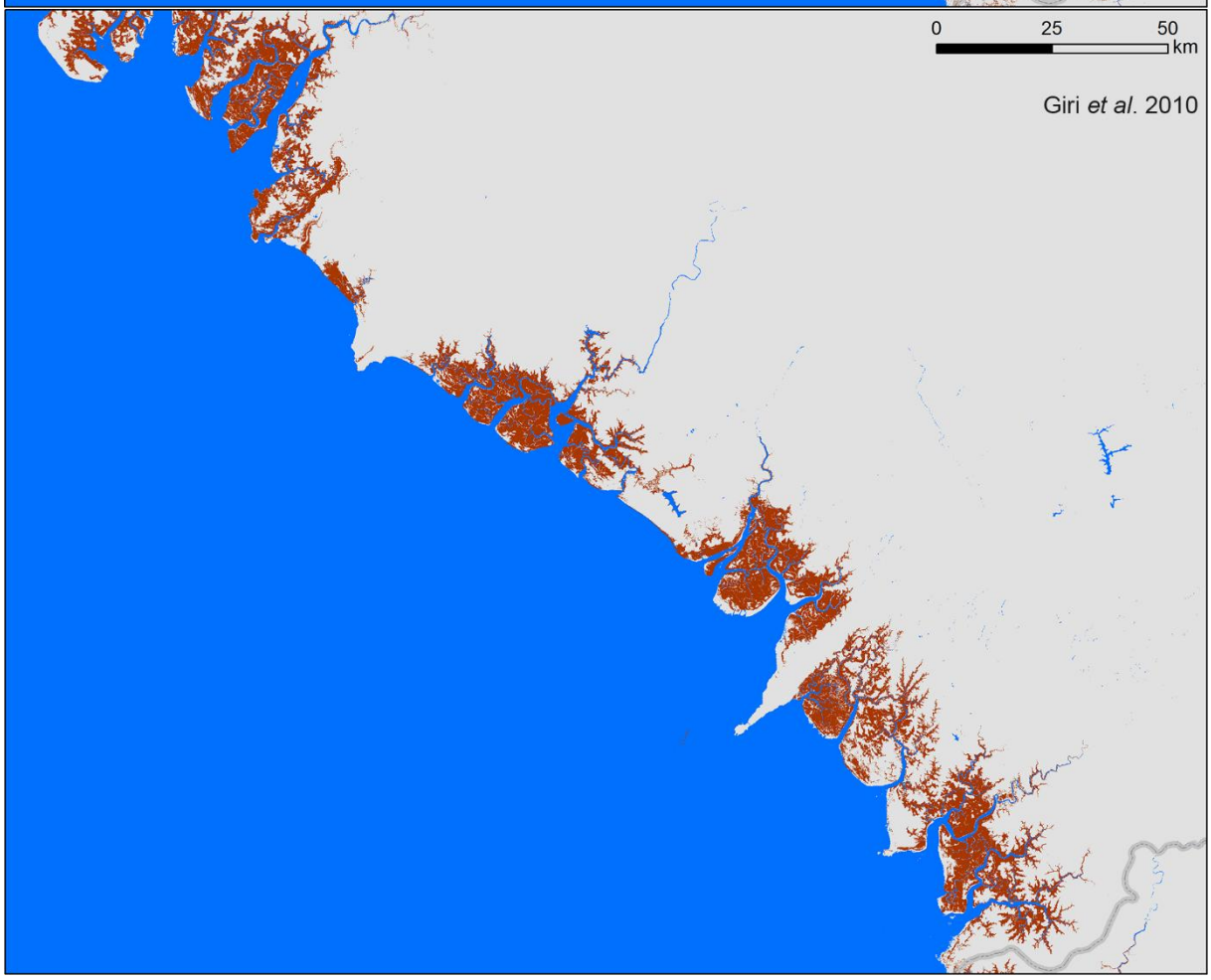
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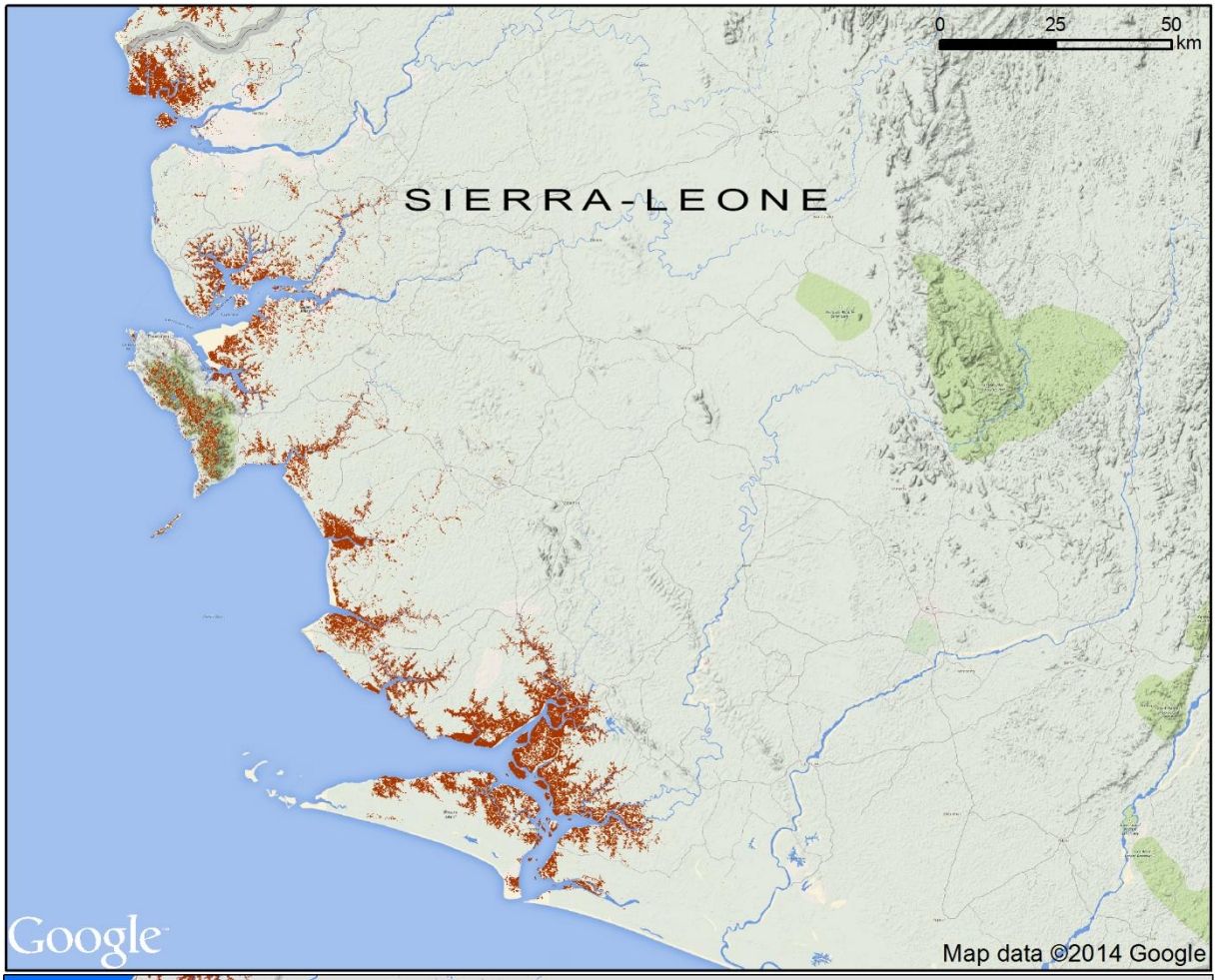
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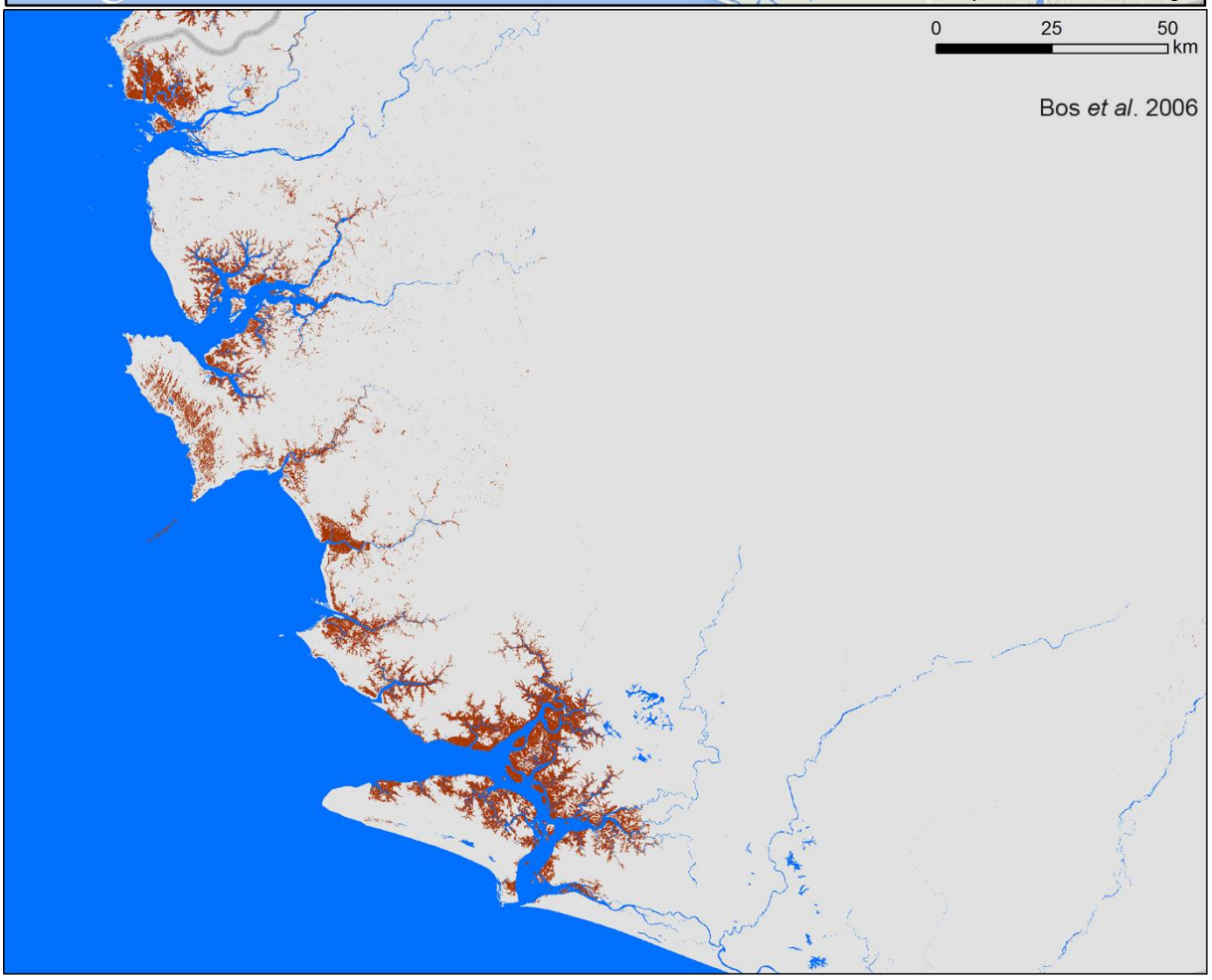
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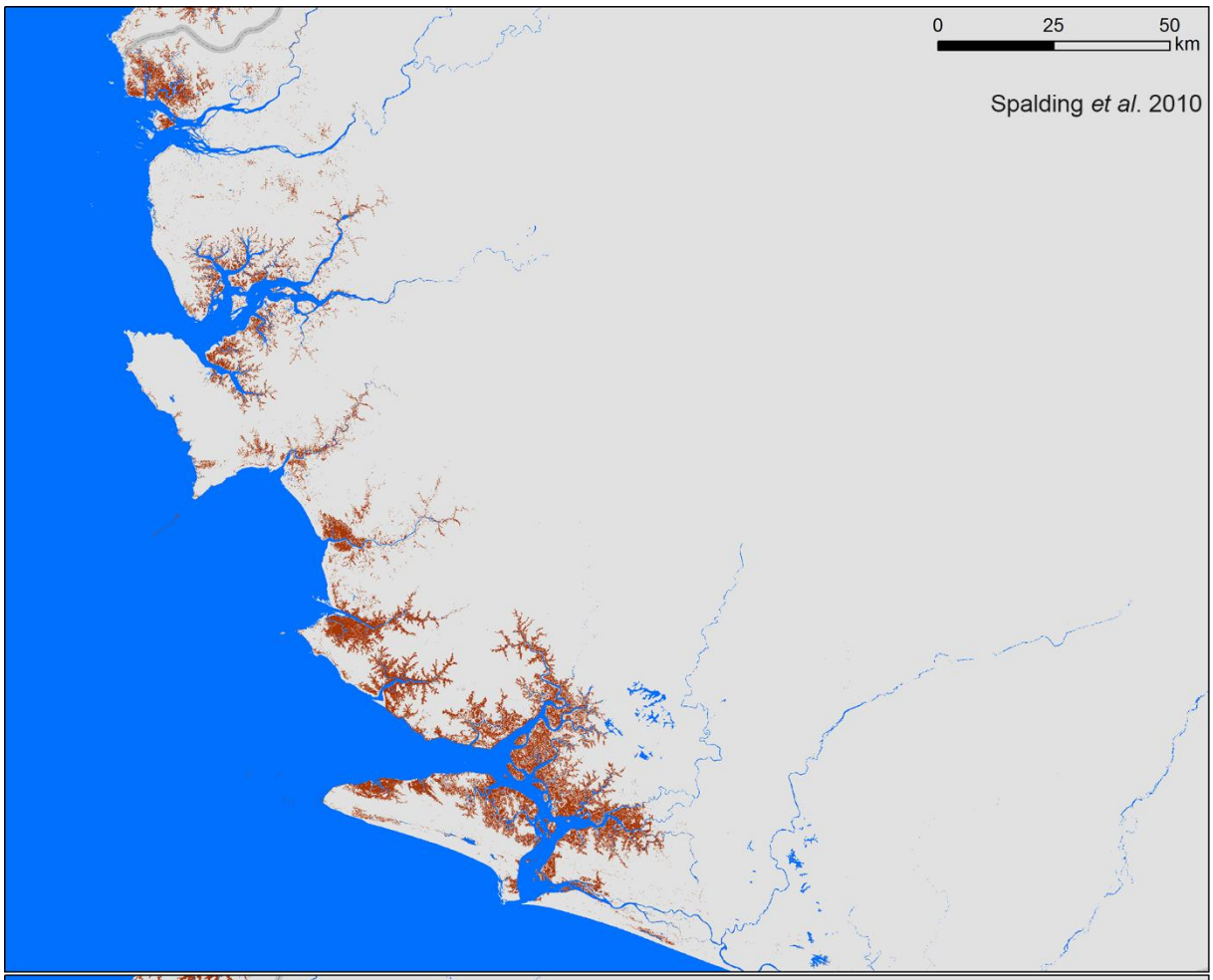
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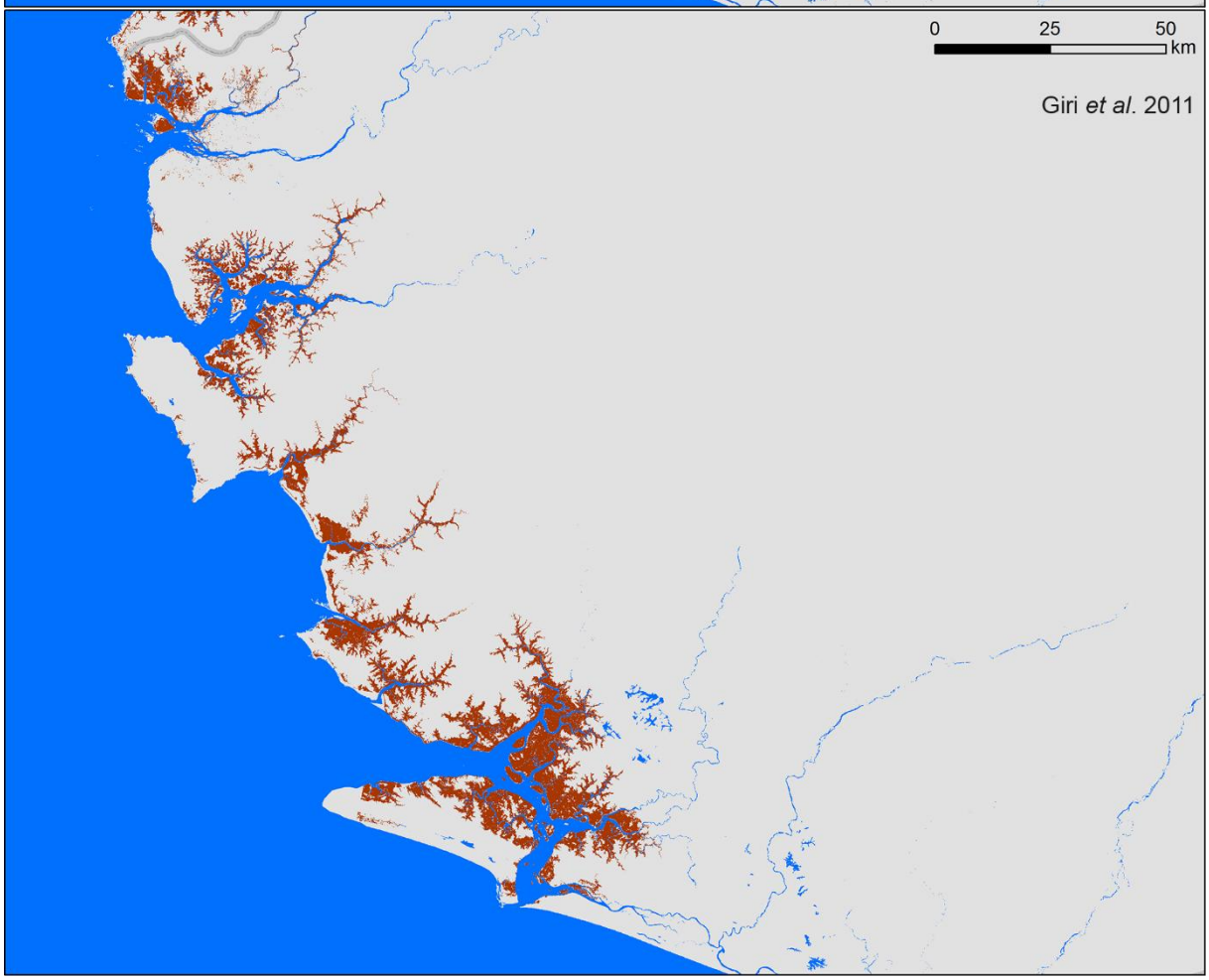
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Fig. 11. Dead mangrove trees in the intertidal zone along the lower Soungrougou River, a northern arm of the Casamance. (Date: 26-8-2008; coordinates: 12.748ºN and 16.037ºW). All mangroves in the middle and upper part of the Casamance and its branches died when during the Great Drought the river flow was reduced and the conditions became hypersaline.

3 Mangrove and the Great Drought

The Somone estuary, situated along the Senegalese coast, 70 km south of Dakar, is small but nicely illustrates the impact of the Great Drought on the mangroves in Senegal. The surface area with mangroves declined from 1.5 km^2 in 1946 to 0.1 km^2 between 1978 and about 1990, to steadily increase thereafter to 1 km^2 in 2006. There was in this estuary in the last ten years no further, or only a small, increase of the mangrove, as can be seen in Google Earth on 12 historical images between 6-4-2003 and 16-10-2013. During the Great Drought period (1969-1993), the discharge of the river Somone went down so much, that the estuary became hypersaline, by which the larger part of the mangroves died off. After the Great Drought mangroves recovered, partly due to actively planting of *Rhizophora mangle* mangroves.

What was seen at a small scale in the Somone, was also the case in the nearby large estuaries, the Saloum, the Gambia and the Casamance. The river discharge of these rivers varies seasonally due to the short raining season. Salinity is more or less stable in the mouth of the estuaries, but further upstream the salinity goes up in the dry season (November-May) due to evaporation, by which there is an inverse salinity gradient within the estuaries and rivers north of the Rio Geba. During the Great Drought, the upper reaches of the estuaries became even hypersaline, causing a mass mortality of mangroves.

The loss of mangroves in the Saloum was large in the first half of the Great Drought, being stable at a low level during the second half of the Great Drought after which the surface area slowly increased at the partial recovery of the rainfall.

The phenomenon of the “inverse estuary” explains why in Senegal and Gambia the mangroves in the river mouth were not affected during the Great Drought and remained stable over a long time: Gambia and Casamance, even over a time span of nearly half a century, while at the same time the mangroves died off further upstream in the Gambia River and increased thereafter. Locally, however, there was a decline of mangroves in the transnational region at the northern and southern border of Gambia between 1986 and 2010 mainly due to illegal cutting.

Similarly to the global trends in Gambia and Senegal, the mangroves in the mouth of the Rio Cacheu (northern Guinea-Bissau) were stable, but disappeared during the Great Drought from its most inland part. Here, the loss of mangrove forest is partly due to tree mortality (likely due to the dry conditions in the 1980s) and for a larger part due to the development of new rice fields at the expense of the mangrove vegetation. A large part of these rice fields have been in exploitation for not more than some dozens of years. The mangrove vegetation has partly recovered since 2000 due to regrowth on bare land and also preliminary recolonisation of the former rice fields. The recovery is evident but things move at a snail’s pace. Hence it may take still many years before the former rice fields have been changed again into mangrove forests from the past.

During the Great Drought the river discharge of the dryland rivers in the north declined relatively much more compared to the rivers from the humid south (Fig. 1). That is why there was no mass mortality in the mangroves along the Rio Geba and further south during the Great Drought period.

Fig. 12. Extensive rice complex fully in exploitation (without abandoned fields) along the southern border of the Rio Geba (24-8-2008; 11.864ºN and 15.387ºW). Mangroves are only found in a narrow strip along the river's edge and on the island in the river.

Fig. 13. Abandoned rice fields along the northern bank of the Rio Cacheu (28-8-2008; 12.204ºN and 16.378ºW). Note that low clay dikes and ditches along these dikes are still visible and that the tree cover of mangroves within the former rice fields is much lower than beyond the former rice fields.

4 Mangroves and rice cultivation

People grow rice along the mangrove coast of West Africa for already 1000 years (Fig. 1, 12). The surface area of the rice polders in Guinea-Bissau has increased in the 20th century at the expense of the mangrove forests, but it was the other way around since the beginning of the anti-colonial war (1963-1974). Since the 1990s many farmers switched to the more profitable cashew and rice fields were more and more abandoned and recolonized by mangroves, especially in the drier north of the country (Fig. 13). A comparison of the satellite images reveal that the mangroves in Guinea-Bissau have increased by about 500 km^2 over the last 30 years. To what degree can this increase be explained by regrowth of mangroves in the abandoned rice fields in Guinea-Bissau? The surface area of rice fields in the mangrove zone amounted to 1810 km^2 in 1976 and 1330 km^2 in 1987, and has declined to 650 km^2 in 2003. Not all abandoned rice fields are covered now by mangroves. On the contrary, the majority of these left fields remain bare, at least for many years. After farmers have left, the dikes remain and the enclosed areas become in fact artificial tannes, being for mangroves too saline to survive the dry season. The historical images of Google Earth can be used again to show how long abandoned rice fields remain bare. One example is given for a complex of rice fields some km west of Bissau city (Fig. 15). In this area the recolonisation took place relatively fast since the dike was broken soon, but were that not the case, the flood cannot enter the area and rice fields may remain bare much longer.

Fig. 14. Farmers do not remove the trunks of all mangroves in recently reclaimed rice fields. The trees die off as soon as the fields are embanked.

During an aerial survey in August 2008, 2200 pictures were taken. Studying these photos again reveals that indeed many rice fields have been abandoned, mainly in the north of Guinea-Bissau and hardly in the south, where still new rice fields are created (Fig. 14). This must explain why the mangroves increase in the northern part of Guinea-Bissau and still decline in the south. Extensive rice fields being abandoned, as observed in the northern part of Guinea-Bissau, were not seen during the aerial survey on the other side of the border, in the Casamance, nor in Gambia.

Fig. 15. Regrowth of mangrove in abandoned rice fields along the northern border of the Rio Geba, some km west of Bissau (11.818ºN and 15.641ºW) as shown on four (of the 18 on 24-5-2014 available) historical images in Google Earth. The area shown measures 780 x 890 m. The dike around the rice fields, still intact on 13-2-2003, was broken before 29-3-2007. Note that mangroves recolonize the bare fields along the ditches and creeks.

5 Planting mangroves

During the field work in January-February 2014 we came across many sites where mangroves have been planted by local people, from the Somone estuary near Dakar in Senegal to the Rio Cacine near the border between Guinea-Bissau and Guinea-Conakry. These sites were usually relatively small so the total surface with planted mangroves must be relatively insignificant compared to the area with natural mangrove vegetation. We learned from our local guides and the participants of two workshops that the people in Senegal are more motivated to plant mangroves than in the south. This seems conceivable. In the north, mangroves are planted in areas where they have disappeared during the Great Drought, while in Cacine, as someone said, “why planting mangroves if you find them here everywhere”.

Planting of mangroves is often supported by international agencies and NGO’s. They can use the historical images of Google Earth to monitor the growth of the planted mangroves (Fig. 16).

Fig. 16. Mangroves planted along the road through tidal flats near Tobor, Casamance, can be monitored afterwards using historical images in Google Earth (Date photo: 21-9-2007; coordinates of images: 12.630º N,16.280º W).

There is one reason of concern regarding the planting of mangrove. People plant *Rhizophora mangle*, since this species produces large seedlings (propagules) which are easy to plant. Much planting has taken place where mangrove forests have disappeared (Sine-Saloum, upper reaches of the Casamance and Rio Cacheu). Unfortunately, *Rhizophora* is vulnerable to hypersalinity and the trees will certainly die off at the next Great Drought. Hence it would be better to plant the less critical mangrove *Avicennia germinans*, but local people involved in planting mangroves told us that either they had never tried or that it would be much more time-consuming.

Fig. 17. A large colony of Pink-backed Pelicans in a dense mangrove forest in the NW part of the Casamance (24-8-2008; 12.864ºN and 16.704ºW).

Fig. 18. Idrissa N'diaye in dense *Rhizophora* mangrove searching for small birds.

6 West African Mangroves: a hotspot for European birds

Mangrove forests are important bird areas. Waders, herons, egrets, storks, cormorants and kingfishers feeding in the surroundings, use mangroves as a safe roosting site. More than one million waders, feeding at low tide on the extensive, bare intertidal flats in West Africa, are nearly all concentrated in the mangroves during the high water period. The same applies for even larger numbers of birds which search for food in the coastal rice fields and use the mangroves as nocturnal roost. The mangroves are hardly accessible for people, which explains why a species, such as the Goliath Heron which has disappeared from inland West Africa, is still found in the coastal zone. Another example is the Pink-backed Pelican of which some breeding colonies are found in the mangrove forests (Fig. 17). This is all well-known and it is also the reason why, for instance, Gambia is visited by so many ornithologists from all over the world.

Hardly known is that the mangrove forests harbour many small birds feeding on insects. The species are not conspicuous and difficult to see in the dense foliage of a mangrove forest (Fig. 18). To know how many are present, it is necessary to do precise counts in small areas with known surface. That was exactly what we did in the *Rhizophora* and *Avicennia* mangroves in Senegal (Senegal Delta, Somone estuary, Saloum estuary, Casamance) and Guinea-Bissau (Rio Cacheu, Rio Mansoa, Rio Geba, Rio Grande de Buba, Rio Cacine).

The bird density of these small- insect-eating birds in West African mangroves appeared to be higher in *Avicennia* (21 birds/ha canopy) than in *Rhizophora* (11 birds/ha). That was also to be expected since the leathery leaves of *Rhizophora* attract fewer herbivorous insects than the succulent leaves of *Avicennia*. From an ecological point of view it is a pity that people plant *Rhizophora* and not *Avicennia*.

The West African mangroves harbour not only local birds, but also migratory bird species breeding in Europe and Asia and spending the northern winter in Africa. The European birds are dominant in the most northern mangroves (14-16˚N), but further south resident birds become as numerous as migrants. The European Reed Warbler is the most common winter visitor in West African mangroves between 12 and 16˚N, with an estimated total of 4-6 million birds, being 30-50% of the European population.

An analysis of the ring recoveries showed that the mortality of European Reed Warblers while crossing the Sahara desert in spring is higher when the Sahel is drought-stricken; apparently, insufficient body reserves can be built up then. This seems to be a reasonable explanation for bird species like Barn Swallow or Yellow Wagtail which prepare their flight over the Sahara in the Sahel, but why should a species like the European Reed Warbler, not present in the Sahel in winter and spring, be hit in dry years, and even more than other species? Given the millions of dead mangrove trees in the Saloum and Casamance during the Great Drought, it is well conceivable that insectivorous birds depending on these mangroves suffer during these dry years and must have had problems to fatten up. Reed Warblers appear to move in such disaster years to mangroves further south being not stricken by the drought, but the drought-related mortality during the spring migration suggests that such a southward shift of their wintering area does not prevent an enhanced mortality during their return flight to Europe. Mangroves are essential in their annual life-cycle, thus in the survival of bird species, even if they breed 7000 km away.

7 Conclusions

The total surface of the mangrove forest along the West African coast (Senegal – Sierra Leone) is estimated at 8000 km^2.

Many mangroves have died off in the northern estuaries (Senegal, northern Guinea-Bissau) during the Great Drought (1969-1993), mostly further inland but not near the sea. The explanation is that during the Great Drought the river flow was reduced by which the soil along the lower rivers became too saline for mangroves. Mangroves have partly recovered from these losses after the partial recovery of the rainfall since 1994.

Farmers in West Africa grow rice in the mangrove zone for already 1000 years. The total surface area of these rice polders amounts to 4000 km^2. Its surface area has increased in the 20th century at the expense of the mangrove forests, but it was in Guinea-Bissau the other way around since the beginning of the anti-colonial war (1963-1974). Since the 1990s many farmers switched to the more profitable cashew and rice fields were more and more abandoned and recolonized (albeit slowly) by mangroves. Making holes in clay dikes might facilitate regrowth of mangroves in left rice fields.

Locally, replanting of mangroves has led to restoring of mangrove habitat. There is one reason of concern regarding the planting of mangrove. People plant *Rhizophora mangle*, since this species produces large seedlings (propagules) which are easy to plant. Much planting has taken place where mangrove forests have disappeared (Sine-Saloum, upper reaches of the Casamance and Rio Cacheu). Unfortunately, *Rhizophora* is vulnerable to hypersalinity and the trees will certainly die off at a next Great Drought. Hence it would be less risky when people plant the less critical mangrove *Avicennia germinans*.

The ecological significance of mangroves is obvious. To the list of ecological values can be added: important wintering area for some small insect-eating bird species breeding in Europe and Asia which are concentrated in West-African mangroves during the northern winter. The European Reed Warbler is the most common winter visitor with an estimated total of 4-6 million birds, being 30-50% of the European population.

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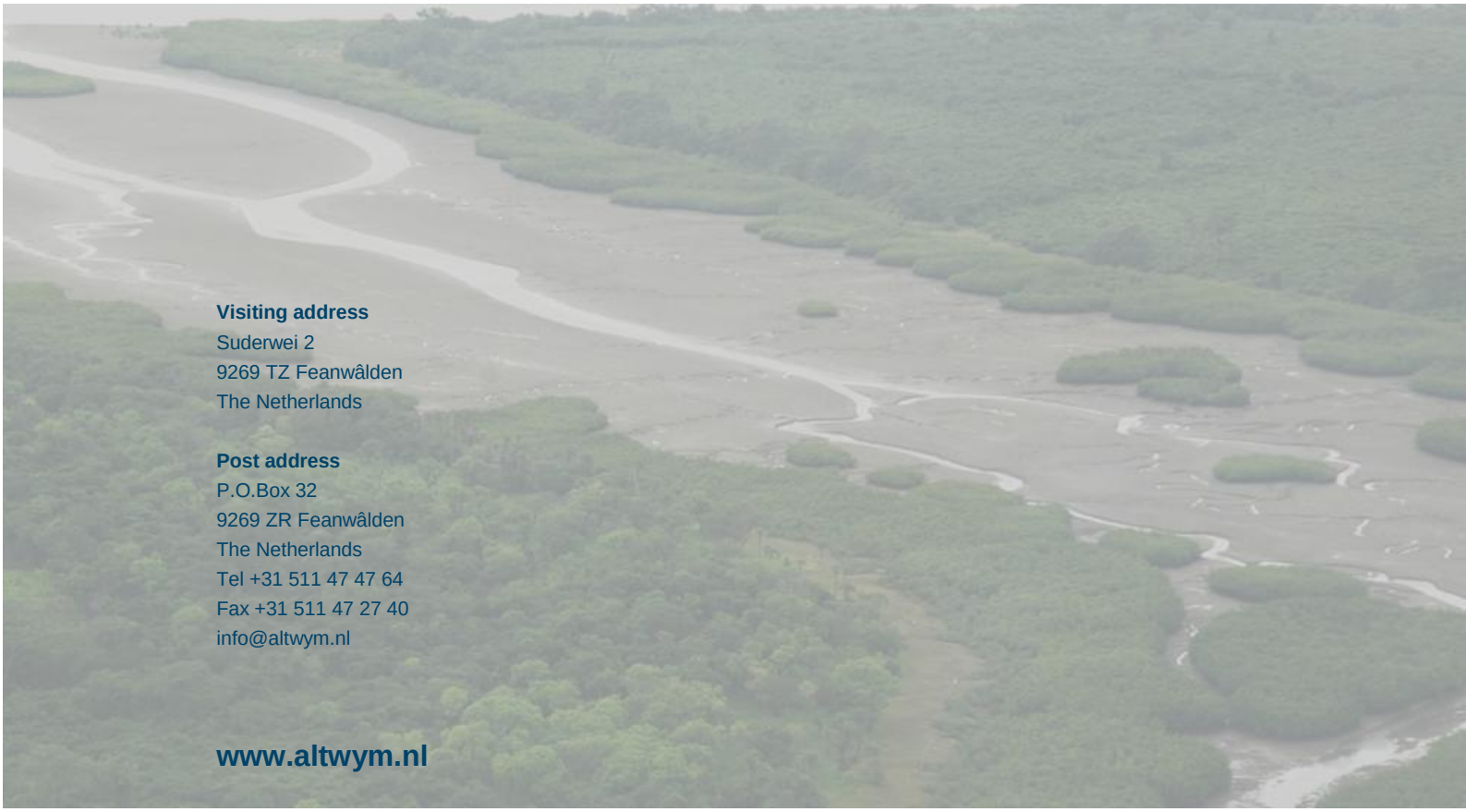

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