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CASE STUDY OF COASTAL EROSION AND SEDIMENTATION IN THE GAMBIA

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National Environment Agency

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I. BACKGROUND OF CASE STUDY

1.1 BACKGROUND INFORMATION

The Gambia lies in the West Coast of Africa and its coastline extends from the mouth of Allahein River (San Pedro River) in the South at 13" 4' N, to Buniadu Point and KarentiBolong in the north at 13'31'56"N. The Coast line of the Gambia is about 80 km long, and 25 km of this lie in the bay-shaped mouth of the Gambia River and the rest facing the Atlantic Ocean. It has an 80 km wide continental shelf which separates the coast from the deep ocean.

The coast line of the Gambia is flat generally, with low dunes being common in the area.The coast line is mostly sandy and of unconsolidated material which are easily eroded. Serious coastal erosion has taken place at some sites and the annual beach retreat is on the average 1-2 m/year along the coast line. Like any other coastal state, the population density is high and increasing along the coastal zone. This has its implications as human activities along the coast line contribute greatly to the rate of erosion. Natural, ware action and man-induced erosion has destroyed the second Banjul Muslim Cemetery, and nearly all the hotels and Fish Landing sites, and the newly constructed highway are all threatened by coastal erosion.

Fisheries sector is very important and therefore developing rapidly. It contributes a lot to the national economy. The continental shelf is 3,855 km^2 and is considered to have a rich fishing zone. The fisheries sector has become an important foreign exchange earner with 1989/90 exports estimated at US $23 million. There are six major fish landing sites along the coastal zone which are threatened by coastal erosion, and these are: Brufut, Tanji, Batokunku/Tujereng, Sanyang, Gunjur and Kartong.

Tourism is fast developing along the coastal zone. New hotels are being built along the Tourism Development Area, and there are 15 newly built hotels which may all be affected by coastal erosion. Some of them are already threatened. The number of tourists have increased from 27,000 in 1974/75 to 74,000 in 1984/85, and is now estimated to be over 100,000 annually. In 1990/91 it was estimated that Government collected about D 48million (US $ 5.3 million) in direct and indirect taxes from tourism amounting to 10 percent of Government revenue. This sector provides employment for over 7,000 people half of which are directly employed by the industry.

As construction industry also expands its activities on the coastal zone, there needs to be proper planning and assessment of sites before construction to mitigate damaging effects of coastal erosion as is being experienced now with structures too close to the sea-front. The effect of coastal erosion is felt in other areas such as the annual land loss which is valued at D 100,000-D 300,000 or US $ 20,000 - 30,000. It is therefore important that concerted efforts are taken to protect the coastal zone for posterity.

Measures to combat the erosion have been implemented since the mid-fifties. Most of the measures implemented, either by the private sector or by the Government, were on an ad-hoc basis. In 1957 rhun tree piles and concrete panels' groynes were constructed near the old Muslim and Christian cemeteries.

Later, similar protection measures were put in place at several places along the coast between Cape Point and Banjul (Sunwing Hotel, outlet of the Oyster Creek, Atlantic Hotel and the sea front north of Banjul Town). Most of the groins have become ineffective, if they not already were, due to a lack of maintenance.

In the nineties coastal erosion of the coast of The Gambia becomes a more and more serious treat. The Government of The Gambia collobrated various partners including Delft Hydraulics to addresse the matter in 1994, with the Danish Hydraulic Institute in 1996, by the Department of Water Resources, Banjul, and in 1996 with UNEP/FAO/PAP in 1998.

1.2 OBJECTIVES OF THE STUDY

The objectives of the study were to (i) Determine the causes of beach erosion and sedimentation along the Gambian coastline including sedimentation near the ferry terminal crossing point at Barra. (ii) Recommended protective measures to mitigate the problems. (iii) The study further focus on technical feasibility, economic viability, and environmental impact of the protective areas.

II. STUDY AREA

2.1 PHYSICAL CHARACTERISTICS (GEOMORPHOLOGY)

The Coastal Zone of The Gambia extends from Buniadu Point and the Karenti Bolong in the north to the mouth of the Allahein River in the South. The Gambia has 71 Km of open ocean coast and about 200 km of sheltered coast along The Gambia River and is bounded on both sides by Senegal. The sheltered coast is dominated by extensive mangrove systems (66900 ha: 15000 ha of high mangroves and 51900 ha of low mangroves) and mud flats.

The subsurface geology of The Gambia consists almost entirely of nearly flat-lying sedimentary beds. , dipping gently and also thickening gradually to the west (Whyte & Russel 1988). During an earther high stand of the sea, rias formed along the lower portion of the River Gambia, the Nigie Bolong, and the Allahen and Tanji Rivers. Today this area is characterized by depostional strand-plan ranging in width from 200 to 400 m in the Batokunku area and from 500 to 800 m in the Sanyang and Kartong areas. Therefore, beach erosion in response to sea level rise will not be a problem in these areas.

Most of the beaches consist of medium to fine, white, well-sorted sand comprised of nearly pure quartz grains. Other beaches are characterized by concentrations of cockle (Acra seneliss) shells, resulting in a well-sorted yellow sand. Beaches are often bounded by rocky headlands, composed of sandstone and laterite rock. Large block of sandstone or laterite lie scattered in the near-shore, at Sanyang, Cape Point and Solitor Point. These blocks also occur as offshore island such as the Bijilo Islands.

The Banjul spit is considered to be a Holocene-age feature. The upper 4 m consists predominantly of sand, with isolated bands of clay. At 4 m depth a compact fine to very fine sand occurs, and below 7 to 8 m of clay dominates. Therefore, Banjul -the capital city has been constructed on a low-lying barrier landform that is entirely composed of erodible sedimentary materials.

The coastline had been divided into four segments S_1-S_4 respectively representing segments 1-4 with the northern-most segment referred to as S_1, followed by S_2 just south and so on.

The coastal zone of segment S_1 (13° 35' 21.99''W, 16° 32' 47.79''N to 13° 29' 07.91''W-16° 32' 41.13''N) comprised essentially of the Essau formation. The width of this rock unit is about two kilometers. It is in direct contact with the older Farafeni and Yundum formations. The coast here is N-S orienting with streams cutting through the generally sandy and clayey Essau and Farafeni formations respectively. The morphology of S_1 is dominated by a crescent shaped beach, typical of a beach under recession and probably under attack from Atlantic waves (TAMS Consultants, 1998).

Segment S_2 bounded by coordinates 13° 25' 30.73''W, 16° 43' 42.90''N to 13° 23' 30.17''W-16° 45' 56.97''N, on the South Bank of the River estuary. S_2 starts from Banjul and ends at Bijilo. From Banjul to Cape point the Essau formation is in direct contact with the Farafeni formation that stretches landwards for kilometers. The orientation of this part of S_2 is in the east-west orientation and is subjected to easterly littoral drift induced by the north-west Atlantic swell and assisted by tidal currents (TAMS Consultants, 1998).

The main geomorphological features in this area are the barrier spits and island systems which, according to Jallow et al 1996, are formed by long-shore sediment transport from Cape St. Mary eastward towards the River Gambia. Erosion and accretion are common features in and around these areas resulting in a constantly changing coastline. The most likely causes for this erosion and accretion are the very oblique wave attack, the presence of protruding points, and the declining capacity of the Gambia River (TAMS Consultants 1998).

Between Cape Point and Bijilo section of S_2, stretching over 10km, the Essau formation with its width reduced to less than a 50m is in direct contact with the Yundum formation which extends for kilometers landward. This section of the coast line is NE-SW orienting and is characterized by active erosion from the direct wave action affecting the cliff sides (Jallow et al. 1996).

At Bijilo, an outcorp of the Sapu formation stretching for about 7 kilometers parallel to the beach, is encountered. It has a small strip of the Essau formation seaward and an extended Yundum formation landward. The Sapu formation here is NE-SW orienting and experiences extensive erosion (Jallow *et al* 1996).

At the southern most section of S_2, accretion from the large supply of sand formed sand spit at the mouth of the Tanji River (Jallow *et al*, 1996).

2.2 HYDRO-SEDIMENTARY/COASTAL CELL DESCRIPTION

The coast line is divided into 9 coastal cells on the basis of their geomorphic characteristics and vulnerability to sea level rise impacts. Some of these delineations are based on the UNEP/OCA PAC Report. (Quelennec 1988). The coastal cells are as follows :

1. Buniadu Point to Barra Point (cell 1)

The North coast between Buniada Point and Barra Point consists of a low barrier beach with a low and relatively undeveloped hinterland. Erosion is reported at the holiday camp (near Buniadu Point) as well as at the location of the fort (near Barra), giving the impression of an overall retreat of this coastal section. Sufficient aerial photographs are not available for this area to derive shoreline trends. Available photographs from 1992 (taken from the air) of this part of the coast have been compared with pictures taken during the coastal protection project. Though no accurate trends can be derived from these photographs, the general impression is that some erosion has occurred. Especially near the mouth of the stream, just north of Barra Point, dynamic behaviour of the shoreline can be observed.

The area located immediately east of Barra Point has accreted in the last decades. This accretion can be directly linked to the blocking of the sediment transport by the old jetty and the Barra ferry terminal next to it, both located about half a kilometre east of Barra Point. The small pocket beach located east of the ferry terminal is trapped between two hard points, the Barra ferry terminal at the western end and a rocky headland at the eastern end. No significant change is observed between the situation of 1972 and the present situation.

2. Banjul Port to Banjul Point & Oyster Creek (cells 2)

The area south of the Banjul ferry terminal is mainly Port area. North of the ferry terminal the coast is accreting. The historical aerial photographs clearly show a "sand wave" in this area propagating from north to south. In 1983 serious accretion is noticed starting from a jetty location some 200 m south of the old government wharf. On the aerial photographs of 1983 and 1993 it can not be noticed what kind of activities were going on at that location but in that period a considerable amount of sediment accumulated near the old government wharf. On the photograph from 1993 it can be observed that the old government wharf is completely "embedded in the sand.

Banjul Point can be defined as the transition between the (roughly) east west and the north south oriented coast of the city. Its position can be expected to fluctuate somewhat with the passing of above-mentioned sand wave.

Before the coastal protection project started, the area between Banjul Point and the Oyster Creek (Denton Bridge) consisted, of narrow beaches, with (damaged) groins and local revetment. Characteristic sites along this coastal stretch are the Atlantic Hotel, the Christian Cemetery, the Muslim Cemetery, Scouts Section, Radio Syd and the New Muslim Cemetery. This coastal section was eroding severely.

This erosive trend increases towards the west. In this area the shoreline behaviour in the period 1972-1983 differs significantly from that in the period 1983-1993. In the first period no significant erosive trend was found, whereas in the latter period erosive trends become significant, up to a retreat of 3 m/yr locally. This change in trend can be explained by the development of the Sand spit east of Oyster Creek from the1980's on. Due to the "capture" of sand (coming from the west) in this Sand spit, the down drift area (located east of the spit) is deprived from the main part of its sand supply. The considerable erosion rates in this area were therefore directly related to the development of the Sand spit (at Tolls Point),

interrupting the continuity of the sediment transport along the Banjul Beach. Evidence of erosion could be clearly observed: Part of the Muslim Cemetery disappeared and Radio Syd and the Scouts Section were protruding into the sea. In 1983 these objects were still protected by a (narrow) beach. In 1999, at one location just east of the sand-spit, the shoreline was located only approximately 10 m from the Banjul high way.

It should be noted that the sand-spit east of Oyster Creek started to develop from 1983 on (as demonstrated clearly by the aerial photographs). Its development was likely to be the result of a relatively large sediment supply in combination with a period of oblique wave attack on the coast. Aerial photographs of 1946, 1960, 1972 and 1983 show that in these years a (pronounced) spit was not present.

The above situation changed from September 2003 – March 2004 during the implementation of the Coastal Protection Project. A total volume of 1,4 million cubic meter of sand has been supplied on the beach which formed a new wide sandy beach and protected buildings, hotels, cemeteries and the road against further destruction.
Also the continuity of the sediment transport along Banjul Beach has been re-established by constructing the so-called S-curve. An over 100,000-m2-triangle area of the Sand spit was excavated to CD – 1.50 m nourishing the area in between the Sand spit and Radio Syd.

Due to the "capture" of sand the Sand spit growth in length, in eastward direction, and created a lagoon inside the original coast behind the spit became shielded against direct wave attack (Palm Grove Hotel, Laguna Beach Hotel (former Wadner Beach Hotel). Nevertheless, locally some erosion occurred, mainly near the lagoon inlet, due to effects of currents at the inlet of the lagoon.

The beach between the spit and Oyster Creek has shown a significant retreat in the period 1983-1993. This is most likely the result of sand mining during this period for the construction of the Serekunda-Banjul highway.

From the start of Sand spit presently a large sand bar, up to some 500 m into the ocean, is present, bending at the outside part towards to Cape Point. This bar is part of the morphological game that the tidal currents of the Oyster Creek play with the sand wave, transported by the ocean waves, from West to East. See also Chapter 4.5.2. for more details on that morphological situation.
The bar is easy accessible for a walk at low tide. At the ocean side of it lots of birds have their habitat.

3. Oyster Creek to Cape Point (cell 3)

In the area between Oyster Creek and Cape Point the main part of the shoreline consisted of large sandbars backed by mangroves. As could be observed at several aerial photographs (1946, 1983, these bars are directly connected with Cape Point via large sand bars which make a "shortcut" between Cape Point and the mangrove area. These "offshore" bars do form a transport system from which the main part of the sand transport at Cape Point is bypassed to the eastern coast (Haskoning, 2003)

Immediately east of Cape Point the Sunwing Hotel, Cape Point Hotel, Maritou Casino and

Calypso Beach Restaurant are located close to the shoreline. This area forms the up drift attachment of the above-mentioned bypass bars at the cape. The beaches just east of Cape Point should therefore not be considered as "normal" beaches but as part of the large-scale sand bypass system along Cape Point. By their nature, (submerged) sandbars are dynamic features. The aerial photographs show different shapes, sizes and positions of the bars in the different periods. The dynamic behaviour of these large sandbars affects the behaviour of the small beaches east of Cape Point (which form only a small part of this sand bars system). The sandbars have a tendency to move in a landward direction. In this process their attachment with the cape will move southward. This has occurred for example in the period 1983-1993, causing considerable erosion of the beaches in front of above-mentioned facilities. This could continue until a new bar develops at the northern tip of the cape. Would this occur, the beaches east of Cape Point would become relatively wide again naturally. The development of a new bar requires a considerable sand supply and therefore considerable time. These cycles of new bar development at the point of the cape are likely to have a period in the order of decades. Due to the above large-scale phenomena the beach width in the hotel area east of Cape Point can be expected to show large variations. The area was in late nineties clearly in an eroding phase and the beaches were very narrow or absent. This situation had to be changed.

Rock Protection Scheme Cape Point
At cape point, a new coastal protection scheme has been designed and implemented. It consists of a 300 m long rock revetment at the west side and the cape itself and connecting with the northern groin of a 5 groins scheme.
Instead of an expected infill 50,000 m^3 excavations had to be carried out to construct the groins at the design level. A considerable infill of the new beach pockets was done by nature in less then half a year. In such a way that the new soil levels around the head of the groins are above Chart Datum.

The revetment at Cape Point is built with an under layer of basalt rock, grading 10-60 kg, placed on geotexile. The under layer of the revetment is covered with an armour layer of basalt rock, grading 100-500 kg. The specific weight of the rock is close to 2,900 kg/m^3. The upper berm is situated at the level of CD+3.50 with an extended splash berm. This splash berm connects with the laterite rock protection placed on the slope above the revetment. The laterite slope reaches the present ground level around the hotel area; The ground level of the hotel area varies from CD+7.00 m at the start of the revetment to CD+4,50m at the Cape.

At Cape Point's bend the revetment follows this bend. The toe berm was lifted to run over the laterite shoal at the Cape's bend. This was done by reducing of the length of the slope. After the bend the revetment smoothly connects to the most northern sea groined. This northern sea groined has a length of 120 m and an orientation of 130 N. The length of other four groins is 100 m. The orientation of the four southern groins is 70 N. The distance of the gap between the most northern groined and the next groined and between the four groins is 120m. The groins are emerged at CD +2.50 m, sloping the last 10 m of the head end to CD +2.75 m, and have a wide body at the head in order to create diffraction zones behind the structures. The heads of the groins are constructed at the level of approximately CD-1,50m. The root ends at the level of CD + 1.50 m.

At the southwestern end of the revetment, the first groined is connected to an existing sloped literate protection wall. This wall has been improved at the out side part of this

groined order to provide sufficient protection to root end of the structure and land area behind it against erosion effects, which this area will suffer until the pocket beaches of the groins are completely filled up and the continuity of the sand by-passing restored.

The coastal intervention has let to the forming of a wide sandy beach, which is very attractive for recreation. The hotel buildings are now adequately protected, also against erosion processes, which also can occur at this part of the Gambian shoreline.

4. Cape Point to Fajara (cell 4)

The cliff coast between Cape Point and Fajara used to be subject to cliff erosion. Retreat of cliffs due to wave action is not a continuous but a stepwise process, governed by hydrodynamic and geotechnical phenomena occurred, Waves are undercutting the toe of the cliff until the cliff becomes geotechnically instable and a significant part of the cliff slides off. Several years may pass without significant cliff retreat, while in one year a retreat of several metres may occur. At some locations a natural (partial) protection of the toe of the cliff has been formed by relatively resistant fragments that form a (partial) toe revetment or in some cases small groins. Between some protruding points ("headlands") along the cliffs narrow sandy pocket beaches are present. Of these pocket beaches only the beach at Bakau has some width above Mean High Water. Between the headlands the cliff alignment has developed to the typical shape of pocket beaches, more or less normal to the incoming waves. This allows the sandy beaches to remain in their pockets almost parallel to the cliff. This shape of the cliffs indicates that wave attack has had an effect on cliff erosion (on a geological time scale). However, there is also very clear evidence of erosion due to rainwater runoff. At many locations channels scoured through the cliff can be observed.

On the basis of detailed aerial photographs of 1946 and 1993 it can be observed that on average the cliff has retreated in that period over a distance of 20 to 30 m, indicating an average retreat rate of 0.4 to 0.6 m/yr. At some locations no significant retreat was found (0 m/yr.), while at one location a retreat of 40 m was measured (0.9 m/yr.).

In order to reinforce the headland and to guarantee indirectly a minimum beach width for fishing boat landings at Bakau Fishing Boats Landing Site, a T-groined is constructed at Bakau in 2003-2004.

The T-groined at Bakau consists of an under layer of rock grading 60-100 kg which is placed underneath the 2-5 ton section of the T at the sea side. The landside of the root of the T-groined can be spilt 2 sections. A section connecting the sea side of the T-groined, at a level of CD+1.50 m, constructed with basalt rock 300 – 1000 kg and a section connecting the land side, constructed with literate rock 60-300 kg. The latter slopes from CD+1.50 m to approximately CD+3.50 m at the connection with the cliff.

5. Fajara to Kololi Point (cell 5)

Between Fajara and Kololi Point the beach is sandy. At Kotu Point, more near to Kololi Point, a large submerged reef (reaching approximately 1 kilometre into the sea) causes a sharp local protrusion of the shoreline. This protrusion is sandy, implying that the reef does not interrupt the dry beach. A similar situation is present at Kololi Point.

Characteristic sites along this part of the coast are the Fajara Hotel with next to it Leybato restaurant, the Bungalow Beach Hotel, the Novotel Kombo Beach Hotel and the Kotu Strand Hotel. Recently a blue glass coloured building was built, to close to the shoreline. It is very dominant present and the front part of the terraces already damaged by the sea before the finishing the building.

This coastal section just south of the Fajara-Bakau cliffs seems to be slightly erosive, while further southward no significant erosive trend can be determined and no signs of severe erosion are observed on the beach. Between Kotu Stream and Kotu Point the position of the shoreline has fluctuated considerably. Kotu Stream deposits sand in the rainy season in an area that is partly sheltered for southwesterly waves by the submerged reef. Re-distribution of the river yield in this area is therefore a relatively slow process. The relatively stable position of the shoreline in the area around and just north of Kotu stream is considered to be due to the sand supply by the stream. No coastal protection structures are present along this stretch.

Also along the coast between Kotu Point and Kololi Point no structures have been built to protect the sand beach. A small net erosive trend is found for this area, though also with some fluctuations with time. Similar to Kotu Point, the sharp bend in the shoreline at Kololi Point is caused by the large submerged reef. However, both Kotu Point and Kololi Point are not really fixed points in the shoreline. The shoreline at Kotu Point and Kololi Point is sandy and should be considered as spots that can retreat. Wave breaking and wave refraction on the submerged reefs cause their protruded position.

6. Kololi Point to Bald Cape (cell 6)

Between Kololi Point and Bald Cape no coastal protection works were present for the long time, except for local sandbag revetments in front of the hotels. In particular the sand bag protection in front of Senegambia hotel was impressive as was the concrete wall in front of Kairaba hotel. Both, however, could not stop the effects of erosion.

Characteristic sites along this section are the Senegambia Hotel, the Kairaba Resort Hotel, the Holiday Beach Club Hotel and the Kololi Beach Club Hotel. The shoreline was retreating. In the hotel and bar area just south of Kololi Point an average retreat rate of 1 m/yr. was found. This trend increased from approximately 0.5 m/yr. in the period 1972-1983 to 1.5 m/yr. in the period 1983-1993.

In the central section an average retreat of approximately 3 m/yr is derived. The main part of this erosion has occurred in the period 1983-1993. The sharp wave cut berm provides evidence of this erosive trend. In the past, massive sand mining from the beaches has been carried out between Kololi Point and Bald Cape, which has contributed to this erosive

trend. Though since 1996 sand mining is prohibited, illegal sand mining continues in this area.

In 2003, extensive beach nourishment has been carried out at Kololi, as part of the Coastal Protection Project. A total amount of 1 million cubic meters of sand has been supplied. The beach at Kololi was constructed at an average level of CD+4.0m, over a length of approximately 1.5 km, starting from Kololi Point.
At the hotel area the levels vary to connect the beach with local levels of each of the hotels. The function of the nourished beach is to protect the infrastructure behind the beach. The nourished beach acts as an erosion buffer. The nourishment has also spread out and fed adjacent coastal stretches during the process of reaching a final stable profile under the present wave and tide regime at the location.

In front of the two storm water drains the beach level has been lowered in order to allow for free flow of the storm water towards the sea during the rainy season. The owner of the Kairaba Resort hotel also installed a 6" PVC pipeline toward the sea to serve a small pumping station of the hotel. (They are also considering installing a larger pump suitable for the distance to the sea,) The pipeline can be removed after at the end of every rainy season to keep the shoreline beach free of visual and physical obstacles when not necessary.
In the southern part of this coastal section, just north of Bald Cape, a trend of accretion is present. In this area the sheltering effect of the Bijol islands and the extensive offshore reef system (partly emerged) considerably affect shoreline development. Waves break and refract on the reef. Since approximately 1970, Tanji stream deposits sediments in this relatively sheltered area during the rainy season. Before 1970 the mouth of Tanji stream was located south of Bald Cape.

7. Bald Cape to Kartong (cell 7 to 13)

The beach between Bald Cape and Solifor Point has been relatively stable. In the last decades the mouth of the Tanji River has moved from a position in the centre of this section to the north, and is now debouching just north of Bald Cape. The most northern part of this coastal section consists of a narrow spit, separating Tanji River from the sea. South of Tanji village cliffs back the beach. No signs of recent erosion are observed in this section. Still, this part of the coast is considered to have been slightly erosive, amongst others due to the loss of its sediment source the Tanji River.

Solifor Point is a hard point in the shoreline, where the sandy beach is interrupted by a cliff and laterite rocks. This coastal section is affected largely by the Bijol Islands, sheltering for northerly to northwestern waves, and by the partly submerged reefs of Solifor Point, sheltering for southerly to southwesterly waves.

The coast between Solifor Point and Sanyang Point is a nice beach backed by low dunes, approximately 1 to 3 m high. No specific sites are present along this part of the coast. No signs of recent significant erosion were observed during the inspection.
The protruded position of Sanyang Point is due to (partly emerged, partly submerged) reefs, which locally keep the coast fixed.

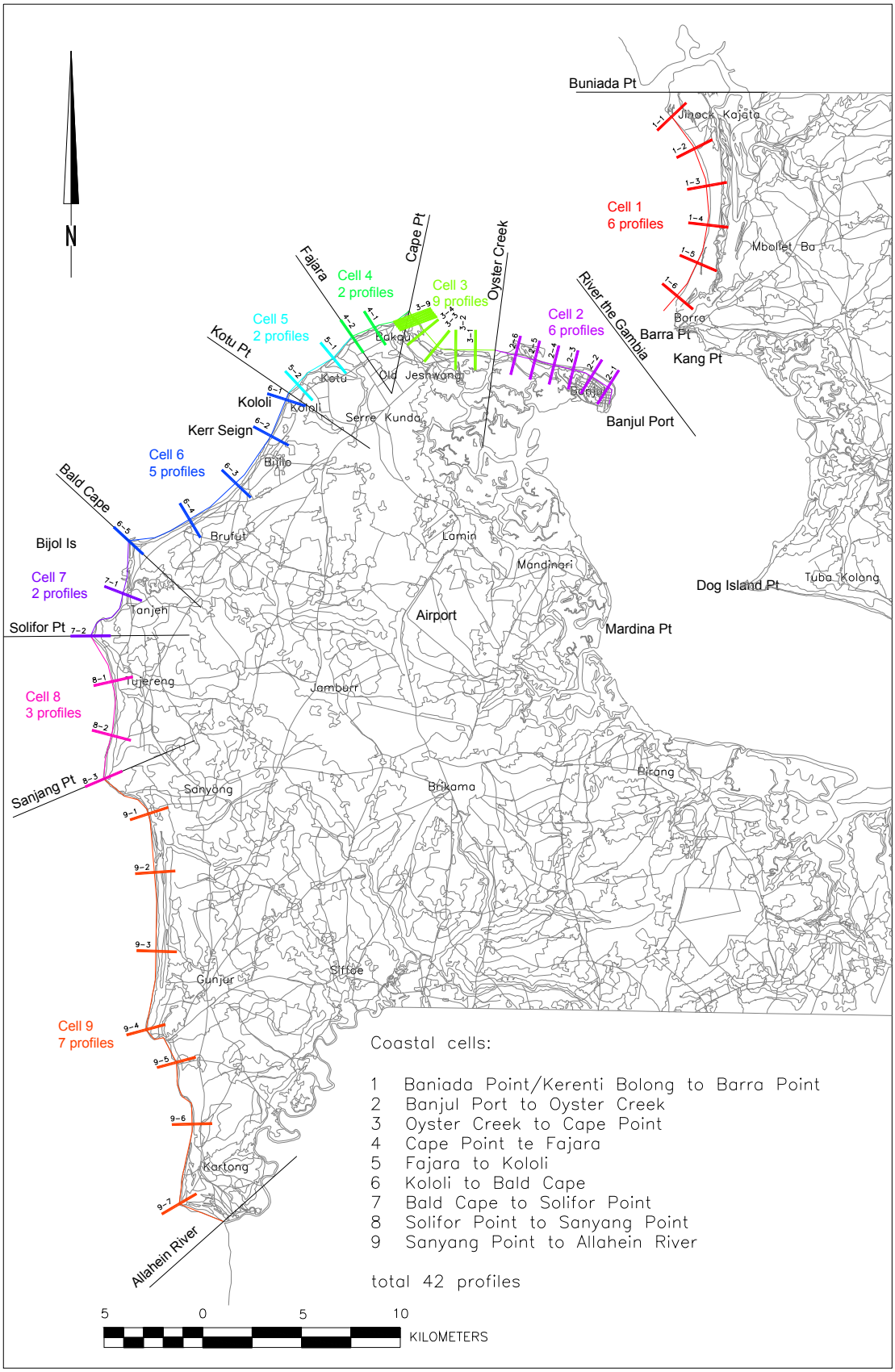
The coast between Saniang Point and Kartong has been inspected on specific locations only. Immediately south of Sanyang Point a laterite rock revetment built on the beach

protects a compound. However, according to the owner of the adjacent beach bar no noticeable retreat of the shoreline has occurred in at least the last 5 years. Estimates of shoreline movement made by bar owners along this part of the coast vary between 0 and 1 m/yr.

These estimates give the impression of a slowly eroding coast between Bald Cape and Kartong, with a retreat rate in the order of 0.5 m/yr. In the absence of significant sand supply sources along this stretch, such small erosive trends can be expected due to sea level rise and small gradients in long shore transport.

This beach section runs in fact from Sanyang Point up to the southern border with Senegal. Different from the general north south orientation of this part of the Gambian beach the last section of some 3.5 km runs more or less east –west.

Fig 1 : Showing the nine (9) coastal cells.



2.3 LAND USE

1. Overview of Land Use Planning

Land is one of our most precious assets. Land stands for property and is a production factor besides labor and capital. It is also an object that is taxed and is therefore desired by government and interest groups; it is a target for different competing users. Land is finite in extent, but the number of people competing for it is still increasing. The Gambia has a total land surface area of 1,037 million square meters but its population has doubled between 1975 and 1995.

With an actual growth rate of 2.8%, it is expected to double again and reach the mark of 2 million by the year 2020. Given the increasing population and competition for land, there is a need for planning and regulation in order to avoid future conflicts. The objective of national land and land use policy is to optimize the sustainable use of land in line with the legitimate needs of all stakeholders, but within the long-term development objectives of the Government.

The Government through the Minister for Local government and Lands has the mandate to design, designate and even make declaration as a measure to control land use and as well as urban sprawl. This is done by means of one of the three strategies of the land use plan 2000 whereby bigger plots are subdivided into smaller plots to meet the urban plot standard of 250 meter square to 500 meter square to prevent urban sprawl. Controls are also done by means of provision of layouts for any parts of the country, provision of community plans and upgrading strategy. Preservation strategy involves conservation of the following: forest, gardening and rice growing areas, green belts, minerals and water resources, special land use features, historical or religious sites, etc. Land conflicts or speculations: this happens within the unplanned industrial, institutional, commercial and even agricultural zones.

Land Use Act, 1991: This indicate that Government to acquire land for certain public purposes. Any private land acquired for public use must be adequately compensated. While the Physical Planning and Development Control Act 1991, also provide legal basis for the systematic preparation of layouts and effective development control mechanism particularly buildings and, this regulations must be followed by all developers. Both the Physical Planning and Department of Land and Surveys regulations are all enforceable for effective and efficient management of all land related issues. These regulations were all promulgated in 1995.

2. Agriculture and Land Use along the Coastline

The agricultural sector is the most important sector of the Gambian economy, contributing 32% of the gross domestic product, providing employment and income for 80% of the population, and accounting for 70% of the country's foreign exchange earnings. It remains the prime sector to raise income levels, for investments, to improve food security and reduce levels of poverty. When the sector is looked at by gender 51% are women.

The coastal area of The Gambia, like other parts of the country, has a mixed crop-livestock farming system on two distinct ecological zones ;

a) The lowlands, including the western lowlands and, the eastern and central lowlands, and
b) the uplands. Upland crop production tend to be separate enterprise lowland rice farming, managed by different production groups (male or female) who neither do nor pool labour or capital. Relative to other parts of the country, the coastal areas are generally low-lying, characterized by wetter soils which make them suitable for low yielding 'upland' rice compared to the inland regions of the country. The 'tendaco' rice ecology is most prevalent, being part of the transition zone between pure upland and lowland occurring in the Western Region. Although with the onset of the drought of the 70s and the 80s, this zone became increasingly redundant, the advent of the drought-tolerant NERICA and more rains over the last few years, have greatly boosted the potential productivity of this region.

The coastal areas are also the site of the most intensive horticultural production in the country dominated by small scale women gardeners who produce for the nearby urban communities. Nearly 88 percent of all women farmers in The Gambia are estimated to be engaged in individual or communal horticultural activities. There are also a few commercial farms that mainly target the export market. The sector currently contributes about 4% to GDP on average, and over 65% of the agricultural labour force is involved in the sector, mainly in combination with one or two other crops. Horticultural crops include tomatoes, onions, cabbage, eggplant, okra, green herbs, peppers, lettuce, cucurbits, carrots, beans, citrus fruits, mangoes, cashew, papaya, banana, cucumber, etc. These crops especially vegetables are grown in small plots by smallholder farmers on an individual basis although communal gardening is also being encouraged.

The rapid development of the horticulture sub-sector is given high priority by The Gambia Government in its export-oriented diversification policy, growth of the productive sector strategy and overall socio-economic development effort of the country.
The production of fruit and vegetable in the Gambia is an important source of on-farm income and food for the rural farm families. Women perform the functions of producing vegetable, marketing the produce and feeding the family despite major obstacles. The Private sector acts as the vehicle of economic growth and export development and promotion of the horticulture industry.

The export of high value Gambian fruits and vegetables registered tremendous increases from 1994. The most popular produce exported includes chilies, Green beans, Aubergines, Asian vegetable, Mangoes, Papaya and Limes. The United Kingdom is the main-export market for Gambian horticultural produce accounting for 95 percent of export revenues.

The horticulture sub-sector has recently emerged as one of the Gambia's key growth areas. In addition, nearly 85 percent of the requirement for fresh fruits and vegetables for the tourist population in the Gambia have been met by the sub-sector. Furthermore, nearly 60% of total women farmers are engaged in horticulture activities. Large commercial horticultural farms mainly located along the coast currently employ over 4000 labourers to produce primarily for export markets. Although horticultural development over the last years have been phenomenal, most of this growth has been mainly due to (I) the private sector establishment of commercially oriented, modern, large-scale producing and exporting operation; and, (II) communal village - based women vegetable growing schemes encouraged by donor assistance catering for the local market boosted by a thriving tourist industry and the role of the Government of the Gambia from 1994 in creating an enabling environment, stable macro-economic conditions, infrastructural development and policies to encourage expansion of horticulture as well as private sector development has been very encouraging.

The intervention of the Agricultural Technical Mission of the Republic of China in this sub-sector since 1994 has given a new impetus to the sub-sector and particularly the women who dominate the sector. The introduction of new varieties suitable for both wet and dry seasons coupled with improved production/water control practices has enhanced income, improved nutritional status, foreign exchange and therefore contributing significantly to poverty alleviation as can be seen at Banjulunding, Lamin and Sukuta Vegetable Garden Schemes.

From 1994 to date, with the introduction of projects like the Women in Development Project, Household Food Security Project and the Chinese Technical Mission Intervention, the sub sector has progressed by 130% in terms of yield increase, hectarage and quality of produce.

2.4 COASTAL DEFENCES PRESENT (PAST AND CURRENT SITUATION)

As early as the mid-fifties, several measures to combat coastal erosion have been implemented. A good number of these measures were implemented by either the private sector or by the Government on an ad-hoc basis. Construction with rhum tree piles and concrete panels groins were done in 1957 near the old Muslim and Christian cemeteries. Later, similar protection techniques have been replicated in other places along the coast between Cape Point and Banjul. Due to lack of maintenance, most of the rhum palm groins have become ineffective.

In the early nineties, coastal erosion of the coast of The Gambia becomes a more serious problem and more intervention were done but not in a holistic way.

To address the matter in a holistic manner, the Government of the Gambia working with development commissioned a Feasibility Study of the erosion problem of the Gambian in 2000 by Royal Haskoning. A detailed design of protection strategy was carried out based on the Feasibility Study Report. The project sites were selected based on an assessment of economic, social and cultural coastal values.

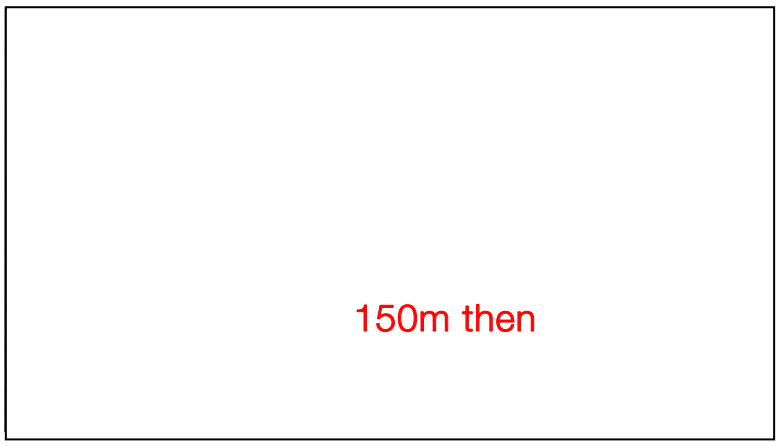
As a result of natural erosion, global climate change, and poor engineering interventions, rapid deterioration of the works has occurred at the seafronts of Senegambia/Kairaba Beach Hotels, the outlet of the Kotu Stream, and the lagoon at Radio Syd. The coastal and Marine Environment Unit team have been paying a close attention to the coastal dynamic at the affected areas.

1. Senegambia/Kairaba Beach Hotels Seafront

The seafront of both Kairaba and Senegambia were with 1 million cubic meters (m3) of off-shore sand during the Coastal Protection Project which was completed in March 2004. Based on the as-built final Bathymetric & Topographic survey maps by D. Blankevoort IDC of the Netherlands map dated 20th February 2004, a length of 130.om-145.0m from the hotel's premises fences to the C+3.0m bench mark was reclaimed. The Coastal Zone Management Unit of the National Environment Agency is charged with the task of monitoring the Gambian coastline including the nourished areas. Occasionally as in April 2005, and October 2005, exceptionally high tides have been recorded which based on our measurements and experiences observed that 15-17meters of the beach parallel to the coastline has been eroded.

Photos 1&2 : Seafront of Kairaba and Senegambia hotels before the coastal project (2000)

Photo 3: Kairaba and Senegambia Seafront after the coastal project (Haskoning, 2004)



Recent measurement shows that nourished beach had decreased from about 150 meters at project completion to 26 meters in February, 2010 to 16 meters on July, 2010. The rate of decrease is estimated to be between 2 to 3 meters monthly, and this rate is expected to accelerate during the rainy season. Powerful wave energy force attacks the beaches and there is the need for devices to minimize the force. Such devices were removed from the Completed CPP implementation because funds were not adequate. In addition, stormwaters from the hotels are channeled through drainage pipes to the beach, and this is contributing to the problem of coastal erosion. The hoteliers have been advised by the Agency to extend those pipes to the high water mark.

Photo 4 : Present situation at the Seafront of Kairaba and Senegambia hotels

(NEA, July, 2010).

It is also observed that deposition only takes when the waves break and dissipate on a wide beach. The situation with Kairaba/Senegambia and Kololi areas is often that the beach embayment is narrow during high tides and hardly any room for waves to break and produce a swash or backwash. Dissipation of waves, followed by deposition of sand will only take place on a wide beach embayment. The Kololi resort area has been nourished very high in such a way that sediment transported to the shores cannot form an equilibrium with the nourish beach sands (NEA, reports, 2007)

During the low tide the waves energy on these shores break and dissipate a short distance, this can be attributed to the steep gradient on the near and foreshore. One reason is that the beach sand is not cohesive and does not sticks together, hence susceptible to aeolian (wind) and fluvial (Water) erosion. The profile of the beach is usually a steep slopping gradient forshore/near shore whereby erosion will take place when strong and high waves break on the beach, allowing more water to advance towards the nourish beach sands. Also during high tides water reaches and undercuts the 1m high sand bank of the nourish beach, and gullies are also created, which can have way for more water to advance towards hotel perimeter fence.

At Spring tides the unconsolidated nourished beach sand at Senegambia/Kairaba and Kololi seafront is constantly attacked by plunging waves breaking and producing high instantaneously pressure capable of trapping air and compressing it between the leading wave front and the banks of the nourished beach sands. This combine effect of the air compression and impact of the water on the nourished beach is capable of dislodging the unconsolidated sediments and render the nourished beach sands susceptible to erosion. Other possibility of the erosion problem could be attributed to impact of breaking waves capable of throwing particles against the shore leading to abrasion of the nourished beach

sands, in other words the nourished beach is being eroded as result of undercutting and strong waves breaking on the banks of the nourishment beach.

2. Kotu Stream Outlet

The stream's outlet to the sea is dynamic. It was observed that always in January the outlet is close to the Palm Beach Hotel. However, by the middle of the year, it moves towards the Sunset Hotel. It creates a deep depression at the outlet that makes it difficult for the tourists to cross from one hotel side to the other. The proprietor of the Sunset Hotel undertook preventive measures to save his hotel from the dynamism of the Kotu Stream outlet.

Photos 5 : Kotu Stream outlet near Sunset hotel
(NEA, 2009)

Photo 6 : boat crossing tourist and people at high tide
(NEA, 2009)

3. Radio Syd/Lagoon

Evidence from multi date digital photographs indicate a change in the beach profile, the seawater is advancing rapidly into the Lagoon and eroding the nourished beach . The inlet to the Lagoon is narrowing down in such a way that more sand is accreting at the edge of the spit and blocking the passage of water movement into the Lagoon.(photos: 11&12)

Photos 7 & 8 : Radio Syd area before and after the coastal project

(Haskoning, 2003)

Photo 9 : Beach profile at the lagoon/Radio Syd
(NEA, 2006)

Photo 10 : Radio Syd/Lagoon
(NEA, 2006)

The sand spit parallel to the Lagoon is developing in an eastward direction, however the rapid flow of water flowing across the edge of the sand Spit has interrupted the littoral system, resulting in a break and change in direction of sand deposition from an eastward direction to a Southwest direction. Pictures taken at different date's best explains changes taking place at that area, a measurement of 4 meters was recorded from the high water mark to the sand bank on a narrow beach embayment; this is evidence of shoreline retreat(photos 11 & 12).

Photos 11&12 : Pictures taken at different dates showing signs of erosion and shoreline retreat at the same place

(NEA, 2006)

The recommendations of the feasibility study for the Completed Coastal Protection Project included the complete filling of the lagoon. However, at the time the contractor felt that the lagoon will be filled up naturally. Instead, the lagoon has not filled up completely and is expanding and eroding the nourished beach. The field team observed that another lagoon is forming. The concern is that if it is not quickly addressed, the lagoon will be expanding and eroding much of the nourished beach and widening landwards towards the Main Highway

4. Banjul Point (Cemetries)

Banjul point is located along the Banjulian Island coastline near State House and the area has experience serious erosion way back in the early 1950s. In 1955 a sea defence study and a report by a Consultant Lewis and Dovier present a sea defence report on the Banjulian coastline. It was suggested in the report to construct local palm groynes and breakwater along the eastern side of the old Muslim Cemetery. In 1957, the old Muslim Cemetery and part of the Christian cemetery suffered serious floods during spring tides and the sea water almost reaches the main road from Banjul to the Kombos (now the Banjul/Serekunda Highway). After the flood period between 1958-1968, the rhun palm groynes served their purpose in protecting further erosion of the old Muslim cemetery.

Photo 13 : Banjul Point before the coastal works
(Haskoning 2003)

Photo 14 : Banjul Point after coastal works
(Haskoning 2003)

Photos 15&16 : Erosion at Muslim Cemetery and Temporal measures implemented

(Haskoning, 2000).

Photo 17 : Christian Cemetry before the coastal works
(Haskoning, 2000)

Photo 18 : Muslim Cemetery along the Banjul highway before the coastal project
(Haskoning, 2000)

5. Cape Point/ Bakau Fish Landing Sites.

As part of the Coastal protection works project that was completed in 2004, a new coastal protection strategy was designed and implemented at cape point which consists of a 300 m long rock revetment at the west side and the cape itself and connecting with the northern groin of a 5 groins scheme.

A considerable infill of the new beach pockets was done by nature in less then half a year.

Photo 19 : Cape Point revetment before the coastal works
(Haskoning and NEA 2000/2004)

Photo 20 : Cape Point after coastal work
(Haskoning and NEA 2000/2004)

2.5 SOCIO-ECONOMIC ISSUES

1. The tourism sector.

Some 100 000 tourists visit the Gambia annually (Tourism Report, 1999), that provide employment for some 7 000 people of which 90% is directly involved in the tourist business proper (travel agencies, hotels, restaurants, bars) and some 10 % benefit indirectly through related activities (beach bars, petty trade). As such it classifies as the second or third economic sector after agriculture. Tourists spend about 25 million US$ annually, average spending is quoted to be some US$ 33. - Per tourist per day (Feasibility report, 2000)

Most of the 33 hotels (Tourism Report, 1997) are located in the Tourist development area, an 800 m. wide zone that runs parallel to the shoreline over the full length of the Southern coast. The coastal erosion threatened many of these hotels.

The new coastal road greatly improves communication between Banjul and the coastal areas in the South and will initiate a rapid development in tourist facilities in these areas with a corresponding increase in demographic pressure on the beaches.

CRAFT, PETTY TRADE AND MARKET TRADE

Along the coastal area from the Greater Banjul Area to Kartong a wide variety of goods and services are provided to the local communities and to the tourists(see Table 1 below). Some of these are from fixed locations such as "bengdulas" (craft markets), markets or identified areas. Others have no fixed locations.

The Ministry of Tourism allocates stalls to the vendors who operate in the bengdulas. They also subscribe at the level of the bengdula towards the payment of electricity and water. A management committee manages each bengdula. Women are also active participants in these locations. They comprise 60% of the vendors. The activities are differentiated along gender lines. The women specialise in tye and dye and batik about 40% of them produce their own products. Men specialise in both the production (60%) and sale of carvings, leather ware, basketry, musical instruments, woven cloth and jewellery (Feasiblity report, 2000)

Table 1: Craft and market sellers

	Site:	Location:
1	Craft Market Bengdula	Near sand spit: between Laguna Beach Hotel and Palmgrove Hotel; Greater Banjul Area.
2	Cape Point Bengdula	Cape Point: near Sunwing Hotel; KMC
3	Cape Point Tourist Market	Cape Point: opposite State House 2; KMC
4	Craft and Fruit Market	Bakau: near St Mary's Food&Wine Supermarket; KMC
5	Fajara Carft Market	Fajara: near the Fajara Post; Kombo North, W.D.
6	Fajara Bengdula	Fajara: near Fajara Hotel; KMC
7	Kotu Bengdula	Kotu Beach: between Novotel and Bungalow Beach Hotel; KMC
8	Senegambia Bengdula	Kololi Beach: adjacent to Kairaba Beach Resort and Senegambia Beach Hotel; Kombo North, KMC

Both men and women engage in tailoring activities. There are more women (90%) with tailoring outfits. They also employ male tailors to work for them. Hairdressing is almost exclusively a women's domain.

Market trade.

Bakau market is under the purview of the Kanifing Municipal Council and is almost directly opposite the Bakau Fish landing Site. It has both permanent and temporary stalls for which the council collects rents and taxes.

There are more women sellers (51%) as compared to men. Women predominate in the selling of vegetables (97%) and in smoked and dried fish (100%). Men predominate in imported items such as textiles and clothing (68%), cola nuts (100%), meat sales (100%) and in imported food items such as pulses, cooking oil and other condiments. Men own all the small shops and monopolise the market in repairs of radios and watches and in any thing that requires technology, no matter how simple e.g. the grinding of groundnuts. There are more women restaurant owners (57%) than male restaurateurs.

Outside the market there are shrimp sellers of whom 67% are women and some craft sellers of whom 63% are male.

Petty trade

These are mostly the iced fruit juice, fruits, groundnuts, sweet and cigarette sellers. They operate around the vicinity of the markets, the fish landing sites or they simply move from place to place. There are no fixed hours of operations and they operate only at their own convenience. The girls (70%) do so after school and mostly engage in this activity to subsidise their schooling or to help offset some household expenditure. Boys and men specialise in selling sweets, cigarettes and some of the boys are shoe shine boys.

Other activities

Some other activities take place along the beach and around the tourism development area. These are the selling of juice, post cards, the operation of beach bars and restaurants, hairdressing and body massage and the hire and repair of bicycles. The juice sellers are all male. The Department of State for Tourism regulates their activities.

2. The fisheries sector.

The Gambian coastal waters present some of the richest fishing ground in West Africa. But also the River Gambia has important fish resources.

The fisheries sector in The Gambia consists of two major domains: industrial fisheries and the artisanal fisheries. The industrial fisheries sector is based in Banjul, and is dominated by private investors. Produce from this sector is largely exported. The artisanal sub-sector is dominated by local fishermen and is characterised by low levels of investment. This sector produces about 90% of the locally consumed fish supply and provides employment opportunities for some 2000 people involved in fish harvesting and another 13,000 -18,000 people involved in boat building, fish handling, processing, transportation and marketing activities.

With respect to demersal fish, the dominant species in catches are croakers (*Sciaenidae*), grunts (*Pomadasyidae*), threadfins (*Polynemidae*) and mullets (*Mugilidae*). For pelagic fish, different species of sardines dominate in the offshore waters, while the bonga (*Ethmalosa fimbriata*) is the main catch by artisan fishermen in shallow, near shore waters.

It is believed that demersal fish, as well as shrimp and lobster are over-exploited. Due to a lack of exact and unambiguous data on the evolution of fish catches it is difficult to qualify the status of fish resources in the Gambian waters. It is noted that many of the artisanal fishermen operating in the Gambia, are expatriates from Senegal to Ghana.

It can be seen that the catch of Bonga fish shows a rather constant rising trend. Since Bonga fish catches constitute 60 to 80% of total catches in most of the years, also the total amount of fish caught shows a rising trend. The catch of other, less dominant species appear to have gone down during the end of the eighties and early nineties, to pick up during the recent years since 1994/95. These statistics indicate that fish resources do not appear to be overexploited.

Fishery, fish landing facilities and fish processing industry was analysed in the feasibility report as this sector uses extensively the coastal space, the fish resources and wood for fish drying. Moreover the artisan fishery provides income for the lower income classes that were examined in greater detail with a view to assess the socio economic impact of the project on the quality of life of this group.

More than 500 men are engaged in artisanal fisheries slightly more worked along the Atlantic coast. 64% of the fisherman along the Atlantic Coast is reported to be of foreign nationality. The performance of artisanal fisheries has risen in excess of subsistence. The artisanal sub-sector is the main supplier of fish to fishing plants.

A total of 11 fish landing sites for artisanal fishermen are established along the coast. The sites, in order of importance in terms of total tonnage of fish landed, are shown in the table below. These landing sites are normally in use by the villagers originating from villages that have the same name and are situated in close proximity. The level of activity differs on each landing site. Women are almost exclusively involved in fish processing (salting, drying, smoking) as well as in selling fresh fish.

In terms of female employment Brufut is the largest fish-processing site (a share of ±32%), followed by Tanji (±19%) and Gunjur (±18%). For males the fishery sector provides employment predominantly in fish catching (full time and part-time fishermen and their assistants) with Gunjur being the largest site. But males are also involved in fish processing and selling of fish.

Table 2 : List of artisanal fisheries landing sites on the Atlantic coast, with total tonnage of landed fish for the year 1995

	Name of landing site	Tonnage of fish landed (In metric tonnes)
1	Barra	4
2	Banjul	1,708
3	Bakau	2,652
4	Brufut	2,011
5	Kololi	100
6	Tanji	4,573
7	Tujereng	115
8	Sanyang	477
9	Gunjur	6,806
10	Kartong	297
11	Jeshwan	1,612

Source: Feasibiltiy Report, 2003.

Seen from the point of view of women, there is a distinct division of roles. All the fishermen are male and nearly all boats/canoes, fish equipment and gear are owned by men. Some women own nets and engines, which they either hire out or make available to fishermen to buy the fish at cheaper prices. Boat building and repair, outboard engine maintenance and fuel supply is a male domain too.

In fresh fish selling there are the middle persons. In some instances this is dominated by men at the beach level or through the marketing outlets by bicycle or motor vehicle. This way fresh fish is supplied as far away as Basse.

In Gunjur and Bakau however the trend of male dominance in fresh fish selling reverses and here women clearly outnumber men. Because women have to rely on public transport, men control outreach markets.

In the area of fish drying women outnumber men with ± 86% of female production as opposed to ±14% by men. There is however a more or less equal female – male representation in fish smoking. Fish smoking was traditionally a female domain and this shows that when adequate incomes can be earned the traditional division of labour –under certain circumstances- can change.

The most rudimentary methods are used in processing fish. Fish smokers use firewood and this has implications for the natural resource base. In Tanji with a bird sanctuary close by, there might soon be a need to closely monitor the collection of firewood.

3. Minerals and aggregates

In the coastal area placer deposits of heavy minerals – zircon, rutile and ilmenite occur in the raised beaches from Brufut to Kartung. The minerals occur as unconsolidated grains or within the sediments, which have been derived from parent rocks in the continental series as result of weathering transportation and deposition processes. These minerals were mined for a short period in the 1950s.
The deposits occur in economic quantities

Construction sand and gravel are of low value, but are high volume commodities, which contribute significantly to the socio-economic development of the country.
In the coastal zone sand and gravel mining is rampant but until recently the only designated site for sand extraction was at Bijilo, used since 1985. Prior to restrictions imposed on sand mining at Bijilo in 1993 the estimated volume of sand extracted per year was approximately 100,000 m3 to 150,000 m3. This had a serious environmental impact on the coastal area, which has also been addressed earlier in this handbook.

The Bijilo beach sand mining was stopped in December 1995 and hence sand mining at Bijilo is now illegal. Sand mining is allowed, only, in specially designated areas further in land and EIA procedures and reinstatement plans should reduce ecological damage of the operations.

4. Forestry/Timber

The Gambia has a Sudano-Savanna vegetation type with a characteristic dry forest cover. In the past three decades alone the forests have undergone considerable degradation from about 60% closed forest type in 1968 to less than 10% closed forests in 1993 (Feasiblity studies, 2000).

Going from Cape Point towards the South, the lack of forest vegetation up to Bald Cape is striking. After Tanji, the vegetation cover becomes denser; between Gunjur and Kartong a relatively dense cover of shrubs and trees covers the coastal zone. The northern section of the coast has been cleared, since this area is closest to population centres such as Banjul, Serkunda and the tourist resorts, where wood is in demand for construction and firewood. Still, in the Western Division to which the entire Atlantic coast belongs, one finds more than 55% of all closed forest vegetation of the country.

It is estimated that 600,000 m^3 of fuel-wood is consumed annually to cover the energy requirements for fish processing. At present the artisanal fish processing industries along the coast still require considerable amounts of firewood. This demand can pose a threat to the remaining vegetation. For example the Tanji Bird Reserve is very close to two landing sites on both sides of the Reserve. This location makes it more than likely that firewood is extracted from this Reserve for fish smoking.

2.6 POPULATION GROUPS

Between 1993 and 2003 the population of the Gambia grew by 2.8 % per annum on average. The population within the study area has been growing by 3% per annum on average. It is projected to reach about 0.7 million persons in the year 2020 and in 2050 about 1.1 million persons (table 3). Most of the settlements along the Atlantic-Ocean coastline depicted negative growth rates between 1993 and 2003. Hence, the average annual growth rate of settlements in this area was less than 2%. The lower growth rate is indicative of a tendency of population mobility in which people would continue to move away from the coast land near sea shore to the nearby hinterland. Notwithstanding this outward mobility the population of the study area is expected to reach 1.1 million in 2020

Table 3 : Projected Distribution of Populations in settlements along the coast line and shorelines within a defined area of the Gambia, 2020 and 2050.

	2003	2020	2050
1. Settlements along the Atlantic Ocean shoreline	85,779	214,314	342,903
2. Settlements on the shorelines of the Lower Mouth of the River Gambia (West of longitude in Essau)	65,409	70,874	113,399
3. Settlements on the shorelines of the Upper Mouth of the River Gambia (East of longitude in Essau and West of longitude in Buniadu)	144,708	417,256	667,609
	295,896	702,444	1, 123,911

Source : Gambia Bureau of statistics (Population census 2003)

Population North coast.

The north coast of The Gambia can be characterised as a low barrier beach. The area is sparsely populated and the few population centres that have developed are confined to an area at its most southern tip at Barra and far away from the coast at Farafenni.

The main source of income is agriculture, which is traditional and small-scale and generally occurs at a sufficient distance from the coast, and artisanal fisheries, which takes place throughout the north bank on a small-scale and seasonal basis. The peak period is between January to March. Artisanal fisheries centres at Barra, Albreda, Jurunku and Salikenni however are not fully functional.

The main commercial areas are Barra and Farafenni. There are weekly market 'lumos' at fass Njagga Choi, Ndugu Kebbeh, Kerr Jain, Kerr Pateh Koreh, Ngeyen Sanjal and Farafenni. Cross border trade with Senegal is significant. This has resulted in growth of towns such as Kerr Pateh and Kerr Jain.

Commercial centres are at Barra and Farafenni, which are important for their strategic locations. The North Bank Division of the country is linked to the southern part of the country via ferry crossings at Barra and Farrefeni. A 9 km road, the Trans Gambia route, connects Barra to the Senegal border by a 22.5 km road and Farafenni.

Contrary to the south coast, very few tourists come to the area. Facilities for tourists, similar to those at the southern beach area, are not present. Tourist activities are therefore limited to experience the ferry crossing and to visit Barra and Fort Bullen.

Population South coast.

Compared to the north coast, the south coast is much more densely populated. The capital city Banjul and the Kanifing Municipal Area are located here, which, together with a number of smaller towns and villages surrounded by their hinterland, constitute the Western Division, covering the districts Kombo North and Kombo South. This region is the administrative and business centre of the country and pays an important contribution to the national economy.

Main tourist facilities are located in the coastal area between Cape Point and the Senegambia area. The area south of this point is still used mainly for agriculture and a number of forest areas are still found here. The construction of the new coastal highway has stimulated development of new tourist facilities here.

The Area between the highway and the coast is part of the TDA and the TDA board controls development.

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III. METHODOLOGY

The National Environment Agency (NEA) is the institutional focal point conducting the case study in the Gambia, and participatory approach has been used to assign various stakeholders to provide information regarding the study. Upon return from the mapping/cartography meeting with the IUCN consultant and representatives of other countries in the subregion in Dakar, Senegal from the 21st to 25th June, 2010, during a signed contract agreement was presented to IUCN reprsentative. A team of experts have been selected within the National Environment Agency to form a coordinating team to be responsible for the coordinating all the activities under the case study.

The National Environment Agency convened a meeting with experts in different areas to share duties and responsibilities as per the Terms Of Reference (TOR) provided by IUCN. The Gambia case study on coastal erosion and sedimentation was based on existing documents and information available at the Coastal Unit of the National Environment Agency and other places.

The methodology used for determining the shoreline evolution was based on pixel separation in a satellite image as developed by the Centre for Suive Ecologique (CSE), Republic of Senegal. In this method, the shoreline is separated from other pixel in a fairly good resolution satellite image and marked with a line. The method results to two lines representing the shoreline at different periods; the evolution is then measured by the difference in the same straight distance of the two shorelines from a given reference point.

3.1 DATA USED

Ideally we would have used medium to high resolution satellite image to measure erosion and accretion at the identified study areas; this was however not possible for cost reasons. In this regard, our analyses are based on field data collected through measurements of the shoreline, from reference benchmarks and profiles, from 2003 when the coastal protection project was implemented to control erosion at key areas of our coastline.

In addition the main data for determining the shoreline evolution were two sateliite images of varying resolutions and dated 1979 and 2009 were used for the delineation of the shorelines such that the evolution was calculated for a span of 30years. The images as provided below

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3.2 THE REFERENCE LINE

This report is limited to seven problem areas along the Gambia's southern coastline that is divided into nine coastal cells, and a series of measurement profiles, for the purpose of monitoring erosion and accretion (refer to coastal cells & profiles map, figure 1..). In addition, each cell has nationally identified benchmarks that guide the positioning of the end points of the profiles from the shoreline as the reference line for measurements.

For the shoreline evolution, The Gambia has two separate coastlines north and south for the River Gambia with a combined length of 81km. The centreline of the coastal road that runs north-south from Cape Point to Kartong was used as reference line was measurement of the southern coastline; the reference line for the northern coastline was partly drawn from a track that also runs south-north from Barra to the border with Senegal.

In the case of reference points, predetermined profile lines were used. The Gambia's entire coastline is divided into nine(9) cells (see figure 1) with each cell having, on average three (3) horizontal profile measurement lines. The reference point for taking straight line distances to the two shorelines is placed at the intersection of the horizontal profile and the reference lines.

3.3 DESCRIPTION OF THE TECHNIQUE

The measurements were based on simple perpendicular tape measurements along profiles to the shoreline.

3.4 DESCRIPTION OF METHOD(S)

The measurements were taken monthly from 2003 for each point and the average value for the year is used as the measurement for that particular point for the year. The seven problem areas identified for this study were all covered by the Coastal Protection Project in 2003 either through beach nourishment or the laying of groins; it is for this reason we use 2003 as our base year since the eroded beaches in these areas, before 2003, were in most cases restored.

3.5 ESTIMATIONS OF ERROR MARGINS

The seven areas fall within only four of the coastal cells that have a combined total of 18 measurement profiles. Apparently measurements were made on only 7 of the 18 profiles giving a percentage measurement of only of 39%. For the error margin, using a 95% confidence level, it will be 23% ($1/\sqrt{18}$), which is indeed very large.

IV. SHORELINE EROSION AND BEACH PROFILING

4.1 PREVIOUS DATA ANALYSIS

Over the last decade, the erosion of the North shore of St. Mary's Island may have been aggravated by sand mining activities along the Toll Point beach area. It was reported that Contractors working on the Banjul-Serekunda extracted in total some 60,000 m'of sand from the beach (Jallow et al, 1996). It was noticed by then that to the East of the radio Syd station the sea already encroached within 50 m of the recently completed highway. South-West Attlantic Coast the Atlantic Coast stretching West and South from Cape Saint Mary is characterized by a series of pocket beaches enclosed between rochy headlands and cliff formations, cut
into Tertiary sandstone. At several places the beach in front of the rock plateau has disappeared and cliffs are readily exposed to the ocean waves, such as at Fajara.

Due to the general orientation of the coast and the predominant NW swell, a southgoing sedimentary transit exists along, the coast, as evidenced by the zeta-shaped beach formations to the South of Bald Cape. In the area between Bald Cape and Cape Saint Mary a divergence point in the littroral drift system is apparent, its exact location yet unknown, but it is possibly located near Kololi Point. North of this erea, with North-East running sediment transit towards and around Cape Saint Mary, socio-economic pressure on the coast is high with the major tourist development area and adjacent residential area of Fajara and Bakau extending up to Cape Saint Mary. The sediment transport in this area is exclusively generated via 'production' of sediments though erosion of beaches and cliff platforms, the (slow) rate of erosion being determined by the erodability of the sandstone formations. At Cape Saint- Mary, the bypass of littoral drift around the headland is evidenced from aerial photographs (1964, 1972) as unstable sand spit and bars.

The coastal area to the East of Cape Saint-Mary is highly dynamical as coastal behaviour is determined by the fact whether or not reattachment on the coast of the spit and bars occurs and, consequently, nourishment of the littoral to the East of Cape Saint Mary takes place. The erratic behaviour of this coast over the last decades gives evidence of this susceptibility. Since 1983, pronounced spit or bar development at Cape Saint Mary is absent, which may point to reduced bypass transport arriving from the Fajara - Bakau coastal area. From the above, it is not surprising that a major area of concern with respect to coastal instability is the area immediately to the East of Cape Saint Mary, here, villas and hotels (Sunwing, Ocean bay) are in intermittent threat from beach erosion, because the width of the beach is subject to great inter-annual fluctuations due to movements of sand spits and positions of offshore bars. To the Southwest of Cape Saint-Mary there are active cliffs which border the shore line.The altitude of the cliffs at the highest point is 10 to 20 meters above high tide. The soft layers of lateritic soils and perched sand dunes above the consolidated basement are subject to erosion. There is considerable cliff erosion at this point due to direct wave action on loose cliff material with slope failures and landslides. The Tropic Garden Hotel and the Medical Research Council Park are in threat of the rapid erosion rate on the beach. A cliff recession rate of half a meter per year is noticed at this area. The African Village Hotel already lost its beach to the sea.

At Fajara cliffs further down the coast, the erosion process is very pronounced. The cliffs are retreating very fast and the structures at this vicinity are in danger. It is at this area where very expensive villas and official residences (Government House) are located. Most of them are within 50 to 100 meters range from the sea front which has been threatened by beach erosion causing cliff failures, and the run-off water from storms eroding the cliff tops. The area South of Fajara cliffs up to and beyond Kololi Point is the major tourist development area till now. There is a chain of over 10 large hotels and other facilities. Often the tourists can't fully enjoy the beach which is narrowing due to erosion. The beach at this area from Kotu Point to Kololi Point has been retreating at a rate of 1meter to 2 meters annually for the past twenty years as observed from the aerial photos (1964-1982). Shoreline recession caused by beach erosion is still prominent at Kololi Point where dune erosion produces sandy cliffs of 2 meters high. Between Kololi Point and Bald Cape, the erosion rate varies from 40 m - 60 m over the past 26 years. At Kololi Beach, the beach bars and restaurants located at the sea front near Senegambia Hotel are threatened by beach erosion.

The erosion behaviour between Kololi Point and Bald Cape may well have been aggravated by the extensive commercial sand mining taken place along Kololi Beach till 1985, but since that time the large-scale sand mining shifted down South towards Bijilo. Estimates of the annual sand extraction from the beach range between 100,00 and 150,000 m3/yr ,which significantly contributes to the sand budget deficit in this area. Down South from Bijilo, a number of important fish landing and curing sites are located; the Brufut site just North of Bald Cape being the only one affected by the sand mining activities. It can yet be noted that this area South of Bijilo is designated for future tourist developments.

4.2 CURRENT DATA ANALYSIS

The results of this case study has only been limited to the seven problematic areas (Banjul Point, Cemeteries, Radio Syd/Lagoon, Cape Point, Senegambia Beach Hotel, Kairaba Beach and Holiday/Kololi Beach Hotels) that are a concerned to the National Environment Agency and the Government of the Gambia currently due to the economic and cultural importance and social assets exposed to this ongoing threat of erosion along the coastline (e.g. Hotels, fishing landing sites, Cemeteries, State house, highways etc). Other areas of the coastline are important as well especially where erosion are taking place but not as serious as the areas highlighted above. In essence the entire 80km coastline of the Gambia, which has nine(9) coastal cells and forty-two (42) profiles, our study focus within four coastal cells(cell 2-5).

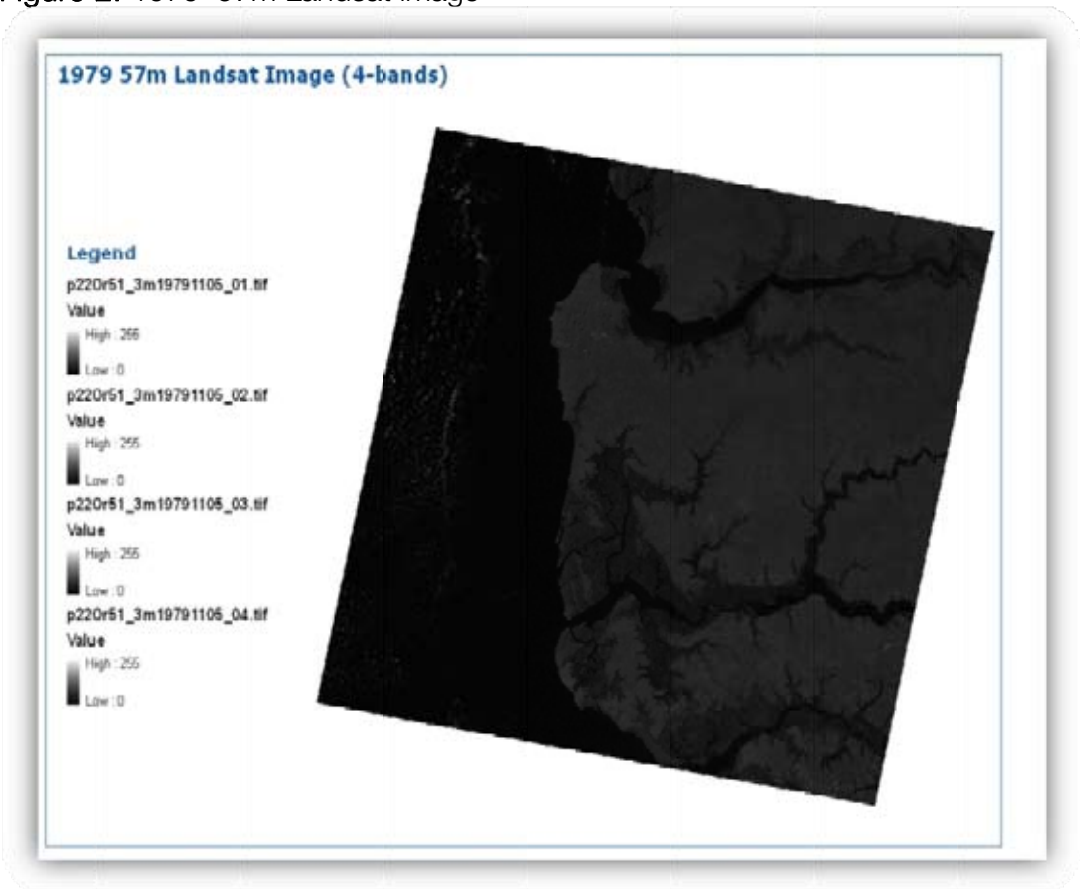
The areas highlighted above as problematic have benefitted from the Coastal Protection Project in 2004 include all the sites selected for this case study. Following the successful completion of the works along the coastline, the National Environment Agency was responsible for the inspection and monitoring of the coastline. Based on our current data which was collected during this study, it shows that the nourished beach of Senegambia and Kairaba Beach Hotels had decreased from 150 meters at project completion to only 16.7 meters in July, 2010, giving a difference of shoreline shift to -138.8m and 132.5m respectively. Holiday Beach/ Kololi area has shown a significant rate of erosion from the original length of 140.1 to 16.6 showing a difference of 123.5m in shoreline shift. The rate of decrease is estimated to be 2-3 meters monthly, and this rate is expected to accelerate especially during the rainy season as a result of heavy down pour of rains and the

stormwater from outside that make their way to the hotel seafront. The possible causes of the high erosion at this area is due to powerful wave energy force that attacks the beaches. The poor sand used for nourishent wihin the area has also contributed to the problem and i twas suggested that there is a need for devices to minimize the force. Such devices were removed from the Completed CPP implementation because funds were not adequate. In addition, stormwaters from the hotels are channeled through drainage pipes to the beach, and this is contributing to the problem of coastal erosion. The hoteliers have been advised by the Agency to extend those pipes to the high water mark.

The kotu stream's outlet to the sea is dynamic. It was observed that always in January the outlet is close to the Palm Beach Hotel. However, by the middle of the year, it moves towards the Sunset Hotel. It creates a deep depression at the outlet that makes it difficult for the tourists to cross from one hotel side to the other. The proprietor of the Sunset Hotel undertook preventive measures to save his hotel from the dynamism of the Kotu Stream outlet. This area has been included in this study so that a long-term monitoring and possible intervention could be implemented in the future. The revetment at the Cape point has performed beyond expectations, because the eroded area of the beach has been filled naturally over the past years. However, on one side of the revetment is currently experiencing erosion from 120m to current measurement of 90.3, showing a difference of -29.7m in shoreline shift.

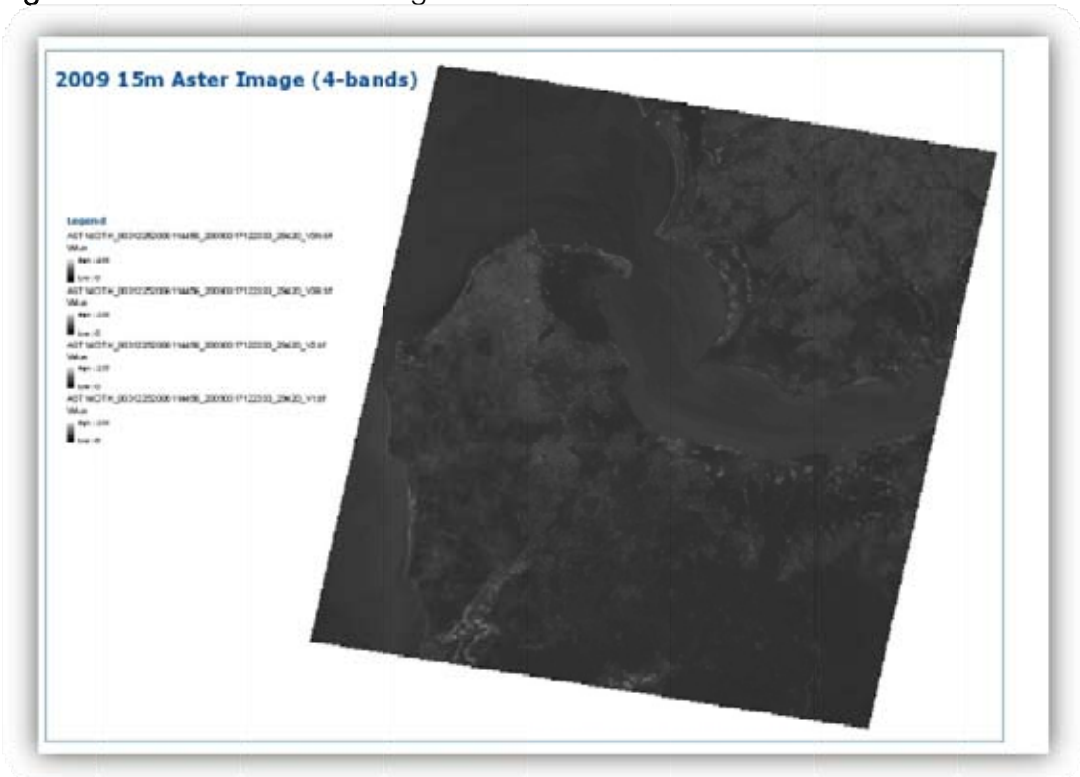
At the Radio Syd, Old Muslim Cemetery and the lagoon area have been a great concern in the past and more especially after the coastal protection project. With reference to the previous monitoring and present data collected during this study shows changes interms of the dynamic of the lagoon causing erosion within the area. The current measurement of 86.7m from the original length of the shoreline after coastal protection work shows that -33.3 difference of shoreline shift. The recommendations of the feasibility study for the Completed Coastal Protection Project included the complete filling of the lagoon. However, at the time the contractor felt that the lagoon will be filled up naturally. Instead, the lagoon has not filled up completely and is expanding and eroding the nourished beach. The field team observed that another lagoon is forming. The concern is that if it is not quickly addressed, the lagoon will be expanding and eroding much of the nourished beach and widening landwards towards the Main Highway.

Figure 2: 1979 57m Landsat image



(Source: ftp://ftp.glcf.umd.edu/landsat/WRS2)

Figure 3 : 2009 15m Aster image



(Source; Dept of Forestry)

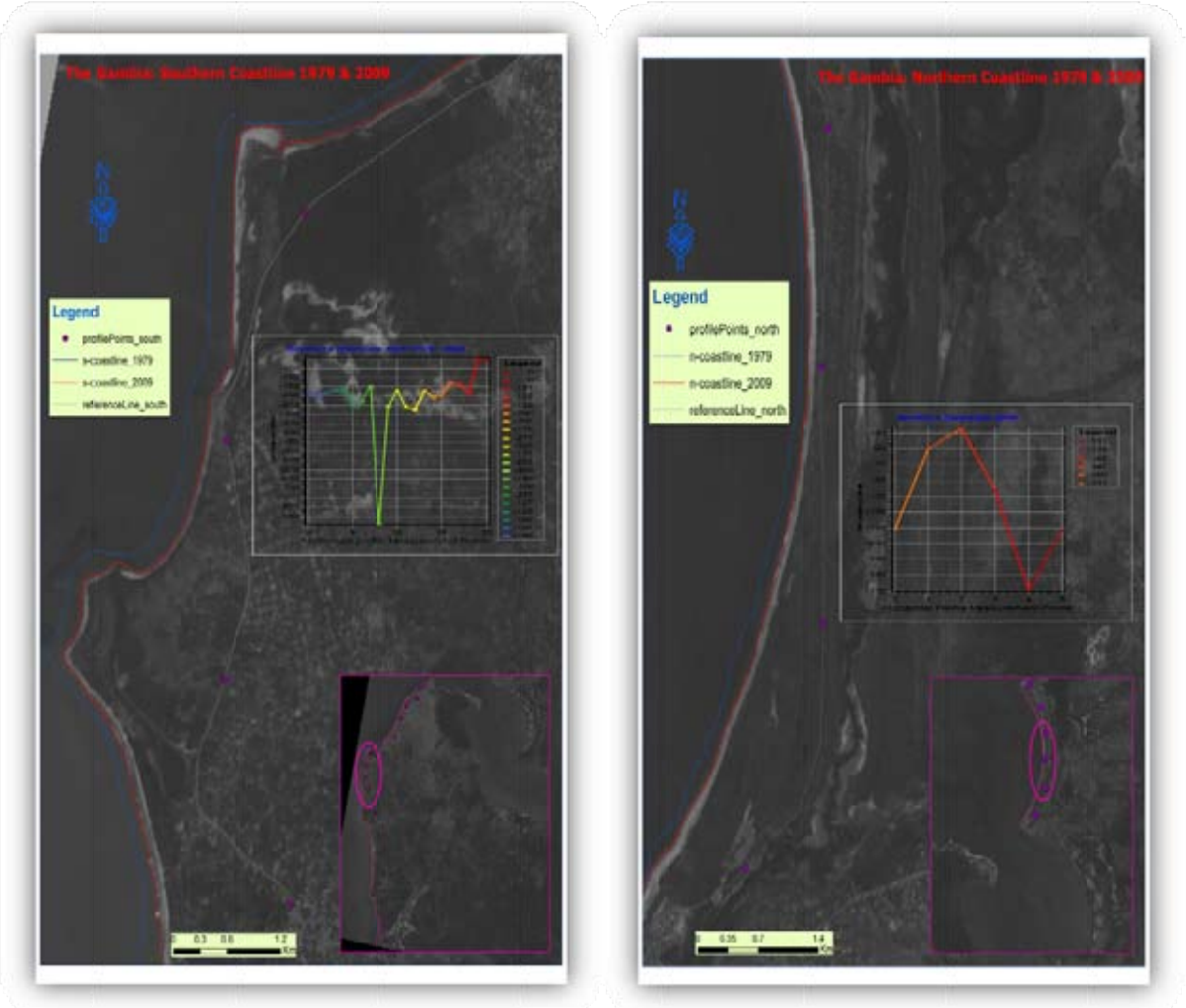
V. SUMMARY OF PRESENTATION OF RESULTS OBTAINED

The Coastline of the Gambia has been separate into two; Northern and Southern Coastline which combined together gives a length of 81km. For the Southern coastline, a centre of the coastal road that runs north-south from Cape Point to Kartong was used a reference line. A total of twenty measurements were taken along the southern coastline. The Measurement indicated only erosion with an average thirty (30) year erosion of -245m at an approximate rate of 7m per year (figures 4). In the Northern coastline a total of six measurements were taken along the northern coastline. Like the south, there was no accretion but mainly erosion over the 30-year period (figure 5)

The long shore transport system that can be summarised as a system with some sand loss at its eastern and its southern boundary, and no significant supply of sand. This in combination with a small erosive trend due to sea level rise results in a coast with an erosive trend. Due to the very small sand supply and the presence of a turning point in the net transport (a zone with negligible net transport) the coast tends to develop to a state of small alongshore transports. As a result of this tendency net alongshore transport are now small to moderate, and the basic erosive trend due to above losses is rather small. However, due to a temporary uneven distribution of sand (formation of sand spit) or human activities (sand mining) erosion rates can locally be significant.

The sand balance also shows that the various cells along the coast are linked via the alongshore transport. This implies that disturbances of the sediment balance in one cell are likely to have consequences in other cells. If, for example, the sand transport along the Atlantic coast north of Bald Cape would be blocked completely by a large structure this would adversely affect the coast north of the structure. The coast north of the structure would erode and after some time the sand bypass along Cape Point would be reduced. Eventually this would result in a reduced sand supply to the Banjul area. This implies that interference with the alongshore transport at for example Kotu or Kololi Point would soon be felt at the cliff area and Cape Point and eventually it would be felt at Banjul.

Figure 4 & 5: Shoreline evolution of Southern and Northern coastline- 1979 to 2009.



The table 4 below show records from the coastline monitoring by the National Environment Agency from 2003 shortly after the completion of the Coastal Protection, and the current situation in 2010.

Table 4 : Shoreline Monitoring Data- Distance(m) of Land Marks from High Water Mark

Point	Beach Site	As-built Doc. DR. Nov 2003	July 2010	Shoreline Shift (2003-2010)
1.	Senegambia Beach hotel Bar Terrace	155.50m	16.7m	-138.8m
2.	Kairaba Beach hotel fence	149.20m	16.7m	-132.5m
3.	Holiday Beach Bar Club	140.1m	16.6m	-123.5m
4.	State House Perimeter Fence	120m	51.6m	-68.4m
5.	Old Banjul Muslim Cemetry	120m	86.7m	-33.3m
6.	Radio Syd/Lagoon	120m	78.4m	-41.6m
7.	Cape Point (Ocean Bay East Fence End	120m	90.3	-29.7m
			Total Shoreline shift difference	567.8m

Based on the data collected in the four (4) out of the fifteen (15) profiles identified within the seven problematic areas, it is estimated that the mean average rate of erosion is estimated at 11.5m per year. (Calculated by summing up the total shoreline shift divided by the number of areas concerned. The total figure is divided again by seven as the number of years between 2003-2010).

Senegambia and Kairaba Beach Hotels seafront shows significant rate of erosion over the past seven years after the completion of the coastal protection project compared to other areas within the study area.The results suggest high annual rate of erosion could be due to the fact there is a gap in availability of data at some areas where previous records did not reflect or were not taken during routine monitoring. In addition the huge erosion rate reflected in the results could also be due to the reason that only two years between 2003(when the coastal protection work was completed and 2010 showing the current situation are considered. It is also suggested that poor engineering interventions and global climate change could also be responsible for the high rate of erosion at the seafront of Senegambia and Kairaba Beach Hotels.

Holiday beach seafront and State house have also experience significant erosion after the coastal protection, although not very serious compared to the problematic areas of Senegambia and Kairaba Beach hotel. The Radio Syd/lagoon area including the Christian and Muslim Cemeteries has eroded to some extend, and this is partly be due to the expansion of the lagoon. The

The Coastal cells

The small net transports along the coast of The Gambia can be partly explained by the natural subdivision into different cells. The cell boundaries are marked by discontinuities in the shoreline (protrusions, sharp bends), that often indicate a local disturbance of the alongshore transport along the coast. In the study area creek or river outlets cause most of

these discontinuities by rocky outcrops, and some. The alongshore interaction between the cells depends largely on the position and dimensions of these rocky features. The main cells in the study area are indicated in the table 5 below. Alongshore transports within each cell, and interactions between the cells largely determine the behaviour of the coastline.

T able 5 : Coastal cells and characteristics

Km (approx.)	Location	Description of beach	Trends in shoreline (last decades)	Existing structures
0 – 12	Buniada Pt. to Barra	Low barrier beach	Erosion	-
0 – 1.5	Banjul Port to Banjul Pt	Beach and port area	Accretion north, Erosion south	Short groins (damaged)
1.5 – 6	Banjul Pt To eastern end sand spit	Narrow beach	Erosion	Short groins (damaged) Revetments
6 - 7.5	Eastern end sand spit to Toll Pt	Sand spit	Accumulation area (growing)	-
7.5 – 13.5	Toll Pt. to Cape Pt	Beach west sand bar east	Fluctuations	Short groins (damaged)-
13.5 – 17	Cape Pt. to Fajara	Cliffs with (low) Beach	Erosion	Revetments

Source : Feasibility Report 2003

VI. PERSPECTIVES, CONCLUSION AND RECOMMENDATIONS

Because the cause of coastal erosion is not always directly evident and is often seen as a natural phenomenon, the question of who is responsible for its management is not an easy one. People often tend to look towards public authorities when it comes to taking measures. Hardly ever are parties responsible for coastal erosion made accountable for the consequences. A study of the coastal situation and littoral regime in the Gambia shows that some of the erosion-inducing processes are inevitable and may even grow in intensity. This is real taking in to consideration the climate change and global rate of sea level rise will probably be increasing over the years because of the increasing Greenhouse effect. Such accelerated sea level rise will have negative impact on low-lying coastal areas of the Gambia and resulting in a continuation of the present coastal erosion.

There is a natural trend of erosion along the coast of The Gambia, due to an annual net sand loss from the coast in a alongshore direction and the effect of sea level rise. Along the low coast of Barra also some effect of wash-over is likely to contribute. The natural erosion rate due to above mechanisms is small, and the trends along the coast of Barra and the coast south of Bald Cape can be explained by these mechanisms. However, for the large erosive trends between Kololi Point and Bald Cape and along the Banjul-Serrekunda highway east of Oyster Creek, other mechanisms dominate.

Along the Atlantic coast, the alongshore transports and the natural gradients in these transport are small to moderate. The observed large erosive trends in the last decades are for a large part due to activities such as sand mining from the beach. This annual volume lost from the beach due to mining was similar to the volume lost due to the gradient in the alongshore transport along the entire coast of The Gambia. However, the deficit due to the gradient in the alongshore transport is spread along the entire coast of Gambia (several tens of kilometres), while the deficit due to sand mining was created very locally, over a stretch of several kilometres around Bijilo. This has locally increased the natural sand deficit with a factor 3 to 4. It is important to realise that the effects of sand mining from the beach affect a coastal stretch, which is larger than the part of the beach where mining is actually taking place. Due to local mining the natural shape of the shoreline will be disturbed. The waves will tend to smoothen out this disturbance by transporting sand towards the mining site, at the expense of the adjacent coastal stretches. As a result, local sand mining causes a shoreline retreat along a coastal stretch, which is significantly larger than the actual sand mining site.

Along the coast between Oyster Creek and Banjul the erosion is the result of the development of the sand-spit at Tolls Point. Due to local accumulation of sand in the spit, the supply to the coast east of the spit is strongly reduced. Since at some distance east of the spit the eastward-directed sand transport continues, the strong reduction of sand supply from the east causes erosion of the coast.

Attempts to modify coastal changes to halt erosion will require an appreciation of the factors at work in the coastal morphogenic system, the pattern of change, the sources and sinks of the sediments and the paths of the sediment transits and the impacts of protection works. Experience from various parts of the world where coastline stabilization measures have been applied without adequate understanding of the coastal sedimentary processes,

frequently show poor performance and ineffectiveness. This may be true for some areas of the Gambian coast. This therefore brings into focus the need to take action holistically and appropriately to coastal erosion problems, including adequate monitoring and maintenance procedures, and appropriate legislation and enforcement.

Whilst a complete rehabilitation of the sea defense interventions may yet restore some of the presently eroding beaches, this is not only expensive but it can be considered for the short term.For the long term, a detailed and comprehensive study of the whole problem of erosion on the coastline of the Gambia is required with the formulation of a coast protection master plan which can be implemented in phases. It is also relevant to work on establishing permanent benchmark along the coastline of the Gambia, especially at areas without identified benchmark including the exact position of the fourty-two profiles identified during the coastal protection project. This will enhance future effective monitoring of coastal erosion in the Gambia.

Our limitations during this study was that the coastal profiles established in 2000 during the feasibility and preparatory face for the last coastal protection project by Royal Haskoning, after completion of the project in 2004 some of the established benchmarks were removed advertently due to coastal structural development. Inaddition, other who felt the bench marks were obstactle to the movement of their vehicles due to the close proximity of the profiles to the highway in some areas were removed as well. As a result only few original benchmarks were identified during this study and utilize by the Coastal Zone Monitoring team as well as adopt new bench mark to continue on the profiling. In this regard we recommend strengthening integrated coastal zone management and the protection of physical infrastructure, economic and cultural assets and activities will include:

- Topographic survey of the coastal strip and inshore area
- Bathymetric survey of the coastal strip and foreshore area
- Beach stabilization(nourishment)
- Construction or rehabilitation of groins
- Establishment and rehabilitation of wetlands
- Enhanced skills and adequate equipment and materials to implement coastal protection works
- Adequate funds to undertake all the envisaged activities

It is envisage that once these activities are implemented, in a short term some areas like Bakau fish landing site and jetty will be protected which will ensure continuity of the livelihood activities carried out in that area. Also the rehabilitation of the Kotu Stream/creek will prevent flooding of homes and property in the area and restore rice cultivation, as well as minimize the frequency of dredging in the Banjul Port and ferry terminal areas. In the longterm the potential output will include development of comprehensive legislation on coastal zone management; regulatory system will be put in place for the enforcement and control of coastal zone. Also development and implementation of coastal zone management plan by all stakeholders. Based on the observations made during this study in relation to coastal erosion, a proposal of intervention detailed below in the tables, is recommend in future as long-term measures and actions to control or reduce the rate of erosion in the study areas.

Table 6 : BANJUL POINT TO SAND SPIT INTERVENTION: Installation of Timber Groynes Area to cover: Appx. 3500metres

Item	Description	Quantity	Unit	Rate GMD	Amount GMD
I.	Supply of Rhum Palms 8.0 m and diam 0.30 m	9	Numbers	2,500.00	22,500.00
II.	Supply of Rhum Palms 6.0 m and diam 0.30 m	513	Numbers	1,600.00	820,800.00
III.	Supply of Rhum Palms 5.0 m and diam 0.30 m	513	Numbers	1,000.00	513,000.00
IV.	Installation of Rhum Palm Timber Groynes	1,035	Numbers	1,800.00	1,863,000.00
					3,219,300

Table 7 : MUSLIM CEMETRY (CLOSE TO THE SANDSPIT)
INTERVENTION: Beach Nourishment

Item	Description	Quantity	Unit	Rate GMD	Amount GMD
I.	Supply and placement of sand	875,000.00	m3	43,407	37,981,125

Table 8 : Kairaba and Senegambia Hotels Seafront
INTERVENTION: Construction of T – Groynes (three)

Item	Description	Quantity	Unit	Rate GMB	Amount GMB
I.	Supply of Rock 2 – 5 tonnes	500	m3	2412.00	1,206,000.00
II.	Supply of Rock 300 – 1000kg	150	m3	1748.00	262,200.00
III.	Supply of laterite stones 60 – 300 kg	500	m3	718	359,000.00
IV.	Place of rock 2 – 5 tonnes	500	m3	898	449,000.00
V.	Place of rock 300 – 1000kg	150	m3	503	75,450.00
VI.	Place of laterite stones 60 – 300kg	500	m3	449	224,500.00
VII.	Beach infill – supply and placement of sand	2500	m3	106.35	265,875.00
	Total for one T - Groyne				2,842,025
	Total for three groynes				8,526,075

Table 9 : Kotu Stream outlet
INTERVENTION: Digging/Deepening the channel outlet.

Item	Description	Quantity	Unit	Rate GMD	Amount GMD
I.	Excavate and or Dredge sand	30,000	m3	90.00	2,700,000.00

Table 10 : Sea view Hotel seafront
INTERVENTION: Construction of T – Groyne (one)

Item	Description	Quantity	Unit	Rate GMB	Amount GMB
I.	Supply of Rock 2 – 5 tonnes	500	m3	2412.00	1,206,000.00
II.	Supply of Rock 300 – 1000kg	150	m3	1748.00	262,200.00
III.	Supply of laterite stones 60 – 300 kg	500	m3	718	359,000.00
IV.	Place of rock 2 – 5 tonnes	500	m3	898	449,000.00
V.	Place of rock 300 – 1000kg	150	m3	503	75,450.00
VI.	Place of laterite stones 60 – 300kg	500	m3	449	224,500.00
VII.	Beach infill – supply and placement of sand	2500	m3	106.35	265,875.00
	Total for one T - Groyne				2,842,025

Table 11 : Summary of Intervention Sites

Item	Site	Proposed Intervention	Estimated cost
I.	Banjul Seafront: From Banjul Point to Radio Syd.	Concrete Groynes/ Palm Groynes	3,219,300
II.	Muslim Cemetery(opposite Foam Factory)	Beach Nourishment	37,981,125
III.	Kairaba and Senegambia Seafront	T Groynes	8,526,075
IV.	Sea view Beach	T Groynes	2,842,025
V.	Kotu Stream	Digging/Deepening the Channel.	2,700,000.00
VI.	Sub-total Estimated Intervention cost		56,261,525.00
VII.	10% Contingency (Currency fluctuation, etc)		5,626,152.5
IX	Cumulative Total		60,894,677.50

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APPENDIX

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Appendix 2: List of Acronyms

FAO : Food for Agricultural Organisation
IUCN : International Union for Conservation of Nature
KMC : Kanifing Municipal Council
NEA : National Environment Agency
NERICA : New Rice for Africa.
UNEP : United Nations Environment Program
WD : Western Division

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