Coastline Migration in Nigeria

The coastal zone of Nigeria has in recent years been subjected to increasing economic activities, primarily driven by seaport activities and oil exploration and exploitation. These activities have reportedly resulted in accelerated shoreline erosion estimated at between 20-30m per annum. Historical data derived from aerial photographs for a section of the Nigerian coastline spanning the years 1900-2002 has been used here to estimate shoreline dynamics, now conservatively put at 1.7m per annum, corresponding to a net sediment loss of 7.3m2 per annum.

The 853km long Nigeria coastline runs through seven of the Southern States of the Federation, Lagos, Ondo, Delta, Bayelsa, Rivers, Akwa Ibom and Cross Rivers bordering the Atlantic Ocean. The continental shelf widens progressively from a western value of 35km in the area of Lagos, 64km around the Cape of Forcados in the Niger Delta area to a maximum of 75km offshore Calabar. The two canyons of Avons and Mahin, westwards, and the Calabar canyon, eastwards, frame the shelf. This study focuses among other things on evaluating shoreline dynamics along the evolving coasts of this second-longest African coastline. A coastline undergoing socio-economic stress must be managed in such a way that it will sustain itself via sediment redistribution within the coastal environment. Net sediment loss has been the norm along the western end of the Nigerian coastline (typified by Lagos), as a result of poor understanding of coastal processes by relevant managing authorities.

Coastal Dynamics and Morphology

The general dynamics of the Nigerian coastline depend on large-scale oceanic and climatic seasonal changes. These occur all over the world but are poorly recognised in Nigeria. This is one aspect; another is man's intervention in the littoral environment in erecting harbour-protecting structures, dam construction, dredging, mining of beach sand, oil exploitation and de-vegetation. These activities invariably deprive the foreshore of its natural protection.

To effectively account for sediment dynamics along representative sections of the Nigerian coastline, sediment budgets have been constructed which sought to account for the removal, transport and deposition, and the resulting excesses or deficiencies of material quantities in a beach system. The resulting excesses (which may lead to accretion) or deficiencies (leading to erosion) give an insight into the dynamics of beach materials within the littoral zone. It is important to note that sediment accretion and erosion (the latter has consistently been given bad press!) becomes of concern only when they occur at undesirable locations within the coastal environment.

Sedimentary Processes

Four main factors have been identified in modification of sedimentary processes of a given littoral unit:

- Strong storms causing a rise in mean sea-level and thus favouring a direct attack on the highest part of the foreshore by up-rush and transfer of sediments down to the nearest part of the submarine beach and off the inner continental shelf. The case of Koluama I and II (Bayelsa State), Forcados (Delta State), Imoluma (Ondo) and Victoria beach (Lagos Island) are some typical examples
- Slumping of sediments accumulated on unstable slopes
- Slow sea-level rise at a rate of 70 to 12cm since the beginning of this century also favours wave attacks on the high foreshore and causes progressive retreat of gently sloping sandy shorelines (a few dozen centimetres per year)
- Man's activities in a system that had been more or less in dynamic equilibrium

Sediment Dynamics

Coastal processes in the Lagos area seem to have been well studied, from the NEDECO project of the 1950s to the current efforts of the Nigerian Institute of Oceanography and Marine Research, NIOMR. The building of the Lagos harbour jetties induced sedimentation westwards of the harbour entrance channel and erosion of Victoria beach eastward. Figure 2 shows the changing nature of Lagos coastline over the years as a result of the construction of harbour moles which obstruct west-east littoral drift, thus resulting in active accretion at Lighthouse beach and acute erosion at Victoria beach - downstream end of the long-shore current. NEDECO estimated eastwards littoral transport at about 500,000m3/year. Various technical reports by NIOMR give an estimate of a 22-29m/year growth at Lighthouse beach and a 20-30m/year recession at Victoria beach. It has also been estimated that a total of about 1,350m of shoreline retrogression has occurred since 1912 at eastern jetty level. The rate of erosion was less severe further eastwards of Victoria beach, amounting only to 750m during the same period. Table 1 presents the average annual rates of erosion at selected study sites along the rest of the Nigerian coastline computed from results of historical studies and/or beach profiling projects.

For the present work use was made of aerial photographs of Lagos beach taken over the years 1900, 1945, 1959 and 2002, Table 2 shows the areal extent of accretion and the associated width of affected beach in meters for the stretch of Lighthouse Beach (West Moles). The cumulative area affected by accretion amounts to 54.8 hec-tares, involving a beach width of 177m measured normal to the average disposition of the shoreline. The rate of accretion is highest for the years 1945 to 1959, averaging 2.4m of shoreline accretion per annum and covering an area of 7,000m2 per annum. Corresponding values for the epochs 1900 to 1945 and 1959 to 2002 show a remarkable similarity.

Table 3, on the other hand, gives values for the eroding beach face at the Victoria Island Bar Beach. As has been noted earlier, the state of the shoreline here has generated a lot of interest on the part of government and other concerned organisations because of the apparent threat to structures situated at the immediate backshore. The areal extent of erosion over the period 1900 to 1945 (immediately after the placement of the moles) was 40 hectares. The corresponding area is put at 17 hectares in later years. Total area affected by erosion over the period is put at 74.8 hectares at a current rate of 7,300m2 per annum.

Total shoreline retreat over the period 1900 to 2002 is 178m, while the current rate of shoreline recession is put at an average 1.7m

per annum from a high of 2.1m and 2.3m for the periods 1900 to 1945 and 1945 to 1959 respectively, as shown in Figure 3. The falling rate of shoreline retreat may be due to the success of current engineering efforts to stabilise the shore.

Conclusion and Recommendation

As population density increases in coastal areas coastal erosion is becoming a critical problem along many Nigerian coastal margins. Accelerated shoreline migration is the trend along several stretches of beach, including Victoria Bar Beach, Awoye-Molume, Escravos and Forcados. Shoreline retreat at rates shown in Table 1 has serious consequences for the stability of the coastal planes and its vast oil mineral and ecological resources, as well as for human settlements.

The current rate of areal shoreline retreat at the eroding Victoria Island Bar Beach is put at 7.3m2/annum, while shoreline retreat is on average 1.7m/ annum. These rates are considerably lower than most other reported rates, as shown in Table 1. These lower rates may be attributed to the success of present efforts aimed at stabilising the shoreline. It is, however, pertinent to state here that coastal erosion is not continuous along an entire beach, as in some cases the adjourning profiles are pro-grading seawards, e.g. at Lighthouse beach and Escravos beach. It is difficult to predict the long-term rates of shoreline dynamics in Nigeria, as the period of historical records is not sufficient to define even the fairly recent (within the last hundred years) fluctuations in the Nigerian coastline. There is therefore a need to establish a relevant infrastructure to collect, compute and manage metocean data along the country's coastline. This would create the needed database and enhance coastal resource planning, management and development within a sustainable framework.

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