BEYOND DATA REGULATION: FINDING A SOLUTION TO THE PERSISTENT PROBLEM OF MARINE DEBRIS AND SEA SURFACE TEMPERATURE MEASUREMENT ALONG THE COASTLINE OF LAGOS, NIGERIA

O A Ediang[1*] and A A Ediang[2]

*[*1]Marine Division, Nigerian Meteorological Agency, PMB1215 OSHODI, Lagos, Nigeria*
Email: ediang2000@yahoo.com
[2]The Nigerian Maritime Administration and Safety Agency, 6 Burmal Road, Apapa, Lagos, Nigeria.
Email: ediang2005@yahoo.com

ABSTRACT

In this paper we discuss environmental changes along the coastal line of Nigeria, especially in the region around Lagos, based on provisional multi-disciplinary analyses of meteorological and maritime observations. This study has revealed that recent environmental change in the Nigerian coastal region has been much more apparent than that of a few years back (1989-2007). Various kinds of ocean debris, transported mainly by coastal wind, are severely affecting the marine and coastal environment. Because the current ocean monitoring system has been found to be troubled by ocean debris, establishing a new system to obtain reliable observational data to monitor and preserve the environment of the coastal region is urgent.

Keywords: Marine environment, Nigeria, Coastal degradation, Data analysis

1 INTRODUCTION

Meteorological data have shown that sea surface temperature (SST) plays an important role along the coastline of Nigeria and that SST and rainfall are linked. Afiesimama (1996) and Indeje (1995) established a relationship between the Pacific Ocean surface temperatures and rainfall over parts of East Africa. The appearance of sea SST anomalies is the primary evidence of an Enso episode, the warm phase of the Southern Oscillation (SO), which is often referred to as an El Niño/Southern Oscillation (ENSO) episode (WMO, 1996). Adedokun (1978) has noted that the upwelling process that takes place, for instance off the Accra Coast, can be weakened or strengthened by an increase or decrease in SST respectively. This increase/decrease can result from a weakening or strengthening of the south westerly winds. Edafienene et al. (1997) observed that the temperature of the Nigerian coastal water is warmest in April and coldest in August by using SST data for the period 1989-1997.

In this paper, we discuss sharing data and information about marine debris, including a wide variety of man-made items that persist in the marine environment. While ship wrecks and other artifacts indicate that man-made items are already present in the marine environment, social and technical changes in modern times have added a new dimension to the marine debris problem. We attempt to highlight multi-disciplinary data analysis in finding solutions to the persistent problem of marine debris and SST measurements along the coastline of Lagos, Nigeria.

2 STUDY AREA

The Nigerian coastline runs about 860 km along the Atlantic Ocean. It is bounded in the west by the Republic of Benin and in the east by the Republic of Cameroon. It lies generally between latitudes $4^0$10'N and $6^0$20'N and longitudes $2^0$45'E and $8^0$35'E and is adjacent to the Gulf of Guinea. A map of the coastal region of Lagos, Nigeria and an example of aerial photographs of the coastline (from Google Maps) are shown in Figure 1. A common feature of the coastline is its low-lying nature. The coastline has been classified into four broad regions according to differences in general morphology, vegetation, and beach types. The regions from west to east are: the Barrier Lagoon Coast, the Transgress Mud Coast, the Niger Delta, and the Strand Coast. The Victoria Island Beach is a part of the Barrier Lagoon Coast. The island beach has suffered degradation resulting from a number of natural and anthropogenic causes in the past two and half decades. This region is located to the east of the Eastern Breakwater (East Mole) of the down drift side of the inlet into the Lagos Harbor. The Kuramo Waters

and the Igbosere Creek are located to the east of this island. The Nigerian Coastline is bounded to the north by Five Cowries Creek and to the south by the Atlantic Ocean, where Tin Can and Apapa Port are located.

Figure 1. A map showing the geomorphology of the Lagos costal area, Nigeria (left) and an aerial photo of a lagoon (Kuramo Waters) in Lekki Peninsula (right). The aerial photo is taken from Google Maps.

3 TRANSPORTATION OF MARINE DEBRIS ALONG THE COASTLINE OF LAGOS

The frequency of anomalous transportation of marine debris along the coastline of Nigeria, especially the coastline of Lagos, has increased in the last decade. Marine debris can enter into the marine environment through a variety of vectors. Land-based debris can be transported to the marine environment as a result of:

- Urban runoff,
- Sewer overflow,
- Inadequate garbage management,
- Industrial activities,
- Terrestrial dumping and littering activities.

Sea based vectors include cruise ships, cargo ships, recreational boats, fishing vessels, and plant forms. The problem with marine debris prevention along the coastline of Lagos is the ocean's ability to move and circulate the debris. The combination of ocean currents and atmospheric winds can transport debris across great distances. It can also retain and concentrate items for later deposition.

4 DATA AND METHODOLOGY

4.1 Data sources

In this analysis, we used data of the SST and the annual maximum temperatures in the coastal region of Lagos, Nigeria, in the period from 1952 to 2007. We also used daily wind data (speed and direction) at 0900z that were obtained for a period of 11years (1997 -2007) at a maritime meteorological station at Victoria Island, near Lagos harbor. This dataset was provided by the Nigerian Meteorological Agency. Outcomes from independent statistical analyses conducted by the Federal Office of Statistics, Lagos and the Institute of Oceanography in Victoria Island are compared with our results.

4.2 Data analysis

Analyses of the trends and patterns of sea SST variations were carried out. The monthly averaged data for the period 1989-2007 were statistically treated to obtain the mean yearly SST values, which give adequate and necessary information on the changes in the Nigerian coastal areas. When the SST increased above the mean level in the analyzed interval, the amount of marine debris decreased. On the other hand, the movement of marine debris was significantly enhanced when a sharp decrease in the SST occurred.

The trend of the annual maximum temperature in the coastal region of Nigeria in 1952-2007 is shown in Figure 2. This analysis shows a clear increasing tendency of the annual maximum temperature as indicated by the linear fit to data, but the increasing tendency is suggested to have been accelerated in 1990s. An increase in temperature results in a decrease in the atmospheric pressure, and the movement of marine debris increases while a decrease in temperature results in an increase in pressure and marine debris movement decreases. Figure

3 shows the monthly frequency of the wind direction in the coastal region of Nigeria in 1997 - 2007. It is apparent that south-westerly winds were dominant in this region over the period. Winds play a huge role in the occurrence and movement of marine debris. Ocean debris is transported mainly by the westerly coastal wind in this region. As shown in Figure 3, winds blew predominantly from WSW and WNW directions. However, there were no cases of wind speeds greater than 19 knots. Within the period of this analysis, the weakest wind speeds were observed in the months between October and January while the strongest winds were mostly observed in August.

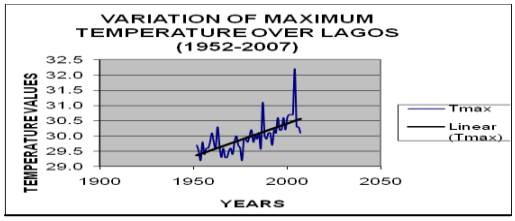

Figure 2.Variations of annual maximum temperatures in the coastal region of Lagos, Nigeria in 1952-2007

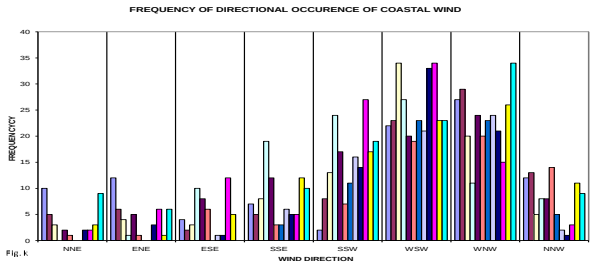

Figure 3.Monthly frequencies of wind directions in the coastal region of Nigeria in 1997-2007. The horizontal axis is divided into 8 bins of wind directions. Bars in each bin show the monthly frequencies from January to December, respectively.

5 DISCUSSION

Our investigation revealed that the Victoria Island beach of Nigeria has suffered degradation resulting from ocean surges, influenced by strong winds of a number of natural and anthropogenic causes for the past two and half a decades. Along the coastline of Lagos, persistent debris has played a significant role in the degradation of the marine environment. Such persistent materials include product packages and single-use beverage containers, such as aluminum cans and bottles. These items injure and kill marine species. The negative effect is suffered not only by animals but also by humans who interact with these coastal resources. SST measurements are frequently influenced by marine debris, and the effects result in missing data and incorrect measurements because marine meteorological stations are using rubber sea-temperature bucket thermometers on an hourly basis. The investigation that was carried out on the coastline of Nigeria revealed that ocean surges were strong in the months of April to October through the influence of a prevailing south-westerly wind not less than 18 knots. Over the area of $10^0$5N – $2^0$5N latitude and 0^0E – 10^0E longitude, high spring tides of about 1.8 m or more are predicted using a parametric wave model (Afiesimama et al., 2000). Also, the amount of marine debris along the coastline of Lagos shows seasonal variation and is usually highest in the summer months, April-October, due to strong westerly wind (Figure 3).

6 COLLABORATIVE DECISION MAKING TO PREVENT MARINE DEBRIS IN COASTLINE OF LAGOS

As technology advances, the concept of Collaborative Decision Making (CDM) has been proven to be useful. In a nutshell, CDM will be effective when users of services have a chance to add their expertise to the decision making process. For the process to work effectively, it is important to have tools with which to view the information seamlessly, and data must be readily available. Some Nigerian organizations have been involved in this process, e.g., the Nigerian Maritime Administration and Safety Agency, NIMASA, Lagos State Environmental Protection Agency (LASEPA), and the Nigerian Meteorological Agency**.** The Nigerian Maritime

Administration and Safety Agency, NIMASA, is committed to the enthronement of global best practices in the provision of maritime services in Nigeria. Its core functions include marine pollution protection, marine pollution control, waste management facilities, and marine environment management. Also the Lagos State Environmental Protection Agency (LASEPA) has inherited the responsibilities of the Pollution Control Unit, in addition to the functions that were indicated in the edict that later established the agency. The Nigerian Meteorological Agency (NIMET) is a federal government parastatal established by the Act No.9 of 2003. The agency is responsible for production of weather, water, and climate information for the socio-economic development of Nigeria. The Marine Division in the Applied Meteorological Services of the agency plays its role in information and data to prevent marine debris in the Lagos coastline.

7 CONCLUSIONS

The effects of marine debris are seen in the mortality among marine species along the coastline of Nigeria, especially the coastline of Lagos, and these effects also influence and affect the measurement of SST. Our study has revealed that the change in the Nigerian coastal climate is much more apparent than before (i.e., some few years back 1989-2007). Taking some past years into consideration, it can be seen that the rate at which the coastal area in Nigeria is changing is higher than that before 1989, but in the Nigerian coastal area over Lagos, the rate was even below the average before 1989. It shows furthermore that in recent years, it is even more above the average. The wind plays an important role in the transport of marine debris along the coastline of Lagos, Nigeria, i.e., the swells (waves generated at a distance) become very active while the sea state becomes slight to moderate over the South Atlantic Ocean extending to North Atlantic. However, the provision of adequate equipment by the Nigerian Meteorological Agency will be a spring board for improvement of the monitoring system in the Nigerian Coastal areas. This will enable data to be readily available for research work. Our recommendation to enforce the monitoring system in the Nigerian coastal area is given in the Appendix.

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9 APPENDIX

Recommendation

The Nigerian Meteorological Agency and the Institute of Oceanography and Marine Research should do more research because they understand the impact of marine debris and can offer solutions based on scientific knowledge and oceanographic conditions. Advanced models developed in Europe and the UK will be able to predict the movement of marine debris in coastal areas of Nigeria. The immediate challenge for the Nigerian Meteorological Agency and other stake holders in the marine industry is to set up and maintain systems that

collect, process, store, retrieve, and disseminate data as necessary, especially data related to sea surface temperature and marine debris. Drawing a strong inference from this, there is no doubt that the effort toward ensuring a sustainable environment quality and healthy economy is highly desirable. This can be achieved only if there is co-operation among the government, general public, and the science world. New research on sea surface temperature and its relation to marine debris is needed, and the government should continue to support the existing private sector.

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