Nature Of Marine winds, Waves and Swells over West African Coasts – Case study of Victoria Island beach in Lagos, Nigeria

By

S. O. Gbuyiro and E. Olaniyan

Marine Unit, Nigeria Meteorological Agency, Lagos - Nigeria

INTRODUCTION

• SEA STATE IS CONTROLLED BY ATMOSPHERIC WINDS WHICH COME IN CONTACT WITH THE OCEAN SURFACE.

• WIND IS THE PRIMARY CAUSE OF OCEAN WAVES DUE TO INTERRACTION BETWEEN ATMOSPHERE AND SEA SURFACE .

• WIND WAVES COMPRISE OF A SMALL PORTION OF THE TOTAL OCEAN WAVE SPECTRUM WITH TYPICAL WAVE PERIODS OF ABOUT 1 SEC TO 20SECONDS.

TYPES OF WAVES AND THEIR SOURCES OF GENERATION

- **INTERNAL GRAVITY WAVES** - CAUSED BY WIND STRESS . ** THE COMMONEST SINCE NEARLY ALL OF OUR OCEAN INTERACTION OCCUR AT THE OCEAN SURFACE.
- **SEICHES** – STANDING WAVES CONSISTING OF TWO PROGRESSIVE WAVES TRAVELLING IN THE OPPOSITE DIRECTIONS.
- **TSUNAMIES**- CAUSED BY EARTHQUAKES.
- **TIDES** - CAUSED BY GRAVITATIONAL PULL BY THE MOON AND SUN ON OCEAN WATER AND CENTRIPETAL FORCES PRODUCED BY A ROTATING EARTH.

WAVES CHARACTERISTICS

- **BASIN GEOMETRY INVOLVING**
  -- BASING LENGTH
  -- WATER DEPTH
- **WAVE LENGTH (L) * WAVE DEPTH (D)**
- **WAVE PERIOD (P)**
- **WATER DEPTH TO WAVE LENGTH RATIO (D/ L)**
- **WIND SPEED * WIND DURATION**
- **FETCH AREA / FETCH DISTANCE**

IMPACT OF WAVES

- TRANSPORTATION & SHIPPING - INVOLVING BOATS AND SHIPS.
- ENGINEERING WORKS: COASTAL STRUCTURES
- WATER RECREATIONAL ACTIVITIES ALONG THE COASTAL ZONES.
- FLOODING AND EROSION ALONG COASTAL SETTLEMENTS

WHY THE STUDY

- ROLE OF ST HELENA HIGH PRESSURE SYSTEMS.
- TO IDENTIFY THE CAUSE OF OCEAN SURGES DURING THE WINTER OR DRY SEASON.
- CONSTANT VICTORIAL ISLAND BEACH EROSION AND FLOODING DUE TO STORM AND OCEAN SURGES WHICH IS A THREAT TO ECONOMIC ACTIVITIES (12000 KM^2 , 6 MILLION POPULATION & US 3 BILLION SPENT ON SAND FILLING YEARLY.

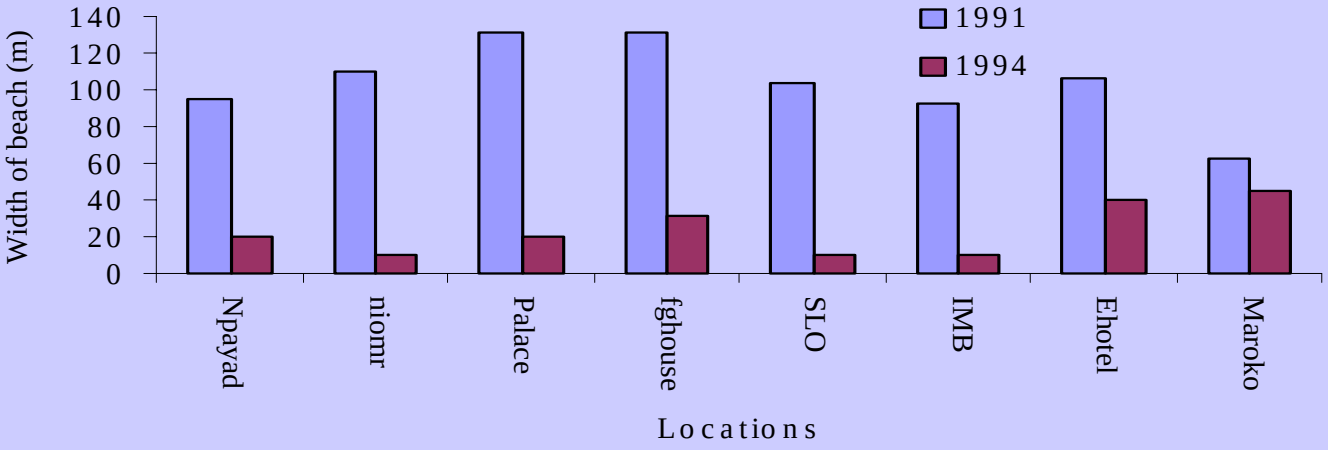

Fig 1.Locations beach width from 1991 t0 1994 in Victoria Island

STUDY AREA

- The Nigeria's coastal zone which also suffer from the coastal problems mentioned above lies within latitudes 4º 10' to 6º 20'N and longitudes 2º 45' to 8º 35'E spanning about 850 km of low-lying coastline.
- The coastal zone can be divided into four distinct geomorphic parts. These consist of
- (1) The barrier-lagoon system stretching for almost 250km from the Nigerian/Benin border
- (2) The Mahin transgressive Mud coast stretching for almost 75km.
- (3) The Niger delta covering almost 20,000 square kilometres is the second largest delta in the world spanning a coastline of almost 450km.
- (4) The Strand coast east of the Niger delta stretches for about 85km from the Imo river eastwards to the Nigerian/Cameroon boundary.

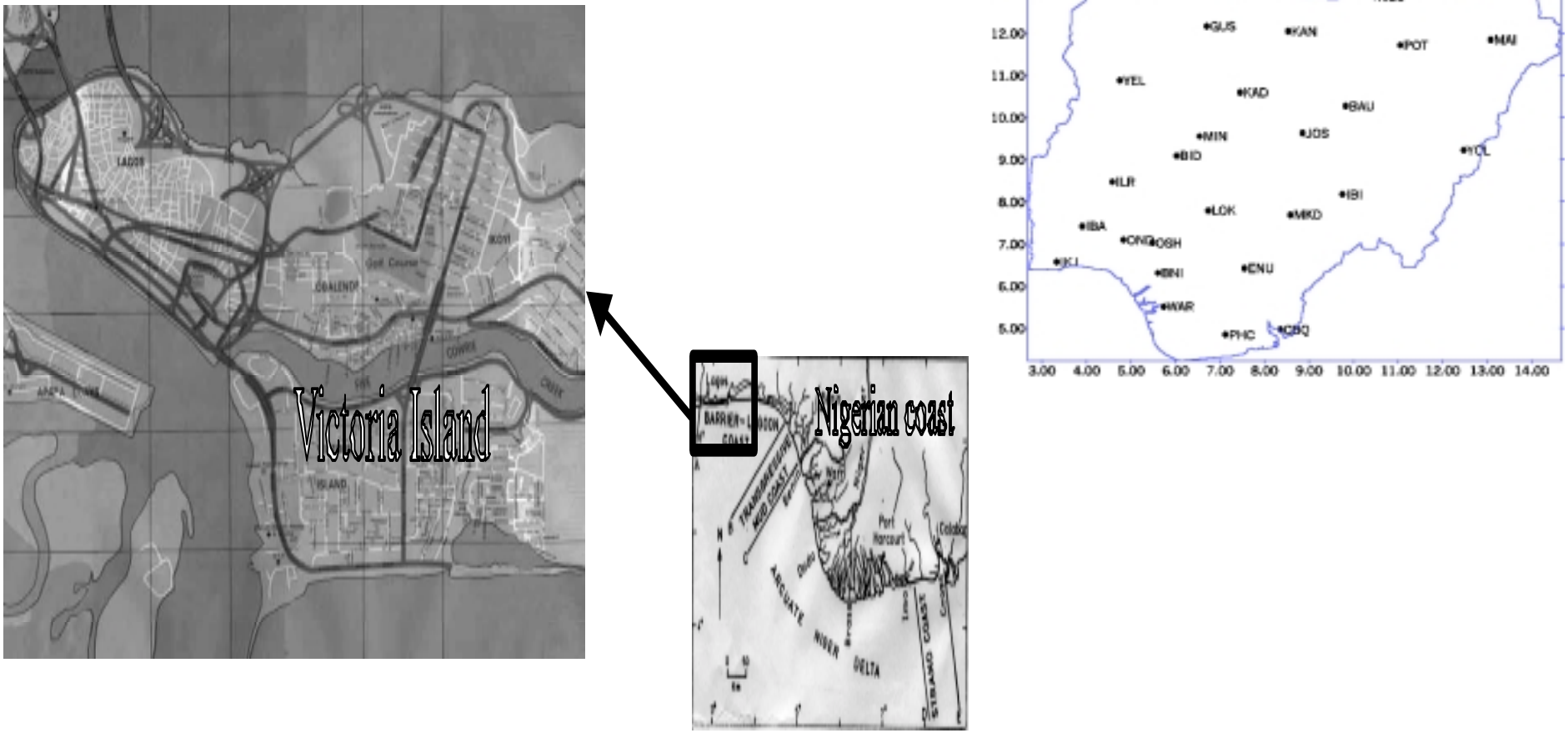

Fig 2 Showing the Nigeria coast (a) and enlarged box (b) Victoria Island

DATA AND METHODOLOGY

- Daily Winds, for 1998 to 2002 winter months (November - March) at 10m level over the Atlantic Ocean, between lat.10^{o}S - 20^{o}S and long 10^{o}E - 20^{o}W, were extracted from the general circulation model (GCM) of METEO-FRANCE.
- The extracted winds between lat. 10^{o}S - 20^{o}S and long 0^{o} - 10^{o}E, served as input data for a parametric wave model. This model has been adapted FROM LYON (1994) AND WHITFORD(2001) to suit local conditions.
- The out put variables (wave height, wave period and swells etc) were then obtained.

RESULTS

a. Winds from the fetch area (lat. 10 degree South - 20 degree South and long. 0 –10 degree East) generally lie between 7-20 knots in strength. The weakest and strongest winds were observed in January and March. (Figs; 3a&b)

b. The corresponding generated significant wave heights were less than 0.3 meters and more than 2.2 meters with period ranging between 2.0 and 7.5 seconds. It takes the lowest generated wave about 10-12 days and the highest 3-4 days to reach the coast as swells. (fig 4a&b). And

c. Swells of about 0.47 meters in height resulting from winds of about 10 knots grazed the coast frequently during the period

a. Rate of erosion from 1998 –2002 was observed to be 27m/year.

RESULTS

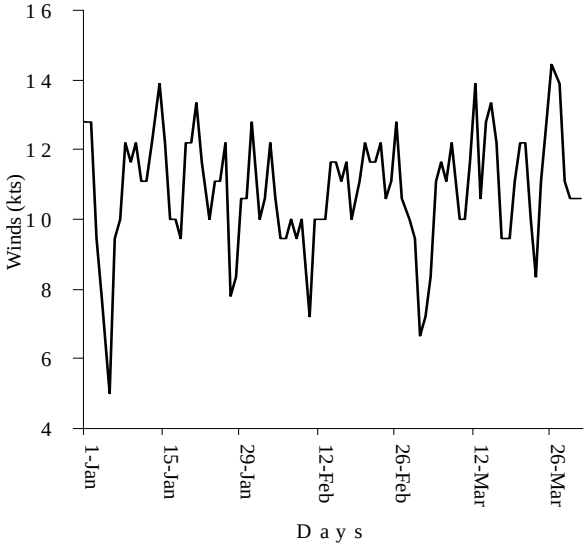

Fig. 3a. Time series of the fetch wind for 2001

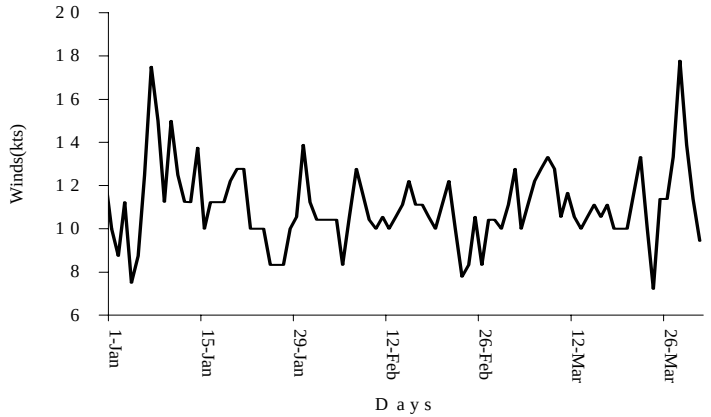

Fig. 3b. Time seriess of the fetch wind for 2002

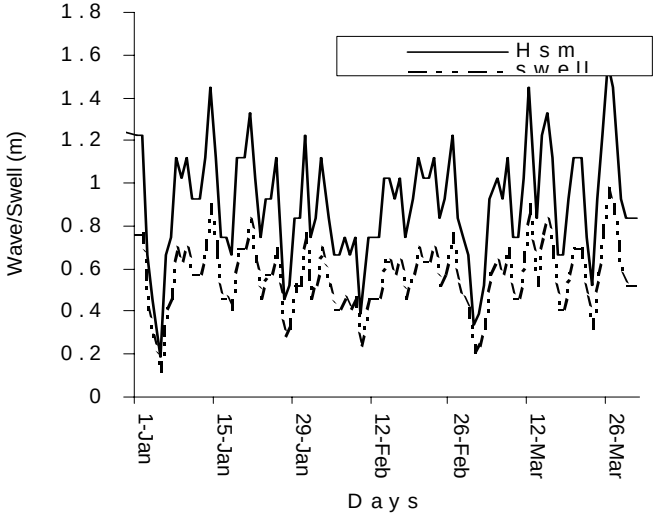

Fig.4a. Fetch significant wave and the corressponding coastal swells for 2001

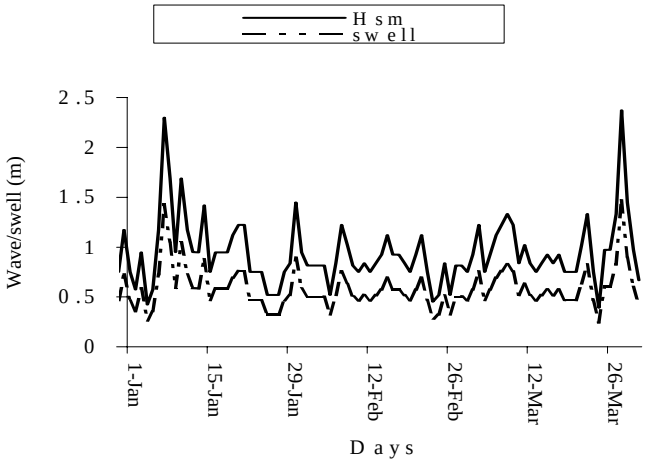

Fig.4b. Generated wave and the corressponding coastal swells for 2002

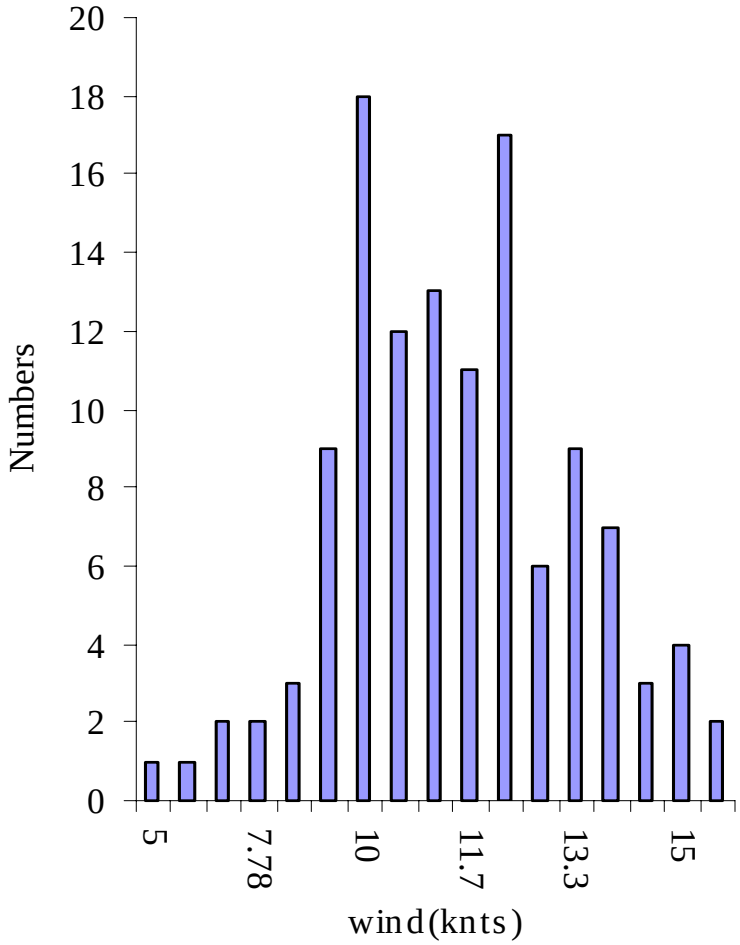

Fig5a. The frequency of occurence of the wind for 2001 period

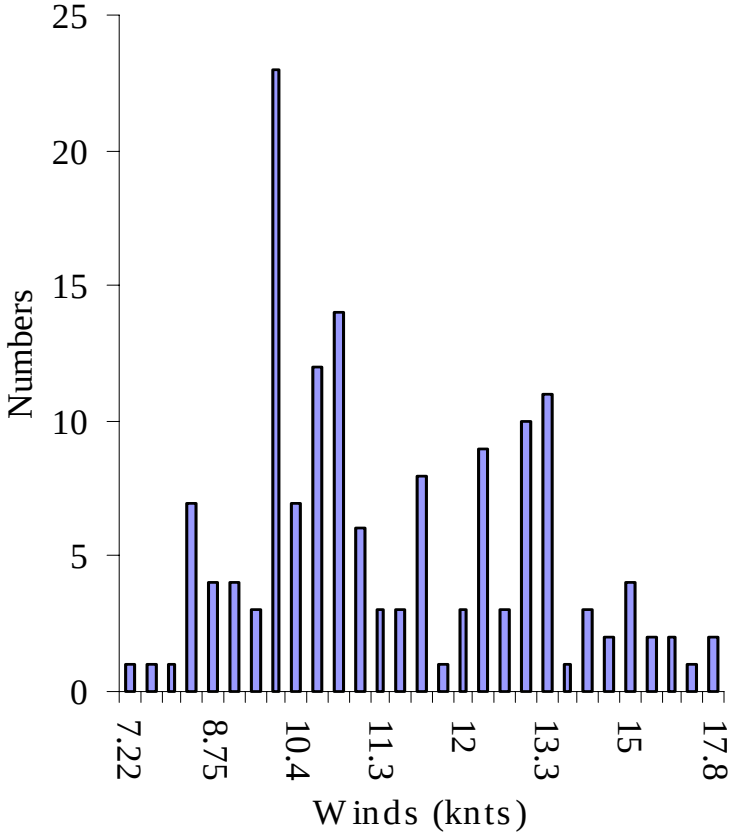

Fig5b. The frequency of occurence of the wind 2001 - 2002 period

CONCLUSION

This type of temporal observation in the marine wind and associated coastal swells from the generated wave can be important in the determination of surge occurrence in the unusual months. With the continuous coastal erosion caused primarily by the wave and the inundation of the coast during ocean surges in winter, this work will contribute to integrated coastal management.

Thank You