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Wind Stress Energy Measurements of Oguta Lake, Southeastern Nigeria

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Abstract

Wind stress energy within Oguta Lake was investigated over a period of one year using anemometer and standard equation. The results of the investigation shows that the highest wind stress energy (0.41g/cm/sec^2) was obtained in the month of January while the lowest (0.18g/cm/sec^2) was obtained in July. The result also indicates that the mean wind stress energy over the period of study was (0.25g/cm/sec^2). The result also indicates that the wind stress energy increases with increases with increase in wind velocity. Consequently, the highest wind velocity (3.60 x 10^2 cm/sec) was obtained in January while the lowest (2.39 x 10^2cm/sec) was obtained in July. The wind stress energy within the lake is considered low and may not be able to cause strong mixing of constituents within the lake. However, the wind stress energy is favourable for tourism, transportation, fishing, recreation and sand mining activities.

Keywords: Wind, Stress energy, Anemometer, Wind velocity, Constituents and Lake.

1.0 Introduction

Oguta Lake is the largest natural fresh water of non-marine habitant in southeastern Nigeria. It lies in a low-lying platform (about 50m) within approximately latitudes 5^0 41' and 5^0 44' North and longitudes 6^0 45' and 6^0 51'. East (see Figure 1) this regions falls within the rainforest best with a mean annual rainfall of 3,100mm.

Some studies (Nwadiaro and Umeham, 1985); (Odigi and Nwadiaro, 1988); (Nwadiaro and Edabor, 1990) have been carried out in some aspects of Oguta Lake. However, the wind stress energy within the lake ecosystem is yet to be investigated. Oguta Lake is of tremendous importance to both the local community and environs as well as the Imo State Government of Nigeria. To the former, it provides domestic water supply and is also used for transportation, recreation, fishing and sand mining activities. To the later, if provides a focal point for research, tourism and development of sporting activities. It is a fact that the current global change in climate can have adverse effects on the lake in terms of wind stress energy, bio-chemical character and shift in shoreline. This is capable of changing the resource status and usefulness of the lake. It is therefore necessary to monitor the wind stress energy and other aspects of the lake on a regular basis so as to ensure its sustainable development.

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Excessive wind stress energy can have adverse effects on tourism, fishing recreation and other activities within and around the lake.

2.0 Geological Setting and Hydrology

The study area (see Figure 2) is within the Niger Delta basin of Nigeria. The area is underlain by the Benin Formation (Pliocene to Miocene in age) which consists of friable sands with interrelations of clay/shale lenses, isolated gravel units, conglomerates and very coarse sandstones (Ananaba *et al.*, 1993). The formation has a mean thickness of about 800m around the study area (Avovbo, 1978).

The Oguta Lake is fed by two rives, Njaba and Awbana; the third river Utu flows into the lake during the rainy season. A fourth associated river, Orashi flows past the lake at its southwestern end (see Figure 1). Apart from the rivers that feed the lake, there is also in put from precipitation during the rainy season.

3.0 Materials and Methods

The wind stress energy is related to wind velocity (Clark *et al.*, 1977). The wind velocity within the lake was measured with the aid of anemometer over a period of one year on a bi-monthly basis commencing from January, 2010 and ending in Novem-

ber, 2010. The wind velocity was measured at five strategic locations (S_1 to S_5) within the lake (see Figure 1) and the bi-monthly average values were computed. The locations were spaced 2km apart. The wind stress energy values were then obtained using the equation developed by (Clarke, *et al.*, 1972).

$$T = 3.2 \times 10^{-6} W \quad ...1$$

where

T = wind stress energy (g/cm/sec^2)

W = wind velocity (cm/sec)

4.0 Results and Discussion

The result of the wind stress energy within Oguta Lake is shown in Table 1.

The result shows that the wind stress energy varies from 0.18 to 0.41 g/cm/sec^2 with a mean value of 0.25g/cm/sec^2. The highest wind stress energy (0.41g/cm/sec^2 was obtained in the month of January while the lowest (0.18g/cm/sec^2) was obtained in July. A plot of the monthly variations of the wind stress energy (see Figure 3) indicates that it is concave in shape. The more plot also indicates two peaks of wind stress energy; the first (0.41g/cm/sec^2) which was recorded in January and the second (0.28g/cm/sec^2) recorded in the month of November. The wind stress energy therefore appears to increase as one approaches the peak of the dry season and thus is typical of most tropical lakes (Oliver, 2005).

It is important to note that wind stress energy causes non-periodic current which are important in the mixing of constituents. The degree of the mixing depends on the wind stress energy. Although, the wind stress energy of Oguta Lake is considered low for strong mixing of constituents it can be of immense benefit mankind, in terms of sustainable tourism and

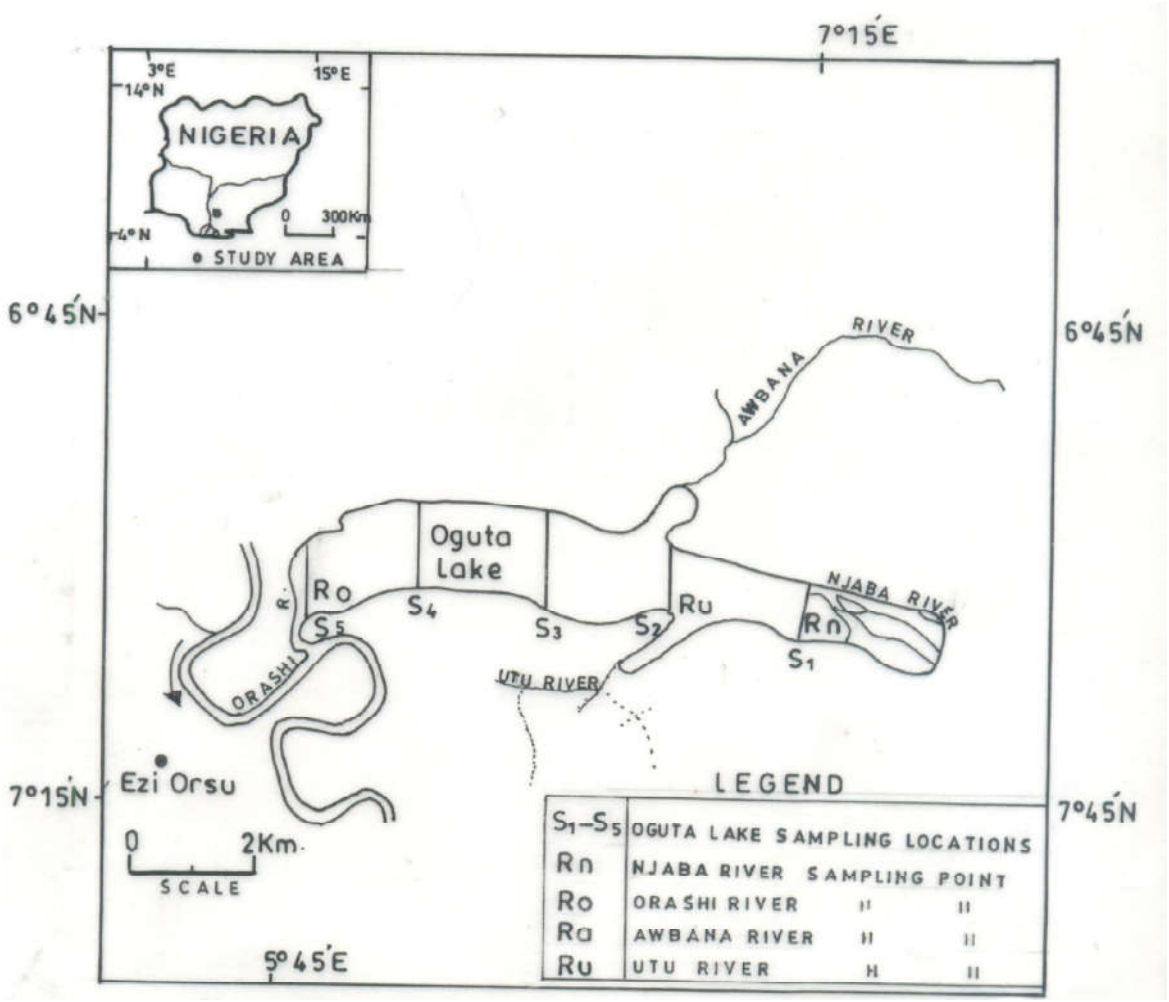

Figure 1: Map of study area showing sampling locations.

Figure 2: Geologic Map of Imo State showing the Study Area

transport development. It is also favourable for fishing and sporting activities. High wind stress energy can result in the mixing of the oxygen-rich surface water with relatively oxygen deficient bottom water. It can also create an isothermal condition whereby the warmer surface water mixes and become neutralized by the colder bottom waters. These conditions are favourable for survival of aquatic life such as fish. On the other hand, very high wind energy stress is inimical to tourism, research, fishing, recreation, sand mining and sporting activities. The wind stress energy of Oguta lake is quite favourable for these activities. The result of this investigation also shows that the wind stress energy follows the trend of the wind velocity. The wind stress energy increases, as the wind velocity increases (see Table 1). Consequently, the highest wind velocity (3.60×10^2cm/sec) was obtained in January while the lowest (2.39×10^2cm/sec) was obtained in July. Accordingly, the plot of the monthly variations of wind velocity (see Figure 4) has the same shape with the monthly variations of wind stress energy (see Figure 3). The wind direction within the lake is mainly, South-West, North-West and West. However, the South-West wind direction is the strongest. This is consistent with the wind directions in Owerrri and environs (Anyanwu and Ogueke, 2003; Anyanwu and Iwuagwu, 1994).

It is a fact that the wind stress energy and the wind velocity can change over a period of time especially with the climate change phenomenon. This implies that the current trend of wind stress may change in future. The result of this investigation thus provides a baseline information for future monitoring of he wind stress energy and wind velocities of the study area.

It is important to note that study on the vertical variation of some constituents (dissolved oxygen, temperature and pH) of Oguta Lake confirms the absence of strong mixing of these constituents (Ahiarakwem, 2011). The Oguta Lake has thus been described as polymeric on the base of its mixing condition (Oliver 2005).

5.0 Conclusion and Recommendations

The wind stress energy of Oguta Lake is favourable for tourism, transportation, fishing, recreation, research and sand mining activities. However, the wind stress energy result in the generation of non-periodic currents which is not high enough to cause strong mixing of constituents in the water. The wind stress, energy is considered low increases with increase in wind velocity. It is strongly recommended that regu

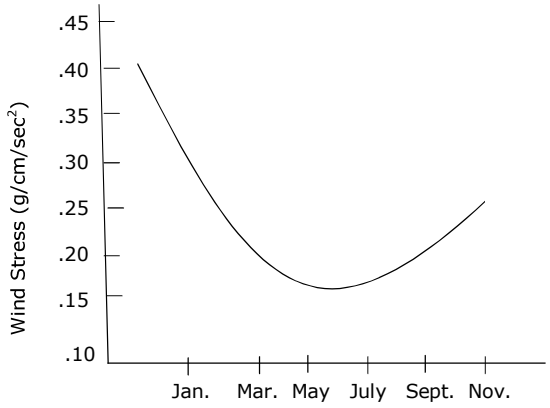

Figure 3: Monthly variation of wind stress energy of Oguta Lake.

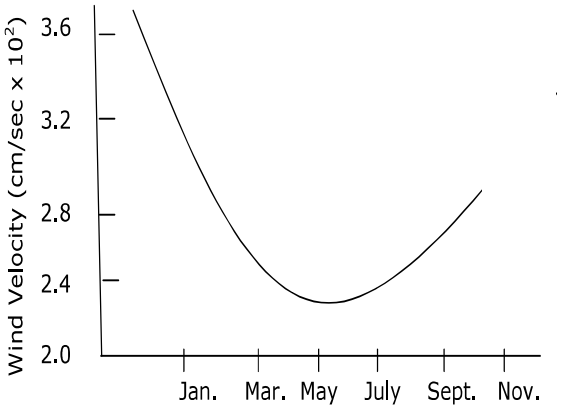

Figure 4: Monthly variation of wind velocity of Oguta Lake

Table 1: Wind Stress Energy Input of Oguta Lake (2010).

	January	March	May	July	Sept.	Nov.	Avg.
Wind Velocity cm/sec $x10^2$	3.60	2.80	2.50	2.39	2.60	3.00	2.80
Wind stress ($g/cm/sec^2$)	0.41	0.25	0.20	0.18	0.22	0.28	0.25

lar monitoring of the wind stress energy and wind velocity should be carried out in view of the current climate change. The present result should serve as a baseline information for further work in the area.

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