Predicting the fisheries potentials of inland reservoirs and lakes: A case study of Kubanni Reservoir, Ahmadu Bello University, Zaria

By

K. Balogun and U. J. Aduku
Department of Biological Sciences
Ahmadu Bello University
Zaria

ABSTRACT

The depth, alkalinity, total dissolved solids and conductivity of Kubanni Reservoir were monitored biweekly between December, 2003 and April 2004. The range values and their means were 0.8 – 4.64m, 42 – 67mg/l, 52 – 71mg/l and 104 – 142 mhos/cm, 2.8m, 42.6mg/l, 59.8mg/l and 119.6 mhos/cm respectively. Total Dissolved Solids correlated significantly ($p < 0.05$) with depth and conductivity while alkalinity correlated highly and significantly ($p < 0.05$) with conductivity, total dissolved solids but negatively correlated with depth. The electrical conductivity was positively and highly correlated with depth while Morpho-Edaphic Index (MEI) which increased with depth decrease correlated positively with conductivity. Based on the average value of the MEI the potential fish catch of the reservoir was estimated to be 38kg/ha. This estimate was compared with other values obtained from other African reservoirs/lakes and management considerations under "private liability company" are proffered.

INTRODUCTION

Planning for fisheries in African reservoirs with the objective of increasing the benefits from such reservoir fisheries has been one of the major concerns of the Food and Agricultural Organisation (FAO) Committee for Inland Fisheries of Africa (Ita *et al.*, 1982). The concern is based on the perception that the full biological and economic potential of reservoirs fisheries have rarely been realized because:

- reservoirs have always been established for purposes other than fisheries as the major objectives e.g. power supply, irrigation, flood control, urban water supply, navigation, etc.
- even when substantial fisheries benefits were expected from reservoir projects the participation of fishery experts often come much too late in the planning process.

Thus fisheries problems are not usually considered in the engineering design or provided for in the basin development plans. Kubanni Reservoir fits into the above pattern. Firstly, the reservoir was constructed primarily for urban water supply. Secondly, fisheries interests were not included in the engineering plan in order to evaluate the fisheries potential contribution to the overall benefits of the reservoir projects. The above observation notwithstand ing, Kubanni Reservoir can still be managed in such away that the reservoir fisheries potential can still be realized.

It has een established that the mineral content of the water expressed as total dissolved solids or alkalinity or conductivity can be used as a rough indicator of the edaphic conditions which play a fundamental role in determining the biological productivity of reservoirs or lakes. Ryder (1965) developed an index called Morpho-Edaphic Index (MEI) which has been found very useful in predicting fish yield both in temperate and tropical lakes.

Henderson and Welcomme (1974) calculated the MEI for 31 African lakes with known catch records by substituting TDS with conductivity which compares favourably with the TDS.

The primary aim of this study is to conduct investigation into the factors determining the MEI which are depth, alkalinity, total dissolved solids and conductivity and follow the Henderson and Welcomme method in the estimation of the fisheries potential and advise on the management strategies aimed at increasing fish production in the reservoir.

MATERIALS AND METHODS

Study area

The Kubanni Reservoir was built in 1973 in order to supply treated water to the University Community. The storage capacity was 2.6 x 10 m;, with maximum depth of about 8.5m. The catchments area was estimated to be 575km with surface area of 83.4ha and water supply capacity of 13.64 million litres per day.

Five sampling stations were established on a transect along the largest axis of the reservoir. Sampling was done biweekly for a period of 5 months (December, 2003 – April, 2004).

The following parameters were measured:

Depth

The water depth at each station was measured using meter rule with one end weighted and dropped into the water and the depth was then measured in meter.

Total dissolved solids

Water sample was collected in water bottles and transported to the laboratory where the total dissolved solids was measured using the Unican Pye Model (292)

Alkalinity

This was determined by measuring 100mls of sample into a conical flask, 3 drops of methyl orange were added to give a yellow colour. This was titrated with 0.02N Standard Sulphuric Acid solution until a faint orange colour was obtained which served as the end point. The calculation was based on Lind (1979)'s equation:

Total alkalinity (mg/l) = ml of titrant x 10

Electrical Conductivity

Water sample from the sampling stations were collected in plastic bottles and transported to the laboratory and electrical conductivity was measured using a Unican Pye Model (292)

Morpho-Edaphic Index

The Morpho-Edaphic Index which is an index of biological productivity is expressed as

$$MEI = \frac{\text{Total Dissolved Solids (ppm)}}{\text{Mean Depth (m)}}$$

which compares favourably with:

$$MEI = \frac{\text{conductivity } (\mu\text{mhos/cm})}{\text{Mean depth (m)}}$$

The results were subjected to statistical analysis employing analysis of variance and where there are significant differences the means were subjected to Duncan Multiple Range test and Rank Correlation Coefficient

Fish potential estimation

The mean value of MEI for the reservoir was matched with the Regression line obtained from the relationship of MEI and recorded catch from 31 African lakes (Henderson and Welcomme , 1974).

RESULTS

Depth

The mean monthly variation of the depth of the reservoir ranged from 0.8 – 4.64m with the mean monthly illustration in Fig 1. The lowest mean depth was recorded in the month of April while the highest mean depth was recorded in December. The analysis of variance shows significant difference between the months ($p < 0.05$) and the Duncan Multiple Range test shows high significance in the month of December and January. There was significant difference between stations ($p < 0.05$) with high significances in stations 2, 3 and 4.

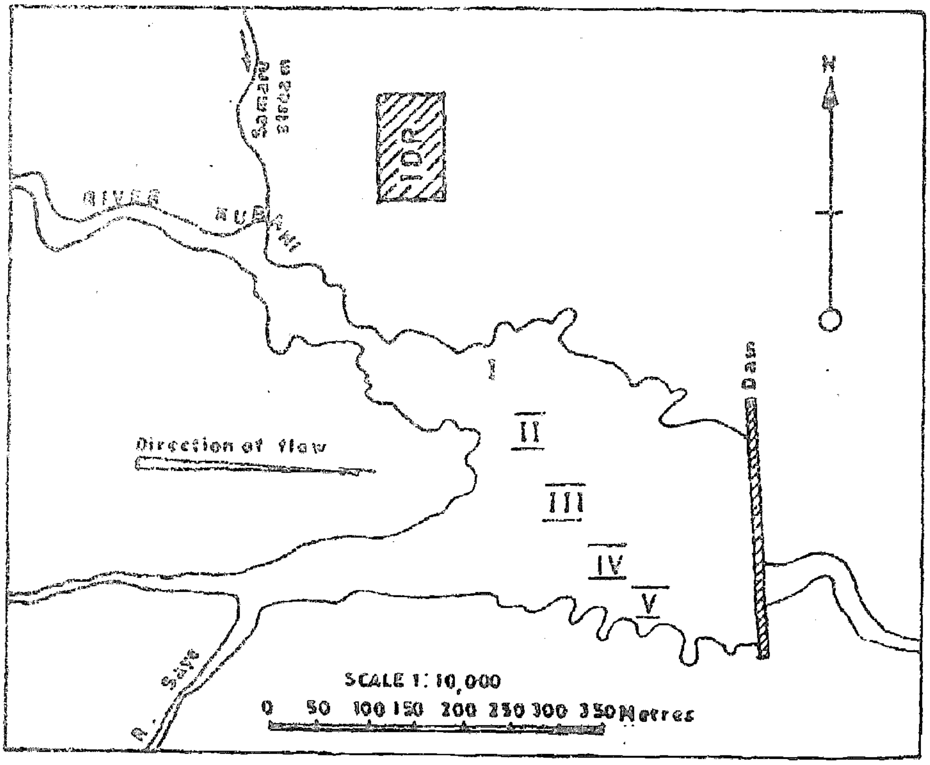

Fig. 1. Kubani Reservoir and the Sampling stations.

Total Dissolved Solids

The TDS mean monthly ranged between 52 and 71 with the mean monthly variation illustrated in Fig 1. The highest TDS was recorded in April and the lowest was recorded in December. The analysis of variance shows very high significance ($p < 0.05$) between months with high level of significance in the month of April, March and February. No significant difference in the monthly means ($p < 0.05$). TDS correlated significantly with depth and conductivity

Alkalinity

The mean monthly variation of alkalinity ranged from 42 – 60mg/l with mean monthly variation illustrated in Fig 1. The highest mean was recorded in April while the lowest value was obtained in February. The analysis of variance shows very high significant difference between months ($p < 0.05$) with high level of significance in April, March and January. There was no significant difference between the stations. Alkalinity correlated highly and significantly with electrical conductivity, total dissolved solids but negatively correlated with depth.

Electrical Conductivity

The mean monthly variation ranged between 103 - 142μmhos/cm with mean monthly variation illustrated in Fig 1. The lowest and highest mean conductivity was recorded in December and April respectively.

of variance shows high level of significance ($p < 0.05$) between months but no significant difference ($p > 0.05$) between the stations. Electrical conductivity show high level of significance in the months of April, March and February. The conductivity was positively and highly correlated with depth

Morpho- Edaphic Index

The trend of MEI is shown in Fig 2 which gradually rose from December through the month of April. The MEI was found to correlate positively with electrical conductivity and negatively with depth.

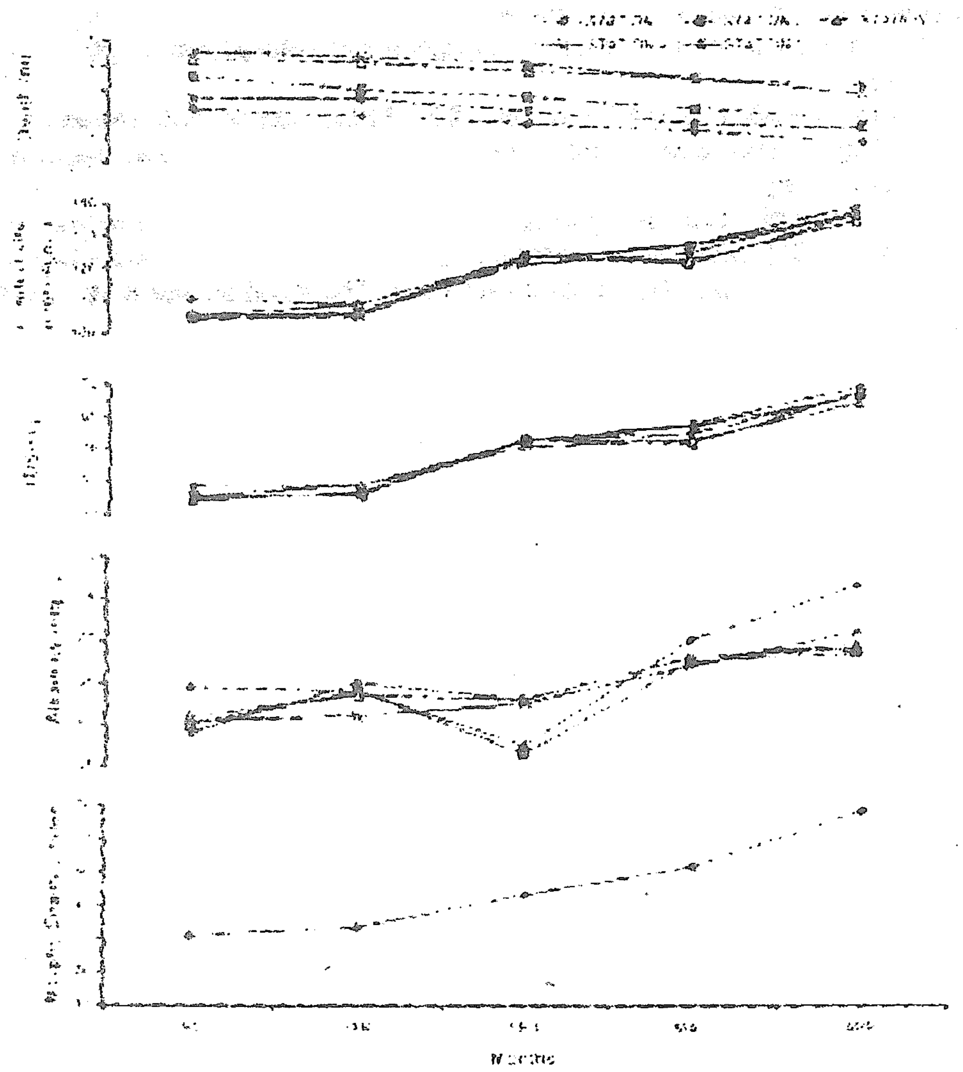

Fig. 2: Mean monthly variations in Depth, Conductivity, Total dissolved Solids, alkalinity and trend of Morpho-Edaphic index in Kubani Reservoir Samaru - Zaria

Fish potential estimation

From the relationship between MEI and recorded catch in the 31 lakes as obtained by Henderson and Welcomme (1974) and its regression line the average value of MEI in Kubanni Reservoir was estimated as 43 with a corresponding fish yield of 38kg/ha.

DISCUSSION

Production in any major ecosystem begins with photosynthesis and continues by way of a maze of food-chains whose most obvious products are successive stocks of organisms that typically increase in individual size as they decrease in total bulk (Ricker, 1978). Fish and the fish-like constitute the ultimate expression of the biological productivity of water, river, pond or lake and economic considerations give them high importance.

Attempts to explain variations in fish production have indicated that the mean depth and total dissolved solids combined into a morpho-edaphic index which are the principal factors determining fish production in both lakes and reservoirs (Noble, 1980). The mineral contents of water expressed as total dissolved solids or alkalinity or conductivity is a rough indicator of the edaphic index in determining the biological productivity of reservoirs or lakes. Ryder (1965) developed this index called Morpho-Edaphic Index (MEI) which has been found useful in predicting fish yield both in temperate and tropical lakes (Henderson and Welcomme, 1974). Thus the higher the MEI value the greater the yield.

The application of this index has enabled the authors to determine the potential fish yield of Kubanni Reservoir which was put at 38kg/ha during the dry season. This estimate does not cover the rainy season when the yield is expected to decline as a result of increase in mean depth even if the MEI remains the same. This estimate suggests that Kubanni Reservoir is potentially productive if adequate management is applied.

Similarly the MEI estimated for Bakolori Reservoir was put at 23μmhos/cm corresponding to a potential of 50kg/ha which was above the observed standing crop of 32kg/ha (Ita *et al.*, 1982).

Adeniji (1980) also estimated the potential fish production of about 25 to 40kg/ha using the MEI method which was also lower than the potential yield of 50kg/ha obtained by Ita *et al* (1982).

On the basis of this index Kainji Lake recorded a higher yield per hectare which was about 60kg/ha than Lakes Volta, Nasser and Kariba with 50, 20 and 8kg/ha respectively even though these other lakes are richer in nutrients. Kainji Lake has an advantage of having the lowest mean depth value.

For management consideration there is the need to investigate into the fish species diversity, distribution and relative abundance as reported by Balogun and Auta (2001). This will enable the fisheries expert to identify the fish species to be stocked (if necessary) or whether to recommend close season for the juveniles to attain adult sizes and enactment of minimum mesh regulation for fish exploitation. Earlier investigation into the actual catch of fish in this reservoir indicated that the reservoir was over-fished . Presently the Authority has banned active fishing in the reservoir, a decision in the right direction.

Henceforth the reservoir should be managed as a private liability company. In order words the reservoir is managed exclusively by the authority for the authority similar to the approach used in private fish management, in which case fishing in the reservoir by the general public is strictly prohibited except for a few registered fishermen and sport fishermen who are permitted to operate with only rod and line. This model will require clearing and stumping a substantial shoreline area of the reservoir to permit active fishing like beach seining.

CONCLUSION

With the use of morpho-edaphic index method, the fisheries potential of Kubanni Reservoir was predicted and management strategies are presented for sustainable yield.

REFERENCES

Adeniji, H.A (1980). Preliminary study of the fisheries limnology of Bakolori Lake, Nigeria. Report to Sokoto Rima River Basin Develpoment Authority, Sokoto State, Nigeria.

Balogun, J. K. and J. Auta (2001). Fisheries Resources and Development Potentials of Lake Kangimi, Kaduna State. Nig. Jour. Bio. Sciences Vol. 1,(1):50 – 56.

Henderson, H.F. and R.L.Welcomme, (1974). The relationship of yield to morpho-edaphic index and numbers of fishermen in African inland fisheries.

Noble, R.L. (1980). Management of Lakes, Reservoirs and Ponds: In: Fisheries Management (eds.) R. T. Lackey and L. A. Nielsen. Blackwell Sientific Publications, Oxford

Ricker, W. E. (1978). Methods for Assessment of Fish Production in Fresh Waters, ed. T. Bagenal, Blackwell Scientific Publications.

Ryder, R.A. (1965). A method for estimating the potential fish production of north temperate lakes. Trans. Am. Fish. Soc. 94(3): 214 – 218.