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# VOLUMETRIC ANALYSIS OF TAGWAI DAM RESERVOIR, MINNA, NIGER STATE, NIGERIA

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## Abstract

Tagwai dam reservoir is major storage of water for Minna and environs, and as such requires constant monitoring and maintenance, using the principles of bathymetric survey and turn around engineering. This study aims at carrying out the bathymetric survey and volumetric analysis of the Tagwai Dam Reservoir, for effective management of the reservoir. The survey, computations and analysis were adequately carried out to produce the floor chart of the reservoir and the sounding depths. Sixty-two (62) control points were established and coordinated for the perimeter survey. Digital Elevation Model (DEM) of the reservoir was generated and the depth/volume analyses at three different levels of the reservoir were computed in order to determine the difference between the observed and designed active volumes of the reservoir. The computed surface area of the reservoir was about 299.10 hectares, with a perimeter of about 9628.930m, while the observed volume of the reservoir was  $19.24 \times 10^6 \text{m}^3$  as against the designed active volume of  $26.50 \times 10^6 \text{m}^3$ , giving a volume shortfall of about  $7.26 \times 10^6 \text{m}^3$ . This shortfall is attributable to the siltation, climate change induced evaporation and hydrologic loss over the years, and minor errors in computation and numerical analysis. The study has been able to produce the first bathymetric chart of Tagwai dam reservoir since it was commissioned in 1978, and it is expected to serve as a reference data for the maintenance and optimal use of the dam reservoir in order to meet the water needs of Minna and environs.

**Keywords:** Tagwai Dam Reservoir, Bathymetry, Sounding, DEM, Volumetric Analysis

## INTRODUCTION

The decline in quantity of drinking water source becomes a concern when population growth and industrial development produced a concentration of society's wastes that imperiled public health. The need to both protect public health and minimize the cost of public water supply leads to the practice of source water quality/quantity management (Fredrick, 1990). The public must be provided with water of highest quality for drinking and general municipal uses. This eventually is the reason why some dams were constructed in other to protect and hold back water which serves as reservoir for the supply of water to the public, after treatment by the water board management authority that are charged with the mandate of supplying quality and constant drinking water to the public.

Volumetric analysis of a reservoir is only made possible after conducting a bathymetric survey. Bathymetric survey is likened to the topographic survey on land, as both techniques however, use spot measurements of height/depth and contours to portray relief (Ingham, 1974; Bannister and Raymond, 1981). The choice of data sources and data sampling techniques is critical for the quality of results from depth model in a bathymetric survey (Henning, 2009). Therefore, with GPS integrated with Echo sounding, it is feasible to collect enough coordinate data to effectively map the entire reservoir bottom, and this data can then be used to develop a digital elevation model (DEM) or carryout any other assessment in the reservoir (Agarwal and Idiculla, 2004; Ferrari, 2008; Hein et al, n.d; Higgins, 2009). Tagwai dam reservoir is major storage of water for Minna and environs in Nigeria, but since it was completed and commissioned in 1978, no documented bathymetric survey was carried out on it. Therefore, this study aims at carrying out the bathymetric survey and volumetric analysis of the Tagwai Dam Reservoir, for the sustainable management of the reservoir.

## MATERIALS AND METHODS

The methodology for the field data collection includes field party organization, and testing of the necessary instruments and machines. The three field exercises include the perimeter survey of the dam reservoir areas by traversing using Leica TC1201 Total Station, The transfer of benchmark elevation to the reservoir water surface by differential leveling with Kern Automatic Leveling instrument, and the sounding of the reservoir using motorized flying boat and Raytheon Echo Sounder and accessories. The data processing and analysis were carried out using integrated hardware and software systems (Surfer-8, ArcGIS, Erdas Imagine, AutoCAD, electronic surveying equipment, etc).



Figure 1: (a) Boat Carrier being used to tow the Boat to the Dam Reservoir; (b) Field Party on board Motorized Sounding Boat during the Echo Sounding Operation at Tagwai Dam, Minna, Nigeria.

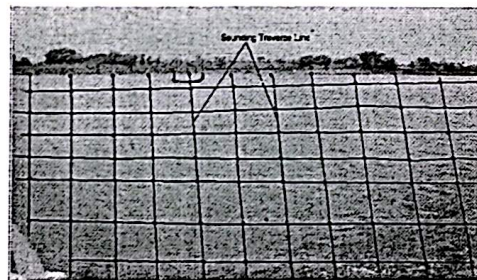


Figure 2: Sounding Traverse Runs (Transect) at 50 meters interval on Tagwai Dam Reservoir, Minna, Nigeria

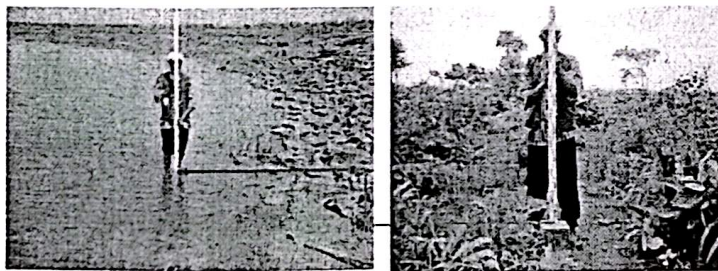


Figure 3: Observing Height transfer from CSN240s to the Water Surface

## RESULTS

Sixty-two (62) control points were established and coordinated for the perimeter survey. Digital Elevation Model (DEM) of the reservoir was generated and the depth/volume analyses at three different levels of the reservoir were computed in order to determine the difference between the observed and designed active volumes of the reservoir. The computed surface area of the reservoir was about 299.10 hectares, with a perimeter of about 9628.930m, while the observed volume of the reservoir was  $19.24 \times 10^6 \text{ m}^3$  as against the designed active volume of  $26.50 \times 10^6 \text{ m}^3$ , giving a volume shortfall of about  $7.26 \times 10^6 \text{ m}^3$ . This shortfall is attributable to the siltation, climate change induced evaporation and hydrologic loss over the years, and minor errors in computation and numerical analysis.

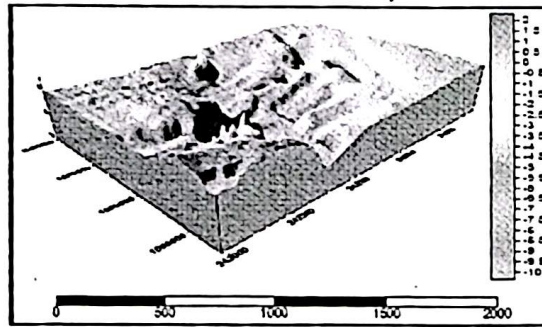
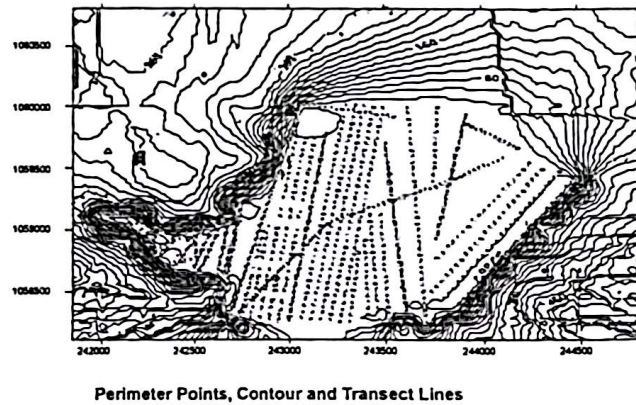


Figure 4: Digital Terrain Model of the reservoir



Perimeter Points, Contour and Transect Lines

Figure 5: Perimeter and the transect lines superimposed on the Contour of the reservoir

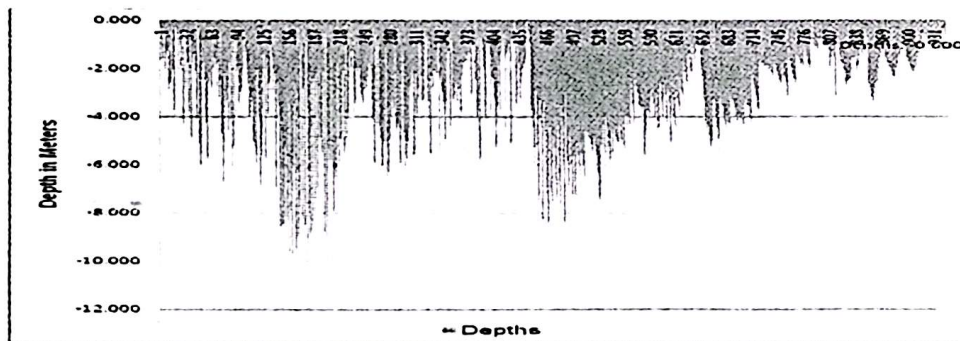


Figure 6: Graph plotted with sounding depths from the zero level which represent the water surface, with height depth of 10.9m.

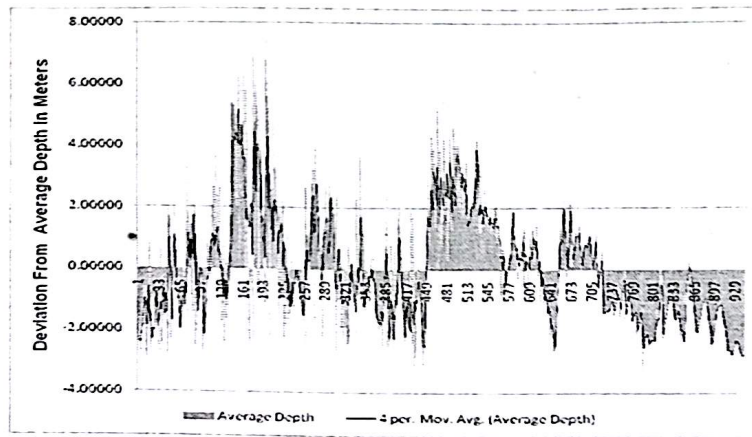


Figure 7 Reservoir depth deviation from the average depth with 4 per moving average trend line overlaid on the graph

## CONCLUSION

The study has been able to produce the first bathymetric chart of Tagwai Dam since its completion and commissioning in 1978. The results are to serve as basic and reference bathymetric information for the maintenance and optimal use of the Tagwai dam reservoir in order to meet the water needs of Minna and environs.

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