Quest Journals
Journal of Research in Environmental and Earth Sciences
Volume 12 ~ Issue 1 (January 2026) pp: 30-38
ISSN(Online) :2348-2532
www.questjournals.org

Research Paper

Current Status of OGOLOGO River: Bathymetric Review

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Abstract
Hydrographic surveying is the acquisition, analysis, visualization and management of spatial information concerning all marine features, processes and properties in four dimensions (space and time). These include scientific study of seas, lakes and rivers. The width and depths of any river, lake, sea or ocean play a very vital role on the economic and wellbeing of any nation. Therefore, it becomes very important to determine the depths profile of any of these water bodies. Objectives considered were to: Produce the reduced depths of Ogologo River, show digital chart and models seabed topography. Materials used were single beam digital echo sounder, chart datum, tide guage, and sounding operations were carried out and the result obtained shows that the depth of the river ranged from 0.1m to 22m. The study recommended that Shorelines protection should be carried out along the river, so as to protect the shores from being eroded and the river from accretion as a result of solid waste dump.

Keywords: Bathymetric Surveys, sounding, bar chart, levelling

Received 03 Jan., 2026; Revised 09 Jan., 2026; Accepted 11 Jan., 2026 © The author(s) 2026.
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I. Introduction

Bathymetric surveying is a specialized branch of hydrographic surveying that focuses on examining the bed or bottom of water bodies such as oceans, rivers, streams, and lakes. It provides the primary means of studying, measuring, and managing large portions of aquatic environments (1). Typically, bathymetric surveys generate maps that depict the relief and topography of the seabed using contour lines (depth contours). These maps are essential for ensuring safe navigation both on the surface and underwater, as they supply critical navigational information. The purpose of this study is to accurately describe submarine topographic features, incorporating adjustments such as sound velocity and pitch corrections. These refinements enhance measurement precision, though they may reduce the margin of safety traditionally built into navigational data (10).

Bathymetric surveys serve a wide range of purposes. They are used to monitor depositional processes, such as identifying areas of sediment accumulation or erosion. These surveys are also essential before and after dredging operations, helping to assess the initial condition of a water body and to quantify the extent of material removed. In addition, bathymetric surveys are often conducted in preparation for activities such as pipeline and cable installation, site positioning, fishing operations, and various geophysical exploration projects(3).Updating bathymetric maps is a demanding but essential process, as it provides critical insights into changes in the ocean and seafloor over time. Because of its importance, the task cannot be overlooked. In practice, regularly revised bathymetric data underpins a wide range of activities, including planning, engineering, construction, maintenance, and the regulation of navigation. It also supports flood control, river engineering, mapping, and coastal development projects(2).

Bathymetric mapping, tidal observations, and reduction are essential processes for adjusting azimuthal depth measurements to the designated map datum. Tide observations are typically carried out both prior to and during sounding operations. These measurements may be taken at permanent stations or temporarily at selected sites where water levels seldom fall below the zero reference point of the temporary gauge (9). The reduction applied to sounding depths is determined through differential subtraction of rising and falling tide data, calculated using the instantaneous time interval corresponding to each sounding location (7).

The lack of up-to-date bathymetric information representing bed depth profiles and bed-related ripples poses constant navigational problems, impacts the movement of ships and barges through river routes, and is an evolutionary challenge,causing the need for bathymetric planning. Therefore, the study will use classical Survey approach to make the research.

1.1 Aim of the Study

The aim of the study is the determination of the seabed profile of part of Ogologo/ Eagle Island River in Port Harcourt.

1.2 Objectives of the Study are to:

1. Produce the reduced depths of Ogologo River
2. show digital chart and models seabed topography

II. Literature Review

Chukwuand Badejo (2015) worked on the Investigation of Lagos Lagoon Sea Bed Topographical changes. The study aimed to investigate the changes in the topography of the northern part of Lagos Lagoon (Ikorodu route) and thereby updating the existing chart. Data collection was performed using satellite imagery, tidal observations and reductions, depth sounding using echo sounders and GPS initial processing of observed bathymetric data including peak distances, relative to current depth. Tidal corrections and reordering using HYPACK 2008 software were performed. Further processing was performed using the software ArcG1S 10.0. The processed depth was analyzed and presented in the form of graphs and charts.Another result showed that surface description of sediment region for accretion and dredge region was developed using depth differential of two data set and their sediment volumes were ascertained. The analysis conducted, there was an indication that accreted sediment volume was greater than dredged volume and perhaps could have been influenced by the adjoining tributaries of the Lagoon water. This result also agreed with (Arzu & Ertan, 2004) on the same lagoon water.

Afonja, Akindiya, Jimoh, Atagbaza and Opoola (2016) conducted Bathymetry mapping of Cowries Creek, Lagos State. The purpose of this study was to conduct a bathymetric Survey of the five Cowries Creeks in Lagos State by collecting relevant information on the nature of the hidden portion of the five Cowries Creeks and presenting the information obtained in the form of topographic elevations. To implement, measure water depth every 50 m using Hypack. It also included mapping the coastline and using AutoCAD and ArcGIS to create vertical profile charts of corridors, averaging 50m and 100m from the creek centerline. Bathymetric surveys were performed using a South SDE 28 single frequency echo sounder, GPS receiver and Hypack 9.0 hydrographic software. The sonar was calibrated before and after the operation, and bathymetric operations were made every two (2) seconds in parallel along the boundary of five Cowleys Creek. A base map and satellite imagery of the area was created, and these maps were used to plan bathymetry. Acquired satellite imagery of the study area were Ikonos Imagery 2013, Goggle Earth 2014, and LandSat 7. The base map and Goggle Earth imagery were spatially georeferenced and the already georeferenced Ikonos imagery was digitized using ArcMap 10.2 software.Undersea surveying was employed to obtain information on five cow hidden parts, starting from the Banana Island-Ikogi area and ending at the Onikan Bridge where the Eco-Atlantic begins.

Adejare, Olusina and Olaleye (2017) empirically researched ferry navigable routes within Lagos Lagoon. This paper attempted an empirical analysis of channel data to simulate a navigable channel within the Lagos Lagoon, with minimum distances maintained by ships passing through harbours and docking. A field survey was conducted between September 2015 and March 2016 to determine the river bed topography using DGPS receivers, single-beam SDE-28 echo sounders, speedboats, tide monitoring and water reduction. The study used Hypack 2008 and ArcGIS software to sort, extract, and process the data. Depths within the project area were observed to range from 0.0m to 14.82m relative to the Lagos datum. In addition, a navigable channel map was created based on the general bed topography along the research corridor and proposed passenger ferry regulations.

2.1 Theoretical Framework

2.1.1 Underwater Acoustic Wave Propagation

According to Ojinnaka (2007), position fixing on the sea surface, land, and in the air relies on optical and electromagnetic systems. However, beneath the sea surface, optical methods are severely restricted, allowing only limited exploration of small areas by divers or cameras. Electromagnetic position fixing (EPF) is also ineffective underwater due to the high conductivity of seawater, which causes rapid attenuation of electromagnetic waves. Since seawater behaves as an elastic medium that responds to pressure variations, the only reliable means of transmitting information through water is via acoustic (pressure) waves. These acoustic waves are widely used for submarine communication, depth sounding, echo ranging and detection, locating and tracking instrument packages, and transmitting data through telemetry.

2.1.2 Acoustic Systems

Acoustic systems refer to that equipment which are employed in underwater acoustic for transmission, reception and analysis of acoustic wave propagation are the signal travel time and the velocity of acoustic wave which include the following:

1. Conventional echo sounders
2. Swath sounding systems
3. Side scan sonar
4. Seismic profilers
5. Acoustic transponders

2.1.3Sounding

Sounding refers to the measurement of sea-bed depths or the distance to objects beneath the water's surface. In routine practice, sounding operations are carefully organized to ensure that a designated area of the sea floor is surveyed in a systematic and methodical manner. Broadly, sounding techniques fall into two categories: direct methods and indirect methods.

In the direct method of sounding, instruments are employed to physically "feel" the sea bed, with depths determined by reading the graduations. The principal instruments used include:

1. Depth Pole – Suitable only for shallow waters not exceeding 5 meters in depth, and effective at slow vessel speeds.
2. Lead Line – A graduated rope with a weight attached to its submerged end. It can be used in deeper waters and allows for quicker measurements, though still slower compared to modern techniques. Remarkably, many ancient charts produced using the lead line have proven to be comparatively reliable

2.1.4 Current Trend in Thinking

In earlier times, bathymetric surveys were conducted using basic tools such as the depth pole, lead line, and analog echo sounder. Today, however, more advanced technologies are employed to carry out these operations. Modern instruments, including digital single- and dual-beam echo sounders and geodetic navigational satellite systems (GNSS), make it possible to measure and visualize even the deepest parts of the world's oceans and seas. These systems can generate detailed three-dimensional models, representing a significant scientific advancement. With the aid of GNSS, surveyors no longer need to physically conduct sounding operations on-site; instead, they can efficiently obtain all necessary data by remotely tracking rivers, seas, or oceans, capturing comprehensive information about the water body with ease.

III. Methodology

3.1Data Collection

The digital sonar was mounted on the flat platform of the boat, and the transducer was rigidly attached to the edge of the boat, one-third from the engine. Before data was collected, the name of the file in which to save the data was specified. A default file name was selected and edited. This was to reflect the date and time the file was created.

3.2 List of Equipment

After reconnaissance, based on the accuracy required and the nature of the terrain, a list of surveying instruments to be used was selected to give the best possible results at optimal cost.

Table 1: List of Equipment used

S/N	Equipment Name	Serial No.	Remarks
1	South Digital Echo Sounder		Good
2	South Transducer Sensor and Cable		Good
3	South Transducer Poles		Good

4	South Echo Sounder Power Cable	Good
5	Garmin Portable Handheld Receiver	Good
6	South Keyboard and Mouse	Good
7	Transducer Clamp	Good
8	12 Volts. DC Battery	Good
9	Bar Check plate	Good
11	Level Instrument	Good
12	Level Staff	Good
13	5m Steel Tape	Good
14	Survey Umbrella	Good
15	Cutlass	Good
16	45 Horse power engine boat	Good

3.3 Instrument Calibration

The instrument calibration was performed to determine the operating condition of the equipment. This included inputting various geodetic parameters into a digital echo sounder and a 2-peg test of digital levels. The level was conducted, a 2-peg test and the results established.

3.4 Field Operations

Field work began with leveling to determine the water level, followed by the installation of water level gauges, a pole check to see how the sonar was working, and followed by a sounding to determine the depth of the river.

3.5 Tide Gauge

Tidalobservation was made and measured the ebb and flow of the tide. The values observed at the tide gauge were recorded and used to reduce the total acoustic depth to the reduced depth using the same reference datum.

3.6 Levelling

Leveling was done with Level instrument. The levelling work was done to establish the vertical shoreline reference points used to set the gauges.

3.7 Bar Check

A bar plate with heavy metal plate fitted with calibrated lines was used to measure the depth of a body of water. A bar check was performed by lowering a bar plate several metres below the surface of the water just below the transducer, and comparing the depth recorded by the sonar to the measured depth of the line containing the bar plate before obtaining a bearing executed. Rod tests were performed before and after the sounding process.

3.8Sounding

Probing operations were performed along predetermined run and cross lines at 5s intervals to completely cover the study area and was hydroacoustic instrument called a depth sounder (fasometer).

3.9 Study Area

The study area is within Mbuosimini and Eagle Island on the mile 4 axis from Port Harcourt, Rivers State, Nigeria. The following geographic coordinates, separated by longitude: 060,581 4.58" to 060,581 37.71" east of the meridian and parallel to Greenwich, 040 471 32.10" to 040 471 59.13" north of the equator. The river is bounded by the Mbuodohia community of Rumuolumeni to the north, the Rivers State University campus to the west, Eagle Island to the south and the Nigerian Agip Oil Company, now Oando, to the east.

Figure 1: Google Imagery showing the Study Area.

IV. Results and Discussion

4.1 Presentation of Result 1

Table 1: An Extract of the data Reduction Sheet

Eastings (m)	Northings (m)	Raw Depth (m)	Tide Corr.(m)	Final Depth (m)
275257.395	529666.030	2.600	0.100	2.5
275254.668	529657.322	2.300	0.100	2.2
275252.608	529648.479	1.700	0,100	1.6
275251.657	529639.633	1.500	0.100	1.4
275250.893	529631.340	1.700	0.100	1.6
275251.609	529623.564	1.900	0.100	1.8
275253.065	529615.448	3.900	0.100	3.8
275254.520	529607.148	3.200	0.100	3.1
275255.160	529598.534	2.800	0.100	2.7

4.2: Presentation of Result 2

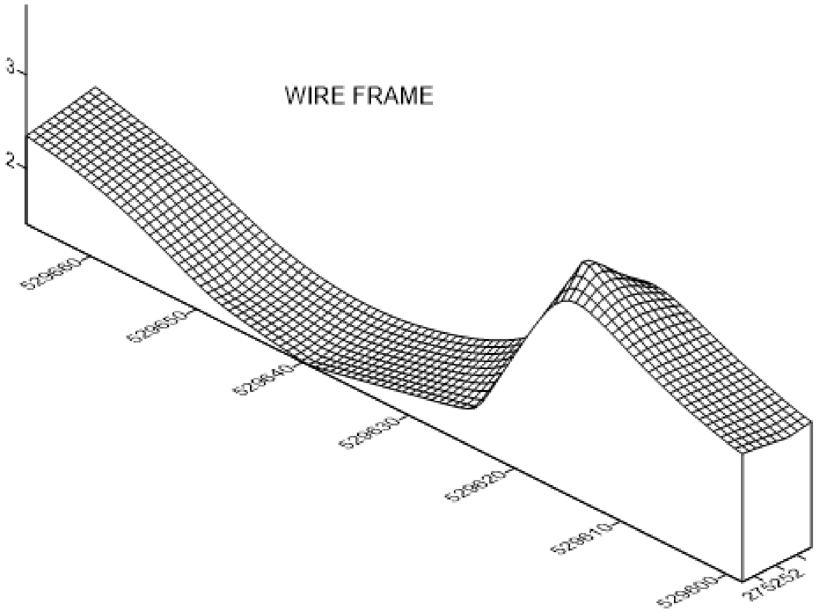

Figure 2: Digital Terrain Model of the Sea Bed

4.3: Presentation of Result 3

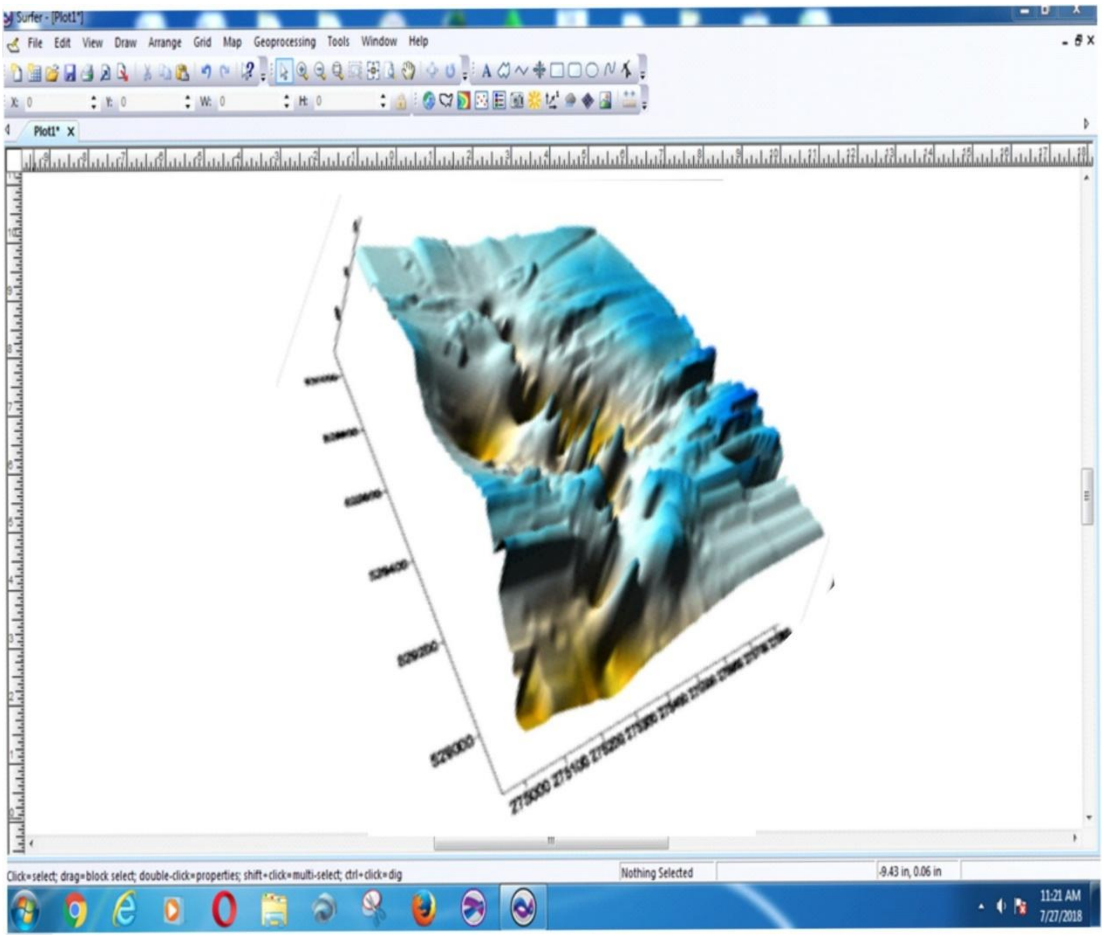

Figure 3: 3-D Model of the Sea Bed

4.4: Presentation of Result 4

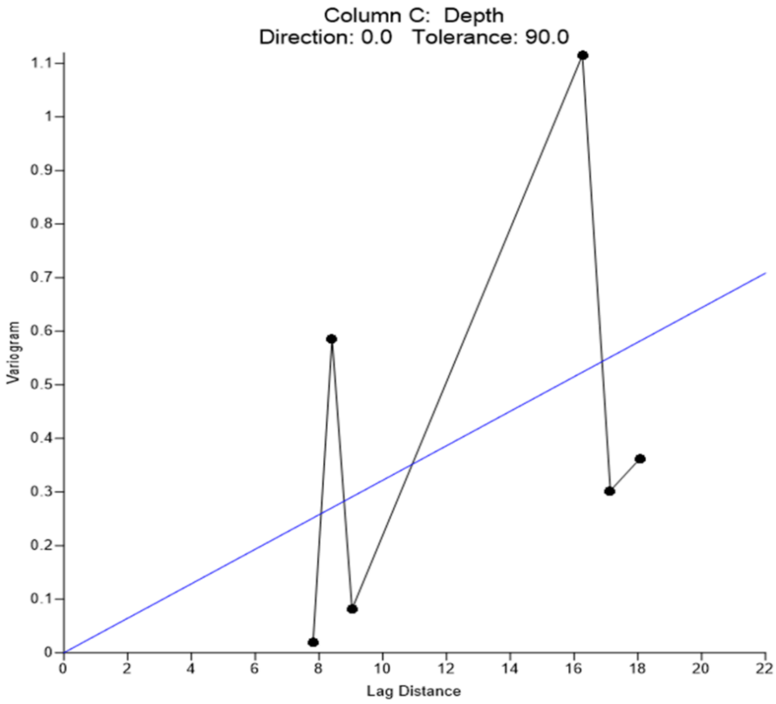

Figure 4: Variogram of the Sea Bed

4.5: Presentation of Result 5

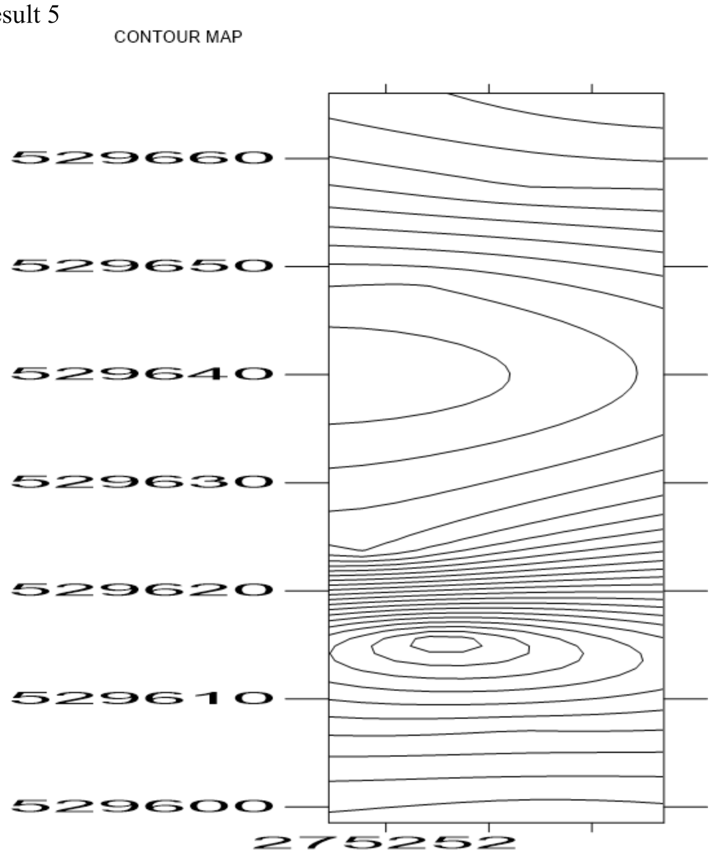

Figure5: Contour of the Sea Bed

4.6: Discussion of Findings

One of the objectives as per the study is to carry out sounding on the water body and ascertain the depth profile of the river.The data obtained during the sounding operationswere not the real depth of the river. To determine the reduced depth of the river (Table 1), the tidal values were subtractedfrom the sounded depth and then referenced to the datum, mean low water spring (MLLWS) to obtain the reduced depth which is the real depth. Secondly, kriging interpolation rules was conducted with respect to the extracted data and polynomial drift order showed zero magnitude of the statistics. However, reduced depth was used to plot the digital model of the study area. The reduced data was plotted using Surfer 13 software to produce the digital terrain model (Figures 2&3) and the flow direction of the sea bed.

In the quest to gain further knowledge about the navigability of the study area, variogram analytical procedures were also conducted linearly, anisotropy angle (0), anisotropy ratio (1) and variogram slope (1) that depicts the depth of the Ogologo River in Rivers State (Figure 4).

Analysis of the result showed that the depth of the area surveyed ranges from 0.l metres to22 metres. It is characterized with undulated Seabed as a result of sand mining or dredging activities located along the river. The diagram above shows the contour of the river bed topography (Figure 5), the river bed is characterized with undulation resulting from the tidal currents and sediments deposit over time.While concluding the result,vesselnavigation is becoming a critical challenge and sometimes impossible during Low Water. Furthermore, the studysupports the study of Adejare, Olusina and Olaleye (2017) that studied ferry navigable routes within Lagos Lagoon with minimum distances maintained by ships passing through harbours and docking. The result of the depths within the project area were observed to range from 0.0m to 14.82m relative to the Lagos datum.

V. Conclusion and Recommendations

5.1 Recommendations

Based on the bathymetric survey operations carried out on part of OgologoRiver in Port Harcourt, Rivers State, I hereby, recommend the following:

1. The entire river should be dredged so as to ease navigation challenges faced by sea travelers and rural dwellers and also to ease the challenges faced by road transports users as a result of traffic conjunction on our roads.
2. Shorelines protection should be carried out along the river, so as to protect the shores from being eroded and the river from accretion as a result of solid waste dump.
3. Further research work should be carried out to ascertain the rates of changes over time on the river.
4. An integrated coastal management plan needs to be embraced, by which the activities of the dredgers would be monitored, environmental impact assessment [EIA] should be strictly adhered to, and legislation fully enforced.
5. Adopting a good coastal management policy, coastal education will be a useful tool in educating the coastal communities on their negative impact on coastal waters and the consequences in terms of flooding, disease spread and use of contaminated water in focus.

5.2 Conclusion

The bathymetric survey operations carried out on part of Ogologo River revealed the tidal river depths ranging from 0.1m to about 22m and is caused by continuous dredging activities.

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