Charting Nigerian Waters for Safer Navigation

Innocent N. EGBUH, Nigeria

Key words: wrecks, danger to navigation, charts.

SUMMARY

In pursuit of Nigeria's international obligations on maritime safety, the elimination of dangers to search and rescue efforts in our coastal waters, environmental pollution and destruction of maritime habitats, and hide-out for sea-borne criminal elements, the Federal Ministry of Transport through the National Maritime Authority (NMA), entered into an agreement on June 16, 2003, with Humber Marine Werks Limited (HMW) for Consultancy on Removal of Wrecks and Derelicts in Nigerian Waterways. The aim of the contract was to conduct hydrographic survey of Lagos Ports Area; a critical input to quotations for actual removal of wrecks by contractors to be nominated by the Ministry. It is the first out of four phases of survey contracts required to cover the various port areas in Nigeria.

Humber Marine developed a survey priority plan, which identified those areas with the highest risk of maritime accidents, taking cognizance of traffic volume, inadequacy of charts or previous surveys, and potentially insufficient under-keel clearance. State-of-the art technologies were deployed to increase the quality of field data collection. Some of the most significant technological survey tools deployed were Differential Global Positioning System (DGPS), echo sounder, magnetometer, and side scan sonar systems with the corresponding computer software - such as HYPACK Max hydrographic software, AutoCAD 2000 software, Surfer Digital Terrain Modelling (DTM) software, and HydroCAD software for reducing sounding data – among others.

The standards adopted for the entire survey conforms to the National Ocean and Atmospheric Administration (NOAA), National Ocean Services (NOS) Hydrographic Surveys Specifications and Deliverables.

The technical operations crew was led by Surv. (Chief) Innocent Egbuh, an experienced and duly Licensed Surveyor. In the team were a Geophysical Engineer, a Marine Engineer, Hydrographic Surveyors, and an Underwater Engineer. This crew was supported by another group of Technical Management and Information Technology & Communication (ICT)-personnel. This paper is about details of the planning, technology deployed, and execution of the survey, the first of its kind in Nigeria's maritime history.

Charting Nigerian Waters for Safer Navigation

Innocent N. EGBUH, Nigeria

1. INTRODUCTION

Hydrographic surveys measure and define the configuration of the bottoms and adjacent land areas of water bodies, especially as they pertain to navigation. This information is critically important to the production of nautical charts and is, also, useful to the fishing industry and coastal zone managers. They are the primary responsibility of the Coast Survey's Hydrographic Surveys Division, like Nigerian Ports Authority (NPA), National Maritime Authority (NMA), National Inland Waterways Authority (NIWA), etc.

The primary product of a hydrographic survey is a smooth sheet. The smooth sheet depicts corrected depths relative to an appropriate vertical datum (usually a water level datum) along with relevant shoreline derived from a variety of remote sensing techniques. Smooth sheets also depict hazards to navigation (rocks, wrecks, obstructions, etc.), shoal developments, channel delineations, aids to navigation and landmarks.

The principal objective of hydrographic surveys is to obtain basic data for the compilation of nautical charts with emphasis on features that may affect safe navigation. In addition to measuring water depths, surveys identify hazards to navigation, delineate channels, and verify aids to navigation and landmarks. Each survey represents a comprehensive record of the coastline and adjacent waters. A record of changes caused by natural processes and human activities can be compiled from a review of contemporary and prior surveys of the same area

2. HISTORICAL BACKGROUND

In the Maritime industry, “wrecks” refers to a vessel that is sunk, stranded, or abandoned in a harbour, dock, pier, tidal water, or port approaches under the control of a harbour authority. Wrecks include jetsam, floatsam, lagan, and all derelicts (including logs) floating or submerged in the tidal waters or the operational shores of a nation.

Wrecks are viewed with seriousness, in international shipping, because they constitute danger to navigation, and to lifeboats engaged in rescue operations and other services at a country’s harbour and waters. The International Maritime Organisation (IMO) insists that member countries have a clear waterway and a regime of clean navigable waters. In developed countries, very special attention is given to the issue of wrecks. Apart from imposing stiff penalties on owners of wrecks, the English Law also empowers nearly all harbour authorities with dual and, to some extent, overlapping power to remove wrecks where the wrecks pose significant dangers.

Although Section 273 of the Merchant Shipping Act Cap 224 Laws of Federation of Nigeria 1990 contains some provisions on "Dealing with wrecks" the Act is not adequate on how to promptly deal with the issue of wrecks, even when they constitute serious danger to navigation and/or the environment. It is not surprising, therefore, that wrecks litter Nigerian waters, posing various risks to navigation, pilotage, search and rescue, recreational boating and routine patrol.

In recent times, there have been reports of abandoned ships at the ports and territorial waters of Nigeria, constituting danger to navigation, and threat to national security. Although there are Government Receivers of Wrecks in each of the country's ports, no significant efforts have been made to firmly address the matter of wrecks, or improve the condition of wrecks on Nigeria waters. Non-availability of funds to promptly address the issue is reported to be a major consideration for this lack of significant effort.

The problems posed by wrecks include:
- Risks to navigation and recreational boating,
- Constraints, and danger to search and rescue operations in emergencies,
- Environmental pollution and destruction of marine habitats,
- Security risk, as abandoned vessels could be used as hideouts for criminals, especially robbers.

Government recognizes these problems, and had made some feeble efforts in the past to address the problems. This observation is included in the findings of a Federal Ministry of Transport Ministerial Committee on Wrecks in Nigeria. According to the report of the Ministerial Committee, two Committees had been set up previously.

Firstly, on October 5, 1988, Maglee Salvage Company entered into contract with the Federal Ministry of Transport (FMOT) for the clearance of wrecks, derelicts, floatsam, and other obstructions from the nation's navigable waters, ports, dockyards, and shorelines. A change in government policy, via Circular No. *SCD/2/320/1/233* of 6 February 1990 reviewed all agreements entered on behalf of government for sales and export of scrap to avoid further export. This circular put an end to the contracts. This initial effort, which involved a detailed listing of the location of the scraps, and full mobilization for removal, were aborted.

Again, in November 1993, a main committee of the Federal Ministry of Transport and Aviation was constituted and charged with the following responsibilities:
- To identify and position the wrecks, derelicts, floatsams and similar obstructions within the navigable waterways of Nigeria (including international and local ports) etc.
- Suggest the best economic ways of clearing the obstructions (with the financial implication) of the same.

A Sub-Committee of this Committee was constituted and given the following Terms of Reference (TOR):
- To collect, compile, collate, and coordinate inputs from the Nigerian Navy (NN); Nigerian Ports Authority (NP Plc); Nigerian Shippers' Council (NCS); Government

Inspector of Shipping (GIS), and the Inland Waterways Department (IWD) of the Ministry, on the identified and identifiable location of obstruction on all ports approaches and navigable channels.
- To use relevant base maps and plot each point of location by indicating the longitude and latitude of the same.
- While focusing on the approach of ports and navigable channels, efforts should be made to draw the line between the obstructions that constitute immediate navigation problems and those that were not in their respective vicinities.
- Suggest the best economic way(s) of getting rid of the obstructions and, where necessary, identify safe passages around any serious obstructions, with attendant implication in both cases.
- An Interim Report should be rendered within a month from the inaugural date while the final report, with useful recommendations, should be submitted to the Committee within two months.

The Committee Report concluded that as of 28 May 1994, no significant effort had been made towards the achievement of these Terms of Reference, simply because there were no funds. The absence of any progress informed the action of government to inaugurate another Technical Committee on Wrecks in Nigerian Waters on July 10, 2002 to address the issue. Almost ten (10) years after the last effort, the wreck situation in Nigeria waters has worsened, yet there has been no serious wreck removal effort since this period.

All the efforts above suffered from:
- Inadequate funding to meet the needs of the data collection exercise;
- Inadequate time frame within which to produce results commensurate with the magnitude of survey expected;
- Weather problems due to disturbances from rains;
- Equipment problems such as the lack of positioning system in some areas, and total absence of sounding, and side scan sonar equipment;

3. PROJECT GOALS

Our mandate as reflected in the Contract agreement may be summarized as:
- To conduct a bathymetric/wreck detection survey for the purpose of identifying the positions of wrecks/derelicts in Lagos Ports Area;
- To identify the wrecks that constitute the most danger to navigation in Lagos Ports Area, with a view to taking adequate steps towards removal;

However, there were overall project goals. These include
- To ensure the safe navigation of ships in Nigerian waters
- To fulfill Nigeria's national and international responsibilities in Africa and to emphasize Nigeria's close interests in the region, especially with the ISPS Code
- To satisfy future information needs Nigeria may have in her waters
- To supplement the existing chart coverage of other nations by the addition of accurate and recent coastline data

- To provide a framework for future survey work, especially in relation to monitoring of and early removal of wrecks/derelicts
- To contribute to the International Hydrographic Organisation's (IHO) International chart scheme for Nigeria

4. TECHNOLOGY DEPLOYED

To collect up-to-date hydrographic survey data and to satisfy the maritime constituency, Humber Marine Werks Ltd developed a survey priority plan to identify those areas with the highest risk of serious maritime accidents. This risk assessment is based on a combination of traffic volume, inadequacy of charts or surveys, and potentially insufficient underkeel clearance.

More modern technologies were implemented to increase the quality and productivity of the survey. This included the detection, location, and identification of wrecks and obstructions primarily using side scan sonar, magnetometer, and Differential GPS technology.
The strength of the return echo is continuously recorded creating a "picture" of the ocean bottom where objects that protrude from the bottom create a dark image (strong return) and shadows from these objects are light areas (little or no return).

5. STANDARDS ADOPTED

The standards adopted for the entire survey conforms to the National Ocean and Atmospheric Administration (NOAA), National Ocean Service (NOS) Hydrographic Surveys Specifications and Deliverables.

These technical specifications detail the requirements for hydrographic surveys to be undertaken by either NOAA field units or organizations under contract to the Director, Office of the Coast Survey (OCS), NOS, NOAA, U.S. Department of Commerce.

The specifications are based in part on the International Hydrographic Organization's Standards for Hydrographic Surveys, Special Publication 44, Fourth Edition, April 1998, especifically for Order 1 surveys. Hydrographic surveys classified as Order 1 are intended for harbours, harbour approach channels, recommended tracks, inland navigation channels, coastal areas of high commercial traffic density, and are usually in shallower areas lower than 100 meters depth.

6. TEAM/RESOURCES DEPLOYED

Equipment & Personnel Sourcing Policy:
"Humber Marine shall retain a core staff of professionals and consultants relevant to our overall Company objectives. But for the execution of specific contracts, Humber shall optimise the utilization of locally available equipment and skills without sacrificing quality and safety." In line with this broad Company policy, we deployed the following resources in the execution of the survey:

6.1 Technical Crew

- Surv. Innocent Egbuh — Hydrographic Surveyor/Team Leader
- Tom Logan — Consultant Marine Engineer & Diver
- Roger Zaune — Consultant Oceanographer
- Titus Igbokei — Senior Geophysical Engineer
- Temitope Solomon — Hydrographic Surveyor
- Henry Adimoha — Surveyor
- Ovie O. Anaidhaimu — Surveyor
- Rufus O. A. — Underwater Engineer
- Emeka Awazie — Driver
- Bassey Etim — Driver

6.2 Support Staff

- Eme Abiayi — Technical Director
- Chris Aruwa — PRO/Administration
- Mike Ukeka — Chief Security Officer (Site/Office)

6.3 Software

- HYPACK Max hydrographic software
- Trimble GeoExplorer Pathfinder GPS software
- Magnetometer software
- AutoCAD 2000 Computer-Aided Design (CAD) software
- MicroStation SE (CAD) software
- Surfer Digital Terrain Modelling (DTM) software
- SurvCAD software, includes transformations
- HydroCAD software for reducing sounding data

6.4 Support and Outside Services

In the course of carrying out the survey, support, cooperation, and outside services were obtained from the following sources:

- Bathymetric Survey — GeoLab Technical Services (Nig) Ltd
- Sonar/Magnetometer sweeping- — GeoLab Technical Services (Nig) Ltd
- Diving Investigation Services- — DiveTech (Nig) Ltd, Lagos
- Purchase of Charts and software- — Meridian Chartware Ltd., Norwich, UK
- Hydrographic equipment Consultants-Inner Space Technology, New Jersey, USA.

7. PROCEDURES ADOPTED DURING THE SURVEY

7.1 Horizontal Datum

All positions were referenced to UTM Zone 31. This datum was used throughout the survey. Documents used for comparisons, such as charts, prior surveys, and junction surveys were referenced to or adjusted to UTM Zone 31. All software used on the survey contained the correct datum parameters.

7.2 Sounding Datum

All sounding data were reduced to chart datum, or 0.38 meters below BM1 at East Mole Signal Station.

7.3 Time

Local time was used for all time records.

7.4 Hydrographic Position Control

Total error in the position of soundings, dangers, and all other significant features, at 95% confidence level, was ± 5 meters + 5 percent of the depth.

7.5 DGPS

GPS receivers were configured such that satellites below 10° above the horizon were not used in the position computations. A minimum of four (4) satellites was used to compute all positions. There were always more than six (6) satellites 95% of the time due to clear visibility.
Horizontal Dilution of Precision (HDOP) was monitored and recorded, and did not exceed 4.0.

7.6 Depth Soundings

Depths were recorded in meters, with decimeter precision. Plotted depths are also in meters and decimeters.

7.7 Corrections to Echo Soundings

Observed echo sounder depths were corrected for all departures from true depths attributable to the method of sounding or to faults in the measuring apparatus. These include draft, velocity, heave, roll, pitch, heading, and navigation timing error corrections.

7.8 Tide

Tide stations were set up at NPA Dockyard, Apapa & Navy P4 Jetty, at Victoria Island. Readings were taken at 30 minutes interval throughout the duration of the survey.

7.9 Towed Side Scan Sonar

Side scan sonar was used for supplementing echo sounding by searching the region for additional indications of dangers and topographic irregularities.

7.10 Quality Control

Confidence checks of the side scan sonar were conducted once a day. Confidence checks were also made during the course of survey operations by noting the check feature on the sonargram.

7.11 Community Affairs, Safety, Health, Environment & Security (CASHES)

Safety meetings, which focused on potential hazards associated with inshore marine operations, was conducted prior to the commencement of the survey. General safety awareness among entire crew members was commendable. No Lost Time Injury (LTI) was recorded during the period under review.

8. SURVEY PROCEDURE

8.1 Positioning System

The positioning method used for the survey was Sokkia Global Positioning System (GPS) receiver interfaced with HYPACK navigation software to compute vessel position from direct satellite observations to get the actual position.

Sokkia Radian GPS Receivers Photo by: Innocent Egbuh

8.2 Navigation And Data Logging System

The navigation system comprised a Compaq Computer driving a printer and a dedicated monitor for the helmsman. The computer received GPS derived coordinates in WGS84 from the Sokkia system to output the final grid coordinates in Universal Transverse Mercator (UTM) Zone 31.

Navigation was conducted with no smoothing applied to the position computation. The HYPACK navigation system software provided display presentations suitable for navigating predetermined lines and included a visual aid for the Helmsman. GPS antenna was used as

the Positioning Reference Point (PRP) for the survey. All other sensors like side scan sonar and magnetometer tow points offsets were measured and cable out documented for data/records post-processing.

The HYPACK system was interfaced with the echo sounder, this enabled raw depths to be recorded in real time and event marking appropriately carried out. Fix intervals were at 50m for all the sensors and logged in the analogue traces as well as in the hard disk for onshore post – processing.

8.3 Echo Sounder

Odom Hydrotrac dual frequency (33 KHz/ 210KHz) digital / analogue recorder was used for survey. The over the side mounted transducer shoe was marked at 1m intervals.

The transducer was installed rigidly to its bracket and side mounted on the survey vessel. The transducer shoe was sufficiently deep and well positioned not to experience turbulence and aeration from the vessel during data acquisition. The depth of the transducer below waterline was guided by the calibrated marks on the transducer pole.

8.4 Side Scan Sonar

J.W.Fishers side scan sonar system was used for the survey. During mobilization, the tow cable was measured and calibrated at 1m intervals to three times the maximum operating depth throughout the survey. The recorder was set to 100m to 200m ranges, ensuring a theorical 100% overlap on lines ran. Cable out, and range scale were noted at the start of each line, and whenever alterations were made.

Odom Hydrotrac Echosounder onboard survey boat.

8.5 Magnetometer

The magnetometer data was acquired with a JW Fishers Proton - 4 magnetometer. The data was displayed on a chart paper. The magnetometer was towed 5m astern of the vessel at approximately 2m depth below the waterline and operated on the 32,000 – 33200 nanoTesla (nT) range.

Preparing the side scan sonar for deployment

8.6 Survey Administration

Daily progress reports were maintained onboard and regularly reviewed by the

Party Chief and the Survey Representative. The on – line computer system was interfaced for closure to all analogue and digital recorders. Event marks corresponding to position fixes were generated automatically from the navigation computer interface, and passed to the analogue records at fixed intervals set at 50m.

The magnetometer and side scan sonar consoles All Photos: Innocent Egbuh

To facilitate the post – processing it was essential that acquired data were clearly labeled and cross – referenced to the survey line log. Each survey line was given a unique identity. Regular checks of time against fix were also carried out and the analogue records marked accordingly. Vessel offset diagram and cable out of the towed sensors was documented, taking care of range, scale, or cable out variations.

8.7 Data Processing

Field data were processed using appropriate survey software such as HYPACK, HydroCAD, SurvCAD, AutoCAD, GPS Pathfinder Office, etc.
GPS positions were processed and differentially corrected in the coordinate system: UTM Zone 31. Tidal corrections were applied to soundings and reduced to chart datum or 0.38m below BM1 at East Mole Signal Station.

8.8 Data Presentation

For purpose of the survey, the Lagos Ports Area was divided into 5 blocks namely, Sheets 1, 2, 3, 4 & 5, plotted on scale 1:5000. In addition, a composite chart covering the entire area was produced on a scale of 1: 12,500.

Each wreck site is highlighted in the chart with symbol of wreck and a number printed in red colour (e.g. Wrk 12). Database of the wrecks, their positions, and other attributes was designed and created using Microsoft Access.

9. SURVEY RESULTS AND FINDINGS

- Water depth in the surveyed area varies from a minimum of 1.1 metres in the Kirikiri area to a maximum of 24.0 metres in the Lagos Port Limit in the Lagos Bar.
- *One hundred and two (102)* wrecks were located at sixty-two (62) wreck sites within the Lagos Ports Area under survey. *Another seven (7)* wrecks were located in the Lagos

Bar, making *a grand total of one hundred and nine (109)***.** Some of the sites may have a cluster of two, three or more wrecks. Each site is numbered with a pre-fix "Wrk" and the number of wrecks at a site may be determined from the database.

- About twenty-one (21) wreck sites have wrecks either fully or partially submerged. At least three (3) of the wreck sites were marked with marker buoys.
- Three portions of the Lagos Ports Area were identified as numerous wreck areas. Wrecks are highly concentrated in these places.
- *Badagry Creek Bay (Sheet 3)***:** This area is opposite the Porto Novo Creek. Several wrecks are found here. In addition, Buoys 30 & 32 have drifted to this bay. The present positions of the drifted buoys, and litter of wrecks in this area are capable of misleading vessels navigating the channel.
- *Snake Island Bay (Sheet 5):* This bay overlooks the Tin-Can Island Turning Basin. Numerous wrecks were found here.
- *Kirikiri Channel (Sheet5):* It would be difficult to establish, on a first visit, whether the area is a fishery terminal or wreck colony. There is high concentration of wrecks on this creek, right from the entrance. Some of the private jetty owners on this creek have converted their jetties to wreck dumps, both on their waterfront, and ashore.

10. PROBLEMS OF WRECKS

The problems posed by these wrecks include:

- Pollution to marine life
- Danger to man's health
- Environment degradation
- Danger to navigation
- Harbour accessibility/navigation problems
- Security problems.

11. RECOMMENDATIONS

- Our preliminary estimate of the cost of removal of all the wrecks in Lagos Ports Area is in excess of forty million dollars (USD 40 million).
- However, it is recognized that funding could be a major constraint. Therefore, we prepared a "Danger to Navigation Report". It lists, by sections, wrecks which constitute the greatest risks to navigation and which should be given priority.
- The National Maritime Authority (NMA) should, as a matter of urgency, notify the Maritime Industry of the locations and distribution of wrecks in Lagos Ports Area, and of the dangers they pose to navigation.
- Now that the essential first step to any meaningful process of Wrecks removal ie detailed hydrographic survey has been accomplished, the NMA should immediately commence the under-listed subsequent steps:
  - Determination of the modalities for the removal of each wreck or cluster of wrecks.
  - Definition of the mode of disposal, including delineation of areas for dumping of removed wrecks. In this connection, it should be noted that metal scraps from

wrecks can be sold to recover part or all of the removal costs. There is indeed, ready market for this in iron & steel recycling industry.

- Since the Removal of Wrecks from Nigerian Waterways is a long, costly but necessary venture, there is a need for a constant professional factor linking the implementation of the series of related activities listed below:
  - Preparation of realistic cost estimates for the removal of each wreck or cluster of wrecks, as basis for the assessment of the quotations from potential Wreck Removal Contractors.
  - Advising NMA\FMT on the realistic basis for determination of the economic value of the wrecks to be removed.
  - Monitoring the performance of actual wreck removal contractors in the field.
  - Up-date of the relevant Admiralty Charts to reflect a clean bill of health for the waterways after the wrecks shall have been removed.

REFERENCES

- NOAA (2003). NOS Hydrographic Surveys Specifications and Deliverables
- National Maritime Authority,
- Nigeria Ports Authority
- Report on previous effort at wreck identification and removal - Federal Ministry of Transport Technical Committee on Wrecks in Nigerian waters

BIOGRAPHICAL NOTES

Innocent Ndubueze Egbuh was born on June 17, 1962 in Aba, Abia State. He studied at the University of Nigeria, Nsukka where he obtained B.Sc. (Hons) in Surveying, Geodesy and Photogrammetry in 1986. He also holds a Post-Graduate Diploma in Journalism of the Nigerian Institute of Journalism (1994). He is a member of Nigerian Institution of Surveyors, a member of GIS Consultants Association of Nigeria, (GIS Specialist Group), and a member of Geoinformation Society of Nigeria, (GEOSON).

He has nineteen (19) years of engineering and field surveying practice experience, during which time he moved from field Surveyor and Party Chief in the Construction and Engineering industry to Senior Surveyor, and Assistant Chief Surveyor on seismic exploration crews. He has supervised and conducted surveys for various methods of seismic data acquisition in various climates and terrain. Project design, planning and coordination for Non-Governmental Organisations. Managing medium scale surveying, engineering, architectural, geoinformation, environmental, and development consulting company.

In 1991, he was registered as a Surveyor by Surveyors Registration Council of Nigeria (SURCON). Since then he has been in the forefront of the awareness campaign of the importance of computers in the Surveying profession. He distinguished himself in professional life, and has veered into software development to assist professionals.

Positions Held

NIS National

Assistant Secretary General, Nigerian Institution of Surveyors (2004-2006)

NIS Rivers State Branch

Public Relations Officer, Nigerian Institution of Surveyors, Rivers State Branch, (1997-1999)
Secretary, Nigerian Institution of Surveyors, Rivers State Branch, (1999-2001)
Merit Award for Untiring Service to the Nigerian Institution of Surveyors Rivers State Branch
December 2004.

PUBLICATIONS

Egbuh, I. N. (2003). "Setting Up and Operating a Surveying Business". Proceedings of the 39th Annual General Meeting of the Nigerian Institution of Surveyors, Port Harcourt. May.
Egbuh, I. N. (2004). "Setting up and Operating a Surveying Business". Proceedings of the 39th Annual General Meeting of the Nigerian Institution of Surveyors, Kano. May.

Innocent Egbuh is the CEO of AERO-GEODETIC SERVICES (NIG) LTD, a firm of surveyors, engineers and architects involved in economic and financial appraisals, feasibility studies, preparation of detailed designs, programming and supervision of construction works (post-design), and specialized in computing and drafting/ system support, *GPS*, *GIS* and Land Information Systems *(LIS)*.

CONTACT

Innocent N. Egbuh
Aero-Geodetic Services (NIG) LTD,
209A Aba Road (Near ABC Transport), Rumuola,
P.O. Box 7624,
Port Harcourt. 500001
Rivers State.
NIGERIA
Tel. + 234 84775449; +234 84575870
Mobile: +234 8030634896; +234805-5304717
Email: aerogeodeticservices@yahoo.com; innocentegbuh@yahoo.com

PICTURES OF SOME OF THE WRECKS

Wrecks: Security Problems

Wrecks: Danger to man's health

Wreck: Danger to Navigation

Wrecks: Harbour accessibility/navigation problems

Wrecks: Pollution to Marine life

Wrecks: Environmental degradation