

# Development of Aids to Navigation Information System: A Case Study of Kenya Coast Waters

Magdalene Wanjagi Njuki and Moses Murimi Ngigi

**Abstract-** Aids to Navigation is an information service facility which is set up to help sea fairing vessels sail safely, economically and expediently by its visual, sound and wireless signals. In Kenya the marine safety along the coast has deteriorated gradually due to destruction, obstructions and lack of Aids to Navigation. Navigation charts, which are the basic Aids to Navigation, are still in analogue paper format, making them cumbersome and inefficient for use on board the marine vessels. The aim of this research study was to develop web-based Aids to Navigation Information System for the Kenya's coastal waters. All the published nautical charts covering the coastline and survey plans were used. ArcGIS software was used to digitize and create spatial and non-spatial attributes of the existing Aids to Navigation. PostGIS for PostgreSQL 9.2 was used as a relational database management system where PgAdmin III was used to host the database. Macromedia Dreamweaver 8 was used to develop the web interface. Bitnami WAMPstack was used to host the web interface in the local computer. Mobile application for the system was developed and hosted by Net beans IDE 7.0. A spatial database, user interface and a mobile application were the results of the development. The research also brought into revelation that most of the physical aids to navigations (beacons and lighthouses) were not functional due to obstruction by built-up developments along the coastline. The developed system facilitates easy updates, maintenance and monitoring of aids to navigation. There is need for integration of the Aids to Navigation System with Automatic Identification System (AIS) for effective marine navigation.

**Keywords:** Aids to Navigation, GIS, marine navigation, navigation charts.

## I. INTRODUCTION

The use of the oceans is becoming more intensive as a result of the increase in maritime transport and other uses, such as offshore exploration and the exploitation of traditional and renewable energy sources, fishing and tourism. In more crowded seas, with greater traffic density and larger ships, shipping routes will need to be supported by better and clearer information systems such as hydrographic services, Aids to Navigation and technology such as Vessel Traffic Services (VTS), Global Maritime Distress and Safety System (GMDSS)

and satellite communication technology for vessels to achieve the required efficiency while enhancing safety [1].

Aids to Navigation are devices or systems, external to a vessel, which are provided to assist mariners in their determining position and course, to warn of dangers, obstructions or to advice of the location of the best or preferred [2].

According to [3] the safety of navigation has been enhanced by the introduction and use of modern technology to improve safety of shipping in Malacca and Singapore Straits and reduce the risk of pollution of the marine environment. The technology has influenced the safety of navigation of a vessel through availability of accurate information to determine the position of the vessel at any given time.

The integration of AIS, VTS, DGPS and other application systems can be realized through GIS information platform to achieve the visual maintenance and management, spatial and model analysis which can be used to construct a variety of waterway models and application models for analysis, of Aids to Navigation [4].

The marine safety along the coast has deteriorated gradually due to destruction and lack of Aids to Navigation. The cost of any marine incidents is potentially significant and likely to impact on trade, tourism and the environment of a given coastal country.

Navigation charts which are the basic Aids to (AtoN) which every master is supposed to have on board his ship as he navigates in the specific sea area, in order to avoid any hazards of navigation are in analogue format thus making it hard for use on board. The shipping industry seeks efficiency and safety. Poorly charted areas and lack of relevant information will cause voyages to be longer than necessary, and may prevent the optimum loading of ships, thus increasing overall costs.

The main objective of the study is to develop a web based Aids to Navigation Information System to serve the Kenyan Coast waters. The Specific objectives of the research will be to document and map the existing Aids to Navigation, design a database for the Aids to Navigation and create a web interface

to link the database, and lastly propose strategies for securing the existing Aids to Navigation.

The study area is the Kenyan coast waters which mostly serves the Kenyan ports.

In Kenya the coverage of the charts starts from sheet number 3362 Lamu to Kismaayo at the Somalia border to sheet

number 3310 Mafia Island to Pemba Island at the Tanzania border as shown in Fig.1.

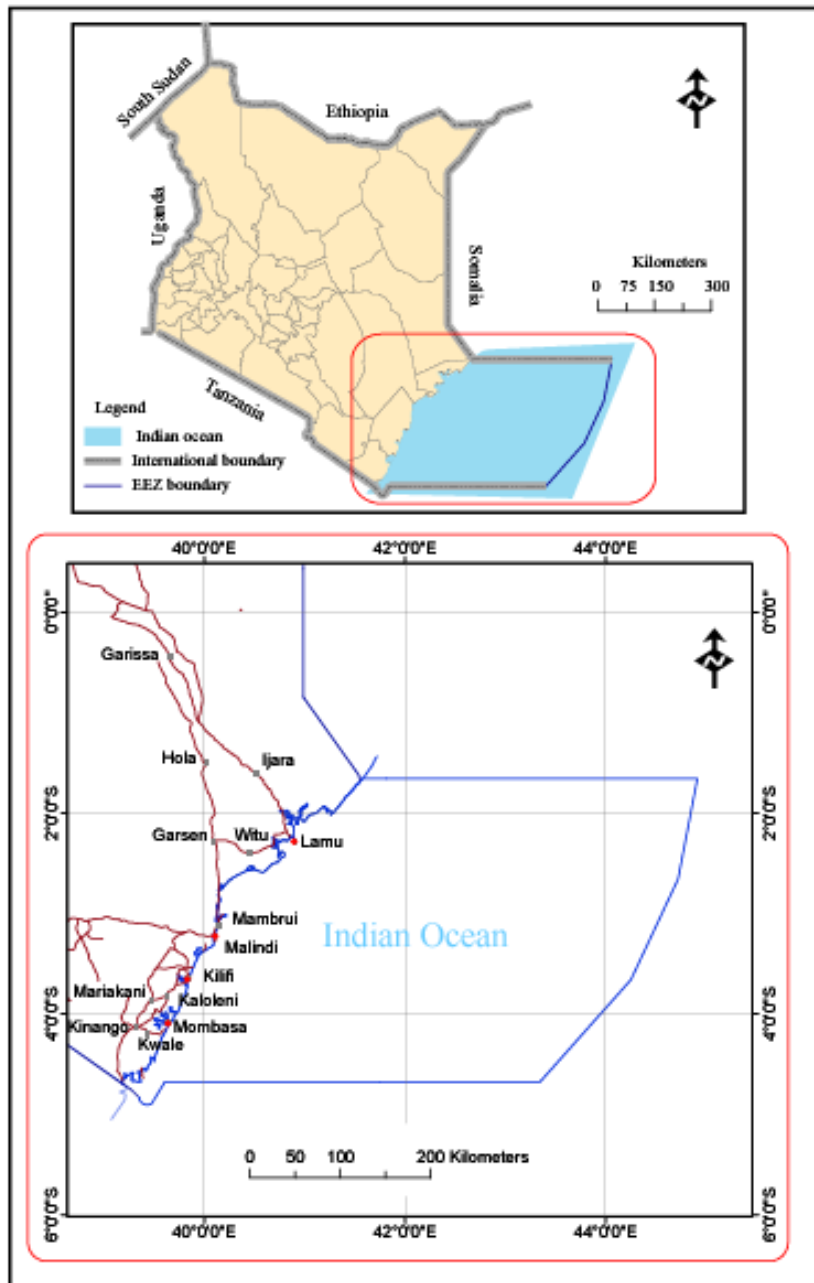


Fig 1 Kenya coastline

## II. PAPER OUTLINE

The whole research entailed the following steps; definition of the problem, formulation of the objectives, justification of the research, data collection, system creation and testing, results and discussions, conclusions and recommendations.

## III. METHODOLOGY

The research objectives formulated were achieved by undertaking the following steps; data collection, data processing, system development and testing as shown in Fig.2.

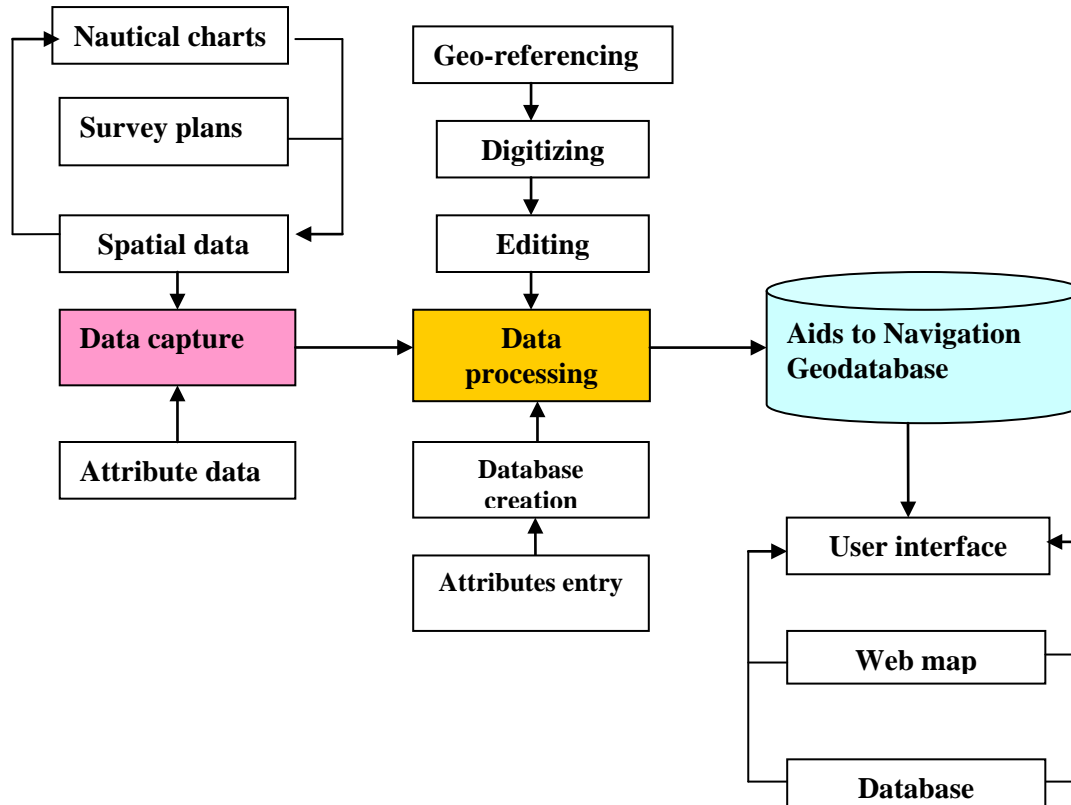


Fig. 2 Methodology

Table 1 List of data

Data	Format	Source
Fr 314/20	Scanned copy	Survey of Kenya
Fr 229/100	Scanned copy	Survey of Kenya
Fr 322/176	Scanned copy	Survey of Kenya
Nautical chart no.668	Scanned copy	Survey of Kenya
Nautical chart no.616	Scanned copy	Survey of Kenya
Nautical chart no.238	Shapefiles	Survey of Kenya
Nautical chart no.3361	Shapefiles	Survey of Kenya

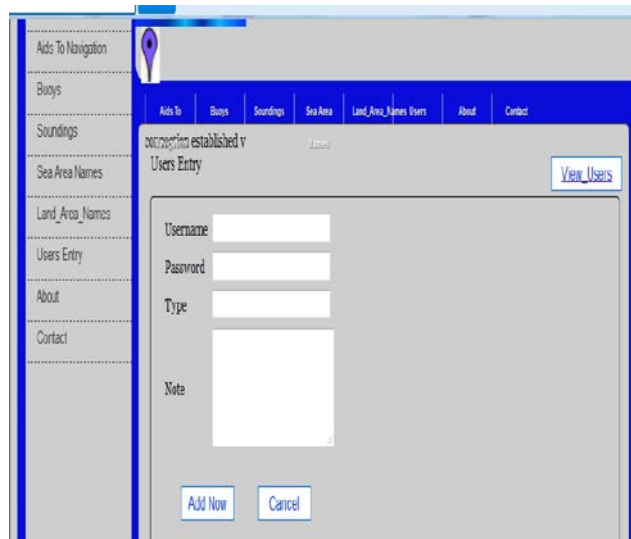
### A. Database creation

PostGIS for PostgreSQL 9.2 was used as a relational database management system. PgAdmin III was used to host the database. A new database was created in Gamin III named Aids\_to\_navigation1 and the shapefiles were imported. The various properties i.e. primary key, foreign key for tables were set. In Gamin all the tables' details could be viewed as well as be queried.

### B. Developing the web interface

Dreamweaver 8 was used to develop the web interface. Dreamweaver supports various coding like PHP which is an Object Oriented Programming language and CSS (Cascading style sheet) was used to add styles to the interface. After coding Bitnami WAMPstack hosted the web interface in the local computer (localhost). To login one must be registered so

as to have the password and username. The web interface also allows login by several users as shown in Fig.3. This regulates the access to the information and to what extent.



**Fig. 3** User entry dialog box

### C. Mobile application

Mobile application for the system was developed and hosted by Net beans IDE 7.0 which runs in a java platform. Net Beans is an Integrated Development Environment (IDE) written in Java that supports development of Java programs and web services. An IDE project was created named Navigation and coding done in Java programming language supported by Java SE Development Kit (JDK7). Using the mobile phone one can access the system created and view all information. Mariners can also track their position while in the sea and confirm they route.

## IV. RESULTS AND DISCUSSION

### A. Aids to navigation map

A map showing beacons and buoys was produced. The buoys define the navigation channel. General lights as well as leading lights are incorporated in the map as they guide the mariner on board. The map shows aids to navigation along Lamu bay as shown in Fig.4.

### B. Aids to Navigation Database

A spatial database was created in PostGIS for postgresQL 9.2. The database created provides the mariner with every detail of a specific Aid to Navigation which is type of aid, colour, structure, colour of light, longitude and latitude as shown in Fig.5.

### C. Current status of aids to navigation

It was discovered that three beacons and lighthouses are not functional as a result of obstruction. Private developers have grapped most the parcels hosting Aids to Navigation. The

present Aids to Navigation is mostly passed through publications of Notices to mariners and use of paper charts. he Aids to Navigation affected were leading lights FL2s16m3m obelisk BW , Q. 11m3m obelisk BW and directional light ISO WRG.5S21m2m (12) obelisk W all in chart No 666 Port Mombasa including Kilindini and Reitz as shown in Fig .6. The parcels obstructing the three Aids to navigation are; Plot MSI/MSA/1817 blocking the Direction Light with coordinates 39°40'5.9546"E4°05'0.4054"S.PlotsMSA/1789,1790,1791,1792,1793,1794,1795,1796,1797,1814,1818,1819,1820,1821,1822,1824,1825,1826, 1828, 1829, 1830, 1831 have walls which block the two leading lights.

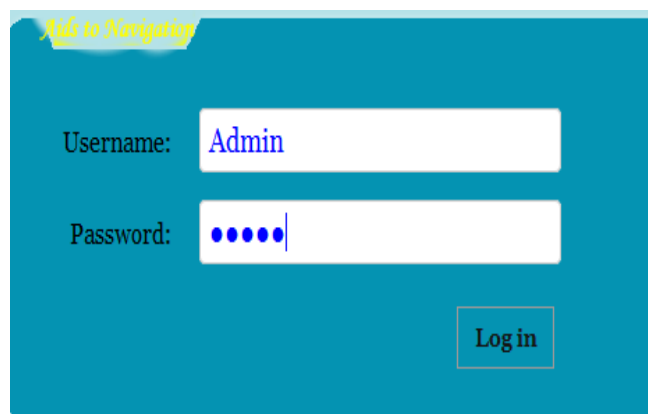
### D. User interface

A user interface was created by Apache PHP and hosted by Bitnami WAMPstack which is open source software.The interface is web based and can be accessed in any browsers.

### E. System access

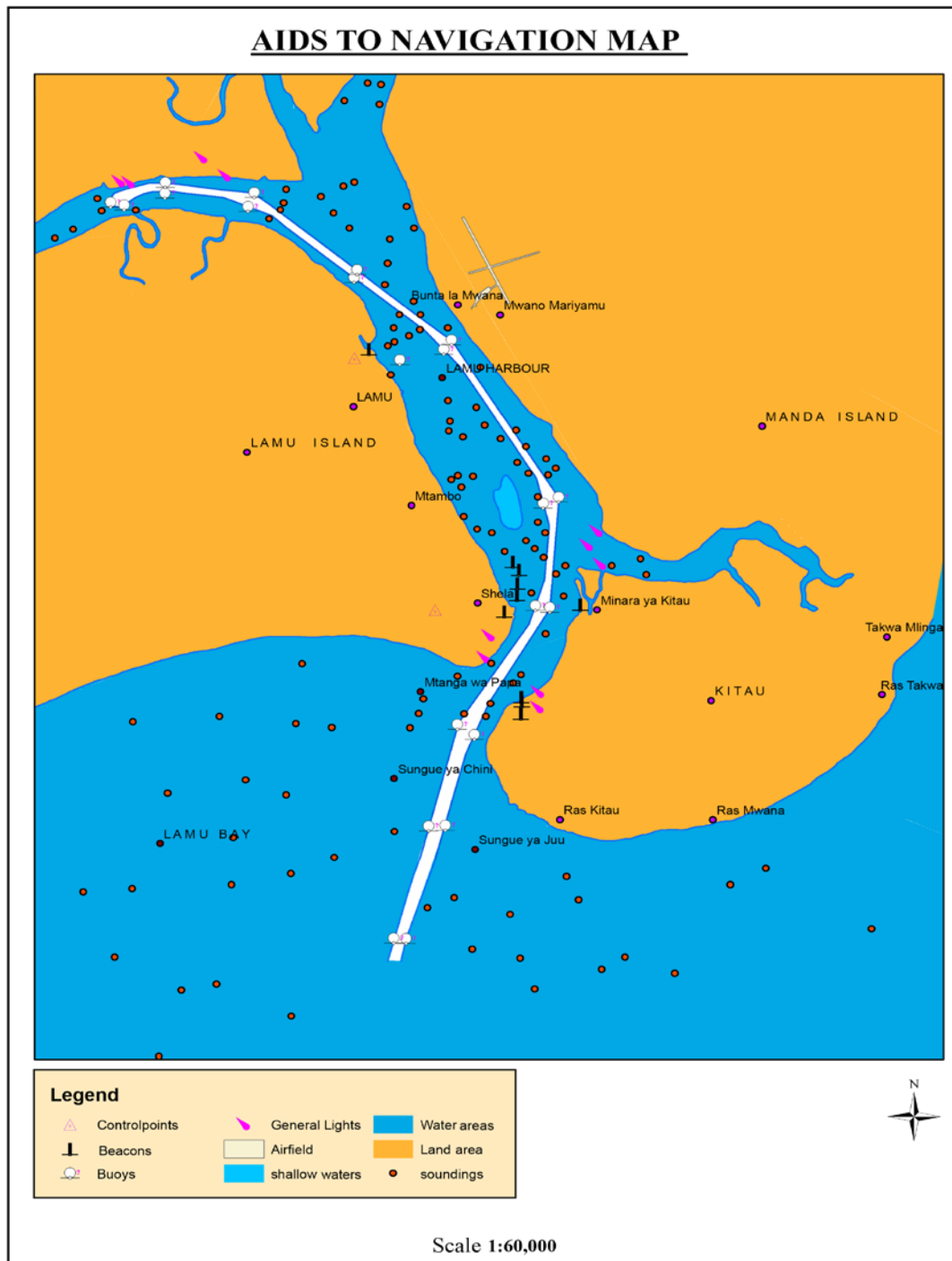
To access the system created in the localhost one must be authorized by the administrator. One must have the user name and password (Fig 7). The system can be accessed on any web browser through the link .While logged to the system one can only view the information about aids to navigation and the maps.

**Fig. 7** User login dialog box in PHPMyAdmin



### F. Data access and retrieval

Users logged to the interface can access the database created. Several maps equivalent to the tables can also be accessed on the web browser. The map created guides mariner to track his/her rout while Navigating.It is also possible to overlay the created maps to google earth maps. The buoys have designed colours which the mariners understand their meaning.It also shows the position for the Mariner to determine position in reference to the channel.



**Fig. 4.** Aids to Navigation Map

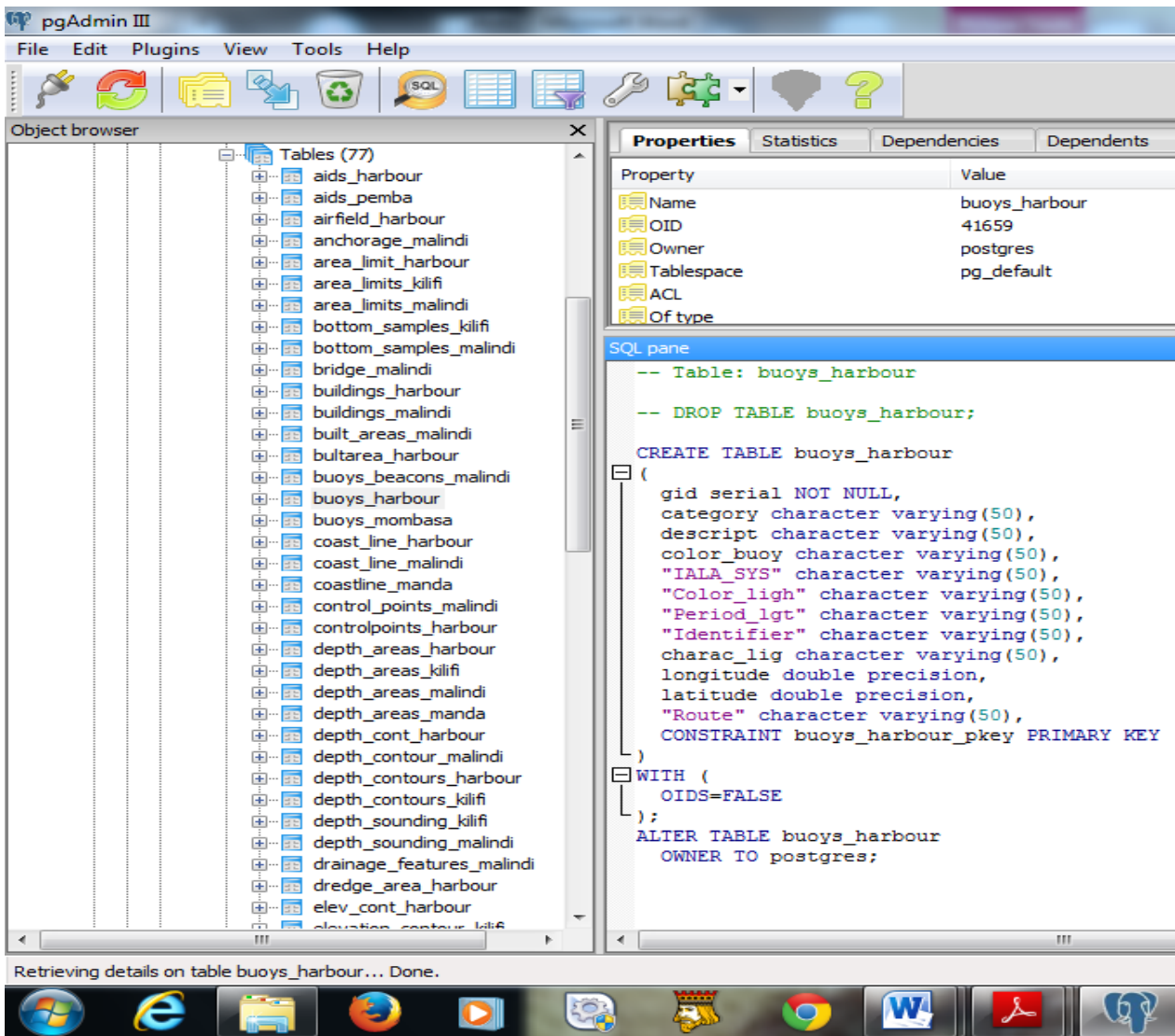


Fig. 5 An overview of the Aids to Navigation database created, showing a list of tables

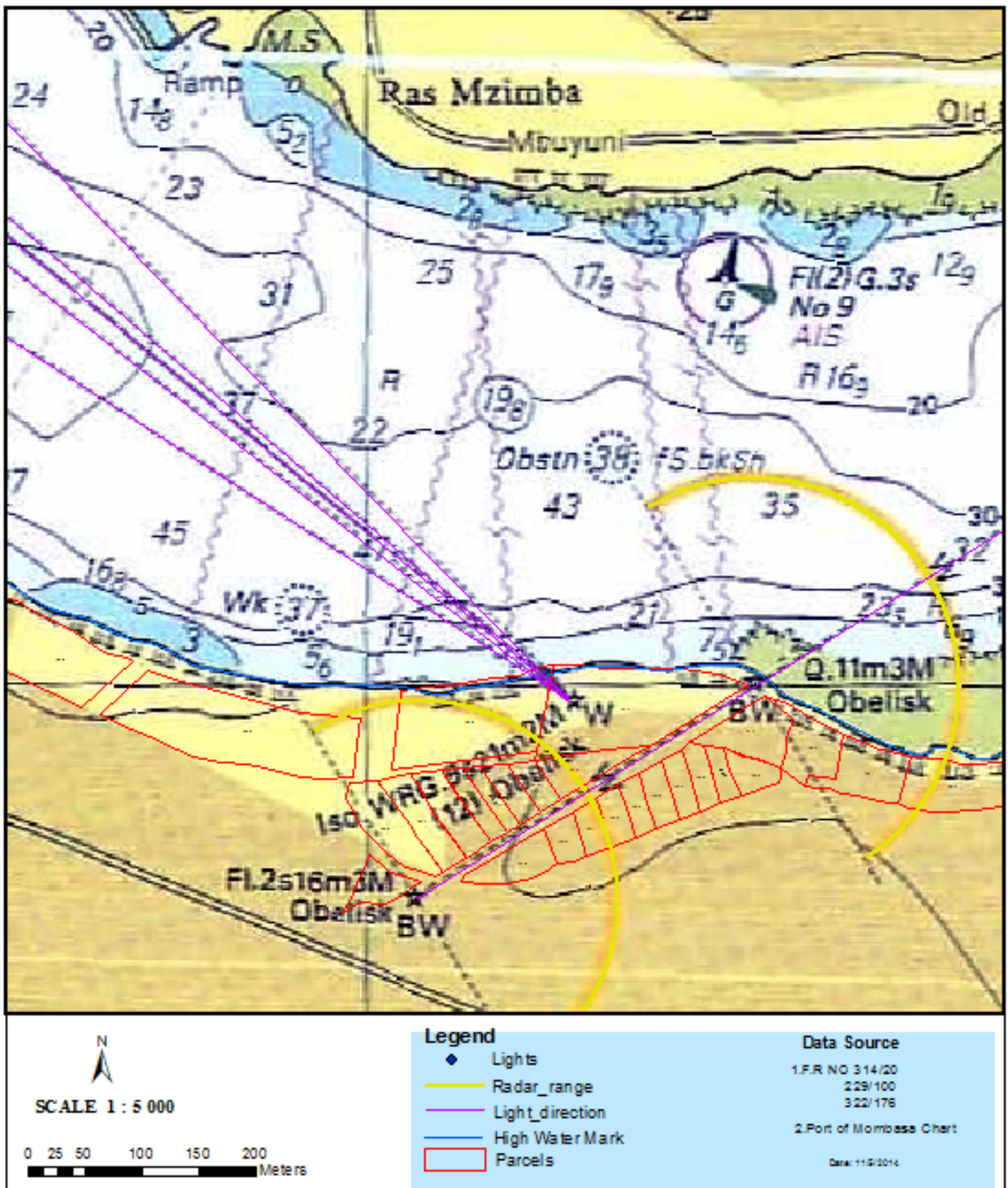


Fig. 6 Navigation chart-cadastral overlay of Kilindini harbour

### *G. Mobile application*

A GPS mobile capability was developed. This is an application whereby a mariners access the application developed on mobile phone which is java enabled and with GPS applications. From the phone it was possible to track one's position by show of longitudes and latitudes. It was also possible to access the database and the map on phone

## V. CONCLUSION

The research study sought to address the problem of how information on aids to navigation is gathered and disseminated to the appropriate users and organisations. From the research an aids to navigation map of Lamu harbour was created which shows a navigation channel.

An information system was developed composed of a spatial, a user interface and a mobile application. How to login and access the system as well as retrieve the information are also demonstrated.

The research also leads to discovery of aids to navigation which have been obstructed by developments. The parcels where these aids to navigation lies were also identified.

From the study one draw conclusions that the system should be adopted for effective management, data and information dissemination to the appropriate bodies about Aids to Navigation to enhance safety at the sea. Generally the system will enhance marine navigation.

## ACKNOWLEDGEMENT

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## References

- [1] International Hydrographic Office (IHO). (2011), publication M-2 version 3.
- [2] Canadian Coast Guard Fisheries. (2012).The Canadian Aids to Navigation System. Aids to Navigation Program.
- [3] Neil, G., & Torsten, K. (1999). Application of New Generation Navigational Aids and Aids to Navigation in the Malacca and Singapore Straits.
- [4] Haigang, S., Jinghwan, X., Jialu, C., & Wenjuan, M. (2008). Discussion on 3d Aids toNavigation planning and setting based on GIS and VR.