IMPLEMENTING A TOPOBATHY DATABASE IN MOZAMBIQUE

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Introduction

The country of Mozambique has a coastline of almost 2.700 kilometres. Approximately 20.5 million people, more than 60% of the total population, live in coastal areas. In many places this consists of lowlands with sandy beaches, estuaries and mangroves. These conditions mean a high vulnerability of both people and landscape to natural events like tropical cyclones, tsunamis, flooding and sea level rise (Mavume & Bundrit, 2009).

Better knowledge of the bathymetry and the topography of the coastal zone can help to take measurements for protection against these events. In this article a project is described within which a database with combined topographic and bathymetric information is created for two pilot areas in Mozambique. Digital elevation models generated with this database, can serve as a basis for better wave run up modelling and coastal zone protection and management.

Project Context

After the devastating tsunami in December 2004 the UNESCO Intergovernmental Oceanographic Commission (IOC) has launched the Indian Ocean Tsunami Warning System. In the framework of this program IOC and the International Hydrographic Organization (IHO) initiated the Coast-Map-Indian Ocean (Coast-Map-IO) project.

The focus of this project was to increase the capacity of countries around the Indian Ocean to collect and use bathymetric and topographical data, to support management of tsunami risk and other extreme ocean events in coastal areas (Berque & Travin, 2009). With more bathymetric and topographic knowledge, governments are better able to protect their countries by building infrastructure like dykes and by preventing people from living in areas that are too vulnerable.

As part of the Coast-Map-IO project, mapping agencies and hydrographic offices in the region were visited during joint IOC/IHO assessment missions, to get a good idea of the current capacities and needs of the different countries involved.

Based on the assessment mission in Mozambique, it was suggested that a pilot database with combined topographic and bathymetric data (a topobathy database) should be set up and that appropriate means and training should be provided to manage the data. After successful completion the results should be made available to other participating countries. The government agency responsible for this database should be the Mozambican Hydrographic Office: the Instituto Nacional de Hidrografia e Navegação (INAHINA) (Travin, 2008).

Based on the above the geomatics software company CARIS is cooperating with INAHINA to accomplish the setup of this topobathy database. In this project a database is filled with both topographic and bathymetric survey data for two defined pilot areas around the coastal port cities of Beira and Quelimane. These areas were identified by IOC/IHO together with INAHINA, because they are large population centres that are extra vulnerable to natural disasters.

The topobathy database software application that will be used at INAHINA is an application of the CARIS Bathy DataBASE suite, which offers a database solution to store, manage and visualize gridded bathymetric and topographic elevation datasets.

As in Mozambique the area for which hydrographic surveys have been done is very limited, there was not much data available to fill the database with. To be able to use the data in the topobathy database to, for example, create a good model for (tsunami) wave prediction, more bathymetric data was needed.

For this reason INAHINA and CARIS also partnered with the company BMT ARGOSS. Specialized in using earth observation data from satellites, BMT ARGOSS offers an efficient alternative to conventional surveys for shallow water areas where no adequate bathymetry information is available.

Using Landsat satellite images of the areas of Beira and Quelimane, the assessment of bathymetric information is based on the optical properties of the water and the seabed. By calibrating the intensity of light reflection with existing datasets a good approximation of bathymetric depths can be accomplished. This depth approximation is not as accurate as a ship survey, so the data should not be used for navigation. However, the accuracy is much higher than any data currently available for the area and is therefore a good input for further modelling.

Project Execution

In the period of October 2011 to January 2012 the project started with a first assessment of available geospatial data in Beira and Quelimane to put in the database. This resulted in some recent INAHINA singlebeam surveys as well as topographic data for both cities acquired from CENACARTA, the topographic office of Mozambique.

At the same time BMT ARGOSS has made an assessment of suitable satellite images and subsequently used the INAHINA survey data to calibrate the resulting bathymetry against. This resulted in two datasets with depth information of a 50 metre resolution for an area of about 150x75 km around Beira and about 100x50 kilometres around Quelimane, which could be imported into the topobathy database.

Finally two publicly available datasets have been used to fill the database in those parts of the pilot areas where no other data was available. For the bathymetric data the GEBCO dataset has been used. The acronym GEBCO stands for General Bathymetric Chart of the Oceans and its aim is to provide the most authoritative, publicly-available bathymetry for the world's oceans. It operates under the joint auspices of the IOC and the IHO.

For areas on land where there was no CENACARTA elevation data available, the public dataset used was the ASTER topographic elevation model. ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) is a satellite imaging instrument that can measure elevations.

In total there were 5 different data sources used for the initial filling of the topobathy database for Beira and Quelimane. These datasets where imported into the Bathy Database application and stored as continuous grids called BASE Surfaces. All 5 surfaces were combined into one digital elevation model, but only after all surfaces had been shifted to the same mean sea level (MSL) vertical datum. The whole workflow is shown in figure 1.
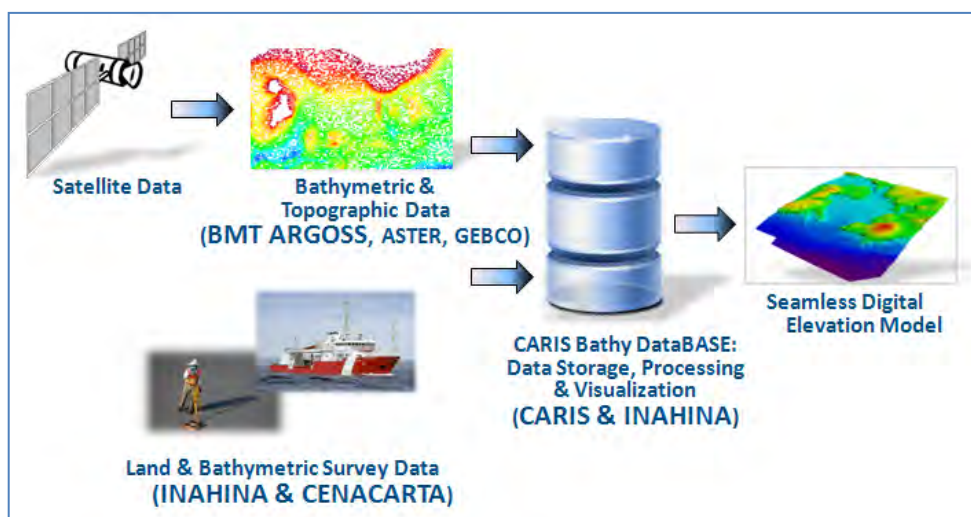
Figure 1: Topobathy database workflow

As a preparation CARIS established and executed a workflow for the Beira area and a training manual based upon this was created. Thereafter, in February 2012, a two week training was held at the INAHINA office in Maputo, Mozambique.

Apart from hydrographers, cartographers and an oceanographer from INAHINA, a cartographer from CENACARTA, as well as a meteorologist from INAM where participating in the training. INAM is the national meteorological institute of Mozambique and they can use the resulting topobathy elevation models, to better model (tsunami) waves and currents.

In the first week the students were trained in the conversion, management and visualization of the different geospatial datasets. The workflow to create a combined topobathy elevation model for the Beira area, as described in the manual, was followed. In the second week the CARIS Bathy Database suite was implemented at INAHINA, so that it can be used to store and manage all bathymetric and topographic datasets in a central location.

In the period of March to June 2012 INAHINA has executed the same workflow that was set up for Beira, to create a combined topobathy elevation model for Quelimane.

The project will be finished in July, with a second consultancy period in Mozambique. In this period the created elevation model for the Quelimane area and the future use of the database at INAHINA will be discussed. After that the results will be shared with the other in Coast-Map-IO participating countries.

After the Project

In the coming years INAHINA can expand their topobathy database in time and space. To improve the elevation model for Beira and Quelimane, new bathymetric & topographic data can be added and implemented, as soon as it becomes available. The area for which geospatial data is stored and managed can also be expanded to other coastal areas, thus supporting the buildup of a spatial data infrastructure for Mozambique.

Next to input for tsunami and storm surge models, the data can be used as a basis for multiple other purposes. Depending on the source and the accuracy of the data, INAHINA can use it both for the creation of nautical charts, as well as for the creation of gridded elevation models. In this way the knowledge based on the topobathy database can be shared with and used by different governmental as well as private organisations, for purposes like coastal engineering and disaster management in Mozambique.

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