Development of methods to get environmental maps in an estuary located at Pernambuco state, Brazil

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ABSTRACT


Environmental maps showing marine ecosystems are very useful for providing baseline information for coastal management. The cartographic information of this kind of thematic map should explore the real scenario to understand the ecosystems. In this particular case of Brazil, with continental extension there is a potential for impacts from activities developed near the shoreline, among which as an example are those related to the oil industry. The cartographic documents can be used for environmental analyses and management and should contain relevant information about coastal zones. Two methods are applied for the production of the cartographic documents. The first one used traditional methods of interpretation, manual vectorization, generalization and edition. And the second used a supervised classification technique to obtain information of the pre-selected classes like hydrograph, vegetation, mangrove, main roads, and urban zones. In this regard high resolution images are important for update and get more detail information of an estuary. The materials used for experimental tests were high resolution satellite images with spatial resolution of 0.60m. This contribution makes the assessment of both techniques showing the maps and a list of advantages and disadvantages. The results of the study provide users the option to visualize a classified image that contains more detailed information than the traditional maps and also the results are important in a case of environmental management.

ADDITIONAL INDEX WORDS: Cartography, Coastal Mapping, Remote Sensing.

INTRODUCTION

Brazil has 7,367km of shoreline, without taking into account estuaries, islands and bays that extend coastal significantly this extension. The average population density of coastal zones is 87inhabitants/km², five times the national average (17inhabitants/km²). The country has around seventy million people living up to two hundred km from the sea. This population has a direct impact on coastal ecosystems (IBAMA, 2010).

In 2002, the Brazilian ministry of environmental (MMA) was prepared a cartographic plan for mapping the sensitivity environmental through three levels of information: strategic maps for regional zones using the scale 1:500.000, tactic maps using the scale 1:150.000 and operational maps for high sensibility risk with using scales between 1:10.000 and 1:50.000 (MMA, 2002).

An oil spill near the shore can change the local environment in a dramatic way. One example was the drilling rig explosion in the Gulf of Mexico that took place in 2010 (BBC-News, 2010); mammals, fish and coral reefs were affected severely. There are also social and economic aspects related to the coastal urban zones that can be affected by an oil spill.

Environmental maps to prevent accidents in coastal zones indicate the geographic features for a specific time frame and also are required to have local information such as: a) description of coastal habitats; b) geographic information about the areas potentially affected in cases of oil spill, c) list of biological information and species protected by law, d) additional details about coastal zone activities, e) relevant data that can indicate local access for oil spill containment and cleaning operations (MMA, 2002).

The requirements in accordance with this prescription are: the maps must contain a clear message and should not require specialized knowledge to be understood and interpreted; it should not be overloaded and only have relevant information, to avoid confusion; it should not divide the natural features; should use convenient symbols and not induce wrong messages; it must be
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Two methods are applied for the production of the cartographic documents following those recommendations. The first one used traditional methods of interpretation, manual vectorization, generalization and edition using the official topographic vector maps. And the second one used a remote sensing image to obtain recent information about the study area.

The result shows the importance to combine techniques and also the importance to use satellite images to elaborate cartographic documents in an estuary.

STUDY AREA

The study area are located at north-east of Brazil in the State of Pernambuco, the capital is Recife with approximate coordinates 8°3’S and 34°54’W. This state has 180km of oceanic shoreline extension (CPRH, 2003). The climate of region is defined as tropical and humid with average temperatures ranging between 26°C and 31°C. The case of study is a specific estuary in Goiana district, located at north of Pernambuco (Figure 1). This coastal ecosystem has mangrove forests, a main river channel, tidal channel and sedimentary beaches, whose promote several ecological services such as: protection of the coast line, nutrients cycling and fisheries productivity. Goiana was responsible for around 1500 tons of the fisheries landing at Pernambuco State. This situation shows the importance of this estuary for the local economy. Also this estuarine ecosystem is important for subsistence fisheries since a large number of local communities are dependent of this site.

METHODS AND MATERIALS

Two methods are applied for the production of the cartographic documents. For both methods was create a cartographic language resulting the legend of the maps that can be seen in Figure 2.

The first method developed uses as basic cartographic information acquired from official topographic maps available in Brazil (Figure 3). The main idea is to apply traditional methods of interpretation, manual vectorization, generalization (McMaster and Veregin, 1997) and edition in order to make the environmental maps.

In the topographic map (Figure 3) it is possible to visualize urban streets, mangrove forest, and water bodies, but those features it is not highlighted for the specific use of environmental maps.

The next step in this process needs a trained operator to perform the manual vectorization of the data to represent accurately and clearly the coastal zone environment along the estuary. The study of cartographic generalization methods were used in the process. The main operations during this process of generalization were: simplification, smoothing, aggregation, amalgamation, merging, collapse, refinement, exaggeration,
enhancement and displacement. These generalization process services are depending on object classes and geometry of cartographic base.

The second method applied used as material a remote sensing image to obtain recent information about the study area where traditional topographic maps could not be found. The high resolution images with 0.6m of spatial resolution were used as material and are showed in Figure 4.

The methodology to create an estuary map using satellite images start with the interpretation of the scene to get information and recognize the features. It is important in this step previous knowledge of the area. The process of features identification on satellite images can only be done after treatment and geometric corrections (fusion/equalization, mosaic, projection and registrations).

The cartographic scale established for the vectoring of the satellite data was 1:5000, so the output data would be compatible with the operational scale of 1:10000. After the selection of cartographic parameters, the standard criteria adopted by the Brazilian Ministry of Environment were followed.

The manual extraction of the themes to be mapped were performed by on-screen vectorization of the estuary image considering the line and area properties of the coastal features.

**RESULTS**

The results are thematic maps according to the methodology related. Figure 5 shows the result of a thematic map having the topographic maps as cartographical base and Figure 6 represents the thematic map resulting of the satellite image generalization.
ANALYSIS AND DISCUSSION

The relation between the geometric resolution of the satellite images and the publishing map scale considered as the output has to be considered as a relevant factor in this process. In this case high resolution images where appropriate for this project.

The reason to choose a second methodology was relevant because there are no topographic maps available in the estuary. The interpretation of topographic maps for this purpose is easier because these maps already have descriptive information. This metadata are not available when using satellite images, in this case the computer operator needs previous knowledge about cartographic features that integrates one particular area.

Comparing information from same time period, provided by topographical maps, high spatial resolution imagery and other cartographic datasets, it is possible to identify some differences regarding important features related to the Environmental Sensitivity Index definition (Figure 7). Eventually, this can be a constraint to more precise measuring and representation of relevant environmental information; this reinforces the need for continuous data update and analysis.

CONCLUSION

It was possible to create an environmental map for an estuarine area using precise and effective interpretation of high resolution satellite images, in this particularly case where topographic maps could not be available. One advantage of using satellite images is to get easier and faster information about a study area.

The thematic maps in both cases are extremely clear and of easy interpretation, as a result valuable information regarding the environmental features can be retrieved faster in the event of an oil spillage. Users can quickly understand and adjust their decisions and needs related to coastal features that can be directly affected by natural or man-made hazardous events. Those characteristics of a generalized map are important and attended the objective for this particular case study.

LITERATURE CITED