Pelagic fisheries study using GIS and Remote Sensing imagery in Galicia (Spain).


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ABSTRACT: This paper presents results from the Local Study Project for Galicia area under the title “Forecasting system for fishing effort in Galician craft fleet”. The Galician region occupies the north-western part of Spain, west and north bounded by the Atlantic Ocean. Despite his "lack" of continental platform, the coast of Galicia has a high productivity. The high productivity of the Galician coast is a logical consequence of his western oceanic bound together with the seasonal northward winds, generating strong upwellings of rich nutrients cold waters along the period from May to September. The study has targeted boats using the ports of Vigo, Bueu, Marín, Ribeira, Muros and Coruña. Trawlers targeting pelagic fish were the first target. The observers have collected fishery, biological and environmental information in situ. They have reported specific data for each trip, such as catch and discards by species, effort, weather conditions, or sea status. With this aim, a navigational and by-catch fisheries database was built and integrated into a GIS, together with processed sea surface temperature images from AVHRR (Advanced Very High Resolution Radiometer) sensor and chlorophyll-a concentration indexes (from SeaWiFS) from RSDAS at Plymouth Marine Laboratory (PML).

1 INTRODUCTION

GIS techniques applied to fisheries can be a very helpful tool for fisheries managers. The need for modern technological aids in fisheries management was stressed by the General Fisheries Commission for the Mediterranean (GFCM) during its 21st Session (Spain, 1995).

Hopefully, GIS techniques could provide only benefits to fisheries studies contributing to:

- Definition of parameters for fishing effort.
- Data organization: database design and graphical analysis.
- Identification of spatial/temporal patterns.
- Spatial overlaying of multiple parameters.

Nowadays, it appears clearly that spatial dimension has to be taken into account when it comes to designing a fisheries management tool.

The main purpose of this paper is to illustrate the utility of GIS tools and techniques in oceanographic studies, not only dealing with physical and morphological patterns, but also with biological data analysis as for example in the fisheries domain.

2 AREA AND SPECIES OF STUDY

2.1 Area of study

Galicia is situated in the North-west of the Iberian Peninsula, approximately between the northern latitude parallels 42º and 44º, and between the western longitude meridians 7º and 8º (Fig. 1). The morphology of the Galician coastline is highly variable with a total length of 1,198 Km. Galicia’s continental shelf is narrow, ranging in width from 20 to 35 Km.
This unfavourable factor (being fisheries mainly situated over the continental shelf) is compensated by the good conditions for fish habitability. Richness of the area is largely due to the periodic upwelling episodes (Fraga, 1981; Blanton et al., 1984), which provide the necessary nutrients to support a high primary production. These favourable conditions make Galicia to play an important role into the world fishery market.

2.2 Species of study

Galicia is the leading fishing region in Spain, due to the high stocks unloaded on its many fishing ports situated on a particular and unique coastline consisting of estuaries named “Rias”. Among this high productivity we find pelagic fisheries. Species as blue-whiting, hake, pouting, mackerel and horse mackerel are caught by bottom and pair trawlers, which operate at depths between 100-200 m.

3 STEPS ON THE PROJECT

We can enumerate the following steps in the project:

- **Task1. On-board collection of catches, discards and effort data for target species**
  Observers collect specific data for each trip on the biological and environmental domain.

- **Task2. Data base assembly**
  All collected data are loaded into a database to be queried by the GIS tools.

- **Task3. GIS integration of on-board collected data and satellite data**
  All spatial data are georeferenced (latitude, longitude) and integrated into a GIS to be analyse.

3.1 On-board data collection and storage

Each time an observer goes out to sea, there is new information to be taken. Each observer has a code-name (A to E) and each day out to sea is reported, so that we are able to classify all data entries by observer and by date.

All the information registered by the observers during the fishing trip is recorded and integrated into a data base. All latitude and longitude data can be represented on the GIS to obtain a fishing location map for all fishing trips and observers (see Fig. 2)

Each observer records, on a haul by haul basis, the following information:

- Species composition of catches and discards as well as catches weight by species.
- Main characteristics of every haul and environmental data, such as fishing location, depth, sea surface temperature, etc.
- General information about vessels such as length, tonnage, hold capacity, etc.

3.2 Data base assembly

All data, collected on-board by the observers, are structured on a geographical reference to allow a quantitative multi-parameter modelling through the GIS tools.

Over this database scheme, any desired query can be easily done.

3.3 GIS integration of on-board collected data and satellite data

The geographical position (latitude, longitude) makes possible to extract fine information of fishing trips.

Figure 2. Area covered = 24915 km².

Figure 3. Example of graphical representation of a fishing trip.
All data and images are integrated as different vectorial layouts on GIS software. The main layouts combine coastal line and bathymetry of the geographical area between latitude 41º- 45ºN, and longitude 7º-12ºW.

Satellite images are pre-processed. On the one hand, SST maps (Sea Surface Temperature) (see Fig. 4) are obtained from thermal data from AVHRR (Advanced Very High Resolution Radiometer onboard NOAA satellite). On the other, SeaWiFS data (Sea-viewing Wide Field-of-view Sensor onboard SeaStar spacecraft) turn into chlorophyll-a concentration images (see Fig. 5).

All satellite images are georeferenced in latitude and longitude and integrated as layouts into the GIS software, so that we can overdraw data taken from the database to obtain any statistical feature of interest.

4 DATA INTEGRATION AND ANALYSIS

The basic idea of the project is the integration of satellite imagery into a GIS, together with the database information (see Fig. 6).

All overlays into the GIS (coastline, bathymetry, fishing ports) must be referred to a same geographical projection which gives directly latitude and longitude coordinates in decimal degrees on the screen.

Probabilistic interpolation techniques are used to elaborate temporal graphics (see Fig. 7) on the basis of data collected on-board the fishing vessels (such as sea surface temperature); or spatial graphics (see Fig. 8), on the basis of data reported by satellite sensors.

Figure 4. SST image from AVHRR

Figure 5. Chlorophyll-a image from SeaWiFS

Generating GIS coverage of resources and fishing effort allows incorporation of a high-resolution spatial dimension into population dynamic models. However, that turns into a series of problems: multiplication of the number of parameters, and phenomena such as migration between space units must be taken into account.
Locating fishing effort is quite a delicate question into a GIS applied to fisheries management. All data must be strictly considered under common criteria. It is usually hard to obtain a reliable measure on the spatial criteria. Data collected on board, are the best source of information and database management through GIS or any database engine results into the most efficient and flexible tool for validation and queries.

In a study of marine ecosystems we must take into account the oceanographic environment. Oceanic fronts, whether thermal or colour, are the primary sites for aggregations of fish species (Simpson, 1994). With that in mind, the colour scanning instruments (as SeaWiFS) are invaluable instruments when paired with the AVHRR data.

The technological developments in data acquisition systems and data modelling had made it possible to map these processes in an space and time distribution of oceanic parameters. GIS interface combine both biological and environmental data, offering the scientist a powerful tool on the processing of great amounts of data.

5 CONCLUSIONS

1 A Remote Sensing/GIS system is an invaluable tool for marine fisheries. Both technologies have been proven to be an advantage in fisheries science.

2 Use of GIS, apart from the management and analysis of georeferenced data under vector format, usually leads to specific tasks to other programs like database management systems, multidimensional statistics packages, or numerical models.

3 GIS permits the elaboration of maps. Maps are a highly synthetic product, showing the spatial distribution of an indicator.

4 Thanks to the experience gained in the field of fishery research joint to the technological developments simplifying the management of increasing amounts of information, scientists are capable of processing once and again historical datasets in order to better understand the space and time variations affecting stocks. As the accuracy and availability of datasets increases, so do the potential number of GIS applications to fisheries.
REFERENCES


