Design of a geographical information system prototype for the management of fishing with light in the Gulf of Tunis(Methodology)

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The design of the information system

The first step in the design of the information system is the data-gathering, the second is the establishment of the physical background and the third is the implementation of "geo-entities". Then, we need to define a unit of fishing effort and to formulate a distribution function of the fishing effort.

1. The data-gathering

To gather the necessary data we have carried out surveys based on questionnaires among the fishermen at the ports of Ghar El Melh, La Goulette and Sidi Daoud.

The surveys covered the following parameters:

- the general and structural characteristics of the fishing vessels
- the engine
- the electronic equipment
- the deck machinery
- the fishing gear
- the auxiliary boats
- the light production
- the fishing operations and fishing areas
- the crew
- the ownership
- the conservation mode
- the sale of the landings

We have also carried out surveys among the fishery entities on the catch statistics, the legislation and the port infrastructure.

2. The determination of the physical background

To determine the physical background, the coastline has been digitized from topographic maps on a scale of 1:25,000 and the bathymetry has been digitized from topographic maps and marine charts.

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A numerical depth model has been generated from the isobaths and the bathymetric probe points, digitized from the marine chart. This model has been used for the extraction of any isobath needed but not figuring on the charts.

3. The geo-entities

A geo-entity is a set of rules, activities, practice and physical characteristics defining the spatial extent of a fishery. Five geo-entities are defined, as follows:

3.1 "Legislation"

This geo-entity represents the zones closed to light-fishing and is composed of polygons.

3.2 "Accessible zone"

This geo-entity represents the zone accessible to each fishing vessel, depending on the height of the gear used.

3.3 "Radius of action"

This geo-entity represents the minimal and the maximal radius of action of each fishing vessel from its port. The data were collected from the fishermen.

3.4 "Abundance zone"

This geo-entity was generated from the acoustic survey OASIS 5 and shows the resource abundance in the Gulf of Tunis.

3.5 "Activity zone"

This geo-entity represents the potential activity zone for each fishing vessel. It results from the intersection of the geo-entities "legislation", "accessible zone" and "radius of action". It is represented by a grid with a cell size of 0.025° latitude × 0.025° longitude. Each cell of the grid in which a fishing vessel is active is assigned the score 1 and those in which it is not are assigned the score 0.

4. Modelling

All the geo-entities and the other parameters of the fleet typology were introduced into a conceptual data model, transformed into a logical data model and into a physical model. A data dictionary describing all the components of the information system was conceived.

5. The distribution function of the fishing effort

After choosing a unit of fishing effort, we formulated a distribution function of the fishing effort, following the "friction of distance" approach by Caddy and Carocci, 1998.

This function is:

$$Fij=(fj.Cij)/\Sigma Ckj \qquad (1)$$

k from 1 to N(j) and where:

- N(j) is the total number of grid cells in which vessel *j* is active;
- fj is the fishing effort of vessel *j* over the whole area;
- Cij=[(dij–xjmin)/xjmin] . [(xjmax–dij)/xjmax].exp[–(xjmax–dij)/xjmax];
- dij is the distance from the centre of the grid cell *i* to the port of vessel *j*; and
- xjmin and xjmax are, respectively, the minimum and the maximum radius of action.

The output is a file including the cells' coordinates and the fishing-effort value by vessel and by cell, calculated according to equation (1).

The cells assigned the score 0 will have a zero fishing effort, and those assigned the score 1 will have the corresponding fishing effort.