

DETERMINATION AND MANAGEMENT OF COASTAL AREAS VULNERABLE TO EPISODES OF SEA LEVEL RISE USING REMOTE SENSORS AND G.I.S. TECHNOLOGY

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ABSTRACT

The effects that climatic changes might trigger in coastal areas affect more than a particular region hence the need for an assessment of the impact the sea level might have on the population and its activities. To help do this, a project was started for the development of a management programme covering the Colorado river through to Quequén river estuary, a large sector of the Buenos Aires province's coastal area in Argentina.

The study area has a high degree of urban development, interspersed with rural zones, so the need of using techniques that can relate the different interacting variables in those areas and allows the planning and management of this kind of environment. The first stage was the creation of an in GIS ARC- Info structure. The information comprises different layers of subjects on a small area level, relating the characteristics of coastal areas and its interactions with inland regions.

The digitalization of cartographic documents, given the interest of the geomorphology of the coastal area, was kept in 1:50,000. A reconnaissance flight was made, with filming of the zone which gave a better reference level regarding the subject. On a second stage, satellite images from the TM sensor will be digitally classified regarding use and covering, completing this task with utilization of aerial photography, including images from other sensors and different dates.

All this information will make possible to achieve the goal.

INTRODUCTION

This work constitutes an advance of the subproject "Evaluation of Sea Level Rise (EVANM)", within the "Project of Study of the Climatic Change (PECC)". (PNUD ARG 95/G31).

The area under study includes 550 km. of coast in Buenos Aires Province, Argentina. In general the coastal area is quite homogeneous and it features broad beaches. Parallel to the beach, there lie dunes, some of which are moving dunes and others are covered with vegetation. In parts the formations have developed to reach an extension of 3 km and a height of 30 m. Numerous lagoons have been formed between the dunes, as well as intermittent hydric courses that drain in the sea or are lost through infiltration in the dunes.

This coastal morphology is only altered by some differentiated environments presenting their own peculiarities, such as the estuaries of the Quequén Salado and Quequén Grande rivers and the estuarine environment of the Bahía Blanca. There are also wide areas with smaller beaches, a pronounced slope and eroding cliffs.

The importance of this sea front and its hinterland lies on two main facts. First, 65% of the population in the area under study lives in coastal urban settlements (about 340,000 inhabitants).

Second, two of the most important ports in the country, Ing. White and Quequén, are situated in the area.

Although the information has been compiled in administrative districts and has been stored in a GIS structure, the study includes the coastal area, i.e. the littoral, a 3 km. wide strip of land, and the interior continental shelf lying from the coastline to the 50 m. Isobath (Codignotto, 1995).

AREA UNDER STUDY

The area under study includes a broad coastal strip in the south west of Buenos Aires Province, from the mouth of the Colorado river to the administrative border that separates the districts of Necochea and Lobería.

It includes eight administrative districts as a whole with an area of 34,500 km² (Figure 1). In terms of absolute location, the area lies between 63° 55' and 58° 32' west of Greenwich and between 39° 55' and 38° 30' south latitude.

OBJECTIVES AND METHODOLOGY

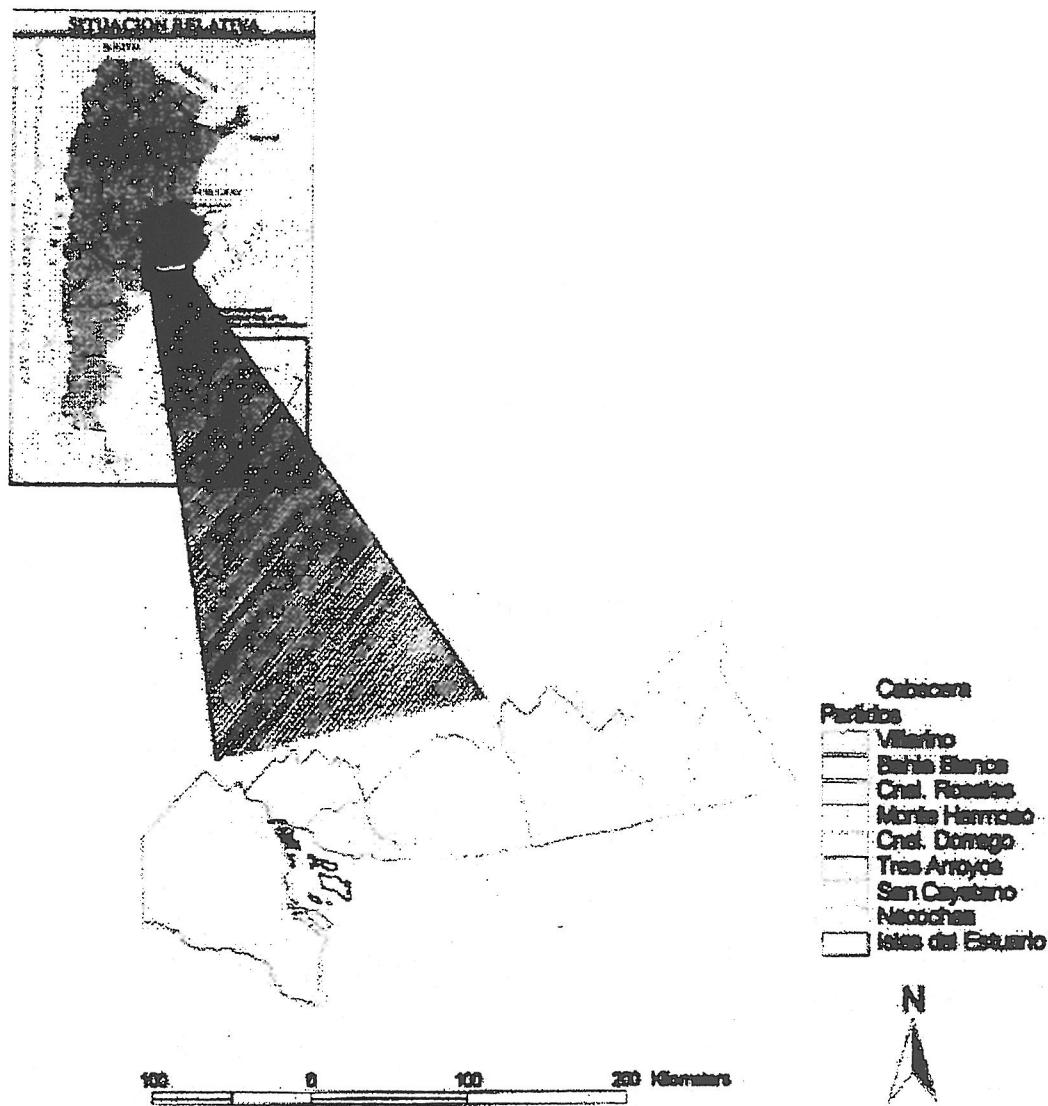


Figure 1. Location of the study area.

The objectives at this work are:

_ To define geomorphological sectors in the coastal area which permit an evaluation of the degree of vulnerability in the face of episodes of sea level rise.

_ To establish appropriate strategies to protect the areas at risk.

In order to define the kind of coast and its geomorphological features, a reconnaissance flight was made and all the coastal area was filmed in super VHS format. The patterns considered for this flight were those suggested by the International Panel to Climate Change (IPCC) in the methodology for Aerial Videotape Assisted Vulnerability Analysis (AVVA) (IPCC, 1990).

This methodology suggest a flight at a height of 70 m. Parallel

to the coastline to carry out the reconnaissance and filming of the coastal geomorphology. As in Argentina the minimum height allowed for a flight is 100 m., the flight was made at that height. For the return flight the specified height is 300 m. so as to define the soil uses and covers in the adjacent coastal areas.

During the flight, the filming was coordinated with a GPS positioning program which provided latitude-longitude data every 2 seconds and the time. These data made it possible to know the coordinates of the places that were being filmed, as the time in the program files matched the time on the videotape.

When the filming was completed, differentiated sectors were defined by their geomorphology and type of beach and in order to be represented cartographically they were combined using a GIS with the cartography obtained from the topographical charts produced by the Instituto Geográfico Militar (IGM) to scale 1:50,000

From the combination of both and the redefinition of the categories a map of the coastal geomorphology in the area under study was obtained (Figure 2).

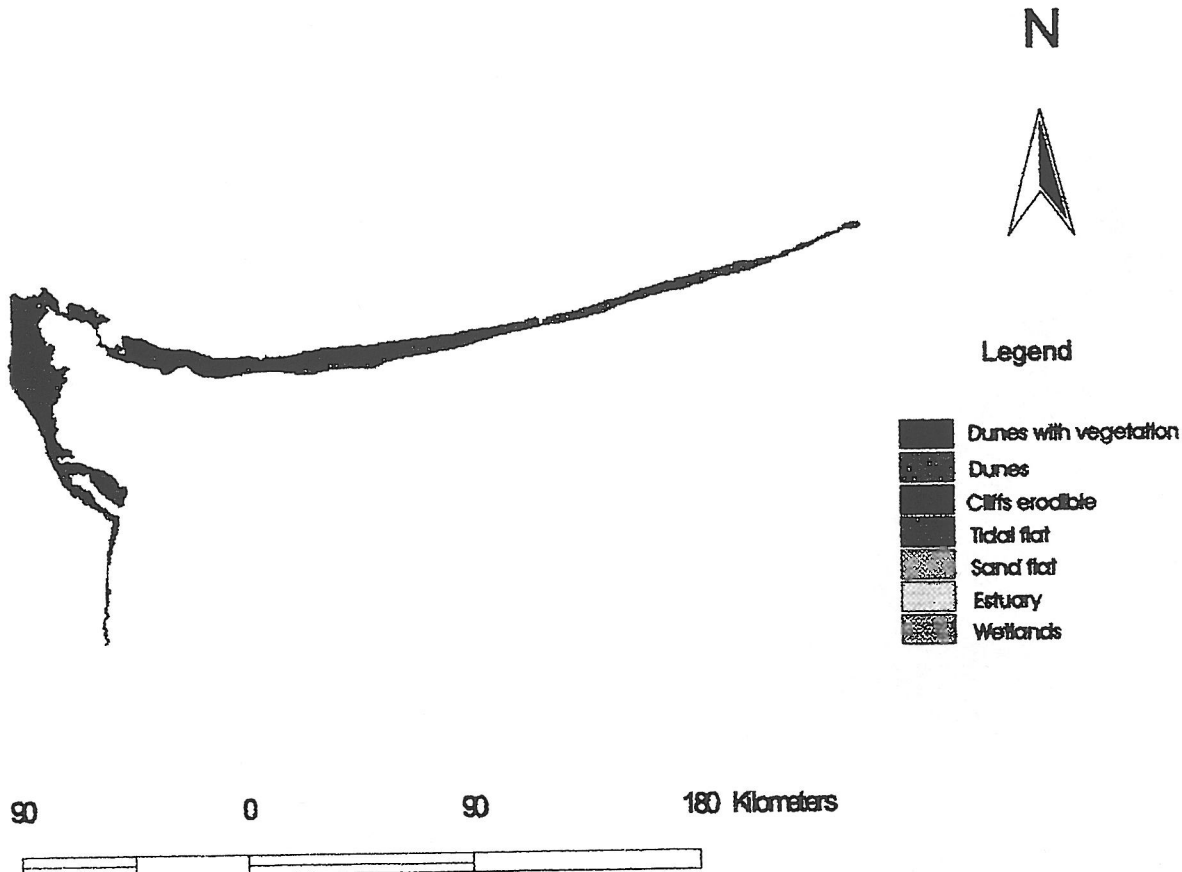


Figure 2. Geomorphological sectors in the coastal area.

In a second stage the types of coast were determined in order to assess the degree of vulnerability. This was done analysing the videos mentioned above. Different sectors along the coast were defined and characterized according to criteria suggested by the IPCC in Appendix H of the common methodology (IPCC,1991) (Figure 3).

After the type of coast and its morphology were defined, the videos obtained on the flight at 300 m. were used and that information was combined with the map of aptitude and use of the land developed by INTA in 1986, to produce a map of land use which would allow the study of the activities carried out in the coastal area. (Figure 4).

RESULTS AND DISCUSSION

According to the type of coast and the land use, three coastal areas were defined as vulnerable:

- A) Accumulation areas: these are virtually pristine areas, with a very low degree of development, where large moving dune fields are prevalent, for example, the coast of Coronel Dorrego and San Cayetano.

- B) Areas of incipient erosion: these are beach sectors with a pronounced slope and eroding cliffs with greater deterioration in river and stream mouths.

- C) Areas with active erosion: these areas are found all along the coast where there is a high degree of urban and port development, such as the coast of the Bahía Blanca estuary, the Necochea sea front and the coast of Monte Hermoso. They are also found on the coast of tourist resorts like Pehuén C6, Claromec6, Reta, Marisol, etc. (figure 5), shows the distribution of these areas along the coast.

STRATEGIES AND PREVENTION TO CONTROL THE EFFECTS OF COASTAL DETERIORATION

Initially the IPCC stipulated episodes of sea level rise of about 6 m (IPCC,1988) linked to abrupt global climatic changes; consequently, it developed a scheme of strategies for protection to be implemented in order to avoid damage to built-up areas, crops, etc., near the coast (Figure 6).

At present it is reckoned that the annual sea level rise is about 2 mm./year. In view of the features of our coasts the steps to be taken are related mainly with preventive strategies in the short

term, which are connected with the planning of coastal environments.

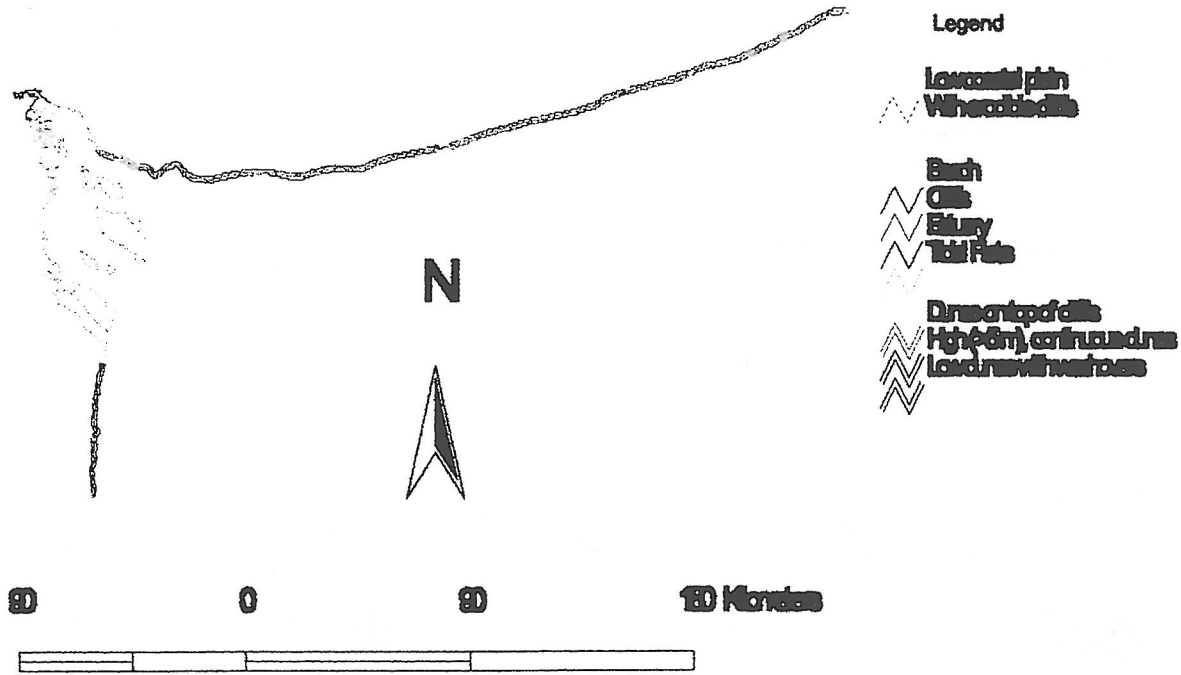


Figure 3. Sectors along the coast according with Apendix H (IPCC, 1991).

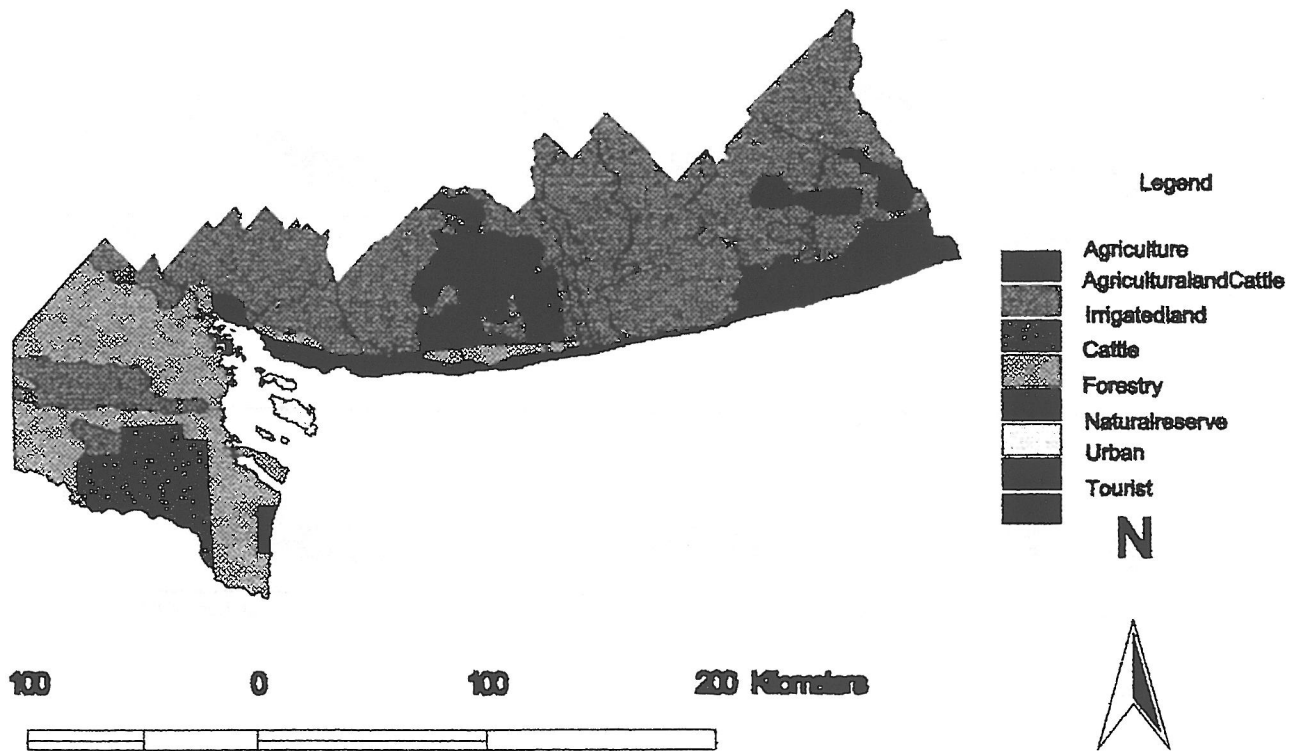


Figure 4. Land uses in the study area.

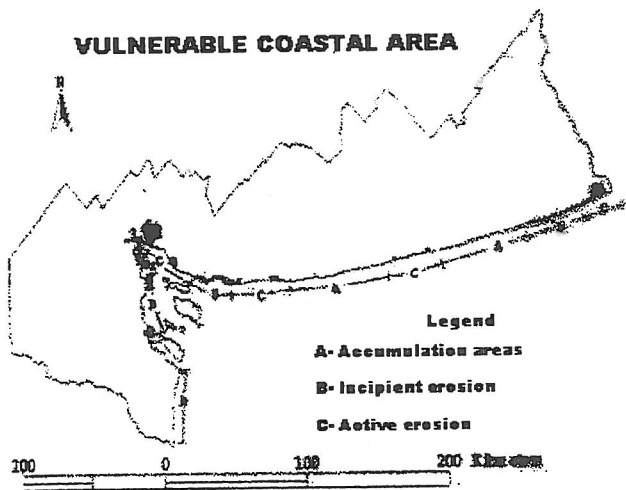


Figure 5.

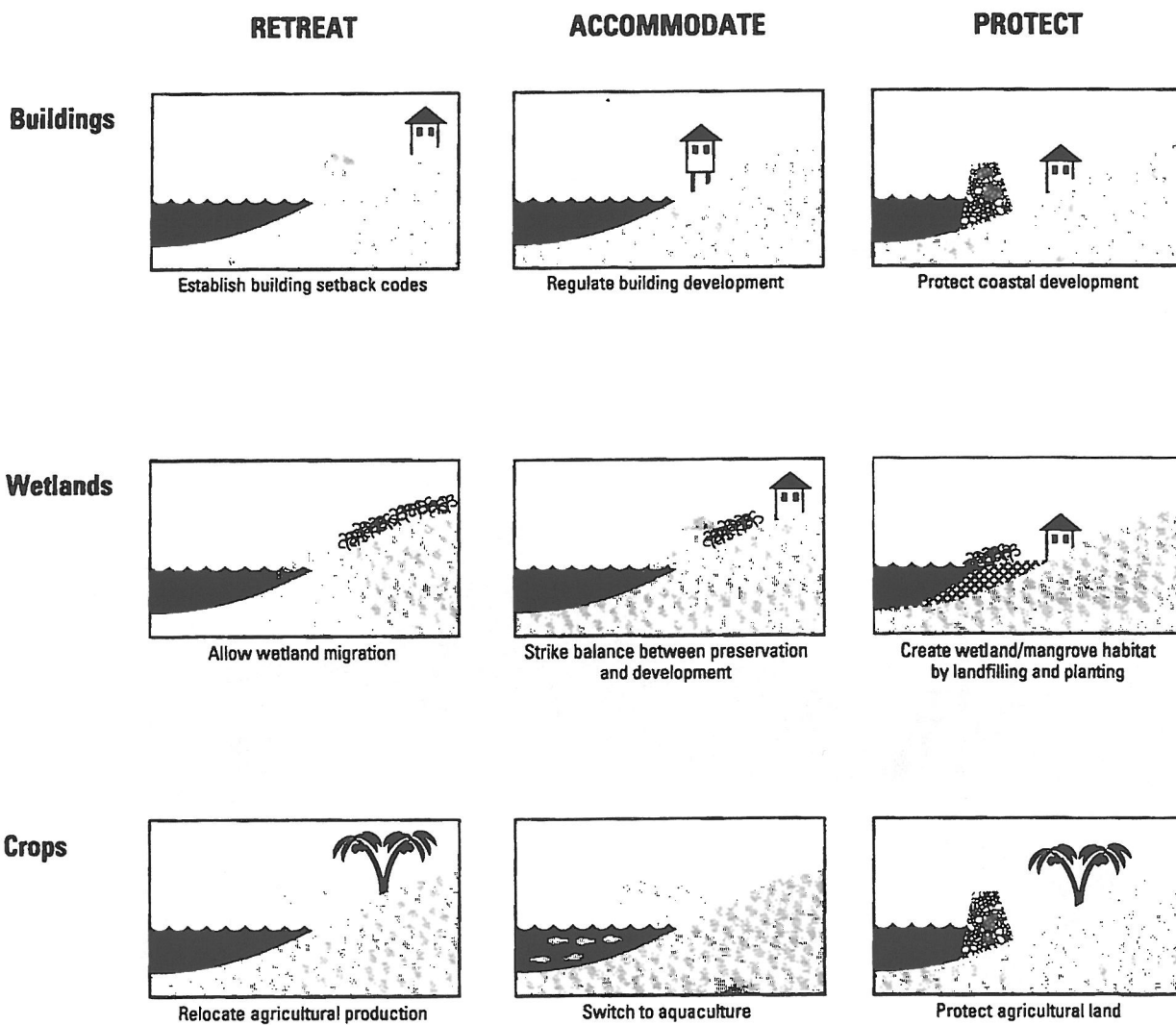


Figure 6. Scheme of strategies for protection. (IPCC,1988).

Such proposals are:

A_ To regulate the extraction and mobilization of beach sand, submerged beach and dunes. These phenomena are perceived in sectors of the coast in Coronel Rosales and the suburban area of Necochea.

B_ To avoid the urban development in the area adjacement to the beach and on the cliffs.

C_ To cover the eroded areas with sand.

D_ Restrict the opening of roads perpendicular to the coast, by cutting them 200 m. from the coastline.

E_ To regulate the construction of jetties and breakwater which obstruct the littoral drift of sediment.

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CONCLUSIONS

The methodology (AVVA) proposed by the IPCC proved to be very useful for the definition of coast types and coastal morphology, as well as for the determination of the land use and covers, which allowed an update of the graphic and alphanumeric information stored at the GIS to be made quickly and easily.

Regarding the objectives of the work, we were able to define qualitatively the different areas vulnerable to erosion and the impact of the sea.

Finally, even though the effects of the global climatic change on the sea level rise will not be so drastic in the short as it was supposed in previous studies, it is shown that it is necessary to adopt preventive strategies to avoid the processes of coastal erosion.

The map obtained, derived from this methodology, may become a useful tool for regional planners who have an influence on the coastal area under study.

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