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Mangrove Cover Loss and Gain on the Colombian Coastline of the Gulf of Morrosquillo

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Abstract : A multi-temporal study of mangrove behavior in Sucre Department, Colombia was carried out for 22 years through interpretation of satellite images. Mangrove forest losses were found to outweigh gains. Some mitigating measures are discussed.
Key words : Multi-temporal analysis, landsat images, mangroves.

Introduction

The Gulf of Morrosquillo coastline subregion located in the Sucre Department in Colombia shows three isolated and separated mangrove areas called: Corchal Mono Hernández, Guacamayas and La Caimanera. Figure 1 shows the location of mangrove areas on the Colombian Caribbean coast.

La Caimanera, Guacamayas and El Corchal Mono Hernandez cover areas close to 1,470 Ha, 2,650 Ha and 6,600 Ha respectively and they constitute 2.82% of the whole mangrove area in the country[1]. Mangrove areas in Colombia occupy 379,954 Ha on both the Atlantic and Pacific coast of Colombia approximately, which almost 40,000 hectares affected by human activity; thus, producing loss of woodland and decrease of fauna[1].

Mangroves are found in littoral zones, at mouths of streams and rivers to be exact, especially in saline soils with either saline or fresh water, making conditions suitable for halophytes[1]. They maintain a high productivity in coastal regions[2], allowing presence of a great biological diversity that feeds and shelters in them. Mangrove species reported for the Sucre department are *Avicennia germinans, Rhizophora mangle* (most abundant) and *Conocarpus erectus*[3].

Furthermore, mangroves serve as living barriers holding back fierce winds from storms and cyclones, helping control tidal erosion[4]. They also help to maintain water quality and nutrients. However, because of benefits brought to humans, they have been widely exploited throughout the world. They provide hydrobiological and forestry sources for the industrial and domestic construction, among others. For this reason, there are human settlements closely related to this ecosystem; as it can be found in the Colombian Caribbean region[5].

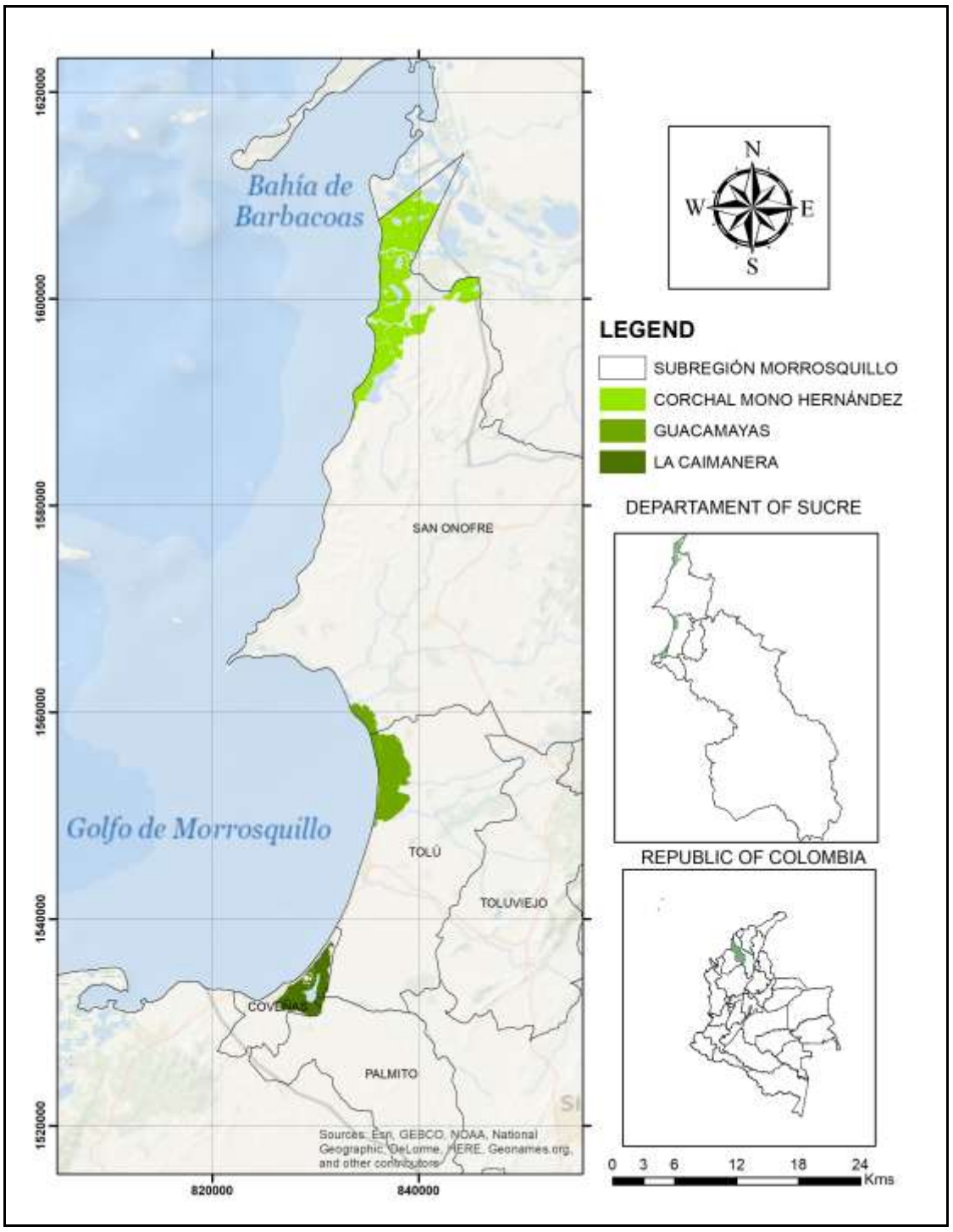


Figure 1. Mangrove areas on the Gulf of Morrosquillo coastline in Sucre, Colombia.

Consequently, it is pertinent to know how deterioration of this kind of ecosystem has progressed over time. This would help to more accurately diagnose how degradation will behave in the future. Research on this aspect has been carried out in Colombia. (6) used GIS tools to specify spatial information regarding trend and direction of changes in a mangrove ecosystem from the Atlantic department[6]. In *Ciénaga Grande* de Santa Marta (Large Marsh of Santa Marta,) department of Magdalena, an economic evaluation of mangrove and the effect of its rational use by fishermen was made[7].

A research study with similar aims in terms of economic evaluation was made for the mangroves from Gulf of Urabá in Antioquia, where relationship between fishermen and mangrove forests was analyzed based on possible environmental conflicts and ethnoecology; i.e., on how different human groups rooted in the area

perceive nature according to their beliefs[8]. (9) characterized vegetation in Cordoba through multi-temporal analysis of land cover, with emphasis on dynamics of mangrove forests from 2000 to 2009. For this purpose, they made permanent tracking and processing of plots, including interpretation of satellite images for each[9]. These authors found loss and gain of mangrove cover in the old and new delta of the Sinu River, thanks to the application of recovery measures of such forest marshes.

Now, there is no research in the Sucre Department that may show results on these aspects; nonetheless, just a diagnosis and preliminary mangrove zoning from the Colombian Caribbean coastline by (10), and the Zoning and Integral Management Plan carried out by CARSUCRE with the approval from the Ministry of Environment, Housing and Sustainable Development, are available.

This research study used satellite images to observe in detail and through remote sensing and perception, places and times in which the Gulf of Morrosquillo's mangroves have undergone a change in their cover for 30 years.

Materials and Methods

To carry out the multi-temporal study of mangrove behavior of the Sucre department, satellite images offered by Landsat were considered[11]. These cover an area of about 32400 Km² each and according to the trajectory grid over the Colombian territory, those of Path 9 Row 53 and 54 were needed. The Landsat 4-5 TM satellite images were downloaded from http://glovis.usgs.gov, corresponding to dates 1990, 2003 and 2012 for the month of February, so that they coincide with their solar radiation[12].

Prior to calculations, digital image processing was performed, in which spectral enhancement of color was carried out to ease photointerpretation[13]. The unsupervised classification method was used, since the processing software can identify spectral patterns, i.e. reflectance of each cover in an autonomous way[14].

Subsequently, the resulting image was taken to another digital format in vector form, to finally use the software ArcGIS 9.3 ®, licensed on behalf of University of Sucre, and the analysis tools, Symmetrical difference, with which the cover evolution or involution over time was calculated. Maps were then elaborated where the relevant calculations are presented.

Results and Discussion

El Corchal Mono Hernández mangrove, located in the San Onofre municipality, has had a gain in mangrove cover in the periods under analysis (Figures 2a and 2b). This gain is even greater from 2003 to 2012, equivalent to 398.9ha mainly due to coastal reforestation works carried out by the Sucre regional corporations and the Canal del Dique. Identified cover losses are of 302.45ha due to clearing for different crops, illegal logging for diverse wood uses and cattle farming, especially towards the east side of *El Corchal.*

In the Guacamaya mangrove (Figures 2c and 2d), losses from 1990 to 2003 (219.25 Ha) and from 2003 to 2012 (147.42 Ha) are much higher than gains, especially in the most remote coastal areas due to illegal logging, crop farming and, above all, livestock, including buffalo breeding.

In La Caimanera marsh (Figures 2e and 2f) there was little loss on the first period, but from 2003 this situation radically changed and losses (123.89 Ha) far exceeded gains (58.21 Ha). This is due to increase of construction sites for beach tourism, business activity and increase of cattle farms that drain the mangrove for this exploitation.

The situation of the Caribbean mangroves is common for the whole area. (15) and (16) identified several types of man-made disturbances in this ecosystem, which coincide with those detected by (10) and (17) for the department of Sucre.

These disturbances include: timber products extraction, fisheries and the impact of ecosystems with resources poor management such as in agriculture and livestock; thermal contamination by oil and other pollutants such as from heavy metals, pesticides and community waste; aquaculture activity, which alters mangrove ecosystems for shrimp or fish farming by introducing exotic species and displacing natives; poorly focused ecotourism which is highly polluting and degrading since road construction causing hydrological

interruption of water flows between mangrove and sea; deforestation due to urban construction, and of roads for access to beaches; and finally, the current problem of climate change as highly disturbing on mangrove growth and mortality in this region.

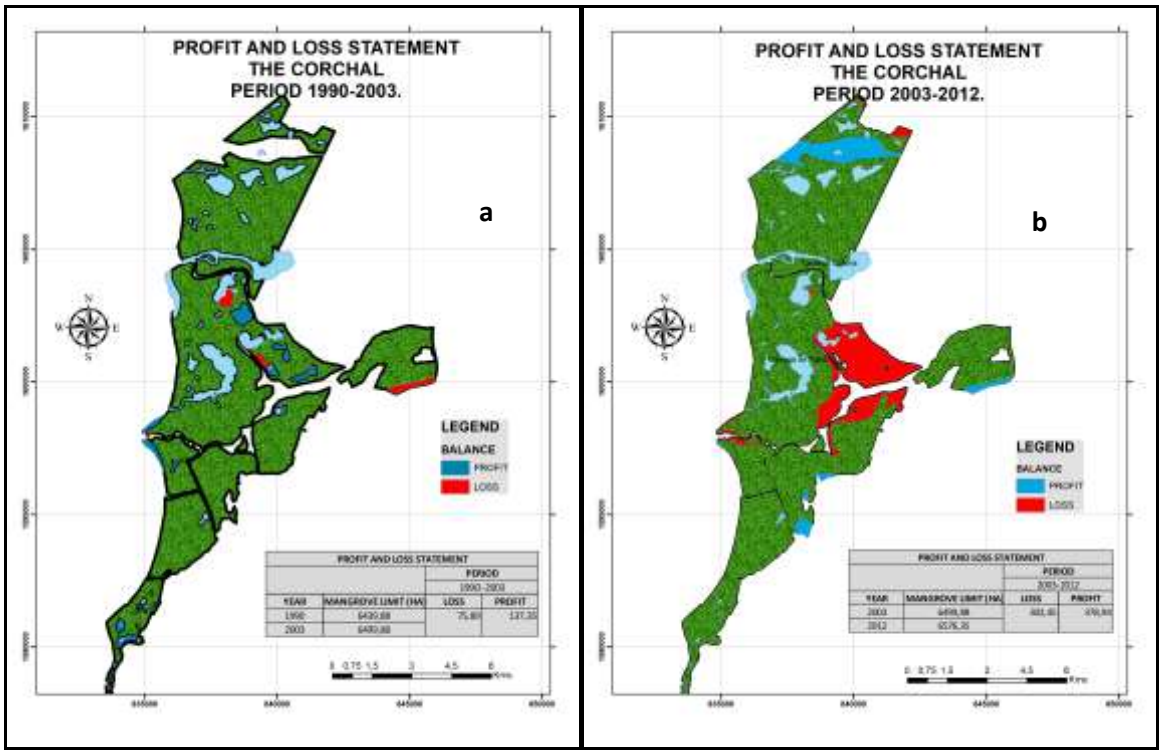
Results make it clear that in Sucre the loss of mangrove cover is increasingly higher than gain and this may endanger ecosystem's life and drastically reduce the supply of environmental services.

In the Córdoba Department, however, from 2000 to 2009, (9) established mangrove losses and gains in the old and new delta of the Sinu River and found large variations due to cover losses caused by similar reasons as mentioned above. However, in 2009 gains were higher than in 2000 due mainly to recovery of mangrove forests in several areas[9]. The same can be said of mangrove forests in the Mallorquin Marsh, in the Atlantic department, where (18) made an ecosystem multi-temporal analysis for 30 years and found that there is a remarkable regeneration of mangrove vegetation and assumed that it is mainly due to adaptive possibilities from the morphological and physiological point of view of this type of vegetation[18].

These data harshly show that man-made impacts on mangroves in Sucre exceed mangroves' adaptive possibilities and the impact is felt in the increasing loss of the ecosystem. Then, it is not only a matter of reforesting, but also of preventing or mitigating cover loss by any means possible.

It can be said that mangrove cover loss in this region, and particularly in the Sucre department, is due mainly to human irresponsible action on that ecosystem. If the causes of this constant environmental predation are examined, it will be found that they are based on the critical economic situation that Sucre has been undergoing for several years and that forces people to seek their sustenance at the expense of the natural environment[19, 20].

Therefore, political, economic, social, judicial and technical actions to stop loss of this important ecosystem in the Sucre Department would be advisable.



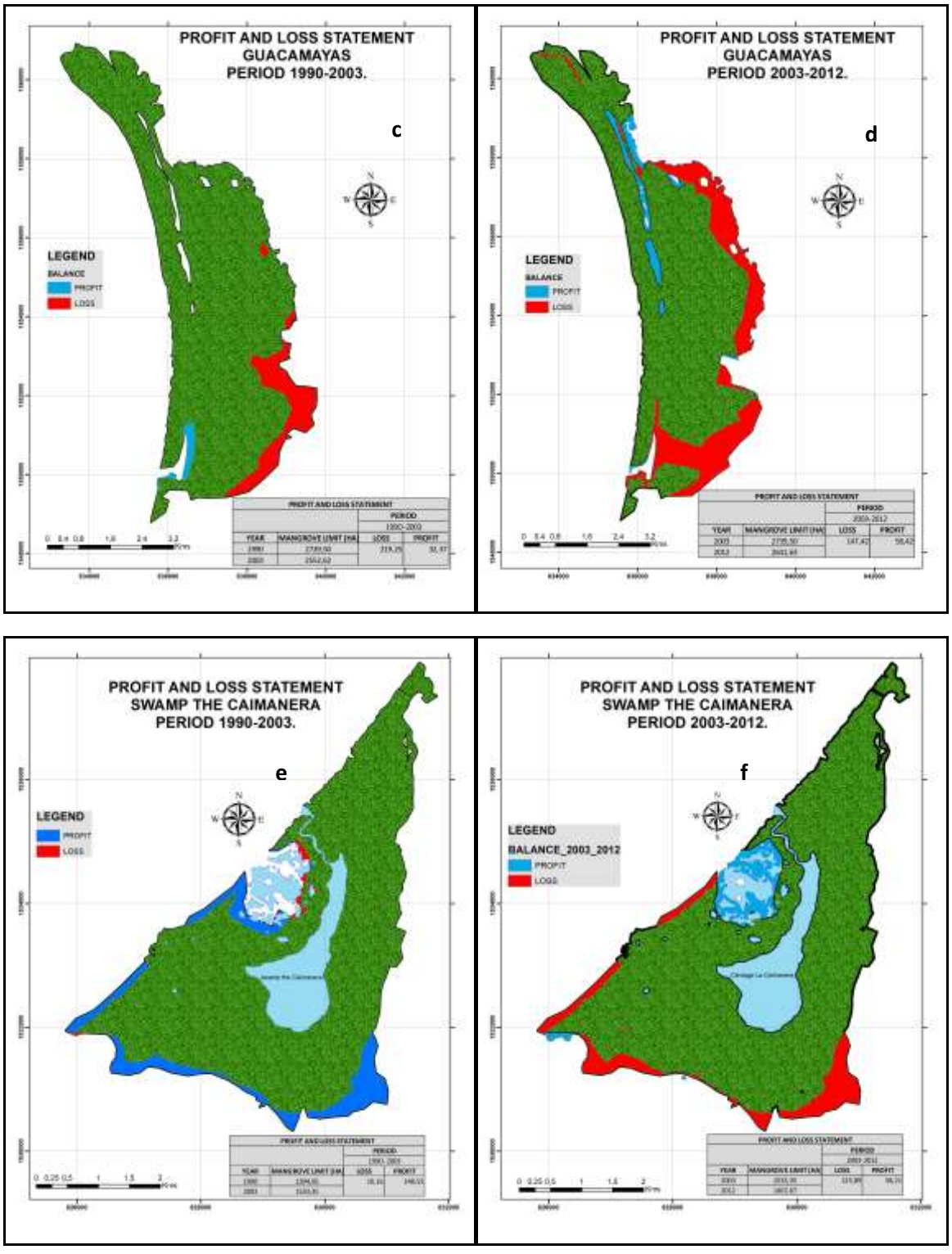


Figure 2. Losses and gains of mangrove cover in three localities of the coastal zone of the Sucre Department. a: El Corchal, 1990-2003; b: El Corchal, 2003-2012; c: Guacamayas, 1990-2003; d: Guacamayas, 2003-2012; e: La Caimanera, 1990-2003; f: La Caimanera, 2003-2012.

Conclusions

Anthropogenic conditions, such as pollution, deforestation, unplanned aquaculture, poorly focused ecotourism and generally poor ecosystem management, are responsible for yearly shortage of mangrove forest cover. These seriously threaten sustainability and environmental services continuity that it currently offers.

Immediate intervention is required, through adequate planning of ecosystem resources that assures sustainable exploitation.

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