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# PAST, PRESENT, AND EXPECTED HYDRO-MORPHOLOGIC EVOLUTION OF THE BAHIA DE SAMBOROMBON (ARGENTINA) BY REMOTE SENSING DATA

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## INTRODUCTION

Hydro-geomorphologic setting of coastal areas is the result of complex interactions between marine and continental processes. Lowland morphologies make coastlands the zones at highest hydrogeological risk because of flooding, land subsidence, and saltwater contamination (e.g., Pousa et al. 2007). As many studies have predicted a significant increase of eustacy, sea level rise (SLR) is the most relevant problem affecting coastal lowlands.

The wetland of the Samborombon Bay (Argentina) is a Ramsar natural reserve affected to periodic floods due to rainfall, runoff, tidal fluctuations, and storm surges. In this work, we show preliminary results of a project aimed at understanding the effect of expected SLR scenarios on the hydro-morphologic setting of the Samborombon Bay. In particular, the outcomes of the first step of the research, i.e., the remote sensing analysis, are illustrated.

## GENERAL SETTING

The Samborombon Bay stretches along 180 km of coastline on the outer estuary of the Rio de la Plata (Fig. 1). The bay is characterized by microtidal regime where marine water penetrates into the Rio de la Plata mouth. The coastland consists of salt marshes and wetlands whose width varies from 100 m to 15 km, in the northern and southern sectors, respectively. The coastal plain is formed by Pleistocene and Holocene sediments. Loess deposits occur in the western plain and shell ridges are located parallel to the coastline. Coastal sector shell ridges gradually thin and pass to small isolated outcrops of aeolian sandy layers to the south. Fluvial deposits are restricted to the plains crossed by of the rivers flowing into the bay.

From the hydrologic point of view, the bay forms the eastern boundary of the depressed area of the Salado River. The coastal plain is characterized by a very mild slope and extremely low morphogenetic potential that makes runoff difficult. In order to mitigate the effect of frequent prolonged flooding occurring in wet periods, a regional drainage network was constructed. Soils and groundwater are highly salinized. Freshwater reserves are scarce and occur only in lenses located inside shell ridges and thin sandy layers: their availability is strictly connected to the amount of local rainfalls, which are their only recharge.

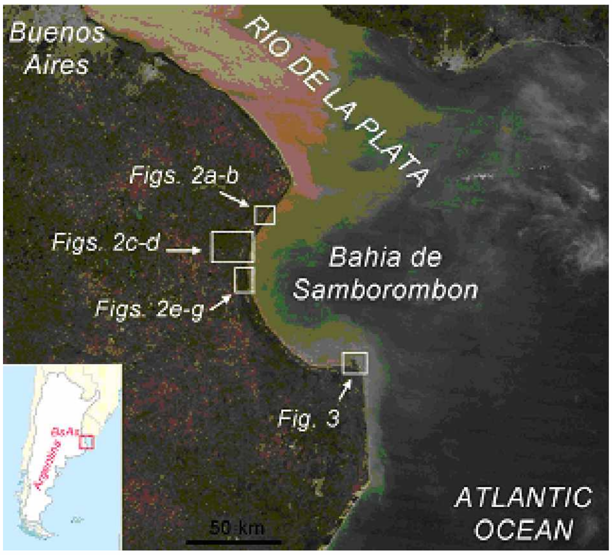


*Figure 1 – The Samborombon Bay (Image* courtesy of MODIS *Rapid Response Project at NASA/GSFC).*

## 1972-2011 MORPHOLOGIC EVOLUTION

Satellite images acquired with the same tidal levels were selected and compared to perform the morphological analysis. The available dataset considers the period between 1972 to 2011. In the northern sector, along the coastline no significant morphological modifications in the marshland occurred over the last three decades. However, since the '990 the ancient shell ridges have been seriously damaged by excavation for mining purpose (Figs.

2a-b). In the central sector, the construction of the Ancillary canal of the Salado River in 1987 (Figs. 2c-d) accelerated the water and sediment discharges into the bay leading to morphologic changes along the coastline (Figs. 2e-g). In the southern coastal plain tidal creek network maintained its shape and extension, whereas a small retreat of the coastline was detected along the southern bay margin (Ajo River mouth). Significant morphologic changes occurred in the Punta Rasa spit (Figs. 3a-b).

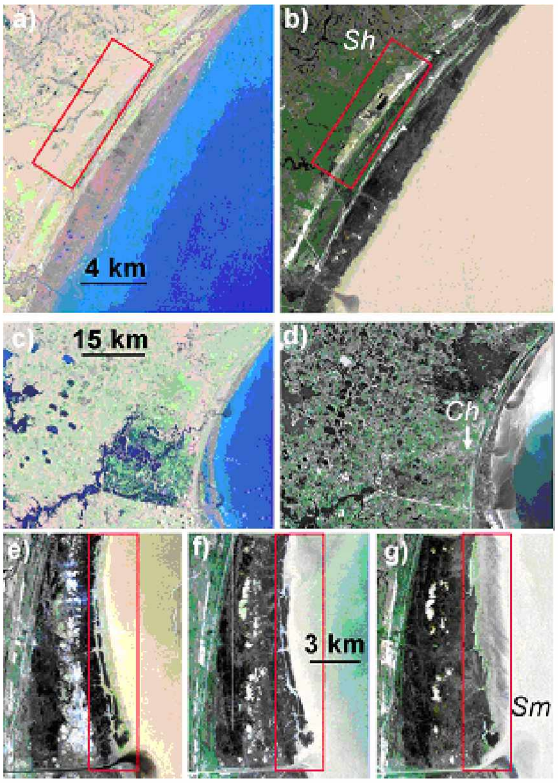


*Figure 2 – Examples of man-induced morphologic evolution detected by Landsat images a) 09.1987, b) 09.2009, c) 01.1986, d) 09.2001, e) 09.1987, f) 10.1996, g) 09.2009. Sh: Shell excavation, Ch: ancillary canal. Sm: salt marsh aggrading.*

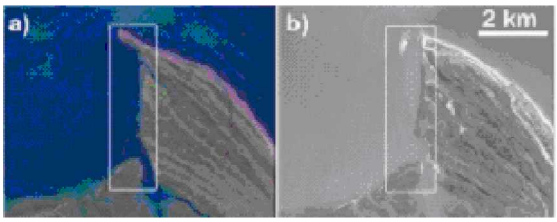


*Figure 3 – Examples of natural morphologic evolution detected by comparing a) the Landsat image, 01.1986 with b) the INPE CBEC image, 08.2009.*

## EXPECTED HYDRO-MORPHOLOGIC SETTING OF THE COASTAL PLAIN IN 2100

SLR is expected to affect the Samborombon coastland in two main ways: permanent changes of the hydro-morphologic setting and the temporary extreme flooding events due to the 'sudestadas' (a strong occasional south-eastern wind). The former is related to the long-term water level rise, yielding progressive permanent coastline retreat, lowland flooding, groundwater and soil salinizations. The latter is triggered by anomalous 3-4 m storm surges due to 3-5 day long meteo-marine events whose effects seriously impacts on built-up areas and human activities.

Taking into account SLR scenarios of 12, 50, and 300 cm resulting from the past sea level rise in Buenos Aires, the IPCC mid-term scenario, and the 5-year return period of 'sudestadas', respectively, the flooding extent during an astronomic mean high tide at the end of the 2100 has been simulated. To do this, the digital elevation model (DEM) obtained by the Shuttle Radar Topography Mission (SRTM), ad hoc calibrated/validated for the study area, has been used.

Results clearly show that the tidal flats and marshes are expected to be permanently submerged (Fig. 4). The extent of the affected areas significantly varies according to the latitude, with the worst situation expected in the southern zones, where the sea could encroach up to 30 km inland. According to this prediction, a serious reduction in the volume of freshwater reserves is expected with a significant decrease of the thickness or freshwater lenses. In the southern sector, SLR will be able to contaminate the whole fresh groundwater lens located in the sandy ridges.

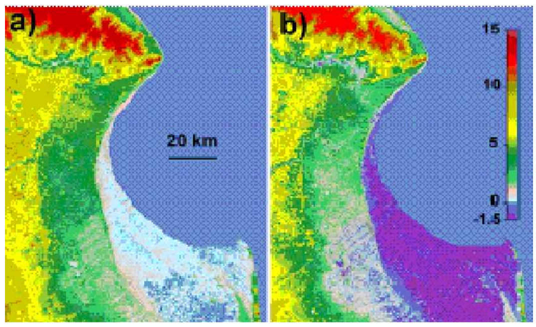


*Figure 4 – a) DEM of the present setting; b) simulation of 50 cm SLR with 1m high tide at the end of 2100.*

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