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Morphology and Dynamics of the Base of the Western Jetty, Probable Area for the Rio Grande Port Pilot Station, RS State, Brazil.

C. Hartmann†, T. B. Arejano‡ and J. A. F. Antigueira*

†Institute of Oceanography, University Federal of Rio Grande - FURG, Rio Grande 96201-900, Brazil, dgecaco@furg.br.

‡ Engenharia Oceanica, University Federal of Rio Grande - FURG, Rio Grande 96201-900, Brazil, arejanot@log.furg.br

Institute of Geosciences, Centro de Estudos Costeiros e Oceânicos, University Federal of Rio Grande do Sul - UFRGS 91509-900, Brazil jose_antiqueira@hotmail.com

ABSTRACT

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The Rio Grande Port has suffered accelerated growth over the past few years, a fact which has provoked the arrival of new enterprises, determining a restructuring (change) in the zoning plan of the organized port. The pilot station of the Barra is presently located at the intermediate portion of the Rio Grande Super Port, Western margin of the access canal, and in order to improve assistance and navigation safety, it will be transferred to an area closer to the lagoon mouth; such area will be determined by the new zoning plan. At this area, provided by the Port, a marina with the entire basic infrastructure for the exercise of piloting will be constructed. This work deals with the acquisition of information concerning the base of the Western Jetty, area located at the Western margin of the port's canal, solicited by the enterprise for the installation of the new piloting station. Seasonal surveys of local environmental conditions and plane-altimetry, utilizing DGPS, were performed, as well as: classification of the bottom type utilizing the sieving method, based on the Wentworth scale; mapping of biota and analysis of dynamics, with observation of waves and wind data; obtainment of 35 mm digital aerial photographs with the ADAR 1000 system at visible and infrared modes, total station Nikon® – DTM 330, and in situ photographs. Results demonstrated that the installation of the terminal will bring improvements to the area, with no environmental inconvenience, and in case implanted, will be extremely useful for portuary activity and port administration.

ADITIONAL INDEX WORDS: *morphology, sedimentology, dynamics, Rio Grande Port.*

INTRODUCTION

For the past few years, many enterprises have focused their attention on the Rio Grande Port, and they demand a better management of the area. One of these enterprises involves the construction of a paper pier, at the area where the pilot station is located today. Wilson & Sons Company, which administrates the Container Terminal, will invest US$60 million for implantation of a private boatyard at the Super Port. Installation of the Shipbuilding Pole, with the construction of the Dry Dock, the largest in Latin America, will greatly increase ship transit at the port. Another enterprise is the Aracruz Cellulose Terminal, which will be implanted at the Eastern margin of the North Canal, near the city of São José do Norte, being pioneer in the utilization of this margin. Many other activities are also foreseen to be implanted at the area destined to be the port.

The piloting station is today located at the Super Port, intermediate portion of the Western margin of the Rio Grande Canal. In order to provide better assistance to navigation, it will be transferred to an area closer to the ocean, near a villa called 4ª Secção da Barra, where the new installations will be constructed. At this area, conceded by the Port, there will be a marina, warehouses, a pier, a tower and a heliport.

The focus region is a 2.3 ha-area, limited to the North by the 4ª Secção da Barra Villa, to the West by a paved road, to the South by a shallow, 5 m-wide washout utilized as an anchoring spot for fishing boats, and to the East by the Rio Grande Canal. The washout drains a saltwater swamp, located to the South, and wetlands (beach ridges), located before the road. Predominant vegetation at the area is saltwater swamp vegetation, typical of beach ridges and dunes.

At the focus area, erosive processes occur due to: ebbing flow of the canal, rise in canal level during flooding periods and North quadrant winds, and to waves caused by South and Southeast winds.

Considering this fact, the canal is suffering a lateral advance in the Western direction at many areas, such as the Navy radio station, where the adopted protection system (breakwater), constructed along with the jetties at the beginning of the last century, is being destroyed.

Tide at the region is classified as micro-tide (mean 0.5 m/year), and water level increase in the canal is due mainly to meteorological tides, which are the highest influence when winds blow from the Southern quadrant. On these occasions, saltwater enters the area, utilizing the washout that drains freshwater from wetlands beyond the road. Wave occurrences at the beach are functions of winds emanating from East & South quadrants.

This work deals with obtaining information on the area destined for the installation of the headquarters of the Barra do Rio Grande pilot station, at the Western margin of the Rio Grande Canal.

Location of study area

The study area is limited to the South by the Atlantic Ocean and to the East by the Rio Grande Canal. Location of the study area is shown in Figure 1.

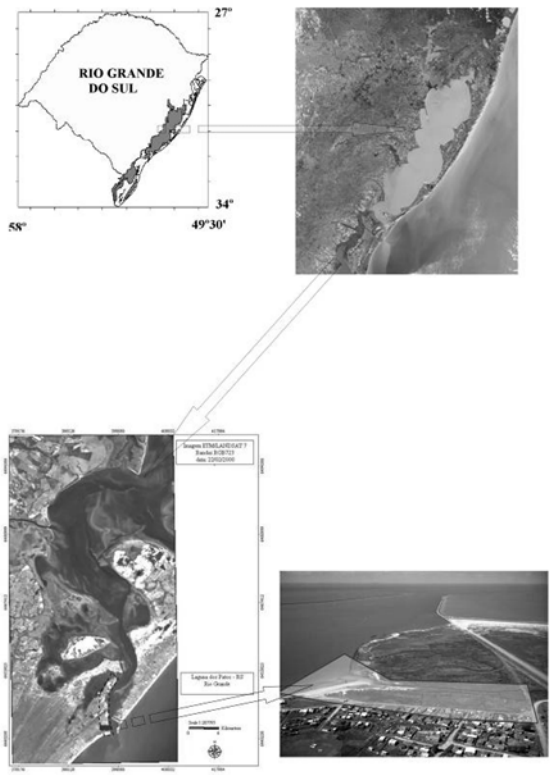

Figure 1. Location of study area.

MATERIAL AND METHODS

For characterization of the water dynamics of the focus area, 35 mm digital aerial images, captured with the ADAR 1000 system in 2000, were utilized (Fontoura & Hartmann, 2000). Images were obtained at the infrared (IR) and visible (VB) modes, and georreferenced utilizing data obtained *in loco* with a GPS.

During periods of low and high water level and periodical visits, topographical (total station Nikon® – DTM 330) and sedimentological (#41) surveys were performed by collecting samples from profiles perpendicular to the beach face, up to the depth of 1.5 m.

Meteorological data were registered and provided by the meteorological station of the Rio Grande Pilot Station, installed at the current headquarters, located upstream at the canal margin.

Sediment samples were analyzed in a laboratory utilizing classic methods of sieving and weighing. Geodesic points for altimetric survey originated at the navigational station, Estação Naval do Rio Grande (ENRG – Rio Grande Navy Station), located at 1.22 km.

Piloting headquarters preliminary project

The project aims towards providing better assistance to ships entering the Rio Grande Port, through modern installations, construction of a marina, maintenance and support workshops, observation tower and heliport, and also provide a touristic attraction.

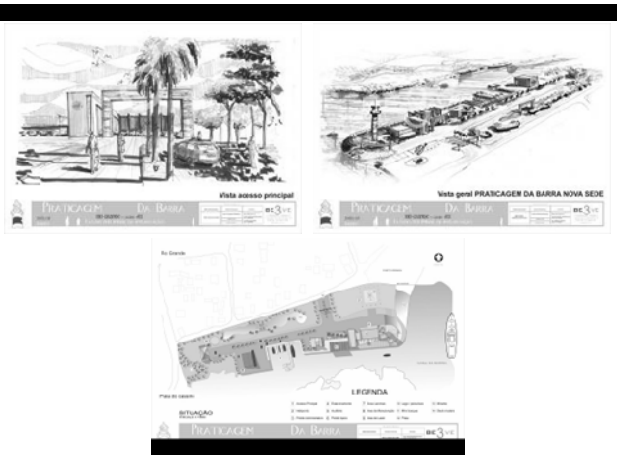

Figure 2. Preliminary project of the Rio Grande pilot station, RS, Brazil.

RESULTS AND DISCUSSION

Relief is represented by a plain formed by a wind aspersion mantle, with the highest elevation corresponding to low-expression, 2 m-high frontal dunes. The soil is made of beach sand composed of quartz, with small to medium-sized grains. It is a soil with high permeability and low plasticity and superficial drainage, presenting little support capacity for the installation of structures.

A 2D model and a Digital Terrain Model (DTM-3D) were generated from the data, both superposed onto a georreferenced aerial image (Hartmann, et al., 2005). Curves demonstrated that the difference between the base station and the canal water level is 1.0 m. At the location of the enterprise, the terrain is flat and highest altitudes correspond to the beach frontal dunes.

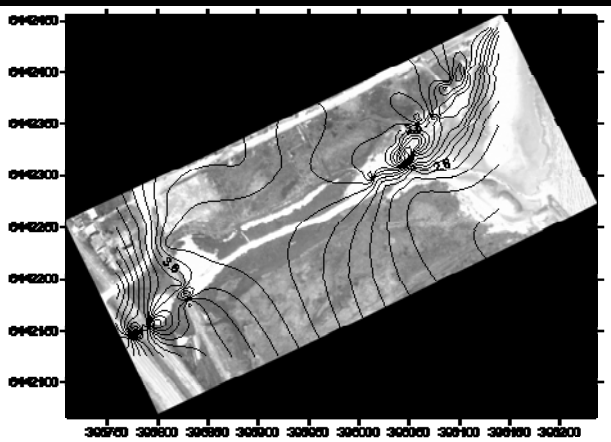

Figure 3. DTM of the area superposed onto an aerial image from 2004

For installation of the marina, it will be necessary to construct a North-South directed breakwater, forming a beach and maintaining the washout's open mouth. The latter would have to be deepened (2 m), and the South margin (salt marsh) protected by gabions. In 2006, construction of the jetty was initiated, with the placement of boulders at the end of the wooden trunk palisades, with a slight arch towards the interior, ending at the coastline limit at the canal margin (Fig. 4ABCD).

Figure 4ABCD. Initiation of jetty construction. Photos from 2006: (A) palisade made of eucalyptus trunks and (B) beach formation; Photos from 2007: (C) end of the jetty and (D) entry of the canal into the salt marsh. Water entry into the washout can be observed. SSW winds.

Comparison of results from the plane-altimetric surveys performed at the study area before (September 2005) and after (February 2007) initiation of construction of the enterprise, showed the occurrence of positive environmental impacts, not only in terms of protection of the coastal dune system but also in maintenance of the flow of the salt marsh washout (Fig. 4D).

Partial recovery of the preexistent breakwater (Fig. 4A) contributed to the retention of sediment transported by wind and navigation canal waters, depositing these sediments in front of these obstacle with consequent fattening of the lagoon beach, provoking increase in beach width as well as height of the adjacent frontal dune.

The mosaic in Figure 5 shows the area before jetty construction; at the upper left corner of the photograph is the eucalyptus trunk palisade, and at the upper right, the partially-destroyed jetty constructed at the beginning of the past century.

The plane-altimetric survey of the area, performed with a two-year interval in 2005 and 2008, shows beach formation with normalization of the canal mouth (Fig. 6 AB).

Figure 5. General view of the area before jetty construction.

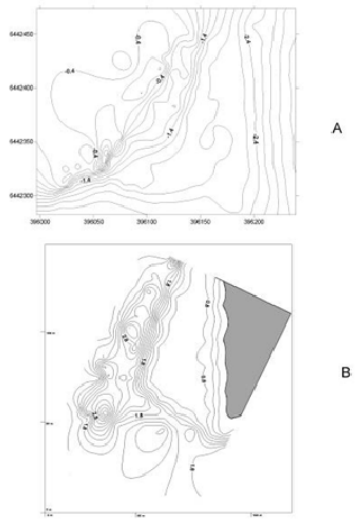

Figure 6. Plane-altimetric survey of the focus area, showing; A) situation without the jetty, in September 2005, and B) situation in February 2008.

Also, retention of sediments at the breakwater substantially reduced the aggradation of the wetland washout, guaranteeing the exchange of its waters with the navigation canal.

Results demonstrated that the enterprise would contribute to maintenance of the washout and increase of saltwater entry into the salt marshes. Low dissolved organic material and lack of particulate matter was noted in the wetlands.

Protection of this margin is essential for maintenance of the port, which fortunately presents minimized erosion due to fixation of low and high-capacity terminals. Due to these constructions, the area upstream from the location of the enterprise was not eroded; in any case, the placement and maintenance of protection structures is necessary.

When allied, both direct consequences of the construction were favorable for maintenance of the ecological functions of the environments, opposed to the previously reported erosion of the margin of the salt marshes and dunes, contrasting with arguments utilized for interdiction of the enterprise.

According to Ferreira (2008), physical interventions in the scenery structure proposed by the enterprise would be limited to borders of the vegetation units of dunes and salt marshes: the recovering breakwater (Fig. 6) is located at the limit of the navigation canal with the lagoon beach; the frontal dune located at its face (amplified by the construction) is a result of the previous accumulation of sediments from the prior obstacle.

Similarly, construction of a monitoring tower should be performed on the vegetation of coastal fields (Fig. 7), at the most

elevated portion of the terrain, not reaching the floodable area of the saltwater swamps.

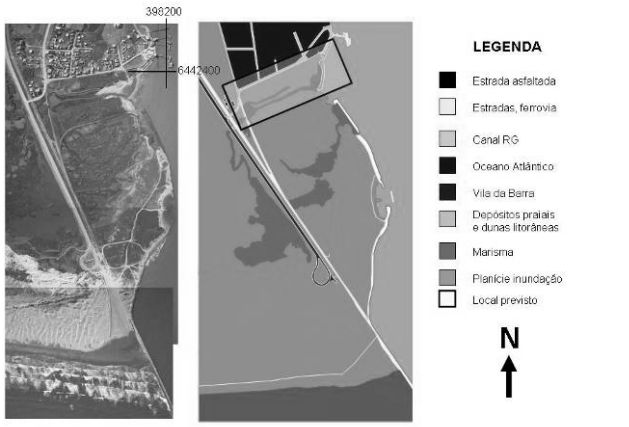

Figure 7. Classification of environments of the base of the Western Jetty of the Rio Grande Super Port, Patos Lagoon, Rio Grande, RS (Source: Lontra, 2004).

CONCLUSIONS

The Rio Grande Port is responsible for transporting the majority of exported and imported cargo and products in Southern Brazil. Many are private terminals, conceded by the state, for operation of containers, grains and fertilizers, with highlight to the Shipbuilding Pole, which is an investment for the construction and repair of oil ships and platforms.

In this sense, the new installations of the pilot station would improve quality of assistance to ships entering the Port, which will almost certainly increase in the future. Comparative analysis of results of the plane-altimetry surveys shows an incidence of positive environmental impacts, not only in terms of protection of the coastal dunes system but also in maintenance of the salt marsh washout flow.

Granulometric analysis indicated a the presence of fine to medium sand, typical of beach and dune sand, important for the beach which will be created next to the canal for recreational use.

Physical intervention in the scenery structure proposed by the enterprise would be limited to the borders of the vegetation units of dunes and salt marshes: the recovering breakwater is located at the limit of the navigation canal with the lagoon beach; the frontal dune located at its face (amplified by the construction) is a result of the previous accumulation of sediments from the prior obstacle.

Despite the ecological importance of the study area, its environmental responsibility, its socio-economical and cultural potential, and the strategic significance for portuary activities for the city and the estuarine area of the Patos Lagoon, as well as the lack of negative environmental impacts and the verification of positive environmental impacts, the new installations of the piloting station will be extremely important for the Rio Grande Port.

Synthesis of the physical environment (Lontra 2004) was summarized in four basic capacities: adequate or inadequate for use, swamps, and villa. Areas adequate for use by different enterprises are represented by the wind aspersion mantles and high fields, which permit good cargo capacity (Lontra 2004).

To the RS state it is suggested that an agreement be made with the enterprise for performance of studies and budget endowment for creating a conservation unit – multiple use conservation unit (environmental protection area, eco-museum…) at the area, as well as the elaboration of a management plan for the created conservation unit (Ferreira 2008).

Results showed that the installation of the terminal would bring improvements to the area, with no environmental inconvenience, and in case implanted, will be extremely useful for portuary activity and port management.

Finally, the new headquarters of the Rio Grande Port pilot station, when implemented, will bring not only service quality, but also a new touristic area, as well as support for small ships, such as sailboats and other boats.

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