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Erosion in Buenos Aires province: Coastal-management policy revisited

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ABSTRACT

As the Buenos Aires Province coastline is dominated by a longshore transport from south to north, obstructions performed at the beginning of the 20th century originated the width reduction of some beaches. Fields of groins were constructed without a master plan; therefore, more obstructions caused a dramatic decrease in the longshore sand supply. These defense alternatives were only applied in the counties of the southeast of the province (General Pueyrredon, General Alvarado, Mar Chiquita), close to the quarries, and with resistant abrasion platforms. Northern beaches (Villa Gesell, Pinamar and Partido de la Costa), on the other hand, are natural with a dissipative morphodynamics. Where the coastal route is close to active cliffs, riprap structures were constructed parallel to the coastline. Today, the southeastern coast remains with the higher erosion rates of the Buenos Aires coastline. With the aim of aerial and satellite photographs, and images, erosion rates were calculated. In order to analyze the success of coastal defenses, comparisons were established according to two intervals: 1960–1980, and 1980–2008. Defense structures have contributed to the decrease in the erosion rates in some areas; in other areas, the rates have increased due to the drift obstruction. In some critic areas, and considering present erosion rates, future positions of the coastline were simulated for the next 20–30 years. At the same time, there are new unexpected problems derived from a project to construct detached breakwaters that were not completed, and considering jetties that were constructed without a previous impact-assessment analysis.

1. Introduction

Coastal erosion has been a significant problem for humankind for long time. During the 13th. century the Frisians (The Netherlands) succeeded to get some protection (Bruun, 1972). Different coastal-defense policies were applied in England, Denmark and USA in response to a different coastal configuration, rock resistance, and magnitude and frequency of dominant processes. Although coastal erosion is still not envisaged as a serious risk in Latin America (Silva et al., 2014), in Argentina coastal defense policies were applied since the beginning of the 20th century. Between 1911 and 1922 the obstruction of the littoral drift caused by the construction of Mar del Plata Port (Fig. 1) initiated erosive processes that continue to our days (Waterman, 1994; Isla, 2015; Pontrellli Albisetti et al., 2015). The other harbor from this sandy coast, the Quequén Port (Fig. 1), was constructed between 1908 and 1922 at the inlet of the Quequén Grande River outlet (Isla et al., 2009; Merlotto et al., 2014); its impact was not so huge regarding to the lower longshore drift.

During the 20th century the blocking of the littoral drift by the construction of groin fields was the only method plausible to stop beach erosion or at least to diminish the cliff retreat (Lagrange, 1993). In areas with submerged caliche platforms, groins succeeded diminishing erosion or creating artificial beaches. These obstructions induced significant changes in the dynamics: the new artificial beaches were completely different than naturals in their composition and morphology (Isla et al., 2001).

Despite beach nourishment was considered a revolutionary defense alternative during the 70s (Williams et al., 2016), it was not applied in Argentina until the end of the century, although it has been proposed in 1984 (Isla and Schnack, 1986). The critic erosion of Playa Grande beach, attached to the northern jetty of Mar del Plata Port, could only be improved by sand nourishment (Isla and Schnack, 1986; Waterman, 1994; Isla, 2006). The dredging was

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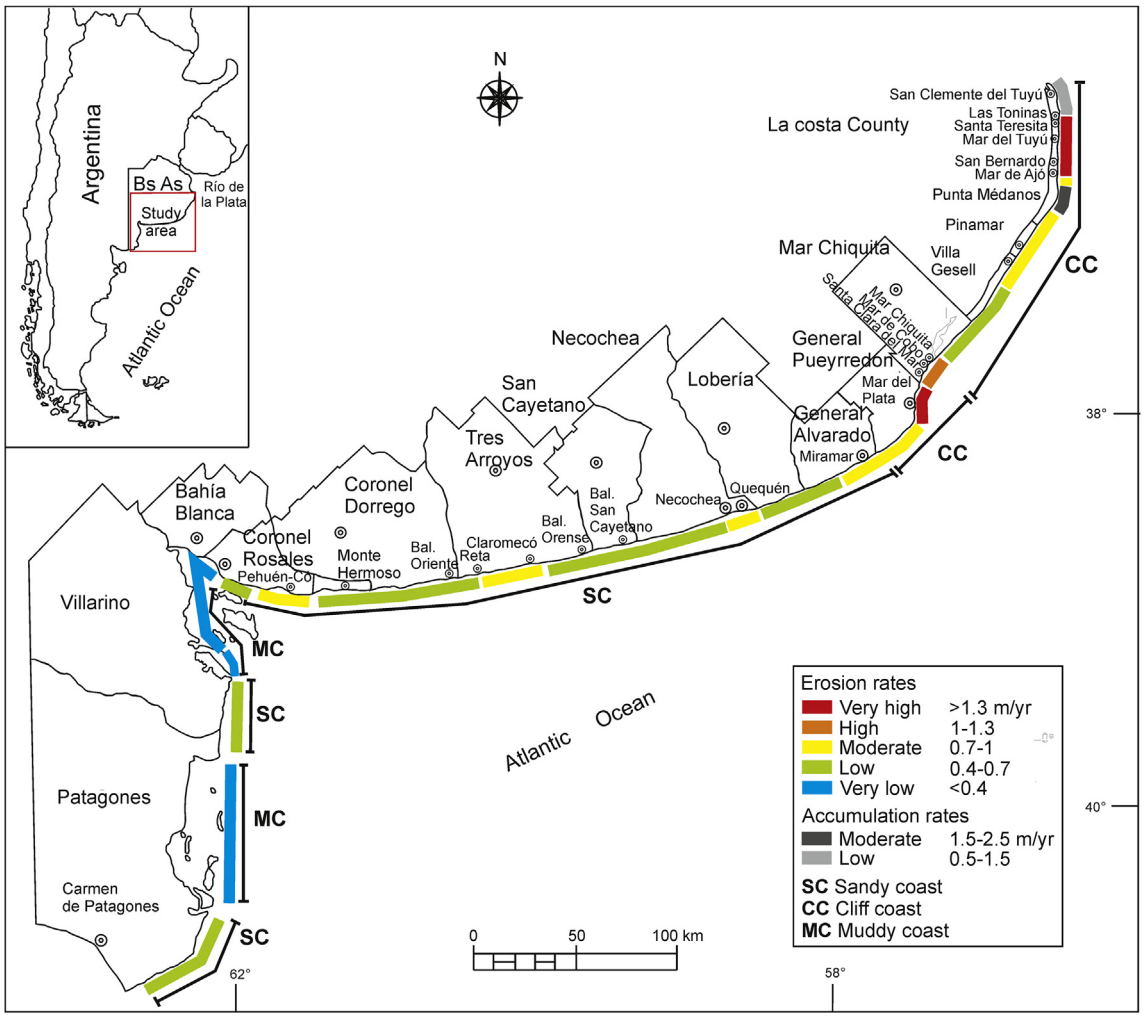

Fig. 1. Coastal erosion rates in Buenos Aires.

finally carried out in 1998 (Bértola, 2001). Three beaches were nourished simultaneously: Bristol beach (1.67 Millions of cubic meters), Playa Grande (0.66 millions of cubic meters) and Varese Beach (0.15 millions of cubic meters; Marcomini and López, 2004).

Assuming that armored structures are the best defense against wave attack, ripraps parallel to the coast were proposed (Waterman, 1994). Although these structures reduced cliff retreat they also reduced the amount of sand supplied to the beach drift (Bunicontro et al., 2015). To avoid drift obstructions, detached breakwaters were proposed in 2007 at Los Acantilados beach (south of General Pueyrredon). Sixteen breakwaters (8 in a first stage) were planned distant 250 m from the coast. Gaps between the extremes of the detached breakwaters were of 70 m (Gyssels et al., 2007). Simulations considered either emerged (2.1 m over mean sea level), and partially submerged (tops at sea level). After some resistance of a non-governmental organization, eight breakwaters were allowed to be constructed. However, the construction method via geotextile bags changed with the compromise that they would be removed. In 2012 the financial support ended: only three breakwaters were constructed but the stone-built connection to the third breakwater was not disassembled. The drift was obstructed.

In the present contribution, the policy based on hard structures (groins, revetments and detached breakwaters) was reanalyzed regarding to the cost-benefit relationships. In this sense, the erosion rates previous and after the interventions were compared.

2. Study area

Buenos Aires coastline has a micro tidal regime that increases to a 3 m range towards the west (Bahia Blanca embayment; Fig. 1). Wave height at the breakers is less than 1.3 m (Lanfredi et al., 1992) with the exception at certain capes of Mar del Plata city where they can exceed 2 m. These wave heights can increase significantly during extratropical storms arriving from the southeast, locally called "*sudestada*". These episodic processes are connected to cold fronts, and can occur during every season, although winter storms are more common, lasting 26–28 h average (Fiore et al., 2009). Wave approach to Quequén Harbor is dominantly from the SSE. Mar del Plata, on the other hand, has a bimodal wave approach dominated by waves coming from the SE, and from the ENE (Isla, 2015).

Buenos Aires has a temperate subhumid climate. Two different coastal plains extend towards the Atlantic Ocean: the Salado Plain towards the east, and the Interserrana ("Between ranges") Plain towards the S. Two sand barriers extend along these plains: the Eastern and Southern barriers. The Tandilia Range separates both plains. The estuarine complex of the Paraná delta and Rio de la Plata is the northern limit of the Salado Plain. Several other small rivers drain the plain towards the Samborombón Bay. The estuarine

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