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Erosion in Buenos Aires province: Coastal-management policy revisited

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A B S T R A C T

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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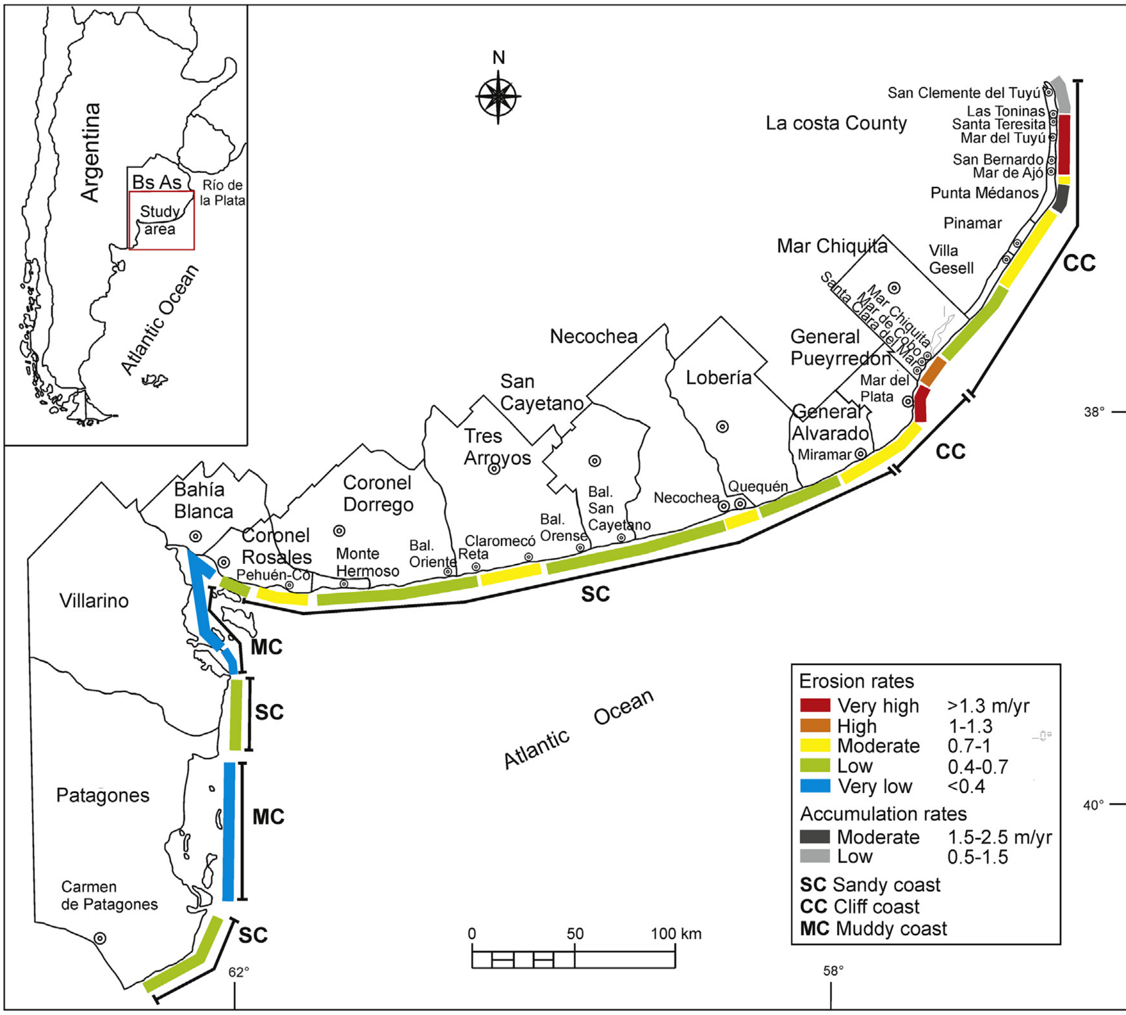

Fig. 1. Coastal erosion rates in Buenos Aires.

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 complex of the Bahia Blanca embayment and the Colorado Delta is the southern limit of the Interserrana Plain (Fig. 1). ENSO-triggered floods strike on both plains but their effects were stronger on the gently-sloping Salado Plain, and at the headlands of the Rio de la Plata (Paraná River Delta).

Three barriers have been discriminated (Isla, 2017). The Eastern Barrier extends from the southern extreme of the Rio de la Plata towards the outlet of the Mar Chiquita coastal lagoon (Isla, 2006). The southern Barrier extends between Mar del Plata and the Bahia Blanca estuarine complex. The Patagones Barrier spans between San Blas Bay and the inlet of the Rio Negro River, southern limit of the province (Isla, 2017). Some km south of the Mar Chiquita inlet, cliffs grew in height to a maximum of 20 m at Mar del Plata, and diminishing gently towards the west.

Beach and nearshore slopes have been reported in previous contributions (Isla et al., 1994, 1997, 2009; Bertola et al., 2009, 2013). Fine sand is the dominant sediment composition although they can be coarser where shells become dominant. Coarse-grained and sandy beaches dominate south of Mar del Plata (Isla et al., 1997). From Mar del Plata towards the north, the littoral drift increases significantly due to the orientation of high-energy waves and the dominant storm-induced currents from the south (Isla, 2015). Estimations of the potential beach drift based on empirical functions derived from wave statistics stated a minimum amount of 100,000 m^3/yr, increasing towards Partido de la Costa (Caviglia et al., 1992). Based on morphological changes, and considering particular time intervals-, 60.000 m^3/yr were estimated for the Mar del Plata harbor and 220.000 m^3/yr for Mar Chiquita inlet (Isla, 2015). However, it was assumed that due to the increase in the spatial frequency of rip currents the real drift has become significantly lower than the potential.

3. Methods

Coastal erosion rates between 1957 and 2009 were estimated based on different remote sensing techniques. Beach balances had already been reported in previous contributions based on periodic topographic surveys (Isla et al., 1994, 1997, 2001, 2009; Bertola et al., 2009, 2013). The sources of data used to determine coastline changes were estimated from vertical aerial photographs from different years: 1957, 1967, 1970, 1975, 1984, 1985, and 1989. Photographs from the Korona KH4 satellite (1965) were also handled. After 2009 the sources correspond to Quickbird satellite images from the Google Earth© (2.5 m spatial resolution). The aerial photographs were digitized with a high-resolution scanner (1200 dpi) and referenced with a minimum of 15 control points in the metric Gauss-Krüger projection system. As the crosses of streets were considered the better control points, in some localities the measurements were oriented to small villages that had been urbanized in 1957. Based on these estimations of coastline retreat, the forecasted coastline positions were simulated for the last 20 or 30 years, applying the OIKOS – Leonardo da Vinci simulation procedure (www.e-oikos.net/gmap/oikos.htm). This program runs simulating the advance or retreat of present coast considering measured or estimate averaged rates. However, cliff retreat is not easy to predict in the sense that other variables can be interacting (Dornbusch et al., 2008; Brooks et al., 2012; Young et al., 2014).

Coastal erosion risks were analyzed considering the hazard and the vulnerability components of risk (R = H x V). The methods were in accordance with modern procedures (Del Río and Gracia, 2009; Merlotto et al., 2016). The hazard index is compound by nine indicators, each rescaled between 1 and 5: storm effects, maximum tidal ranges, mean wave-breaker height, type of wave breaker, beach mean grain size, beach width, foreshore slope, coastal geomorphology, and coastal erosion or advance rates. The vulnerability index (also rescaled between 1 and 5) was calculated considering demography, living conditions, and jobs and consumption indicators. They include population census data such as demography, education, health, sanitary, economic, production, and work and population exposure aspects (Merlotto et al., 2016).

4. Results

1. Long-term erosion rates and vulnerability

The coast of Buenos Aires is dominated by low to moderate erosion trends (Fig. 1). Very low rates were recorded in areas related to the Colorado River delta. High retreats are located at General Pueyrredon (Northern Mar del Plata) and Partido de la Costa. Erosion rates over 1.3 m/yr were estimated at the southern coast of Mar Chiquita (Fig. 1). Coastal accumulation was only recorded at the north of Partido de la Costa (Northern San Antonio Cape).

The hazard index is very high in areas subject to drift obstruction such as Necochea and Mar Chiquita departments (Fig. 2). These coasts are characterized by low-altitude cliffs (Quequén, Santa Clara, Mar de Cobo) or receding foredunes (Mar Chiquita), and subject to frequent storms from the SE. The Partido de la Costa, Villa Gesell, General Pueyrredon, and General Alvarado counties presented a high hazard due to high values in the erosion rates, storm effects, and beach width indicators. Moderate hazard indexes correspond to non-urbanized areas.

The vulnerability is very low to moderate along the Buenos Aires coastline. Due to social conditions, in Partido de la Costa, Santa Clara del Mar, and sectors of Mar del Plata and Miramar moderate vulnerability categories were estimated (Fig. 2). These results show that the coastal areas of the province record the highest demographic and socio-economic values of the population indicators.

Regarding risks analysis, the higher values correspond to the touristic coast of Buenos Aires province. There are localized areas of high risk concentrated at the southeast region, subject to the impact of recurrent storms (Fig. 2).

2. Variations in the erosion rates

At the northern oceanic coast of Buenos Aires accumulation diminished from north to south. Comparing the intervals 1957–1985 and 1985–2009, it is clear that in the last years the deposition increased along Partido de la Costa (Fig. 3). At this north-south oriented coast the erosion rate is approximately 1 m/yr, and remained stable in both intervals. At Punta Médanos, there is also an area of accumulation of about 1 m/y that increased slightly in the last years.

In Pinamar the erosion rates (1957–1985 and 1985–2009) remained stable between both periods about 1 m/yr. To the south of this locality the erosion rates diminished.

In Villa Gesell, there are significant variations along the coast. The analyzed periods were 1957–1985 and 1985–2009. At the northern urbanized areas the retreating rate of the foredunes is about 2 m/yr increasing in the recent interval. At the south, beaches are less unbalanced with a retreating rate of less than 0.5 m/yr (Fig. 3).

In Mar Chiquita there is a transition of a sandy barrier at the north to small cliffs to the south (Fig. 4). The northern portion has a retreating rate of foredunes of about 1 m/yr (1957–1987) increasing in the interval 1987–2009. The southern section is dominated by dunes on top of low-altitude cliffs. The erosion rates diminish significantly from north to south (4–1 m/yr) as the cliffs are more resistant (Isla and Cortizo, 2014; Fig. 4). Cliff retreats between 0.22 and 0.79 m/yr were reported assigned to southeastern storms (Medina et al., 2016).

In General Pueyrredon (Mar del Plata city) is where erosion has

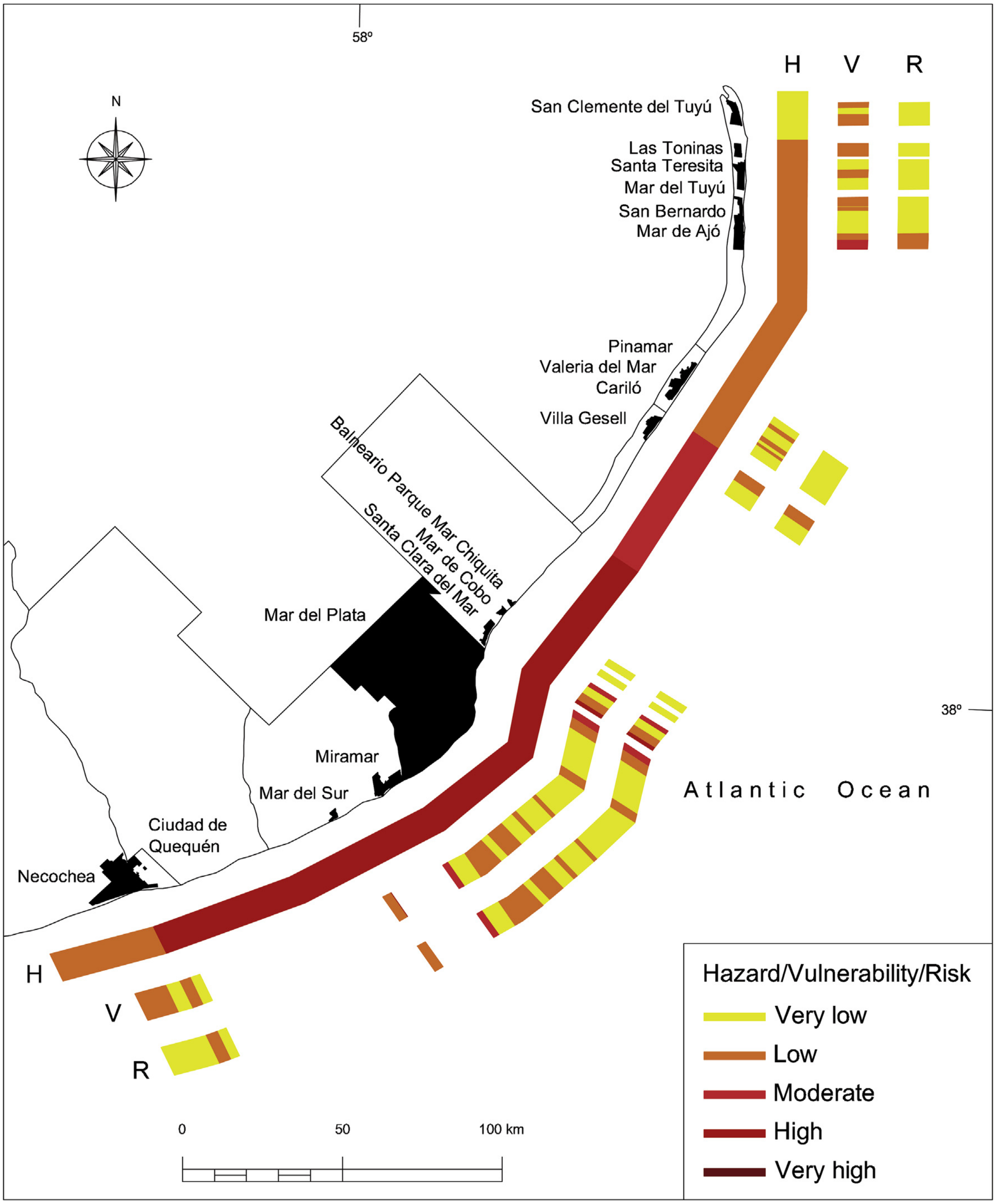

Fig. 2. Threats, vulnerability and risks along the touristic coast of Buenos Aires.

been more intense. Three beaches were artificially nourished (Bértola, 2001), and several groin fields (Isla et al., 2001) and rubble-mound structures were constructed (Bunicontro et al., 2015). At the northern interval the retreating rate was about 1 m/yr decreasing in the last years. South of Mar del Plata, the coast is oriented normal to the frequent storms striking from the SE (Fig. 4). Close to the city erosion rates of 4-3 m/yr estimated during the interval 1970–1987, diminished significantly during the interval 1987–2009 (Isla and Cortizo, 2014). However, to the south of the county low retreating rates (0.5 m/yr) have been increasing in the last years (Fig. 4).

In General Alvarado, a coast with limited groin fields, the erosion rates were moderate (0.5 m/yr) during the 1965–1984 interval, but also increasing in the last years (1984–2009). The erosion processes of the embayment of Miramar city increased due to the forestation of a dune field that had been supplying sand from the south (Isla, 2003).

In Arenas Verdes (Lobería), erosion was less than 0.5 m/yr in the past but increasing in the last years (Fig. 5).

In Costa Bonita (Necochea), without some groins constructed during the XX century, the erosive rate is approximately the same: 0.5 m/yr (1965–1984), although increasing in the last years (Fig. 5). The erosion rates are higher to the east due the effects of the Quequén-Necochea Port obstruction and a modern prolongation of

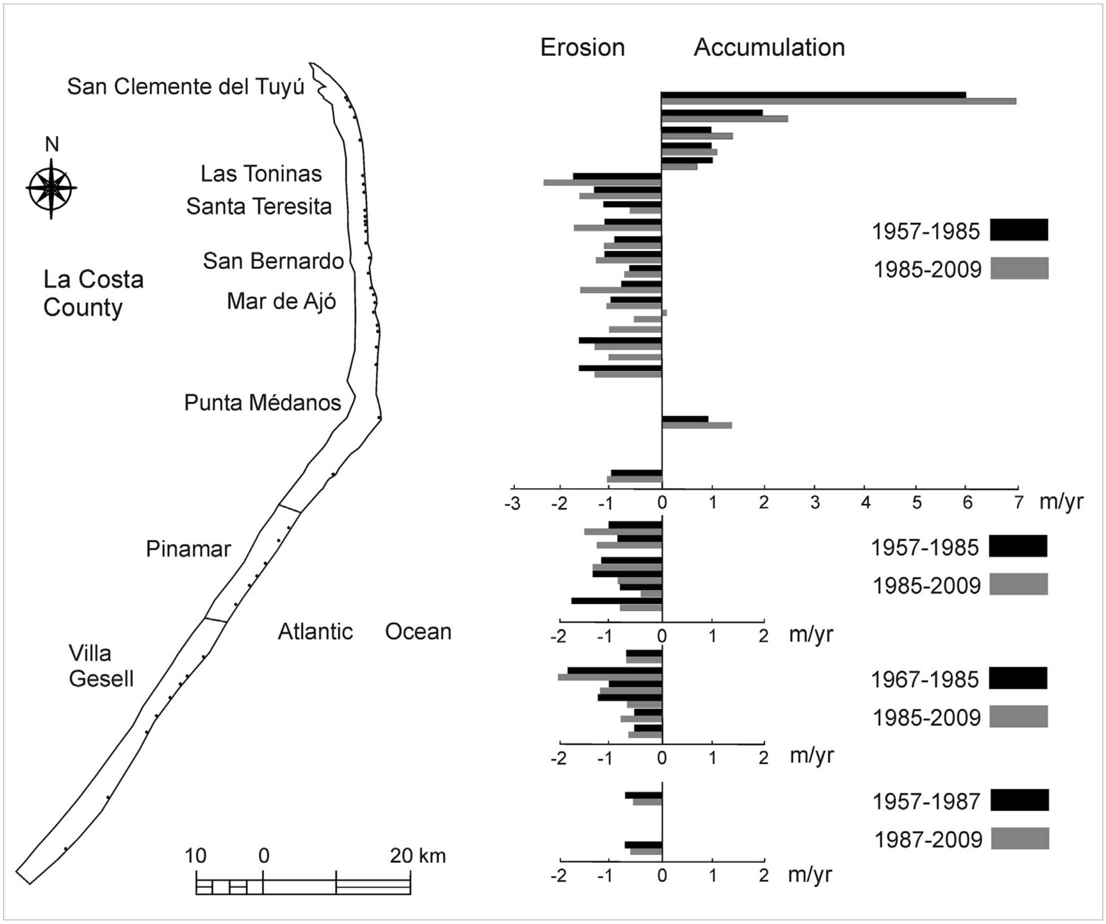

Fig. 3. Coastal variations along the Eastern Barrier of Buenos Aires.

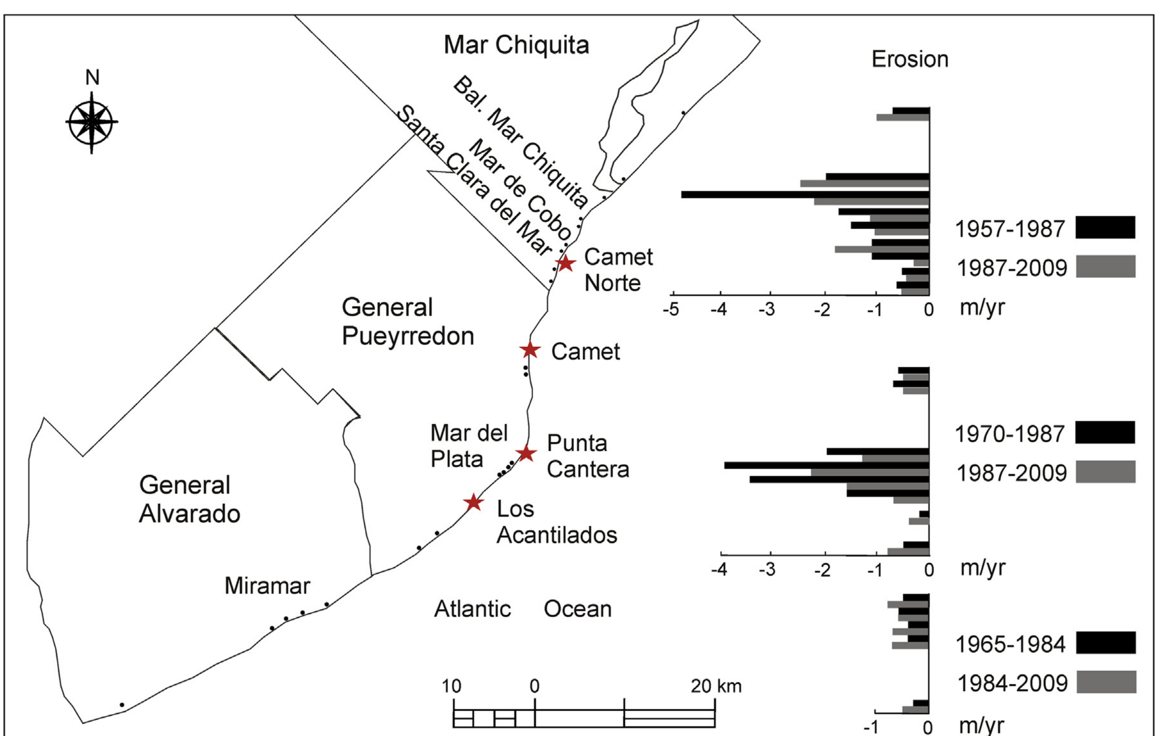

Fig. 4. Variations in the erosion rates at the southeastern region of Buenos Aires, a coast dominated by artificial structures.

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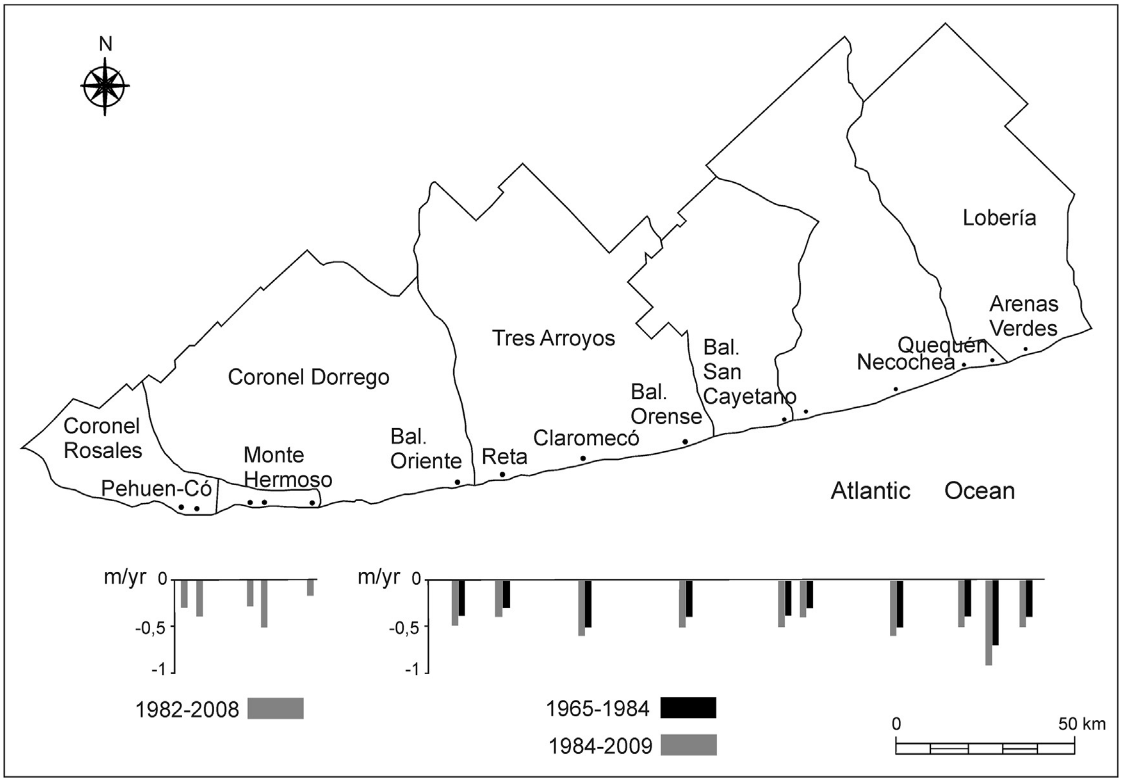

Fig. 5. Erosion rates along the southern barrier of Buenos Aires.

the western jetty (Isla et al., 2009; Merlotto et al., 2014). In Necochea city, erosion was between 0.5 and 1 m/yr (1965–1984) and increasing in the last years (Fig. 5). One of the crucial processes of this coast is the deactivation of sand ramps: sand climbed to former cliffs remaining as cliff-top dunes (Marcomini et al., 2007; Isla et al., 2009).

In San Cayetano, only one site was tested (Balneario San Cayetano). Erosion rates were below 0.5 m/yr but increasing slightly in the last years. Very similar is the situation at the bathing villages of Tres Arroyos and Coronel Dorrego counties (Fig. 5). Between 1967 and 2004 erosion rates of 3–6 m/yr were reported along this coast (Bertola et al., 2009).

In Monte Hermoso, the erosion rates were only calculated for the 1982–2008 period. They were below 0.5 m/yr. Modern erosion rates were estimated for the Pehuen-Có village (Coronel Rosales; Fig. 5).

Recent Coastal Engineering improvements

In the last years, the critic erosion problems along the south-eastern coast of Buenos Aires province, and complaints about the drift-obstruction policy, led to Buenos Aires authorities to propose alternative solutions. However, errors and a questionable policy are still carried out.

a. The detached-breakwaters project of Los Acantilados

The project of Los Acantilados was proposed for a narrow beach fronting cliffs receding less than 1 m/year (Isla and Cortizo, 2014). Detached breakwaters were planned to achieve a stable beach without obstructing the littoral drift. Groins would have been constructed normal to the beach to allow the accumulation of blocks for the definitive breakwater, and later they would be dis-assembled (Gyssels et al., 2007). However, the project was subject to critics in regard to:

1. Quarry stones were the material invoked for the project; sand bags or other geotextile alternatives were alternatively suggested to be modified if the project failed in its purposes.
2. Breakwaters were planned to be constructed 2 m over MSL, and therefore the sea sight would be partially eliminated.

At last, and after rough controversies with a non-governmental organization (NGO), the project was approved with few variations. In 2012 the construction was interrupted during the construction of the third breakwater. Although they were simulated 250 m from the foot of the cliffs (Gyssels et al., 2007), they were built at about 230 m. Worse, the "temporal groin" to access to the third breakwater was never disassembled, and therefore the drift became obstructed (Fig. 6). The project in this sense failed to achieve its principal purpose. The longshore transport remains obstructed in the last five years. The artificial beaches are frequently impacted by increments in the runoff from the top of the cliffs, a subject not considered in the impact assessment report.

b. The stability of the sewage disposal outfall

For many years, Mar del Plata city has a sewage network discharging at the northern coast in Camet (Fig. 4); the outfall was located at the beach. The growth of the city was progressively conditioning the bathing quality of the northern beaches (Elias et al., 2004). A 3500 m pipeline with diffusers at the extreme was originally projected to operate at 12 m depth (Isla and Aliotta, 1999). After a failed attempt at the end of the 20th century, another project was conceived during the beginning of the 21st century. However, during the building operation several problems arise about the method of construction and the stability of the pipeline. These obstacles led to the construction of two jetties not planned, meaning without a previous impact-assessment analysis (Fig. 7). The sewage outfall was definitively installed at the

Fig. 6. Eight detached breakwaters were proposed in 2008. In 2012, the third breakwater (right) was not detached from the coast (modified from Isla, 2015).

beginning of 2016, and since then it has been operating properly.

c. Non-authorized groins

Although groins provoke erosion at their downdrift side, they are still envisaged as an easy way to create artificial beaches. In Punta Cantera (Fig. 4), during the end of the nineties a private company (restaurant with seaside facilities) constructed two groins taking advantage of quartzite blocks from the surroundings, and without consulting the government authorities, although the law precisely stated that only the Province has jurisdiction at the coastline. With a certain delay, the owner of these facilities was demanded to destroy both goynes. Finally, about 2014 Punta Cantera was modified into its natural conditions (Fig. 8).

At the coast of Estancia San Manuel, 1 km north of Camet Norte (Fig. 4), the owner of the land constructed a short groin without the necessary permission of the Buenos Aires authorities (Fig. 9). The groin is still there.

5. Discussion

In Latin America coastal erosion is not considered a serious threat (Silva et al., 2014). In Colombia, the hard-defense policy has been applied along the sun-and-beach touristic coastline (Rangel-Buitrago et al., 2017). However, most of those structures were planned based on empirical experiences. Coastal retreat rates of 21 m/yr were estimated. One significant problem is the competency of three institutions on the subject. On the other hand, at some portions of this shoreline there is no authority responsible for the environmental impact assessment requirements. Close to 90% of the hard structures constructed failed in their purposes; negative consequences were estimated in 85% at the downdrift side of groins. At one of the most erosive areas, detached breakwaters planned 125 m from the coast were finally constructed 40 m from the coast (Rangel-Buitrago et al., 2017).

In Mar del Plata the obstruction caused by the harbor and the recurrent strikes of southeastern storms constitute a problem initiated a century ago (Isla, 2006). Similar processes occurred with the construction of the Quequén Port (Isla et al., 2009).

Pre-construction studies concerning hard-structure interventions were oriented to survey nearshore profiles to calculate the volume of rocks necessary for the length and widths (top and bottom) of each revetment (Lagrange, 1993). Concrete or rubble-mound structures constructed from the sixties to the eighties are subject to toe scouring, as expected at this type of structures (Pilarczyk, 2010). In Mar Chiquita, General Pueyrredon and General Alvarado groin fields partially succeeded recovering beaches, but transformed into artificial beaches with different dynamics (Isla et al., 2001; Bertola et al., 2013). These groin fields took advantage of the resistant, caliche-composed, abrasion platforms. For these areas, it can be applied that these hard structures are not "universally bad" (Nersesian et al., 1992).

However, the experience does not signify a straight forward improvement. In La Perla beach, northern Mar del Plata, groins were constructed too close each other, and therefore some of them should be removed (Boer et al., 1997). Groin lengths and spacing are known to be determinant to avoid blocking totally the longshore transport (Kristensen et al., 2016). On the other hand, groins constructed too distant failed in their purposes, as it occurred in Ilhéus, Brazil (Do Nascimento and Lavènere-Wanderely, 1997). It is also known that groins projects should be completed without significant delay (Nersesian et al., 1992). Although previous local experience can be granted for new projects, designers should be very cautious where the longshore sediment budget was artificially altered or affected by groin fields constructed updrift. The beach drift is dramatically affected by storm frequencies: years with several southerlies signify an increase in the longshore drift at Mar del Plata coast (Isla, 2015). In this sense, in Africa it was concluded that projects should be based on longshore measurements performed during 5–8 years (Schoones, 2000). However, the sedimentary balances of some beaches where the rip density has been artificially increased indicate that the drift has diminished (Isla, 2015), or significant changes in the dynamics could have occurred (Dragani et al., 2010, 2013). The consequence of this hard-structure policy focused to solve local problems is that erosion extends to areas immediately downdrift of the obstruction. These problems are common to other countries without planning as Mozambique (Palalane et al., 2016).

As it was recorded on the Suffolk coast, cliffs higher than 20 m are subject to significant changes in the water table, a process less important at low cliff areas (Brooks et al., 2012). Where cliffs are subject to significant retreat rates, parallel ripraps are unavoidable (Fig. 10). As seawalls may affect the elevation of the groundwater level, they can alter beach dynamics: during high tide the effluent line deflects landward, and deflects seaward during low tide (Plant and Griggs, 1992).

Beach nourishment is the preferred method for coastal protection in many countries (Hansom et al., 2002; Campbell and

Fig. 7. To fix the stability of the outfall pipeline in Camet, two jetties were constructed.

Fig. 8. Non-authorized groins were constructed at Punta Cantera, and later destroyed by the demand of Buenos Aires authorities.

Fig. 9. Clandestine groin constructed at San Manuel Estancia.

Benedet, 2006). In Argentina, nourishment efforts were only conducted in three beaches of Mar del Plata during 1998 (Bértola, 2001; Marcomini and López, 2004). Lately, this alternative was systematically discarded due to the lack of large dredge equipment in the country. Geotextile sand containers (Oumeraci and Recio, 2010) should also be considered for areas where the transport of rocks is too expensive.

Regarding detached breakwaters, there are empirical approximations recommended to induce salients and avoid tombolos (López, 2014). The breakwaters constructed at Los Acantilados beach were proposed based on wave data from NOAA collected at three different points. The objectives were to guarantee the formation of salients preventing the formation of tombolos (Gyssels et al., 2007). However, significant tombolos formed between 2011 and 2012, even where the "access groins" were disassembled (Fig. 6).

Authorities of Buenos Aires Province concerned about the coastal erosion regional problem, made a contract in 2007 for a

Fig. 10. Rock revetments protection the foot of sea cliffs at Mar del Plata. Sand accumulates at the foot of the ripraps during the summer season.

state-of-art diagnosis and an implementation of a master plan. Unfortunately, they lately ignored the agreement when the technicians of the hard-structure policy made objections to the methods and results suggested by the university academics. In the meantime, non-authorized hard structures have been constructed without the agreement of the Province technicians. In Ventura, California, public pressure with the leadership of an NGO induced agreements with a multiagency and a groupo of stakeholders to accept a retreat-approach position (Kochnower et al., 2015).

There is much information about the resistance of low-lying or barrier-protected coasts subject to storm episodes (Park and Edge, 2011; Mull and Ruggiero, 2014). Parameters to be considered are the statistically-based frequency of these storms (Nebel et al., 2013), their potential effects (Zhang et al., 2001; Bakker et al., 2012) and/or predictive models (Cañizares and Irish, 2008). The statistical analysis of the storm erosion potential index (Zhang et al., 2001) indicated that at Mar del Plata a significant storm strikes every two years (Fiore et al., 2009). Another possible cause for an increase in coastal erosion is related to increments in the wind wave heights (Dragani et al., 2010, 2013). At the South Atlantic Ocean, cyclonic weather systems generated from the SE cause the highest surges (Machado et al., 2010). Climate change simulations indicate that these extratropical storm tracks are shifting polewards in both hemispheres (Bender et al., 2012), and therefore increasing the effects of those storms moving from high to low latitudes.

Regarding global changes -and their indirect coastal impacts such as the increments in storms and floods frequencies-, it is recommended to avoid traditional cost-benefit analysis. The holistic analysis should envisage the consequences of these changes in the touristic economy and non-market effects upon the environment (André et al., 2016).

6. Conclusions

Considering that erosion problems are occurring since last century, it is worth to analyze the solutions that have been handled. Comparing the recession rates of cliffs within two intervals (1960–1980, and 1980–2000), it was confirmed that they have increased, even in areas where defense improvements were applied. Several factors (vicinity to quarries, presence of erosion platforms, littoral drift amount) have conditioned the local preference of groin fields as the best defense alternative, although drift obstructions are nowadays considered very harmful. The nourishment operation performed in three beaches during 1998 were not very successful in the sense that fine sand was disposed on coarse-grained beaches, and therefore increasing the erosion rates.

In the sandy coast of Buenos Aires, there is a storm-triggered erosion problem that increased where man activities are inducing sand imbalances, either by foredune forestation or by the construction of bathing resorts of large dimensions. Although these activities are definitively not recommended, decision makers are still promoting the rent of shadows at the beach.

Some recent coastal defense projects failed, either because they were still being conceived as definitive hard structures or caused by administrative errors during the construction stages. New strategies to prevent drift obstructions should be planned, but based on a scientific-based knowledge of the nearshore dynamics and validated by models.

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