Rio de la Plata (La Plata River) and Estuary (Argentina and Uruguay)

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Contents

Abstract

The La Plata River system can be defined as a funnel coastal plain tidal river with a semi-closed shelf at the mouth. La Plata River is both the world's widest freshwater system and an estuary that drains the second largest basin in South America and the fifth largest in the world. The Rio de la Plata system is shared by Argentina and Uruguay and has an area of 38,000 km^2, extends almost 300 km in length, and widens from about 40 km at the inner freshwater part to 227 km at the Atlantic Ocean boundary. The system is mainly formed by the Paraná and Uruguay rivers that provide 97 % of the water discharge contributing with a mean annual flow of 16,000 and 4,000 m^3/s, respectively. The Rio de la Plata comprises three well-defined areas: the internal zone that starts at the end of the Parana Delta and is characterized by only freshwater, an intermediate or mixing zone, and an external or marine zone.

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Introduction

The Río de la Plata system can be defined as a funnel coastal plain tidal river with a semi-closed shelf at the mouth. La Plata River is both the world's widest freshwater system and an estuary that drains the second largest basin in South America and the fifth largest in the world. The Rio de la Plata system is shared by Argentina and Uruguay and has an area of 38,000 km^2, extends almost 300 km in length, and widens from about 40 km at the inner freshwater part to 227 km at the Atlantic Ocean boundary. The system is mainly formed by the Paraná and Uruguay rivers that provide 97 % of the water discharge contributing with a mean annual flow of 16,000 and 4,000 m^3/s, respectively. The Rio de la Plata comprises three well-defined areas: the internal zone that starts at the end of the Parana Delta and is characterized by only freshwater, an intermediate or mixing zone, and an external or marine zone.

Main Environmental Characteristics

The Río de la Plata system exhibits a complex topography with a mean depth of 5 m and a maximum of 18–20 m at the mouth. The system's main environmental characteristics are defined by the presence of longitudinal thermal, saline and sediment gradients. The estuary is divided into two main areas by the submersed Barra del Indio (Del Indio bar) that crosses the river transversally at 6.5–7 m depth (Fig. 1). Sediments close to the Parana and Uruguay river mouths are mostly coarse (sand and silty sands), increasing the fraction of fine sediments (silt and clay) to the riverine-estuarine zonal boundary (FREPLATA 2005). The inner or freshwater riverine zone is defined by salinity values up to 5 practical salinity units (PSU) whereas the boundary with the estuarine zone occurs where the halocline intersects the bottom, corresponding to the bottom salinity front and boundary for the brackish estuarine water (Guerrero et al. 1997).

Turbidity varies along a gradient and is influenced by river discharges, wave effects, dredging and fishing, sedimentation, and flocculation processes. Most of the sediments are carried by the Paraná River contributing 160 million tons per year, 50 % of which is silt and 28 % clay (Sarubbi et al. 2006). A noticeable characteristic is the appearance of a turbidity front with high suspended sediment concentrations, typically from 50 to 300 mg l^{-1} at the boundary between the riverine and inner estuarine areas (Acha and Mianzán 2003). This turbidity maximum is due to the suspended matter flocculation at the tip of the salt wedge and re-suspension of sediment due to tidal stirring (Acha et al. 2008). The estuarine waters extend to the oceanic shelf delimited by the maximum horizontal gradient of surface salinity (Fig. 2).

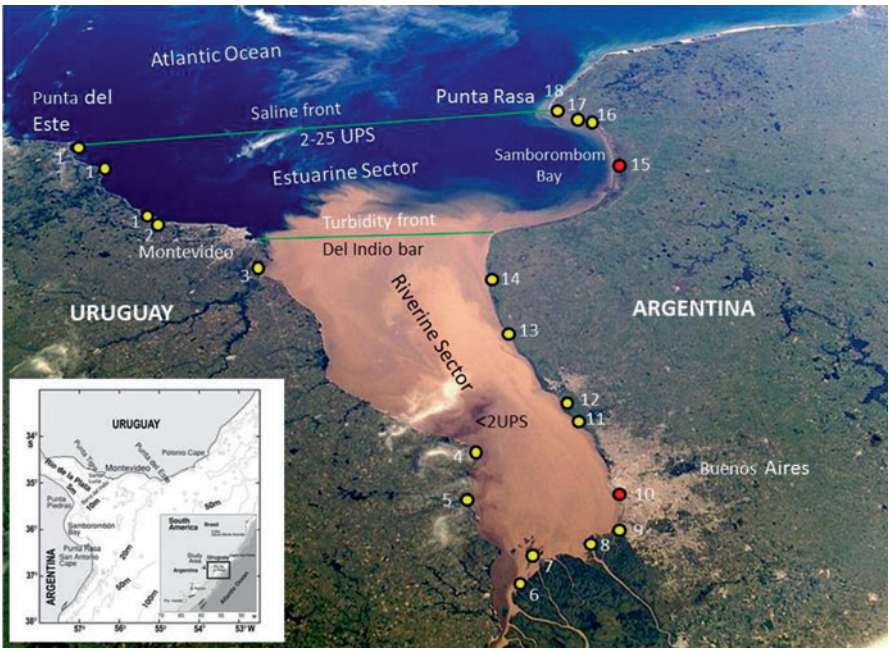

Fig. 1 The Río de la Plata system showing the main sectors and protected natural areas: *1* Parque Nacional Islas Costeras; *2* Parque Nacional F.D. Roosewelt; *3* Islas del río Santa Lucía; *4* Parque Nacional Isla San Gabriel; *5* Parque Nacional Anchorena; *6* Isla Martin García; *7* Río Barca Grande; *8* Bajos del Temor; *9* Ribera Norte; *10* Costanera Sur (Ramsar Site); *11* Selva Marginal de Hudson; *12* Punta Lara; *13* El Destino; *14* Parque Costero Sur; *15* Samborombón Bay (Ramsar site); *16* Rincón de Ajo; *17* Punta Rasa; *18* Campos del Tuyú (Image courtesy of the Earth Science and Remote Sensing Unit, NASA Johnson Space Center, NASA Photo ID ISS006-E-38952, ▶ http://eol.jsc.nasa.gov)

Biodiversity Patterns

Distribution and abundance of organisms in the Río de la Plata are strongly associated with environmental factors but mainly salinity gradients (Jaureguizar et al. 2004). Several of these species are potadromous moving seasonally to the Paraná and Uruguay rivers. A few species such as *Odontesthes* sp., *Lycengraulis grossidens*, and *Genidens barbus* show anadromous behavior migrating from the estuary or the Atlantic Ocean to spawn in the lower Parana River (Baigún et al. 2003; Baigún and Minotti 2012).

Fish assemblage variation is related to the horizontal gradients of salinity (Jaureguizar et al. 2003). The innermost area comprises only freshwater species such as *Prochilodus lineatus*, *Saaminus brasiliensis*, *Pimelodus albicans*, *Parapimelodus valenciennsi*, *Lucipimelodus pati*, and the exotic *Cyprimus carpio.* Estuarine species are characterized by the presence of *Micropogonias furnieri*, *Brevoortia aurea*, *Macrodon ancylodon*, *Paralonchurus brasiliensis*, and

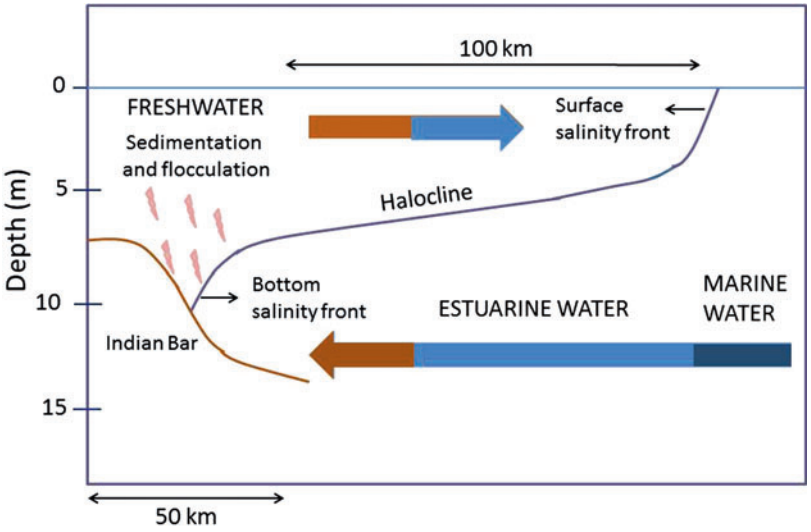

Fig. 2 Water circulation at the boundary between the riverine and estuarine zones (Adapted from Acha and Mianzán 2003, with permission)

Paralichthys orbignyanus, whereas the marine group includes *Cynoscion guatucupa*, *Conger orbignyanus*, *Discopyge tschudii*, *Paralichthys patagonicus*, *Percophis brasiliensis*, *Atlantoraja castelnaui*, *Mustelus schmitti*, *Sympterigia bonapartei*, *Stromateus brasiliensis*, *Squatina guggenheim*, *Myliobatis goodei*, and *Prionotus punctatus*. Some species, including *Micropogonias furnieri*, *B. aurea*, *Macrodon ancylodon*, and *Pogonias cromis*, spawn in the estuary taking advantage of convergent water masses that facilitate the retention of eggs and larvae within the estuary and share it as rearing habitat with other species, e.g., *Menticirrhus americanus*, *Parona signata*, *Paralichthys patagonicus*, and *Anchoa marinii* (Brazeiro et al. 2003).

In the same vein, benthonic species are distributed according to saline tolerance (Masello and Menafra 1998). For example, estuarine species are represented by *Brachiodontes darwinianus*, *Tagelus plebeious*, *Littoridina australis*, *Erodona mactroides*, *Balanus improvisus*, and *Mytella charruana*, and euryhaline species are composed of *Cyrtograpsus angulatus*, *Mactra isabelleana*, *Neanthes succinea* whereas marine species include *Mesodesma mactroides*, *Ocypode cuadrata*, *Hemipodus olivieri*, *and Emerita brasiliensis*. Occasionally cetaceans including the dolphin (*Pontoporia blainvillei*), porpoises (*Phocoena dispotica*, *Tursiops gephyreus*, and *T. truncatus*), and whales (*Balaenoptera musculus*, *B. physalus*, and *B. acutorostrata*) enter the estuary.

Several important wetlands are located in the Río de la Plata such as Santa Lucía and Samborombón along the Uruguayan and Argentinian coasts, respectively (see Fig. 1). The latter is a Ramsar site and one of the largest and most important wetlands in South America covering 140,000 ha of freshwater and brackish marshes (Lasta

1995). The area contains a diverse plant community adapted to different soil conditions. In the wet prairies, the most common species are *Eleocharis* spp., *Juncus* spp., *Paspalidium paludiphalus*, *Paspalum* spp., *Panicum* spp., *Polypogon elongatus*, and *Lolium multiflorum*. Characteristic species occupying lowland wet areas with saline soils are *Agropyrum* spp., *Spartina* spp., *Salicornia ambigua*, and *Spergularia* spp. whereas aquatic vegetation communities are composed of *Scripus californicus*, *Typha* spp., and *Zizanopsis bonariensis*. Shallow waters are inhabited by polychaetes (*Heteromastus similis; Poludora ligni*), amphipods (*Corosium insidiosum*), and bivalves (*Tagelus gibbus*). The burrowing crabs (*Chasmagnathus granulata* and *Cyrtograpsus angulatus*) are a distinctive characteristic of Samborombón Bay's intertidal zone (Fig. 3).

The south portion of the bay has been identified as a resting area for piscivorous marine birds including *Sterna hirundo*, *Thalasseus maximus*, and *T. sandvicencis* and migratory species such as *Rynchops niger*. Moreover, the bay represents the southernmost distribution for *Tachyphonus rufus*, *Icterus cayanensis*, *Synallaxis frontalis*, *S. cinerascens*, *Limnornis curvirostris*, *Cyclarhis gujanensis*, *Phylloscartes ventralis*, *Geothlypis aequinoctialis*, *Parula pitiayumi*, *Circus bofoni*, *Polyborus plancus*, *P. chimango*, and *Elanus leucurus*.

Common mammals found in this wetland are *Myocastor coypus*, *Hydrocaeris hydrocaeris*, *Cavia pamparum*, *Ctenomys talarum*, *Didelphys albiventris*, *Galictis cuja*, *Conepatus chinga*, and *Ozotoceros bezoarticus*. Several amphibians can be also found (e.g., *Rhinella arenarum*, *Leptodactylus ocellatus*, *Odontophrynus*

Fig. 3 Typical crab community of Río de la Plata coastal intertidal area (Photo credit: courtesy of Alejandra Volpedo ©)

americanus) along with reptiles (e.g., *Tupinambis teguxin*, *Prhynops hilarii*, *Lystrophis dorbignyi*, *Oxyrhopus rhombifer*). The coastal area of Samborombon Bay also provides rearing habitat for fish such as *Brevoortia aurea*, *Pogonias cromis*, *Micropogonias furnieri*, *Macrodon ancylodon*, and *Mugil* sp.

Ecosystem Services

The Río de la Plata River provides a number of valuable ecosystem services related to the use of the coastal and offshore areas. Commercial foreign trade is a main activity but passenger transportation between Argentina and Uruguay and recreational navigation are also important (FREPLATA 2005). An artisanal fishery based on *Prochilodus lineatus* has been an important activity formerly relevant in the inner Argentinean sector (Baigún et al. 2003) but is still practiced in Uruguay. The main fishing area for both countries is currently located in the estuary, with *Micropogonias furnieri* as the main target species (Fig. 4). An important inshore recreational and sport fishery occurs along the riverine and estuarine sectors for *Odontesthes* sp., *Genidens barbus*, and *M. furnieri* as the main target species (Colautti et al. 2003; López et al. 2012). In the coastal areas several wetlands, but particularly the Samborombón Bay, provide a wide mosaic of feeding, reproductive and rearing habitats for terrestrial and aquatic organisms.

Fig. 4 Fishing boats used in Río de la Plata River estuary (Photo credit: Claudio Baigún © rights remain with the author)

The Río de la Plata River is a major source of water for domestic use in the most highly populated urban areas of Argentina and Uruguay. At the boundary with the Atlantic Ocean where freshwater and salt water merge, contaminants adsorbed and transported by clay particles sink and are immobilized due to flocculation thereby reducing the input of contaminated particles to the marine environment.

Threats and Future Challenges

Water and sediment contamination are the main threats affecting the ecological integrity of Río de La Plata, impacting planktonic, benthonic, and nektonic communities with population reductions, mortality, and disease that can ultimately affect human health through bioaccumulation. Coastal and urban areas, particularly in Argentina, are heavily impacted due to land use and lack of appropriate treatment of industrial and domestic sewage effluents, affecting in turn a wide spectrum of biological communities and human health. Inshore fecal bacteria levels in the water column exceed limits for safe recreational use, acceptable levels only occurring 3,000 m from the coast. Harmful algal blooms based on Ciliates, Cyanophytes, and Dinoflagellates are commonly triggered by high nutrient loads, mainly in the Argentine sector.

Waters contaminated by PCBs, PAHs, hydrocarbons, and heavy metals are found along the south coastal area of the Río de la Plata between Buenos Aires and La Plata at levels higher than those recommended for aquatic biota (PNUD 2009). Along the Uruguayan coast, however, only the Montevideo area is impacted by heavy metal (chromium and lead) inputs from sewage and tributaries (Kurucz et al. 1998).

Offshore sediments along the estuary are only slightly contaminated except at the turbidity front (see Fig. 1) where flocculation promotes the sinking of clay particles with adsorbed metal ions. Waves, currents, dredging, and bottom fishing tows can re-suspend and even alter sediment transport and result in bioaccumulation of pollutants by filter feeding and detritivorous species. Habitat structure and the diversity and abundance of benthic communities are also impacted by these activities. The fishing areas encompass many of the main spawning and rearing habitats, and without proper management the fisheries can be severely impacted as has been shown for *Micropogonias furnieri* (Ministerio de Asuntos Agrarios 2007). In turn, on the Uruguay coast *Cynocion guatucupa* and *Mustelus schmitti* have been acknowledged as overexploited (Defeo et al. 2009).

International commercial navigation can result in introductions of invasive species via transport in ballast tanks or adhering to the hull. The diversity of exotic species in de la Plata River Estuary is still low although reported species show high population abundances. In addition to *Cyprinus carpio*, and *Oreochromis niloticus*, the bivalves *Corbicula fluminea*, *C. langilleri*, and *Limnoperna fortunei* are currently widely distributed and have a high economic impact on shore structures and water pumps (Darrigran 2002). Other exotic species such as the gastropod *Rapana venosa* has also been found (Giberto et al. 2006). Brazeiro et al. (2003) stated that the Ortiz Bank, the Turbidity Front, and the Santa Lucía and Samborombón wetlands

can be classified as the most highly critical areas because they have both functional relevance for the fluvio-marine ecosystem but also support important environmental risks.

Coordinated management policies are required to restore the Río de la Plata's ecological integrity, particularly in coastal and wetland areas and to maintain their ecosystem services. This will require managers to enforce appropriate water treatment for both urban and industrial effluents, improve socioeconomic conditions for people inhabiting shore areas, and develop appropriate governance institutions and processes to apply and enforce environmental laws, including sustainable fishing regulations and management policies. As the Río de la Plata system represents the end point for the second largest river basin in South America, conservation strategies should also encompass transboundary policies and agreements oriented to balance socioeconomic benefits and ecological requirements at a basin scale.

Cross-References

- ▶ Estuaries
- ▶ Paraná Delta
- ▶ Paraná-Paraguay Fluvial Corridor
- ▶ Tidal Freshwater Marshes

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