Journal of Integrated Coastal Zone Management
Revista de Gestão Costeira Integrada

http://www.aprh.pt/rgci/pdf/rgci-596_Wallner-Kersanach.pdf | DOI: 10.5894/rgci596

Wallner-Kersanach *et al.* (2016) - Temporal evolution of the contamination in the southern area of the Patos Lagoon estuary, RS, Brazil. *Journal of Integrated Coastal Zone Management / Revista de Gestão Costeira Integrada*, 16(3):263-279. DOI: 10.5894/rgci596 Supporting Information

Supporting Information I

Overview of the industrial development and occupation of Rio Grande city

Rio Grande, a municipality, located on the southern margin of the Patos Lagoon estuary, was founded on February 19th, 1737 and is the oldest city in the Rio Grande do Sul state. It was called Vila de Rio Grande when the first port – the Porto Velho – was founded in the northern part of the city (Figure 1).

The installation of the Rio Grande Customs in 1804 enabled the importation and exportation of goods and raw material (Torres, 2008). The dredging of the pier area in the Porto Velho in 1823 led to urban development, a fact that changed the military purpose of the village to urban development (Souza, 2011).

The construction of the Barra jetties at the end of the estuarine area was carried out from 1911 to 1915; it aiming at assures the communication between the Patos Lagoon and the ocean and at enabling the development of the importation and exportation sectors. In 1913, the city had already got 18 industries. The construction of the second port, the Porto Novo (Figure 1), at the eastern part of the city, was achieved in 1915; since its draft was about 10 m, it triggered not only transportation and maritime commerce but also industrial installations near the jetties. As a result, there was a strong economic and population growth.

The third port – the Super Porto (Figure 1), located at the southern part of the city – was built in 1964 on the margin of an industrial district. The dredging of the canal began in 1970 to enable the navigation of vessels with drafts of up to 40 feet.

The existing fishing industries were encouraged and new industries, such as fertilizer units, vegetable oil plants, gasification centers and oil terminals were installed in the expanded area (Super Porto) from 1970 to 1980 (Torres, 2008). However, several fishing industries closed in 1990, while the naval industry underwent some stagnation. The opening of the Ipiranga oil refinery in the city in 1937 was a shift of the industrial profile of the city since this pioneering company produced solvents for rubbers. It processes 17,000 oil barrels/day and yields several derivatives, such as gasoline, diesel oil, kerosene, fuel oils, LPG, solvents and special oils nowadays.

There were about 180,000 inhabitants in Rio Grande in the 1990's (www.ibge.gov.br). The increase in population growth and the development of industries in the city led to the first study which aimed to identify and map effluent discharge spots that surrounded the city from 1991 to 1992 (Almeida *et al.*, 1993). This study, which excluded the Super Porto area, mentioned 76 effluent discharge spots around the city; 24 were industrial, 18 were domestic, 4 were mixed (domestic ones officially connected to the pluvial system) and 40 were pluvial. Most industrial and domestic illegal effluents had no, or little, previous treatment. At that time, 14 out of 30 main industries were predominantly fish processing units; 5 were fertilizer units, 3 were vegetable oil refining plants, one was an oil refinery and the others included textile and food industries (Almeida *et al.*, 1993) (Figure 1A). Rio Grande went through deep changes in its production chain in the 1990's. Afterwards, an economic stagnation led to the closure of two fertilizer plants and a soybean oil plant, moreover the crisis in the traditional fishing industry. However, fast economic growth has occurred in the port-industry in Rio Grande since 2000, due to the increasing development of

the port zone in the Super Porto where the pier is 4 km-long and the draft has been deepened to 60 feet. New businesses were implemented in the industrial district; port and industrial terminals were enlarged and modernized. Container terminals, the naval complex, chemical and petrochemical units, mainly of wood, paper and cellulose byproducts, were developed, as well (Domingues *et al.*, 2013)

There were about 200,000 inhabitants in Rio Grande in 2013 (www.ibge.gov.br). A total of 31 industries with potential to generate liquid effluents and solid residues was identified in the urban and port-industrial areas of the city (Büttenbender, unpublished data). The Rio Grande Port has currently focused on developing as the main center, which concentrates cargo in the Common Comercial Market of South America (Mercosul), comprised by Argentina, Brazil, Paraguay and Uruguay.

In the Super Porto, moreover agricultural bulk, there are fertilizer and vegetable oil plants, oil, petrochemical and liquid bulk cargo terminals (Figure 1B). The largest shipyard in South America, a dry dock, is located in this area. Its construction started in 2006 on an area which stretches over 550 thousand square meters to construct and repair oil drilling platforms. There are also two older shipyards which repair vessels in the port area. The Santos Shipyard, which is located in the Super Porto area, has been reparing recreational, fishing and governamental vessels from 10m to 25m long for more than 20 years. The Gustavo Fernandes Filho LTDA Shipyard, which is located in the Porto Velho, has been repairing vessels as large as 27m long for more than a century, even though it has worked on small scale lately.

Supporting Information II

Tabel 1. Concentrations (μg L^{-1}) of trace metals in estuarine water, before, during and after the sediment dreading activity in 2006.

Metal	**Depth**	**Dredging activity**			**Legislation***
(μg L^{-1})		**Before**	**During**	**After**	**(μg L^{-1})**
Cr	Surface	0,65	2,12	0,65	<1100
	Middle	0,69	1,38	0,79	
	Bottom	3,13	4,98	1,11	
Pb	Surface	1,22	2,03	1,20	210
	Middle	0,76	1,10	1,36	
	Bottom	1,86	1,32	1,75	

***** Resolution No. 357 for brackish water of Class 2 (CONAMA, 2005).