



IMPACTS OF A FORMER LANDFILL IN AN ESTUARY

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ABSTRACT

This work is done within the frame of the research project named "Risks of an environmental liability on Bahía Blanca estuary (Argentine Republic)". The aim is to demonstrate that the lack of proper management has allowed the location of a garbage dump on the floodplain of the estuary, which does not guarantee the preservation of the water resource. For this purpose, this paper includes a description of the area, the chronological evolution of the former dump from its beginning to its current status as a seafront. In addition, the results of the analysis carried out at the monitoring stations nearby the former dump are evaluated in order to confirm whether the detected metals dissolved in water may be originated by their leachates. In conclusion, the absence of planning and implementation of urban development plans, plus to the discontinuity of these and the need for immediate solutions, compromises the sustainability of the estuary by the location of the former landfill.

Keywords: Management, Estuary, Municipal Solid Waste (MSW), Former Landfill, Sustainability.

INTRODUCTION

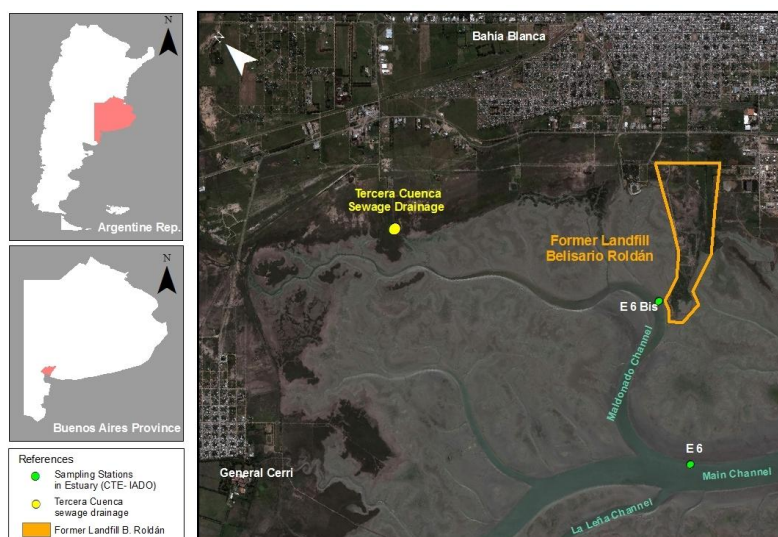
The reason to this paper is the detection of dissolved metals in waters of Bahía Blanca Estuary (Buenos Aires Province, Argentine Republic), in the proximities of a former garbage dump. The intention is to research about the management of the area and the Municipal Solid Waste (MSW) dumped on its floodplain during more than four decades, from the beginnings until the current status as a recreational seafront.

The main goal is to demonstrate that the lack of appropriate management allowed the location of a garbage dump on the estuary floodplain, which does not warranty the preservation of the water resource.

To achieve this, the following topics are developed: study area; historic review about the evolution of the coastal area and the management of the solid waste at Bahía Blanca City; products thrown at the former dump that could leachate the metals found in estuary waters (Cd, Pb, Cu, Zn, Cr, Ni, Hg); evaluation of the results of monitoring stations nearby the former dump that support this research.

METHODOLOGY

In first place, the Study Area is precisely indicated. The former garbage dump is located on the Bahía Blanca Estuary, South West (SW) of the Buenos Aires Province, Argentina Republic. (Picture N°1).



Picture N°1: Bahía Blanca Estuary (Buenos Aires Province, Argentine Republic).

Then, a chronological historic review about solid waste management in Bahía Blanca City is done. This includes the location and abandonment of the former dump until its current status as a seafront, to expose the consequences of the lack of timely management.

On the other side, a compilation and evaluation of monitoring results corresponding to period 2006-2012, is done in the estuary waters at the stations nearby the landfill, and published by the Comité Técnico Ejecutivo (CTE) of the Bahía Blanca City Administration and the Instituto Argentino de Oceanografía (IADO). To have an updated technical framework, about the products containing these metals found in the estuary (Cd, Pb, Cu, Zn, Cr, Ni y Hg) a bibliographic review is done. This is to establish their origin, maybe they come from the leachates of the dumped waste at the landfill. There are two monitoring stations close to the dump: E6 - Proximity to Maldonado Channel flow (38° 45' 54.1"S ; 62° 20' 25.2"W) and E6 BIS - Maldonado Channel (38° 44' 50.86"S ; 62° 19' 31.54"W). This last one is close to Tercera Cuenca sewage drainage area and Belisario Roldán former landfill. The mentioned points can be found at Picture N°1.

The concentrations of the dissolved metals found in the monitoring stations are compared with the reference levels of the National Oceanic and Atmospheric Administration (NOAA), not only for the Chronic Exposure but also with the Acute Exposure. This last one is defined as the average concentration for one hour of exposure and for the Chronic Exposure, the average is calculated for 96 hours (4 days). Also the values are compared with the water quality guide levels for protection of aquatic life in sea surface waters established by the Regulatory Act N° 831/93, corresponding to the National Law N° 24.051/93 of Dangerous Wastes. All these reference values are included in Table N°1:

Parameter	Cadmium (Cd) (µg/l)	Lead (Pb) (µg/l)	Copper (Cu) (µg/l)	Zinc (Zn) (µg/l)	Chromium, Total (Cr)* (µg/l)	Nickel (Ni) (µg/l)	Mercury (Hg) (µg/l)
Acute Exposure (NOAA)	40	210	4,8	90	Unestablished	74	1,8
Chronic Exposure (NOAA)	8,8	8,1	3,1	81	Unestablished	8,2	0,94
Act N° 831/93	5	10	4	0,2	Unestablished	7,1	0,1

* Inexistent Reference Values for Cr, Total. NOAA and Decree N° 831/93 only establishes reference values for Cr⁺⁶

Table N°1: Reference Levels established by NOAA and by the Regulatory Act N° 831/93

Final remarks are inferred from the evaluation of the compiled data.

DESCRIPTON OF THE STUDY AREA

The Bahía Blanca Estuary, located at the southwest of the Buenos Aires Province (Argentine Republic) has an approximate length of 80 Km in NW-SE direction. Next to its header coexist, the cities of General Cerri, Ingeniero White and Bahía Blanca, a Natural Reserve, the Maldonado Swimming Pool (Municipal beach), a Petrochemical Hub, an Industrial Area and the following ports: Cuatros, Galván and Ingeniero White. The already mentioned different activities cause that the estuary historically, has received exogenous substances, originated by sewage or industrial discharge, landfill leachates, agrochemicals and others coming from the port activity (Cifuentes et al, 2012).

Between the cities of General Cerri and Puerto Galván, on the estuary floodplain, up to the streets Belisario Roldán and Crisólogo Larralde, next to Maldonado Swimming Pools, the municipal former landfill Belisario Roldán (Picture N°1), is found. It has peninsula shape, surrounded by a sector that at low tide becomes a surface of muddy consistency and at high tide is covered with water.

The amount of garbage dumped at the former landfill, during the forty years of activity, is estimated in more than one and a half million tons of waste.

Curiously, the sector used by the old landfill is considered as an area of Urban Park by the Code of Planning of the City of Bahía Blanca. Nowadays, without any previous cleaning process it has become a promenade for recreational activities with direct access to the estuary water.

HISTORIC REVIEW

Chronological evolution of the coastal area

In 1909 Bahía Blanca had a Strategic Development Plan, with a concentric radio scheme, structuring the space around the center of the city. This type of structure enhanced the beauty of the streams landscape and coastal area, having many recreational areas (Usina, Atlántico, Galván, Colón and Maldonado beaches).

In the 30s, Galván Beach became the most preferred one, due to the place that had been generated by the deposition of dredged materials during the deepening of the Main Channel (Rosake et al, 2012)

In the 60s, both the port infrastructure growth and the development of the Petrochemical Hub started, causing the progressive deterioration of the beach areas until their extinction. The coastal area value increased with the construction of the Almirante Brown Park project.

In the 70s, a new Development Plan was created and at the same time, the city was declared as a Provincial Growth Hub. A structured proposal tried to solve the problems that arose from the growing process of the city. A Zoning Code, that divides the city in different areas according their specific activities, was defined. This code was overtaken by the dynamic growth of the city activities and the Buenos Aires Province Act N° 8.912/77 (Spatial Planning and Land Use), that meant the adaptation of the Code to the new regulations.

Studies on where to locate an Industrial Area according to the city perspective were done, taking in consideration the Industrial Development Act. This, helped to find appropriate conditions for industrial establishment. In this decade, the Petrochemical Hub was developed, close to the port. At the same time the Coastal Area Strip was reserved, as a zone for important industrial activities related to the port (Sartor, 2000).

In the 80s, the Development Plan was changed (1986). The goal was to recover the patrimonial value of the city, and create an appropriate urban framework to conceive the city as a meeting space. The Zoning Code, faced the following problems: too many areas and subareas that did not represent the urban reality, the different allowed activities were not enough and some aspects were not even included like forestry, contamination and preservation (Sartor, 2000).

In the 90 decade, a Strategic Plan started. A new action and management model tried to get over the traditional practices based on participative methods that warranty a sustainable development of the city. This plan showed the coastal area as a critical area of the city, because of the clandestine landfills.

Once in the XXI century, in the year 2006, the “Municipal Natural Coastal Reserve with Specific Purposes” was declared bylaw N° 13.892. This included an area of approximately 319 hectares of municipal land, other areas refilled in the coast and the open dump Belisario Roldán.

In the year 2011, a tender was launched to build the first stage of the seafront “Paseo del Humedal”, located on the former dump. The goal of the project was to develop the recreational and touristic activities on the estuary coast, increment the community knowledge on the value of natural ecosystems (particularly those of the estuary) and promote the people care towards natural environments. Among the works executed, terrain elevation is done to avoid flooding, paved parking lots are created and the coast is protected with gabions. All these works were done without considering the location of the landfill on the floodplain of the estuary, the leachate of the accumulated waste and the need to remedy this environmental liability.

Chronological evolution of the Municipal Solid Waste Management

Up to the 40 decade, Bahía Blanca MSW was dumped in a four block green area located between the streets of Brickman and 25 de Mayo of de city.

From the 50s up to the 70s, this area started to expand due to the demographic growth of the city, leaving the waste dump close to populated zones. The need of coastal terrains to deposit the garbage started. This situation created an open landfill named Belisario Roldán, located next to Maldonado Swimming Pools on the seafront, increasing its size along the flood plain of the estuary. Garbage was used to fill different sections of lands reclaimed from the sea for productive projects (Sartor, 2000).

In the 80 decade, the community and media worries about the water quality of the estuary increased because of the proximity of the open landfill to the Municipal Maldonado Beach, since the swimming pools of the bath area were filled with the estuary waters that also covered the flood plain were this environmental liability was located. For this reason, controls on the water quality started at the watering place and the first proposals to relocate the MSW began.

Since 1992, the area of the Belisario Roldán waste dump was assigned only to inert waste (mainly spoil or rubble) with the purpose of filling the place where the urban park Almirante Brown on the seafront was projected. The MSW was sent to a landfill located on 229 Route, southeast of Bahía Blanca. Since then, the coastal area where the landfill was located could not be recovered. Only in 2011 the idea of approaching the community to the sea started, considering the integration of urban uses in the coastal zone, through the execution of a Project called “Paseo Marítimo del Humedal”. This included the former landfill, even though the area now keeps receiving clandestine garbage.

Chronological evolution of products accumulated in the former landfill

Before the 70 decade, the city waste was generated by small and medium metallurgical industries, mechanic and carpenter shops, food providers, meat packing plants and garbage from the burning of sunflower husks. Because of this, the former landfill received metals, organic waste, packages (glass, cardboard, paper), oils, fats, petroleum by-products, pathologic waste.

Since the 70s, new industries, habit changes in the population and new technologies (mainly electronic) started. New types of garbage appeared: plastics and fertilizers, agro industrial, chemical, construction, printing and computers products, health and industrial inputs, beside the pathological wastes, slaughterhouse waste, urban wastes and those from gas stations. For this reason, it is possible that the MSW dumped in this landfill until the 90s, has products that may be leaching and may be the source of the metals appeared dissolved in the estuary waters.

For example, it could have products containing:

Cadmium (Cd): Ni-Cd batteries; components of electric tools; walkie-talkies; shavers, video cassette recording equipment; galvanized; welded pipes sections; cans whit scraps of paint pigments and preparations based on cadmium compounds (fluorescent paints); mineral fertilizers or phosphate chemicals materials; cathode ray tubes; old televisions (components fluorescent of black and white TV and activators to produce blue and green in color TV tubes); old PVC cables; photographic film; dye wastes and printing; glass, among other things.

Lead (Pb): pipes; batteries; dumbbells; projectiles and ammunition; coating for cables; sheets for X-ray protection and house roofs; paintings and varnishes; cathode ray tubes; ceramics and enamels (glass), electrodes for electrolysis of glass for computer screens.

Copper (Cu): coins; cables; tubes; wires; radiators; brakes; bearings; coil boilers; musical instrument parts; fertilizer packages, pesticides y algacidas.

Zinc (Zn): galvanized elements; automobile parts; electric equipments toys and ornamental articles; sheets for house roofs; batteries; photoengraving plates; paint cans, lacquers and varnishes; rubber remains; bronzers and creams to heal wounds, vitamin supplements; glass, matches, white glue, printer ink; pesticides and fungicides; remains of dyed or stamped tissues.

Chromium (Cr): treated wood; stainless-steel kitchen articles; toners; batteries; candles; dye residues; rubber; cement; refrigerators; electroplating and metallurgy remains; leather tanning and chemical labs wastes; remnants of firebricks and refractory materials; magnetic tapes used in cassettes.

Nickel (Ni): coins; stainless steel; Nickel colored ceramic; batteries; catalysts; magnetic substances, steel waste.

Mercury (Hg): electrical and electronic switches; dental amalgams; soda caustic containers; biocides and pesticides; paintings; laxatives, antiparasitics and dentitions powders; fluorescent lamps; thermometers, barometers, gauges to measure and control pressure; data transmitter relays; thermostats; batteries; radio and TV transmitters; TV cameras; cathode ray tubes; diodes, transistors and semiconductor devices; Pigments and dyes; latex, antifouling paintings; gyro compasses with mercury; railways signs, tanned and steel engraving; certain types of color photo paper; fusils.

SAMPLING IN THE ESTUARY

Table N°2 is the result of the processing and evaluation of the analysis results in the estuary monitoring stations E6 and E6-BIS, done by IADO (2006-2011) and CTE (2012). The comparison of these results with the reference values proposed by NOAA and by National Act N° 24.051 (Decree N° 831/93), is exposed in the following Table with the maximum concentrations detected. Those concentrations that have surpassed anyone of the guideline levels are highlighted in red.

This table shows that all the analyzed metals (Cd, Pb, Cu, Zn, Cr, Ni y Hg) have been found sometime in the waters of the estuary near the former landfill. Particularly, in station E6, the concentrations of Pb and Hg at some point have overcome the NOAA reference levels of Chronic Exposure and those at Decree N° 831; and those of Zn have surpassed the NOAA Acute Exposure levels and those at the mentioned Decree. For station E6-BIS the most significant concentrations area those of Cu (still under review) surpassing all the reference guideline levels; the one of Ni overcomes the NOAA Chronic Exposure values and those of the mentioned Decree; and the Hg only surpasses this last one.

Estuary stations	Cd (µg/l)	Pb (µg/l)	Cu (µg/l)	Zn (µg/l)	Cr (µg/l)	Ni (µg/l)	Hg (µg/l)
E6	0,40 ⁽²⁾	19,63⁽⁴⁾ 10,14⁽⁴⁾ 9,57⁽³⁾	1,80 ⁽⁴⁾	6,40⁽⁴⁾ 4,93⁽⁴⁾ 150,44⁽³⁾	2,26 ⁽¹⁾ 2,21 ⁽⁴⁾	2,39 ⁽²⁾	0,12⁽⁴⁾ 0,41⁽⁴⁾ 0,35⁽⁴⁾ 1,06⁽³⁾
E6-BIS	0,014 ⁽⁵⁾	4,30 ⁽⁵⁾	1227⁽⁵⁾⁽⁶⁾	⁽⁷⁾	⁽⁸⁾	18,80⁽⁵⁾	0,83⁽⁵⁾

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- (1) IADO, 2008 - (2) IADO, 2009 - (3) PIM Adenda, 2009/2010 - (4) IADO, 2011 - (5) IADO, 2012.
- (6) The value that has been published, is not yet included in the data base because it is being analyzed to determine whether or not it is an anomalous value (PIM 2012, Sub Programa Ría Bahía Blanca).
- (7) All the values detected in the monitoring period surpass the guide levels of Decree N° 831, without specifying values (PIM 2012, Sub Programa Ría de Bahía Blanca).
- (8) Detectable values are indicated, without specifying values (PIM 2012, Sub Programa Ría de Bahía Blanca).

Table N°2: Maximum concentrations of metals dissolved in estuary waters (Period 2006-2012)

Even though the evaluated results are not statistically representative and do not show signs of alert, as the IADO highlights in its reports, the existence of metals dissolve in water indicates recent incorporation into the system, this phase is extremely ephemeral for metal compounds and quickly displaced to other system compartments (e.g., suspended particulate matter, sediments and organisms). Consequently, already mentioned concentrations of metals dissolved in waters of stations E6 and E6-BIS show present incorporation and, in turn, the existence of one close source introducing it into the system.

FINAL REMARKS

Monitoring results in estuary waters close to the former landfill Belisario Roldán, show the existence of concentrations of some metals. This would appear to be a consequence of the leaching of the residues that advanced on the floodplain during more than four decades. The garbage dumped without waterproofing, its degradation, its leachates and constant flooding, would be modifying the estuary water quality in this location.

Locally, it is necessary to update the current regulations concerning the guidance values for those parameters that have not been legislated or that need review, to unify criteria between international and national regulations. This would lead get to better conclusions. In addition, in terms of monitoring, the number of samples should be statistically representative. It should indicate in each one, date and time, weather, tides. This would give more support to the results.

No environmental regulations concerning management of MSW (Municipal Solid Waste) existed when the former landfill started in the 50 decade. The idea of land reclaimed from the sea through garbage was reinforced by the lack of knowledge and legislation about the adequate treatment of MSW. At that time no environmental impact assessments were requested. Thus, leachate was not considered to be a threat to the sustainability of the estuary and its use for future generations.

Only in the 70s, the international environmental regulations appeared in Stockholm Convention. This was a starting point for the appearance of the environmental awareness. From that moment, the national regulations with the first laws that prevent the contamination of the water through the discharge of residues appeared. In 1992, at Rio de Janeiro's Convention, a growing and development world paradigm was proposed, including ecological, social and economic aspects. Along with this world trend, in 1993 the National Act on Hazardous Waste was stated. In 2006, the first regulation about integrated management on MSW appeared in Buenos Aires Province, Argentine Republic.

In Argentine, the MSW management belongs to town government. The province governments are the owners of the natural resources. They have the duty to take care and preserve them, avoiding potential negative impacts on the environment and the population health, that might happen because of inadequate treatment of solid waste. This shared management needs a plan that warranties health, protection and preservation of the environment. Particularly in this paper shows how the estuary's recreational areas, flora and fauna are engaged because of this.

The lack of regulations and the ignorance about the risks that an open landfill on estuary floodplain could cause, enabled the location and growth of this landfill. The leaching of it creates a diffuse discharge, difficult to control and to solve. This problem becomes to be a challenge. The Buenos Aires Act N°14.343/12 about Environmental Liabilities states as a goal "legislate the identification of environmental liabilities, and the obligation to restore contaminated sites or areas with population health risk, with the idea of reducing the environmental negative impacts".

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