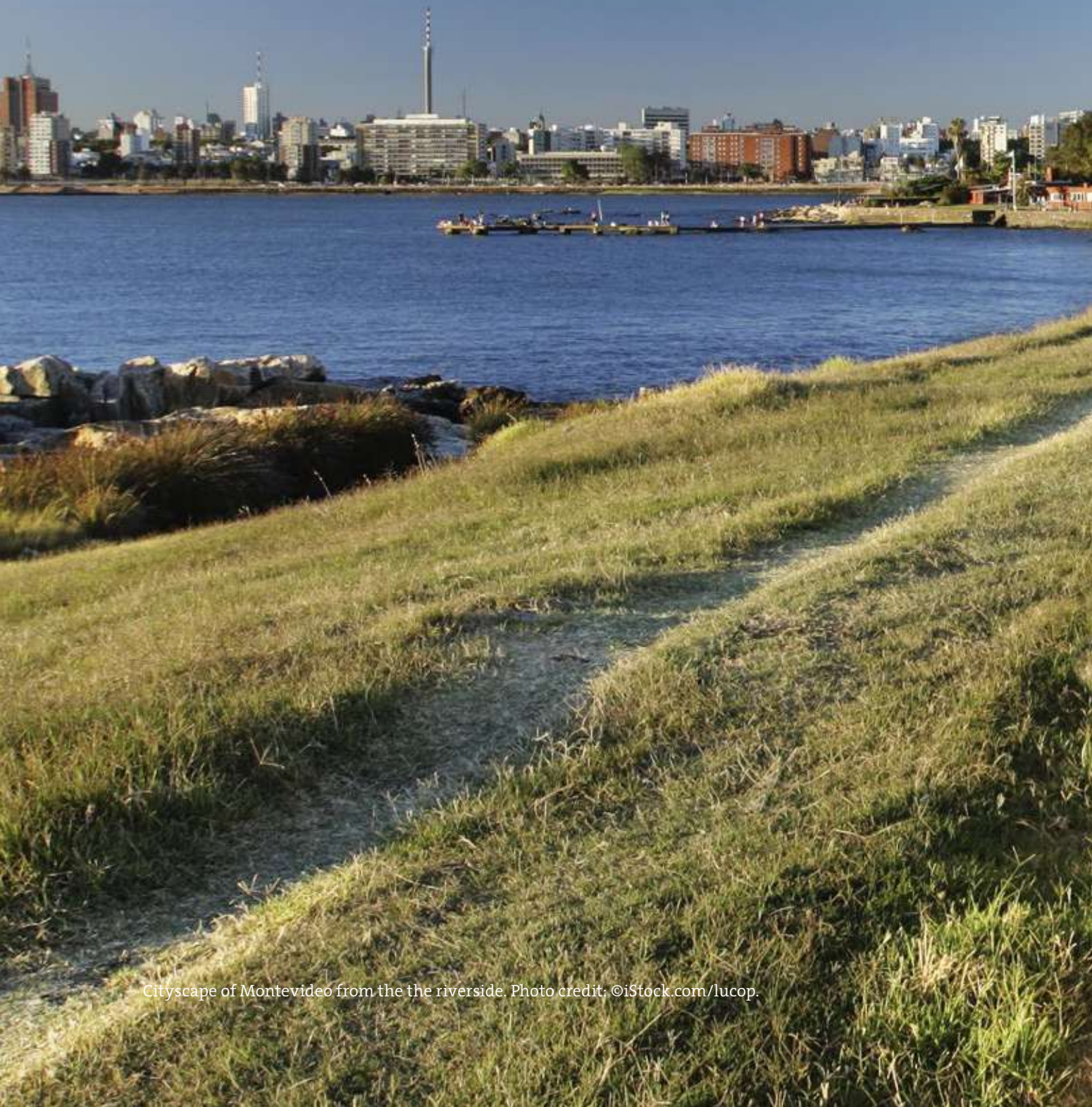


Uruguay



Cityscape of Montevideo from the the riverside. Photo credit: ©iStock.com/lucop.



“Uruguay has a very high urban population of 95% of the total with more than half living in the capital, Montevideo, and its surrounding metropolitan area. Uruguay is close to providing universal access to drinking water through its single water utility company. The management of rainwater in better designed urban drainage systems is one of the special challenges confronting management authorities”

Urban Waters in Uruguay: Progresses and Challenges to Integrated Management

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Summary

Within the context of South America, Uruguay is a small country with gently undulating terrain and an evenly distributed water supply, with average precipitation of 1300 mm per year without a specific seasonality. The urban population comprises 95% of the total (3,390,077 inhabitants), with more than half living in the capital, Montevideo, and its surrounding metropolitan area. Population growth is low, since the country has consolidated its urban transition (in 1963, the urban population accounted for 81% of the total).

The country's regulatory framework is advancing towards the integration of water, land and environment, as borne out by the amendment to Article 47 of the Constitution, which states that the protection of the environment is in the interest of all citizens and that access to drinking water and sanitation is a fundamental human right. However, the regulation and implementation of this regulatory framework is as yet incipient.

Uruguay is nearing the provision of universal access to drinking water through its single water utility company, OSE, Obras Sanitarias del Estado (State Sanitation Company). The challenge currently lies in protecting water resources, reaching small rural communities and reducing losses in distribution systems. And although sanitation coverage is high, the challenge is to expand sewerage

coverage, increase the amount of treatment for wastewater and household connections, and investigate alternative sewerage systems capable of providing service for inaccessible areas.

As for storm water management, problems in the drainage system affect the capitals of the departamentos or provinces into which the country is divided and small localities. Since over 60 urban centers are affected by drainage problems, with 70% of the cases classified as moderate to serious, the challenge is to improve and develop planning systems and incorporate more sustainable technology.

Floods are the main factor activating the National Emergency System. Since cities with flooding problems are distributed evenly around the country, the challenge is to incorporate risk maps into local plans, strengthen riverbanks and improve monitoring and warning systems.

A change is taking place in Uruguay, from sectoral visions to a more integrated vision of urban waters. This translates into a non-linear process of dynamic, multi-stakeholder transformations with enormous potential, although they are not free of difficulties. Increasing coverage and access to all water services, incorporating water into land planning, improving the quality of and access to the information required for effective decision making, adjusting the system of governance, strengthening technical capacities, encouraging an interdisciplinary approach and involvement of cross-cutting spheres are key issues for sustainable urban water management in Uruguay.

1. Introduction

This chapter proposes an interdisciplinary approach to identify and systematize the main problems affecting the urban water in Uruguay and determine how they affect the quality of life in cities; what their causes are and which processes, if not addressed, will exacerbate problems. Emphasis is also placed on identifying the engines of change towards sustainable models.

To this end, the Uruguay Academy of Science (by invitation of the IANAS (Inter-American Network of Academies of Sciences) Water Program and the Urban Water Supply Group of the International Hydro-

logical Program for Latin America and the Caribbean at UNESCO (Spanish acronym PHI-LAC) brought together a wide-ranging group of specialists in an attempt to set a baseline to provide continuity for technical and scientific coordination and generate integral information.

1.1 Conceptual focus of the study

The quality of life in cities, where urbanization has significantly changed the natural characteristics of the water cycle, depends largely on their water management. Intensive water use, particularly because of the infrastructure required for its use and final disposal, has further complicated its dynamics and has generated particularities comprising the urban hydrological cycle (Marsalek et al., 2008).

Surface and groundwater, supply water (drinking water for the population and raw water for non-domestic use), wastewater, and storm water interact with each other, impact and are affected by the city. The historical lack of an integral understanding of urban water and its link with the territory has led to disconnected policies, works and structures, which has become one of the leading causes of the problems identified in Uruguay and elsewhere (Piperno and Sierra, 2013).

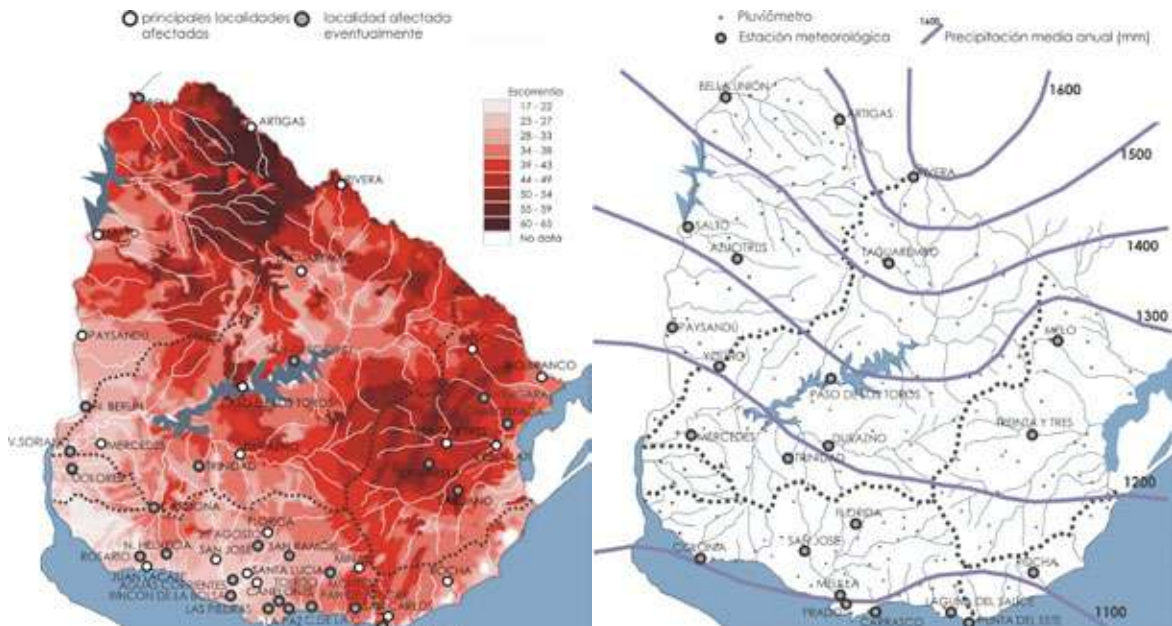
This chapter begins with an explanation of how the current situation arose, how each subsystem in the urban hydrological cycle developed and what its main challenges are. It then examines the framework of the urban water supply's system of governance in order to describe the country's main challenges.

1.2 General Characteristics of Uruguay

Uruguay's urban population¹ (3,390,077 inhabitants, National Institute of Statistics, 2011) accounts for 95% of the total with over half being concentrated in the metropolitan area of Montevideo, the capital. There are only three cities with approximately 100,000 inhabitants, the rest being medium-sized and small towns. The country has a low population

1. Urban population (according to the criteria used by the National Institute of Statistics (Spanish acronym INE) is a population that resides in all portions of land that, from the point of view of the census, are defined as blocks with at least 10 households.

Figure 1. Average run-off (mm/month) (left) and average annual rainfall in Uruguay (right)



Source: Urbanism Theory Institute, (Spanish acronym ITU) Architecture Faculty, based on data from the Institute of Fluid Mechanics and Environmental Engineering (Spanish acronym IMFIA) Faculty of Engineering and the National Office of Meteorology.

growth rate² (National Institute of Statistics, 2011) and has consolidated its urban transition (the urban population in 1963 was 81%)

Within the context of South America, Uruguay is a small country (176,000 square km) with gently undulating terrain and a dense, evenly distributed water network; average rainfall is 1300 mm per year with undefined seasonality (Figure 1).

The country's GDP is \$49 billion USD (GDP/capita \$13,500 USD), making it a high income country according to the World Bank. The last decade, after the severe economic crisis of 2002, was characterized by constant economic growth (an average of 5.5% over the past 10 years), which has affected employment levels (6% unemployment in 2013). Life expectancy at birth is 76 years, there are high levels of educational attainment (nearly 100% net enrolment in primary school and almost 70% in secondary school, according to the World Bank) while 62% of households are connected to the Internet (see: <http://datos.bancomundial.org>).

2. The growth rate is 0.19% per year (National Institute of Statistics Census, 2011).

2. Historical Development of Urban Water in Uruguay

Societies reproduce the structures they inherit, then make their mark on it, thereby determining future transformations. Thus, each era forms cities, which, in turn, affect the way of life in them. In order to understand the link between the city and the water supply, one has to understand the urban and environmental paradigms of each era and how they affect and influence a city, the needs of its inhabitants and the way the surroundings are understood.

Within this context, it is possible to point out certain singular events that characterize a city and its relationship with water. Firstly, cities in Latin America bear the stamp of Spain and Portugal, which set out "to make the American world (which they considered to be empty) a world of cities", like the European world (Romero, 2009). Water played a decisive role in the occupation of land since it was regarded as both a source (mainly freshwater) and a receptor where to deposit waste.

Most of the cities built on rivers “turned their backs” on the watercourse and focused more on services, equipment and the population, structured by the main streets and central plazas constituting symbolic places. Drinking water was stored in a system of reservoirs and wastewater was disposed of on the land or through individual systems of wells that eventually emptied their contents into the nearest riverbed.

The rapid industrialization, expansion and densification of cities at the beginning of the 18th century without considering sanitation transformed the polluted water into a source of disease that affected the quality of life of both the new salaried classes and the new bourgeoisie. In response to this, a school of thought arose in Europe called the “hygienist model” that associated health with urban development and developed a vision of healthy cities, associated with the construction of large-scale works. Montevideo, in particular, was not exempt from this problem and incorporated these “solutions” developed in Europe into both the building of the infrastructure and the design of parks and gardens. The second half of the 19th century saw the modernization of urban services. Cities began to be provided with sanitation, drinking water, electricity, railway and tram services. Montevideo was the first city in South America to have a sewage network (drains). Between 1854 and 1916, 211 km of sewers were built (Arteaga network), although private connections were not compulsory until 1913. In the provinces this development began later.

As far as potable water is concerned, the 1867 drought triggered the decision to provide permanent water service in Montevideo, with the Santa Lucía River being chosen as the main source. The service was run by licensees from 1871 to 1950, when the state took over. In 1952 the State Sanitation Company (Spanish acronym OSE) was established and since then, this organization has been responsible for the provision of drinking water, drainage and wastewater treatment services in the provinces, whereas in Montevideo, these services were provided by the Municipal Government. The hygienist model led to a reappraisal of urban parks with the water supply being the central factor. Cases in question include the development of the Prado Park in Montevideo that took into account the flow of the Miguelete River in its design and also the works carried out by the Cities and Town Improvement Department of the Ministry of Transport and Public Works.

The modern city gradually materialized and its water supply, small natural streams, sewer networks and storm water collection were supposed to take place invisibly, underground (Figure 2).

Urban expansion progressed during the 20th century with the creation of formal and informal residential developments, which ignored small water courses (Figure 3). The state was subsequently asked to provide the missing urban infrastructure. Depending on the physical characteristics of each city, the banks of large rivers either became an attractive urban residential area, or were

Figure 2. Miguelete River in Montevideo. Visit to the Arteaga Network c. 1900



Source: Photography Center (Montevideo City Hall)

Figure 3. Blocks in the city of Salto in 1892 (Agrim. T. Herrán). This shows the lack of knowledge about the natural course of the Sauzal Stream in the north of the city



Source: L. Vlaeminck

consolidated, as happens in many medium-sized Uruguayan cities, as another “poor” periphery where the poorest families settled on the flood plains.³

The crisis experienced by the country in the early 1960’s (after several decades of growth) spawned new forms of territorial settlement, with irregular urban growth in sectors without services, occupying the riverbanks and flood plains of urban water courses. Public investment dropped sharply, leading to problems that highlighted the inadequacy of the existing infrastructure, difficulty in building new public works and the failure to incorporate water sources into the design of integrated urban solutions.

In the past decade, economic stability in Uruguay has achieved progress in services and infrastructure in cities. New approaches to urban water management have also gradually been adopted.

3. Although the Law of Population Centers (N° 10,723, 1946) residential areas not be constructed in flood areas and that private constructors provide adequate services for effective urbanization, the inability to ensure compliance with this law has resulted in extended cities that lack services.

3. Drinking water supply in urban areas

A total of 98% of the population in Uruguay enjoys access to drinking water, with an average consumption of 130 liters/household/day (see: www.ose.gub.uy). With an almost universal supply of potable water to urban centers, the challenge lies in providing this service to small nuclei of rural dwellings. In order to achieve the Millennium Development Objectives, the OSE (the State Sanitation Company) plans to provide drinking water, collectively and individually, for an additional 28,000 inhabitants in rural townships across the whole country by 2015 (see: www.ose.gub.uy).

3.1 Drinking water coverage at the urban level

Drinking water coverage in urban areas in Uruguay is among the highest on the continent (Rojas, 2014) who used the main indicator as the availability of drinking water delivered to households by pipes. Over the past few years, Uruguay (like other countries) has used other indicators that fail to distinguish between water being provided inside or outside a home and which use the term “improved sources.” Having a service with improved sources means that: 1) the source of the water is a general drinking water supply network or ii) a protected emerging well.

It is important to note that the high coverage rate of this service in the country is historical. In 1996, 83% of the urban population had access to drinking water through a public network connected to their homes. Currently, according to data from the 2011 Census, 96% of the urban population are connected to a general supply network and 99.4% have access to potable water through an improved source inside or outside their dwelling.

3.2 Drinking water service provision through networks

Potable water supplied through a network to a permanent population is mainly provided by the OSE (the State Sanitation Company) (with over 99.5% of the population being served by network). The service is provided in accordance with the

provisions of Article 47 of the Constitution and the Law for the Establishment of the State Sanitation Company, which was enacted for social rather than economic reasons. Information on the State Sanitation Company (OSE) is given in Table 1.

The State Sanitation Company fee structure allows the poorest, most marginalized communities as well as those that fulfill certain conditions to have access to drinking water. Subsidies are granted to those that consume between 10 and 15 cubic meters, depending on the individual case, and the company also has an action plan that allows for access to drinking water in irregular settlements (see: www.ose.com.uy).

There are also other organizations that make important contributions to the provision of potable water to low-income groups in cities: the Program for the Improvement of Neighborhoods, which regularizes settlements and improves the neighborhoods inhabited by these groups (Spanish acronym PMB-PIAI); the Juntos (Together) Plan which undertakes social works and the Housing Programs of the Ministry of Housing, Territorial Arrangement and Environment (MVOTMA) designed to improve the habitat of people living in extreme poverty and precarious housing (Rojas, 2014).

The State Sanitation Company's potable water service is not subsidized and or exempt from taxation; its investment in service improvement is therefore financed by the income obtained from its service provision. Since drinking water service is profitable, some of the earnings are invested in sanitation works, which are currently deficient.

3.3 Water sources

Availability

Article 47, Section C of the Constitution states that the National Water Policy is based on, "establishing priorities for the use of water by regions, basins (or parts of them), the main priority being the provision of potable water to the population".

Surface water. Uruguay has extensive surface water resources, and an average annual rainfall of about 1300 mm, uniformly distributed throughout the year and across the country. However, the availability of freshwater for conventional potabilization has certain constraints, including the fact that on the Atlantic shoreline, saltwater intrusion has been found in some of the water courses. There is also significant climate variability, with frequent periods of drought resulting in flows far below the monthly average. In several cases, this situation has required the construction of reservoirs (the State Sanitation Company has 22 reservoirs) and the undertaking of extensive pumping. This is the case of Montevideo, supplied by the Santa Lucía River located about 56 km from the city as well as by two reservoirs, measuring 70×10^6 and 20×10^6 m³. Since the introduction of these reservoirs, apart from specific cases that have been addressed, problems have not arisen during extreme drought events.

Groundwater. Groundwater in Uruguay comes mainly from granular aquifers in sedimentary rocks and fissured aquifers in crystalline rocks. These and the less permeable granular rocks are located in 55% of the total area in the country, mainly in

Table 1. Information on drinking water service provided and managed by OSE in Uruguay (see: www.ose.gub.uy)

Localities served	More than 350
Service continuity	24 hours
Volume of water produced (annual)	348 million m ³ (Surface almost 91%; underground 9%)
Residential consumption rate (15 m ³ /month)	US \$15.7/month (dollar exchange rate on April 30, 2014) equivalent to 0.85% of average household income
Micro-metering	90% of water connections with meters that work
Non-billed water/water provided	52.6% (in 2013)
Financing	With income by rates; does not receive subsidies
Operating margin	16.9% (operating income invoiced – operating costs)/invoiced operating income 2013
Planning	Strategic planning and yearly action plans
Investment in drinking water infrastructure (2010-2013)	US\$165 million
Drinking water quality management	Progressive implementation of water safety plans 50,000 analyses per year

the south (the most populated area) and have low productivity, with flows of between 0.5 and 5 m³/hour. One of the main granular aquifers is the Guaraní Aquifer, covering a significant area of the country (approximately 33%, basically in the North). However, most of it is found under basalt rocks at great depths and the water is extremely hot, with temperatures of up to 45 °C, making it difficult to use as drinking water. There are other aquifers with good yields, such as the Raigón Aquifer, occupying only 1.3% of the country. In short, groundwater as a source of supply has many quantitative constraints in several parts of the country.

3.4 Water quality

Surface Water Quality. In recent years, surface water in Uruguay, especially that used to supply potable water, has shown a significant increase in its nutrient levels. Phosphorous has been the most commonly reported nutrient, with levels in many sections of different river beds that exceed the level for being classified as eutrophic. This process is related to significant changes seen in recent years in the production matrix in agriculture and livestock farming. This has promoted the development of blooms of algae, cyanobacteria and aquatic plants under certain environmental conditions. This phenomenon has also been seen in the Uruguay and Plata Rivers, jurisdiction of which is shared with Argentina. Since this phenomenon affects water quality, the government has taken measures, such as formulating the Plan for the Protection of the Santa Lucía River Basin (see Box 10). It has increased its monitoring programs and set up Regional Water Resources Councils and Basin Committees whose members include representatives of civil society, as well as demanding that agriculturalists propose land use plans for certain activities.

The State Sanitation Company has also included surface water quality as a part of its strategic planning and has already approved action plans for 2014. Moreover, in terms of potable water production, several actions have been undertaken to improve the quality of potable water, such as improving hydrobiological monitoring and determining cyanotoxins with the introduction of warning protocols (including a preliminary protocol at the production level), introducing the use of activated

carbon at existing drinking water production plants and incorporating these units into the construction of new plants.

Groundwater Quality. In general terms, groundwater quality is not a problem when used as a drinking water source, except in isolated cases. These isolated cases are derived from the hydrological characteristics of certain aquifers, salinization caused by over-exploitation, human contamination caused by agricultural activities or inadequate wastewater systems (e.g. a lack of sanitation networks). It is necessary to advance groundwater management, however, and knowledge of many of the aquifers is still limited (some, like the Raigón and Guaraní aquifers have been studied in depth). For example, there are very few vulnerability studies and little has been done to develop the perimeter of protection of the wells (which in any case have not yet been legally established). Another aspect to be considered is ensuring compliance with the laws.

3.5 Drinking water and communicable diseases

Among the diseases caused by lack of availability of drinking water, which must be reported by law in Uruguay, there are three major ones of worldwide importance. There have been no cases of typhoid fever or cholera reported in Uruguay (nor have there been cases of the cholera epidemic that ravaged Latin America in the 1990s). Hepatitis A has an incidence of 0.65/100,000 inhabitants, although it is important to point out that since 2008, there has been free, compulsory vaccination against Hepatitis A. In 2012, the infant mortality rate in Uruguay was 9.3/1000 live births (the post-neonatal mortality rate was 3.7/1000 live births). In the cases of deaths of infants under the age of one, 0.7% were caused by diarrhea and gastroenteritis. High drinking water coverage is an environmental condition that should be taken into account when considering these data (see: www.msp.gub.uy; www.higiene.edu.uy).

3.6 Challenges in drinking water provision

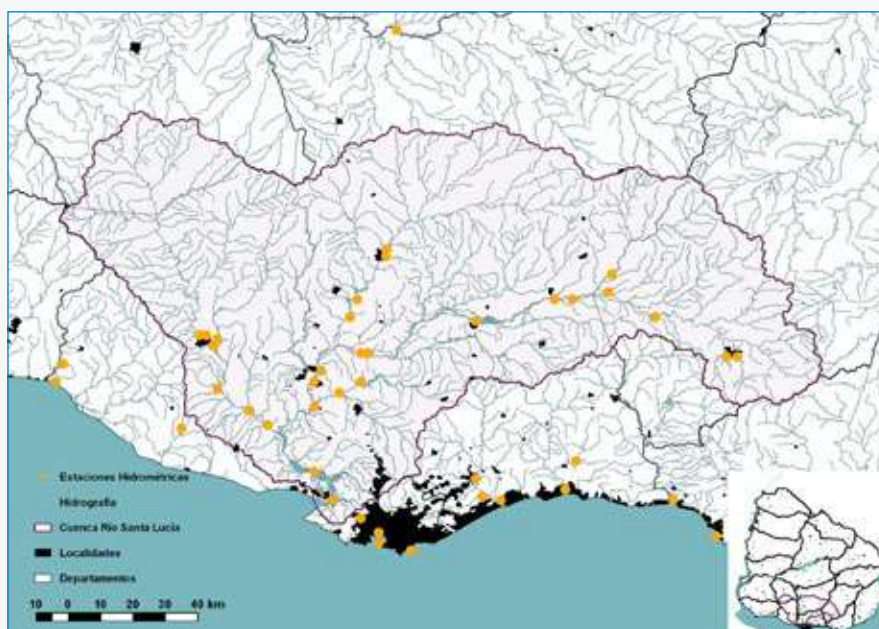
Below are some of the challenges related to drinking water provision at the urban level in Uruguay:

- Guarantee universal access to safe drinking water inside the home, since the lack of safe drinking water inside the home is regarded as

The Santa Lucía river basin, the main drinking water source in Uruguay

The Santa Lucía River supplies 60% of Uruguay's population with potable water. There are two reservoirs in the basin, (Paso Severino and Canelón Grande) and studies are underway for the construction of a new dam in order to ensure continued supply in the future. The basin covers 13,433 square km and nearly 32% of the total rural population lives there. It is one of the main food producing areas in the country, with significant industrial activity. This human activity has affected the quality of the water, accounting for 81% of the contaminants from different sources and 19% from point sources of pollution (industrial and domestic) (DINAMA-JICA 2011). Studies undertaken by researchers in the Department of Limnology of the Faculty of Science at the University of the Republic (UdelaR) concluded that most of the basin's tributaries are in poor ecological condition, with significant deterioration of the banks, the riparian vegetation and the canal. The physicochemical variables of the water demonstrated the effect of human activity on this environment, showing levels of phosphorous indicative of a eutrophic environment (Pacheco et al., 2012). This finding has worried politicians as well as the general population and resulted in the creation of an Action Plan designed to protect the quality of the water in the Santa Lucía River that features 10 emergency measures. At the same time, the Aguas Corrientes potabilization plant has been expanded and improved. As far as long-term measures are concerned, given the importance of the Santa Lucía River in the supply of freshwater to the metropolitan area, the Santa Lucía River Basin Commission (Executive Branch decree 106/2013 dated April 2, 2013) was created, which was regarded as a strategic maneuver by the Executive Branch.

Since its inception in 2013, the Basin Commission has served as a space for linking institutional and sectorial policy for water-related issues and its members (state, users and civil society) must agree on a contribution to the design and implementation of the Integrated Water Resource Management Plan for the Basin, in compliance with the principles established in the Constitution and regulated by the National Water Policy Law. It is the responsibility of this Committee to monitor the undertaking of the Action Plan.



a basic need that has not been met within the country. Just over 2.6% of the population still lacks access to drinking water supplied by a network inside the home, while approximately 1.3% of the population has access to drinking water inside the home supplied from protected wells, many of which, given the lack of quality control, cannot be considered sources of safe water. Most of the population without access to drinking water inside the home belongs to the most disadvantaged sectors, with a large percentage living in small localities. As already mentioned, the State Sanitation Company and other institutions are making efforts to improve this situation. The challenge is to set up and implement a national plan with objectives and goals.

- Improve the protection of surface water sources and recovery of surface water used for drinking water production and develop a better system for aquifer management and protection.
- Continue and reinforce the implementation of hydrobiological warning systems; improve the equipment in drinking water production plants and their management in order to address current and potential problems of water source eutrophication.
- Advance nutrient monitoring system in surface water, as well as the measures for controlling them.
- Continue developing Water Security Plans.
- Increase the invoiced water/used water ratio.
- Reduce potable water consumption by promoting the use of smaller cisterns, taps and showers with water volume control, washing machines that use less water; create legislation to this effect and step up the communications campaigns.

4. Wastewater

The sanitation sector in Uruguay has two situations: one in Montevideo and another in the rest of the country. There are several reasons for this: firstly, the capital city was the first urban center to have drain networks, much time before the provincial cities. Moreover, since sanitation in Montevideo was developed under just one system (storm water

and wastewater were linked in the same network), it was run by the government while the rest of the country's sanitation was the responsibility of the State Sanitation Company (OSE). This issue must therefore be approached by bearing these two situations in mind.

4.1 Domestic Wastewater

Decree 78/010 defines sanitation as "systems that transport wastewater through a network of drains or in special trucks and dispose of them in a treatment plant, as well as systems that store and dispose of wastewater "in situ" in filtering wells and/or by infiltration into the ground". A cesspool or septic tank is defined as an impermeable deposit where wastewater is stored; when its capacity is reached, it has to be emptied by "barometric trucks" (in Uruguay this is the name given to sewage tankers with cisterns into which wastewater or silt is suctioned). However Decree 253/79 forbids that wastewater be filtered into the ground in urban areas.

Sanitation coverage reaches 94% of households nationwide. Of those, 54% have a sewerage network, while most of the rest have cesspools or septic tanks (Table 2).

Sanitation coverage of sewage systems in the provinces is 43%, less than the national average (National Institute of Statistics, 2011), while Montevideo has the largest sewage network (more than twice the provincial average).

Montevideo

It is estimated that 90% of the urban population is connected to the sewage system, which covers 14,500 hectares and consists of 2,700 km of pipes and gutters. In Montevideo, there are two types of drains: the older ones are combined (transporting wastewater as well as storm water), which account for 60% of the total; while the remainder separate the two functions. Today, improvements and developments are only carried out on the latter system.

The objective of the sanitation and drainage system is to improve the quality of the urban environment. As already stated, the Sanitation Division of the City Council (IM) of Montevideo, unlike the rest of the country, not only operates the

wastewater system but also the whole drainage system, including storm water drainage and in management of the watercourses. Thus, both systems are simultaneously planned, built and managed, thereby eliminating interference and interconnection problems; the City Council also manages the waterbodies into which these systems release their contents.

When the final stage of the Plan for Urban Sanitation IV (Spanish acronym PSUIV) is completed, the final deposition of wastewater will be released into the River Plata by means of two underwater ducts. Before it reaches the duct, wastewater will pass through a pre-treatment plant with gates, sieves and sand removal equipment. One plant on the east of the city has been in operation since the 1990s. This plant is fed by the combined system and operates even when there is no rainfall. The future duct will only receive wastewater (given that it is connected to the system that separates the two types of wastewaters) from the west side of the city.

According to the 2011 Census, 14.2% of households in the Department of Montevideo use an impermeable septic tank for their wastewater. The goal of the Sanitation Division of Montevideo City Hall is to expand the system to the entire urban population to reach the 130,000 inhabitants in the urban area who currently lack this service. To this end, the Montevideo Sanitation Master Plan has been implemented since the 1990s; the Master Sanitation and Urban Drainage Plan (Spanish acronym PDSUM) whose planning horizon extends to 2050, is currently being updated (see Box 11).

Interior of the country

Approximately 42% of the urban population in the provinces has access to a sanitation network operated by the State Sanitation Company (OSE) with about 280,000 connections. This system is independent and only deals with wastewater, while stormwater drainage in the urban areas is the responsibility of each local government. Sewage coverage in the various urban areas is heterogeneous, exceeding 60% in some cities (with 30,000 to 70,000 inhabitants), though in some cases, it is less than 30%, and there are some areas (with over 20,000 inhabitants) in the metropolitan area that are still not connected to the network.

Although the State Sanitation Company is advancing in the construction of new sewage networks, particularly one in a major city in the metropolitan area (Ciudad de la Costa, with over 100,000 inhabitants) and major network extensions in several of the capital cities, there are still many towns with over 5,000 inhabitants (and even 10,000) that do not have a drainage network. Thus the proposed goals for sewage coverage through the sewage networks do not yet include the whole urban population.

On the other hand, 16% of the population that has a sanitary system in front of their dwelling is not connected to it. In order to increase the number of connections, the State Sanitation Company and the Ministry of Housing, Land Management and the Environment have created the National Sanitary System Connection Plan to provide financial support for low income homes for the purposes of improving

Table 2. Type of sanitation service in private households in rural and urban areas

	Total		Urban		Rural	
		%		%		%
Population (inhabitants)	3,286,314	100	3,110,701	100	175,613	100
Sanitation network		53.6		56.9		-
Septic tank		37.8		35.6		84.8
Pipes leading to a watercourse		0.6		0.5		1.6
Other system		0.3		0.2		1.1
Without sanitation services		1.6		1.5		3.3
Information not available (%)		>4		>1		>8

Source: INE, 2011 Census

their internal sanitary system so that they can be subsequently connected to the drainage system network (Rojas, 2014).

An important feature in Uruguay are the interferences and interconnections between the transport and evacuation of storm water and sewage waters in separate systems. This means that the network often works at overpressure, often causing a delay in the flow of water due to the connections, and overflowing into the streets (lifting up manhole covers), or channeling the flow into storm sewers or watercourses, with the corresponding negative effects.

Regarding sewage treatment, the State Sanitation Company's sanitation investment plan, begun in 1990, emphasizes the construction of treatment plants in urban centers with sewage networks. Twelve treatment plants have been built in several provincial capitals, while other cities have oxidation ditches and treatment lagoons. Thus, wastewater in approximately 80% of the homes connected to the sewage networks in the provinces is channeled into wastewater treatment plants. Cities located on the Uruguay, Negro or Plata Rivers only have pre-treatment plants, although plans are

Box 11

Montevideo Master Sanitation and Urban Drainage Plan

The city of Montevideo has a continuous sanitation planning process. Between 1992 and 1995, the first version of the Montevideo Sanitation and Drainage Master Plan (Spanish acronym PDSM) was created. This is a strategic plan whose planning horizon is divided into three periods: two 10-year periods (1995-2005 and 2005-2015) and a final period of 20 years to 2035. During the first stage (Urban Sanitation Plan III, Spanish acronym PSU III), 570 km of networks and 10 pumping and syphoning stations were built on the Miguelete and Pantanoso Rivers. Sanitation and drainage was extended to 3,900 hectares of the city and to 11,000 persons. The existing sanitation and drainage system was restructured while networks built during the 19th century were refurbished. Measures to reinforce organization were also adopted, including the design of new structures and management tools.

During the second period (2006-2015), extensions to the networks were completed and the final disposal sites on the west side of Montevideo were built, together with four pumping stations, a pre-treatment plant and a new underwater duct. Total investment in these two periods amounted to \$440 million dollars (an average annual investment of \$22 million dollars).

Due to the changes in the environment, society, the economy and practices, the strategic planning process began to be updated in 2005 with the Montevideo Sanitation and Drainage Master Plan (Spanish acronym, PDSMUM) (see: www.montevideo.gub.uy). In the figure in this box, blue shows the final disposal system on the west side of the city (to the Punta Yeguas duct); violet indicates the final disposal system in the east, (Punta Carreta duct) while green denotes areas without sanitation services, mostly in rural areas.



in place to improve the quality of waste disposal. Likewise, there are residential complexes subsidized by state programs with independent treatment systems (individual septic tanks and lagoon systems) run by the State Sanitation Company. Table 3 shows the domestic sewage treatment plants managed by the State Sanitation Company nationwide.

Fifty-eight per cent of the urban population in the provinces lack a sewage system network although they do have septic tanks managed by their users. These tanks have an approximate volume of six cubic meters. Given that a typical four-person household consumes 18 cubic meters of water per month on average (130 liters/inhab./day), the impermeable tank must be emptied at least once every two weeks and its contents transported to the appropriate plants for their final treatment.

The service with barometric trucks are expensive for their users. Although theoretically impermeable, these systems often experience surface or underground losses, dumping their contents in the storm drains in the public thoroughfare or underground. A variation on this theme is the direct discharge of “gray water” (water used for washing and cooking) into the street to delay the filling of the septic tank. According to the 2011 Census, only 65% of homes with a septic tank use sewage tankers. According to an estimate by the Potable Water

and Sanitation Division of the National Water and Sanitation Office, sewage tankers in cities in the provinces are able to handle just 16% of septic tank contents, assuming they were all totally impermeable. Moreover, there are not enough places for the sewage transported in these trucks to be dumped. As an example, only six departments have a suitable place for the disposal of these contents.

4.2 Non-Domestic Wastewater

Apart from domestic wastewater, there are several other types of wastewater in Uruguay.

Industrial wastewater: the authority in charge of regulating and controlling the disposal of industrial wastewater is the National Office of the Environment (Spanish acronym DINAMA) of the Ministry of Housing, Land Management and the Environment. Given that approximately 40% of industries that produce wastewater are located in Montevideo, Montevideo City Hall also controls and monitors these industries (National Office of the Environment, DINAMA, 2012). In 1996, a Plan for the Reduction of Industrial Contamination was launched, resulting in a significant reduction of the volume deposited which made it possible to achieve significant progress in the quality of industrial wastewater in Montevideo (Montevideo City Hall, 2012).

Table 3. Quantification of treatment systems managed by the State Sanitation Company (OSE, 2012)

Type of system	Quantity
Pre-treatment and discharge	3
Imhoff tank	1
Activated sludge (extended aeration); nitrogen removal; UV disinfection	6
Transported in sewage transport truck	53
Treated in lagoons	229
Treatment of sewage by upward-flow anaerobic reactor (UASB)	2
Run-off plots	2
Imhoff tank with percolating filter	1
Activated sludge with conventional aeration	2
Activated sludge with extended aeration	11
Oxidation ditches-UV disinfection	1
Oxidation ditches	5
Dumping nearby system	38
Information not available	69
Total	420

Storm water and street cleaning: storm water carries solids, oil and other contaminants, but nationwide figures for this are as yet unavailable.

Water for businesses, shops and other services: some businesses (restaurants, laundries and dry cleaning, health centers, etc.) produce waste that constitute localized discharges of a significant volume and poor quality that are dumped into the sewage networks. These businesses need to undertake specific actions to improve the quality of their wastewater.

Leaching in final solid waste disposal: on a national basis, the broad majority of final Waste Disposal Sites (WDS) for solid waste are sites over which there is a widely varying degree of control, but which are not usually properly managed (Office of Budget Planning, Spanish acronym OPP, 2011). Of 23 WDS that receive more than 10 tons/day, only two have landfill characteristics and five have leachate recovery and treatment systems.

4.3 Sewage sector challenges

Below is a list of some of the main challenges facing the sanitation sector nationwide:

- Expand sanitation network coverage. Although construction of sanitation systems and treatment plants continues, (\$220 million dollars were invested during the period from 2010 to 2013), several major urban areas still lack this service. This is the case of at least 14 cities and urban centers with over 5000 inhabitants (six localities with over 1000 and seven with over 5000 inhabitants for an approximate total of 168,000 inhabitants), as well as outlying areas in cities that already have networks.
- Increase the number of connections in areas covered by networks. Connecting up with networks can be expensive, especially for low-income families. However financing and subsidy projects such as the Fondo Rotatorio de Conexiones (Montevideo) (the Rotating Connections Fund) and the Plan Nacional de Conexión al Saneamiento (National Sanitation Connection Plan) have been developed, and are supported by social promotion activities in order to make connecting up with a sanitation network viable.
- Provide alternative decentralized sanitation solutions to the impermeable septic tank and

improve quality standards. To this end, certain restrictions have to be overcome, such as the low technical capacities of municipal organizations; weaknesses in the legislation regulating the service (the existence of other systems that are not septic tanks is not contemplated), as well as users' lack of awareness of the system's shortcomings. Providing universal, affordable sanitation that is environmentally sustainable requires long-term planning that incorporates land-use management principles.

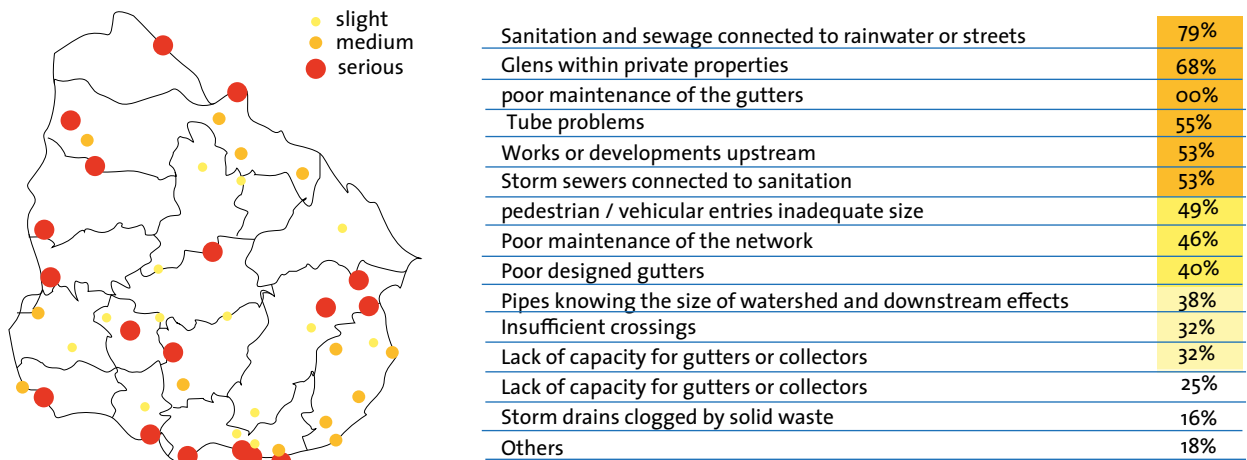
- Update the legislation for domestic and non-domestic wastewater. It is essential for the laws to introduce control criteria for disposal volumes; limits should be set not only on the basis of concentrations, but also of absolute volume.
- Investment to improve WDS management in the provinces. The improvements not only require an increase in funding but also in qualified human resources.
- Some areas that require immediate improvement in their operations have been identified: all aspects of control (control of discharge quality; monitoring waterbodies, etc.) and technical capacities in different parts of the country. Moreover, as in the potable water sector, institutional reinforcement is required for the departments involved in the planning and management of sewage services.

5. Stormwater

Stormwater provides several benefits for cities (use for irrigation and green areas, among others). However, from the traditional hygienist point of view, its management focuses on conflict resolution, which conceals its potential. This section presents the country's main problems affecting rainwater drainage as well as recent initiatives that are successfully addressing these problems and changing the approach adopted, in order to move towards a system of sustainable rainwater drainage management.

5.1 Principal problems

In Uruguay, storm drainage problems affect both capital cities and small localities. More than

Figure 4. Cities with drainage problems and type of drainage problem arranged by percentage of localities with problems

Source: MVOTMA/DINAGUA, 2011

60 urban centers are affected by storm drainage problems, with 70% considered to be moderately serious or serious (National Water and Sanitation Office, Ministry of Housing, Land Management and the Environment, 2011) (Figure 4).

The most frequent problems are caused by the conflicting interaction between subsystems: intrusion of stormwater into the sanitation system, reduction of drainage capacity due to interference from other piping systems; little or no consideration of water resources in city land planning (streams on private plots of land), upstream works or urban development, an increase in natural runoff, etc.), or cultural factors (poor management of gutters and storm drainage systems; sewage systems connected to storm water or vice versa, etc.)

Although stormwater drainage problems are similar between localities, local capacities to address them differ (Figure 5). The differences between provincial cities and Montevideo are significant, as evidenced by the fact that Montevideo has had a Master Plan for public works since 1994.

Montevideo has several sorts of flooding problems. In the consolidated urban area, the lack of drains causes flooding in the streets and homes. This is due, among other factors, to the design criteria applied to the construction of some of the networks (before 1950). Moreover, an increase in the impermeability of watersheds has caused an increase in

the water flow. Other types of flooding occur along riverbanks, and where dwellings have been built in areas liable to flooding. There is also a third type of flooding caused by high water levels of the River Plata, which can cause flooding even in times of drought. These occurrences, if they coincide with precipitation, cause the greatest impact in cities.

According to an analysis undertaken by the National Water and Sanitation Office, technicians in local governments believe that the problem is caused by lack of planning and human resources dedicated to planning processes. The absence of drainage system planning makes it impossible to analyze storm water drainage problems on a national basis, thus making it difficult to quantify the amount of investment required.

Nevertheless there is information from various sources that allows an estimate for the current situation to be made. The Urban Environment Census⁴ (The National Institute of Statistics 2011, Spanish acronym INE) yielded several items of interest: types of road surface, location of pipe infrastructure (gutters, drains, curbs), collection systems, (storm drains), as well as the existence of landfills. Although the information is very general,

4. Together with the Population Census, the INE undertook the first Urban Environment Census that classifies street sections according to their features and different types of infrastructure.

it does have the advantage of being national. The Urban Flooding and Drains Team of the National Water and Sanitation Office has identified problem areas related to water in cities using a participatory methodology with technicians and information on cities. The information was used to create conflict perception maps that identify storm water problems, interaction with other subsystems, proposals and complementary information (Figure 6).

Montevideo City Hall has a Geographic Information System that publishes land registry information on the drainage and sanitation system. The information describes the geometric and altimetric features of drainage networks and their special structures. There is also a general analysis and an estimate of what is required to solve existing problems and to develop and expand the city.

5.2 Advances and challenges in rainwater management

Within the framework of creating an effective public sector planning system, progress has been made in the following areas:

- Coordination with local Land-use Planning Teams, especially as regards to the designation of areas for city expansion, proposals for parks built on rivers, limits on the impermeability factor for soils, etc.
- Integration with other infrastructure projects in order to identify possible synergies among the different subsectors is beginning to be common. For example, the implementation of projects that combine storm water drainage with sanitation, roadways or park planning works.

Figure 5. Rainwater drainage problems in various cities in the country



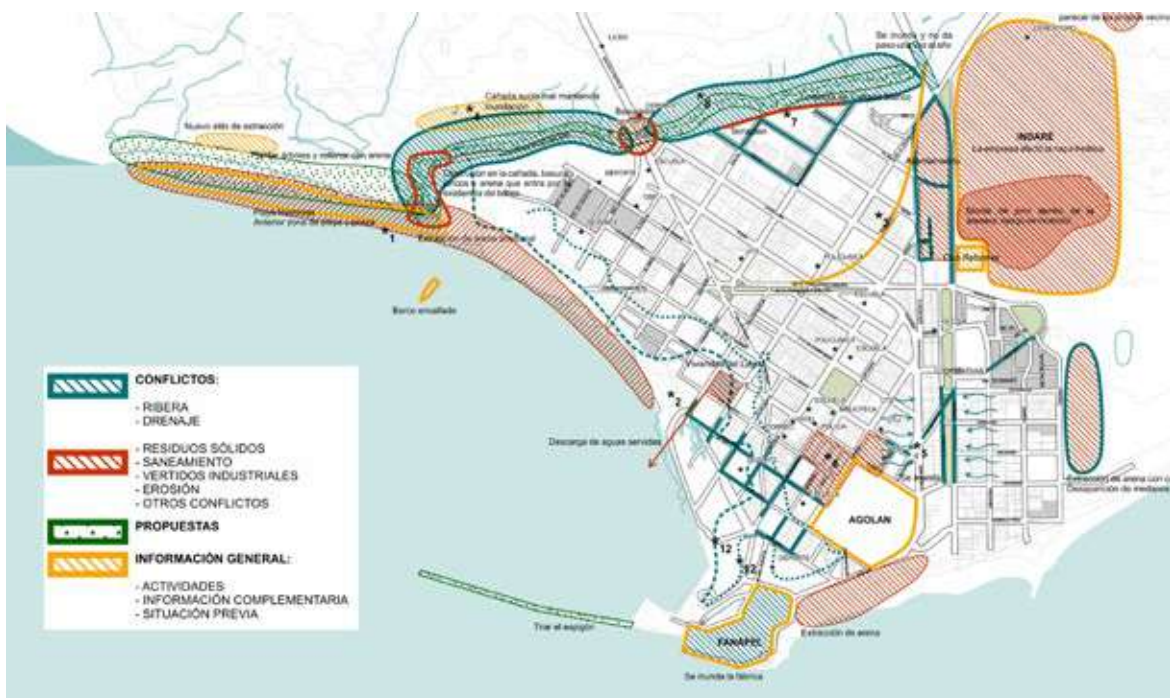
Source: MVOTMA/DINAGUA, 2011.

- Experience of control at source, both in Montevideo and more recently in other cities, has enabled the legislation to define measures limiting ground impermeability and buffering capacity within set standards. As a result, studies have been carried out in Montevideo on more than 20 residential buffer lagoons in large impermeable areas. Another interesting experience involved Ciudad de la Costa, where buffer ditches have been built to protect the water supply, thereby reducing its contact with the beach (Figure 7).
- Buffer pools in public spaces; for example, the construction of retention ponds has reduced the impact of flooding in several areas in Montevideo and in the provinces, and in many cases they have been able to be used by the public. In recent years more than six buffer areas or flood zones have been built, and a flood zone and four underground buffer tanks are currently in operation in Montevideo.
- Experience in the sharing of responsibilities and benefits by permitting exceptions in building laws, has meant that private constructors have built a number of storm water works (as in the case of the Diamantis Plaza building).
- Joint planning. The experience of planning and coordinated works has shown the need to undertake integral water management plans. Urban Water Supply Plans related to groundwater supplies, flooding, water for industrial and residential use, storm water drainage, industrial effluents and sanitation, and their link with solid waste and land-use planning are underway in the cities of Salto, Young and Ciudad del Plata.
- Updating the Master Sanitation and Drainage Plan (Spanish acronym PSDUM). Montevideo has a Master Plan that defined infrastructure works over the past 20 years. At present, the bidding process has begun to update this plan, whose projection horizon extends to 2050.

6. Urban Riverbanks

Riverbanks are a fundamental part of city life, but at the same time they are a problem (basically due to flooding) as well as providing an opportunity for recreation and tourism.

Figure 6. Juan Lacaze conflict maps



Source: DINAGUA/IDU, 2012

Urban floods

Most of the rivers and streams in Uruguay lie on slightly sloping alluvial plains, with long, slow swelling as opposed to the sudden, short swelling typical of mountain rivers and streams that flow quickly down steep slopes. Flooding severely affects local economies and cities, though loss of human lives or injuries to people are rare

6.1 Situation in cities

Since 2000, 73% of the events recorded by the National Emergencies System were hydro-meteorological (floods, drought, storms, hailstorms, tornadoes) and 63% were floods. According to that database, more than 30 population centers located in 18 of the 19 provinces in the country have been affected. The population of 25 of these centers, of which 14 are capitals of their provinces, amounts to over 10,000.

Nationwide, more than 67,000 persons have been affected since 2000, with the situation being

considered critical in the city of Río Branco, where more than 20% of the population were affected by the worst flood ever recorded (2002), Durazno (6,966 evacuated in 2007), Artigas (5069 in 2001), Paysandú (4,355 in 2009), Salto (3,230 in 2009) and Ciudad de la Costa and Costa de Oro in the 2014 floods (Figure 8).

The reasons behind the scope and persistence of the problem are varied and complex. Hydro-climatic factors (such as an increase in the magnitude and frequency of flooding causes, such as rain and/or sea level) can be critical, but do not fully explain the impact caused, since the risk of flooding is a process of social construction of threats and vulnerability (Blaikie et al., 1996), which complicates the search for long-term solutions.

6.2 Advances and challenges regarding floods

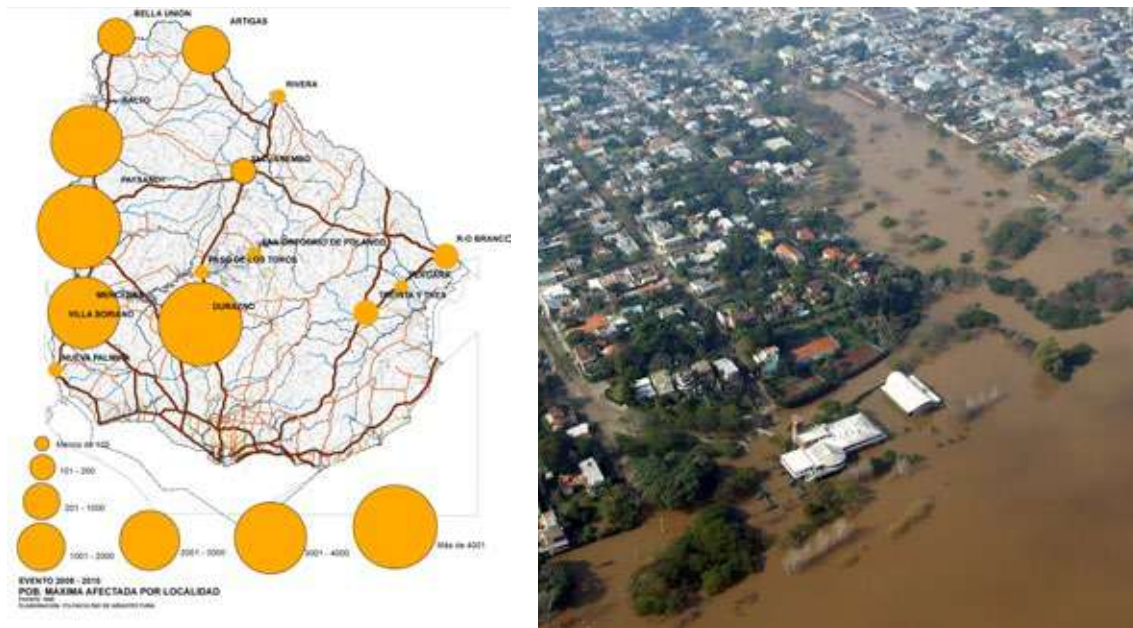
For a number of years now, integrated flood measures have begun to be implemented (Integrated Risk Management, Integrated Flood Management). A process exists for the coordination of structural

Figure 7. Storm drains in Ciudad de la Costa: buffer ditches (left); area with project not implemented (right)



February 2014 flood; Source: www.lr21.com.uy

Figure 8. Evacuees in the 2009-2010 floods (left) Salto flood 2014 (right)



Source: Piperno et al., 2009; Photo: Salto City Hall.

measures (civil works) and non-structural measures (regulatory measures, training, coordination and participation) and for risk management through prevention and mitigation as well as warning and response. Below are some of the measures in which Uruguay is currently advancing:

- Inter-institutional coordination: The Law of the National Emergencies System (Law 18621) promotes risk management through a national network, incorporating key national and provincial organisms. Though still very new, it is slowly being implemented.
- Advances in knowledge: in recent years the country has capitalized on the improved knowledge on hydrological processes in river basins, the hydrodynamics of rivers and fluvial ecosystems, and the concept of threat and vulnerability. Progress has been made in the analysis and evaluation of solutions and with in-depth studies that help management. The developments in the cities of Artigas, Salto, Tacuarembó, San Carlos, Treinta y Tres, Melo and Durazno are good examples of this, particularly the solutions proposed by the populations affected (San Carlos, Salto and Melo), and by the University of the Republic (UdelaR Spanish acronym) (Institute of

Fluid Mechanics and Environmental Engineering, the Institute of Theory and Urbanism, Faculty of Science, among others).

- Advances in professional training: there are experienced professionals who are trained to deal with flooding problems from the point of view of fluvial engineering, fluvial ecosystems, social and economic factors and land planning; training programs also exist that promote interdisciplinary action. However, the numbers and the nationwide distribution of these suggest that improvement in local training is required. The decentralization of the University of the Republic in 2009 and interdisciplinary options such as the bachelor's degree in Environmental Management, Applied Water Sciences and the master's degree in Integrated Coastal Management are some examples of this.
- Improve emergencies warning and management systems, particularly the Hydrological Warning System and the Emergency Action Plan (Spanish acronym PADE) at the Salto Grande hydropower dam and the Negro River dams managed by the National Administration of Power Plants and Electricity Transmission (Spanish acronym, UTE), as well as the Early Warning Sys-

tem (Spanish acronym SAT) currently in operation in Durazno and soon to be implemented in Artigas as part of an interinstitutional project supported by the National Innovation and Research Agency (Spanish acronym, ANII).

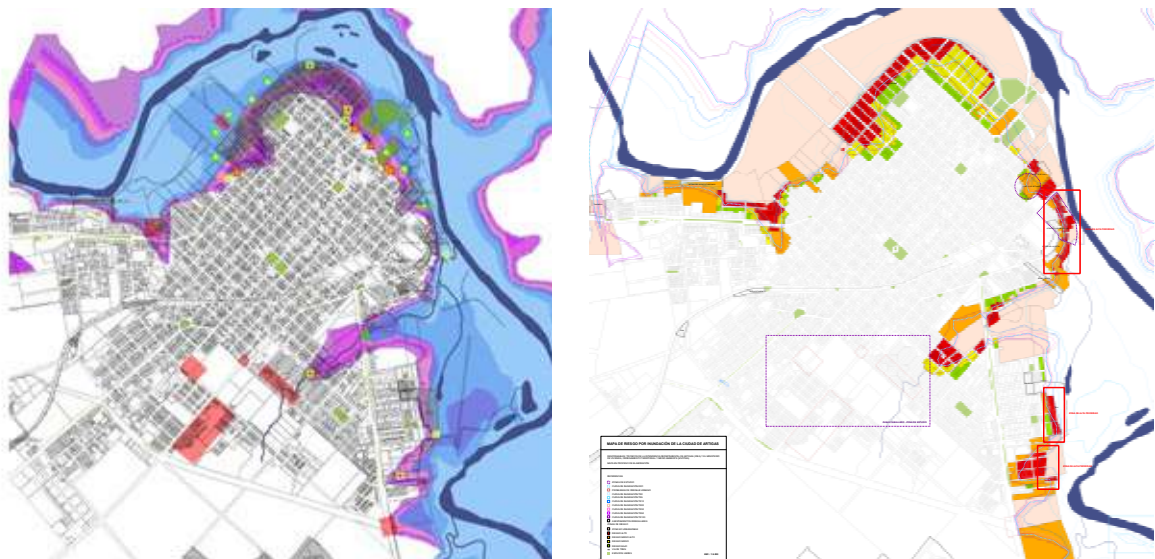
- Hydrometric networks with telemetric transmission are very useful for alerting, monitoring and operating emergencies in the event of hydrometeorological extremes. Although the main objective of the telemetric stations in the Yí River basin (National Administration of Power Plants and Electrical Transmissions, Spanish acronym UTE) is to quantify the contribution of central hydroelectric plants to the reservoirs, they are also used as an Early Warning System in Durazno, a concept that could be adapted to at least six localities in the Negro River basin (see Box 12).
- The incorporation of risk maps into local land-use planning in order to be able to define transformation areas (high-risk) and mitigation areas (medium and low risk). Flooding, vulnerability and risk maps have been created for the main cities with this problem (Artigas, Durazno, Salto, Treinta y Tres and Melo) (Figure 9).
- Flood risk is a high priority item in the implementation of public housing policies (Relocation Plans; acquisition of a new land portfolio, etc.).

6.3 Ecosystemic services of urban river systems

Urban populations have historically depended on a group of services provided by water ecosystems, several of which are essential to human well-being. Ecosystemic services include all the goods and services human societies obtain from natural systems (supplies, support, regulation, culture). The interaction between ecosystems, related ecosystemic services and the key factors in human well-being create extremely complex entities, now known as socio-ecological systems.

In Uruguay, ecosystemic services have not been historically identified or properly appreciated by the population or by those directly or indirectly involved in the management of the environment. This lack of knowledge, among other issues, has caused legislation, urban residential development and infrastructure works to ignore natural systems, thus jeopardizing sustainability as well as numerous services. At the urban level, although fluvial systems or rivers have historically been used for discharging wastewater and their banks for recreation, rivers are seldom regarded by society in an integrated manner while recognition of the importance of ecosystemic services in public policy is still incipient. Moreover, the increase in pressure caused by the need to make productive use of these resources promotes the

Figure 9. Flood risk and threat in the city of Artigas



Source: DINAGUA, Artigas City Hall

The early warning system in the city of Durazno

Throughout its history, the city of Durazno, located on the Yí River, has been liable to heavy flooding. Its most famous flood was said to have occurred in 1959, until the events of 2007 and 2010, which far exceeded it in terms of water levels and numbers of persons affected. Within the framework of the agreement between the World Meteorological Organization and the Julio Ricaldoni Foundation-Uruguay, improvements in flood management in Durazno were sought by means of a flood warning system. The result was the Durazno Early Warning system (Spanish acronym SAT), a locally operated system on the occurrence of drainage levels and their estimated permanence, which guarantees the required accuracy and reliability.

This system includes three modules: the first reads the data entered into the system from multiple sources (the telemetric network's rainfall records, other rainfall records and weather forecasts), the second module (Silveira et al., 2012) simulates the course of the Yí River Basin in order to obtain predictions for increased water levels in the city of Durazno (hydrological-hydrodynamic model) while the third module produces and prints out the results, including maps of the urban areas that will be affected by the predicted flood. The main advantage of the new systems lies in its ability to accurately predict between 48 and 72 hours in advance the date and time of the oncoming flood's highest water level and the permanence in time of levels above critical parameters, to enable emergency measures to be adopted. This system has greatly improved the flood emergency management service, run by the Durazno Emergency Coordinating Center (Spanish acronym CECOED).

perception that they are not finite and shifts the subject of the value of natural ecosystems into the sphere of management.

Although a systematic record of studies and practices that incorporate this perspective has not been undertaken in Uruguay, they are identifiable given the importance of the problem and of certain associated practices in particular cases. One case is the Maldonado River in the city of Maldonado, which has incorporated into its Local Planning project soil categories and an Eco-Park project, based on hydrological and biological studies carried out by the University of the Republic (Spanish acronym UdelAR). Another interesting case involves the Carrasco Stream located in the metropolitan area of Montevideo, seeking to emerge from a historical problem of deterioration. The first urban-rural land-use plan is currently being prepared with the purpose of ensuring the sustainability of an ecosystemic service (potable water supply) in the basin of the Laguna del Sauce (Lagoon) and evaluating the economic benefits of several environmental services.

More than 300,000 persons (45,000 in precarious settlements) currently live in the Carrasco River Basin and the introduction of industries over the course of time in the upper part of the basin has been a permanent source of contamination since earlier times. Major canals began to be built in the wetlands near the Carrasco River in 1975 in order to dry them out and to take advantage of "fallow land." However, these works eliminated an important component in the buffering and filtration of the wastewater provided by the ecosystem,⁵ affecting the activities of groups of wealthier social sectors downstream. This made the problem visible and its recognition led to a series of actions, including the Integrated Strategic Management Plan for the Carrasco River basin (Spanish acronym PECAC) in 2007.

5. Monitoring campaigns by Montevideo City Hall have registered total phosphorous and nitrogen levels that far exceed the maximum levels established by national and international legislation. <http://www.montevideo.gub.uy/ciudadania/desarrollo-ambiental/cursos-de-agua/programa-de-monitoreo>

6.4 Challenges to an ecosystemic vision

Uruguay must change the way it systematically incorporates ecosystems, particularly water ecosystems, into the management of its cities, given that:

- In order to protect and/or restore ecosystemic services, a multiplicity of processes and related scales must be taken into account. Future action on urban watercourses must not focus exclusively on what takes place inside the city and must instead contemplate longitudinal (up and downstream), lateral (e.g. flood plains) and vertical (groundwater) interactions.
- The response of ecosystems' to human use is neither linear, predictable, nor controllable, while the ways natural processes work has a number of counter-intuitive characteristics that create a discrepancy between human perception and actual functioning. This will require the understanding and appropriation of the scientific knowledge currently available in management spheres.
- Urban planning must systematically incorporate the idea that the various uses of water resources in the urban environment can be conflicting and cause the loss of one or more services.

7. Governance of the urban water

Governance is the process of interaction between public and private stakeholders at different levels and their rules of the game, both informal and formal, on the basis of which a society determines its behavior and makes and implements decisions. Below are three dimensions related to this concept: public institutions that plan and manage the urban water, the regulatory framework and forms of participation of organizations and the general public in decision making.

7.1 Institutions responsible for planning and managing water resources

As regards the planning and management of water resources, there are several institutions acting at

various levels. In Uruguay, the Executive Branch is the national authority responsible for water management and related policies. It operates through the National Water and Sanitation Office, (Spanish acronym DINAGUA), which reports to the Ministry of Housing, Land Management and the Environment (Spanish acronym MVOTMA). This organization is responsible for drafting the National Water Resources Plan and the National Drinking Water and Sanitation Plan. Likewise, MVOTMA, through the National Office of the Environment (Spanish acronym DINAMA), is responsible for policies regulating the quality of the environment, watercourses, and discharges.

The State Sanitation Company is responsible for the provision of drinking water service nationwide and of sewage to provincial cities. It is a decentralized service administered by MVOTMA. Although it enjoys budgetary autonomy and receives no national government subsidy, its rates require approval from the Executive Branch and its plans must be consistent with the guidelines set by the National Water and Sanitation Office (Spanish acronym DINAGUA).

Local governments across the country are responsible for urban drainage systems and establishing rules for the occupation and use of flood areas. They also regulate the indoor sanitation facilities of households and construct individual sanitation systems. They provide sewage tankers and are responsible for the final disposal of silts and solids and sometimes deliver this service themselves. Montevideo City Hall is also responsible for the Sanitation Service of the entire province.

The Ministry of Public Health is responsible for sanitation and the supply of potable water in the country in cases where human health is at risk; it also sets environmental health control standards (National Food Technology Regulation) (Reglamento Bromatológico Nacional).

The Water and Power Services Control Unit (Spanish acronym URSEA) is a decentralized organ of the Executive Branch that enjoys technical autonomy and is connected to it through the Ministry of Industry, Energy and Mining. It is responsible for activities "... related to the adduction and distribution of drinking water through networks

when it is destined partially or completely for third parties, and drinking water production, understood as the collection and treatment of raw water and its subsequent storage, when it is intended for distribution at a later date.”

The Office of Budget Planning (Spanish acronym OPP) was created to help the Executive Branch design development plans and programs, and plan the decentralization policies to be implemented.

The Advisory Commission on Water Resources and Sanitation (Spanish acronym COASAS), established in the Law of National Water Resource Policy, allows for the participation of the three sectors: government, water consumers and civil society.

At the same time, the University of the Republic, a public institution, conducts significant research and training activities on water resources in general and on the urban water in particular.

There are also housing improvement and access policies such as the Neighborhood Improvement Program (Spanish acronym PMB), which includes, among other financeable works, the refurbishment, expansion and/or construction of sewage systems, household connections, connections to urban networks and the construction of individual or collective solutions for wastewater treatment, pumping stations, pumping lines, effluent treatment plants and the like (see <http://pmb.mvotma.gub.uy>). Likewise, the Movement for the Eradication of Unhealthy Rural Dwellings (Spanish acronym MEVIR) constructs housing with built-in sanitation.

7.2 Principal normative instruments

The introduction of the Land-use and Sustainable Development Law No. 18.308 (2008) (Spanish acronym LOTDS) and the Law on the National Water Resource Policy, Law No. 18.610 (2009), led to the start of a paradigm change regarding water resources that advanced the idea of integrated water, environmental and land-use planning. Although the legal framework for flood management and urban drainage systems has yet to be consolidated, progress has been made in institutional organization. Below is the most relevant legislation on the subject (see www.parlamento.gub.uy and Box 13 on water as a human right in Uruguay, according to Article 47 of the Constitution):

- The Land-use and Sustainable Development Law (Spanish initials LOTDS) states that “land-use instruments should direct future urban development towards areas not affected by floods identified by the state entity responsible for water resource legislation”.
- Law No. 18.610 (Law on National Water Resources) based on land-use, conservation and protection of the environment, includes the preservation of the hydrological cycle and sustainable management of water resources, the setting of priorities for water use by region, basin or parts of them, giving priority to the providing of potable water and sanitation services over other demands, and also provides for the establishment of Regional Councils.
- The Land-use and Sustainable Development Law (Spanish acronym LOTDS) states that “land-use instruments should direct future urban development towards areas not liable to flooding identified by the state entity responsible for water resource use.”
- Law No. 18.610 (Law on National Water Resources) based on land-use and environmental conservation and protection, includes the preservation of the water cycle and sustainable water resource management, the setting of priorities for water use by region, basin or parts of the latter, giving priority to the delivery of drinking water and sanitation services over other demands, and also provides for the establishment of Regional Councils.
- Law No. 18.621, which establishes the National Emergencies System (Spanish acronym SINAE) states that “the public institutions responsible for formulating and/or implementing development plans, sectoral strategic plans and/or land-use plans are obliged to incorporate planning, analysis and risk zoning so that the policies resulting from this process contain the necessary provisions to reduce the risks identified and address the emergencies and disasters they may cause.”
- Law No. 18.840 states that connections to existing public sanitation networks and their construction in the future are of general interest.
- Executive Branch decree No 78/010 defines sanitation as systems that transport wastewater through drains or sewage tankers for final dis-

BOX 13

The human right to water in Uruguay

Taken from Article 47 of the Constitution (reform approved by 65% of eligible voters through a referendum conducted October 31, 2004)

- Protection of the environment is in the public's general interest.
- Water is a natural resource essential to human life.
- Access to drinking water and access to sanitation systems are basic human rights.
- Sustainable water management that takes future generations into account and the preservation of the hydrological cycle are both in the public's general interest.
- Users and civil society will take part in all planning, management and control of water resources, with river basins being established as basic units.
- Setting priorities for the use of water by region or basin (or parts of them), the first priority being the supply of potable water to the population.
- Drinking water and sanitation service delivery should be provided for social rather than economic reasons.
- Water is a unitary resource, subject to general interest, which forms part of the public state domain, as public water domain.
- The supply of potable water for human consumption and sanitation system services to the public at large will be carried out exclusively and directly by state legal entities.

posal in a treatment plant, as well as storage and final disposal "in situ" with filtering wells and/or by filtering into the ground.

7.3 Citizen participation in the urban water

Recent legislation reflects the state's interest in involving citizens, whether or not they are organized, in development processes related to water, land, the environment and local political representation.⁶ Since the mid-20th century, citizen participation has evolved from demanding public services for providing information and consultation and to a very incipient joint management between the state, consumers and/or civil society (Garcés, 2013).

Participation in filing complaints

The State Sanitation Company (Spanish acronym OSE) and local government have a system for

receiving complaints with stages of development. In particular, Montevideo City Hall offers a Customer Service Center, while the Residents' Defender's Office has existed since 2007.

Budgets and financing

Departmental committees (local government legislative bodies elected by citizens) are responsible for the five-year budget, external financing and urban legislation. The Montevideo Departmental committee is responsible for monitoring the sanitation policy designed and implemented by the Sanitation Division of the Department of Environmental Development.

Citizen involvement in programs

The micro-financing program for indoor work in dwellings and for connecting them to the sanitation networks requires citizen involvement in planning the system; which ends when the debt is settled. Likewise, active lobbying by grassroots organizations for urban housing and for official approval of non-conventional sanitation systems increases the portfolio of land suitable for urbanization.

6. The Law for the Evaluation of the Environmental Impact (Law No. 16.466 and its regulation Decree 349/005; Land-use and Sustainable Development Law (LOTDS) (Law No. 13.308) Law on National Water Resources (Law No. 18.610) and the Law of Decentralization and Citizen Participation (Law No. 18.644).

Information and citizen consultations

Uruguayan law requires that citizens be provided with information and consultation on environmental matters for projects with potentially negative effects on the environment, as defined by the National Office of the Environment (Spanish acronym DINAMA) (Decree 349/005). There are also provisions in the Water Code (Art. 177) for works associated with public water concessions and in the Land-use and Sustainable Development Law (Spanish acronym LOTDS) for Local and Special Plans (Chapter V, Art. No. 25). These often include risk mapping and land-use and land occupation categories.

Co-management

Members of the Water Resource and Sanitation Advisory Service (Spanish acronym COASAS) actively participated in the drafting of the Water Resources Law, completed in 2010. Since then, their participation in the sector's activities has been minimal.

As of 2011, the Regional Basin Councils and the Basin and Aquifer Commissions, as provided for in Law No. 18.610, have been responsible for promoting the organic participation of government representatives, consumers (i.e. water users) and civil society (NGOs, unions, universities, and grass-roots social organizations). Their advisory nature,

lack of funding and the small number of public servants in the technical ministry have, however, limited their ability to bring about change. To date, urban issues have been largely ignored.

Beyond formal participation

At the civil society level, there are social and environmental organizations –mostly local– whose educational, ecological and political activities are centered around water. The National Commission for the Defense of Water and Life (Spanish acronym CNDALV) played an active role in the promotion of the Water Referendum (Figure 10).

7.4 Challenges in urban water governance

- Uncertainty and the large number of uncontrollable variables demand constant evaluation and a continuous, creative, participatory redesign of strategies.
- Although the new legal framework is advancing, integrated water, environmental and land-use planning, state organizations are far from being prepared for the flexible management processes required by an integrated focus. Moreover, citizen participation structures must be updated to include more creative participation from the various sectors.

Figure 10. Mural painted during the 2004 referendum



Photo: Gonzalo Gómez

- It is also necessary to reinforce the institutions responsible for urban water policies, especially those that improve coordination between organizations with different roles in national policy design (the organization governing public health, the public drinking water supply and sanitation provider; those responsible for regulating and auditing public services and protecting users of the latter).
- The small size of the country provides a comparative advantage and allows for interpersonal exchanges between national and local authorities. At the same time, the scale of the cities makes it possible to design strategies involving a high degree of participation by the population, thus mitigating the problem.
- The knowledge production network is generally associated with management, which enables innovation to be incorporated into it.
- Although there are conflicts of interest, the large number of technicians in political spheres facilitates dialogue in the definition of priorities.
- It is essential to shift from command and control to adaptive structures. In this respect, the recently established Basin Committee liaises between the various stakeholders to overcome these difficulties, and its performance must be evaluated in the near future.

8. Challenges to integrated urban water management in Uruguay

In Uruguay, evaluation in various spheres of the historical conflicts regarding cities and their water supply, coupled with an examination of the many associated practices and experiences is achieving a shift from the current sectoral approach to a more integrative one. This translates into a non-linear process of multi-stakeholder, dynamic transformations with enormous potential, although they are not entirely free of problems.

A series of critical problems have been identified in this process. Some are already being addressed, while others are more complex. There are also other major potential problems that have

yet to be evaluated. Several good practices have been developed from which lessons can be drawn, while gaps or weaknesses in the knowledge of certain subjects have been identified. This all falls within the context of conflicts of interest, financial restrictions, and the need to address priorities in other sectors.

Uruguay possesses a series of basic characteristics that could encourage the development of the traditional water management towards integrated water management (GIRH). Key aspects include a well distributed water network, average rainfall of 1,300 mm; population centers with good physical and telecommunications connectivity; a relatively small country; sustained economic growth; confidence in the country's institutions, low corruption levels and slow population growth.

In order to understand the complex process of urban water management in Uruguay, a number of

Integrating issues and the main challenges are described below.

8.1 Water in urban planning

Water supply is an essential component of cities and should therefore be incorporated into their planning. Building a city with a water supply poses a challenge on various levels (town council, neighborhood, metropolitan). The construction of urban landscapes that include storm drainage systems, or restoring small internal watercourses or the integral design of riverfronts not only reduces impacts, the cost of infrastructure and the risk of flooding but also creates spaces for public recreational use, turning threats into a resource. In this regard, there are good national practices that are gaining ground over the outdated yet still dominant model that promoted the construction of channels and the expulsion of wastewater as quickly as possible. Fortunately, good national and international practices, aided by the institutions' hiring of young technicians, are driving this transformation (Figure 11).

Taking water into account in provincial and urban land-use planning has been a slow but steady process, which has included the incorporation of flood risk maps into the use and occupation categories. Flood risk mapping provides technical support for the process of flood zone transformation

and management based on the needs of the city's population and the vulnerability of river ecosystems, which, in turn, increases a city's resilience and gives rivers value in residents' collective imaginary.

All the issues related to the interaction between the nature and quality of urban life require in-depth study. Knowing what can be transformed without compromising nature implies bringing together the scattered knowledge on ecosystems, urban projects, land-use planning and social education.

8.2 Drinking water: a key human right and the intensification of productive uses

Supplying potable water for the population is the first priority of river basins, as stated in the country's Constitution (Art. 47). However the intensification of agricultural uses and its implications for the quality of the resource is increasingly affecting raw water (both surface and groundwater), requiring greater monitoring from the organizations responsible for managing the resource and increasing the cost of producing drinking water. This warning led –albeit insufficiently– to coordinated measures being adopted between the institutions involved in drinking water production and the environment to encourage more integrated public policies. Within

this context, the territorial dimensions of basins associated with funds from the urban sector (whose budget allocation is particularly relevant) must be taken into consideration in a cross-scale, inter-institutional management strategy.

8.3 A system of governance appropriate to the new paradigm

Waster system management in urban areas is so complex that it can only be addressed by using an interdisciplinary, multi-sectoral approach. One of the main problems observed in Uruguay is the need to change single-sector analyses (based mainly on the command and control paradigm) into integral approaches with the capacity to promote adaptive schemes and incorporate effective monitoring and learning mechanisms to understand the causes of both successful and unsuccessful decisions made in the past.

During the past decade, Uruguay has made great strides in legislation and the organization of institutions directly involved in land and water resource management. However, real interaction between the different disciplines involved is still limited, as is fluid interaction between different levels of government. Under the current governance

Figure 11. Holding pond in the Diamantis Plaza building in Montevideo. Experience in sharing responsibilities and benefits, undertaken with financing for maximum use

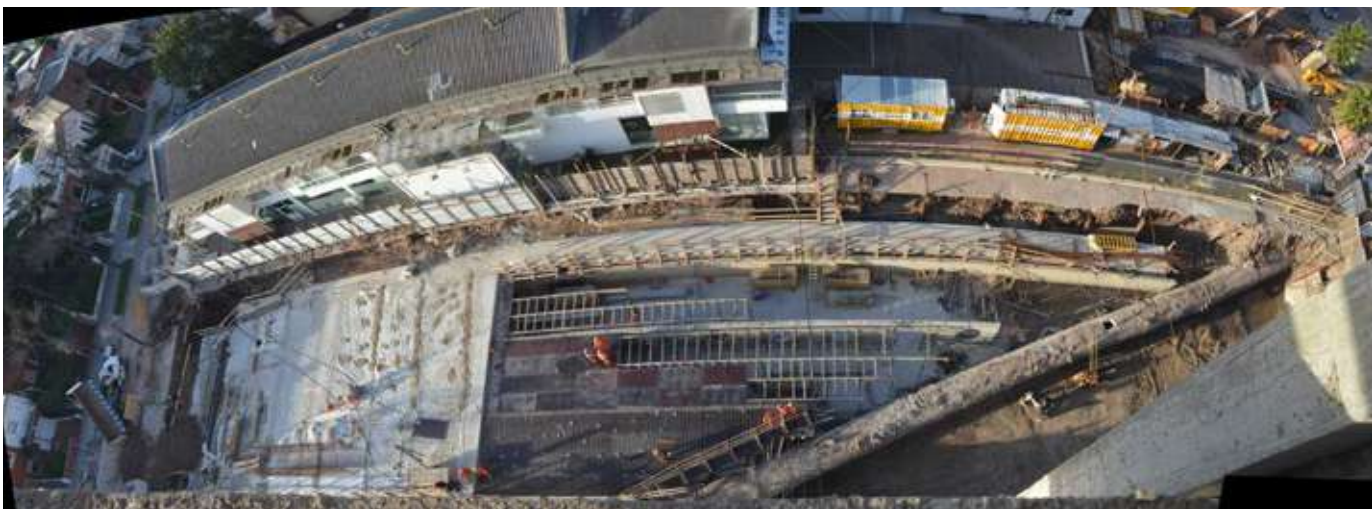


Photo: Montevideo City Hall

scheme, recently created cross-cutting organizations such as the Regional Councils and the River Basin Commissions, the National Emergencies System network and the Land-Use Committee, are groups that should be considered and strengthened.

8.4 Information and monitoring in areas of uncertainty

Urban water planning and management in a changing environment (climate variability, economic, social and cultural change) requires access to the best possible information for decision making.

Information in Uruguay varies according to the different subsectors. As an example, while large amounts of data exist on the amount of water available, information on its quality is recent and incomplete, as is the data on aquifers and rainwater. In general, the information available on water resources is insufficient for managing them properly. There is often a problem of lack of coordination of initiatives, frequently due to unawareness or proper planning (e.g. duplicate collections), leading to unnecessary expenditure. This same lack of coordination between the agencies gathering the information sometimes prevents efficient cross-evaluation. Moreover, some of the information is difficult to access (in some cases, because it is filed on paper) and/or its interpretation is extremely laborious.

Improving monitoring systems and adapting them to the urban reality would allow trends and possible modifications to be identified, which could be useful for reformulating strategies. This would also provide for transparent management and participation, based on quality information, which is essential for decision making.

Another major challenge is the need to adjust academic research projects in order to make them more useful for water management. Although this aspect has significantly improved in the last decade, there is room for improving the understanding between science and management.

8.5 Drinking water, sanitation and quality drainage services coverage and accessibility

Access to potable water, sanitation and quality drainage services by the entire population is one of the country's current challenges. Urban areas that currently do not enjoy these services are generally located in high-risk areas (areas not included in town planning) and/or low income areas. These population sectors tend not to be connected to formal drainage systems due to their inability to invest in remodeling their indoor sanitation systems. Moreover, these areas have a low population density, which increases the per capita cost of investment in networks.

In this respect, the expansion of the sanitation service faces the major challenge of having to adjust its strategy to specific urban characteristics due to the fact that not all the zones currently lacking sanitation networks are able to receive them. Consequently, other types of more economical networks must be found and other types of sanitation technology that treat wastewater "in situ" implemented.

Addressing this lack of services implies a challenge that not only involves building networks, but also a multidisciplinary and inter-institutional effort with short-, medium-, and long-term measures in which the population's participation is vital. Moreover, apart from needing to ensure that the expansion of sanitation services into potential town development zones is carried out in accordance with the city's urban plans, plans and projects must incorporate sanitation, storm drains and the design of associated public spaces (streets, plazas, squares, etc.). Likewise, related non-structural measures such as organizational adjustments and training the population and local technicians to use and give maintenance to the new system must be implemented.

One of the most pressing issues in solving this problem is the pressure on public housing programs to comply with the Land-use and Sustainable Development Law (Spanish acronym LOTDS), which requires that dwellings be developed and built in areas with basic services.

One issues requiring special attention is the need to implement plans to eliminate septic tanks, or reduce their impact on both the environment and human health. This widespread form of contamination, along with poor solid waste management, pollutes groundwater resources, ditches and small

watercourses and is one of the main problems in the peripheries of Uruguayan cities. Given the living conditions of the population, users' economic and financial conditions must be taken into account in order to ensure the sustainability of sanitation services.

9. Final Considerations

Promoting the value of water, responsibility and innovation in its use, both consumptive and non-consumptive (recreational and educational), should not be complementary or secondary tasks, but rather a central axis of an integrated urban water management strategy, combined with the improvement of mechanisms for the population's access to information, opinion and control. This

investment in the empowerment of the population, together with building the capacities of the human resources that form part of the management system and implementing changes in the structures of the service providers towards decentralization, will lead directly to a flexible, adaptive management system that will contribute to the sustainability of water within the context of integrated management.

10. References

- Blaikie, P.; Cannon, T.; Davis, I. and Wisner, B. (1996). *Vulnerabilidad: el entorno social, político y económico de los desastres*. Original title: At Risk, La Red.
- DINAMA (2012). Mapa del Uruguay con industrias con Solicitud de Autorización de Desagüe Industrial (SADI). (<http://www.mvotma.gub.uy/control-ambiental-de-emprendimientos-y-actividades/item/10003245-mapa-del-uruguay-con-industrias-con-tr%C3%A1mite-de-sadi.html>).
- DINAMA-JICA (2011). Proyecto sobre control de la contaminación y gestión de la calidad del agua en la cuenca del Río Santa Lucía. Informe final (Principal y Anexos), available on the DINAMA-MVOTMA website.
- Garcés, A. (2013). La participación en la gestión de los recursos hídricos. Monografías de la *Revista Aragonesa de Administración Pública*. ISSN 1133-4797, XIV, Zaragoza, pp. 473-495.
- IM (2014). Informe de efluentes Industriales. Intendencia de Montevideo [<http://www.montevideo.gub.uy/ciudadania/desarrollo-ambiental/industrias/efluentes-industriales/efluentes-industriales>].
- INE (2011). Censo Nacional 2011. Instituto Nacional de Estadística, (<http://www.ine.gub.uy/censos2011/index.html>).
- Marsalek, J.; Jiménez-Cisneros, B.; Karamouz, M.; Malmquist, P.A.; Goldenfum, J. & Chocat, B. (2007). Urban Water Cycle Processes and Interactions: Urban Water Series - UNESCO-IPH.
- MVOTMA-DINAGUA (2011). Inundaciones urbanas: Instrumentos para la gestión del riesgo en las políticas públicas. Montevideo.
- OPP (2011). Uruguay Integra. Información de base para el diseño de un plan estratégico de residuos sólidos. Uruguay. 358 pp.
- Pacheco, J.P.; Arocena, R.; Chalar, G.; García, P.; González, M.; Fabián, D.; Olivero, V. y Silva, M. (2012). Estado trófico de arroyos de la cuenca de Paso Severino (Florida-Uruguay) mediante la utilización del índice biótico TSI-BI. *AUGMDOMUS* (<http://revistas.unlp.edu.ar/domus/article/view/502/500>).
- Piperno, A y Sierra, P. (2013). Análisis de la interacción del sistema hídrico con el sistema territorial: el caso de Uruguay (unpublished).
- Piperno, A.; Sierra, P.; Varela, A. y Failache, N. (2009). Inundaciones Urbanas en el Uruguay: del río amenaza al río oportunidad. Facultad de Arquitectura Udelar, Uruguay.
- Rojas, F. (2014). *Políticas e institucionalidad en materia de agua potable y saneamiento en América Latina y el Caribe*. CEPAL, serie Recursos Naturales e Infraestructura. Santiago, Chile. 81 pp. ISSN 1680-9017.
- Romero, J.L. (2009). *La ciudad occidental. Culturas Urbanas en Europa y América*. Buenos Aires, Siglo XXI Editores.
- Silveira, L.; López, G.; Chreties, C. & Crisci, M. (2012). Steps towards an early warning model for flood forecasting in Durazno city in Uruguay. *Journal of Flood Risk Management*, 5:270-280.

Web consulted

- <http://datos.bancomundial.org>. Last accessed: July 10, 2014.
- <http://pmb.mvotma.gub.uy>. Last accessed: July 13, 2014.
- <http://www.lr21.com.uy>. Last accessed: July 2, 2014.
- <http://www.montevideo.gub.uy>. Last accessed: August 7, 2014.
- <http://www.parlamento.gub.uy>. Last accessed: June 19, 2014.
- <http://www.msp.gub.uy>. Last accessed: August 1, 2014.
- <http://www.higiene.edu.uy>. Last accessed: July 27, 2014.
- <http://www.ose.com.uy>. Last accessed: April 10, 2014.

11. Acronyms

ANII - Agencia Nacional de Innovación e Investigación (National Innovation and Research Agency)	OPP - Oficina de Planeamiento y Presupuesto (Office of Budget Planning)
CECOED - Centro Coordinador de Emergencia Departamental de Durazno (The Durazno Emergency Coordinating Center)	OSE - Obras Sanitarias del Estado (State Sanitation Company)
CNDAV - Comisión Nacional en Defensa del Agua y la Vida (National Commission for the Defense of Water and Life)	PADE - Plan de Acción Durante Emergencias (Emergencies Action Plan)
COASAS - Asesora en Aguas y Saneamiento (Water Resource and Sanitation Advisory Service)	PDSUM - Plan Director de Saneamiento y Drenaje Urbano (Sanitation and Drainage Master Plan)
CSIC – Comisión Sectorial de Investigación Científica (Sectorial Scientific Research Commission UdelaR)	PECAC - Plan Estratégico de Gestión Integrada de la Cuenca del Arroyo Carrasco (Integrated Strategic Management Plan for the Carrasco River basin)
DINAGUA - Dirección Nacional de Aguas y Saneamiento (National Water and Sanitation Office)	PEDECIBA – Programa de Desarrollo de la Ciencias Básicas de Uruguay (Program for the Development of Basic Sciences of Uruguay)
DINAMA - Dirección Nacional de Medio Ambiente (National Office of the Environment)	PHI-LAC -Programa Hidrológico Internacional para América Latina y el Caribe, UNESCO (The International Hydrological Program for Latin America and the Caribbean at UNESCO)
IANAS - Interamerican Network of Academies of Sciences	PMB-PIAI - Programa de Mejoramiento de Barrios, Programa de Integración de Asentamientos Irregulares (Program for the Improvement of Neighborhoods, the Program for the Integration of Irregular Settlements)
IDU - Equipo de Inundaciones y Drenaje Urbano de DINAGUA (Urban Flooding and Drains Team)	PSU - Plan de Saneamiento Urbano (Urban Sanitation Plan)
IM - Intendencia de Montevideo (Montevideo City Hall)	SAT - Sistema de Alerta Temprana (Early Warning System)
INE –Instituto Nacional de Estadística (The National Institute of Statistics)	SDF - Sitios de Disposición Final Final (Waste Deposit Sites)
LOTDS - Ley de Ordenamiento Territorial y Desarrollo Sostenible Land-use and Sustainable Development Law	SINAE - Sistema Nacional de Emergencias (National Emergencies System)
MEVIR - Movimiento para la Erradicación de la Vivienda Rural Insalubre (Movement for the Eradication of Insalubrious Rural Housing)	UdelaR - Universidad de la República (University of the Republic)
MVOTMA - Ministerio de Vivienda, Ordenamiento Territorial y Medio Ambiente (Ministry of Housing, Land Management and the Environment)	URSEA - Unidad Reguladora de Servicios de Energía y Agua (Water and Power Services Control Unit)
OMM - Organización Meteorológica Mundial (World Meteorological Organization)	UTE - Administración Nacional de Usinas y Trasmisiones Eléctricas National (Administration of Power Plants and of Electrical Transmissions)
ONG – Organización No Gubernamental (Non-governmental organization)	