Water security and charging for the use of water in river basins: a case study in São Paulo, Brazil

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Abstract

This paper aims at discussing the relation between charging for water use and water security in river basins, and analyzing how the funds have been used. The methodology is divided into two parts. First, a literature review on the issue of water security. Second, a qualitative and quantitative analysis of water management indicators, based on the São Paulo State Water Resources Public Policy. Our results show that in the first years of charging the sanitation sector (including issues such as garbage collection, sewage and water treatment) accounted for the largest portion of the payment (84%) and 165 works and projects executed – 68% of which was allocated to basic infrastructure.

Keywords: water security, charging for water use; Brazil, water resources

Introduction

This paper aims at discussing the relationship between charging for water use and water security in river basins, and analyzing how the funds have been used. For this purpose, we chose the state of São Paulo in Brazil.

Brazil has 11% of the world's potable water, enough water for its 208 million inhabitants – 2.8% of the world's population (World Bank, 2016). Nevertheless, 70% of the water in the Brazilian territory is available only to 7% of the population, resulting, as a consequence, in economic water scarcity (Brasil, 2008; Johnsson, 2014). This disparity between the availability of drinking water in Brazil makes the distribution a central problem.

The Brazilian population is concentrated in areas with relatively low water availability. On the other hand, the greatest water availability is in low population regions, such as the Amazon (Carmo, 2001). About 32% of the Brazilian population is located in the Paraná Hydrographic Region (31% of the National water demand). São Paulo represents 25% of this region (Agência Nacional de Águas, 2007).

In the state of São Paulo the water resources availability is critical. São Paulo Metropolitan Region (SPMR) has more than 20 million inhabitants, being a heavily industrialized area and the most important economic center of Brazil. This population is distributed in an 8051 km² area, about 0.1% of the national territory, meaning that 10% of the Brazilian people are concentrated in 0.1% of the country.

The intermittent lack of water is closely related to building characteristics and urban concentrations without essential investments by the government to provide basic sanitation.[1]. Metropolitan areas have stretches of very low quality surface water courses, mainly due to the high water demand and the launching of organic load (domestic sewage) in rivers, for example. This is a great problem for Brazilian cities, since almost all the water used for water supply comes from this surface water.

However, the problem is not only the water scarcity, but also the excess of water. Carmo, Johansen & Anazawa (2014) discussed how the excess and lack of water affect different regions in Brazil. These extreme events, which coexist in

[1] The concept of basic sanitation includes the adequate collection of sewage, the treatment of this sewage and the proper destination of the treated water. Basic sanitation (Law 11.445/2007) includes the availability of drinking water for the population, sewage collection, sewage treatment, proper disposal of treated water, and several guarantees to public health (Brasil, 2007).

alternating scenarios of long periods of drought and high rainfall, are characterized as important issues that become part of the metropolitan agenda.

Although São Paulo as a whole has abundant resources (32% of the country's GDP), when considering the water availability, many problems related to water management become more evident. In addition to the high-density population, it is necessary to highlight the existence of different water users. Agricultural consume 60% of the water available, industrial activities, 23%, and domestic use, 17%. Even though a great portion of this water used for agricultural production is from rainwater, it can create conflicts in the context of extreme events (Picoli, 2016b). Therefore, it is reasonable to say that there are regions with water scarcity due to the multiple uses (Carmo, 2002).

Considering water availability, Piracicaba, Capivari e Jundiaí River Basins (RB-PCJ) (7% of the country's GDP) presents critical levels. For instance, in 2010 RB-PCJ had 37.98m³/s of water availability, with a catchment level of 34.55%, i.e., 91% of the basin capacity.

The Government has not been able to provide solutions to the water crises in the last five years. There have been crises affecting regions with abundant water resources. For many decades, public policies aimed at addressing basic structural problems such as sewage and sanitation, and only in the last decades, issues such as water pollution and contamination and its rational use have become priorities for public policies (Costa & Monte-Mor, 2002).

The Brazilian water management model was instituted by *Política Nacional de Recursos Hídricos* (PNRH – National Policy of Water Resources) (Law 9433/1997) (Brasil, 1997), as a decentralized agency that counts on the participation of many actors, and the main objective was to develop the sustainable management of water resources, to ensure their availability for future generations, with quality standards appropriate for their respective uses (Cassuto & Sampaio, 2011). However, it is important to emphasize that water management policies in Brazil began in 1989 in São Paulo with the creation of the Piracicaba, Capivari and Jundiaí River Basins Consortium (Consórcio PCJ), which preceded the state legislation on water resources established in 1991 (Nelson, 2008; Silva & Folegatti, 2009).

The NPWR management includes Water Resources Plans; granting the right to use water; charging for water use; framing of water bodies in classes of use, and the *Sistema Nacional de Informações sobre Recursos Hídricos* (SNIRH – National

Information System on Water Resources) (Goulart Junior, 2014).

The main management tool is charging for water use (Agência Nacional de Águas, 2014). The first experience in charging for water use took place in São Paulo: The Paraíba do Sul River Basin (RB-PS), in 2003; and the Piracicaba, Capivari and Jundiaí River Basins (RB-PCJ) in 2006. In addition to these, there are four basins charging for water use: Sorocaba and Mid-Tietê river, coastline region, Low Tietê and Upper Tietê.

Figure 1 shows the charging situation in São Paulo. The territory is divided by the 22 Unidades de Gerenciamento de Recursos Hídricos (UGRHs – Water Resources Management Unit). The RB-PS is represented on the map by UGRH 2 and RB-PCJ, UGRH 5. Of 22 UGRHs, 9 have implemented charging for water; 10 had the decree approved, but have not yet started the charging process and two are being elaborated.

Charging for water use as a management tool was designed to stimulate an economic relationship between users and water resources (Thame, 2000). This tool applies to all users. The users under the agreement are those that divert or capture water from surface water bodies, extract ground water, emit sewage or residues into water bodies, hydroelectricity generators and other users that change the water quality and quantity of a basin.

On the other hand, citizens pay a fee for the water supply service, which is used to cover the costs related to water catchment and treatment. Law 9433 from 1997 justifies the charging because these uses represent an economic value of water resources; at the same time, the rational use of this resource is encouraged, while raising financial resources that allow the financing of infrastructure programs and improvement of the management of water resources. Therefore, charging for water use allows the Government to guarantee water security (Brasil, 1997).

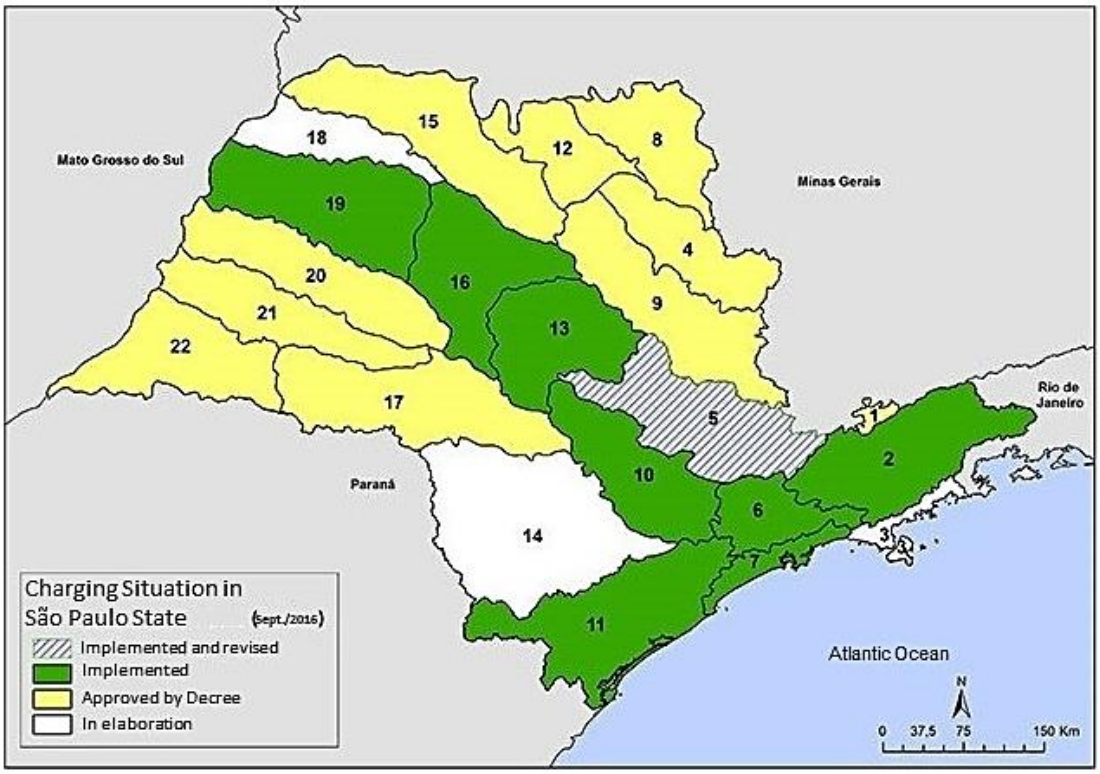

Figure 1. Charging for the water use in UGRHs in the state of São Paulo

Source: SIGRH

Methodology

The methodology was divided into two parts. First, a literature review on the issue of water security, seeking to outline the impacts on water availability in the state. Second, a qualitative and quantitative analysis of water management indicators, based on the São Paulo State Water Resources Public Policy, and available at SNIRH. There are 45 indicators, divided into three groups: socio-economic and cultural scenario (group 1), general situation of water resources in São Paulo (group 2), and implementation of the Basin Plan (group 3). These include the rational use of water resources; investments programs aimed at protecting the quality and quantity of water resources; conservation and protection of water resources, including the recovery of water resources, payment for environmental services and restoration of riparian forests.

The analysis started focusing on the state itself, i.e., considering *Plano Estadual de Recursos Hídricos* (PERH – State Water Resources Plan), and then a wider context: the Basin Plans. We decided to limit the analysis to two Board basins

– RB-PCJ and RB-PS, the first to introduce charging for water use. Moreover, it was easier to obtain data from them.

PERH information allow to verify the amount of commitments made during the plan execution period. There are five investment areas: institutional development and negotiation about water resources management; development and implementation of water resources management tools; multiple uses and integrated management of water resources; conservation and recovery of water resources; environmental education, technological development, training and communication; and dissemination of information on integrated management of water resources. Based on information from the Basin agencies, we carried out an analysis of the allocation of resources in River Basins that implemented charging for water use.

We had specific results for RB-PCJ. The charging during the first period (2006-2010) was analyzed; after that, based on the Basin Plan (2010-2020) and Management Reports, the allocation of resources for works and projects in the RB-PCJ was verified. Then, based on the Charging Evaluation Report (2003-2011) and on the Annual Monitoring Report of the Multi-Year Implementation Plan, it was possible to check the division of activities by components within the RB-PS Basin Plan, as well as the Resources.

Results and discussion

The river basin investment between 2012 and 2015 was US$ 4.3 billion[2], according to the *Plano Estadual de Recursos Hídricos do Estado de São Paulo* (State Water Resources Plan) – PERHSP-2012. This investment was divided into five areas regarding water resources: (1) Institutional development and negotiations, received 0.10% of the total; (2) Development and implementation of tools for water resources management – 0.37%; (3) Multiple uses and integrated management – 86,4%; (4) Conservation and recovery – 12,95%; (5) Environmental education, technological development, qualification, communication, and information diffusion in integrated management – 0,11%.

In all, there are 380 agreements, 365 executed in the first year of the PERHSP (Table 1). The resources from the water use was allocated in actions and programs in thematic area number 2.

[2] Currency conversion from R$ 16.8 billion to dollars – December, 2015 (R$ 1 ≈ US$ 3,87).

The Basin of the Piracicaba, Capivari and Jundiaí rivers (RB-PCJ) is composed by 62 cities, 58 in São Paulo and 4 in Minas Gerais. About 92% of the territory is part of São Paulo and 8% of Minas Gerais. In São Paulo all basin rivers of the PCJ are tributaries of the Tietê river – with 14 thousand km². The tributaries are divided as the following: 82% Piracicaba River basin, 11% Capivari River basin and 7% Jundiaí River basin. There are seven principal sub-basins, five in the Piracicaba river – Piracicaba, Corumbataí, Jaguari, Camanducaia and Atibaia –, besides the Capivari and the Jundiaí.

The RB-PCJ is an essential element to supply the São Paulo Metropolitan Region through the Cantareira System that supplies water for about half of the RMSP population. Therefore, only a part of the hydrological potential is available to the RB-PCJ region. In addition, the PCJ region has its own water supply. For example, the Atibaia sub-basin, through the water supply system of Campinas, which flow towards the Capivari and Piracicaba basins (Irrigart, 2007).

Table 1- Distribution of resources by thematic area based on the São Paulo's PERH – (2012-2015)

Distribution by thematic area	Agreements	Resource 1st year (US$)*	Sources
1. Institutional development and negotiation			
- SIGRH improvement - Intersectoral action of PERH - Integration between public power in federal, state and municipal levels in respect to public policies	63	3.130.136,64	1st Federal charging 67% 2nd FEHIDRO 33% 3rd State budget --
2. Development and implementation of for water resources management tools			
- Water Resource Plans monitoring and implementation - Updating the framework of water bodies in classes - Control System, Access and Granting improvement - Charging implementation and dissemination - Water Resources Monitoring System improvement - National System of Water Resources Information development	66	16.184.736,26	1st FEHIDRO 59% 2nd State budget 24% 3rd Federal budget 8% 4th Federal collection 6% 5th Financing 2%
3. Multiple uses and integrated management			
- Expansion, Maintenance and Improvement of Basic Sanitation System -Optimization of water use - Prevention and reduction of critical events regarding Water Resources and Population - Equilibrium among multiple uses	96	3.772.444.021,03	1st Financings 40% 2nd Federal budget 27% 3rd State budget 26% 4th Federal budget 7% 5th FEHIDRO 1%
4. Conservation and recovery			
- Qualitative and quantitative protection, recovery, and promotion of water resources, especially surface water - River basins renewal - Promotion and Achievement of environmental services for water protection - Negotiation between Collecting System and Water resources	78	565.641.280,81	1st Secretaries, coordinators, institutes and foundations 29% 2nd Managing agencies 29% 3rd Board Basins 2%
5. Environmental education, technological development, qualification and communication and information diffusion in integrated management			
- Environmental education, Technical development, Qualification, Communication, and Dissemination of information - Promoting Environmental education and Water resources studies and researches	62	4.638.676,74	1st FEHIDRO 81% 2nd State budget 15% 3rd Own revenue 3%
Total		**4.352.994.923,84**	

Source: Elaborated by the authors based on CRHi (2014).

* Currency conversion – December, 2015 (R$ 1 ≈ US$ 3,87).

The first results from the RB-PCJ show that from 2006 on – when started the charging – to meet the demand of projects that had been ignored for years (Cobrape, 2010). Basically to attend emergency sanitation issues that result from the urban expansion.

During the 2010-2020 period (Table 2), it is estimated that the total investment in programs and actions in the PCJ Basins will be about US$ 0,7 billion[3] – about 38% for the promotion of rational use of water resources and 32% to improve water quality.

Table 2 – Investments in programs and actions in the RB-PCJ, 2009-2020.

Programs and actions in the River Basin	Total invested (R$ million)
Database, registers, studies and surveys	79
Water resources management	19
Restoration of the quality of water bodies	888
Conservation and protection of water bodies	383
Promotion of rational use of water resources	1037
Multiple use of water resources	179
Defense against external hydrological events	139
Technical qualification, education environmental and social communication	30
Total	2.755

Source: PICOLI (2016a: p.40).

Our initial results show that in the first years of charging in the RB-PCJ (2006-2010), the sanitation sector accounted for the largest portion of the payment (84%), industry 13%, and agriculture 3%. 165 works and projects were executed in the RB-PCJ, of which 68% was allocated to basic infrastructure; 28% to prevent losses; 4% for environmental education, prevention and protection against extreme events and others.

[3] Currency conversion from R$ 2.7 billion to dollars – December, 2015 (Table 2).

Relatório de Situação dos Recursos Hídricos – 2015 (Water Resources Situation Report) of the RB-PCJ – an instrument of water resources management of the São Paulo State – shows that the financing of actions and programs is almost exclusively derived from water charges. However, the amounts charged are not enough to preserve and recov the surface water, to maintening water security, as well as mitigate the effects of extreme events. This means that although the basin establishes the priority investments, there is low capacity to make them viable.

In general, the revenue from charging water was used for projects aimed at preventing losses in water distribution systems, as well as in water monitoring and forest recovery. Since 2014, measures have been established to deal with water scarcity. Between 2006 and 2015, the total amount transferred to the PCJ Basin Agency was about US$ 39 million. However, the estimated amount to treat all sewage disposed of in the basin was about US$ 258 million[4].

The resources raised from water charges in the Basin PCJ – rather by the tranfers from State Water Resources Fund (FEHIDRO) or the values charged by the Country, São Paulo and Minas Gerais – amount to approximately US$ 121 million[5] (Table 3). Of this total, considering only the resources obtained from water charging, in just seven years federal charging accounted for about 42% of the total revenue from water charges. For the first seven years, the charging in São Paulo was about 31% of the total amount (note that the FEHIDRO resources refer to two decades and account for about 27% of the total).

Table 3 – Total of the charging water in the RB-PCJ – (1994-2014)

Resource source	Enterprise	Total value (US$[6])
FEHIDRO (1994-2014)	277	127.143.908
Federal charging (2006-2013)	145	196.646.788,1
Charging in São Paulo (2007-2014)	137	146.819.617,3
Charging in Minas Gerais (2010-2014)	1	100.000.000
Total		470.710.313,49

Source: CBH-PCJ (2015).

Among the projects conducted are works for sewage treatment and

[4] Currency conversion from R$ 1 billion to dollars – December, 2015 (R$ 1 ≈ US$ 3,87).
[5] Currency conversion from R$ 470 million to dollars – December, 2015 (R$ 1 ≈ US$ 3,87).
[6] Currency conversion – December, 2015 (R$ 1 ≈ US$ 3,87).

prevention of losses, environmental education, construction and improvement of databases and user registration etc.

The Paraíba do Sul river basin (RB-PS) covers an area close to 57.000 km^2 and crosses three states: Rio de Janeiro, Minas Gerais, and São Paulo (Kumler & Lemos, 2008). RB-PS is part of the most developed Brazilian regions. Altogether, there are 180 municipal areas, 36 of which are partially inserted in the river basin. The urban population is about 4.922.779 inhabitants (Agência Nacional de Águas, 2015). It is estimated that the annual value of the charge to be paid in this river basin is about US$ 5.4 million[7]. Considering the 2003-2011 period, the sanitation sector accounted for 56% of the amount charged, equivalent to US$ 26.4 million[8]. Then, industry sector paid for 43% of the total charging. Irrigation and animal facilities, as well as other uses, such as mining activities, did not reach 1% of the total.

In 2003, 186 registered users paid for the water use, and in 2011 there were 296. Industrial users represent 34% of this total – 75 in 2003 and 100 in 2011. The sanitation sector represents 30% of users and also had an increase compared to 2003. Other uses, accounting for 23% of the total, - had the highest increase – from 16 users in 2003 to 69 in 2011.

The agricultural sector is included in “other users”. However, until 2010 agricultural (irrigation) users of the state rivers were exempt from paying water charges and not all users of this group are charged (CRH nº 101/2009). Annually, Monitoring Reports of the Multi-Year Resource Implementation Plan (PAP) are published, an instrument to plan actions to be carried out with the charging resources collected. Table 4 presents the resources applied with the implementation of the PAP (2015).

[7] Currency conversion – December, 2011 (R$ 1 ≈ US$ 1,84).
[8] Currency conversion – December, 2011 (R$ 1 ≈ US$ 1,84).

Table 4 – Destined resources by component and programs in the RB-PS – 2015

Component	Programs	Resource destined by program (thousand US$[9])	Committed (%)	Disbursed (%)
1. Water resource management	1.1 Water resources planning	656		
	1.2 Participative management building tools	7.384		
	FORESEEN	8.040	99,7%	17,2%
2. Recovery of environmental quality	2.1 Reduction of pollution loads	74.047		
	2.2 Urban drainage and flood control	8.573		
	FORESEEN	82.620	63%	25,2%
3. Protection and use of Water Resources	3.2 Protection plan and sustainability in soil use	13.992	91%	76,5%
4. CEIVAP demand	4.1 Charging evaluation	40		
	4.2 Basin plan	3.500		
	4.3 Monitoring of induced demands	710		
	4.4 Integrated environmental assessment	3.500		
	4.5 Dam executive project	5.250		
	4.6 Remediation of waste landfill	1.000		
	4.7 New transpositions	661		
	4.8 SES Rural centers	6.871		
	4.9 Emergency actions Water stress of the Basin PS	17.022		
	FORESEEN	38.553	76%	52,5%

Source: Elaborated by the authors based on CEIVAP (2015).

The major amount was intended to be spent on quality recovery programs of water resources, which includes pollution reduction and urban drainage and flood

[9] Currency conversion – December, 2015 (R$ 1 ≈ US$ 3,87).

control.

The expected revenue from water charges between 2013 and 2016 is US$ 15.5 million, and there are ten priority programs in the RB-PS. The funds used up to 2015 exceeded US$ 12.9 million[10], of which 50% was allocated to sanitary sewage system projects. The application of the resources in the RB-PS has 36 programs divided in three components: (1) Water resources management; (2) Environmental quality recovery; (3) Protection and utilization of water resources. The fourth component, CEIVAP demand, was created to allocate resources from contracts cancellation and works. The component 2 (Environmental quality recovery) received 58% of the expected financial contribution from the program, about US$21,2 million[11], of which 89% was destined to the reduce pollutant loads in the river basins. The component "CEIVAP Demands" received about 27% of the total expected revenue, US$ 9.8 million[12]. The evaluation of water charges by water use is performed with this component. The funds received from 2014 onwards increased considerably due to water stress events, which affected the river basin reservoir operations.

In general, the revenue is passed on entirely to the basin. The mechanism of charging for water use made possible works and actions in several São Paulo regions. In doing so, these changes imply the protection of surface water and the increase of water availability from basins. In RB-PCJ, the participation of sectors in the charging mechanism does not cover all users homogeneously. The sanitation sector accounted for 81.2% of the revenue; industry, 15.2%; commerce, services and residential uses only 2,2%; the energy sector, 1,3%; agriculture, 0,04% and the mining sector, 0,02% (CBH-PCJ, 2016).

Water management in RB-PCJ and RB-PS requires actions aimed at increasing the basin resilience to minimize the effects of extreme events related to water resources. The ability of water resources to provide ecosystem services needs to be considered in the management plan, and not just concerns about the amount that can be produced or reproduced (Vieira, 2005). The diversity, variability and adaptability of these resources must be preserved, respecting, above all, the resilience capacity of this resource.

[10] Currency conversion – December, 2015 (R$ 1 ≈ US$ 3,87)
[11] Currency conversion – December, 2015 (R$ 1 ≈ US$ 3,87)
[12] Currency conversion – December, 2015 (R$ 1 ≈ US$ 3,87)

Conclusion

The results show that the vulnerability of water resources in São Paulo state was related to the degradation of native forest areas. Apart from that, coexisting problems of susceptibility to flooding, groundwater drawdown risk, improper disposal of solid waste, demand for higher water availability or water supply at critical levels, among others, also contributed to the vulnerability of the resources.

The funds from water charges need to be seen as a possibility to minimize the impacts of extreme events, shortages or excess water, resulting from climate change.

However, the charging for water use in the São Paulo was implemented despite the difficulties related to water management. This management tool has allowed investments that will make an important improvement in the water quality. Measuring the effectiveness of the charging through these indicators can help to focus investments and public policies in river basins.

Finally, investments need to be expanded to other areas that have an important role in developing water management: environmental education; preservation of environmental conditions associated with rivers, riparian forests and forests in general; and that the "ecosystem services" associated with water resources should be increasingly emphasized.

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