

An Assessment model of Water Resource policies in River Basins: the Piracicaba, Capivari and Jundiaí case, Brazil

Giuliano Marcon
Arlindo Philippi Jr.

ABSTRACT: The Piracicaba, Capivari and Jundiaí River Basins - PCJ - present one of the most advanced performances in water resource management in Brazil. Additionally, this region entails characteristics which can be found at least partially in many other river basins. An assessment was performed in this region and is here described. It was based on research of concept and ruling documents until 2004 and operational texts regarding water resource management in the period between 1994 and 2003. Interviews with staff of the PCJ's water resource management in 2003 were also used in this assessment. Applicability of the Water Resource Policy of the State of São Paulo in the PCJ and frequency of opinions gathered in the interviews about this legislation were defined as the assessment's parameters. Eventually opportunities for improvement of water resource management in the PCJ were proposed by the author. Such assessment may support a model for analysis and re-thinking in other river basins in Latin America and around the world, towards the evolution of water resource management.

KEY-WORDS: river basin; water resource; management; policy assessment.

RESUMEN: Las cuencas hidrográficas de Piracicaba, Capivari y Jundiaí - PCJ presenta uno de las más avanzados rendimientos en el gestión de recursos hídricos en Brasil. Adicionalmente esta región trae consigo características que pueden encontrarse por lo menos parcialmente en muchas otras cuencas hidrográficas. Una evaluación fue realizada en esta región y se describió aquí. Esto se baso en la investigación de documentos conceptuales y legislaciones hasta el 2004, y los textos operacionales con respecto a la gestión de recursos hídricos en el periodo entre 1994 y 2003. Entrevistas con el personal del gestión del recursos hídricos del PCJ en 2003 fueron también aplicados en la evaluación. Aplicabilidad de la Política del Recursos Hídricos del Estado de São Paulo en el PCJ y frecuencia de opiniones recogidas en las entrevistas acerca de esta legislación fueron definidos como los parámetros de la evaluación. Finalmente, las oportunidades para la mejora del gestión de recursos hídricos en el PCJ fueron propuestos por el autor. Esta evaluación puede sustentar un modelo para análisis y re-pensando en otras cuencas hidrográficas en América Latina y alrededor del mundo hacia la evolución del gestión de recursos hídricos.

PALABRAS-CLAVE: cuenca hidrográfica, recursos hídricos, gestión, evaluación de política.

CONTEXT

A successful example of dealing with conflicts and problems regarding use of water resources can be found in the Piracicaba, Capivari and Jundiaí River Basins - PCJ, which represent one of the Units of Water Resource Management of the State of São Paulo. This region is relevant, taking into account the economic power of some municipalities, conflict in water uses, and transposed water up to 31 m³/s from its watershed to the Metropolitan Region of São Paulo - RMSP. Moreover, its Basin Committee is well known for implementing institutional solutions and advocating actions for recovering water resource conditions of economical, environmental and social

use. The PCJ has been recognized as a leading water resource management river basin in the State of São Paulo and Brazil, and its characteristics previously quoted can be found, at least partially, in many other regions.

The water resource management assessment in the PCJ was based on the Water Resource Policy of the State of São Paulo, defined by Law 7.663, from 30 December 1991. This was the first state legislation in Brazil aimed at organizing water resource management that was underpinned by the decentralization, participation and integration concept.

The current objective is to describe the assessment of the Water Resource Policy of the State of São Paulo

in the PCJ, developed by Marcon (2005), for the period 1994 to 2003. Updates in operational documents, and also actions regarding water resource management in this region after 2004 are not considered.

The methods used in this assessment are presented in the next section.

METHODS

The assessment of the Water Resource Policy of São Paulo in the PCJ was designed to:

- Gather information and contextualize the PCJ's water resource management.
- Assess the PCJ's water resource management based on specific parameters.
- Propose opportunities for improvements of the PCJ's water resource management.

In order to deliver this assessment documental research and interviews were developed.

The main aspects of the documentation on water resource management used for contextualization, background and discussion included conceptual and law texts: books and papers containing concepts on water resource management and ruling documents until 2004. Additionally, planning, reporting and other operational texts related to the running of the PCJ's water resource management between 1994 and 2003 were considered.

Opinions were collected from interviews with staff of the PCJ's water resource management in 2003, who were working through a decentralized structure of entities formed basically by the State of São Paulo, municipalities, communities and water resource users. The interviews were based on the questions:

- a) "Are you familiar with the Water Resource Policy of the State of São Paulo? What do you think about it?"
- b) "What do you consider the most important issue in this legislation?"
- c) "Do you think this issue (what was considered the most important in the legislation) has been put into practice?"
- d) "How could it (what was considered the most important issue in the legislation) be implemented or improved?"

Both reflection on the documentation and opinions are presented in the coming section, opening with the information gathered and the contextualization of the water resource management.

RESULTS

Information gathered and contextualization of the PCJ's water resource management

The context of the PCJ's water resource management was composed of some key factors in environmental issues in Brazil and in the State of São Paulo.

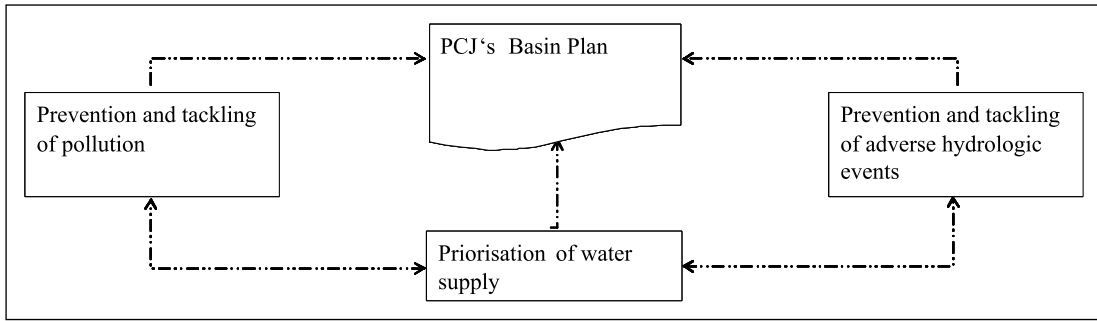
During the 70s, 80s and 90s reflections on a new water resource management concept in Brazil were acknowledged by the public which allowed a suitable political atmosphere for environmental laws.

Initiating factors for the development of environmental policies were considered, such as the Limits to Growth publication and the United Nations Conference on the Human Environment, which both took place in 1972. Such events raised the awareness of pollution, a motivating factor for industrial regulation on health and environment. Specifically for water resource management, driving factors considered included the Agenda 21, adopted in the United Nations Conference on Environment and Development of 1992, and The Dublin Statement on Water and Sustainable Development, which was established at the beginning of the same year.

Moreover, considerations were taken from reforms in the Brazilian public system in early 80s with an effort to equilibrate governmental finances in the Public Sector and the demand for democracy. As a result, environmental policies were shaped in order to meet mutual responsibility between governments and the public. These environmental laws provided opportunity for development and operation of water resource management such as the PCJ in the State of São Paulo.

The water resource management between 1994 and 2003 were organized in strategic, primary and supporting processes. The classification of these processes was adapted from Hronec (1994): strategic processes coordinated primary and supporting processes as well as addressed the final intention or impact of the State of São Paulo's Law 7.663/91; supporting processes were required for delivering primary processes; and primary processes were composed of activities which were in direct contact with water users.

Prioritization of water supply and prevention and tackling of both pollution and adverse hydrologic events were considered strategic processes of the State of São Paulo's Law 7.663/91. They were supposed to address special attention to the PCJ's Basin Plans,

**FIGURE 1. Strategic processes.**

Source: MARCON, G. 2005. *Avaliação da Política Estadual de Recursos Hídricos de São Paulo nas Bacias Hidrográficas dos Rios Piracicaba, Capivari e Jundiaí*. Doctorate Thesis at Faculdade de Saúde Pública, Universidade de São Paulo, Brazil. <http://www.teses.usp.br/teses/disponiveis/6/6134/tde-21042005-203718/>. [2008 Sep 14].

providing information to be transformed in targets. These strategic processes are showed in Figure 1.

The prioritization of water supply was classified as a strategic process because of its focus on the public's water needs. The prevention and tackling of both pollution and adverse hydrologic events were related to the prioritization of water supply, taking into account their potential impacts on water quality and quantity. Such impacts could affect public access to water or impose additional costs in obtaining proper water in conditions for different uses.

The PCJ's Basin Committee promoted regional events for the implementation of Act 1.469, of 29 December 2000, of the Ministry of Health in Brazil, which ruled on drinking water standards and its implementation. Some mention was also made to the 2000/03 planned funding, which intended to provide and distribute drinking water to 98% of the PCJ's people, by 2005.

The prevention and tackling of pollution was defined as a strategic process itself because of the importance of water quality not only to human needs but also to other species and maintenance of ecosystems.

Records had showed that the largest share of investments in water resource management was being spent on tackling domestic pollution, with a target of 90% in wastewater treatment by 2020. Industrial pollution was also significant in the PCJ and for this reason its prevention and tackling was aimed at both raising the efficiency of treatments and driving more attention to the top ranking companies altogether

responsible for half of the total polluting load in the region. Prevention and the need to tackle the effects of pollution were identified only in 1995, acknowledging the spreading out of cyanobacteria in the Dam of Salto Grande, and also the need for wastewater treatment and further studies to improve water supply.

The last strategic process, prevention and tackling of adverse hydrological events, was relevant in anticipating and facing extreme events related to water such as floods, droughts, erosion, and silting issues. Such events, when not properly prevented, could impose not only problems in access to water, but also emergency situations for the public.

The drought between 1994 and 1995 was dealt with by imposing water restrictions on the public and increasing flow diversion from the Cachoeira and Atibainha reservoirs. Therefore, proposals such as those made by the PCJ's Basin Plan 2000/03 focusing on building dams in order to store water in drought periods and keep water bodies levels under control in wet periods could be helpful. The PCJ's Basin Plan 2000/03 had also targeted actions on erosion and drainage, and studies on silting issues.

Supporting processes of the PCJ were composed of structuring water resource entities, water resource planning and water resource feed-back. Apart from structuring water resource entities, they are depicted in Figure 2. Nonetheless, the structuring water resource entities process had been very important for implementation of the State of São Paulo's Law 7.663/91. It aimed at providing institutional

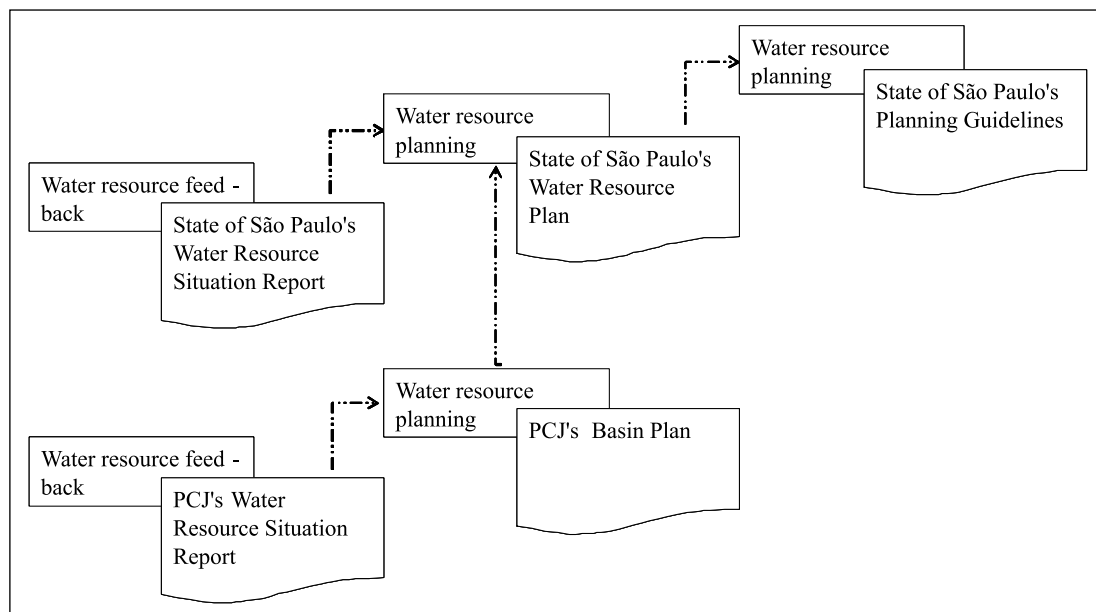


FIGURE 2. Supporting processes.

Source: MARCÓN, G. 2005. *Avaliação da Política Estadual de Recursos Hídricos de São Paulo nas Bacias Hidrográficas dos Rios Piracicaba, Capivari e Jundiá*. Doctorate Thesis at Faculdade de Saúde Pública, Universidade de São Paulo, Brazil. <http://www.teses.usp.br/teses/disponiveis/6/6134/tde-21042005-203718/>. [2008 Sep 14].

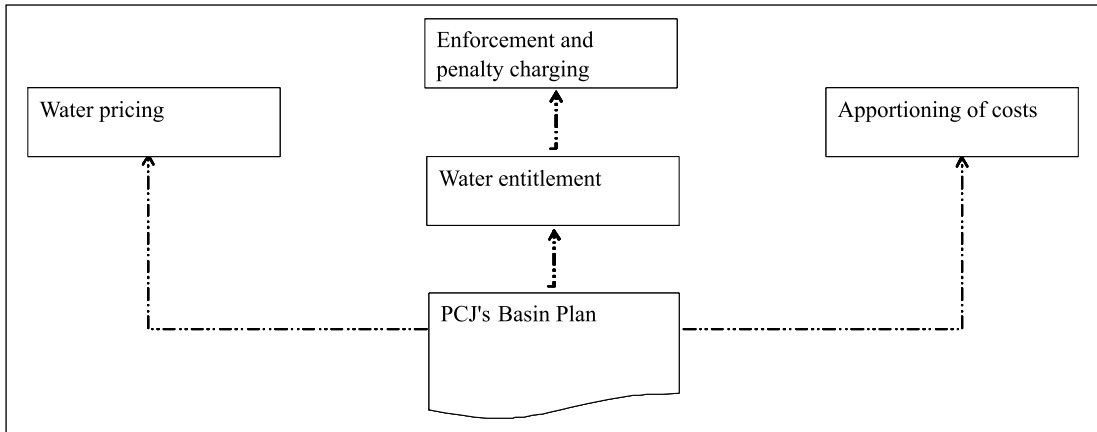
structure for the water resource management in this region, represented by the entities: PCJ's Basin Committee, State of São Paulo's Water and Electric Power Agency - DAEE, State of São Paulo's Environment Agency - CETESB, State of São Paulo's Water Resource Council - CRH, Coordinating Committee for the State of São Paulo's Water Resource Plan - CORHI, Advisory Council for the State of São Paulo's Water Management Fund - COFEHIDRO. The PCJ's Basin Agency was the only entity which had not been implemented until 2003. Although its funding was dependent upon water resource pricing, its implementation could be funded by municipalities and the public.

The water resource planning was mainly represented by the development of the State of São Paulo's Water Resource Plan, the State of São Paulo's Planning Guidelines and the PCJ's Basin Plan. This process was mainly aimed at defining targets and alternative solutions, starting at regional levels, such as the PCJ and other river basins, and ending up at the most aggregated level, the State of São Paulo.

The Water Resource Policy of the State of São Paulo was based on 22 Units of Water Resource Management and 12 Water Resource Programs brought by the State of São Paulo's 1994/95 Water Resource Plan, depicted in the State's Law 9.034, from 27 December of 1994. There were other State's Water Resource Plans intended to address different periods of time within 1993 to 2003, but although all steps for their development had been followed, including approval by CRH, they had been not approved by the State of São Paulo's representatives.

For the period 1994 to 2003 there were 2 PCJ's Basin Plans. The first, approved on 18 November 1993, defined geographical boundaries for the PCJ, while the second, for the period 2000/03, consisted of proposals regarding water quality standards for waterways, targets for recovering water quality and availability of water resource in the region.

The water resource feed-back was mainly represented by development of the State of São Paulo's Water Resource Situation Report and the PCJ's Water Resource Situation Report. Both reports had

**FIGURE 3. Primary processes.**

Source: MARCON, G. 2005. *Avaliação da Política Estadual de Recursos Hídricos de São Paulo nas Bacias Hidrográficas dos Rios Piracicaba, Capivari e Jundiá*. Doctorate Thesis at Faculdade de Saúde Pública, Universidade de São Paulo, Brazil. <http://www.teses.usp.br/teses/disponiveis/6/6134/tde-21042005-203718/>. [2008 Sep 14].

enabled access to information on water quality, level of use and follow-up regarding actions deployed, as well as adjustments as required. Even though this information provided a basis for comprehension of the regional issues and actions taken in order to solve problems, there were some problems related to data reliability.

Primary processes, presented in Figure 3, are conveyed by water entitlements, enforcement and penalty charging, water pricing, and apportioning of costs for water infrastructure works.

Except enforcement and penalty charging, other primary processes were supposed to receive enough information from the PCJ's Basin Plans in order to both prioritize water for particular uses and fund actions on water resources management.

Obtaining a water entitlement was a necessary condition for use of water resource from either surface water or groundwater, and for other actions which could alter the water regime, quality or quantity of water bodies. It was not possible to recognize liability of water entitlements and licenses either in the State of São Paulo's Water Resource Plans or related guidelines. The water resource shortage in the PCJ required water allocation through water entitlements and users identification. Improvements in information about the use of water resource for irrigation were expected to be met with the implementation

of a project aimed at organizing data. In the PCJ's Basin Committee meetings, participation of the public had been feasible both in approval of water quality standards for the waterways and in defining conditions of use of regional water resource.

The water pricing process was intended to promote rational use of water and fund water resource management actions. Marcon (2005) performed some simulations considering both the then proposed Law for implementing water pricing in the State of São Paulo and water supply service fees in the PCJ. Such simulations had suggested a low impact of implementing only the water pricing itself in order to advocate rational use of water resource, though.

Enforcement and penalty charging depended on water entitlement and real conditions of water use. CETESB prioritized its enforcement through focusing on the biggest generators of pollution and also provided annual reports on water quality monitoring. CETESB, in addition to the above strategy, performed its enforcement in line with offence reporting. On other hand, DAEE used offence reporting in 70% of its enforcement. Taking into account the shortage of water resource per habitant in the region, the enforcement performed by DAEE should be addressed e.g. to intensive water resource users and others which can cause bigger impacts on the

regional water resource. It was not possible to gather data about penalty charging by DAEE.

The process of apportioning costs for water infrastructure work referred to water resource infrastructure aimed at multiple uses, of common or collective interest. Such infrastructure should have been paid for by its users. The PCJ had not yet developed this process, which is reflected by the lack of discussions and, consequently, requirements absent from this process.

The parameters of this assessment are described next.

Assessment of the PCJ's water resource management based on specific parameters

Two parameters, applicability and frequency of opinions gathered in the interviews, were considered for the PCJ's water resource management assessment.

Applicability referred to feasibility of a full or partial process to be implemented, based on supporting legislation and regulatory documents. The frequency of opinions was calculated per question, regarding how many times a particular opinion was quoted divided by the total number of people asked about the same question. The apportioning of costs for water infrastructure works and water pricing primary

processes had no applicability, based on the lack of supporting legislation and regulatory documents. Also there was no applicability for the PCJ's Basin Agency due to its dependence on funding either from water pricing primary process or municipalities and the public.

The answers to each question and their frequency are summarized in Figures 4, 5, 6 and 7. For each question, the total frequency of opinions added up to more than 100%, as each interviewee was allowed to refer to more than one opinion in their answer.

As can be seen in Figures 4 and 5, most of the interviewees spoke about integration, participation and decentralization. For Figures 6 and 7, water pricing is the most frequent subject in the answers, which can be understood as independent funding, and therefore linked to decentralization.

It was important to consider the interdependency of water resource management, sanitation, protection of sources of water and their surrounding area, and land use, among others. At the same time, the concept of integration should be also used in the quality-quantity water management, shared between CETESB and DAEE, and the hydrological cycle, from erosion prevention and water bodies silting, to development and protection of surface water and groundwater.

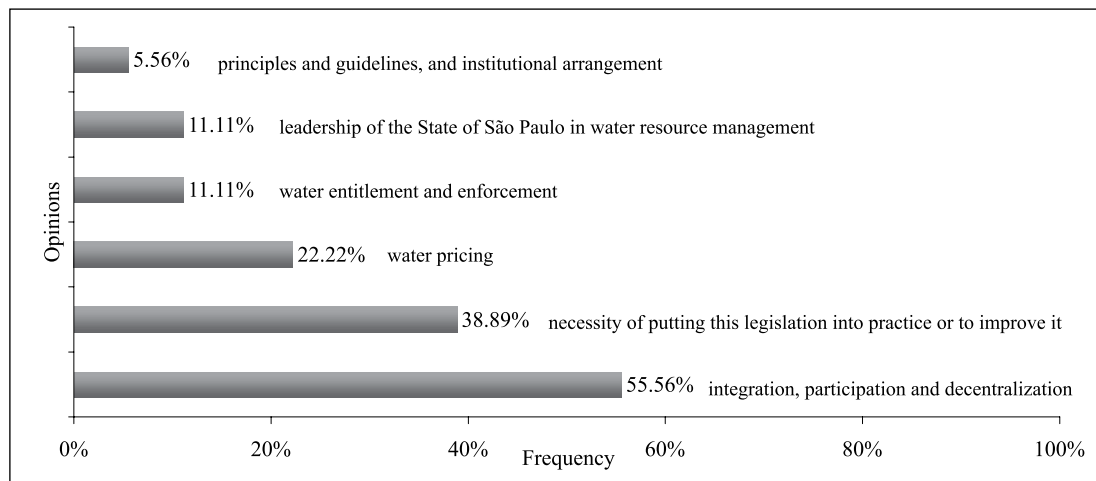


FIGURE 4. Results gathered from the question a) "Are you familiar with the Water Resource Policy of the State of São Paulo? What do you think about it?"

Source: MARCON, G. 2005. *Avaliação da Política Estadual de Recursos Hídricos de São Paulo nas Bacias Hidrográficas dos Rios Piracicaba, Capivari e Jundiaí*. Doctorate Thesis at Faculdade de Saúde Pública, Universidade de São Paulo, Brazil. <http://www.teses.usp.br/teses/disponiveis/6/6134/tde-21042005-203718/>. [2008 Sep 14].

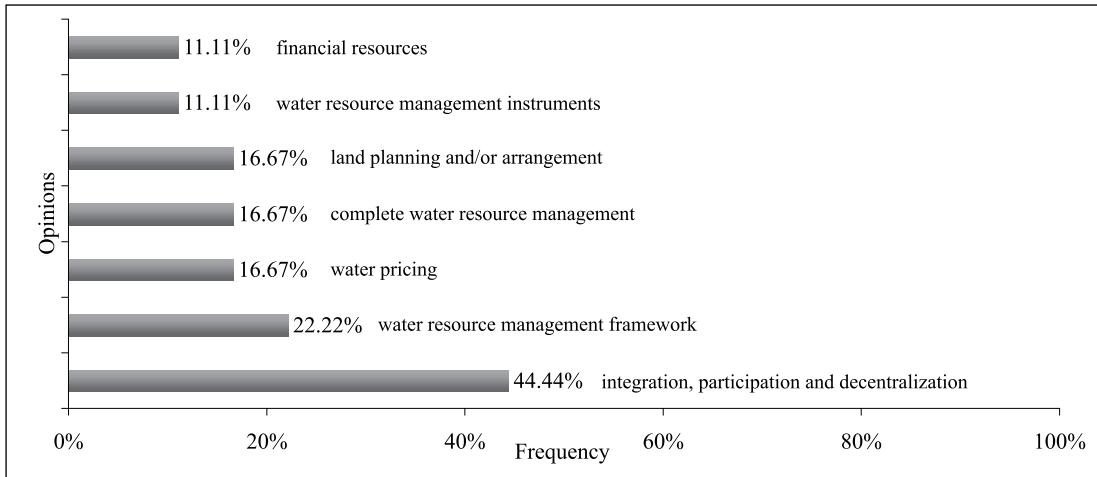


FIGURE 5. Results gathered from the question b) “What do you consider the most important issue in this legislation?”.

Source: MARCON, G. 2005. *Avaliação da Política Estadual de Recursos Hídricos de São Paulo nas Bacias Hidrográficas dos Rios Piracicaba, Capivari e Jundiaí*. Doctorate Thesis at Faculdade de Saúde Pública, Universidade de São Paulo, Brazil. <http://www.teses.usp.br/teses/disponiveis/6/6134/tde-21042005-203718/>. [2008 Sep 14].

The water pricing primary process could generate financial resources to the PCJ. Its implementation would also provide funding for its Basin Agency, towards the technical independence to support the PCJ's Basin Committee's decisions. Therefore, the partial financial and technical independence achieved by this primary process would boost the decentralization concept targeted by the region.

A particular understanding of the water pricing was in place, aimed at gathering funding for water resource management improvements. The apportioning of costs for water infrastructure works could be also used to improve access to water, but it had not been implemented yet, as was shown in the primary processes discussed beforehand.

The most important objective of the water pricing should be the advocacy for a rational use of water. Although current water supply service fees at the stage of development of this assessment could have been applied also towards this objective, at least one water supply company was offering an optional service with cheaper fees per cubic meter of water, provided the client had a consumption of more than 5,000 cubic meters per month. This situation highlighted a contradiction in which there was a potential

incentive for water consumption in a region with a serious shortage of water.

Enhancement of public participation represented a step towards a better understanding of problems related to water resource in the PCJ. This would mean not only an increase in the number of public representative voting members in the PCJ's Basin Committee, but also a diffuse participation, e.g. by grass roots organizations, advocating shared responsibility of water resource management and gathering of information on impacts on the environment. Yet municipalities, as decentralized entities, could act as organizing and enforcement authorities in order to accomplish local regulations for environment protection, including water resource.

Regardless of frequency, findings of the interviews could be organized into five categories: i) integration, participation and decentralization; ii) implementation of water pricing and a basin agency; iii) the necessity of putting into practice and enhancing the Law of the State of São Paulo 7.663/91; iv) water resource management structure; v) land organizing and planning. Marcon and Philippi Jr (2007) provided discussion on these subjects, in the context of the assessment of the Water Resource Policy of the State of São Paulo for the PCJ.

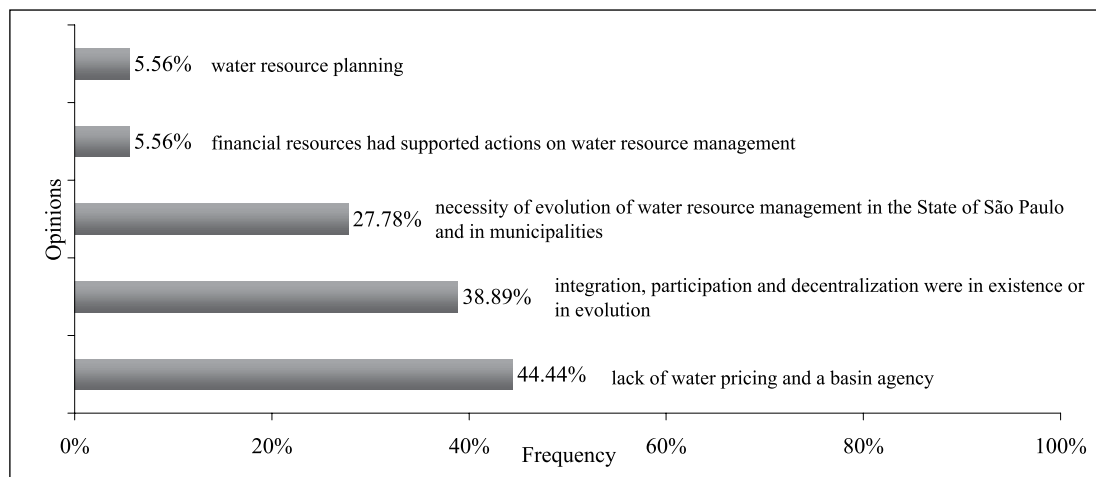


FIGURE 6. Results gathered from the question c) “Do you think this issue (what was considered the most important in the legislation) has been put into practice?”.

Source: MARCON, G. 2005. *Avaliação da Política Estadual de Recursos Hídricos de São Paulo nas Bacias Hidrográficas dos Rios Piracicaba, Capivari e Jundiaí*. Doctorate Thesis at Faculdade de Saúde Pública, Universidade de São Paulo, Brazil. <http://www.teses.usp.br/teses/disponiveis/6/6134/tde-21042005-203718/>. [2008 Sep 14].

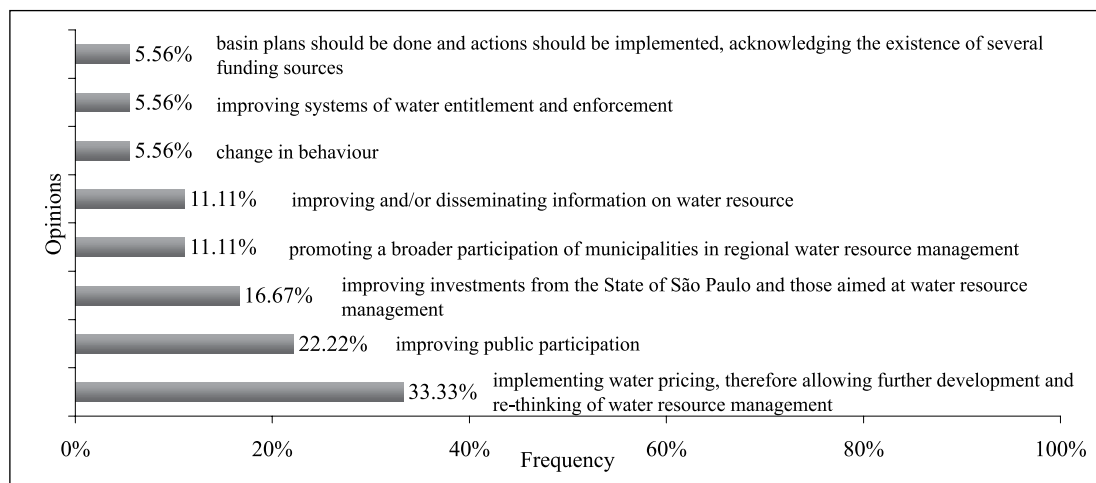


Figure 7 - Results gathered from the question d) “How could it (what was considered the most important issue in the legislation) be implemented or improved?”.

Source: MARCON, G. 2005. *Avaliação da Política Estadual de Recursos Hídricos de São Paulo nas Bacias Hidrográficas dos Rios Piracicaba, Capivari e Jundiaí*. Doctorate Thesis at Faculdade de Saúde Pública, Universidade de São Paulo, Brazil. <http://www.teses.usp.br/teses/disponiveis/6/6134/tde-21042005-203718/>. [2008 Sep 14].

The last part of this section is the description of proposals from the author's point of view, which follows.

Proposal of opportunities for improvement of the PCJ's water resource management

Opportunities for improvement of water resource management in the PCJ were defined from the author's theoretical reflections upon strategic, supporting and primary processes and also opinions based on questions a), b), c) and d).

An increase in the range of water quality parameters and more analysis by index e.g. eutrophication, could provide a more productive use of the dense water quality monitoring network owned by CETESB.

The development of a centralized database for plans and water resource situation reports of the PCJ was an important achievement to be met, advocating standardization in data handling for the decision making process on water resource management. Efforts to standardize information should also be focused on dealing with prevention and tackling pollution effects, such as difficulties in treating water for drinking purposes and respective solutions adopted by water supply service companies in the region. Therefore past situations could be organized in order to provide possible solutions in future events of a similar type.

Cooperation between entities participating in water resource management in the PCJ and civil defense services of the State of São Paulo could better support not only municipalities ruling on prevention and tackling of adverse hydrologic events, but also definition of priorities on actions to tackle erosion and floods when necessary.

Other concepts should be developed in order to provide alternatives for implementation of water pricing. Taking into account the increasing demand for water, the water pricing process should be used to lessen the consumption of water. The bigger the consumption, the higher the price to be paid per volume of water, provided water supply service fees are integrated with water pricing values and objectives. The dilution flow concept should also be aggregated in the water pricing process. In addition, risk analysis and management could be used along with water entitlements criteria, taking into account the variation in flow of natural waterways in the region.

The water pricing depended on proper control over the water resource. Such control entailed water

entitlements, licensing, enforcement and penalty charging. It relied on integration of procedures of DAEE and CETESB, which should undertake studies on quantitative and qualitative impacts and related hydrodynamics conditions involved. Partnerships among DAEE, water supply service companies and the public could involve advocating actions in order to regulate water resource uses and implement the Act 518, from 25 March 2004, of the Ministry of Health, then updated version of the Act 1.469/00. This partnership could also provide information for water resource uses allocation.

The water supply service fees should be integrated into the land planning and regional objectives of the PCJ. It was necessary to define sub-river basin areas to be protected and adapt master plans and land use ruling documents of the PCJ's municipalities aimed at water supply to the public.

More public participation in water resource management was possible and examples such as the Community-Based Watershed Management in Santo André, Brazil (CBWM, 2008) should be considered.

The improvement of water resource management in the PCJ depended mostly on a change in behavior of water users. Environmental education had a lot to contribute in this process (Philippi Jr and Pelicioni, 2000).

Conclusions about the main aspects of the results presented up to this stage are summarized in the coming section.

CONCLUSIONS

Information gathered from documental sources was important to comprehend the context and background of the water resource management of the PCJ, as well as to provide significant information for discussion. Opinions gathered from interviews offered insight into the Water Resource Policy of the State of São Paulo and priorities for the region.

The representation of the Water Resource Policy of the State of São Paulo in strategic, supporting and primary processes supported a better understanding of water resource management issues, from definition of ultimate goals to development of ways to implement solutions, resulting in actions to be taken by water resource management entities.

Parameters for this assessment, such as applicability and frequency of opinions gathered from the interviews, were used to establish objective criteria on the implementation of the Water Resource Policy

of the State of São Paulo in the PCJ. Opportunities for improvements in water resource management actions proposed by the author provided a theoretical counterpoint to challenge the regional view.

As a result, this particular assessment may support a model for analysis and re-thinking in other river basins in Latin America and around the world, thereby allowing improvements towards the evolution of water resource management.

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Giuliano Marcon Núcleo de Informações em Saúde Ambiental - NISAM, Universidade de São Paulo. São Paulo, Brazil (giulianomarcon@hotmail.com).

Arlindo Philippi Jr Departamento de Saúde Ambiental, Faculdade de Saúde Pública, Universidade de São Paulo. São Paulo, Brazil (aphij@usp.br).