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Water supply to the two largest Brazilian metropolitan regions

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Abstract

The Sao Paulo Metropolitan Region (SPMR) is heavily industrialized and it is the most important economic centre of Latin America. It is the home to over 20 million people. The Rio de Janeiro Metropolitan Region (RJMR) was in the past the country´s capital city and is presently the second most important economic centre of Brazil. It is the home of 12 million people. Although the two metropolitan regions are 400 km apart, they increasingly depend on water from the same source. Rapid urbanization and economic development in both areas have increased demand for water. With insufficient collection and treatment of sewage and with the current unprecedented drought, local sources of water are not sufficient and/or unsafe. As a result, the two giant metropolitan regions now dispute water from the same river, the Paraiba do Sul, which runs for roughly one thousand kilometres crossing three Brazilian states: Sao Paulo, Minas Gerais and Rio de Janeiro State. Recently there was a change of the operation rules for reservoirs located in the basin, conceived originally to optimize hydropower production, in order to accommodate the new situation. This paper explains the political, technical, and water-energy consequences of this dispute for water.

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Keywords: water conflict; metropolitan regions; scarcity; water constraints, brazil southeast; wastewater collection/treatment

1. The Sao Paulo Metropolitan Region – SPMR

SPMR is located in the upstream reach of the Tiete River, a tributary of the Parana River (Figures 1 and 2). The water supply system operated by Sabesp (Water and Sanitation Company of the State of Sao Paulo) serves practically the entire population that lives in the "regular city". There are meters in virtually all households. However, this is not the case in most of the slums, where roughly 10 per cent of the population lives (IBGE, 2011)

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They get access to water produced by Sabesp without any payment, usually through some informal, precarious and wasteful distribution systems e.g., by small diameter plastic tubes.

Figure 1. Map providing an overview of the location of the two largest metropolitan regions in Brazil (within the circle). Source - Political Map of the world 2013 edited by author (Original map: http://www.lib.utexas.edu/maps/world_maps/world_pol_2013.pdf)

Figure 2. The Paraiba do Sul River Basin (white dashed line) and the basin formed by Piracicaba, Capivari and Jundiaí rivers, also known by its acronym PCJ Basin (yellow dashed line). Arrows 1 and 3 show the water sources of the two metropolitan regions, SPMR and RJMR (orange dashed lines). Arrow 2 illustrates the proposed water transfer from Paraiba do Sul River Basin to the PCJ River Basin and from there to SPMR. Source: Google Earth 2015, edited by author.

Several barriers impede Sabesp from entering these slums to provide regular services. Some relate to judicial disputes about the land ownership (people have invaded private property), other to environmental restrictions (people have invaded protected areas), and still other – the majority – to the impossibility of installing water supply and sewage collection systems in neighborhoods where there are no streets to bury the pipes. This unorganized urbanization process began in the fifties, when only 30 per cent of the Brazilian population lived in the cities, and has grown worse, especially in the early 1970s with the intensification of the industrialization process. In a few years, the urban population swelled to 70 per cent of the national population, but the infrastructure growth was much slower, resulting in several problems. Among them, a high generation of untreated sewage dumped into the local water bodies, impelling the search for new water supply sources far away from the demand center (Braga et al., 2006). In spite of difficulties, practically all people living in metropolitan São Paulo have access to potable water in their households, either through formal or informal connections.

Sewerage services coverage indices don´t rank well when compared to other countries of similar per capita income (Seroa da Mota and Moreira, 2006). Although Sabesp has been working in the last 20 years to solve the problem, investing USD 3 billion in sewage collection and treatment systems, the coverage for collection is still 84 per cent and of this volume, only 70 per cent is undergoing treatment (Sabesp, 2014). Although these rates are much better than the corresponding Brazilian averages, e.g. for Rio de Janeiro as discussed below, they are clearly far from sufficient and satisfactory.

1.1. Quality problems reduce usability of local water resources

Under ideal conditions - that is, if there wasn´t a pollution problem and if water was properly regulated – the amount of water locally available in the rivers Tiete and Pinheiros would almost meet the bulk water requirement, which is around 70 m^3/s. In other words, the production and supply of potable water is essentially a quality problem. In order to avoid pollution of bulk water as much as possible, the intakes for the water treatment plants are located upstream from the metropolitan area. Since the intakes are upstream and close to the boundaries of the watershed, river flows are not sufficient to supply the immense population. Therefore, since the 1970s, SPMR draws water from the neighboring PCJ basin at a distance of about 80 km (Figure 2, arrow 1). Several reservoirs, tunnels, channels and pumping stations convey the water, forming the “Cantareira System”, Figure 3, which is one of the biggest water supply schemes in the world (Barros, 2010).

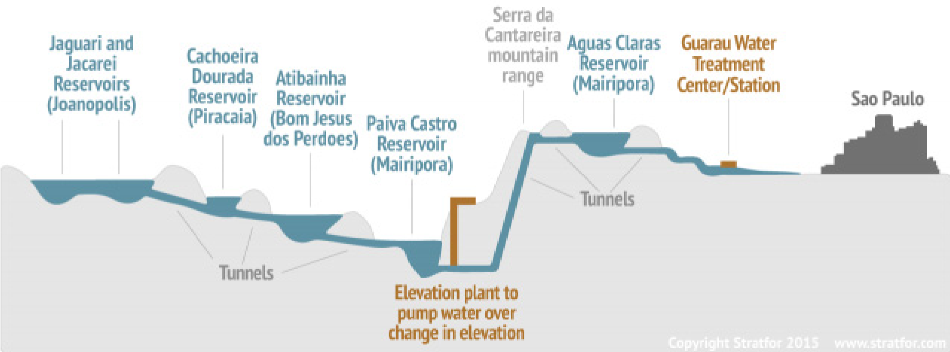

Figure 3. The Cantareira System is a set of reservoirs linked by tunnels, a pumping station and a treatment plant with installed capacity of 33 m^3/s. Source: Sabesp.

The Federal Government granted the authorization for the diversion through the Cantareira System in 1974, at a time when there was no serious dispute about water and how to use it. Even if there were such disputes, they would not have surfaced because the country was under a military regime, unfriendly to the democratic process. As the authorization was valid for a period of 30 years, it expired in 2004 when the newly created Brazilian Water Authority (ANA) had to deal with the discussion around the renewal of the authorization.

It was not a simple matter because the donor basin had experienced strong growth during the 30 years and needed more water. The political leaders in the PCJ basin resented the effects of water shortage in SPMR and claimed revision of the authorization in order to decrease the water quota allocated to SPMR. Naturally, their purpose was to remove the bottleneck to the development of the PCJ valley itself, where many important and industrial cities are located. However, contrary to political and religious leaders in other areas of Brazil, who have strongly opposed the use of “their” water outside “their” river basin (Kelman, 2009), the leaders of the PCJ basin have always recognized that some authorization had to be issued and that some of the water in their basin would need to be transferred to other areas. They realized that the interruption of the diversion of water to SPMR, where 10 per cent of the Brazilian population is concentrated, would create a chaotic situation that would harm all.

During the discussion, one of the possibilities was to leave the decision to a committee of how much water should be conveyed to SPMR and how much water should be left to flow downstream to the cities of PCJ Basin, e.g., on a monthly basis. The assumption was that the committee would be flexible dealing with the water allocation problem, i.e., not practice the stiff dictates during the previous situation. However, the creation of such a committee prompted a political battle centered around membership, rather than on how to evaluate the costs and gains of each possible allocation. Instead of supporting such a chaotic approach, ANA and the Sao Paulo State Government chose a "mathematical solution", which is simple to understand. It consists of a pro rata allocation of the inflow proportional to the basic water needs of the population respectively in the donor and in the recipient regions. Under average hydrological conditions, this means an allocation of 31 m^3/s to SPMR and 5 m^3/s to the donor basin. Under adverse conditions, the water shares decrease proportionally. Volumes of water allocated but not used are supposed to be available for later use, as if water could be stored in a "water bank". Occasional overflows are discounted from the "savings" of each region, proportional to the volume each region decided to keep in storage.

It was learned from this experience that stakeholder participation in the decision making process is desirable, provided the participants understand the basic constraints of the water allocation problem. Their involvement may not necessarily be optimal from an economic point of view. However, a simple rule, that is easy to understand and where users´ choices are accountable, proved to be the best choice in the case of the water transfer from the Piracicaba basin to SPMR.

1.2. Unprecedented drought

Because of legal constraints, the 2004 authorization was valid only for 10 years, that is, for a much shorter period than the 30 years of the previous authorization. In other words, in 2014 a new negotiation had to take place. Rather than being simpler, thanks to the experience gathered during the 10 years period, the negotiation became harsher due the occurrence of the most severe drought in the PCJ River Basin recorded in more than 80 years.

This unprecedented drought prompted ANA to change temporarily the rules enacted in 2004 and to postpone negotiations for the new authorization. The amount of water withdrawn from the Cantareira System decreased, both in the PCJ River Basin and to the SPMR. However, this was not sufficient to control the emptying of the reservoirs. In June 2014, the minimum operating level for the inter-basin transfer had been reached, i.e., the water level in the reservoirs was below the intake for the diversion and water could not be driven out of the reservoirs by gravity anymore. It was necessary to install pumps to keep withdrawing water, from the so-called dead storage. The expression "dead storage" caused unjustified fear that the water would be unsuitable for drinking. In reality, the lowering of the water level created no water quality problem. However, it meant that more energy had to be used to pump and convey water.

1.3. Need for new measures

In order to compensate for the decrease in bulk water delivery from the Cantareira system, Sabesp had to use more intensively the water stored in other reservoirs located in the metropolitan territory, which increased the probability of losing control of the entire water supply system. There was a need for new measures. First, Sabesp successfully decided to decrease the pressure in the pipes, in order to minimize leakages. Unfortunately, this approach came at the cost of increasing the frequency of water shortages in some of the households located up on the hills. Second, consumers that saved at least 20 per cent of their average consumption would get a 30 per cent discount on their water bill. A similar economic incentive had been offered to electricity consumers all over Brazil in 2001, in order to smoothen the consequences of another severe drought that forced an energy rationing all over the country (at that time, more than 90 per cent of the electricity was produced by hydro plants, Boadle, 2013). Contrary to the 2001 experience, unconcerned citizens had to pay no penalties for excess use of water in 2014, but they will have to do so, starting in 2015.

During droughts, it is necessary to try measures that have proved successful in other parts of the world. For instance, a voluntary transfer of water rights, through trade of permits to withdraw water could be a powerful economic tool to stimulate use of water in sectors and activities that produce valuable goods and services per unit water and reduce allocation of water to activities that generate less valuable output. Such measures may minimize damage to the economy as illustrated by the water policies adopted in e.g., the American West and in Australia. ANA successfully implemented a system for the trade of water rights in 2001, during a drought that affected the Northeast state of Ceara, a typically arid region in the Brazilian northeast. Fruit growers had to pay for the water they used by depositing money in a fund used to temporarily compensate rice growers while they were improving the efficiency of the irrigation installations. Farmers could also opt for substituting a water intensive rice culture for other less thirsty and higher added-value crops such as watermelon, melon, cashew, coconut, papaya and banana (Lemos and Oliveira, 2004).

However, the positive results of the experience from Ceara were not sufficient to prompt the creation of the legal and regulatory framework to allow the trade of water rights in other parts of Brazil. Therefore, ANA didn´t act to decrease irrigation in the PCJ River Basin during the current drought. Since the 2014 Sao Paulo water crisis has had repercussions on a national scale that are much larger than the problems faced in Ceara during the 2001 crisis, there will perhaps this time be a political interest to approve legislation that could induce the trade of water rights.

1.4. The future

If the future reveals that 2014 was the first one of a succession of very dry years, the situation can become extremely serious. In fact, social unrest due to water rationing may become a reality. In addition, the bill for the use of energy to pump water over longer and longer distances is likely to increase and the need for investments and arrangements for treatment of sewage, which also requires energy, will become acute. Moreover, health hazards may occur due to the infiltration of contaminated water into the pipes during periods of no water or low pressure in the pipes, for instance, if some rotating rationing of water provision becomes unavoidable. While writing this article, in the first days of January 2015, the drought seems not only to persist, but to become more severe. If this fear is confirmed, the dealing with the continuation of the crisis in 2015 will be even more difficult than in 2014. The natural hardship will be compounded by foreseeable budget constraints of Sabesp; the drought in 2014 caused both a physical decrease in the volume of water and a reduction of revenues since there was less water to distribute and the possibility to charge for water services was curtailed.

The 2014 crisis has revealed that SPMR needs to:

- Increase the water supply by 10 m^3/s in the next 2 years.
- Decrease the physical losses of water from 20 per cent to 10 per cent in the next, say, 10 years.
- Collect and treat all the sewage produced in the metropolitan region in the next, say, 20 years.
- Co-ordinate water and energy policies.

1.5. Decisions under uncertainty

The wisdom of an investment decision taken under hydrologic uncertainty in order to alleviate an extreme drought is often analyzed ex-post, that is, when one knows whether the low probability event has or has not occurred. Although unfair, many label the decision as wise or unwise based solely on its outcome, as if the decision maker had the knowledge about future hydrological conditions.

Experience during the 2001 rationing of energy in Brazil revealed that the best Government attitude when faced with the necessity of rationing of a vital service like electricity is full disclosure of information. In 2001, practically the entire population, even those that opposed the Government for political reasons, supported the energy saving policy because of total transparency. Furthermore, this success story of how to manage a crisis proved that those who were afraid that the worse self-triggered prophecies would become true due to the spread of rumours were wrong. A similar strategy of full disclosure should apply also to water supply. Moreover, it is important to inform the public about the close connections between water and energy issues, especially in cases of droughts and scarcity.

1.6. Sao Paulo and Rio de Janeiro in search for water from the same, distant river basin

The challenge of increasing bulk water supply to SPMR was thoroughly dealt with in the Master Plan for Water Supply of Sao Paulo Macro Metropolis (Governo do Estado de Sao Paulo, 2013). It identifies several optional hydraulic conveyance structures, combined into different alternatives, which are capable of meeting the forecasted water demand by 2035. One of these options included the building of hydraulic structures that would transfer 5 m^3/s from the Jaguari reservoir, located in the Paraiba do Sul River Basin, to the Atibainha reservoir, in the PCJ River Basin

(Figure 2, arrow 2 and Figure 3). The Master Plan didn´t consider this solution as the best one for various reasons. The most important one was that the Paraiba do Sul River Basin is also the source from which water is diverted to the Rio de Janeiro metropolitan region. Although the RJMR is far away from the Paraiba do Sul River Basin, most of its water comes from that basin through a transfer scheme built in the 1950´s (Figure 2, arrow 3). Given these facts, intense political dispute would certainly erupt between the two giants – SPMR and RJMR – around the rights to water from the same river basin, the Paraiba do Sul.

However, when faced with the exceptional 2014 drought, the Sao Paulo Government realized that it would be necessary to start construction of a system that could be implemented as soon as possible. Despite all the *cons,* there was a simple and sound reason for choosing the alternative that previously wasn´t considered as the top priority: a system that could transfer water from the Paraiba do Sul Basin to the PCJ Basin is the alternative that would take the shortest time to implement (Figure 2, arrow 2). The Rio de Janeiro´s Governor initially opposed this decision, but after mediation of ANA and of the Federal Government, all parties accepted the solution. If properly conducted, the water supply system to both metropolitan regions may result in a win-win situation.

2. Rio de Janeiro Metropolitan Region - RJMR

RJMR is located in a narrow stretch of land confined between the Atlantic Ocean and the mountains. Like in the SPMR, over 95 per cent of the households are connected to the public water supply system. However, in RJMR the sanitation conditions are worse than in SPMR: 65 per cent of the sewage are collected (compared to 84 per cent in SPMR), and only 48 per cent of the collected volume is treated (compared to 70 per cent in SPMR). That is, about two thirds of the sewage flows into the Ocean or into the Guanabara Bay without proper treatment (Ramos and Kelman, 2015).

2.1. Water and energy linkages in the emerging situation

Similar to the situation in the SPMR, the local rivers are very small and as a result, the per capita water availability from the local sources is insufficient to meet the needs and demand. Nowadays, most of the water used in the metropolitan region therefore comes from the inter-basin transfer from the Paraiba do Sul River Basin through infrastructure that was originally built primarily to generate power (Figure 2, arrow 3).

Transfer of water generally requires energy. However, there are also cases where it is possible to co-plan water supply and energy production with positive synergy effects. As illustrated in Figure 4, the conveyance of water from the Paraiba do Sul River Basin to RJMR requires pumping. On one side of the mountain, the pumps elevate the water some 50 meters, which of course consumes energy. After reaching the top of the mountains water drops for some 300 meters on the other side of the hill, passing through a cascade of power plants operated by Light, the local power company. In the process, energy production is much larger than energy consumption to lift the water (Kelman, 2014).

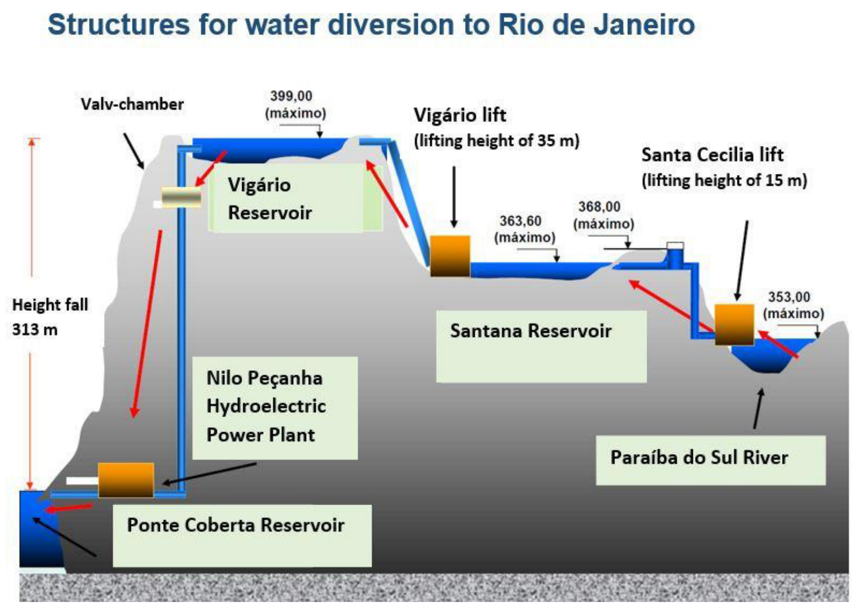

Figure 4. Schematic view of structures for water diversion to Rio de Janeiro and the associated need for energy to lift water and the energy production when water drops on the other side of the hill before reaching Rio de Janeiro (located to the left in the Figure). Source: Light

It is interesting to note how the connection between water and energy has changed over time. As mentioned, the Light company built the pumping and power plants in the 1950s and it still produces electricity, but the most important use the infrastructure, by far, is the water supply to the RJMR. Indeed, after the water from the Paraiba do Sul River Basin passes through the turbines of Light, it flows as an almost artificial river called Guandu towards the Sepetiba Bay, in RJMR. Along the route, part of the water flows through the intake of the Guandu Water Treatment Plant. Average production of this plant is about 50 m^3/s.

Before the drought crisis, the operation of the reservoirs in the Paraiba do Sul River Basin, some of which are located in Sao Paulo State and others in Rio de Janeiro State, solely followed the decisions of a mathematical model of the Power System, configured to represent all "arc and nodes" of the electrical grid, covering most of Brazil. Under this operation rule, the river flow at the Light´s pumping station (Santa Cecilia) was kept at least at 190 m^3/s, from which some 119 m^3/s were diverted to RJMR, forming the River Guandu, and 71 m^3/s followed the natural river course. Therefore, the minimum flow in the River Guandu plant was more than twice the intake of the Guandu water treatment plant. Under these conditions, obviously there was no problem of water supply to RJMR.

During 2014, the reservoirs located in the Paraiba do Sul Basin upstream from the diversion to RJMR were getting empty very rapidly. This posed a problem not only for power production along the cascade of power plants located in the basin and in Light´s plants, but more importantly, it created a menace to RJMR water supply. It became obvious that the operation rules needed to be changed in order to save water in the upstream reservoirs. In this way, water supply was prioritized over power production. There is a simple explanation for this choice: it is possible to compensate the decrease of energy produced locally in a range of, say, 100 kilometers, by bringing energy produced by power plants located one or two thousand kilometers away. However, the transfer of water over such distances would not be economically feasible.

This change had no serious impact in the integrated power system of the country. However, there was an impact for the water utility of Rio de Janeiro, Cedae. This is so because the diversion flow from the Paraiba do Sul River Basin was decreased to save water in the upstream reservoirs, most of them located in the Sao Paulo State. Even so, some 100 m^3/s were kept running in front of Cedae's intake. As Cedae abstraction is roughly half the available discharge, one may wonder why there was an impact. The explanation relates, once again, to the lack of proper sanitation. Part of the drainage area of the Guandu River lies in very poor cities at the outskirts of metropolitan Rio de Janeiro, where sewage collection and treatment is grossly insufficient. The decrease of flow coming from the Paraiba do Sul River Basin increased the concentration of pollutants in the Guandu River and posed a severe challenge for the water treatment process.

2.2. Sanitation is a public service, water supply is individual

As discussed above, the need for increasing water conveyance from far away sources to the two metropolitan areas, Sao Paulo and Rio de Janeiro, is partly due to pollution loads and insufficient collection and treatment facilities at the local level. If these problems are reduced, the local water and environmental situation will improve and the dependence on water transfers will be less compelling. It is thus important to include these aspects in a proper water supply strategy.

Water supply and sanitation are usually provided by the same utility. Generally, the tariffs aim at full cost recovery for both services. This kind of policy ignores a fundamental difference between the two services: water supply benefits the individual on a daily basis while sanitation benefits the community. The benefits and problems of poor sanitation do not affect people in the same direct manner as in the case of water supply. In general, there is a great deal of political pressure to ensure the continuity of water supply; modern life would be impossible without water and electricity. On the other hand, in poor neighbourhoods, where the ability to pay is limited, all kinds of service costs seem high. Although sanitation is also desirable, but less intensively needed than water supply, some of the poorest even prefer not to have sanitation in order not to be obliged to pay a larger bill.

There is an obvious error of public policy when clients pay for services that benefit all as if they were individually appropriated and beneficial. Like drainage and street lightening, sanitation is a public service that the taxpayer should contribute to finance, at least partially, rather than the individual consumer. In other words, a policy of subsidies for sanitation is not necessarily bad, as it benefits the whole community, rather than individual citizens, contrary to water supply services. However, as always, it is necessary to use subsidies wisely. Unfortunately, in most cases they help inefficient service providers to perpetuate unsustainable operations.

2.3. Subsidize results – not engineering works

ANA has a pilot program that intends to use the taxpayers' money effectively. Instead of subsidizing the building of new structures, only the actual results receive payments, in this case, the treated sewage. This modality of Output Based subsidies is an innovative response to decades of ineffective subsidies, which have been allocated to sewerage companies who have been more interested in building physical infrastructure and buying equipment than in using the assets to produce continuous operational results. The business-as-usual approach practiced by some construction companies has often resulted in "white elephants", that is, huge ineffective infrastructure that stays idle for years, sometimes forever.

Within ANA´s pilot program, the sewerage treatment gets subsidies throughout the first five years of operation (Kelman, 2004). The disbursement, however, is subject to an adequately provided service. If the service provision does not meet the required standards, the allocated funds, deposited in a development bank, return to the National Treasury. The required standards are set in terms of sewage quantity and on the quality of the treatment. This arrangement reduces risks for both sides. It ensures the service provider the elimination of the non-compliance risk due to government budget cuts as the committed funds are set aside in a development bank. On the other hand, the Government eliminates the risk of paying for an inadequately implemented service.

In a sense, the most interesting result of ANA´s pilot is not what went right, but what went wrong. In the beginning of the program, many municipal authorities responsible for sanitation approached ANA and presented excessively ambitious projects during the negotiating stage. When they realized the difficulty of fulfilling their promises, either because the sewage collection system did not work as satisfactorily as originally thought or because the pollution removal process was not as efficient as foreseen, they returned to ANA seeking a renegotiation. They came to the obvious conclusion that it is preferable to receive less subsidies than to receive nothing. Taxpayers' money was thus not used to pay for a service that was not being rendered.

Regardless of these very positive results, ANA´s version of the Output Based subsidies remains a pilot program. Unfortunately, it has not become the standard way of providing subsidies for sanitation. Many hypotheses and facts may explain this failure. All of them are beyond the scope of this article.

3. Conclusions

During a conference at the Industry Federation of Sao Paulo State (FIESP), in December 9, 2014, the author was asked what would be the most relevant change in the water resources management system that FIESP should lobby for. The answer that perfectly fits to the situation described in this paper was:

- Water losses: strengthen and improve the infrastructure to decrease leakage and the need to bring water from other rivers.
- Tradable water rights: the absence of the legal and regulatory framework inhibits the allocation of water to its more efficient use.
- Tackle pollution in water bodies: insufficient sewage collection and treatment of the pollution of rivers is a threat to the water security of both SPMR and RJMR. The technical solution of this problem is straightforward. The real problem lies on the public policy regarding expenditures with sanitation.
- Coordinate the water and energy policies: there are engineering solutions that can simultaneously be of advantage to water supply and to energy production. However, in case of a dispute - for example, setting the reservoir operation rules - the decision maker needs to take into account that it is economically feasible to transmit electric energy over thousands of kilometres, but there isn´t such flexibility in the case of water supply.

Under normal circumstances one can´t expect that sanitation and water resources management become top governmental priorities, vis-à-vis so many demands in a developing society, e.g., better education, health, security and transportation. However, one could expect that governments will do their best to use public resources in an optimal way. Hopefully, the 2014 drought will reveal the need to perform better. A crisis is too good an opportunity to waste.

References

Barros, L.A.A.B. (2010). Uma história visual da construção do Sistema Cantareira. Pp. 15. Publisher: Editora Autor, São Paulo.

Boadle, A. (2013). Ghosts of 2001: Brazil worries about another energy crisis. *Reuters*, U.S. edition. 9 January 2013. Retrieved on January 1, 2015, from http://www.reuters.com/article/2013/01/09/us-brazil-electricity-idUSBRE90818N20130109

Braga, B. P. F., Porto, M. F. A. and Silva, R.T. (2006). Water Management in Metropolitan São Paulo. *International Journal of Water Resources Development*, 22(2), 337–352. Retrieved on January 1, 2015, from http://www.researchgate.net/publication/228651083_Water_management_in_metropolitan_So_Paulo

IBGE (Brazilian Institute of Geography and Statistics) (2010); *2010 Population Census*. Retrieved on January 1, 2015, from http://www.ibge.gov.br/home/presidencia/noticias/imprensa/ppts/00000015164811202013480105748802.pdf

Governo do Estado de São Paulo, Secretaria de Saneamento e Recursos Hídricos. (2013). *Plano Diretor de Aproveitamento de Recursos Hídricos para a Macrometropole Paulista*. DAEE - Departamento de Águas e Energia Elétrica. São Paulo. Brazil. Retrieved on January 1, 2015, from http://www.daee.sp.gov.br/index.php?option=com_content&view=article&id=1112:plano-diretor-de-aproveitamento-dos-recursos-hidricos-para-a-macrometropole-paulista&catid=42:combate-a-enchentes

Kelman, J. (2004). Effective subsidies in developing countries. *Water science and technology*. IWA. 49(7), 55-59.

Kelman, J. (2009). Good and Bad Forms of Participation in Water Management: Some Lessons from Brazil. In: Dinar, A. and Albiac, J., (Eds.). *Policy and Strategic Behaviour in Water Resource Management*, Earthscan, Pp. 189-206.

Kelman, J. (2014). Disputa pela água entre Rio e São Paulo. *Brasil Energia*, no 406, p. 66. Retrieved on January 1, 2015, from http://www.kelman.com.br/pdf/bec406_idkelman.pdf

Lemos, M. and Oliveira, J. (2004). Can Water Reform Survive Politics? Institutional Change and River Basin Management in Ceará, Northeast Brazil. *World Development* 32(12), 2121-2137. Retrieved on January 1, 2015, from http://www.sciencedirect.com/science/article/pii/S0305750X04001445

Ramos, M. and Kelman, J. (2015). Os compromissos olímpicos e o legado para o saneamento ambiental da cidade e da Baía da Guanabara. In: Giambiagi F. (coord.). *Depois dos Jogos: Pensando o Rio para o pós 2016*. Publisher: Elsevier.

Sabesp - Basic Sanitation Company of the State of Sao Paulo (2014). *Sustainability Report*. Sewage Treatment: Health, Environmental Preservation and Development. Pp. 35-36. Retrieved on January 1, 2015, from http://site.sabesp.com.br/uploads/file/asabesp_doctos/sabesp_sustainability_report2013.pdf

Seroa da Motta, R. and Moreira, A. (2006). Efficiency and regulation in the sanitation sector in Brazil. *Utilities Policy*, 14(3), 185-195. Retrieved on January 1, 2015, from http://ac.els-cdn.com/S0957178706000154/1-s2.0-S0957178706000154-main.pdf?_tid=ba499ab2-ce45-11e4-a46a-00000aacb360&acdnat=1426776140_1658a402731361e898c5761bdf7301a2.