WATER CRISIS IN SÃO PAULO EVALUATED UNDER THE DISASTER'S POINT OF VIEW[1]

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1. Introduction

In 2011, the consequences of the Eyjafjallajökull volcano eruption were reported by media worldwide. Although there were no direct risks to the population living next to the volcano, the impact of its ashes increased restrictions in European airspace, affecting millions of people. Likewise, water supply issues do not usually result in direct deaths, but may represent large economic losses and affect the daily lives of millions of people. An expressive number of people is affected, both directly, due to scant supply of homes and indirectly, through increasing costs of food and goods that depend on water to be generated or produced. Water scarcity, therefore, can set up a disaster.

Under the disaster's point of view, both natural and anthropogenic processes and phenomena may cause the crisis in water supply. Most of those processes are well known and can be previously identified. To understand the disaster, we must know not only the risks to which communities are exposed, but also the different levels of vulnerability of different groups of people. Risk, according to the United Nations International Strategy for Disaster Reduction (UNISDR) (2009), is "the combination of the probability of an event and its negative consequences". Vulnerability is determined by both natural forces

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and social systems (WISNER et al., 2003). The demand for water reflects the human activities along the basin and also an environmental component which is severely affected by climate change, increasing the vulnerability of places and populations, such as the water stress in degraded areas (AUGUSTO et al., 2012).

Brazil's Southeast region has been facing one of its worst recorded droughts, mainly affecting the state of São Paulo, since 2014. Considering this scenario, this paper aims to analyze the water crisis in the Metropolitan Region of São Paulo (MRSP).

The historic drought in southeastern Brazil in 2014-2015 began in São Paulo in October 2013 and extended to other states of the Brazilian Southeast over 2014 and 2015. The consequences of this lack of rainfall, coupled with poor planning in supply and distribution and irregular and/or disorderly occupation of the springs have resulted in a water crisis and the severe reduction of the main water supply systems, especially in the MRSP.

International scenario

Water is a renewable resource, but it is dependent on the dynamics of the hydrological cycle. Its total volume does not change, but there are many variables that affect its availability for human activities, what highlights the limitations for the use of this resource. However, its growing demand in various economic sectors, also associated with population growth, rises the necessity of changes in the water resources management. According to Tundisi (2006), the water crisis refers to more than water scarcity; it is a management crisis. The management efficiency is achieved through the integration of scientific knowledge and management.

The World Commission of Water estimates that in 2025 the world population growth will require an increase in the global water supply by 17% for irrigation and by 70% for urban purposes (RAMOS, 2007; WORLD WATER COUNCIL, 2000). This demand, combined with other destinations for water, means an increase of around 40% in the total demand in the planet. That Commission points out the need for doubling global investments in water management and sanitation in order to contribute to the assessed needs and to reduce the number of people without access to clean water (1 billion) and sanitation (3 billion) (RAMOS, 2007; WORLD WATER COUNCIL, 2000).

Currently, 35% of the world's population have no access to clean water and 43% are not provided with basic sanitation (UNICEF). According to the World Health Organization (WHO), approximately 10 million people - 4.6 million children aged up to five years - die every year from diarrhea in the world. It frames a problem directly associated with the consumption of non-potable water. Considering the management challenges, distribution problems, performance of water-related public policies and especially the neglected social groups, we can observe a recurring disaster worldwide (LONDE et al., 2014).

National scenario

From 2006 to 2010 there was an increase of 29% in the removal of water from river springs in Brazil, from 1,842 m^3/s to 2,373 m^3/s. This increase was mainly due to water

withdrawal for irrigation purposes, which increased from 866 m^3/s (47% of the total) to 1,270 m^3/s (54% of total). This sector accounts for the largest share, followed by urban human consumption purposes, industrial, animal and rural human consumption (BRAZIL / ANA, 2013).

As the Brazilian Electric System is largely based (about 70.6%) on hydroelectric generation, the lack of energy poses a risk that can trigger an economic disaster in various regions of the country. According to the National Electricity System Operator (ONS), in January 2015, the rainfall volumes in the Southeast and Midwest regions were lower than those required for the storage of water in the reservoirs of the major hydroelectric plants in the country, contributing to the crisis of the national electricity system. The report indicates a storage capacity of 18.72% in January 2015, during the rainy season in these regions. The southeastern region of Brazil - in particular the state of São Paulo, - is highly impacted by hydrological extremes, because besides being densely populated, it has only 6% of the country's available water resources and a high demand for industry, agriculture, irrigation, hydropower generation and public supply (ISA, 2014).

The Cantareira System is a system for capturing and water treatment for the MRSP, created to supply 8.8 million people. It is composed of six interconnected dams and a pumping station to overcome Serra da Cantareira (SABESP). In addition, it is considered one of the biggest Systems of Water Production in the world, covering 12 municipalities and producing about 33,000 liters of water per second. Most of this water comes from the Piracicaba River Basin and is transposed to the Upper Tietê Basin, where the Metropolitan Region of São Paulo is located. (WHATELY & CUNHA, 2006). With the worsening drought, the use of a technical reserve of the Cantareira System is authorized, known as "dead volume", which adds up to about 480 billion liters of water located below the operating structures of reservoirs and accessible only by pumping (ANA).

2. Water Crisis

Urban expansion represents a challenge for the management of water resources in many countries. Most large cities in the world are subject to precipitation variation and, consequently, to problems in the supply system.

The problem - which can be understood as a risk - depends on a minimum amount of precipitation to avoid a breakdown in the water supply. It greatly depends on the occurrence of a natural process with uncertain frequency and volumes for specific periods. Considering the historical average rainfall, the monthly measurements represent an average of a certain period, usually thirty years. Thus, there are expected values, but there is no guarantee neither for rain occurrence, nor for specific values for a determined period. Added to this uncertainty, changes in patterns of soil use and occupation, urbanization and environmental conditions can also influence the precipitation occurrence.

Water scarcity may take different degrees of intensity, usually associated with the variety of concepts for "drought". According to the Brazilian Civil Defense Glossary (CASTRO, 1998), "drought" can be defined as a "prolonged period with low or no rainfall, in which the soil moisture loss is bigger than its replacement.

The UNISDR (2009, p.8) defines a drought as a:

> Deficiency of precipitation over na extended period of time, usually a season or more, which results in a water shortage for some activity, group, or environmental sectors. However, in terms of typologies, droughts are classified as meteorological, agricultural, hydrlogical, and socioeconomic.

Santos (2007) mentions four types of drought, from (1) the absence of precipitation for a period of time, with a decreasing amount of water in rivers and reservoirs; (2) hydrological drought; (3) water deficit in the soil, resulting in losses in agricultural production and (4) socioeconomic drought, causing economic stagnation and poverty in the affected regions.

From a meteorological point of view, the Standardized Precipitation Index (SPI) may be applied to the monitoring of precipitation during a specified period, which may range from 1 to 24 months, compared with the historical average, according to the scale:

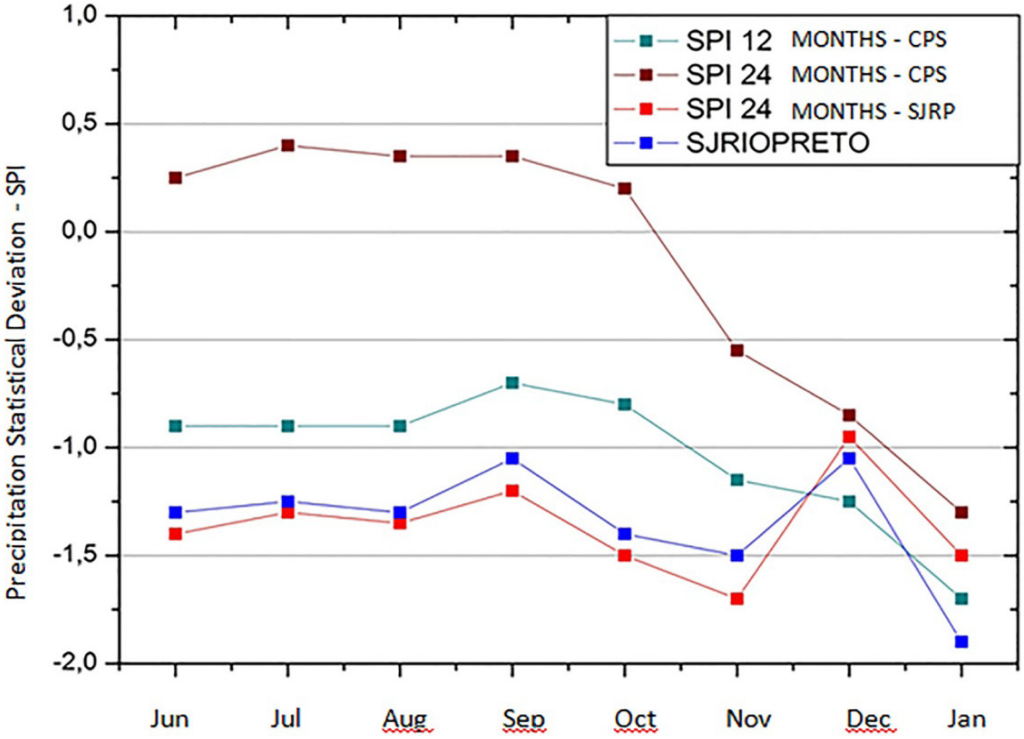
Table 1: Relationship between SPI values and dried category

SPI Value	Dry Category
2 and above	extremely wet
1,5 to 1,99	very wet
1,0 to 1,49	moderately wet
0,99 to -0,99	next to normal
-1,00 to -1,49	moderately dry
-1,5 to -1,99	severe drought
Less than -2	extreme drought

Source: Department of Agriculture and Supply, State of São Paulo (2014).

Analyzing data from the Integrated Center for Agrometeorology Information (CIIAGRO) for 12 and 24 months, the Department of Agriculture and Supply in São Paulo State (SÃO PAULO, 2014) estimated an evolution of the SPI for the period of June 2014 to January 2015 for the state (Figure 1).

Figure 1: Hydrological drought estimated for the state of São Paulo.



Source: Department of Agriculture and Supply, State of São Paulo (2014)
Subtitle: SPI-Standardized Precipitation Index; CPS- Campinas; SJRP and SJRIOPRETO- São José do Rio Preto

Considering the precipitation of the last 12 months, the systems were already in a situation of "moderate drought" or "severe drought" during the period before June 2014 (the dry line corresponds to "0" in the chart in Figure 1 and the points located below this line are featured as drought). In this scenario, the useful volume of water from the Cantareira System finished on July 11, 2014 and the first part of the technical reserve (called "dead volume 1") started being used, as shown by the report of the Brazilian Center for Monitoring and Warnings of Natural Disasters (CEMADEN, 2015). According to the same report, the "dead volume 1" finished in November 15, 2014, and the "dead volume 2" started being used. After the rainy season, the "dead volume 2" was recovered on February 24, 2015.

As this study aims to analyze the water crisis under the disaster risk management perspective and drought's impacts occur gradually over time, we established that the moment that best represents the beginning of the drought impact (including the socio-economic point of view) is when the reservoir's useful volume is exhausted, i.e., immediately before the technical reserve is accessed.

However, we must also define the situation in which the drought is a threat, even though there are no adverse effects. Based on experts' opinion, which establishes the percentage of 10% of the effective volume as the reservoir's minimum level for power generation purposes (TOMAZELLI & NEDER, 2015), we defined this value - 10% - as an indicative of a period of preparation for the drought impacts on water supply. It is noteworthy explaining that power shortage threat is not discussed in this paper, but its importance must be considered for an integrated risk analysis.

3. Characterization of demand and water availability in the MRSP's main basin

According to Ribeiro (2011, p.119), the necessity of analyzing the water supply in São Paulo is an ongoing exercise. The intense activities that happen in the urban space generate a high demand for water, in addition to the basic needs of the population, the use for recreation, and the allocation for industrial use, which creates a complex picture of competition for water. The water supply should be planned in an integrated manner, considering fine scales.

To understand the use of water resources, we must consider the water consumption demanded by the MRSP, with 39 municipalities and 20,284,891 inhabitants. According to Ribeiro (2011), the MRSP is over an area of approximately 8.051km2, representing 0.1% of the Brazilian territory. However, it supports about 10% of all inhabitants of the country, in an area which does not have abundant water supply. This spatial representation (FIGURE 2) illustrates the scale.

In Figure 2, polygons refer to State Hydrographic Units - UEPGRH. These units are defined with focus on water resources management. The total SPMR area classified as critical sums 73%.

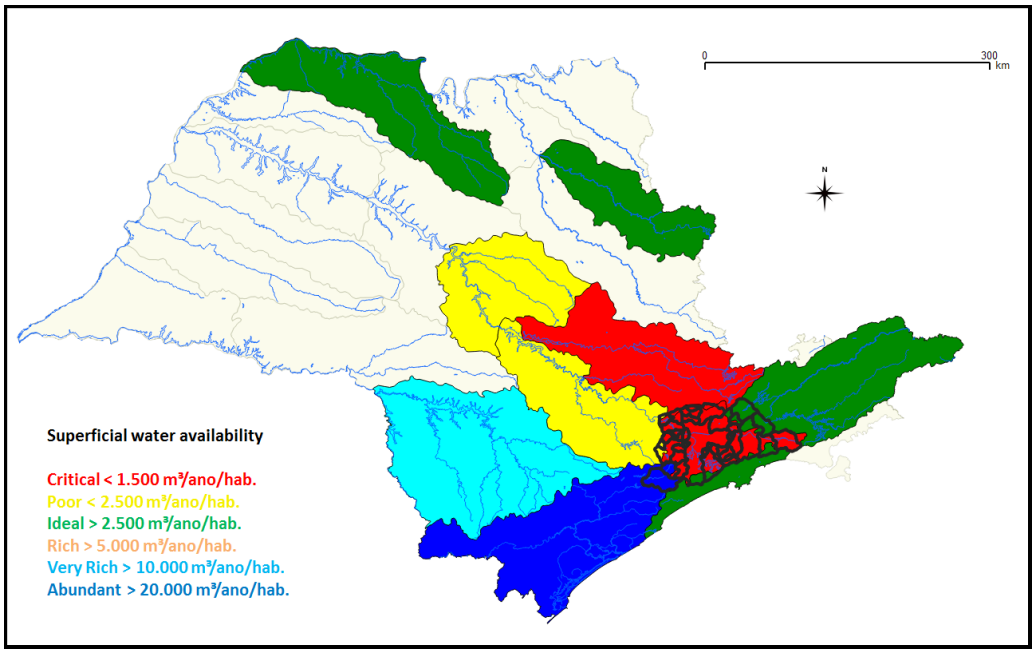
The basins "PCJ" are formed by the Rivers Piracicaba, Capivari and Jundiaí, with an area of 15,303.67 Km^2, approximately 92.6% in São Paulo state and 7.4% in Minas Gerais state. In 2008 approximately 50% of the urban water supply of the metropolitan region was withdrawn from the Piracicaba River Basin (BRAGA et al., 2008).

The PCJ basins cover 76 cities with a growing population that increased 56% from 1991 to 2013. It is estimated that in 2020 the total population will be approximately 5.9 million inhabitants, from which 98% will be in urban areas (AGÊNCIA DAS BACIAS PCJ, 2013).

Furthermore, the PCJ basins head is responsible for supplying water to 9 million people (about 50% of the population of the MRSP), which is in the most critical situation in the Cantareira system. The availability of surface water from the PCJ basins is very limited and there is a trend to reduce even more the amount of available water per capita, due to population growth (RELATÓRIO DAS BACIAS PCJ, 2013).

The Upper Tietê Basin, also responsible for supplying the MRSP, presents critical situation regarding water availability, according to UN criteria, as shown in Table 2.

Figure 2: Availability of surface water in different basins in the state of São Paulo, with highlight for the cities of the Metropolitan Region of São Paulo (larger gray borders)



Source: Adapted from DAAE. Hydrography from CPRM (www.cprm.gov.br/), Basins from ANA (www.ana.gov.br/) and SPMR shapefiles from IBGE's homepage (www.ibge.gov.br/).

Table 2. Water availability for some sites in Brazil		
UN classification	Water availability (m3/inhabitant/year)	Region
Abundant	More than 20.000	Brasil (35.000)
Correct	From 2.500 to 20.000	Paraná (12.600)
Poor	From 1.500 to 2.500	State of São Paulo (2.209)
Critical	Less than 1.500	State of Pernambuco (1.270)
		Piracicaba Basin (408)
		Upper Tietê Basin (200)

Source: SABESP 2015

According to Silva (2007), there are specific conflicts involving the use of water in the basin of the Upper Tietê River, comprising the conurbation of MRSP as to:

The problems faced by the PCJ and the Upper Tietê River basins can be extended to the Paraíba do Sul basin, because that river may be used to support the Cantareira

System's supply, although the technical evaluation from the concerning Committee states that there is no water availability for this support (CEIVAP, 2015). As the river Paraíba do Sul flows through more than one state, it is a federal river, with state and federal committees. This may worsen the scenarios, indicating conflicts and problems in water supply for human consumption and other uses. It is noteworthy that the river Paraíba do Sul is the main supplier of water to the state of Rio de Janeiro.

4. Water management in the basins that affect the MRSP supply

According to Braga et al. (2008), the challenge of water management in Brazil is linked to the management of demands, to the increase and garante of water supply in hydrographic regions with low availability and to the improvement of water quality with reduction of domestic and industrial pollution. There are serious social problems related to water, such as deprivation, waste, low-quality problems and organic and chemical contamination (AUGUSTO et al., 2012).

The Sanitation Company of the State of São Paulo (SABESP) is responsible for operating most of the São Paulo state water system. In December-31/2010, the Company was directly operating sanitation services in 364 of the 645 municipalities of São Paulo. It also provides water for other seven municipalities in the state and treats sewage for five of them, serving a total of around 27.2 million people, representing approximately 68% of the urban population of the state" (SABESP, 2015).

A specific evaluation of Cantareira System, conducted by the Social Environmental Institute (ISA) during a drought crisis in 2003, points out the loss of vegetation cover, occupation of permanent preservation areas (APP); poor sewage collection services and inappropriate disposal of solid waste; mining activities in the basin area; and inappropriate land use planning (WHATELY, 2007).

In a scenario of water scarcity, due to population increase, changes in ecosystem services, inappropriate land use and water pollution, the PCJ Committee considers the River Basin Planning for determining actions. Thus, several technical chambers (Planning, Environmental Education, Use and Conservation of Water in Industry; Hydrological Monitoring, Use and Conservation of Water in Rural Areas) were established. Such chambers and the action of the PCJ Committees are essential to address and minimize the effects of drought, seeking for rational water management.

The PCJ Committees, however, failed to promote an equitable distribution of water among users in the basin. According to Jacobi (2014, apud ARTIGO 19, 2014), in the most serious crises, the Basin Committees have limited power and it is necessary for them to state strong and clear arguments about the water crisis issues, otherwise they will lose their effectiveness.

After a decade, São Paulo faced again a lack of water. Environmental variables were presented as the cause of the problem, but several experts mentioned that SABESP and the government did not assume the existence of problems for the supply of the metropolitan region, failed to promote campaigns for the rational use of water at first (TUNDISI apud LENHARO, 2014) and chose the strategy of providing water by technical reserve. In addi-

tion, SABESP should maintain permanent programs of loss control, rational use of water, reduce waste and encourage reusing water, according to Decree No. 1213/2004 DAEE.

Information poorly provided to population about the real situation of Cantareira System is another problem. According to Bauman (2008), the uncertainty arises when an individual or social group understands what is at risk, but is unsure about either the possibilities of occurrence or the strength of security measures.

The demand from SABESP for withdrawal of 116 billion liters of water from the "dead volume" (second dimension of technical reserve), in June 2014, is not in accordance with the government's statement made in April and ratified in June, that the supply would be guaranteed until 2015, with the use of 182.5 billion liters from "dead volume 1", taken in May 2014 and exhausted in 15 November 2014 (ARTICLE 19, 2014; CEMADEN, 2015).

According to ANA, SABESP should adjust the volume of used water according to the tributary flow conditions, informed as daily data of river monitoring by the Department of Water and Power and ANA, and also reduce the using volume to enable the reservoir recovery to 10% of the original storage volume of the equivalent system (97.39 million cubic meters, which correspond approximately to the volume observed in April 30, 2014, which was 100.75 million m^3).

Considering accessibility, quality and communication understanding, Article 19 (2014) presented an analysis of the transparency in access to information provided from different state and federal actors involved in the water crisis process. As a negative highlight, the website from the Government of São Paulo did not present information about the water crisis and the information about the Cantareira system in the SABESP website was restricted to technical data about the volume of water remaining in the system and rainfall averages (ARTICLE 19, 2014).

The water crisis was also influenced by Brazilian political/institutional scenario. We highlight some emblematic facts that help undertstand the political aspects of the problem:

- According to the State and Federal Ministries, the possible collapse of the system is due to SABESP's breach of the grant conditions. SABESP would have not carried out the planned investments to minimize the dependence on the Cantareira System.
- In May/2014 the State's Governor and the Secretary of Sanitation and Water Resources claim that there would be no need for water rationing in 2014. In the same month, a report from ANA, DAEE and the PCJ Committee contradicted the governor's statement and advised that the supply - at those rates of consumption - should only be guaranteed until November of the same year.
- Although the State Government denies the practice of rationing, in May/2014 the Data Popular Institute released a research showing that 35% of the SPMR population - 30% of capital and 14% of the interior - had been affected by water shortages. The governor's party said it would notify the electoral justice against the survey on water shortages, claiming that, as it was an election year, the information could negatively impact the current governor, who was candidate for reelection.

- With the mediation of the federal government in August/2014, the governments of São Paulo and Rio de Janeiro made an agreement on the flow transferred from Jaguari and Paraibuna reservoirs, impacting the supply in both states.

Based on the above, we can enumerate some political and institutional factors that directly contributed to worsen the water crisis throughout 2014:

- Confidence in scenarios based on the resumption of normal precipitation regimes, even without scientific basis;
- Difficulty in access to information and highly technical language used in communications;
- Conflicting information from various agencies;
- Delay from the government in recognizing the severe situation and predominantly reactive governance to the problem, rather than preventive;
- Excessive interference of electoral issues in dealing with the crisis, disorienting the measures taken and the information disclosed about the problem to be faced;
- Difficulties involving state and federal governance, so that the problem could not be solved by conventional institutional processes, requiring action from media and public opinion to foster effective cooperative institutional actions.

5. A Water Crisis in the Context of Disaster Risk Management Processes

According to the National Secretariat of Civil Defense, a disaster is a "result of natural or human adverse effects on a vulnerable ecosystem, causing human injury, property, environmental, economic, cultural and social losses." The UNISDR (2009) defines disaster as "a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources". As stated earlier we consider that water crisis can be configured as a disaster. An integrated disaster risk management comprises the following steps or phases, which will be discussed below: prevention, mitigation, preparedness, response and recovery.

Prevention

The prevention phase expresses "the outright avoidance of adverse impacts of hazards and related disasters" (ISDR, 2009, p. 22). Among the actions to prevent the water crisis, we can mention the structural measures for the transposition of rivers, construction of new reservoirs (dams), interconnection-works between existing reservoirs, construction of raw water supply systems, construction of reused water production stations, well drilling, as well as regular maintenance and monitoring of the supply network, minimizing leaks.

According to Ribeiro (2011, p.125), the São Paulo Metropolitan Region needs to develop conditions for rainwater storage and thus carry out the appropriate treatment and make its distribution.

Another way for long-term prevention is the conservation of riparian forest reservoirs. According to Embrapa, to meet the range established by the new Forest Code, 30 million trees should be planted from the regular river bed, to restore the riparian forest on 34.000 hectares.

Urbanization and land use by various economic activities, when unplanned or conducted in inappropriate areas, decrease the ability of water production (WHATELY and CUNHA, 2007), and cause deterioration of water quality due to lack of effluents treatment (TUCCI, 2008). Pereira (2012) notes that municipal management of the urban space occurs in a disintegrated way, with little preventive action planning, limited technical views that do not consider the main issues of a city's' Master Plan, such as sewage, solid waste, land use and fountains, urban drainage and flooding. For Machado (2003), the city should not establish a Master Plan in which the ecosystem appears together with political, social and economic matters.

Municipal actors can plan the city›s occupation from a zoning that respects the environment and its problems, fostering protection of watercourses, springs and protected areas and adopting land use and environmental laws in accordance with state and federal laws. In this sense, rural and urban areas embraced in the Forest Code or other laws, especially with regard to respect for protected areas (APP) and Legal Reserves, would contribute to reduce natural disasters and to preserve essential environmental services to the population, such as water supply (Coutinho et al., 2013).

Mitigation

Mitigation is the reduction or limitation of the adverse impacts of hazards and related disasters (ISDR, 2009, p. 19). In other words, mitigation activities seek to reduce the magnitude of the threat and vulnerability exposed to the risk system.

While prevention measures are designed to support some scenarios (e.g. building a new reservoir), mitigation measures are addressed to more aggressive scenarios, which exceed the capacity of the projected supply system (considering the example above, the new reservoir cannot avoid the shortage but it contributes to minimize the intensity of the impact).

Mitigation measures can be carried out in advance or later, i.e. in a time relatively close to the impact (such as the outbreak of water scarcity). When carried out in advance, mitigation actions are better planned, have a long-lasting effect, and usually cost less.

In São Paulo, the measures to mitigate the water crisis were bonus payments for customers who decreased their consumption and the use of pressure reducing valves, which resulted in a 20% drop in demand (PORTO, 2015). According to Whately (2015), the use of a palliative action bonus was a questionable alternative to rationing, as the reduction of consumption was insufficient, from 69 to 55 m^3/s, in addition to the risk of decapitalizing Sabesp.

Considering the scope of the anticipated mitigation of the water crisis, water rationalization measures could also be implemented (instead of rationing), such as: reduction of supply for agricultural use (accompanied by compensation to farmers), restrictions for sidewalks and car washing, and other businesses that require intensive water use (with

compensation to entrepreneurs), financial incentives (tax breaks, facilitated financing, etc.) to implement individual systems of rain water use and water reuse, incentives for research, development and implementation of systems to reduce water consumption. The conservation and preservation of water sources and areas of river springs can also be considered for early mitigation, given its importance for public supply systems and for the maintenance of this resource.

Reducing output discharges may also be considered a mitigating measure, but the issue involves a conflict of interests: when the river is federal, it implies in reducing flow of the downstream tributary, which may be a State River. In this regard, representatives of the states of São Paulo, Rio de Janeiro and Minas Gerais met in ANA (National Water Agency), to optimize the water flow in Paraíba do Sul River to avoid future droughts. They determined that ANA would authorize the reduction of the output discharge with the three states' endorsement. In January 2015, ANA authorized interconnected works of the Paraíba do Sul River Basin to the Cantareira System. Representatives of those three states approved the feasibility of the project and indicated that there was no risk to water security.

It is noteworthy that most of the population joined positively to campaigns to reduce consumption, which represents a paradigm shift in the states of the southeast region of the country. In this sense, it can be an opportunity to develop a culture for consumption reduction and preservation of this resource.

Among the actions programmed for 2015 by SABESP, understood here as mitigation measures for a dry scenario, the most important are:

- Intensification of actions started in 2014 (described in the response phase);
- Pumping 4 m^3/s of water from the Billings reservoir to the Taiaçupeba reservoir;
- Pumping 1 m^3/s from the Guaio River to theTaiaçupeba reservoir;
- Expansion of the ABV ETA treatment capacity from 15 to 16 m^3/s;
- Expansion of the pumping of the Taquacetuba river to the Guarapiranga reservoir;
- Transfer of 1 m^3/s from the Alto Juquiá River to the Santa Rita River (Guarapiranga basin);
- Transfer of 2.5 m^3/s from the Itapanhaú river to the Biritiba reservoir (Alto Tiete basin);
- Transfer of 2 m^3/s from the São Lourenço River to the Lavras River (Guarapiranga basin)
- Transfer of 1.2 m^3/s from the Itatinga river to the Jundiaí reservoir (Alto Tiete System)

Preparedness

According to the UNISDR (2009, p. 21), preparedness is:

> The knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to

> effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions

The Contingency Plan can be understood as a preparedness measure for a dry scenario, in case of breaching of the commitments for 2015 (the ongoing reduction in water consumption by the population and no delay in the works to be delivered in 2015). This plan (SABESP, 2015b) consists of: Diagnostic of the emergency supply through well - Agreement Sabesp / FUSP; Plan for emergency services for places of maximum social interest; Other places where an uninterrupted supply would be desirable but not feasible.

Response

Response phase is related to providing emergency services and public assistance during or immediately after the occurrence of a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic needs of the affected population subsistence (UNISDR, 2009, p. 28).

As the primary response action in this case, the government decided to use the "dead volume" of the Cantareira System's reservoir, a water reserve of about 400 million cubic meters, located below the floodgates of dams that form the system.

A contingency plan was put in place, reducing the pressure in the network distribution, the withdrawal of water from the Cantareira System, and the supply, facilitating the raising of the reservoir level during the rainy season. However, this decrease in pressure left the population temporarily without water.Other response measures are the use of volumes of other reservoirs in a more favorable situation of availability, as occurred with the use of water of the Guarapiranga System. According to data from Sabesp, before the crisis, the Cantareira System supplied 9 million people and recently started to supply 6.2 million. On March 9, 2015, for the first time, Cantareira ceased to be the largest source of water for the MRSP, overcomed by Guarapiranga.

Alongside the use of technical reserves of the reservoirs, rationing is a complementary measure of response needed to be implemented ideally during the preparation phase. In this work, it was agreed to adopt the term rationing meaning the partial reduction in the availability of drinking water, either in the form of rotation or restrictions in schedules and / or supply flows, but not implying full shortages to any group for a period longer than three days. It considers that a shortage for more than this implies a change in routine and in the storage conditions of water. The affected population will hardly be able to absorb this water without suffering severe impacts. Therefore, it means that a shortage for a period of three days sets no rationing, but a breakdown in supply to the affected groups.

Another critical issue that must be ensured as a response action is the emergency supply of community facilities with kite cars, such as schools, kindergartens, hospitals and clinics, as well as water for human consumption in general, followed by watering livestock.

SABESP adopts the following measures to confront the water crisis, here understood as response measures to the dry scenario occurred, given the advanced stage of the crisis they were applied: Supply casters to reduce the flow available to the population;

Contingency measures to reduce discharges; Bonus programs and awareness campaigns; Intensification of combating and reducing losses; Use of treated water from other producers, such as Rio Grande; Use of technical reserves; Development of institutional actions, such as communication campaign in major media warning the public about the criticality of the situation, encouraging the reuse of water consumption and reducing consumption in public buildings. (SABESP, 2015b).

Recovery

Recovery is defined as "the restoration, and improvement where appropriate, of facilities, livelihoods and living conditions of disaster-affected communities, including efforts to reduce disaster risk factors."(UN-ISDR, 2009, pg. 23). The United States of America (2011) and UNDP (2011) indicate the following dimensions of recovery:

– Economy. Directly related to the resumption of the production capacity of local companies, the provision of jobs and livelihoods to the affected population.

– Health and social services. Focus on primary infrastructure (shelter, water, sewage, garbage collection, albeit temporary), psychosocial support and facilities (health, education and others).

– Housing. Provision of temporary and permanent housing, with or without the resettlement of families seeking resilient recovery with added value.

– Infrastructure systems. Rehabilitation / recovery of built environment and local physical infrastructure, within the philosophy of "recovering for the better".

– Natural and cultural resources. Measures for rehabilitation of natural resources affected by the disaster and strengthening of local culture in the affected communities, seeking to preserve the cultural identity of the group.

Recovery is the great challenge of southeast and especially the MRSP. Because of the way the disaster was managed, the recovery step would represent a return to the first step of prevention, aiming to recover actions that were insufficiently conducted: structural works to reduce losses during distribution, legislative review on the subject and planning new ways and water abstraction sources and wastewater reuse, as well as restructuring of the economy and support for socio-economic uplift of the affected population. In late 2014, the governor of São Paulo presented the following necessary works for the President of Brazil (G1 SÃO PAULO, 2014), which clearly demonstrated the integrated nature of recovery actions and prevention / mitigation: the Jaguari reservoir Interconnection to Atibainha by withdrawing water dam, which supplies Santa Isabel and other cities that make up the basin of the Paraíba do Sul River, and taking up the Atibainha reservoir belonging to the Cantareira System; the construction of a dam in quarries, Rio Pequeno interconnection with Billings, increasing the water supply in the Rio Grande system that supplies the ABC region, reducing the area covered by the Cantareira System; Station Reclaimed Water Production (EPAR) for strengthening the Guarapirangua Producing system, drilling wells in outcrop areas of the Guarani Aquifer, by building wells, by obtaining

a grant from the Department of Water and Power (DAEE), and obtaining a license from the Environmental Company of the State of São Paulo (CETESB), as an alternative to the lack of water; adduction to PCJ basins by increasing the water supply to municipalities located in the western portion of the PCJ basin by drilling 24 deep wells and adduction stretch of about 60 km, among others.

In short, the state of an element is constraining and determining the state of another element, and so on (SANTOS & CALDEYRO, 2007), so if we change habits in order to eliminate waste, reduce power consumption to promote water reuse, create alternatives for storage and use of rainwater in homes, buildings, commerce, industries, etc. we will not feel the severe effects of drought and will be less depend on rainy seasons, which are not so frequent.

6. Conclusion

When we finished this paper, the MRSP was still at risk of collapse in water distribution, especially for homes that were supplied exclusively by the Cantareira reservoir in São Paulo. According to SABESP's data, in April 23 - 2015 the six main river springs that supply the MRSP had 305 billion water liters, while the same sources amounted to 558 billion liters in the same period of 2014. It means that even with rains above average in January and February, the situation is still critical and the negative scenario remains: in 2014 there was a useful volume in the Cantareira System and in 2015 the technical reserve is being used.

It is clear that São Paulo faces a serious risk of water shortage, but, beyond that, it also lacks proper management and more investments, especially in reducing losses during distribution.

Although some negative consequences are not yet recorded, the water crisis can be an opportunity to achieve a more efficient and sustainable water consumption, avoiding losses and pollution, and promoting population involvement.

The suggested measures and projected scenarios in which the Government has been working must be clear enough to count on population trust and support. There is an urgent need to inform the real condition of the crisis and the measures to be taken.

A similar rationale is valid for industries: extreme situations like these may promote great interest in environmental issues and sustainability, since the use of water represents a key role in strategic production plannings. The optimization of the consumption process and the promotion of more efficient uses can reach the production environment. In this scenario, the pressures of a water crisis (and potentially energy crisis) towards the government, business and civil society have the strength to work as a catalyst of paradigm shifts, depending on how the crisis is managed and the measures are taken. It is necessary that political issues are set aside to prioritize the interests of business and population.

It is important to analyze the issue from the perspective of opportunities because the crisis has demonstrated a catalyzing potential for the structural advances that the country needs. Government actions must be rapid and effective. The crisis enabled a channel for definition of major structural works for the states of São Paulo and Rio de Janeiro, to be sponsored mostly by funds from the Federal Government. Since there is no

option and the works must be fast (2-year forecast) to avoid a supply collapse, it is likely that from 2017 the Southeast region can count on a more reliable supply system despite the forecast for extension of climatic extremes.

The water crisis also speeded deep discussions about polemic issues, such as the transposition of rivers (the current drought in northeastern Brazil has lasted three years), the high losses in the supply network (estimated around 37%), conflicts of interest in the concession model for private or mixed capital companies, political interference on technical issues, government negligence, the need for alternative sources of water (such as water reuse, rainwater, groundwater aquifers and even desalination technologies), evaluation of individual and collective behaviors towards sustainability, and the need for improvement in the institutional and social communication model.

Considering the consequences of a disaster associated with lack of supply in the large MRSP, planning and prevention measures must be taken to reduce the risk of a severe water shortage.

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WATER CRISIS IN SÃO PAULO EVALUATED UNDER THE DISASTER'S POINT OF VIEW

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***Abstract*:** Brazil's Southeast region has been facing water supply challenges, especially concerning the metropolitan region of São Paulo, since 2014. We adressed the water crisis from the disaster's point of view, considering that one of the guiding features to characterize a disaster is the amount of affected people and the losses associated. In the situation under review, there are people directly affected, because of intermittent house water supply, and indirectly affected by the increase of prices for goods, since their production and manufacturing depend on the availability of water. We presented each of the stages of a disaster risk management: prevention, mitigation, preparedness, response and recovery. The risk of water scarcity in São Paulo is only one aspect of the discussion involving the effectiveness of management processes and the need for investments in the area, especially in reducing wasteful distribution.

***Keywords*:** risk; disasters; water scarcity; water supply; management.

***Resumo*:** Desde 2014 a região Sudeste do Brasil, especialmente a região metropolitana de São Paulo, vem enfrentando problemas no abastecimento de água para a população. Buscamos neste artigo abordar–a crise hídrica sob o ponto de vista da gestão integral de riscos de desastres, considerando que uma das características norteadoras é a quantidade de pessoas afetadas e os prejuízos associados. Na situação em análise, há pessoas afetadas diretamente, pela intermitência no abastecimento das residências, e, indiretamente, pelo aumento nos preços de insumos cuja produção ou fabricação depende da disponibilidade de água. Apresentamos este cenário para cada uma das etapas do ciclo de vida dos desastres: prevenção, mitigação, preparação, resposta e recuperação. O risco de falta de água em São Paulo é apenas um aspecto dentro da longa discussão que envolve a eficiência dos processos de gestão e a necessidade de investimentos na área, principalmente na redução do desperdício na distribuição.

***Palavras-chave*:** gestão de riscos; desastres socioambientais; abastecimento hídrico; crise hídrica.

***Resumen*:** Desde 2014 se ha enfrentado a problemas en el suministro de agua para la población en la región sudeste de Brasil, especialmente en la región metropolitana de São Paulo. En este artículo enfocamos la crisis del agua desde el punto de vista del riesgo de desastres, teniendo en cuenta que una de sus características es el número de personas afectadas y las pérdidas asociadas. En la situación que se examina, hay personas directamente afectadas por el suministro intermitente de los hogares e indirectamente, por el aumento de los precios de los insumos cuya producción o fabricación depende de la disponibilidad de agua. Se presentam cada una de las etapas de la gestión del riesgo de desastres: prevención, mitigación, preparación, respuesta y recuperación. El riesgo de falta de agua en São Paulo es sólo un aspecto de la discusión que involucra la eficacia de los procesos de gestión y la necesidad de inversiones en el área, sobre todo en la reducción de la distribución derrochadora.

***Palabras clave*:** riesgo; desastres; escasez de agua; suministro de água; gestión.