# WATER SUPPLY AND HYDROSOCIAL SCARCITY IN THE RIO DE JANEIRO METROPOLITAN AREA[1]

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## 1. Introduction

After more than 15 years of debates, in July 2010 the United Nations General Assembly recognised "the right to safe and clean drinking water and sanitation as a human right that is essential for the full enjoyment of life and all human rights".

The human right to water and sanitation determines that all people are entitled without discrimination to affordable, acceptable, safe water and sanitation services. It also obliges States to progressively eliminate inequalities in access to water and sanitation services, such as inequalities between groups of populations in rural or urban areas, formal or informal settlements, and rich or poor conditions.

Brazil's National Sanitation Plan (PLANSAB) was approved in 2013 and highlights to what extent the country is far from fulfilling this right due to very significant shortcomings in all components of basic sanitation. The Plan used data from the Brazilian Institute of Geography and Statistics (IBGE) dating from 2008 to show that the majority of the Brazilian population has adequate conditions of access to a supply of clean drinking water, but that 33.9% of the country's population had precarious conditions of access and 6.8% had no access whatsoever. With respect to sanitation services, 50.7% of the population experienced precarious supply conditions. Specifically, this refers to sewage collection that is not followed by treatment or the use of a rudimentary pit latrine. Concretely, this

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signifies that millions of people are living in unhealthy environments and are exposed to various risks that can compromise their health (BRASIL, 2013).

In the Rio de Janeiro Metropolitan Area, wherein these services have still not been universalised, the theme of access to water and sanitation has gained increasing coverage in the media, although not to evoke the need to ensure people's the right to water. Above all, reference is more often made to the debate on compliance with commitments to improve the water quality in the Guanabara Bay for the 2016 Olympic games, the recent dispute with the state of São Paulo concerning the waters of the Paraíba do Sul river basin, or the extreme drought affecting the water supply sources in metropolises São Paulo and Rio de Janeiro. These slightly more media-friendly subjects mask a historic violation of the human right to water for entire parts of the metropolitan population. Indeed, there are remarkable differences between the central municipalities, Rio de Janeiro and Niteroi, and the peripheral metropolitan municipalities. For instance, the water supply in Duque de Caxias is intermittent – residents only receive water three to four days of the week – and entire parts of the land belonging to this municipality (Districts 2 and 3) do not receive regular water supply service.

This article analyses the current situation regarding water supply in the Rio de Janeiro Metropolitan Area (RJMA) through the conceptual lenses of hydrosocial scarcity and the human right to water. In addition, it assesses to what extent the availability of bulk water may act as an aggravating factor in this context, especially in consideration of recent water crises.

The research is oriented by the following questions: Is bulk water really becoming scarce in the RJMA? Is said water scarcity the product of environmental changes (in terms of droughts that affect water availability) or is it a social and political construct? How does this problem impact the human right to water? How does access to water supply services actually play out in the metropolitan region? In what way does the existing management model for water and sanitation services, in its technical and institutional characteristics, aggravate the security of water supply services in situations of low water resource availability?

We lead with the hypothesis that the problems related to access to water are directly linked to the management model for water and sanitation services, as well as to weaknesses associated with planning, technical choices and the way in which existing systems are operated.

Herein we will juxtapose research findings from each of the three authors that draw upon different sources of information. Thus, this research adopts the methodology proposed by Lorrain and Poupeau (2014). The cited authors realise that many sources of information are referenced in studies on water management and affirm that, for this very reason, it must be considered an essential methodological rule to multiply these sources. This includes: contractual documents; statistical data; newspapers (in order to establish a chronology of events); official reports; studies commissioned by different organisms; municipal, state or national databases; the testimony of interviewees; survey data; etc. This research's main sources are: the State of Rio de Janeiro Water Resources Plan; the diagnostic reports created for the different municipal sanitation plans of the municipalities surrounding the Guanabara Bay, those developed through the Sanitation Programme for Municipalities Surrounding the Guanabara Bay (PSAM), and documents produced by the State of Rio de Janeiro Water and Sewage Company (CEDAE). Other sources include: scientific articles; semi structured interviews with CEDAE technicians and managers performed by researchers from the PROURB-FAU-UFRJ Laboratory of Urban Water Research as a part of the Desafio project (Democratisation of Water and Sanitation Governance by Means of Socio-technical Innovation - financed through the European Union's Seventh Framework Programme).

## 2. Discussing the concept of hydrosocial scarcity

The infrastructure required to produce water for urban consumption is, of course, composed of more than just technical artefacts. Organisational systems, institutional arrangements and differing sociocultural meanings also comprise such complex socio-technical systems (Guy et al., 2010). Technique and technology are both products of human action. Given their insertion in humans' social relations and historical development, these two products are expressive of the combination of political, economic, social, cultural and geographic conditions that make their installation, operation and utilisation possible.

The majority of residents in large metropolises receive water and sanitation services with common technical characteristics: centralised infrastructure organised on a metropolis-wide scale into supramunicipal macro systems; water production concentrated in large units for abstraction and treatment purposes; standardised water quality parameters; and, in the majority of cases, one sole operator. As Swyngedouw (2004 and 2009) has indicated, such systems are organised through bureaucratic and technical controls with highly centralised decision-making processes. When considering the monopolistic aspect of these services, this style of organisation in fact grants those in control a formidable ability to exercise social and political dominion on an essential good for human life – no less, one that is recognised by the UN as the right of all people.

In the Rio de Janeiro Metropolitan Area, two macro systems provide water supply service to the vast majority of the population (Systems Guandu/Lajes/Acari and Imunana/Laranjal - explained in further detail below). They both possess the previously mentioned characteristics in technical terms and in terms of their management and control by the CEDAE, the utility responsible for water supply in the near totality of the metropolis.

As affirmed by Guy et al. (2010), metropolitan systems are prisoners of technically and economically oriented choices. Being made in beforehand stages, these choices often impose restrictions on the possibility of adaptation to new challenges. Generally speaking, they share the traits of: being technical networks with high degrees of centralisation and weak adaptability, maintaining a standard of quality for treated water that ends up being the same for all uses, and using finance models that are almost always premised on user payment per volume of water consumed. Dependence on infrastructure that is designed in the past reinforces the rigidity that one may currently observe in these systems.

Infrastructure for public water supply systems is managed with overshadowing consideration for technical considerations. This implies a disregard of the complex and multidimensional nature of managing such systems, including interplay with bulk water resources management and the role of the citizen in decision-making processes. Ultimately, the dominance of technical considerations entails an onus for utility effectiveness in decision-making and in action. Indeed, systems management is frequently driven by a logic geared towards the continual increase of water production and a neglect of demand management or loss reduction.

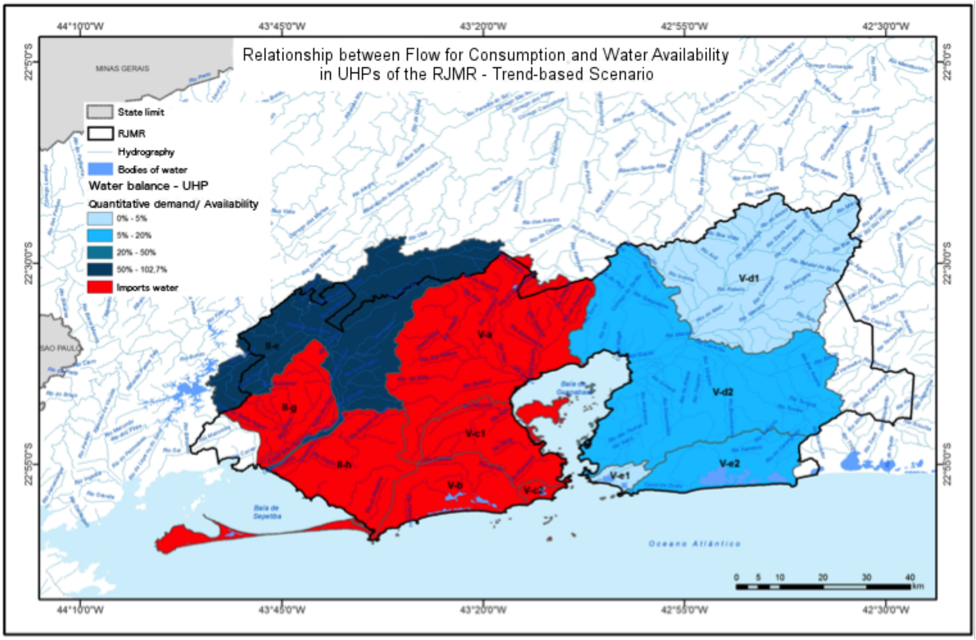
Thus, what we are discussing is socially constructed scarcity within what Swyngedouw (2004, 2009) defines as the hydrosocial cycle. According to this author, the circulation of water is fundamentally tied to the circulation of money and capital. Similar to other goods and urban services, the circulation of water is part and parcel of the political economy that structures power relations and gives shape and coherence to the urban space. The hydrosocial perspective sees the circulation of water as a combined physical and social process, like a hybrid flux in which nature and society meld inseparably into one another (Swyngedouw, 2004). Historically, mechanisms that facilitate either access to or exclusion from water have been inserted in the hydrosocial cycle. Exclusion or scarcity thus denotes a hydrosocial scarcity. Otherwise said, social groups with a lesser capacity to defend their interests (such as poor residents from outlying metropolitan districts) and people who are socially and politically "disempowered" are more vulnerable to being affected by this scarcity.

Yet another type of scarcity is on today's agenda. In certain regions, hydrosocial scarcity can be aggravated by a number of global environmental changes: the scarcity of bulk water associated with both climatic stressors (extreme hydrological events, environmental variability and change) and non-climatic stressors (environmental characteristics and anthropogenic pressures) (Pahl-Wostl, 2007; Formiga-Johnsson, 2013; IPCC, 2014; PBMC, 2014). The themes of water scarcity and water security have gained ever more importance in public administration and in society in general. Current examples include the water crises affecting supply in the metropolises São Paulo and Rio de Janeiro. However, as Swyngedouw (2009) points out, it is important to realize that the effects of climate change, including those that impact on water availability, are mediated through the hydrosocial cycle by particular forms of political and institutional organisation.

## 3. Availability of bulk water for the Rio de Janeiro Metropolitan Area, droughts and water crisis

A striking feature of the Rio de Janeiro Metropolitan Area is its strong dependence on sources located outside of its metropolitan borders. Indeed, the water available in its own territory is insufficient – in quantity and/or quality – to meet the increasing needs of its municipalities (see Figure 1).

**Figure 1: Relationship between flow for consumption and water availability in the RJMA – trend-based scenario (2035)**




Source: Integral de Engenharia Ltda/Firjan (elaborated with data from PERHI, 2014).

The eastern region, which receives services from the Imunana/Laranjal System and other isolated systems, is currently facing a supply deficit of 2.2 $m^3/s$ (PERHI, 2014). It is the region facing the most pressure from increasing demand for water due to the installation of the Rio de Janeiro Petrochemical Complex (COMPERJ), the presence of Petrobras and the construction of the Metropolitan Arch. Supply in this region is also affected by low water security due to the absence of regulation in its main rivers (Guapiaçu and Macacu) and to recurring episodes of prolonged droughts in passing years.

The western part of the RJMA receives service mainly through the Guandu/Lajes/Acari Integrated System. It imports water from neighbouring river basins and benefits from greater water security.

## 3.1. High dependency on the Paraíba do Sul river basin

The State Water Resources Plan (PERHI, 2014) states that 83% of the metropolitan population, or 9.4 million people, receive service from the Guandu/Lajes/Acari Integrated System. Of these three systems, the Guandu System is the most important. It abstracts water from the Guandu River, which is almost exclusively composed of waters that are diverted from the Paraíba do Sul River.

Thus, a point of vulnerability for the system is its high dependency on the Paraíba do Sul river basin, which is shared between the states of São Paulo and Minas Gerais. The basin's main river is regulated by a sophisticated hydraulic system including reservoirs, hydropower plants and interbasin transfer, which is a rather complex operation involving federal and state institutions in addition to multiple water users. Since the installation of the Guandu Water Treatment Plant (ETA Guandu) in 1955 and the transfer of water to the Guandu, which was initially created to generate electricity, this system has become the RJMA's main source of public water supply. It has also come to serve other purposes in the Guandu river basin.

The Paraíba do Sul river basin has become a point of tension with the state of São Paulo, which has suggested on numerous occasions to reduce the flow of water transferred to the Guandu in times of hydrological normality. However, the Rio de Janeiro state government – via the SEA and the INEA – and the State Water Resources Plan (2014) highlight the importance of securing the present rate of flow for current and especially future demand in the RJMA (Formiga-Johnsson et al., 2015). Therefore, if ever the Paraíba do Sul Hydraulic System's operating rules were modified in such a way as to entail the reduction of transfer to the Guandu, this supply system would be made even more vulnerable.

## 3.2. Severe drought and water crisis in the Paraíba do Sul and Guandu River Basins

In like fashion to the Southeast Region, the Paraíba do Sul river basin has been going through a severe drought that started in 2014 and lasted throughout 2015. The drought has substantially affected the water availability of the Paraíba do Sul River and, consequently, the waters that are transferred from it to the Guandu river basin.

Experts have pointed out that there were strong signs in the beginning of 2014 that indicated a critical period for rainfall and that the National Electric System Operator (ONS) could have taken preventative action. Possible measures would have included reducing the amount of water released from reservoirs for electricity generation in order to preserve the reservoirs' stock of water for several other uses (interviews conducted in 2015).

Moreover, recent studies on the conditions of the Guandu river basin (PERHI--RJ, 2014) highlight that its available water resources are highly committed to meeting the future demand of the RJMA. They also underline the importance of the current operating rules pertaining to the reservoirs of the Paraíba do Sul river basin, indicating mainly that their current priority of electricity generation should be altered. Thus, due to the Paraíba do Sul River's low resiliency in the face of drought, these reservoirs must be operated with the main objective of guaranteeing stocks of water needed to supply the public (Carneiro, 2015).

There is consensus between representatives of public authorities and civil society that the current operating rules pertaining to reservoirs in the Paraíba do Sul river basin are no longer appropriate in the light of the new conditions facing the river basin. To name a few examples, demand is increasing for other uses and especially for public water supply. Moreover, hydrological extremes, such as the severe drought being felt since 2014, are becoming more and more frequent in this river basin.

Indeed, since 2014 the Paraíba do Sul river basin has been suffering its worst recorded drought in the past 85 years. As a result, the regulated flow of the Paraíba do Sul and Guandu Rivers had to be progressively reduced. Users of both rivers, including the Guandu ETA which supplies a great deal of the RJMA, have never had to adapt to such an extent to avoid depletion. Abstraction systems for public and industrial water supply have had to adjust to the lesser flows of water being released by reservoirs from the Paraíba do Sul river basin (Paraibuna/Paraitinga, Santa Branca, Jaguari and Funil). A number of collective efforts have been made since the beginning of the water crisis to save water and make corresponding changes to the operating rules of reservoirs under the responsibility of the National Water Agency (ANA), in cooperation with the National System Operator (ONS). It is important to point out that the Integration Committee for the Paraíba do Sul River Basin has been accompanying these changes through its Technical Monitoring Group of Hydraulic Operations (GTAOH).

This collective effort has already saved more than 1.8 billion cubic metres of water as of November 2015. If it were not for it, the Paraíba do Sul river basin would have started using the dead volumes of its reservoirs' waters—similarly to the Cantareira System—at the beginning of its dry season in April 2015.

Until now, problems with water availability have been acute, with temporary paralysations in water supply affecting the municipalities along the Paraíba do Sul River and the industries at the mouth of the Guandu River. The reduction of minimum flow from 190 $m^3/s$ to its current rate of 110 $m^3/s$ was done gradually with care to affect as little water users as possible. Yet the crisis still persists. Returning to a situation of normality in terms of bulk water availability and ending the "regime of exception" will require consecutive years with above-average rainfall indexes.

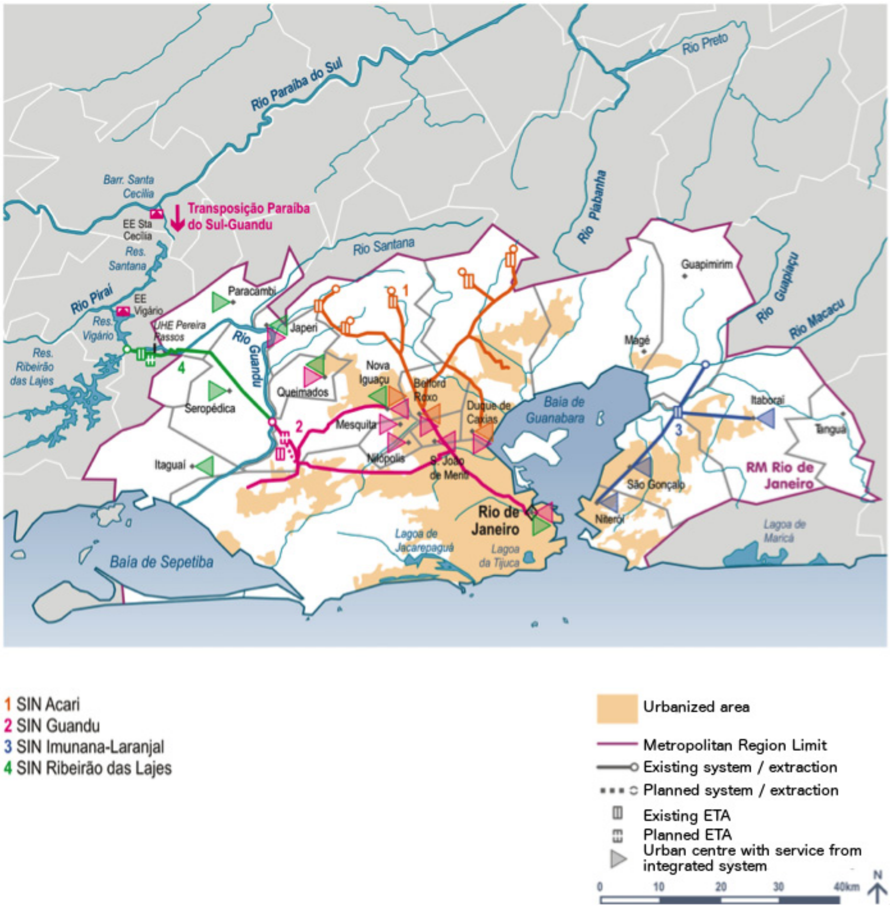
It is worth underlining that the water supply of the RJMA was not affected at any point in time by this drought due to successive adaptations in the Guandu ETA's abstraction system, which had never operated with such low levels of flow in the Guandu River. Thus, the existing problems related to water supply in the areas of Baixada Fluminense, explained in further detail below, may not be attributed to water scarcity in the Paraíba do Sul and Guandu Rivers.

This water crisis, which is product of the worst recorded drought in 85 years and whose effects were observed in 2014 and 2015 in the Piracicaba and Paraíba do Sul river basins, is demonstrative of an important lesson. Mainly, that the intensification of extreme events is capable of significantly accentuating vulnerability in water supply systems and reinforcing structural and non-structural problems unless important changes are made in the processes of water governance and management.

## 4. Metropolitan water supply systems: the current situation

The Rio de Janeiro Metropolitan Area is essentially supplied by two systems: the Eastern System (SIN Imunana/Laranjal) and the Western System (SIN Guandu/Lajes/Acari), as indicated in Figure 2.

**Figure 2: Interconnected water supply systems in the Rio de Janeiro Metropolis**




Source: ANA, 2010.

Only three (of eighteen) metropolitan municipalities receive service from isolated supply systems. Their water abstraction sites are from local surface waters and other sources of water; mainly from deep wells.

## 4.1. Eastern Metropolitan: Imunana/Laranjal System

The Imunana/Laranjal water supply system is operated by the CEDAE and has provided service to the municipalities of Niterói, São Gonçalo, Itaboraí and Paquetá Island since the end of 1999. According to the IBGE's 2010 census, the total number of urban residents in these territories is 1,701,973.

This System abstracts water via the Imunana Canal, located in the municipality of Guapimirim. The Imunana Canal receives water from the Macacu and Guapi-Açu river basins and supplies the municipalities of Niterói, São Gonçalo and Paquetá Island. The system also provides bulk water to the municipality of Itaboraí.

In the Imunana/Laranjal System there is no physical separation between the conduits that transport treated water to storage infrastructure and the final distribution network that brings treated water to consumers. This is especially so in the São Gonçalo region. This characteristic tends to make the system's distribution system fluctuate according to variations in demand and consumption. Water shortages can thus be provoked at certain points of the network or, on the contrary, network pressure may rise in excess, which can cause leaks and damage to pipes.

It is worth highlighting that the Laranjal treatment station has a maximum treatment capacity of 7,000 L/s due to its limited upstream flow. The city of Niterói receives 1,800 L/s water from the CEDAE via the Laranjal ETA. Water distribution is performed by the Niterói Water Concessionaire, who is responsible for the system's operation and maintenance. The remaining municipalities receive service directly from the CEDAE.

The Imunana/Laranjal System currently produces a total flow of 6,200 L/s. This is insufficient in the light of the current demand, which is about 10,900 L/s and thus requires water production to be expanded by 4,700 L/s.

The situation in each of the municipalities receiving water via the Imunana/Laranjal System is rather varied. There are marked differences between the municipality of Niterói, which has good service quality and 100% of its population receiving service, and other municipalities such as São Gonçalo and Itaboraí, whose service indicators are worse.

IBGE data indicates that 80% of São Gonçalo's population receives service. If we consider the total population of São Gonçalo in 2010, this would signify that nearly 150,000 people in the municipality do not have access to water supply services. On the other hand, irregularities caused by a lack of reservoirs to regulate and distribute treated water also affect some of the areas that do receive service. Although São Gonçalo possesses seven reservoirs, its Municipal Sanitation Plan reveals that "the municipality of São Gonçalo has a significant deficit in stocking capacity; its deficit is actually greater than the existing reserve volume" (ENCIBRA, 2014). Lacking adequate reserves for the distribution of treated water, supply has consequently become irregular in a significant portion of this municipality.

The IGBE's 2010 census indicated that only 27% of the population in Itaboraí receive water supply service. The municipality's 2014 Municipal Sanitation Plan states that 29% of the population receives service from the CEDAE. The Plan also points out that part of the municipality receives service from an Autonomous Water and Sewage System (SAE). This SAE is judged as precarious as it consists in artesian wells and other surface water sources whose waters do not receive any treatment. Due to the installation of the COMPERJ, Itaboraí has recently experienced a population boom that has included a greater number of informal settlements and has made supplying water to this municipality's territory even more complex.

Therefore, we can affirm that São Gonçalo and Itaboraí, municipalities located in the eastern metropolitan region that depend on the Imunana/Laranjal System, have been experiencing decades of water supply problems due to incomplete systems. What is more, these problems will only be aggravated by the supply system's deficit in water production.

## 4.2. Western Metropolitan: Guandu/Lajes/Acari Systems

### i) Guandu System

The Guandu was once a small-scale river in its natural conditions but became more voluminous following the diversion of waters from the Paraíba do Sul and Pirai Rivers in the 1950s. This operation was initially executed for electricity generation and industrial uses. Today, the river's waters are mainly used as the water supply for the majority of the Rio de Janeiro metropolitan population.

The Guandu ETA is located off the BR 465 carriageway in the municipality of Nova Iguaçu. It treats and distributes 45,000 L/s. Post-treatment, its waters are transported through two subsystems: Marapicú and Lameirão. From the Marapicú subsystem, water is pumped through six pipes toward the Western and Northern Zones of the city of Rio de Janeiro, in addition to the Baixada Fluminense region. The latter receives a maximum flow of 15,100 L/s from the Baixada conduits via interconnected subsystems and the Acari system. Water from the Lameirão subsystem is piped as much as 33 km through various transfer systems to supply several districts in the Western, Northern, Central and Southern Zones of the city of Rio de Janeiro, as well as the municipality of Nilópolis in Baixada Fluminense.

### ii) Lajes System

The Ribeirão das Lajes System became operative in 1940 with the conclusion of its first pipeline. In 1949, this system was expanded with the construction of a second pipeline in the aim of securing a water supply for the city of Rio de Janeiro at this point in time. Until then, the city was supplied exclusively by unregulated supply systems that subjected water availability to seasonal variations (local sources and the Acari System)

This water supply system was made possible by the construction of the Lajes dam in 1905 and the Fontes Velha hydropower plant. Indeed, this system initially aimed only to generate electricity. The pipelines that start in Lajes pass through Seropédica and Nova Iguaçu and arrive in the Pedregulho reservoir in Benfica, in the municipality of Rio de Janeiro.

Water from this reservoir is of good quality for human consumption and requires only simple treatment. These waters are not mixed with those transferred from the Paraíba do Sul River, which are stocked successively in the Santana and Vigário reservoirs. Pipelines transport a total flow of 5,500 L/s in order to supply the municipalities of Paracambi (104.50 L/s), Seropédica (319 L/s), Queimados (44 L/s), Japeri (154 L/s), Nova Iguaçu (38.50 L/s), Rio de Janeiro (4,510 L/s) and Itaguaí (330 L/s).

From the municipality of Rio de Janeiro, about 8 km after the Guandu ETA, the pipelines from the Ribeirão das Lajes System connect with the pipes that transport treated water from the Guandu System, forming one sole system.

## iii) Acari System

The Acari System was constructed between the years 1877 and 1909 to supply the municipality of Rio de Janeiro, the former federal capital. The System is composed of five conduits of melted iron (known as the 'black lines'). It abstracts water from the Serra do Tinguá and transports water from the springs in Rio d'Ouro, Xerém and Tinguá to the former federal capital (Santa Rita, 2009). In the era in which it was constructed, this infrastructure was very important in attenuating problems in water supply that the city was facing (Santa Rita, 2009).

Today, the average flow produced by the Acari System is 1.9 $m^3/s$, which limits the areas that it supplies to the regions close by abstraction points in the municipalities of Nova Iguaçu, Duque de Caxias, and, at the most, some areas in the municipality of Belford Roxo (PERHI, 2014). Water from the Acari System does undergo disinfection, as its waters are abstracted from sources situated in regions that are protected by the Atlantic Forest.

At various points throughout the distribution systems, different waters are mixed with the waters distributed by the Guandu ETA, making the Baixada Fluminense's supply system highly complex.

## iv) Current service indexes per municipality

In the areas that receive service from the Guandu/Lajes/Acari System, a significant percentage of the population does not have adequate access to water supply. This violation of the human right to water is difficult to observe in the official data maintained by the IBGE and the SNIS, but may be detected in finer analyses and empirical research studies on water supply systems. Using IBGE data, one may trace the evolution of service provision for the municipalities receiving service from the Guandu/Lajes/Acari System (Table 1).

The data in Table 1 exhibits the evolution of access to water via distribution network. Between 2000 and 2010 there was a general increase in the number of residences that received water via the distribution network. However, among the most populous municipalities receiving service from the Guandu System, such as São João de Meriti and Nilópolis, the increase in access to water was not proportionately accompanied by an increase in the total number of residences.

Duque de Caxias, one of the most populous municipalities receiving service by this System, experienced a reduction of residences receiving service via distribution network between 2000 and 2010. In 2000, the total percentage of residences receiving service via distribution network was 69% compared with 63% in 2010. The aggregate data detailing percentages of access to water services (Table 2) especially demonstrates that the deficit in 2010 remained very significant even in the municipalities that experienced an increased rate of access via distribution network.

**Table 1: Service provision via the Guandu/Lajes/Acari System distribution network, evolution from 2000-2010 by municipality**

| Municipality | Residences receiving service through water distribution network (A) | | Number of residences (B) | | Rate of Growth | |
|---|---|---|---|---|---|---|
| | 2000 | 2010 | 2000 | 2010 | A | B |
| Belford Roxo | 87,847 | 108,529 | 121,650 | 145,667 | 23.5 | 19.7 |
| Duque de Caxias | 152,546 | 168,535 | 219,876 | 269,284 | 10.5 | 22.4 |
| Itaguaí | 17,314 | 27,524 | 22,985 | 33,894 | 58.9 | 47.4 |
| Japeri | 14,531 | 28,239 | 23,029 | 28,424 | 94.3 | 23.4 |
| Mesquita* | - | 48,439 | - | 53,108 | - | - |
| Nilópolis | 42,731 | 46 056 | 44,407 | 50,496 | 7.7 | 13.7 |
| Nova Iguaçu* | 210,894 | 189,199 | 260,594 | 248,092 | - | - |
| Paracambi | 7,712 | 10,372 | 11,419 | 15,242 | 34.4 | 33.4 |
| Queimados | 22,137 | 34,831 | 33,352 | 42,230 | 57.3 | 26.6 |
| Rio de Janeiro | 1,762,817 | 2,111,133 | 1,801,863 | 2,145,379 | 19.7 | 19.6 |
| São João de Meriti | 123,467 | 137,175 | 129,323 | 147,435 | 11.1 | 14.0 |
| Seropédica | 15,531 | 22,741 | 18,114 | 24,249 | 46.2 | 33.8 |

Source: IBGE, 2000 & 2010 Censuses
*The reduction between 2000 and 2010 in Nova Iguaçu's total number of residences and number of residences receiving service through the water distribution network corresponds with the demunicipalisation of the area corresponding with Mesquita, which became a new municipality. Thus, for these two municipalities, it is impossible to ascertain the evolution of access to these services with precision.

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## Table 2: Rate of service via water distribution network - Guandu/Lajes/Acari System

| Municipality | Residences connected to water distribution network | |
|---|---|---|
| | 2000 | 2010 |
| | % | % |
| **Belford Roxo** | 72% | 74% |
| **Duque de Caxias** | 69% | 63% |
| **Itaguaí** | 75% | 81% |
| **Japeri** | 63% | 83% |
| **Mesquita** | - | 91% |
| **Nilópolis** | 96% | 91% |
| **Nova Iguaçu** | 81% | 76% |
| **Paracambi** | 59% | 68% |
| **Queimados** | 66% | 83% |
| **Rio de Janeiro** | 98% | 98% |
| **São João de Meriti** | 95% | 93% |
| **Seropédica** | 86% | 94% |

Source: IBGE, 2000 & 2010 Censuses.

In municipalities such as Paracambi and Belford Roxo, in which there was an increase in the number of residences connected to a water distribution network, the supply deficit is nevertheless significant.

However, for municipalities located in the Baixada Fluminense region, having a residential connection to the water distribution network does not necessarily mean that one will receive these services. Serious problems of intermittent supply exist that are known by the public and accepted by CEDAE technicians (interviews performed in 2014 under the Desafio Project). In a significant portion of the municipalities of Duque de Caxias, Nova Iguaçu, Queimados, Belford Roxo, Paracambi and Japeri, the frequency of water supply is usually limited to two or three times a week. According to a technician from Queimados' Department of Water and Sewage (DAE-CEDAE), whose jurisdiction effectively includes Queimados, Japeri and Paracambi, several districts in these municipalities receive service through periodic switchover operations to the water distribution infrastructure. Concretely, said populations receive water for two days and then spend three days without water. In the case of Duque de Caxias, the Secretary of Urbanism affirmed during a presentation in the Rio Metropolitan Seminary, the 5th of June 2015, that several districts suffered from intermittent supply (residents only receive water three or four days a week) and that areas in Districts Two and Three (Imbariê and Xerém) are not even equipped with distribution network infrastructure (Leite, 2015).

Empirical studies reveal that the problem is twofold. First, there is not enough treated water to meet the demands of the Baixada Fluminense region. Secondly, there are insufficient structures to stock water for distribution, which could otherwise provide greater supply security. The lack of sufficient distribution reservoirs partially explains the intermittence in supply and the constant need to switch over different districts' water supply. In Belford Roxo, only one of its five reservoirs is operational (Conen, 2013). In the centre of the municipality of Queimados stands the only reservoir that provides service to its population.

Meanwhile, according to interviews performed with technicians from Queimados' DAE, this reservoir always contains a low level of water since the volume of water that arrives in the municipality is not sufficient to fill it entirely. In São João de Meriti, the Parque Araruama reservoir is out of order. This means that this sector, which spans the districts of Parque Araruama, Parque Analândia, Parque Santana, Parque Tietê, and Parque Novo Rio, is left with precarious supply conditions (STE, 2014).

The use of personal reservoirs in residential and commercial buildings (cisterns) is consistent throughout the region. This practice is a product of constant water shortages and intermittence in supply. Housing units that are built through the *Minha Casa Minha Vida* programme in the municipalities of Baixada Fluminense, such as Queimados, may only receive a Declaration of Possibility for Supply (DPA) from the CEDAE if they can prove that the unit has enough reserve capacity to supply its residents with three days worth of water. Moreover, the CEDAE understands that the water which will supply these housing units will be distributed via manual switchovers.

On the other hand, in the very same region where insecurity is manifest for the public's water supply, also within the Guandu/Lajes/Acari System, there is infrastructure for supply and storage systems that has been constructed for the exclusive supply of industrial activities. Two examples may be cited that pertain to areas receiving service via the Guandu System. Firstly, in Duque de Caxias stands the Petrobras Refinery (REDUC), one of the company's main refineries that was installed in the Second District (Campos Elíseos) in the early 1960s. Ever since, innumerable industries have arrived in the REDUC's catchment area, the Campos Elíseos region, which makes up Duque de Caxias' petrochemical complex. The existence of such abundant industry allowed Duque de Caxias to become the municipality with the second greatest revenue from Tax on Distribution of Goods and Services (ICMS) in the state, second only to the capital of Rio de Janeiro and eighth in all of Brazil.

When it became operational, the REDUC had two available sources for water abstraction: the Saracuruna dam and the Guanabara Bay, whose water is salty. The REDUC constructed the Saracuruna dam between 1960 and 1962 for its exclusive use. With a total capacity of six million $m^3$ of water, the dam receives waters from the Carqueja, Mantiquira and Pedra Branca Rivers in the eastern region of the Tinguá Biological Reserve, downstream from the CEDAE's abstraction points for the Acari System. After abstraction, the water is transported 20km via gravity through a pipeline that leads to the REDUC. The water is of good quality; with adequate treatment, it is appropriate for human consumption.

With the passing of time, the expansion of the REDUC's facilities also expanded its demand for water. It thus opted for a source that would guarantee the possibility of meeting its then-current and future demand: the Guandu River, close by the Guandu ETA's abstraction point. The REDUC's abstraction system is composed of a lifting unit with a maximum capacity of 7,200 $m^3$/h and a 32" (81,28 cm) diameter pipeline that spans 48km, passing through the municipalities of Nova Iguaçu, Belford Roxo and Duque de Caxias before arriving in the REDUC. The CEDAE operates this system, but only uses the Guandu ETA's decantation tanks and thus does not pass through all available treatment processes at this treatment station. In 2007 this system met 48% of the REDUC's needs (1,246 $m^3$/h) and 85% of the needs of industries in the gas-chemical complex (850 $m^3$/h), providing a total flow of 2,096 $m^3$/h (Lemes, 2007).

In the Campos Elíseos region, the petrochemical complex's wealth and ample supply contrasts with the situation of Duque de Caxias' residents, who live in precarious conditions without any access to water supply services.

The municipality of Queimados offers another example. Given the extremely irregular supply provided by the CEDAE, a significant portion of the population resorts to fetching water from wells and springs, which is often not of good quality (Maiello et al., 2015). One of the municipality's existing reservoirs is located in the Queimados Industrial District (CODIN Reservoir), which receives 200 L/s of water from the Ribeirão das Lajes River. This river's water is of good quality and yet it is destined for industrial use in a municipality wherein the majority of the population suffers from a lack of regular access to water. A high-ranking technician with the CEDAE stated in an interview that the System's main philosophy was to supply the Queimados Industrial District first and foremost, and afterward to only perform small operations of little significance for the supply of some districts and communities (interview under *Desafio* Project).

## 5. Outlook for greater water security and expansion of water services in the RJMA

As previously highlighted, the **Guandu/Lajes/Acari Integrated System, which provides service to the western metropolitan region**, produces a total flow of 52,400 L/s. Of this total, 45,000 L/s comes from the Guandu ETA, 5,500 L/s from the Lajes Reservoir, and 1,900 L/s from the Acari System. Current demand (2015) is approximately 56,000 L/s, which signifies that the system is operating at an estimated deficit of 3,600 L/s. Based on current trends in demand, projections for 2035 estimate that demand on the system will be approximately 73,200 L/s (Table 3).

**Table 3: Guandu/Lajes/Acari System – flow produced, current demand (2015) and future demand (trend-based scenario 2035)**

| System | Flow produced (L/s) 2015 | Demand (L/s) | |
|---|---|---|---|
| | | 2015 | 2035 |
| Guandu | 45,000 | 56,000 | 73,200 |
| Lajes | 5,500 | | |
| Acarí | 1,900 | | |
| Total | 52,400 | | |

Source: Integral de Engenharia LTDA/FIRJAN (2015).

The Guandu ETA's production capacity is going to be progressively expanded by 36,000 L/s via the construction of three new modules, each with a capacity of 12,000 L/s. Thus, when these modules will be complete, total production will be approximately 81,000 L/s. It is important to highlight that the abstraction infrastructure and the supply pipelines are already designed to support this rate of flow.

In a presentation at the SEAERJ, the 29th of April 2015, the CEDAE disclosed that it already possessed the design study for the implantation of a new ETA (*Novo Guandu*) to treat 24,000 L/s in two equal steps of 12,000 L/s. The first step has already commenced and received R$ 3.4 billion from the World Bank. It will have 300km of distribution network, a production capacity of 12,000 L/s and a stocking capacity of 161 million litres of water.

According to the CEDAE, the new ETA will have different objectives. First, it aims to increase the supply of water to Baixada Fluminense to relieve the deficit in supply in the metropolitan region. Secondly, it should provide greater security to the current production system of treated water, serving as an alternative in cases of high-risk or required maintenance.

It must be pointed out that the Guandu River is the only viable option to increase the water supply for Baixada Fluminense and other areas of the metropolitan region covered under the Guandu-Lajes-Acari System. The Lajes and Acari systems do not have the right conditions for expansion. The former is limited by the capacity of the CEDAE's conduits and, mainly, by restrictions on the total storage capacity of the Lajes reservoir. The latter is already operating at maximum capacity.

Herein is the importance of maintaining the minimum flow of 190 $m^3/s$ from the Paraíba do Sul River to the Santa Cecília dam and the minimum flow of transfer to the Guandu (119 $m^3/s$). This was one of the points that the state of Rio de Janeiro defended most in negotiations regarding São Paulo's proposal to divert waters from Paraíba do Sul river basin to reinforce Greater São Paulo's water supply: reducing the flow of the Paraíba do Sul River was non-negotiable for the state of Rio de Janeiro. Thus, reconciling the projects envisaged by São Paulo and ensuring water security in this state required modifying the operating rules of the Paraíba do Sul Hydraulic System (Formiga-Johnsson et al., 2015). When the new rules come into effect, the stored water will start to be managed in such fashion as to ensure water security for multiple uses, with public supply as number one priority. In doing so, the system will become more resilient against severe droughts such as that which has been felt since 2014.

Protecting the Guandu ETA also depends on consolidating the Guandu River's Environmental Protection Area (APA Guandu), which was created in 2007 via State Decree nº 40.670. The APA Guandu aims to safeguard the quality of its waters and springs, the riparian zones, and the remaining forest in close proximity. Among the measures that shall continue to be stepped up, the protective strip around the river should be completely reforested as per Brazil's Forestry Code.

The strategic importance of the Lajes reservoir is undeniable for the RJMA's water supply. The Master Plan for Water Supply in the RJMA (CEDAE, 1985) made provision for the expansion of flow through "CEDAE pipelines" from 5.5 $m^3/s$ to 18 $m^3/s$. This expansion would potentially implicate conflict regarding the use of these waters, as it would reduce the potential energy that could be generated through the Fontes and Pereira Passos hydroelectric power plants. Furthermore, the pipeline structure as well as the Lajes conduit system would also have to be expanded. It may be noted that the CEDAE was planning to build a new ETA to treat water that would be supplied through these pipelines.

In the area situated east of the Guanabara Bay, the situation is more worrisome in the short and long term than to the west, which receives service through the Guandu/Lajes/Acari System. The Imunana/Laranjal System, which provides service to the municipalities of Niterói, São Gonçalo, Itaboraí and Paquetá Island is operating at a deficit, as explained in section 4.1. This region's water sources are insufficient to meet its residents' needs for water supply in the long term.

A study performed by the Integral de Engenharia LTDA engineering firm for the Federation of Industries in the State of Rio de Janeiro (Firjan) (2015) calculated that demand for the year 2035 could attain 14,200 L/s, which would require an expansion of 8,000 L/s by 2035 (Table 4).

**Table 4: Imunana/Laranjal System - flow treated, current demand (2015) and future demand (trend-based scenario 2035)**

| Sources | Flow treated (L/s) 2015 | System Demand (L/s) | |
|---|---|---|---|
| | | 2015 | 2035 |
| Guapiaçu | 6,200 | 10,900 | 14,200 |
| Macacu | | | |

Source: Integral de Engenharia LTDA/FIRJAN (2015).

In the short term, a viable solution to increasing the water supply to the Imunana/Laranjal is to build a dam on the Guapiaçu River. This dam would provide an increase of 4,000 to 5,000 L/s of water, which would be enough to close the Imunana/Laranjal System's current deficit of almost 4,700 L/s.

From now until 2035, the above-cited study (Integral de Engenharia/Firjan, 2015) designed an alternative meant to dovetail with the expansion planned for the Guandu

ETA. It suggests the integral treatment of the RJMA's water supply, with the Guandu System complementing part of the deficit in the eastern area of the Guanabara Bay. Considering that by 2035 this system requires an increase of about 3,300 L/s and that Magé and Guapimirim require 580 L/s, a new pipeline from Guandu would require sufficient capacity to support a flow of approximately 4,000 L/s. This pipeline could be constructed in two phases, in accordance with demand.

Of course, the viability of this alternative depends on the implantation of the three aforementioned expansion modules to the Guandu ETA, each with a production capacity of 12,000 L/s. The alternative consists in transporting water from the Guandu System via the construction of a tunnel originating in the Marapicu reservoir, passing through the Serra do Mendanha and leading to the Juscelino Kubitschek district in Nova Iguaçu. From hereon, water would be channelled through a conduit to São Gonçalo, reinforcing supply to this municipality and to Magé and Guapimirim on its path.

In the long term, installing this alternative would resolve the deficit in the Imunana/Laranjal System. It would provide necessary flow to the system, supplying the municipalities Niterói, Itaboraí and Paquetá Island, leaving the supply of São Gonçalo to the Guandu System.

In conclusion, it is appropriate to point out that flow is very reduced in all other available sources from the river basins that flow into the Guanabara Bay. In addition, the quality of water is compromised in the majority of these sources. However, some local alternatives could be recovered or implemented as complementary sources to supply locations situated at the backend of the Guanabara Bay, which do not currently receive service from public supply systems.

## 6. Final considerations

This work attempted to provide elements to the discussion of the right to water in the Rio de Janeiro Metropolitan Area. In addition, it demonstrated how a possible water crisis could aggravate precarious water supply conditions for substantive parts of the population living in the metropolis' outlying districts.

Independently of the water crisis, which, contrary to the case of São Paulo, has not yet affected water supply in the metropolitan region, the data indicates that the RJMA was already facing previous problems with access to water, especially in the municipalities located in the metropolitan outskirts. In these areas, various districts live through structural scarcity due to incomplete public supply systems and the style of service management. These are components of what has been designated hydrosocial scarcity. Above all, the style of service management has not managed to install complete and efficient water supply systems in the outlying metropolitan municipalities. System incompletion includes various components of these systems: supply conduits, reserve capacity and distribution network infrastructure.

Although it affects all outlying metropolitan spaces, it was observed that hydrosocial scarcity materialised in different ways in the two metropolitan water supply macro systems: the Imunana/Laranjal and Guandu/Lajes/Acari Systems. In both systems, there are areas that do not receive service in municipalities that surround the cities considered to be the dual core of the metropolis: Rio de Janeiro and Niterói. The lack of service to these areas is fruit of public sanitation policy implemented by the CEDAE, which is marked by the low effectiveness of investments made in these territories. In despite of different governmental programs aiming to expand their water supply systems since the late 1980s[i], areas within the Baixada Fluminense, in São Gonçalo and Itaboraí still have incomplete systems, inoperative reservoirs, unorganised water distribution (by sector), and dry distribution networks or service restricted to two or three days a week. Thus, these are vulnerable systems that are incapable of supplying water to their entire populations. Yet, it can be affirmed that this situation is currently more severe in the area receiving service via the Imunana/Laranjal System. As explained previously, there is a deficit of water available to meet the demand of the population covered by this system due to a lack of available bulk water. Meanwhile, the Guandu System has adequate water availability and legal water reserves for future expansions to the Western Metropolitan supply system.

In the midst of increasingly intense extreme events, as the 2014-2015 drought in the Paraíba do Sul river basin, water supply systems risk becoming significantly more vulnerable in terms of bulk water availability if there are not changes in processes of governance and management that increase water security for future generations.

It is nevertheless important to differentiate, once more, that these systems are not equally vulnerable. Despite the complexity of managing the Paraíba do Sul Hydraulic System in cooperation with the Federal State and the states of São Paulo and Minas Gerais, the Guandu System is more resilient, especially thanks to the Hydraulic System. Indeed, the Guandu System possesses a significant capacity to reserve and regulate water, which, thanks to successive adaptations to the system, has allowed it to react to water crises without impacting the Guandu ETA's production of water. The Imunana/Laranjal System, on the other hand, does not possess regulating reservoirs and thus is more vulnerable to hydrological variation. Even the total capacity for water reservation in this river basin is limited; even if more was built, it would only meet current needs and the projected medium-term needs for future expanded public water supply.

Given the differences between these water supply systems, the future thus holds the real possibility that there will be less water available, which will impact the hydrosocial cycle in the metropolis of Rio de Janeiro even more. A reduction in available water could further aggravate the scarcity that is already a common aspect of access to water in the metropolitan region. Indeed, the RJMA is marked by power relations that determine differential access for different uses and users; generally speaking, the areas that comprise the metropolitan nucleus are given priority and, more specifically, industrial uses are given priority to the detriment of residential uses in outlying metropolitan districts. All of these aspects reinforce the hypothesis that hydrosocial scarcity exists in the Rio de Janeiro Metropolitan Area.

In this context, wherein water is an increasingly disputed good whose access is mediated by power relations (Swyngedouw, 2006 e 2009), it is fundamental to give priority to access for human consumption and to manage services in the most comprehensive way possible in order to increase water availability.

In the RJMA, it is of great significance to emphasise how important and urgent the CEDAE must treat reducing its losses, which are far greater than the average levels attained by other countries with more efficient standards for the management of water resources and sanitation services. The PERHI (2014) estimated average losses in the state's water supply systems to be around 40%. Reducing losses to a mere 30% would result in gains of sufficient water to supply 1.5 million people. Furthermore, permanent programs must be conducted to provide incentive for end-users to save water, and to stimulate industries to create methods for rationalisation and water recycling in production processes.

In sum, this article analysed access conditions to water supply services and the management of these services in the Rio de Janeiro Metropolitan Area. It indicates that overcoming the existing hydrosocial scarcity will demand a profound improvement in systems management, notably on the part of the CEDAE. The utility must adopt a new standard of action based in principles that reconcile the human right to water for all residents in the metropolis and the protection of an essential and increasingly scarce resource.

## Note

i Special Project for Baixada Fluminense and São Gonçalo (Projeto Especial para a Baixada Fluminense e São Gonçalo - PEBS); Sector Creation Plan for Water Supply in Baixada Fluminense (Plano de Setorização Abastecimento de Água na Baixada Fluminense); Guanabara Bay Clean-up Program (Programa de Despoluição da Baía de Guanabara - PDBG); Projeto (Project) Baixada Viva/Nova Baixada; and PAC I.

## 7. Bibliography

BRASIL. Ministério das Cidades, Secretaria Nacional de Saneamento Ambiental, *Plano Nacional de Saneamento Básico- PLANSAB*, Brasília, 2013.

BRASIL. Ministério das Cidades. Secretaria Nacional de Saneamento Ambiental. *Sistema Nacional de Informações sobre Saneamento. Diagnóstico dos serviços de água e esgoto 2013*. Brasília: Ministério das Cidades, 2015.

BRITTO, A.L.A. "Evolução dos Serviços de Saneamento na Baixada Fluminense", In: *Serviços de Saneamento na Baixada Fluminense: problemas e perspectivas*. Rio de Janeiro: Observatório de Políticas Urbanas IPPUR/FASE, 1998.

CARNEIRO, P. R. F. (2015). Água, um bem natural e precioso. FAPERJ – Rio Pesquisa, Ano VIII nº 30, Rio de Janeiro, March 2015.

CEDAE/CNEC. *Serviços de Revisão do Plano Diretor de Abastecimento de Água da Região Metropolitana do Rio de Janeiro relativamente aos municípios atendidos pelos sistema Guandu, Ribeirão das Lajes e Acari*. Report Summary, 2004.

CONEN. *Estudos Regionais de Saneamento Básico*. Public Conference , 2013. Available at : https://drive.google.com/file/d/0B4FeWWmt3UkyM1QwcDZoUndoOVE/edit. Accessed: May 2015.

ENCIBRA. *Plano Municipal de Saneamento Básico do Município de São Gonçalo,* Diagnóstico: Sistema de Abastecimento de Água, 2014. Available at http://pmsbsg.blogspot.com.br

FORMIGA-JOHNSSON, R.M., FARIAS JUNIOR, J.E.F. de, COSTA, L.F. da, ACSERALD, M.V. "Segurança hídrica do Estado do Rio de Janeiro face à transposição paulista de águas da Bacia Paraíba do Sul: relato de um acordo federativo". *Revista Ineana (Revista técnica do Instituto Estadual do Ambiente, RJ)*, v.3, pp. 48-69, 2015.

FORMIGA-JOHNSSON, R.M. *Water allocation in Brazil. A global overview and the case of Ceará State*. Final Report for the World Bank Project "Turkey: Watershed Dialogue – National Basin Strategy and Project", 2013.

GUY, S., MARVIN, S., MEDD, W. & MOSS, T. *Shaping Urban Infrastructures. Intermediaries and the Governance of Socio-Technical Networks*. London: Earthscan, 2010.

INEA-FUNDAÇÃO COPPETEC. *Plano Estadual de Recursos Hídricos do Estado do Rio de Janeiro*. Final report. 2014.

INTEGRAL DE ENGENHARIA LTDA/FIRJAN. *Avaliação da segurança hídrica da Região Metropolitana do Rio de Janeiro. Relatório Final: Diretrizes para o aumento da segurança hídrica da Região Metropolitana do Rio de Janeiro*. Rio de Janeiro, May 2015.

IPCC. "Summary for policymakers". In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 32, 2014.

LEITE, L.E.C. Como Universalizar o Saneamento na Metrópole. Presentation at Rio Metropolitano Seminar, Duque de Caxias, 05/05/2015.

LEMES, D.R. *Disponibilidade hídrica para uma refinaria de petróleo sob a ótica da gestão de recursos hídricos. Estudo de caso: Refinaria Duque de Caxias – REDUC*. Masters dissertation. Civil Engineering Post-Graduate Program, COPPE, UFRJ, 2007.

MAIELLO, A., BRITTO, A.L., QUINTSLR, S. *Grassroots solutions vs large infrastructures for water supply: is an integrated strategy feasible? A tale from the Rio de Janeiro Metropolitan Region*. Paper presented at 45th Annual Conference of the Urban Affairs Association, April 2015.

PAHL-WOSTL, C. *Requirements for adaptive water management. Adaptive and Integrated Water Management. Coping with Complexity and Uncertainty*. Pahl-Wostl, C., Kabat, P., and Miltgen, J. (editors). Springer Verlag, Heidelberg, Germany, 2007.

PBMC. *Impactos, vulnerabilidades e adaptação às mudanças climáticas. Contribuição do Grupo de Trabalho 2 do Painel Brasileiro de Mudanças Climáticas ao Primeiro Relatório da Avaliação Nacional sobre Mudanças Climáticas*. COPPE, UFRJ, 2014.

SANTA RITTA, J. *A água do Rio - do Carioca ao Guandu. A história do abastecimento de água da cidade do Rio de Janeiro*. Rio de Janeiro: Synergia, Light, Centro Cultural da SEAERJ, 2009.

STE. Serviços Técnicos de Engenharia. *Plano Municipal de Saneamento Básico do Município de São João de Meriti – RJ*. Report Summary, 2014.

SWYNGEDOUW, E. *Social Power and the Urbanisation of Water. Flows of Power*. Oxford: Oxford University Press, 2004.

SWYNGEDOUW, E. “The Political Economy and Political Ecology of the Hydro-Social”. *Journal of Contemporary Water Research & Education,* issue 142, august 2009, pp. 56-60.

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# WATER SUPPLY AND HYDROSOCIAL SCARCITY IN THE RIO DE JANEIRO METROPOLITAN AREA

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***Resumo*:** Este trabalho analisa a situação atual do abastecimento da Região Metropolitana do Rio de Janeiro à luz do conceito de escassez hidrossocial e do direito humano à água, e avalia o quanto a disponibilidade de água bruta pode agravar esse quadro. Parte-se da hipótese que os problemas relacionados ao acesso à agua estão diretamente ligados ao modelo de gestão das águas e dos serviços de saneamento, às deficiências no planejamento e nas escolhas técnicas bem como na forma de operação dos sistemas existentes. Procura-se demonstrar que, para além desses problemas estruturais atuais, a vulnerabilidade dos sistemas de abastecimento tende também a aumentar em termos de disponibilidade de água bruta, caso não haja mudanças nos processos de governança e gestão com vistas à maior segurança hídrica, sobretudo no contexto de intensificação de extremos climáticos a exemplo da seca nas bacias dos rios Piracicaba e Paraíba do Sul em 2014 e 2015.

***Palavras-chave*:** Abastecimento de água, disponibilidade de água bruta, escassez hidrossocial, Região Metropolitana do Rio de Janeiro

***Abstract*:** This paper aims to analyse the water supply systems in the Rio de Janeiro Metropolitan Area in the light of the hydrosocial scarcity concept and the human right to water. It also assesses how bulk water availability may aggravate this situation. We argue that water access-related problems are directly related to several aspects: the way that water and sanitation services are managed, deficiencies in planning, technical choices, and the way in which existing systems are operated. In addition to these current structural problems, the vulnerability of supply systems also tends to increase in terms of lesser water availability as long as no changes are made in management processes to promote greater water security, as the 2014-2015 drought affecting the Piracicaba and Paraíba do Sul river basins.

***Key words*:** water supply; bulk water availability; hydrosocial scarcity; Greater Rio de Janeiro

***Resumen:*** En este trabajo se analiza la situación actual de los servicios de suministro de agua en la región metropolitana de Río de Janeiro, a la luz del concepto de escasez hidrosocial y del derecho humano al agua, y evalúa la forma en la disponibilidad de agua cruda puede agravar esta situación. Sostenemos que los problemas relacionados a el acceso a agua están directamente relacionados con el modelo de gestión de los servicios, con las decisiones técnicas y opciones de planificación y, así como con el funcionamiento de los sistemas existentes. Se trata de demostrar que, además de los problemas estructurales actuales identificados, la vulnerabilidad de los sistemas de suministro también tiende a aumentar en términos de disponibilidad de agua cruda, si no hay cambios en los procesos de gobernanza y de gestión con miras a una mayor seguridad del agua, sobre todo en contexto de condiciones climáticas extremas, como la actual sequía en las cuencas de Piracicaba y Paraiba do Sul

***Palabras clave:*** suministro de agua; la disponibilidad de agua cruda; escasez hidrosocial; Región Metropolitana de Río de Janeiro

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