

Urban water supply and the changes in the precipitation patterns in the metropolitan area of São Paulo – Brazil

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ABSTRACT

The Metropolitan Area of Sao Paulo presents today one of the most critical situations in Brazil with regard to ensuring sufficient water supply in quantity and quality to its population. Declining water resources coupled with increased demand for clean water has already become a political issue in many localities. This study aimed to examine whether climate changes (especially in rainfall) resulting from the urbanization process are related to the urban water supply problems detected in the MASP, or whether they are due to poor management and the rapid growth of cities. Broadly, what can be concluded from the results of this research is that they indicate that there are signs of urbanization effects on the behavior of rainfall in the MASP. It was also identified that the averages of the volumes stored in the reservoirs that supply the MASP did not have a default behavior, even in similar weather conditions, suggesting the need for improvements in the systems.

1. Introduction

Created by the Complementary Law No. 14 of July 8, 1973, the Metropolitan Area of Sao Paulo (MASP) is composed of 39 municipalities, including the city of Sao Paulo (the state capital) and it is located at an altitude of approximately 750 m above sea level, with a large part of its territory in the Alto Tiete Basin within the Paulistano Plateau. According to the latest census (IBGE, 2011), the total population in the metropolitan area is 19,672,582 inhabitants.

The MASP presents today one of the most critical situations in the country with regard to ensuring sufficient water supply in quantity and quality for its population (Lima, 2015). Declining water resources coupled with increased demand for clean water has already become a political issue in many localities. This situation is becoming more and more aggravated by the constant urban expansion that generates the occupation of peripheral spaces and environmental protection areas, where are located drainage headwaters and important water bodies.

Currently, in the MASP the water supply is carried out in an integrated way that basically uses surface water sources, and consists of eight complexes (Cantareira, Guarapiranga, Rio Grande – Billings, Rio Claro, Ribeirão de Estiva, Alto Cotia, Baixo Cotia and Alto Tiete) that are responsible for the production of 67 thousand liters of water per second, to supply 32 municipalities served by the Companhia de

Saneamento Básico do Estado de Sao Paulo (SABESP) (Basic Sanitation Company of the State of Sao Paulo) and seven others that buy water wholesale (Santo André, Sao Caetano do Sul, Guarulhos, Mogi das Cruzes, Diadema, Santa Isabel and Mauá).

In the evaluation carried out by the Agência Nacional de Águas (ANA) (National Water Agency), almost all the producer systems, except for the Ribeirão de Estiva, require extensions or improvements to ensure the water supply to the MASP in the coming years.

Faced with this situation, in which the disorderly urban growth and increasing demand for water finds with obsolete supply systems that urgently need improvements to meet the population of the metropolis in the coming years, it is also important to discuss the issue of climate change (in particular precipitation regimes), which has been largely ignored by the authorities.

The MASP is located along a climatic transition range (23° 21' S and 46° 44' W) between high-altitude Tropical Climate, with a defined dry period, and those subtropical, permanently humid in southern Brazil.

The combination of humid oceanic winds with the frontal positioning of the Planaltina escarpment and the crystalline mountains (beyond Tiete) favors the spatial variability of the precipitation in the MASP (Fig. 1). The Tiete valley is the area with the lowest precipitation rates, as well as the highest evapotranspiration losses, becoming the warmest and least humid part of the Alto Tiete Basin.

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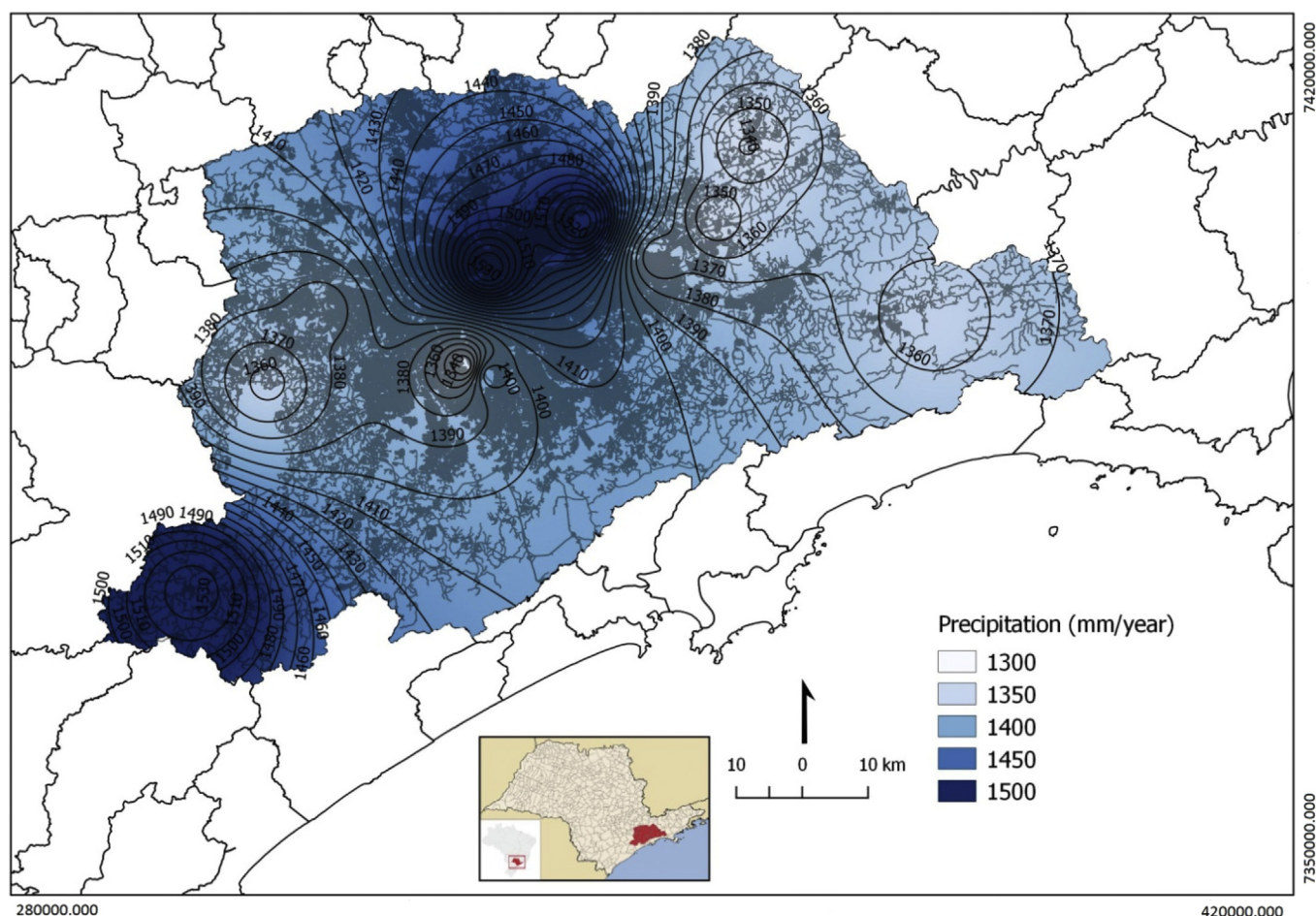


Fig. 1. Average annual rainfall in the MASP (1933–2014).

In the MASP, precipitation systems of convective origin are the most representative and are attributed to topography, surface characteristics, the injection of moisture brought by the sea breeze and the existence of Islands of Heat.

The increasing urbanization, acting in synergy with the temperature increase, presents potential for the occurrence of events with intense precipitation increasingly frequent, especially considering the tendency for the next decades of a pattern of urban growth in the metropolis similar to the current one in which the quality of life, the environment and the sustainable future of natural resources are ignored.

However, the episodes of higher rainfall are not well distributed throughout the year. Sant'anna Neto (1995) verified a generalized increase of precipitation in several cities of the state of Sao Paulo, with higher concentrations in the spring/summer, that is, the rainfall increment did not occur uniformly in the different seasons of the year, on the contrary, they were higher from October to March. The author also noted that the dry season, which used to be concentrated between April and September, in most of the state, has lasted until October in the last decades.

It is considered that the urban supply systems in the MASP are not prepared to adequately serve the population, given the problems presented, namely, the disorganized occupation of areas of environmental protection, and the trends of changes in the rainfall regime in urbanized areas, which will worsen in the coming decades.

- Thus, the main objective of this work is to demonstrate that the problems of water supply in the MASP are not due to the reduction of annual rainfall, as the media often says, but in the absence of an adequate planning to face the new rain patterns, in which the dry

season is prolonging while in the summer months occur more intense precipitations.

2. Materials and methods

Analysis of trends and climate variability was carried out using the climatic data of seven (07) pluviometric stations distributed by the MASP (ANA, 2017) and three (03) meteorological stations monitored by the National Institute of Meteorology (INMET, 2017) (Table 1), both seasonally and yearly, from daily and monthly values. It was sought to obtain long series, with at least 30 years of data and that had records until the year 2015.

Information on urban water supply comes from government agencies such as the ANA, the Departamento de Águas e Energia Elétrica (Water and Electrical Energy Department) and the SABESP.

For the analysis of the annual behavior of precipitation classes, the hydrological year was considered (August to July), to include the entire rainy season, which in the Southeast region runs from September to March. Regarding the seasonal behavior, the quarters for each season were considered, with emphasis on the January, February, and March (summer) analyses, which are the rainiest months in the region.

The daily precipitations of the 10 stations were classified into three categories: light rain, with totals between 0.1 mm/day and 5 mm/day, moderate, with totals between 10 mm/day and 30 mm/day and severe or intense, with totals higher than 30 mm/day. For each hydrological year and summer period, the case numbers were computed for each of the three categories of precipitation considered. These annual and seasonal series of the number of events of light rainfall, moderate and intense precipitation were submitted to Mann-Kendall (MK) trend tests,

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