



## **2. Introduction**

It is a reality that there are still millions of people who suffer from the lack of water facilities; a large number of them live in big cities of developing countries. The lack of these facilities is known to be related to other factors, like high incidence of illnesses related to bad water quality.

It is a priority for the humanity to increase the access to water and sanitation systems, as it is exposed in Objective Number 6 of the Sustainable Development Goals of the United Nations. To

### 3. Objectives

The objective of the study has been the development of a system for the identification and quantification of the vulnerability of the population living in a certain district of an urban area, in order to obtain a tool that helps in decision-making for the prioritization and planning of new water infrastructures that must be carried out.

We get to the object by showing an example of an Index that can be used to help characterize the priority of investments, and the correlation among certain variables in a big city with a recent development, where there are enough data available. This correlation can be used in the study of cities with less information, in countries with a lower development.

### 4. Materials and Methods

To materialize the method proposed, we start from the information available of the city of Sao Paulo, in Brazil. This city has experienced a big and rational growth in the last decades, being an example as a city that successfully manages migration. The current "Strategic Master Plan" of 2014 has been awarded by ONU-Habitat, and it seeks to ensure a socially equilibrated city, inclusive and environmentally responsible, productive and, above all, with a good quality of live for its citizens.

It is, so, a good reference for cities in countries on process of development. Starting data in the city information system is quite rich; this has also been important for taking Sao Paulo as an example for this study.

We analyze the correlation among the data available and we propose an equation to classify the different areas. Finally, a global Water Investment Necessity (WIN) map at the municipal level is obtained as a result. This map already constitutes a decision support tool; in this way, actions can be planned based on objective criteria.

#### Equation:

The relation among vulnerability, development and investment necessity can be expressed by a simple equation:

$$WIN = VUL / EWSD$$

where:

WIN=Water Investment Necessity, with values from 1 to 5, the higher the WIN value is, the higher the necessity of investment

VUL=Vulnerability, with values from 1 to 5, the higher the Vulnerability is, the higher the value

EWSD= Existing Water System Development, with values from 1 to 5, the more developed the system is, the higher the value

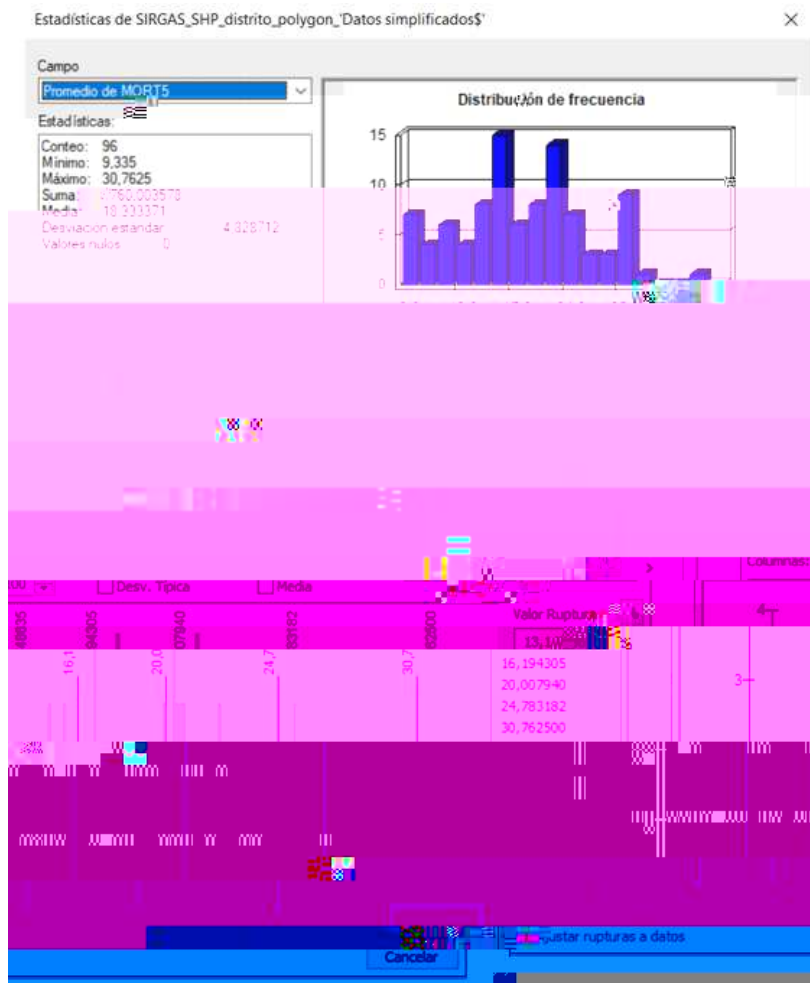


In the case study of Sao Paulo, in the sources consulted there is a specific variable that shows the percentage of houses with piped access to drinking water and the private sanitation system. Therefore, this is the variable than can be directly used to establish the representative ranges with values from 1 to 5.

**Case Study:**

For the city of Sao Paulo the information for the different districts can be obtained from the public

MORT5: Mortality at five years. This variable is obtained from the maps available. We propose a geometrical interval method to establish 5 ranges. This method provides a similar number of values in each range.



**Fig. 3:** values and ranges for the variable that represents the number of children died before 5 years out of 1000

Each of these ranges can be assigned with a value from 1 to 5.



## 5. Results

The results in this study are obtained in the form of GIS maps by applying the criteria of Vulnerability and Existing Water System Development described. The assignment has been made by using the available variables. Values are obtained for the subdistricts in which the city is divided.

**Fig. 5:** representation of children mortality (left) and existing water services (right) in 5 ranges



**Fig. 6:** Index of vulnerability attending to infant mortality

**Fig. 7:** Index for development of water facilities

**Fig. 8**

The representation of the information available in this example lets us easily appreciate how the

## References

A. Pinilla, A. Lastra and M. Ortega. Canal de Isabe