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Measurement of the Flow of the River Canastra in Itapuranga (Goiás) as a strategy for Planning and Management of Hydrographic Basins

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SUMMARY

This study aimed to measure the flow of the Canastra River, located in the municipality of Itapuranga (Goiás), from 2017 to 2018, using the float method. This river plays an important role in providing water for the urban area, for industry and for the irrigation of extensive areas of cultivation. Thus, the analysis focused on showing how these results can contribute to the planning and management of river basins. The methodology used for data collection was the estimation by the float method. The results obtained showed that in the wettest months the flow rate reached a relative average of 200 m³/s, with a maximum flow rate of 450 m³/s. In the dry months, especially in October 2018, the flow reached a minimum of 4.1 m³/s. The flow data of the watercourse allowed to show the extremes of the water source capacity, which has been increasingly under pressure from increasing demand for supply in the urban area of Itapuranga and also from industries and agricultural activities. Furthermore, this experimental study demonstrated how the use of techniques considered simple and cheap, such as the one used, emerge as possibilities for the practice of watershed management, available to managers, especially in small municipalities in the country with limited financial resources.

KEYWORDS: Limnology. Flow rate. Planning and Management of Hydrographic Basins.

1 INTRODUCTION

The hydrology studies water on earth, taking on the task of understanding the circulation of water, its occurrence in certain places, as well as its physical and chemical properties, including laws and interactive phenomena that occur between water and the environment. Therefore, it is the science of the various processes of the hydrological cycle (PAZ, 2004). As a subfield of Hydrology, Limnology can be highlighted, which aims to study continental waters such as lakes, rivers and reservoirs. In this context, limnological studies aim to analyze the chemical, physical and biological characteristics that allow understanding the correlation between organisms and their environment, such as the influence of the quality and quantity of aquatic organisms (LIMA, 2004).

An important parameter in Limnology is the flow, which can be defined as a certain amount of fluid that flows through a section of space, in a considered period of time. That is, flow is the ratio between the volume flown by a spatial unit and the measure of time (TORRES; MACHADO, 2012). Thus, studies to monitor the flow of water resources are important, given the relevance of water to humanity.

It is known that water is of fundamental importance for the maintenance of life, as well as for use in food production and in the application of the development of industrial technologies. It can be seen, therefore, that in the contemporary context, guided by Capitalism, water has become a primordial element, being at the center of discussions at a global and national level. Therefore, studies directed to the planning and management of water resources are important, in the search for the preservation of water sources and recovery of degraded areas, since the world population tends to increase, the economic pressure is increasing, while water resources have considerably lost its potability and its ability to recover.

A determining factor that has been reflected in environmental degradation is the decrease in the volume of water at the catchment points for the supply of cities, which is explained by the siltation process of the riverbeds that occurred as a result of the deforestation process on the banks (SILVA; FERREIRA, 2011). The lack of environmental preservation of the banks of the drainage channels puts the capacity of the riverbeds at risk due to the silting process. Thus, limnological research is important because the lack of flow data makes it difficult to properly plan human activities. Therefore, monitoring the flow of fresh water sources is important for the knowledge, planning and management of hydrographic basins.

In Brazil, the different uses of water are governed by the National Water Resources Policy (PNRH), Law No. 9433, of January 8, 1997, which in its article 2, item I, aims to ensure the current and the future generation the necessary conditions for water availability. It is also highlighted, in item IV of the PNRH, the preservation and use of rainwater. From Article 7, the regulation presents conditions to implement projects in order to diagnose the situation of water resources, as alternatives for population growth. It also presents ways to develop strategies in relation to water demand and resource management. For this, the National Water Resources Policy aims to stimulate the regulation and inspection of its multiple uses (BRASIL, 1997).

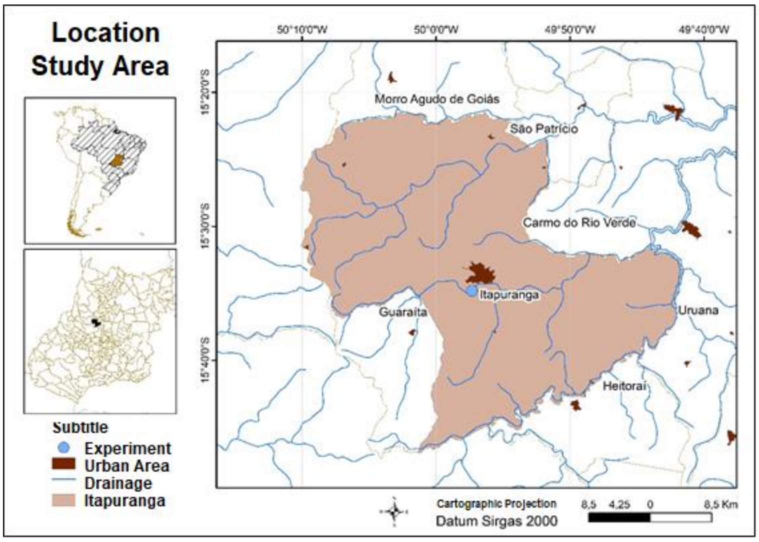
Based on the aforementioned problem, the increasing economic pressure on water resources and limnological studies as instruments that can help in the planning and management of water resources/watersheds, this study aimed to measure the flow of the Canastra River, located in the municipality of Itapuranga (Goiás), from 2017 to 2018, using the float method. This river plays an important role in providing water to the urban area and in the irrigation of extensive cultivated areas. Thus, the analysis focused on showing how these results can contribute to an improvement in the planning and management strategy of river basins. The methodology used and the results are presented below.

2 METHODOLOGY

2.1 Characterization

The study area defined for this study was the Canastra River Basin, located in the municipality of Itapuranga, located in the state of Goiás (Figure 1). This water resource is responsible for supplying water to the urban population of 25,600 inhabitants (IBGE, 2020) and also for the irrigation of extensive agricultural areas.

Figure 1: Location of the Canastra River, Itapuranga (Goiás)



Source: Authors, 2021.

The hydrographic basin is inserted in the morphoclimatic domain of the Cerrados, characterized by the occurrence of savanna, forest and countryside formations (COUTINHO, 2006). According to Ab'Saber (2003), it is characterized as a mosaic of various types of plant formations, climate, topography and a great diversity of soils.

The climate is tropical savannah, with dry winter (Aw), with strong influence from the South Atlantic Convergence Zone (ZCAS), characterized by the large amount of moisture transported from the ocean to the interior of this region - from east to west - from the coast. Other events that directly influence the climate of the region are the occurrence of the so-called Intertropical Convergence Zone (Amazon convection), originating in the northern portion of the country, and the Upper Bolivia, originating in the West, forming a continuous band of nebulosity in the northwest- southeast, which extends from the Amazon region to the South Atlantic, where large blocks are formed, with long periods occurring with high rainfall (SILVA *et al.*, 2008).

2.2 Flow measurement

There are several methods of measuring the flow of a river, from the most sophisticated methods with a higher financial cost that provide more precision in the results to simpler (rudimentary) methods. This work chose a method considered simple - the float method. The materials used to measure the flow were two pieces of rope with lengths of 15.72 m (upstream or higher section) and 17.58 m (downstream or lower section), four stakes, hammer, measuring tape, ruler, timer and a pet bottle. The Figure 2 shows the upstream section of the experiment. A stretch of the linear river was chosen, avoiding stretches with many curves, which could influence the result. The monitoring of the Canastra River flow was carried out from December 2017 to November 2018.

Figure 2: Upper section on the river Canastra

Source: Authors, 2018.

The float method consists, therefore, in the possibility of defining the displacement speed of a floating object in order to measure the displacement time spent in a given section and from this, calculate the fluid flow through space. It is, therefore, an easy-to-handle technique, and it can be built in a rustic way and with easily accessible materials, such as a pet bottle.

The flow calculation was elaborated considering equation 1, where: A= average of the river area (distance between the banks multiplied by the river depth); L= length of measurement area; C= coefficient or correction factor (0.8 for rivers with a rocky bottom or 0.9 for rivers with a muddy bottom). The coefficient allows for correction due to the fact that water moves faster on the surface than on the bottom portion of the river.

$$(A \times L \times C) / T \ (m3/s) \quad (1)$$

The data were collected over a period of 12 months, thus enabling an annual estimate of the average flow of the Canastra River. The data show different amplitudes according to the months with the highest and lowest rainfall. The rainy months were the ones with the highest peak of flow. On the other hand, in the dry months, the lowest levels of flow occurred.

3 RESULTS AND DISCUSSION

The flow of a given watercourse is mainly related to two processes – precipitation and infiltration. Precipitation is the phenomenon of the hydrological cycle defined as the moment in which water in the atmosphere is moved by the effect of the cloud's gravity towards the earth's surface in a liquid or, in specific cases, solid state. Infiltration, on the other hand, results from the water's ability to penetrate the soil layers, which promotes the recharge of aquifers. Thus, in the analysis of the Flow, one should always seek to relate these results to the precipitation levels, which can vary from year to year, with the processes of environmental degradation, with the conditions of the preservation areas, among other elements that interfere in the dynamics. of river basins. The Table 1 shows the raw results collected in the field, between 2017 and 2018.

Table 1: Average of raw data collected in the Canastra River Basin

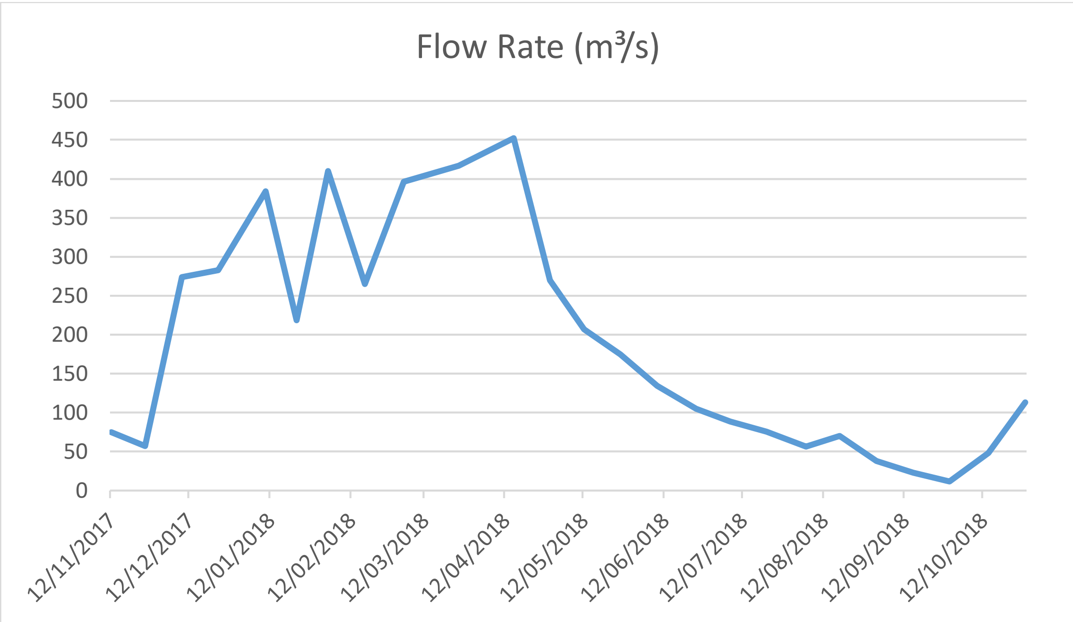
Collections	Date	Average Depth (cm)	Float Average Time	Collections	Date	Average Depth (cm)	Float Average Time
1	12/11/2017	40,3	17,39	14	26/05/2018	37,3	16,06
2	25/11/2017	34,0	22,77	15	09/06/2018	32,8	18,35
3	09/12/2017	45,6	12,50	16	24/06/2018	31	22,11
4	23/12/2017	48,1	12,78	17	07/07/2018	28,8	24,37
5	10/01/2018	56,3	11,00	18	21/07/2018	27,4	27,28
6	22/01/2018	43,5	14,94	19	05/08/2018	25,5	33,91
7	03/02/2018	59,0	10,81	20	18/08/2018	28,1	30,03
8	17/02/2018	46,3	13,11	21	01/09/2018	25,1	49,38
9	04/03/2018	54,7	10,37	22	15/09/2018	22,2	72,74
10	25/03/2018	59,4	10,70	23	29/09/2018	9,8	63,26
11	15/04/2018	56,8	09,43	24	14/10/2018	28,1	43,58
12	29/04/2018	45,4	12,62	25	28/10/2018	31,7	20,99
13	12/05/2018	40,7	14,77				

Source: Authors, 2021.

The collection data were tabulated and from them the flow calculation was performed. The results of the Flow of the River Canastra were presented through a hydrograph (figure 3). For Righetto (1998), aspects such as the drainage area, degree of permeability, depth of the water table, soil porosity and type of precipitation that occurred over the basin are determining factors in a hydrograph. The hydrograph consists of the graphical representation of the flow distribution in a watercourse unit in relation to time. Therefore, this distribution characterizes the drainage area of the basin caused by the rain that affects this location.

The results obtained showed that in the wettest months the flow rate reached a relative average of 200 m³/s, with a maximum flow rate of 450 m³/s. In the dry months, especially in October 2018, the flow reached a minimum of 4.1 m³/s. The results showed two distinct dynamics: flow increase during the rainy season, as a function of surface and subsurface runoff; and decrease in the dry period. According to Gontijo (2007), this flux and frequency variation are related to each hydrographic basin, considering the formation of the surface and its distribution may vary according to the occurrence or not of precipitation.

Figure 3: Flow evolution over the analyzed time period



Source: Authors, 2021.

In the area analyzed, the dry period between April and October 2018 caused a considerable decrease in water volume. This occurrence puts the availability of water at risk, in a considerable part of the year, both for the supply of water to the urban area of Itapuranga, as well as for agricultural irrigation. Thus, as pointed out by Simedo et al. (2015), monitoring the flow of a watercourse is extremely important and indispensable for quantifying the volume of water in a given hydrographic basin, as a form of planning and management, with a view to the rational use of water resources.

It follows that there has never been so much concern related to public water supply in Brazil, as in recent decades. Nowadays, it is noticed more and more the worsening of water scarcity, year after year, in several regions. Large cities have been the most disadvantaged in relation to the decrease in water availability in periods of drought, and some have adopted measures to ration this resource, as occurred in the low of reservoirs in São Paulo from 2014 to 2015, a result of a combination of low levels. rainfall and the lack of planning for water resources in view of the high demand seen in the city (ANA, 2016).

Marengo et al. (2015, p. 34), corroborates this finding by stating that,

> [m]any are the speculations about the causes of this historic drought: natural climate variation, deforestation in the Amazon, global climate change, among others. In general, it can be said that the water crisis is generated by a combination of factors that include the lack of management of water resources and the scarcity of rain, as observed in 2001 and now in the summers of 2013-2014 and 2014-2015.

While there is an increasing demand for water, urban growth corroborates the pressure on water courses, both in the capture of water for supply, as well as with the contamination of urban springs. In the case of the Canastra River, this urban supply is directed to domestic, commercial, industrial use, among others. As it is a river that cuts through part of the urban area, the environmental impacts caused by human action have generated uncertainties about water security at the local level, as shown in the 2019 Annual Report on the Quality of Water Distributed by the Rio Canastra system, developed by the company responsible for water supply in the state of Goiás - SANEAMENTO DE GOIÁS (SANEAGO). The same report also points out problems related to agricultural practices, which have caused “the pollution and degradation of the water source” (SANEAGO, 2019, p. 1).

The need to guarantee water availability in its various functions is a relevant topic in current discussions, given that the Brazilian population in different regions has felt the effects of adverse climatic phenomena. There are countless municipalities that have suffered from extreme shortages of supply during the dry season, while others face the problem of severe flooding, thus portraying when Brazil faces water insecurity in all its complexity.

About water security, Ribeiro (2017, p. 172) mentions that “[on]the vertical axis of security (internal water security plan), saving water resources in the field includes water use management technologies and political actions, such as reforestation and rigorous inspection of permits for use and deforestation”. Thus, the need for regional, national and international planning and management involvement is noticeable, when it comes to the insecurity experienced in all aspects of public supply and water security.

In the municipality of Itapuranga, according to SANEAGO (2019), the Canastra River is measured at different points every year, especially during critical periods of drought, as a way to guide planning and management strategies for the hydrographic basin. The company participates in the “Be Nature” project of the Public Ministry of Goiás, which consists in the recovery of degraded water sources, and works in partnership with the city hall by planting seedlings in the springs.

It is known that with the significant increase in demand for water, there is also a great waste of this resource in the pipes until it reaches the final consumer. In Brazil, in 2016, losses in the distribution of public water were 38% (TRATA BRASIL, 2018). Not only does the use of water lead to significant waste, but the handling of the product is responsible for bringing significant losses.

Furthermore, the importance of hydrographic basins and their socioeconomic role is indisputable, given that they provide water flow to replenish rivers. Therefore, it becomes necessary to discuss the environmental impacts that influence all kinds of natural resources. Therefore, it is essential to carry out studies aimed at hydrographic basins, reflecting on the enormous demand for water resources exploited by human activities.

The organization and planning of the territory put the ecological functioning of the hydrographic basin at risk. Factors such as urban expansion, disorderly use of land for agricultural activities, disordered deforestation, among others, have increasingly put pressure on water sources. Within these environmental impacts related to hydrographic basins, it is increasingly necessary to discuss sustainable ways that enable economic growth without further attacking drinking water sources, since the quality and availability of water resources affect different socioeconomic sectors. Therefore, political discussions, social education and planning for the preservation of water resources become extremely important because there are major problems in different parts of the world, in which each region needs to commit to preserving its water resources (ARAUJO et al. 2009).

Thus, it is also necessary to think about the levels of soil cover, erosion caused during the rainy season, the indispensable recovery of riparian forests, the control of pollution in water sources, among other factors that put water stability at risk. Thus, new planning actions are needed to really develop and generate results in the short, medium and long term, which reconcile economic development with the effective management of water resources.

4 CONSIDERATIONS

From the work carried out, the importance of the Canastra River for the municipality of Itapuranga is highlighted, given that it is responsible for supplying the city, but also for meeting the demands of industries, agriculture, ranchers, etc. This factor corroborates the reaffirmation of the importance that limnological analyzes have in aiding the management of water resources, since knowing the flow levels of certain water courses, at different times of the year, enables the management and control of the catchment capacity of water. Furthermore, the use of techniques considered simple and cheap, such as the one used in this study, emerge as possibilities of management practice that are within the reach of managers, especially in small municipalities in the country.

In view of the data collected about the flow, it is considered of great importance to evaluate measures related to the use of water for the management of hydrographic basins, especially in periods of drought. Thus, this study may serve as a subsidy for works that wish to assess the importance of management and planning of hydrographic basins, as well as associating land use and the conditions of native vegetation cover with silting processes. It is also highlighted the importance of monitoring the government in the implementation of projects as alternatives to degradation, with a view to preserving water sources and recovering hydrographic basins, always evaluating water as a public good and as an essential source for the full development of the society.

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