

Management of Water Resources in the Semiarid Region of Rio Grande do Norte: a case study on the municipality of Lucrécia

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SUMMARY

This research aimed to identify water resources management strategies in extreme drought event scenarios in the municipality of Lucrécia, in the state of Rio Grande do Norte (RN), in the period 2012 to 2018. As a methodological procedure, a bibliographical and documentary, in addition to field research, with interviews with municipal managers and residents. A photographic record of the study area was also carried out. It was found that, in the city, there is a folder dedicated to water resources that guides water management and is the basis for the adoption of measures aimed at municipal supply in times of difficult access to water, due to the reduction in water availability. It was observed that part of the interviewed population understands the drought as responsible for the difficulties faced in the city, mainly about the reduction of the water level in the reservoir. It was found that, of the 52 towns belonging to the hydrographic basin of the Apodi-Mossoró river, only 10 participate in the meetings of the basin committee, the municipality of Lucrécia does not have representatives on the Committee. This finding deserves special consideration since water and the administration of its multiple applications are generators of conflicts, it highlights the importance of understanding how municipalities in the Semiarid region carry out the management of water resources and how they understand the challenges of coexistence with its area, aiming at the sustainable use of water.

KEYWORDS: Management. Water resources. Semiarid.

1 INTRODUCTION

Water is an essential resource for life and can be considered one of the most precious goods of the millennium. However, the availability of this resource to supply human needs and activities has become increasingly scarce, especially in regions where the climatic condition is characterized by low rainfall and high temperatures, as is the case in the Brazilian semiarid region. In addition to natural conditions, there are problems related to waste, contamination, and lack of management, intensifying the process of water scarcity and rationing, on this finding Viegas (2012) mentions that the main factor in the water crisis is environmental pollution.

In that sense, it is necessary to think about planning strategies, integrated management, and appropriate social technologies to adapt to water scarcity in the semiarid region of Brazil. The city of Lucrécia, located in the semiarid region of the state of Rio Grande do Norte, was created due to the construction of a large water tank in 1963.

The availability of water from this reservoir for a long time gave the feeling of guaranteeing a water resource for the local population. However, with the prolonged drought period from 2012 to 2017, the container dried up, causing the inhabitants of the municipality to experience a hydrological collapse, as well as the other surrounding municipalities that are supplied by the reservoir. From this incident onwards, a series of emergency measures were initiated by the government, since it was not expected that the population would experience this extreme drought event.

The reservoir was at less than 2% of its maximum capacity, with a volume of 1,310m³ measured in March 2017, according to the Daily Hydrometeorological Monitoring Bulletin No. 051/2017, developed from a partnership between the State Secretariat the Environment and Water Resources of Rio Grande do Norte (SEMARH), the Rio Grande do Norte Water Management Institute (IGARN), the State Coordination for Civil Defense and Protection (CEPDEC) and the Agricultural Research Company of Rio Grande do Norte State (EMPARN), according to (ESTADO.,2017).

Authors such as Setti *et. al.* (2001) define water supplies administration as to how it is intended to equate and solve the scarcity issues related to water resources, as well as to make adequate use, aiming at the optimization of resources for the benefit of society. Thus, environmental awareness and proper resource control must accompany society's development. The authors also state that the

conditions for accessing water reserves occur through good management and an adequate political process.

Based on this concept, we sought to understand how the administration of water reserves in the municipality of Lucrécia (RN) has been carried out, to raise the actions of the local government to face prolonged periods of water shortage. According to Sousa Filho (2011), the semiarid climate, predominant in the state of Rio Grande do Norte, has its history based on severe drought events resulting from climate variability and water scarcity, becoming indelible marks of the semiarid region.

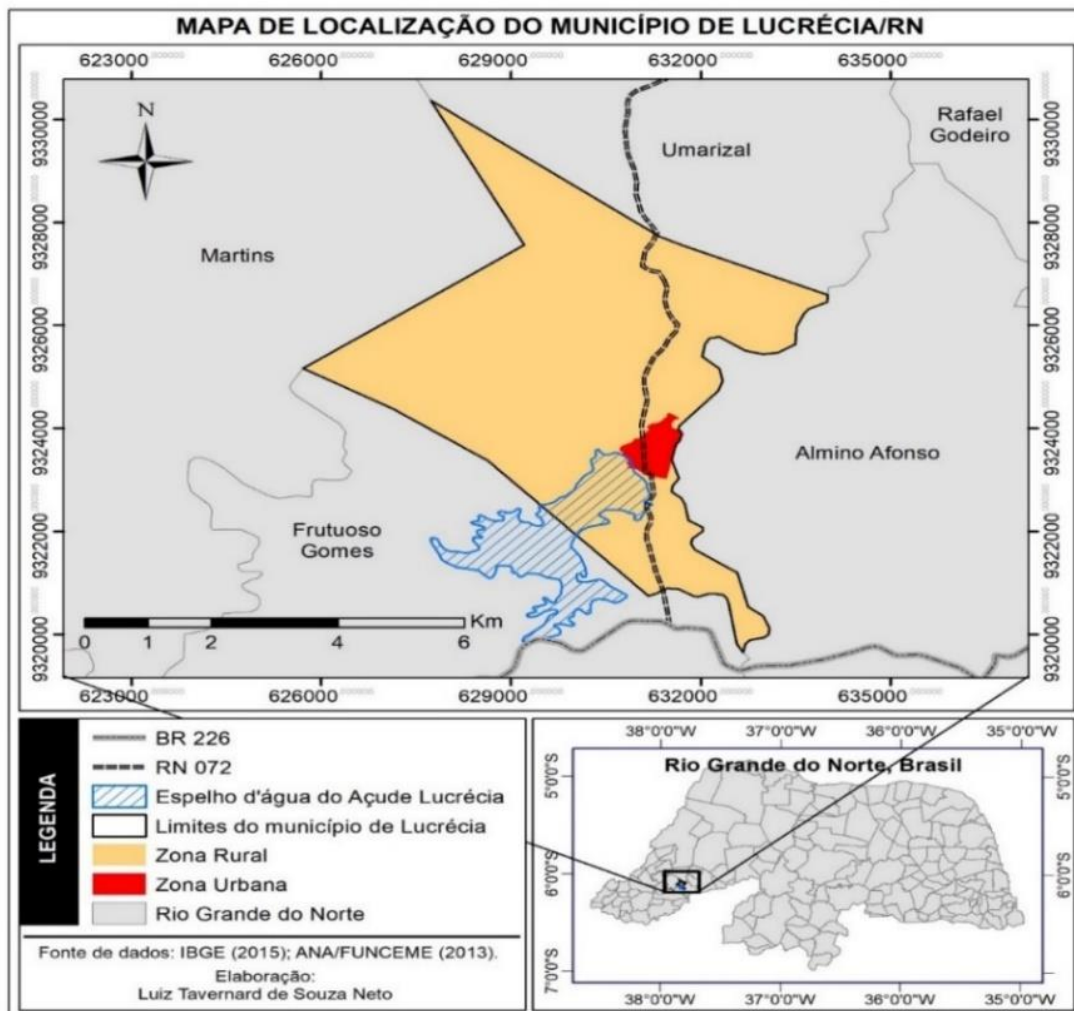
Based on the importance of this reflection, this paper aims to identify water resources management strategies in extreme drought event scenarios in the municipality of Lucrécia (RN), from 2012 to 2018, based on the perception of surrounding residents reservoir, about drought and water resources management.

2 METHODOLOGY

The research was conducted in the municipality of Lucrécia, state of Rio Grande do Norte, according to the Sustainable Development and Environment Institute – IDEMA (2008), the municipality area covers 30.94 km², representing 0.06% of the state surface. Lucrécia is in the Geographical coordinates: latitude: 6° 07' 12" South, longitude: 37° 48' 56" West, Figure 1. The distance concerning the state capital, Natal is 348 km and has limits: north (with the municipalities of Umarizal and Martins), to the south (with Frutuoso Gomes), east (with Almino Afonso), and the west (with the municipalities of Martins and Frutuoso Gomes).

Concerning the socioeconomic characteristics of the municipality, according to the Brazilian Institute of Geography and Statistics (IBGE, 2015), the total population of Lucretia is 3,966 people, the demographic density of 117.45 inhabitants/m², with GDP per capita of R\$ 8,867.77 (eight thousand, eight hundred and sixty-seven reais and seventy-seven cents), in comparison with other municipalities in the state, its position was 84th out of a total of 167 municipalities. It should be noted that 97.3% of its budget comes from external sources and Lucrécia's Municipal Human Development Index (IDHM) is 0.646.

Figure 1: Political map: location of the municipality of Lucrécia (RN), 2019.



Source: IBGE, 2015.

The region has a tropical rainy climate with a dry summer. The rainy season occurs between February and May. The annual average temperatures are 36.0°C maximum, 28.1°C average, and 21.0°C minimum, while the average annual relative humidity is 66% and the hours of insolation are 2,700. The predominant soil is red and yellow argisol. With a restricted agricultural aptitude for yields and suitable for long cycle crops such as arboreal cotton, sisal, cashew, and coconut. A small area is indicated for the preservation of flora and fauna or recreation (IDEMA, 2008).

The municipality of Lucrécia is fully inserted in the Hydrographic Basin of the Apodi-Mossoró River, and its territory contains the main reservoir, better known as the Lucrécia Dam. The municipality's hydrology is represented by the Aluvião Aquifer, which is dispersed, consisting of sediments deposited in the beds and terraces of larger rivers and streams.

Search Typology

The methodological procedures of the research were based on bibliographical and documental investigation and a case study of the municipality of Lucrécia (RN). The bibliographical and

documentary research was developed in digital databases, in which we searched for: dissertations, theses, and scientific articles on the theme of water resources and their management. In terms of documents, pertinent law was analyzed, at the federal and state level, as well as seeking to know the legislation and instruments for the management of water resources in the municipality.

The target audience of this research was the community around the reservoir and public servants in the municipality. It is noteworthy that the research was conducted within ethical standards and in its execution, the Informed Consent Term (TCLE) and the Audio Recording Authorization Term (TAGA) were used. For the interviews, cell phone recording was used.

The interviews were carried out with 03 (three) municipal civil servants, responsible for the departments of Agriculture, Fisheries and Water Resources, Finance and Budgets, and Urbanism and Environment; 05 (five) residents of the municipality living in the vicinity of the reservoir were also examined.

The following criteria for choosing residents were adopted: (i) living close to the reservoir; (ii) residing in the place for more than ten years; being over 30 years old. Finally, to complement the understanding of the management of water resources in the municipality studied, an interview was carried out with the president of the Hydrographic Basin Committee of the Apodi-Mossoró River.

On-site observations and photographic documents were also carried out during data collection, the images recorded were used to compare the surface reservoir in the present period and past tense, to observe the records of its capacity at the registered levels.

The data were cataloged and organized into three thematic axes, which deal with: (i) analysis of water resources management, from the perspective of the municipal government; (ii) the perception of residents concerning drought and the management of water resources, and (iii) the vision of the Apodi-Mossoró Basin Committee with municipal participation and conflict management.

3 RESULTS AND DISCUSSION

3.1 Analysis of water resources management from the perspective of municipal government

From the interviews carried out with the local managers, it was possible to verify that the municipality has a folder dedicated to the management of water resources and is associated with the Department of Agriculture, Water Resources, and Fisheries, but also receives attention from the Department of Urbanism and Environment.

The choice of the person responsible for this Department is not carried out employing a public tender and is not considered the area of formation of the person responsible. According to Interviewee 1 (2019), in his choice, it was observed: "the vast experience, considering his experience with the countryside and agriculture, which are also related to the conscious use of water bodies." It does not need academic training related to environmental management, with the level of education of the secretary of Agriculture, Water Resources and Fisheries, high school and the secretary of Urbanism and Environment, higher level, with training in pedagogy. When asked whether public examinations are held in the municipality to train specialized professionals, respondent 1 mentioned that:

Tenders have not yet been held; however, the municipality has a municipal council for the environment that also involves agendas related to water resources, made up of various professionals (RESPONDENT 1, 2019).

By what was previously reported, respondent 2 (2019) stated that "about the indication of professionals, this obeys the criteria of affinity with the area, since, in the composition of municipal managers, there are no qualified people, specifically, in the area in question."

The Municipality of Lucrecia, in partnership with bodies such as the Technical Assistance and Extension Company of Rio Grande do Norte - EMATER, the Brazilian Micro and Small Business Support Service – SEBRAE and the National Service for Industrial Learning, among others, carry out courses and training for municipal employees. According to Interviewee 2, the courses are focused on topics such as land use, water reuse, water damming, waste management, and depository, among others. Likewise, according to Interviewee 1, forums, meetings, and lectures with environmental themes are held with the population.

Interviewee 3 reported the holding of conferences and specified the preparation of the II Conference on the Environment, which covers all schools in the municipal education network. In addition, leafleting and visits to homes with conversations with residents about environmental awareness.

According to Interviewee 1, the municipality does not have specific legislation for water resources as the state of Rio Grande do Norte is responsible for the management, however, Interviewee 2 informed the elaboration of the Municipal Basic Sanitation Plan. According to Interviewee 3, the relevant legislation is being drafted.

As strategies for the municipality, which has also been hit by dry weather in recent years, Respondent 1 stated that methodologies were used for agriculture as well as a pipeline, the drilling of underground wells, the distribution of drinking water through the operation of a kite and other systems. Water storage, etc. Such methods of coping with drought are seen as preparation against other drought events, but there is no specific program.

The drilling of wells can be considered a negative factor for the management of water resources in semi-arid areas, since indiscriminate drilling and without proper monitoring and monitoring by the Rio Grande do Norte State Sewage Company (CAERN) can contribute to putting groundwater reserves at risk, which would further aggravate the situation of water availability.

Interviewee 2 informed that the municipality was badly hit by the drought and presented the strategies adopted by the municipal government:

The municipality's actions were aimed at partnering with the federal government for the supply of water trucks to supply the city in rural areas and the acquisition of silage machinery and availability of tractors and machines for farmers to manage to keep their herds, with planting and storage of grass from other types of animal forage. (RESPONDENT 2, 2019).

Interviewee 3 discussed the existence of income transfer projects and the guarantee for local farmers during times of drought, Safra's Insurance, for example, offers small farmers financial resources to minimize the damage and losses caused by droughts, he also mentioned the creation of

small dams to accumulate water during the rainy season, as a social technology to minimize the problems caused by prolonged droughts.

On such municipal actions, Ferreira and Figueiredo (2016) add: we want to emphasize that mitigation measures and programs with welfare characteristics are extremely important, for example, the supply of drinking water through water trucks and the opening of wells to meet basic water needs.

The rationing of water use, whether from the reservoir itself or wells, is a reality in terms of water distribution to the population and other uses, such as irrigation. As for the measures adopted, when the decrease in water availability in the reservoir became noticeable, Respondent 1 (2019) cited the increase in water rationing, decreasing availability for the population as well as the opening of wells, etc. In agreement with the informed.

Interviewee 2 stated that there was a ban on irrigation with the use of water from the dam. In agreement with what was informed by the other secretaries, Interviewee 3 informed that he was instructed to those responsible for running water to start releasing water for a shorter period. And although determined by SEMARH, the body responsible for overseeing the reservoir, through the Daily Bulletin^o 051/2015, only 1.48% of the total volume of the reservoir, the water remaining in the reservoir was still being used, with limitations on the amount of use, for animal pasture (ESTADO..., 2015). He added that the water from the reservoir was not used when the volume of less than 2% reservoir was determined.

Regarding the difficulties faced during the period of reservoir shortage, it was observed:

Many were the difficulties encountered; however, we can highlight some such as the issue of fishing that was extinguished due to the dam drying up, reducing the income generated in the municipality; as well as the difficulty in maintaining herds and plantations; among other issues. (RESPONDENT 1, 2019).

In addition to the difficulty with the death of animals and difficulty in maintaining the plantations, Interviewee 3 mentioned the difficulty in supplying families, especially from the farms. Ferreira and Figueiredo (2016) portray that Drought is the central element of the climatic and symbolic heritage of the Northeast that affects economic activities and the daily lives of communities. Unable to carry out fishing activities for subsistence, the municipality's income drops considerably. Likewise, for Interviewee 2, during the reservoir shortage, there was a lack of fish to feed the population, however, the consumption and supply of the population were facilitated due to the arrival of the Alto Oeste Water Supply, which brings water from the Apodi Dam that it still supplies the city today, through CAERN.

With the increase in the water volume of the reservoir and with plans, to cope with droughts, the maintenance, and expansion of technologies aimed at living with droughts have been carried out, such as, for example, barriers, cisterns, and weirs in the municipality to maintain the storage of water, from rainfall volumes. And, according to Interviewee 2, "CAERN implemented hydrometers to measure consumption in almost all water branches, aiming at better use of water, guaranteeing a supply for longer periods and droughts." (RESPONDENT 2, 2019). Interviewee 3 mentions processes for improving the infrastructure of the reservoir as well as the inspection of water use. He highlighted.

Our reservoir was presented with a major renovation aimed at strengthening the walls of the weir. An inspection for the non-pollution of water is being carried out. We are digging wells that allow the accumulation of water to cope with possible future droughts. (RESPONDENT 3, 2019).

Regarding the inspection process for the use of the weir, according to Interviewee 1, it was verified that it is the responsibility of IGARN and SEMARH for having a capacity of more than five million cubic meters and, regarding the weir as one of the tourist spots in Lucrécia, no use or access control is adopted. However, Interviewee 2 informed that the use of water for irrigation made by farmers with land on the banks of the weir is monitored due to the use of herbicides and chemical fertilizers.

3.2 The perception of residents regarding the management of water resources

According to the information collected through the interviews, it is possible to mention elements related to the perception of Lucrécia's residents. Thus, part of the population living in the surroundings of the reservoir understands that the drought faced by their municipality and region is responsible for numerous troubles experienced, such as the low rainfall, consequently, the difficulty of recharging the reservoirs (figure 2), the water amount of the repository is greatly reduced, and this is due to that.

Following Malvezzi (2007), the volume of rain that precipitates is less than the volume of water that evaporates, reaching up to 3,000 mm/year, making it three times greater than the precipitation. They also understand, given these difficulties, the growing need to conserve water resources, either through the rational use of water as well as in the disposal of waste, also avoiding other types of pollution that exist in the cradle of water, such as that mentioned recurrently, mainly, the creation of animals, plantations and the use of pesticides.

In this sense, succeeding is important to emphasize the importance of raising awareness among the local population regarding the proper usage of water to avoid predatory use. In Figure 5 it is possible to observe the creation of goats and, along the reservoir, other animals such as cows and horses could be studied.

Regarding the types of human actions with polluting potential mentioned by the interviewees, Pereira (2004) states that the pollution of water systems is a problem for the whole society and warns that if the community intends to have potable water that can be consumed in the future, it must, most importantly, review its activities, whether domestic, commercial or industrial, as they all have implications that directly or indirectly end up degrading the available water sources.

Figure 3 - Lucrécia Dam (RN), 2015.



Source: Lucídio Ferreira, 2015.

Figure 4 - Goats reared within the weir area, Lucrécia (RN), 2019.



Source: Research Archive, 2019.

During the interview, respondent 4 dealt with an important and even recurring theme in arid and semi-arid regions, the exodus to other cities, which is generally due to better financial and working conditions, but also places with more access to the water and, as many consider a more dignified life. He declared that if there is no longer water, the city will become a desert due to the exodus of the population and asked a question: "Who will stay here dying of thirst? Nobody" (RESPONDENT 4, 2019).

According to Ferreira and Figueiredo (2016), in the history of the region, the drama of migrants is well known, that is, the flight of populations plagued by dry weather. However, there has been no record of any alarming situation regarding the drought that has lasted since 2012.

In this way, it becomes clear that the struggle to coexist with the semi-arid and the drought does not only affect the physical conditions of the environment but also politically and especially socio-environmental ones. Thus, the main challenge faced in the Semiarid region concerning water is available for human and animal consumption and agricultural production, as perhaps it is not the lack of rain, but an integrated and shared management with different users of water resources. Since the drought situation is associated not only with irregular rainfall and a high rate of evapotranspiration but also with poor water distribution.

For this reason, it is important to achieve sustainable development, based on economic growth, but not excluding the need for environmental and social growth. It is noteworthy that governance, in this case, becomes important because the population needs to have a feeling of responsibility and participation in the management and care of natural supplies, precisely with water resources.

Therefore, it is increasingly necessary that the population's awareness grows so that, as in the past, the repository waters become their own and available for consumption and fishing for the population, for leisure, as a tourist attraction for the exuberant landscape of the reservoir and saws among many other uses.

3.3 The view of the Apodi-Mossoró River's Basin Committee

Considering the reality that most municipalities do not have legislation, the president of the Apodi-Mossoró River's Basin Committee emphasized an important factor: "normally, municipalities do not have legislation, structure, and employees for water management." (RESPONDENT 9, 2019). If this reality were changed, it would pave the way for complete management, in all spheres and which, consequently, would present significant results in the management of water resources.

All municipalities included in the territory of the Apodi-Mossoró River Basin should participate in the meetings that concern their water resources. Regarding the representatives that make up the Apodi-Mossoró River Hydrographic Basin Committee, only 10 of the 52 municipalities that make up the basin are part of this representation. According to Interviewee 9 (2019), the municipality of Lucrécia is not among the components of the CBH in this administration, and since the beginning of the current administration, which began in 2018, there has still been no contact from the municipality about its participation.

Regarding the possibility of public and society participation in CBH meetings to discuss the uses of resources, the president of the Basin Committee informed that 4 ordinary meetings are held per year and all information is disclosed electronically, either by e-mail or WhatsApp group, directed to full and alternate members and their respective bodies.

The respondent also highlighted the importance of social participation in decision-making processes regarding the use and conservation of resources:

The importance is absolute, as it is necessary to be aware that water is a common good with multiple uses, consequently, a generator of conflicts. These conflicts are best resolved within the scope of river basins and their respective committees. Everyone must be involved in the rational use of water. It is also important for society to demand the conservation of springs that are generally polluted by domestic and industrial effluents. (RESPONDENT 9, 2019)

The conflicts mentioned concern the fact that in the basin there are several types of economic activities, being developed and that directly affect the quantity and quality of water resources. Water, due to its ability to guarantee multiple uses, being subject to poor management, can be considered a generator of conflicts. In this regard, Amorim, Ribeiro, and Braga (2016) state that water scarcity, as well as inadequate management, are the main reasons for conflicts to occur.

The Apodi Mossoró River Basin Committee - CBHRAM participates in the management of water resources with recommendations and in the quest to minimize conflicts when called upon, due to not having a structure of human and financial resources available to monitor the management processes of all 52 municipalities belonging to the basin. However, questionnaires are being organized to be applied in such municipalities to assess the situation of water resources in the municipalities (RESPONDENT 9, 2019).

Also in this conflict management bias, noting the main conflict that is the decrease in the water supply at the time of drought, the case of the Pau dos Ferro's weir was mentioned, which dried up and generated several supply problems for the city, but it was softened due to the main dams (Santa Cruz and Umari) remaining with the water volume that allowed certain security of supply. Even so, many

cities had their water supply carried out by water trucks for several months, as is the case in the municipality of Lucrécia (RESPONDENT 9, 2019).

Regarding the encouragement of environmental awareness about the importance of water resources and bringing more information about the Apodi-Mossoró River Hydrographic Basin, Respondent 9 (2019) reported that an educational video and a map were being developed to be used in schools of 52 member municipalities and, in addition, there is participation in events, visits, lectures and courses to raise the population's awareness about the importance of water preservation.

According to the result of the opinion poll of the members of the Apodi Mossoró River Basin Committee - CBHRAM carried out by Santos (2017), one of the most recurrent problems mentioned was the pollution/degradation of the basin, resulting from the number of potentially polluting activities which are carried out within the limits of the basin, such as agriculture, oil activities, among others and also as a result of urbanization without adequate planning where, consequently, there is no proper disposal of waste, with the release of domestic sewage, among others anthropic activities.

It is important to emphasize that the technical team that makes up the CBHRAM has the experience and technical knowledge that guarantee the quality of the organ and its ability to work, despite the difficulties faced. And, greater engagement of the government and society, will enable better resolutions about water management, seeking to resolve the challenges that arise.

4 FINAL CONSIDERATIONS

Because of the research being carried out in the municipality of Lucrécia (RN), it is possible to affirm that the local government does not have municipal legislation focused solely on the management of water resources. State legislation and the National Water Resources Policy are used as guidelines for management activities, concluding that the local government does not have an emergency policy for times of extreme drought.

In the studied municipality, there is a folder dedicated to water resources linked to the Department of Agriculture, Fisheries, and Water Resources, but it is not managed by a professional trained in the environmental area, but life experience was taken into account to the specialized in the area.

During the time of reduction of water availability in the reservoir, it was found that emergency measures were adopted, such as the supply of drinking water by water trucks, water rationing, drilling of new wells, among others.

Regarding municipal participation in the meetings and discussions held by the Apodi-Mossoró Hydrographic Basin Committee, based on the information collected from the committee's president, this was considered negative, which is noteworthy, since water management generates conflicts due to the multiple capacities of water uses. This participation supports the improvement in decision-making and management as well as the conservation of water resources, considering the recurrent citations of environmental problems faced in the municipality obtained from the research, such as the inadequate disposal of waste and domestic sewage, the use of pesticides in plantations in the reservoir bed, among other anthropogenic actions that put the quality of water resources at risk.

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