

## Participative management of water resources under conditions of water scarcity in a semiarid region

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### Abstract

The adoption of the river basin as an unit of planning and management inserts, in a model of participative management of water resources, the River Basins Committees (RBC) as public spaces of consultative and deliberative nature making it increasingly necessary to develop this management model and to adapt it to regional realities. The studied RBC is located in a semiarid region, where the scarce water conditions are subject to periods of up to 5 years with rainfall amounts below normal. Thus, this study aimed to research the guidelines and decisions taken by the Curu River Basin Committee between the years 2009 and 2015. The guidelines and decisions were analyzed by an analytical matrix that lists them by typologies in order to assess their demands. This study produced subsidies for understanding the reality of the RBC actions, showing that is important to applied adaptations for RBC in semiarid regions due the constant drought.

**Keywords:** Participative management; Semiarid; Water resources

### Resumo

A adoção da bacia hidrográfica como unidade de planejamento e gestão insere, em um modelo de gestão participativa dos recursos hídricos, os Comitês de Bacias Hidrográficas-CBH, como espaços públicos de caráter consultivo e deliberativo necessário cada vez mais desenvolver esse modelo de gestão e adaptando-o às realidades regionais. O CBH estudado se insere em uma região semiárida, onde as condições hídricas escassas estão sujeitas a períodos de até 5 anos com chuvas abaixo da normal climatológica. Desse modo, o referido trabalho teve como objetivo pesquisar as pautas e decisões tomadas CBH do Rio Curu durante 2009 e 2015. As pautas e decisões foram analisadas por uma matriz analítica que as elencou em tipologias a fim de avaliar as demandas deste. Este estudo produziu subsídios para a compreensão da realidade das ações dos CBH, mostrando que é importante aplicar adaptações para CBHs em regiões semi-áridas, devido à seca constante.

**Palavras-chave:** Gerenciamento participativo; Semiárido; Recursos hídricos

## INTRODUCTION

Historically in Brazil, the policies regarding water in general used to be fragmented and centralized. As a result, the ones that supported general interest emerged, privileging certain sectors, like the case of the Water Code instituted by the Decree-Law n° 24.643, of 10 of July, in 1934 (Barros and Barros, 2009), which had as its main interest to promote the use of water to generate hydroelectric energy, to foster the Brazilian industrialization. (Ahit and Rothbarth, 2015). State policies were created in an attempt to manage the growing social demands, especially in regions where there were problems with water scarcity in Ceará State, floods and pollution São Paulo State (Abers, 2010). It was then that, in the 1980s, a National Water Resources Policy (NWRP), was suggested, but the actual creation of a legislation on the subject only happened in 1997 (Teixeira, 2004), through the law n° 9.433 of January 08, 1997, which established the NWRP, when river basins were adopted as units of planning, and when the committees of river basins were created and regulated as public spaces of consultative and deliberative character aimed to provide a more decentralized, participative and integrated management of water resources (Santos, 2005).

The River Basins Committees (RBC) are fundamental for participative management, since they are made of users, government representatives and civil society. According to the Article 38 of the Law 9.433, it is RBC's job to: I – promote the debate of the questions related to water resources and articulate the performance of the intervening entities; II - arbitrate, in the first administrative instance, the conflicts related to water resources; III – approve the basins' Water Resources Plan; IV – monitor the implementation of the Water Resources Plano of the basin and suggest the necessary measures to achieve its goals; V – propose to the National Council and to the State Councils of Water Resources the accumulations, derivations, abstractions, and launches of little expression, for the purpose of exemption from the obligation to grant rights of use of water resources, according to their domains; VI – establish the mechanisms to charge for the use of water resources and suggest the amounts to be collected; IX – establish criteria and promote the apportionment of cost of the multiple use works, of common or collective interest.

In this way, the actions of the RBC are composed of deliberative, fiscalizing and mediating actions. Thus, the aspiration is that the discussions are a condition for mediation of the conflicts promoting democratic consensus.

However, five years before the Law 9.433 / 97, there was already in the State of Ceará, the State Water Resources Policy (SWRP), which was instituted by Law No. 11,996 of July 24, 1992, provided for in Article 326 of the State Constitution of Ceará. In its Article 48, this Law established the creation of the first State River Basin Committee, the Curu River Basin Committee, object of this study. Since this law is prior to the national law, it was necessary to make adjustments, so on December 28, 2010, there was the promulgation of Law No. 14,844 that provides for the SPWR of Ceará. However, some basin committees that had already been created in the previous law now have a broader approach, and include representatives of river basin committees at the Water Resources Council of Ceará – CONERH, which has normative assignments in SWRP.

The RBC are understood by the current SWRP as consultative and deliberative entities served to the CONERH According to article 46 of Law 14.844, the state RBC's attributions are:

I - to promote the debate of questions related to water resources and to articulate the action with interested entities; II – to propose the elaboration and approval of the Water Resources Plan of the River Basin; III - to arbitrate, in the first administrative instance, conflicts related to water resources; IV - provide support for the preparation of the annual report on the water resources situation of the hydrographic basin; V - monitor the implementation of the river basin water resources plan and suggest how to achieve its goals; VI - propose to the CONERH, the criteria and mechanisms to be used to collect income for the use of water resources, and to suggest the amounts to be collected; VII - establish the criteria for apportionment of costs of works of multiple use, of common or collective interest; VIII - propose to CONERH programs and projects to be executed with funds from FUNERH; IX - to establish specific commissions and technical chambers defining, in the act of creation, its composition, attributions and duration; X - to monitor the application of the resources derived from the collection for the use of water resources; XI - to approve the proposal of framing of water bodies in classes of prevailing use of the river basins.

The RBC attributions arranged in the SWRP are in accordance with the NWRP. It is important to emphasize the importance of the RBC's role in the state in its role of mediating conflicts by water use, planning of the watershed that it represents, conservation of water resources and proposal of strategies for the application of legal instruments for the management of water resources.

However, there are difficulties in the articulation between the municipal entities for the composition of their policies aimed at the river basins, and also in relation to the financial and political independence of the Basin Committees (Barros and Barros, 2009). On the other hand, Rauber and Cruz (2013) state that "The implementation of the River Basin Committees allows the construction of the Water Resources Management Policy at a regional level, creating an opportunity for dialogue about the regional needs and problems related to water" (Page 137). According to Jacobi and Fracalanza (2005), river basin committees reflect the implementation of an integrated and decentralized management model, which presupposes negotiations between different agencies at different levels of government.

In fact, the management of water resources in the Curu River basin is perceived as a good model for the other Ceará Basins, due to the experience gained since the creation of the Committee. Although aware of the constant droughts, since it is a semi-arid region, when they happen, it is difficult for the managing organs to be prepared for eventual conflicts.

To respond to water needs in Ceará, as in the Brazilian Northeast region, public policies were, over time, mainly concentrated in the construction of dams, whose efficiency remains insufficient, mainly in long periods of drought, because they suffer a great loss by evaporation, which, together with the rainfall deficit, end up failing to meet the water demands of the population (Silveira, 2014).

As a result of the fundamental role of water in the various human activities, conflicts can easily arise in situations of scarcity, both in the face of high demand and inadequate management (Pinheiro et al. 2011). The technique of negotiated allocation among users, moderated by the Water Resources Management Company (COGERH), is an efficient strategy, applied as a tool to anticipate and manage drought conflicts (Pinheiro et al. 2011).

Currently (2016) the Curu Basin faces one of the largest droughts in history, causing losses of animals and agricultural areas, and compromising human supply with lack of potable water. In view of this context, this research aimed to rescue and analyze the decisions taken by the Curu River's RBC during the period of normal precipitation (2009) and during water shortages (2010 to 2015) and to assess the demands of this RBC.

## MATERIALS AND METHODS

In order to analyze the Curu River's RBC's participative management, 15 (fifteen) minutes of meetings that occurred between the years of 2009 and 2015 were obtained and the decisions that were taken about the negotiated allocations of water for the operation of the reservoirs of the Vale do Curu were evaluated, which were confronted with the state and national legislation on the State Water Resources Policy (IRP) and the National Water Resources Policy (PNRH), which advocate an integrated, decentralized and participative management.

A matrix model of systematization of the demands was elaborated. It provides a better understanding of the referral of the Committee's demands. The matrix analysis model consists of classifying the problems pointed out in the RBC deliberations according to their "nature" or typologies. These can be classified as: I. Administrative, II. Structural, III. Organization, IV. Management, V. Institutional, VI. Legal and VII. Preservation:

I. Administrative: when there are limitations of logistic, material, financial, personnel, functional performance of the organism or server, causing problems in the action of the SIGERH. As a means of mediation of the problems of this nature, the following typologies of the solutions are considered: personnel enlargement; acquisition of material and / or equipment; training of personnel; financial or material compensation; logistic implementation; appointment of personnel; replacement of personnel; transfer of personnel.

II. Structural: when resulting from the maintenance of infrastructure, construction of water works, correction or complementation of water works and demolition of irregular works. As a form of mediation of the problems of this nature, the following typologies of the solutions are considered:

study; construction or completion of the works; correction or reform of the works; demolition of irregular work; maintenance of the works; project; recovery of the works.

III. Organization: this aspect includes local action or inaction at the tip of the water supply system, such as waste, vandalism, operation of hydraulic equipment, measurement, fair distribution of water, inspection, technical assistance, recovery of degraded areas (protection of springs), among others. As a means of mediation of the problems of this nature, the following typologies of the solutions are considered: water allocation; water control; inspection; water release; water measurement; protection of springs.

IV. Management: when it depends on an administrative act with “police power”, executive action of the authority constituted by the direct administration, such as collection, application of an infraction notice, fine, grant or cancellation of grant, indication of irregular use of water to the public ministry or competent authority, communication, planning (study, registration, evaluation, promotion of workshop, seminar or audience), etc. As a means of mediation of the problems of this nature, the following typologies of the solutions are considered: assessment; concession of use; communication; recognition; moderation; notification for misappropriation of water; notification for misuse of water; pollution notification; planning; punishment of user.

V. Institutional: when characterized by inefficiency of the State or delegated authority, lack of an instrument between institutions, informal or formal understanding between agencies. As a form of mediation of the problems of this nature, the following typologies of the solutions are considered: articulation; authorization; formalization; intermediation; recognition.

VI. Legal: when completely not supported by a law generally stated in the law, however, not regulated by decree or without complementary normative diploma of the ordinance type, resolution, among others. As a means of mediation of the problems of this nature, the following typologies of the solutions are considered: celebration of partnership; legislation; normalization; regulation.

VII. Preservation: it means maintaining the use of water within the standards of environmental preservation, avoiding its degradation. As a means of mediation of the problems of this nature, the following typologies of the solutions are considered: assessment; training; promote denunciation; request embargo; zoning

#### AREA CHARACTERIZATION

The Hydrographic Basin of the Curu River presents itself from a hydroagricultural point of view as one of the most important basins of Ceará, being formed by 25 municipalities and having a drained area of 8,528 km<sup>2</sup>, which comprises about 5.73% of the territory of Ceará. It has a high number of dams, with special emphasis on the public dams General Sampaio (322.2 hm<sup>3</sup>), Pentecoste (395.6 hm<sup>3</sup>) and Caxitoré (202.0 hm<sup>3</sup>) (Santana, 2009). These three reservoirs have the capacity to accumulate 86% of the expected maximum volume when comparing them to the thirteen reservoirs monitored by the Water Resources Management Company (COGERH) in this Basin, which is 1,028.1 hm<sup>3</sup> (Ceará, 2013).

The region of Curu Valley encompasses 15 municipalities, has great economic importance due to its proximity to Fortaleza, and its potential for irrigated agriculture. This was due to large investments in water storage and distribution for the irrigated perimeters of this basin (Kemper, 1997).

## RESULTS AND DISCUSSION

#### CURU RIVER BASIN'S WATER RESOURCES

The basin has suffered with below-average rainfall for four consecutive years (2010-2015) (Figure 2), adding to this the high evaporation rate of the semi-arid region and the growing demand, the stored volumes tend to be scarcer. The management of water resources is of fundamental importance for them to be used efficiently. Thus, the positive balance between the supply and demand of scarce resources (Barth, 1987) is necessary.

In January 2016, the Basin presented only 2.76% of water stored in the reservoirs monitored by COGERH. The General Sampaio dam, Pentecoste dam and Frios dam, which are responsible for supplying the irrigated perimeters, had only 2.16% (6.98 hm<sup>3</sup>), 1.49% (5.36 hm<sup>3</sup>) and 4.42% (1, 46 hm<sup>3</sup>) of stored volume respectively, a critical situation for both the region's population and irrigating farmers.



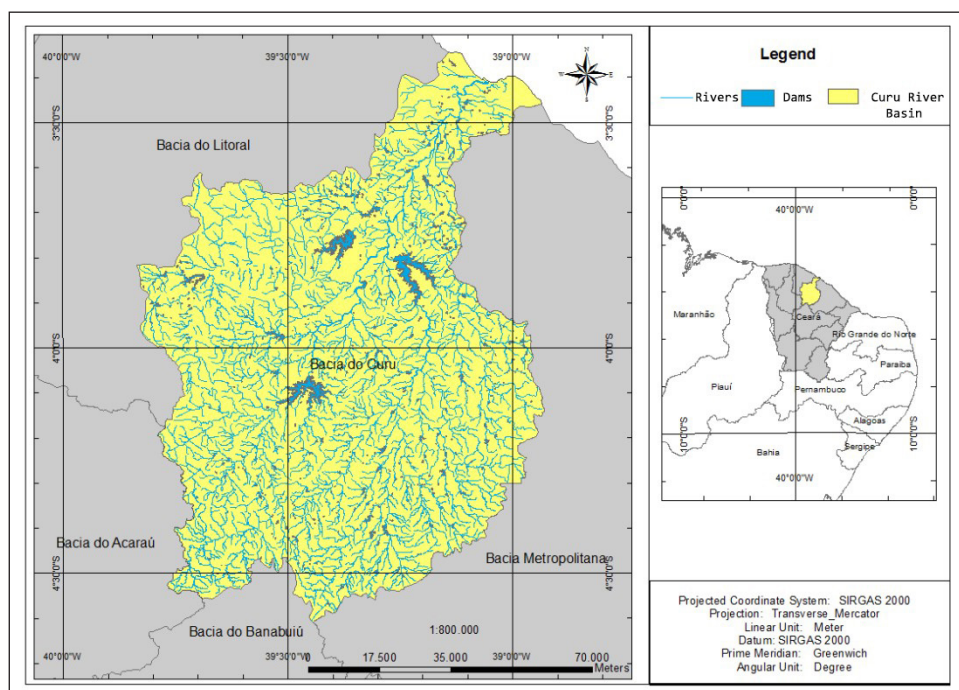


Figure 1 - Location map of the Curu River hydrographic basin, Ceará.

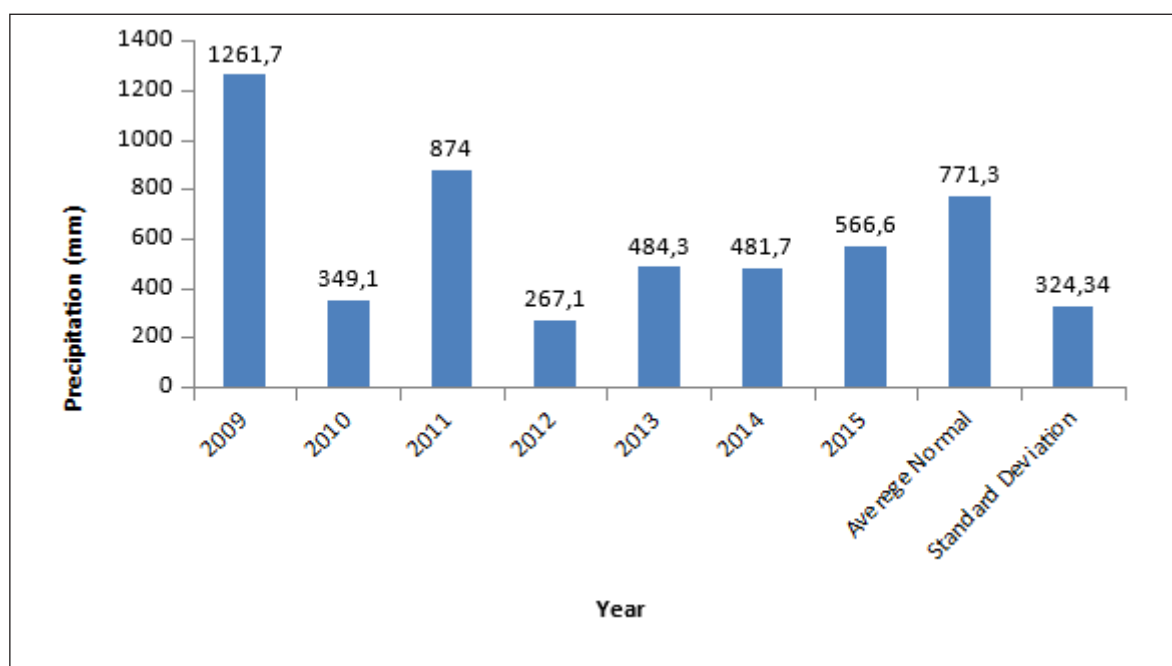


Figure 2 - Average annual rainfall of the Curu Basin (2009-2015)

Figure 3 shows the evolution of the volume stored in the Pentecoste reservoir from 2009 to 2016, this behavior is representative for the other reservoirs in the Basin. From the second half of 2011 the volume stored in the dams of the region decreased dramatically. In the case of the Pentecoste dam, illustrated example, this volume went from 300.86  $\text{hm}^3$  at the end of the rainy season of 2011 to 13.51  $\text{hm}^3$  at the end of the rainy season of 2015, that is, from 83.57% to 3.75%.

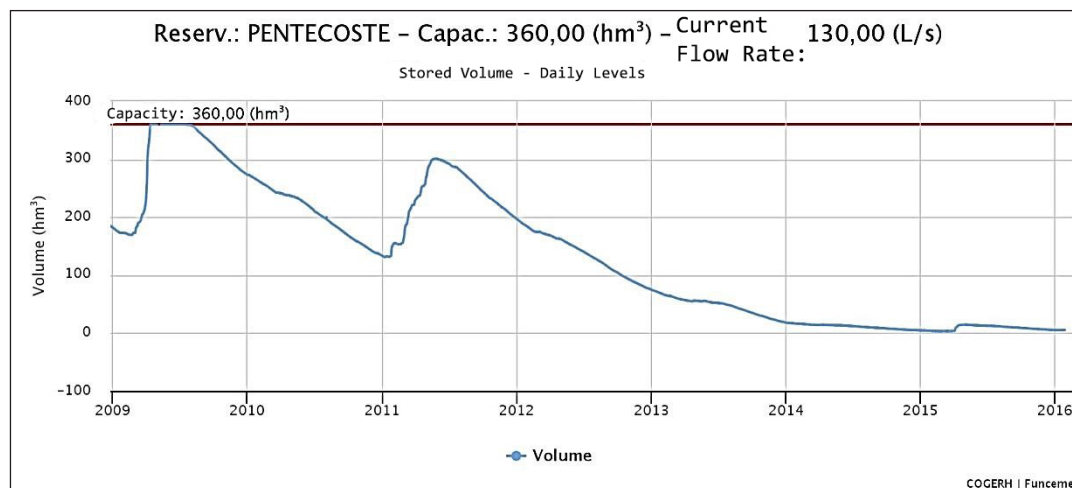


Figure 3 - Evolution of the stored volume of the Pentecoste reservoir, Pentecoste - Ceará.

This fact leads to the condition of further deliberations on the allocation and conservation of water resources. According to (Menezes, 2014) in periods of drought the tendency is to opt for emergency actions that aim to reduce the problem of water scarcity, among them the transposition of water via pipelines to supply human demand.

#### THE CURU RIVER BASIN COMMITTEE, TYPE AND NATURE OF CONFLICTS

The Curu River's RBC is composed of 50 members, according to the percentages established in the legislation, being: 30% made up of civil society entities, 30% water user entities, 20% Municipal Government and 20% State and Federal Government. The members are committed to attend the quarterly ordinary meetings, provided for in the Internal Rules.

Within the National System of Water Resources, it is necessary that the RBC act as an efficient organ in its attributions so that there is effective participative management. For this, collective plans and actions must be executed, involving the participation of all stakeholders, to guarantee the conditions of universal access and multiple use of water, as well as democratic debate (Brasil, 2011).

In the application of the matrix, we have the following diagnosis about the main problems discussed by the Curu River's RBC (Table 1):

In 2009, 50% of the problems identified in the Curu River basin committee meetings were classified as of "management" nature, 25% legal and 25% preservation, while in 2010, 2011 and 2012, 100% of the discussions were about management, since despite the low rainfall in 2010, the reservoirs still had a good supply of stored water.

As of 2013, the discussions were divided into more typologies, with 50% of the problems being classified as management, 33% organization and 17% preservation. In 2014 and 2015, discussions began to emerge about structural problems, such as the demand for more well constructions, water adductors, among others. The problems pointed out for these last years of analysis were 22% and 23% structural, 11% and 8% organization, 33 and 15% management, 11 and 38% institutional, 11 and 8% legal and 11 and 8% of preservation, respectively. These problems can be associated to the decrease in the water supply stored in the dams presented from 2012.

Administrative problems such as lack of material, logistical and personnel conditions were not discussed, in a way that, in the years following the onset of the drought, there was no discussion about this type of conflict.

On the other hand, the discussions about structural conflicts were strongly associated with the water scarcity indicated in Figure 3, and in Figure 1, which places the flows released for allocation, emphasizing the demands for works that would alleviate the water shortage. Thus, in discussions of this typology, there are more discussions about the viability of water works that promote the increase of the water supply in the basin. Another recurrent discussion occurs in the hydrogeological evaluation to enable greater water supply in the crystalline and alluvium through the construction of wells. The deliberations on groundwater abstraction have only been carried out in periods of water scarcity,

characterizing an emergency condition, and without planning of groundwater use, disregarding the integrated use of this resource.

Organizational deliberations that include enforcement actions regarding waste of resources, vandalism and even technical assistance began to be more discussed in 2013. As soon as there were signs of an imminent and more serious water shortage, meeting guidelines mainly point to a greater inspection of water waste, with strategies to combat wasting with environmental education being discussed.

However, discussions on management, which encompasses the concession or recession of grants, in addition to the implementation of water resource planning, were less discussed as water scarcity worsened. This is due to the fact that the main issues in the meeting guidelines were based on the first years of the drought (2009 - 2010), with deliberations to strengthen the composition of the user's board via cadastre. Other actions related to management are in the construction of strategies to reduce the amount of water used in the Curu-Pentecoste Irrigated Perimeter - PICP, to improve the monitoring of the use of water resources, to implement plans and the regularization of uses of the reservoirs for fish farming.

The deliberations about the institutional typology that points to the lack of political articulation and actions among the organs of water resources management systems were more discussed as the water crisis worsened. According to Meier (2014), the composition of the water resources system requires the articulation of several bodies, each with its attributions, responsible for instituting the instruments that are the indicators of water management and management at both national and state levels.

Thus, the demand for political articulation between the entities involved with the water resources in the basin happened to trace systematic changes in the irrigated perimeters, promoting a better conservation of water and other environmental resources, especially with the aim of reducing the demands for irrigation. To promote this, institutional articulation between State Environment Secretary (SEMACE), National Department of Construction Against drought (DNOC's), COGERH and Water Resource Secretary (SRH) is necessary.

The problems of legal typology and preservation were not discussed in 2010, 2011 and 2012 when the situation of scarcity was not serious. In 2009, the deliberations marked the discussion about the restoration of the riparian forests of the Curu River and tributaries, while in relation to the later issues regarding the preservation there were demands for the order of land use in the vicinity of rivers and dams, with worries about surface water quality and mining inspection towards sand removal in the river bed. In the "Legal" typology, what appears to be the main issue is the concern with compensation policies for irrigators, since these are the most affected in the short term by the drought, in addition to the regulation of grant applications in the years of 2014 and 2015 respectively. The granting requests appeared with the creation of alternative irrigation strategies for the use of water in order to promote excavations in the lower river bed, exposing the surface water used for irrigation (Figure 4).



Figure 4 - Excavations in the lower bed of the Curu River (SILVEIRA et al., 2016)



According to Moreira (2010), many countries currently manage water resources with the participation of water users and the society of the river basin in question. However, there is a difficulty in participatory management, not in the “unpreparedness” of society, but in the public institutions themselves, which do not consider social knowledge. Watanabe et al., (2015) points out that RBC decisions and guidelines tend to go through a maturation stage as an institution, initially the guidelines are mostly about quantity and quality of water, after which more complex issues are discussed.

#### WATER ALLOCATION

According to Federal Law 9.433 of 1997, which establishes the NWRP, the priority use of water resources in a situation of scarcity is the human consumption and the watering of animals. In accordance with Federal Law, the State Law No. 14,844 of 2010, which refers to EWRP of Ceará, reproduces this information adding the competence of other uses, leaving the managing body responsible for defining other uses, after hearing the respective River Basin Committee.

The process of water allocation is a political process that occurs through the negotiation of the annual rule of operation of the reservoirs. This type of model presupposes: i) the identification of interest groups; li) identification of potential exchanges and negotiation strategies; lii) popular participation; Iv) the establishment of alternatives that allow approximations towards the resolution of conflicts; V) the identification of individual and group preferences; Vi) analysis of behavior, voting and other concepts of political sciences (Ceará, 2010).

Given the rainfall regime in Ceará, where precipitation is concentrated between February and May, allocation meetings usually take place shortly after the rainy season, between June and July of each year, and the allocation is defined until January of the following year. However, in case of scarcity and uncertainty of precipitation, meetings may occur in other periods (Lima and Sales, 2015).

In order to approve the flows to be made available, a survey is made of the necessary parameters for the allocation, such as knowledge of the demand, initial reserves compared to previous years, priority use, among others, after this survey, COGERH studies simulations are carried out, which presents ideal scenarios to the Basin Committees for consideration. The RBC may approve or adjust the proposal. If the RBC proposal is within a technical and legally acceptable range within the scope of the Integrated Resource Management System (SIGERH), the proposal with a range of scenarios or a range of flows values (minimum and maximum) is submitted for approval by the Management Committees, during the meetings of allocation of isolated dams (CEARÁ, 2015). In this context, Curu River's RBC allocates the water resources stored in its basin.

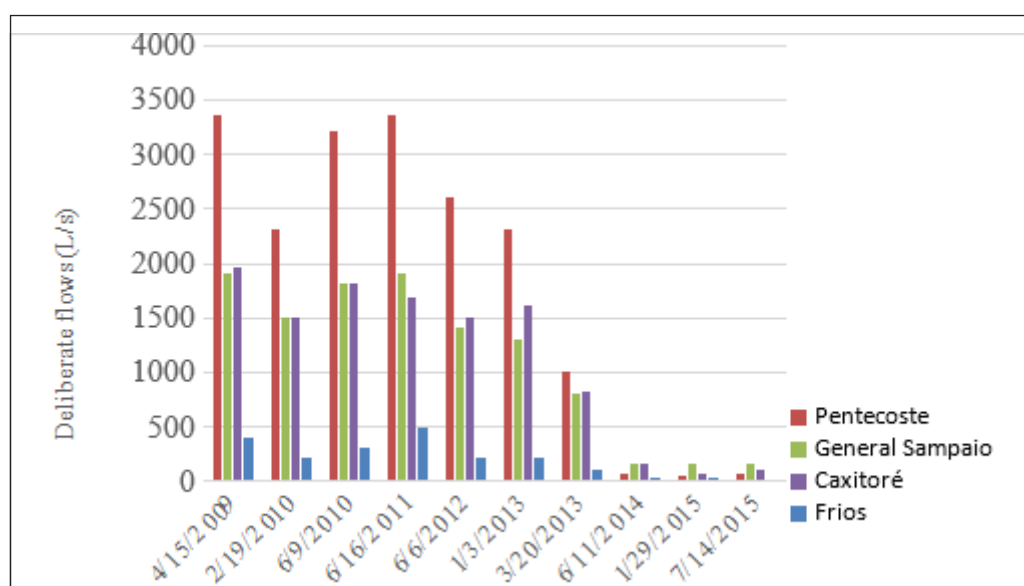


Figure 5 - Deliberate flows of the Curu Valley reservoirs, Ceará.



Figure 5 shows the deliberate flows approved by the Curu River's RBC of the main reservoirs of the basin, the Curu Valley reservoirs where, during a previous analysis of the flows approved by the Committee during the studied period (2009-2015), It is possible to realize that after 2011 the flows only decreased, arriving in 2014 well reduced. Since the largest raw water users in the basin are the irrigators, and according to state water legislation, priority use is human supply, only as of 03/2013, when the Valley's reservoirs were already not receiving enough water to increase the volume, the Committee decided to bring together the ten main irrigators in the Curu Valley, and reduced their irrigated areas by 50%, thus providing a greater balance for human supplies and an extension of the use of the reserves.

The organization of water management in perennial valleys is complex because it involves one or more reservoirs and/or stretches of perennial rivers, in which, ordinarily, the large public perimeters are irrigated with private irrigators, agroindustries, industries and catchment to supply several cities, users that must deliberate jointly on the operation of a perennial system (Pinheiro et al. 2011) and, in a period of scarcity, such as what the Curu basin was from 2010 to 2015, this complexity in management tends to increase, and the Committee has the duty to mitigate conflicts as recommended in Article 49, item II of the EWRP: "It is the responsibility of the RBC to arbitrate, in the first administrative instance, the conflicts related to water resources."

The Committee has always emphasized priority uses, according to the Law. However, in the Curu Basin the DNOC's maintains a fish survey, which demands a high flow rate for its maintenance, considering the importance of this research for the population, even with a low accumulation of water in the reservoirs of the region and with the definition of priority supply according to the EWRP, while there was water in the Pentecoste dam, a flow was defined to be released for this purpose. Considering that, according to the State Law, in a situation of scarcity, after the mandatory deliberation for the priority use, the managing body has the competence to define the other uses, listening to the respective RBC. However, in this case, it was understood that the idea was imposed by the managing body, leaving the irrigators without supply.

#### POLITICAL ARTICULATION WITH THE CURU RIVER BASIN COMMITTEE

Participatory management involves a structure that brings together the River Basin Committee, Reservoir Management Commissions, and the COGERH as the Executive Secretariat of the Committee. Its administration is made by a board composed of a president, a vice-president and a secretary, by the plenary of the collegiate, supported by the Executive Secretariat, through the Regional Management of Curu and Litoral, which has the structure and means necessary for the committee to work (Ceará, 2009).

In order to provide clear and objective guidance to the Curu River's RBC needs, users were asked at the meeting of the Committee to arrange the demands of the Basin on cards, in order to prepare the systematization matrix. The cards were separated according to the nature of the problem, the typology of the solution and the institutions involved, four axes were considered: water balance, institutional aspects, environmental interference and conflict identification.

It can be observed in Table 1 that RBC actions during the water shortage (2012-2015) were mainly of Institutional, Management and Structural nature. The demand of structural nature occurred only in 2014, when the Basin was already entering water collapse. Knowing that it is a basin in the semi-arid, one can see a deficiency in this aspect, where the management directed to coexistence with the drought should be uninterrupted.

Since the 2010 rainy season was below average, the committee institutions discussed ways to mitigate water waste, such as the need to change predominantly irrigation systems in the basin, which is the flood irrigation system, which becomes inefficient when it is not well managed, being that an action of institutional nature.

According to Patrício (2005), from 1997 to 2000 there was a great deal of social participation in the management of the Curu basin, mainly from 1998 to 2000 due to periods of water shortage, and from then on, the Committee has been exercising great participation. This Basin has a dedicated Management Center and a manager sensitive to participatory management. However, one can notice the greater participation and articulations during the periods of water scarcity.

#### EMERGENCY WORKS

Regarding the proposed solutions and actions carried out in the Curu basin, it was noticed the

great interest in programs of well construction, by the members of the committee, but there are some deficiencies or lack of data to better lease and build them, since, according to what was reported in committee meetings, the Superintendency of Hydraulic Works - SOHIDRA got to drill four wells in the irrigated perimeter Curu-Pentecoste, but only one presented a considerable flow. Since this water source is an emergency alternative so much discussed by the Federal and State governments, there is a flaw in this aspect, but the lack of technical knowledge cannot be affirmed with only the evaluation of the minutes of the meetings.

In order to save perennial crops, irrigators excavate the river bed, but these excavations are causing the water table to fall more rapidly, affecting the vegetation on the banks of the river. This was one of the questions asked in a meeting during this period of scarcity, where the collegiate decided that emergency wells could be built where the river was not being forged. Some rules have been passed to irrigators, such as: the construction of the wells must be carried out 100 meters from the river channel, and the distance between the wells should be at least 100m.

According to State Law no. 14.844, Article 12, in order to carry out a water interference work or service, a grant must be made to the Secretary of Water Resources of the State of Ceará, which informs that: the execution of works or services that alter the regime, quantity or quality of water resources, will be granted under the terms and conditions expressed in the respective act, without prejudice to other forms of environmental licensing in charge of the competent institution (Silveira, 2014).

Given the lack of legislation to ensure that economic resources are provided to irrigators at critical times, such as crop insurance, especially for rainfed agriculture, there is a great concern of irrigators in the Curu Valley to find a solution. Meanwhile, as the Committee's mission is to propose measures to alleviate these situations, as an alternative for the survival of irrigators in the current period of scarcity, some programs are being implemented, among them the incentive to raise chickens, which demands less water and can guarantee livelihoods.

Although everyone in the Basin knows what the priority uses are, there are irregularities in this aspect, such as the clandestine pumping of water for irrigation, which requires constant monitoring in the stretches of the rivers perennated by the water of the dams, as well as in the ponds and in the dams.

## CONCLUSIONS

The lack of capacity of hydric maintenance of the basin dams is verified. After 3 years of drought (2010, 2012, and 2013) interspersed by a year with rains above the normal climatological levels in 2011, the Pentecoste dam, the main one of the region, decreased to less than 10% of its capacity. Thus, the water scarcity consequent of the climatic irregularity and the water reservation model requires effective measures to be taken regarding management during these periods of constant drought.

Soon after the rainy season of 2011, the reservoirs of the Curu basin did not receive any more recharges due to the low precipitation of the later years (2012 to 2015), but the deliberated volumes only had a significant reduction in the second quarter of 2013 with the drastic reduction of the supply compared to the previous 3 years. The emergency nature is verified as the most important aspect when deliberating drought mitigation strategies. For example, construction of wells and excavations to increase the water supply, in an attempt to mitigate the losses. Thus the typology most discussed in this period are of structural nature, to increase the water supply of emergency character. The fundamental problems of the basin are also pointed out in periods of drought, and when there is water supply the guidelines for deliberations are focused fundamentally in the distribution of water according to the demands.

The analysis shows the need for insertion of drought scenarios during planning, and deliberation on a contingency plan, in a way that management is promoted to increase the water resilience against the drought situations

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