

**Sustentabilidade econômica das políticas públicas de abastecimento de água nas regiões  
semiáridas do Brasil**

**Economic sustainability of water supply public policy in Brazil semiarid regions**

**Sostenibilidad económica de la política pública de suministro de agua en las regiones  
semiáridas de Brasil**

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**Resumo**

As secas afetam regiões semiáridas em todo o mundo, ameaçando as atividades econômicas e a vida de seus habitantes. No Brasil, 11% da população habita o semiárido e, apesar de várias medidas de mitigação adotadas pelo Estado, é classificada como a região brasileira de maior vulnerabilidade social, especialmente no que se refere às mudanças climáticas. Ao longo da história brasileira, várias políticas públicas voltadas para o abastecimento de água no semiárido fracassaram por diferentes razões. Dois argumentos recorrentes são a falta de recursos financeiros e a má administração. Este trabalho apresenta a análise de uma política pública que visa fornecer água perene e de qualidade, dessalinizando a água subterrânea

salobra local, o Programa Água Doce (PAD). A metodologia possui caráter qualitativo e exploratório, através de análise documental e revisão de literatura para compreender os principais pontos fortes e fracos do PAD. Por fim, utilizou-se a teoria do ecodesenvolvimento para discutir a sustentabilidade econômica da política. Constatou-se que o fluxo contínuo de investimentos públicos e privados foi um elemento decisivo para a implementação da tecnologia durante o momento inicial da transferência de responsabilidades. Contudo, com a redução do investimento público, o gerenciamento passou a ser local, com recursos dos beneficiários. O PAD apresenta avanços no campo da disseminação de tecnologias, principalmente os Acordos de Gestão. No entanto, a ausência de processos de empoderamento das comunidades e de cooperativismo resultaram em sistemas desconectados e incapazes de garantir sua sustentabilidade econômica.

**Palavras-chave:** Escassez de água; Resiliência; Investimentos privados; Programa Água Doce; Mudanças climáticas.

### **Abstract**

Droughts affect semi-arid regions around the world, threatening economic activities and the lives of its inhabitants. In Brazil, 11% of the population inhabits the semiarid region and, despite several mitigation measures adopted by the State, it is classified as the Brazilian region of greatest social vulnerability, especially with regard to climate change. Throughout Brazilian history, several public policies aimed at water supply in the semiarid have failed for different reasons. Two recurring arguments are the lack of financial resources and maladministration. This paper presents the analysis of a public policy that aims to provide perennial and quality water, desalinating the local brackish underground water, the Água Doce Program (PAD). The methodology has a qualitative and exploratory character, through document analysis and literature review to understand the main strengths and weaknesses of the PAD. Finally, the theory of eco-development was used to discuss the economic sustainability of the policy. It was found that the continuous flow of public and private investments was a decisive element for the implementation of the technology during the initial moment of the transfer of responsibilities. However, with the reduction of public investment, management became local, with resources from the beneficiaries. The PAD presents advances in the field of the dissemination of technologies, mainly the Management Agreements. However, the absence of community empowerment and cooperative processes has resulted in disconnected systems that are unable to guarantee their economic sustainability.

**Keywords:** Water scarcity; Resilience; Private investments; Água Doce Program, Climate change.

## **Resumen**

Las sequías afectan a las regiones semiáridas de todo el mundo, amenazando las actividades económicas y la vida de sus habitantes. En Brasil, el 11% de la población habita la región semiárida y, a pesar de varias medidas de mitigación adoptadas por el Estado, está clasificada como la región brasileña de mayor vulnerabilidad social, especialmente con respecto al cambio climático. A lo largo de la historia brasileña, varias políticas públicas dirigidas al suministro de agua en los semiáridos han fallado por diferentes razones. Dos argumentos recurrentes son la falta de recursos financieros y la mala administración. Este documento presenta el análisis de una política pública que tiene como objetivo proporcionar agua perenne y de calidad, desalinizando el agua subterránea salobre local, el Programa Água Doce (PAD). La metodología tiene un carácter cualitativo y exploratorio, a través del análisis de documentos y la revisión de la literatura para comprender las principales fortalezas y debilidades de la PAD. Finalmente, la teoría del desarrollo ecológico se utilizó para discutir la sostenibilidad económica de la política. Se encontró que el flujo continuo de inversiones públicas y privadas fue un elemento decisivo para la implementación de la tecnología durante el momento inicial de la transferencia de responsabilidades. Sin embargo, con la reducción de la inversión pública, la gestión se volvió local, con recursos de los beneficiarios. El PAD presenta avances en el campo de la difusión de tecnologías, principalmente los Acuerdos de Gestión. Sin embargo, la ausencia de empoderamiento comunitario y procesos cooperativos ha resultado en sistemas desconectados que no pueden garantizar su sostenibilidad económica.

**Palabras clave:** Escasez de agua; Resistencia; Inversiones privadas; Programa Água Doce; Cambios climáticos.

## **1. Introduction**

Economic activities and the very survival of the Brazilian semiarid population are conditioned by the drought phenomenon, which lasts nine to seven months a year. The low rainfall and high evapotranspiration make the area susceptible to desertification processes (Brasil, 2012). The climatic characteristics and the soil composition lead to a low surface

water availability, composed mostly by intermittent rivers. Therefore, to supply the water demand of the region, water is normally storage through dams, tubular wells, cisterns, and underground dams. However, this process is difficult due to the soil characteristics and the fact that the groundwater has high saline levels, being unsuitable for human consumption without proper treatment (Brasil, 2012).

Even with mitigation measures, the semiarid is one of the most vulnerable Brazilian regions and potentially the most affected by climate change (Ipcc, 2007). It is also important to understand that semiarid vulnerability does not happen solely due to climatic and physiographic issues. According to Sivakumar et al. (2005), it is a conjuncture of social, political and economic processes and events that influence the occurrence of economic and social losses. In addition, Marengo (2007) states that the peasant and the family farmer with the least resources and, consequently, the least ability to adapt are the most vulnerable to the consequences of climate change.

Building more sustainable and climate resilient societies is an international concern. According to the Chapter 18 of the United Nations (UN) Agenda 21, strengthening the functioning of governments in the management of water resources, while fully recognizing the role of local authorities as an important part of building sustainable societies. As well as assisting communities to manage their own sustainable-based systems by encouraging local people, especially women, youth, indigenous people and local communities, to participate in water management.

In Brazil, the III National Conference on the Environment, promoted by the Ministry of the Environment (2008), aimed to contribute to the construction of the National Climate Change Policy and Plan. The National Policy on Climate Change (PNMC) is the consolidation of Brazil's commitment to the United Nations Framework Convention on Climate Change and was instituted by Law No. 12.187 / 2009 (Brasil, 2009), later amended by Decree No. 9.578 / 2018. It is one of the PNMC guidelines to implement adaptation measures to reduce the adverse effects of climate change and the vulnerability of the environmental, social and economic systems (Brasil, 2009).

The issues discussed above are part of the theoretical and empirical framework of the *Programa Água Doce* (PAD). The PAD presents itself as a public policy of permanent access to quality water for human consumption through sustainable use of groundwater,

incorporating environmental and social care in the management of desalination systems. By reducing vulnerabilities to water access in the semiarid, PAD is considered a climate change adaptation measure, with effectiveness recognized by the Court of Auditors Ruling 2462/2009 (Brasil, 2012).

The PAD base document states the commitment of the initiative to guarantee the sustainable use of water resources in the Brazilian semiarid. For this, it uses as part of its theoretical framework the description of “sustainability”, referring to development aspects from what was discussed at the Stockholm Conference in 1972. Consolidated by Sachs (1993), the term *ecodevelopment* is conceptualized as a form of development that aims to harmonize social and economic objectives, based on an ecologically prudent management of natural resources (Montibeller-Filho, 2001). For this to happen, Sachs predicted five dimensions of sustainability: social, cultural, economic, spatial and environmental.

Among these five dimensions, economic sustainability deserves prominence in the context of PAD. This is because the technology selected for the desalination process, despite generating high quality water, needs much more management efforts in terms of monitoring and operation, as well as maintenance resources, especially when compared to other non-treatment initiatives (rainwater cisterns). These characteristics indicate, in principle, the need for robust, participative and integrated management to meet the objective of providing quality water in a sustainable manner. However, the socioeconomic fragility of the beneficiary population, as well as the distrust on the state politics and the very discontinuity due to electoral cycles can serve as a barrier to the success of the Program (Brasil, 2010).

According to Sachs (1993) and Tavares (2005), economic sustainability becomes possible through the efficient management of resources and the constant flow of public and private investments. Thus, to verify the approach taken by the PAD and its results, this paper was divided into two steps. At first, a brief presentation of the components of the Programa Água Doce was made and a specific search of the constituent elements of the two categories proposed by Sachs (1993) and Tavares (2005) - (i) Efficient management of resources and (ii) Constant flow of public and private investments. After, these categories were discussed, with the relevant theoretical basis, from the following perspectives: (i) Management and organization; (ii) Participatory space; (iii) Effectiveness and (iv) Perpetuity. This discussion aimed to raise possible weaknesses of the PAD regarding economic issues, in order to

contribute to a better understanding of the program and possible improvements that may be made.

## **2. Água Doce Program**

In 1996, the Programa Água Boa (PAB) was implemented to promote the desalination of brackish water from tubular wells in the semiarid. However, the inconsistency of state policies, the lack of adequate disposal of waste and poor capacity of the population to operate the systems caused strong obstacles to their success (Brasil, 2010).

In order to resume the initiative, the Ministry of Environment promoted the evaluation of the PAB and, from this, established partnerships with other entities to improve the proposed system, launching the initiative as the Programa Água Doce (Brasil, 2012). After the reformulation, the initiative was based on the premise that participatory and integrated management of the systems would be able to make the policy more successful. The Program was divided into six main components: Management; Studies / Research / Projects; Environmental Sustainability; Social Mobilization; Desalinization Systems and Concentrate Utilization Unit. In this context, Management and Social Mobilization are considered the biggest differentiations of the PAD from its predecessor. Each component is dependent on the progress and results of the others, and this work has focused on those most relevant to the discussion of the Program's economic sustainability.

### **2.1. Management and social mobilization**

PAD uses local agreements (Management Agreements) as a management mechanism. They lay the foundations for cooperation and management of desalination systems and production systems. Such mechanisms aim at the autonomy of communities, respecting the structures of social organization, identifying local leaders and harnessing the potential of traditional ways of overcoming social dilemmas. It is intended that social actors involved with systems management find their own solutions to their problems, and that pre made templates are not offered by the Program (Brasil, 2012).

The agreements are made up of rules, rights and duties for families, such as: the right to use desalinated water and the concentrate; instances to improve the agreement; conflict resolution and community monitoring of compliance with the agreement; equipment operating and maintenance costs; definition of fee for users; form of collection and the

definition of value and responsibilities of states and municipalities. One of the goals of the PAD is that after three years, the benefited communities take over the management of their respective local systems (Brasil, 2012).

The PAD Base Document uses the experience of previous programs to differentiate Program mechanisms, pointing out that "installing or restoring desalination systems is not sufficient to guarantee the continued supply of good quality water to semiarid families." There is a need for management mechanisms to enable the continuity of actions and the resilience of communities.

The Program uses the author Sachs as the theoretical framework, which defines economic sustainability as practices that support long-term economic growth without negatively impacting social, environmental, and cultural aspects of the community (Sachs, 1993).

## **2.2. Technological solution**

The lack of concern with the management of saline concentrate generated in the desalination process led to negative environmental impacts under the previous Program, Água Boa Program (Brasil, 2010). Thus, in addition to desalination systems, concentrate recovery units were also developed. In general, the system works as follows: saline water is collected and stored in reservoirs and sent to a system using reverse osmosis membranes. During filtration, the hydraulic pressure imposed on the system forces only the water to pass through the membrane in order to retain the salts forming the concentrate. Thus, in the end, there is high quality drinking water - which is only used for direct consumption - and a salt-rich liquid stream.

In order to properly dispose the concentrate and bring greater economic benefits to the localities, Embrapa Semiárido - Brazilian rural extension company - proposed its use to feed three dependent subsystems that complement each other in a chain formed by fish farming, use of organic saline concentrate for irrigation of halophyte plants and the use of saltgrass associated with other feed crops.

### **3. Methodology**

This work aimed to understand and discuss the theoretical context and the knowledge bases used in the elaboration of the public water supply policy entitled Água Doce Program. For this, the authors opted for a qualitative project, in which it seeks to understand the meaning that certain institutions and individuals attribute to a given social issue (Creswell, 2007). The social issue addressed in this work is the supply of water in quality and quantity to communities in the Brazilian semiarid, based on the criteria dictated by the legal framework of sanitation in Brazil. The authors decided to use as parameters of comparison in the task of understanding and discussing the studied public policy, the authors and theoretical bases mentioned in the documents that establish public policy.

Thus, the document analysis of the texts, rules and reports that make up the public policy in question, Programa Água Doce, was chosen as the source and method of data collection, in the time interval between its creation and the publication of this article, 2010 to 2019. The research, or technique, or documentary method, according to Sá-Silva et al. (2009) differs from bibliographic research in that it is restricted only to the analysis of documents, and in the case of this work, official written documents launched by state agencies that present, explain and report on public policy.

Following the steps described by Minayo (2008) and Sá-Silva, Almeida & Guindani (2009), the authors collected the material from official sources, fluctuated reading and categorized them according to the typology of the document. After the organization and careful reading, a content analysis was performed (Bardin, 2011) and the results are discussed in the next topics.

## **4. Discussion**

### **4.1. Água Doce Program in the context of the economic sustainability**

According to Britto (2016), sanitation in Brazil is marked by the technocratic dimension that is refractory to participation and social control and only recently has this scenario begun to be reversed. Social participation, according to the author, aims at strengthening civil society, not necessarily for participation in public management, but as a means of strengthening and avoiding State interference in the life of the individual.



In Castro (2016), the importance of aspects such as society's participation and social control in public policies is increasingly recognized at the discursive level, but in practice there is a preeminence of technocratic views, on the one hand, and the influence of neoliberalism on the other. This scenario, according to the author, is fundamental to explain the slow progress of democratization and citizenship processes in the field of public policies.

Piccoli et al (2016) discuss that social participation in sanitation is only possible with the empowered population, mobilized by the importance of water and other components of sanitation. For these authors, education is the main mechanism of this process, and thus, through an organized, informed and active population, the effectiveness of their rights is claimed and their duties are fulfilled. Education can contribute through cooperation, self-management and participation in social movements, as well as non-traditional learning and teaching practices that develop critical awareness. In this context, sanitation actions would result from collective learning, sharing different points of view about the difficulties and possible solutions (Aguiar & Melo, 2016).

However, for population participation to be legitimate, it is necessary to change the technicist discourse of specialists and open them to the discourse of communities, so that the population can understand and participate in a qualified manner (Rubinger et al, 2016). Contrarily, Britto (2016) points out that the main demand by the social movements and population in Brazil is the access to water and sanitation services, and when access is guaranteed, occurs a demobilization and a weakening in social participation, jeopardizing the economic sustainability of policies and the resilience of communities.

The PAD uses in its bibliographic framework Sachs's (1993) theory of eco-development, which describes economic sustainability as one of the five dimensions of sustainability, and which must be in balance with social sustainability, assuming the creation of processes supported by a vision of a "good" society, with greater equity and citizen social participation. This participation stems from the common idea of limiting political power and highlighting popular sovereignty.

From these concepts, we point out the importance of discussing the participatory space within sanitation policies and programs, in order to critically analyze not only the existence of these spaces, but also the way they are constructed, the intensity of social participation and how these factors affect the outcomes and impacts of these policies and programs.

Another relevant factor for public policy analysis is their perpetuity. According to Couto and Lima (2016), several elements affect the continuity of public policies, and it is necessary to “understand who forms the coalition of actors that support the policy, what coordination problems are involved and the ability of policies to be self-binding, integrated to social, economic, political and - especially - institutional factors”.

Given this scenario, Frey (2000) points out that the continuity of public policies in Brazil, as well as in young democracies in Latin America, can be strongly affected by the political cycle determined from elections, since they alter the actors involved on policy coordination. Based on the characteristics of the electoral process, Tourraine (1989) states that politics in Latin America is “less a matter of interest than of passion,” meaning that citizens are driven by instantaneous passions more strongly than they organize themselves around common goals. As a consequence, there is a strong inclination to the often sudden and radical changes, which manifest themselves both in the political-administrative discontinuity in the transition between governments and in the course of management (Lobo, 1998).

To circumvent this cyclical fragility, the constitutionalization of public policies is a tool that, by bringing greater rigor to changes in the texts, can contribute to their continuity. In addition, Couto & Lima (2006) consider that constitutionalization becomes especially relevant when the policy has no sources of resilience per se. There are few and/or weak actors interested in its preservation, there are no feedback mechanisms and coordination is poor.

#### **4.2. Resource management and public and private investment in the Água Doce Program**

According to Sachs (1993), the eco-development model has five sustainability dimensions: (a) social sustainability, as a growth process subsidized by another view of society, with greater equity, participation and lower income inequality; (b) economic sustainability, which, according to Tavares (2005) and Sachs (1993), must be made possible by more efficient allocation and management of resources and a steady flow of public and private investments; (c) ecological sustainability, by increasing the capacity for renewal of the Earth's ecological cycles, limiting the disordered consumption of natural resources and respecting ecological biodiversity, intensifying research for low-waste, energy-efficient technologies. urban, rural and industrial development and the definition of more appropriate forms of environmental protection; (d) spatial sustainability, achieving a more appropriate and

balanced rural and urban configuration, and better territorial distribution of human settlements and economic activities; and finally, (e) cultural sustainability, which includes the search for endogenous roots of modernization processes and integrated agricultural systems (Sachs, 1993 and Tavares, 2005).

Based on this concept of ecodevelopment used in the PAD framework, the two categories that underlie the discussion on the economic sustainability of the PAD were defined: (i) Efficient leasing and management of resources and (ii) Constant flow of public and private investments.

#### **4.2.1. Efficient resource management**

To define the locations to be benefited by the systems, state technicians are responsible for conducting a social and environmental risk analysis of the communities. The assessment is based on the Novo Rural method and the Environmental Sustainability Index (Rodrigues et al., 2003). In addition, the PAD works on two main lines: recovery of discontinued desalination plants and installation of new units. The recovery takes place in states that have already received desalination systems installed by public and private firms, whose operation has been unfeasible in recent years (Brasil, 2010). In addition to the installation and recovery of desalination plants, application of the concentrate to activities that may bring economic gains is seen as a way to minimize the environmental impact of desalination and to engage the population in activities that may bring economic development to the locality.

Although integrated, the proposed solution needs constant monitoring and maintenance, which makes project management extremely important. In this context, the actions to be implemented by the PAD are directed by the State Management and Implementation Plans (Brasil, 2012). The institutional arrangement consists of a National Management Nucleus, State Management Nuclei, Local Nuclei and Thematic Units. Local Nuclei aim to promote and monitor management, aiming at the sustainability of desalination systems or Demonstration Units and to ensure compliance with the agreements. After an average period of three years, the production units would be passed on to duly qualified localities and able to continue the process (Brasil, 2012).

After the installation of the systems, the “local agreements” are formalized through the signature of all actors involved for the management of the desalination system. Management

agreements have rules, rights and duties related to the provision of fresh water to beneficiary families. Among these rules are the norms related to the operation of desalination systems, those responsible for the day-to-day management of the equipment, cost coverage for the operation and maintenance of the equipment, and the community's own monitoring of compliance with the agreement. This “local agreement” determines that the benefited localities assume part of the responsibilities with the equipment operation, as well as part of the costs with the recovery and installation of the systems. Thus, in return for the investments, they provide manpower to maintain and monitor the systems, and create a revolving fund for eventual expenses, fed with the regular payment of each family that benefits from desalinated drinking water (Brasil, 2010).

In terms of resources, PAD costs are subdivided into capital and cost. The costing resources are maintenance and management, daily payment to technicians, conducting physicochemical and microbiological analysis and preparation of dissemination and training material. In the case of desalination systems, 70% of resources are spent on deployment and the other subcomponents act as support for deployment and sustainability. For production units this number rises to 79%.

#### **4.2.2. Continuous flow of public and private investment**

The source of financial resources for the development of the PAD is mostly public. The public resources invested in the PAD are implemented and jointly managed by federal, state, municipal and technical and financing institutions, within of their skills.

This work is considered as a private resource the investment from the community in the recovery and installation of the systems (labor), and the revolving fund for the maintenance of the systems. The operation of the revolving fund is defined in the Management Agreement, which may be only payment for water use or include an extra fee to cover possible unforeseen costs. These agreements with the communities also delimit the coverage of the costs of equipment operation. Private investments are the resources that communities must collect and manage on their own. Production systems also operate on the basis of the Agreement, which defines the people who will be able to produce and how the production system will be maintained, as well as the payment for the use of water and waste used in the production of plants and fish.

At first, costing expenses are shared among states, municipalities and communities. It is up to the municipality to share the cost of systems costs in communities when necessary, to avoid system discontinuity, as well as to develop a policy of environmental monitoring of water use in households through community health agents. However, one of the objectives of the program is the transfer of responsibility to the benefited community, fostering self-management. The initial deadline defined in the Base Document is three years and may be extended if technicians do not identify autonomy in the management of the systems. If transferred, maintenance and operating costs are passed on to the community and the revolving fund becomes the only available resource stream. Aid for operation up to five years is foreseen in the budget of the PAD.

#### **4.3. Continuity of Água Doce Program and the social participation**

The methodology for the definition of the beneficiary localities is based in an environmental and social risk assessment, developed by Embrapa, a rural extension enterprise (Brasil, 2012). Although the nucleus responsible for the formulation of this evaluation is not clear, an analysis of the Executive Summaries indicates the strong participation of state nuclei at this stage, where there is no evidence of popular participation or an analysis of social cohesion. In this context, disparities in the quality of this assessment are very noticeable from state to state, which may be linked to previous experiences and also in the organization and consolidation of the respective state managements structures. Still in this context, it is interesting to highlight the possible fragility of the assessment in relation to electoral cycles, since the organization of the State Secretariats, as well as the appointment of Secretaries are directly linked to the State Executive power.

This strong dependence on the electoral cycles increases the image of a policy of interests, confronting the ideal of a State policy. According to the United Nations (2013), community water security depends on several factors including political stability, the lack of a long-term plan on municipalities it is also a factor to strengthening the dependence to the State Executive power.

According to Bakker & Cook (2011) decentralized governance research, entities at the local level are closer to people's needs, understanding better the demands of the communities. On the other hand, the involvement of unprepared actors or without responsibility may compromise the results. In the same sense, Madrigal, Alpízar & Schlüter (2011) associate the

good performance of local systems with a set of working rules responsible for managing financial resources, infrastructure maintenance and water quality monitoring. However, when water governance becomes so dependent on technical solutions it becomes more difficult to take another approach and creates a rigidity trap where there is little room for innovation (Moore, 2013).

With respect to capital and cost leasing, the importance of monitoring and preventive maintenance of systems for extending component life makes investment in these factors a key measure. This is because, comparatively, the cost to maintain sustainability is low compared to the system. Thus, although there is a tendency to decrease the costs of elements mainly associated with membrane technology (REF), allocating resources for the proper training of operators and monitoring becomes fundamental for the effectiveness and longevity of the Program.

In this sense, in a semi-structured interview with PAD technicians in five states, Saia (2018) found that one of the main difficulties of the Program lies in the composition of the local management group and in convincing municipal managers of the advantages of the model. This is strengthened by the lack of dialogue between the proposed technical solutions and popular knowledge, which often results in unilateral decision-making by the government (Azevêdo, 2015). In addition, when considering the historical dynamics of power relations in states, a challenge for technicians involved in state management groups and PAD coordination is to avoid paternalistic practices, since the results of this relationship are often the dependence, centralization and fragility of community organization.

Still regarding the weaknesses mentioned by the technicians, Saia (2018) also raises the difficulty of forming the reserve fund for operation and maintenance and the challenge of defining a remuneration for the system operators. Certain sanitation policies are centred on technologies that make beneficiaries dependent on monetary income generation (capital for installation and maintenance, income regular to pay monthly fees etc). Groups without these financial conditions may be deprived of their human right to water and sanitation.

In the context of the PAD, community indebtedness and limited socioeconomic outcomes still compromise access to drinking water. According to Azevedo (2017), several farmers have borrowed from financial institutions and are having difficulty paying off their debts. This indebtedness was due to several factors: periods of prolonged drought, different

interest rates for farmers in the semiarid region and, above all, lack of structuring policies aimed at solving problems related to water scarcity - which causes various disturbances and prevents them from having social and economic development (Azevêdo, 2015). In addition to this indebtedness, beneficiaries from Paraíba State reported that tilapia production is generally far below expectations, so as not to be able to help maintain the fund. Furthermore, many farmers also complained about the lack of adherence of Salt Herb to cattle feed, which did not adapt well to it (Azevêdo, 2015).

Besides the context of payment for water use and beneficiary management, PAD's economic sustainability is also dependent on social participation at the time of technology implementation. And for community resilience, participation must be preceded by the empowerment of the population. The change proposed by the shift from the “drought-fighting” paradigm to “living with the semiarid” generates a conflict of management models, models that, in theory, should put communities at the centre of the decision-making process. This must be an individual and collective change, reflecting the way these individuals insert themselves in society, a transition from citizens who are spoken to those who also speak.

The demand for recognition of their rights, based on self-respect and prior knowledge of their role in society, leads to empowerment and a demand for participation in the construction, implementation and management of these policies and programs. If there is no effective participation of the PAD's perennial actors, the Program loses its potential for private resources, funds from payment for water use and production systems.

In the case of the PAD, municipal health agents, municipal sanitation, environment and health councils should be engaged as perennial actors, if inexistent, should be encouraged. In this way, the perpetuity and resilience would be strengthened and the Program's actions would not be so at the mercy of the political and ideological turnover of the municipal and state governments. These PAD resilience and feedback mechanisms should strengthen post-implementation links to ensure economic sustainability following the transfer of responsibility.

## **5. Final Considerations**

The “Programa Água Doce” is based on the premise that previous projects and programs failed due to the hierarchy of actions, where welfare policies guided the actions to combat drought in the Brazilian semiarid. These policies were not aimed at the participation

and social control of the communities served, and many facilities were abandoned and / or damaged over time, impairing the continuity and effectiveness of actions. In order to differentiate itself from previous programs, the PAD proposes the construction of Management Agreements, seeking to involve communities and generate these agreements based on local demands and characteristics, from the economic, social and cultural point of view. Such strategy also aims to reduce the predominance of the technical and assistance discourse, which is very present in the sanitation sector, by reversing the protagonism of the actions from the technical staff to the real demands of the communities served.

In this sense, the empowerment process of these communities tends to be expanded and improved. However, the process of building Management Agreements would require a longer time for communities to mature and monitor, so that social technologies are enhanced and incorporated by their social actors. Due to the scale of the program, goals and deadlines, these processes may not reach the maturity needed to ensure their effectiveness. The construction of the agreements foresees the protagonism of the local leaders, however, it is not able to assure the involvement of the communities as a whole. In addition, there is a risk that PAD benefits will be appropriated to some communities rather than others. The continuity of its actions proves to be another important challenge, since the program is focused on self-management. Management and planning tools need to be incorporated to deal with unforeseen events, such as contingency measures to deal with adversity.

On the other hand, simplified systems (desalination) tend to have greater assimilation by communities when compared to complex systems (demonstrative and productive units), which involve the use of residues for agricultural production and fish farming. In order to make better use of complex systems, continuing education can be carried out with communities, as well as monitoring and support through associations and public entities linked to education, research and management. From the point of view of the public authorities, further monitoring of the systems after deployment is needed, not only over the three to five-year period as planned but over a longer period. Fostering integrated social control structures, either through the creation of councils or support existing ones, such as health, environment, sanitation, education and social assistance. They can contribute to the involvement of communities in the construction, consolidation, implementation and self-management of the systems and, consequently, the empowerment of these communities.



Associativism, present in other programs, is another important tool, promoting integration, the search for common problems solving and the exchange of experiences.

Finally, the Programa Água Doce presents, in its dynamics, advances in the field of the dissemination of water treatment technologies and social technologies, especially in relation to the Management Agreements. However, the continuous involvement of the populations, the appropriation of the necessary knowledge and skills, the exchange of experiences, interinstitutional support and planning are fundamental for their objectives to be effectively permanent.

We suggest, for future work, the analysis of data with the state governments on the installation of the equipment and in relation to the history of transfer of financial resources for its operation. It is also suggested to carry out field studies in locations served by the program, identifying its particularities, positive aspects and difficulties faced, in order to evaluate and discuss strategies for the program's longevity and effectiveness.

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