Water Resources Policy for the Brazilian Semiarid Region

Bruna Letícia Oliveira da Silva [1]
Henrique de Castro Silva [1]
Iran Oikawa Cordeiro[1]
Rafael Aguiar de Miranda [1]
Rômulo Henrique Teixeira do Egito [1]

Maria Edelcides Gondim de Vasconcelos [2]

Academic of Environmental Management, IFPB Campus João Pessoa/Paraíba - Brazil [1]
Professor of Environmental Management, IFPB Campus João Pessoa/Paraíba - Brazil [2]

Abstract: The characteristics of the Brazilian semiarid region require specific technologies for the use of water resources. It is necessary to analyze the alternatives of obtaining water for diverse uses. In contrast to the traditional ways of accumulating water in small surface reservoirs and drilling wells in the crystalline terrains, alternatives have been sought such as deep wells in sedimentary areas. Facilities for water desalination, destination and use of effluents and to integrate river basins are beginning to be built in the region. We want in this paper to address the water resources policies developed for the Brazilian semiarid region.

Introduction

The expression semiarid normally is used to describe the climate and regions where median annual precipitation is between 250 and 500 mm and the vegetation is primarily composed of bushes which lose their leaves in the driest months or pastures that become dry during droughts. This kind of vegetation is characteristic of semiarid regions, such as, the steppes of Kazakhstan, in the northern Central Asia, or the caatinga, in the northeast of Brazil (Cirilo, 2008)

The northeast Region of Brazil occupies the territory between 1º and 18º30' latitude south and 34º30' and 40º20' longitude West of Greenwich. Its area, which is about 1,219,000 km2, is approximately equivalent to a fifth of Brazil, and includes nine states: Maranhão, Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe and Bahia. (Cirilo, et al., 2007). The population in this region is 22.6 million, 38% of them are in the rural zone. The area officially classified as semiarid is 969,589.4 km² (INSA, 2016).

The Brazilian semiarid region is poor in surface drainage due to the temporal variability of rainfall and the dominant geological characteristics with predominantly a shallow soil on top of crystalline rocks. As a consequence there is poor penetratoin of water into the subsoil which result in fast run-off and a dence network of temporary rivers The major exception is the São Francisco River.

The northeast territory constitutes of more than 80% crystalline rock with predominantly elevated salt level in groundwater which is captured in low flow wells in the order of 1 m³/h. The exception occurs in sedimentary formations, where the water is generally of better quality and where it is possible to exploit flow in the order of tens to hundreds m³/h, continuously (Cirilo, 2008).

In other semiarid regions in the world such as Israel, agricultural productivity is greatly superior to the semiarid of the Northeast Brazil, thanks to the efficiency obtained by technological control and reuse of water, recharging of aquifers and other actions (Rebouças, 1997, p.144).

Water Policies for the Brazilian Semiarid Region

Historically, the semiarid region of Brazil has been plagued by catastrophic events of severe droughts, while the general shortage of water has been one of the major obstacles to development in the region.

Developmental models have been largely based on "combating drought", leaving aside the search for alternative models that might have enabled people to cope with this phenomenon by focusing directly on water management solutions more suitable to the current reality (Dias et al, 2016).

According to Malvezzi (2007, p. 11) the widespread perception of the climate of the semiarid region, has always been distorted and convey the impression of an arid not semiarid region.

Policies related to combating drought were historically formulated in a disjointed manner with other social policies in the semiarid region. These further contributed to a character of emergency and creation of welfare policies (Albuquerque, 2010).

This discourse largely remained until the 21st century. From this time on, the discussions focused on development policies based on the concept of "coexistence with the semiarid climate".

The first law of coexistence in the semiarid landscape is about capturing rainwater, an ancient practice that has been mostly abandoned in the region. However, it must be remembered, that apart from capturing and storing water, we need to prevent the evaporation.

As a result of this discussion, a greater acknowledgement of the need for building better infrastructure and management planning for water resources was developed over time. The principle result was a robust strategy that permits a society to coexist with the semiarid climate.

Medeiros et al. (2011) showed, that these discussions finally brought more attention to the major water challenges facing the semiarid regions and their most important aspects: access to water by a diffuse rural populations; efficient use of water resources in production processes; the inclusion of new social stakeholders with local knowledge in the decision making process; managing conflicts and ensuring the operation of existing infrastructure as the critical means by which the desired results can be achieved.

1. Water Accumulation in Dams

The policy of accumulating water in dams, typical of the Brazilian semiarid, has been carried out in two ways. In large reservoirs with the capacity for multiannual regularization in large scale river basins, and in small reservoirs with the capacity in the order of a few thousand cubic meters.

The large reservoirs, with capacity in the order of a billion cubic meters, is present in several states of the region, although in small numbers, especially as a result of the actions of the National Department of Construction Works Against Drought (*DNOCS – Departamento Nacional de Obras Contra a Seca*).

Projects such as dams, reservoirs and irrigation systems commonly generate social and environmental impacts, as well as serving the interests of a minority of businesses interested in generating capital from agriculture (Dias et al, 2016).

The small reservoirs, known as "*barreiros*", have a capacity of a few thousand cubic meters, and are spread over the entire region.

High evaporation levels, in the order of 2,500 mm per year, present a serious policy challenge, especially for small dams, which are not able to withstand the effects of prolonged drought.

In addition to the water storage facilities, which constitute the most usual way of securing water for a diffused rural population, rural wells and cisterns are the most common means of collecting and storing water in the region (Cirilo, 2008).

2. Rural Wells

In the northeast of Brazil it is estimated that there have been drilled nearly 100 thousand wells. As the greater part of the semiarid region of the northeast consists of crystalline formations, the drilling of wells to supply the different needs is subject to the following limitations: low flow, in the majority of cases up to 2 m^3/h; in a significant part of the wells, salt contents, above recommendations for human consumption; and a large number of dry wells due to geological peculiarities.

The wells drilled in crystalline terrains are about 50 meters deep, while in sedimentary basins, the depth varies, mainly between 100 and 300 meters (Cirilo, 2008).

3. Rural Cisterns

Various initiatives of the states, municipalities and governmental entities have multiplied the number of cisterns in the northeast of Brazil. The cisterns, with a normal capacity of 7 to 15 cubic meters, provides a daily supply of 50 liters during 140 to 300 days. They are filled by the end of the rainy season and not refilled during the rest of the year. Doing the necessary cleaning of the roof, the cistern, the gutters and pipes is a basic solution for satisfying the most essential needs of the diffuse rural population.

The forum Semiarid Brazil (*ASA – Articulação no Semiárido Brasileiro*), brings together various non-governmental organizations in northeastern Brazil with the aim to “not combat drought, but coexist with the semiarid region.”
According to Albuquerque (2010), the ASA has succeeded by participating in public forums for political mediation, collaborating on the drafting and adoption of laws, and contributing proposals for public policies aimed at the semiarid region, especially regarding access to water resources, initially through the One Million Cisterns Program (*P1MC – Programa Um Milhão de Cisternas).*

With these approaches, the ASA seeks to disseminate water related Social Technologies through sustainable alternatives, to capture and store water in the semiarid region. These so-called “social technologies” are easily replicable, simple, and address the problems of local society (Malvezzi, 2007).

One of the highlights of the “One Million Cisterns Program” *(P1MC – Programa Um Milhão de Cisternas*) is the slab cistern. It is a covered and partially buried

tank, designed to capture and store rainwater for human usage. Until today, these tanks served residents of all nine states of North-eastern Brazil and the semiarid regions of Minas Gerais and Espírito Santo, transforming the lives of about 336,000 families. The P1MC quickly became a Federal Government program, with the main objective of achieving quick and effective results.

The P1MC proposal is not limited to water access, but also aims to introduce new social values, such as participation and empowerment in the construction of citizenship and democracy in the semiarid region as an alternative to the paternalistic and clientelistic political practices that have developed over the years.

This is especially significant where access to water has become a political instrument, as currency in exchange for votes, which is the case in so many places throughout the semiarid region of Brazil (Dias et al, 2016).

4. Subsurface Dams

In the middle of the 1990s successful experiments in the construction and management of small subsurface dams were implemented by Caatinga, an NGO, providing support for family agriculture in the region. Nearly 500 reservoirs were constructed underground, the results of which need to be evaluated and monitored. Parallel to technical activities, preparatory work among the affected communities is also necessary in order to make the best use of the available water.

5. Water Desalination

Due to the bad quality of the water in existing wells, in recent years many reverse osmosis desalination plants have been installed in Brazilian semiarid regions. The Sweet Water Program (*Programa Água Doce - PAD*) is one of the Federal Government programs coordinated by the Ministry of the Environment, through the Secretary of Water Resources and Urban Environment, in partnership with federal, state, municipal and civil society institutions.

According to the Ministry of the Environment (2016), PAD aims at establishing a permanent public policy of access to good quality water for human consumption, promoting the implementation, recovery and management of environmental and socially sustainable desalination systems to serve, as a priority, low-income populations in diffuse semiarid communities.

Launched in 2004, the PAD has six components: management, research, desalination systems, environmental sustainability, social mobilization, and production systems. The management component is responsible for the training of human resources, elaboration of technical and environmental diagnostics, maintenance and operation of the systems, as well as support for systems management and maintenance.

The research component aims at optimizing production systems by generating new knowledge about halophyte plants, animal nutrition and fish farming.

Through its commitment to guarantee the sustainable use of water resources, and promote the coexistence with the semiarid region in an environmental and socially sustainable way, PAD benefits approximately 100 thousand people in 154 locations in the Northeast, expanding its actions to guarantee access to the water of diffuse communities in the semiarid region (Ministry of the Environment, 2016).

Notwithstanding desalination plants showing effective in providing potable water the following problems need to be addressed: disposal of the refuse originating from the desalination, the high cost of maintenance and the logistics of a complex operation.

6. Reuse of Sewage Water

In general, sewage continues to be discharged into water bodies. In the case of low or lack of treatment, the consequences are pollution, destruction of the biodiversity and reduction of potable water to supply populations and productive processes.

The disposition of residues rich in nutrients, especially nitrogen and phosphorus, in rivers and other bodies of water has increased the level of nutrients in the water and contributed to the flourishing of toxic algae known as cyanogens, which by themselves constitute a plague for storage reservoirs.

These algae release toxins (neurotoxins and hepatotoxins) which cause serious damage to human health, including death. The treatment of water, besides being difficult is extremely costly (Cirilo, 2008).

In the northeast, the reuse of water for industrial activities has surged in sectors such as clothing production. It is still very limited, practically to pilot projects, with regard to the reuse of sewage, treated or not, for agricultural activities.

7. Transporting Water a Great Distance

In recent years major works for water transportation have been concluded. Others are in construction or are projected to supply cities of semiarid regions and give support to productive activities.

This is the case, for example, of the Integration Canal in Ceará, intended to convey water from Castanhão Reservoir, the largest in the northeast outside of the basin of São Francisco River (capacity of 6.7 billion cubic meters), to the region of Fortaleza along 225 kilometres. Another example is the 500 kilometers network of aqueducts in Rio Grande do Norte. In both cases it may be noted that the water reserves belong to the state.

Another option being explored is to transport water from the São Francisco River to the states of Ceará, Rio Grande do Norte, Paraíba and Pernambuco. According to the Minister of National Integration (2016), the final stage of the

project will have a continuing water withdrawal of 26.4 m³/s of water, equivalent to 1.4% of the flow guaranteed by the Sobradinho Dam (1,850 m³/s) in the stretch of the river, where the extraction will take place. This water is intended as potable water for the urban population of 390 rural municipalities in the semiarid region of four northeast states. The project is an initiative of the Federal Government, which includes the construction of two canals (North and East Axes) with a total length of 700 km.

This project is also intended to support irrigation in the semiarid Northeast. However, the project faces strong political and technical resistance from non-governmental organizations, river basin committees and the population in general, especially concentrated in the so-called “state donors”: Minas Gerais, Bahia, Sergipe, Alagoas and on the banks of the São Francisco River in Pernambuco territory. This controversy is caused by the extremely high cost and the negative impact on the ecosystem of the San Francisco River. Others argue that the implementation of this project will solely help big farmers as a large part of the project will supply areas with large farms. If this is the case, the project will not solve the problems of the majority of the Northeastern population in need of water (Cardoso,2015).

The official debate focus on how the federal government should prioritize revitalizing the São Francisco relative to other pressing investment, the real need for water of the people in the receiving basins, the economic viability of implementing future irrigation projects, considering the costs and possible losses of water in transport, and whether the project will result in social justice.

In turn, the major argument in favour of transporting the São Francisco water, aside from human supply, is that the reservoirs intended for irrigation within the project will have great synergy gains, given that it will not be necessary to save water for use during dry periods and, therefore, will suffer lower losses due to evaporation (Cirilo, 2008).

Scientific and Technological Development

The National Institute for the Semiarid Region (*Instituto Nacional do Semiárido – INSA*) was created through Law 10.860, on April 14th , 2004, as a Research Unit part of the basic framework of the former Ministry of Science and Technology (*Ministério da Ciência e Tecnologia – MCT*), as set forth in Decree 5.886 of September 6th, 2006

The INSA aims at promoting scientific and technological development of the Brazilian semiarid region, as well as conducting and disseminating research and studies to strengthen the sustainable development of this region (INSA, 2017).

The activities carried out by the Institute are based on joint research, training, dissemination and public policy.

RESEARCHES AND PROJECTS

1. Management of Water Resources and Water Reuse

This program the INSA aims to link up with national and international institutions for the implementation of strategies, mechanisms and institutional arrangements for the feasibility of pilot projects Research and Development (R & D) on the management of water resources and the reuse of water in the semiarid regions of Brazil.

2. Desertification and Climate Changes

This program aims to combine national and international institutions to carry out studies and projects on the dynamics of the desertification process, strategies of recuperation, management of degraded areas and climate changes in Brazil's Semiarid regions through the organization of debates on the theme and diffusion of their results.

Since 2006 INSA has promoted different activities, such as technical meetings and workshops with parties sympathetic to the theme, which have generated four interinstitutional projects of regional reach, namely:

a) Systematic monitoring of desertification processes in Brazils Semiarid region: especially due to deforestation, misuse of soil and intensive use of pastures and agricultural areas. In this context, the Brazilian Semiarid region is considered one of the greatest areas in the world susceptible to the process of desertification.

b) Agricultural systems based on family farms resilient to extreme environmental events in Brazils Semiarid region: alternatives to face the processes of desertification and climate changes (INSA - ASA). This project was born by the combination of the National Institute for Brazils Semiarid Region *(Instituto Nacional do Semiárido – INSA/MCTI*) and the Articulation in Brazils Semiarid region *(Articulação no Semiárido Brasileiro – ASA Brasil)*, joining science, technology, innovation and social inclusion in order to build alternatives for productive and sustainable life in Brazilian Semiarid region.

c) Organization of agricultural production systems in Brazils Semiarid region: fighting against the desertification and land degradation in the semiarid region must be a priority for the Country, since this region is home to nearly 23 million Brazilians, of which 8.6 million live in the rural area.

d) Creation of the Research Center of Mineralogical Characterization and Environmental Biogeochemistry at Headquarters and Industrial Region of Brazilian Semiarid. The project aims at the creation of the Research Center in order to provide the mineralogical analysis of soils and biogeochemistry of areas subject to desertification processes in the region.

Conclusions

The Brazilian semiarid regions present more difficult conditions to overcome, than other semiarid regions of the world: for most part, the soil here is very shallow, with rocks that are almost protruding, this reduces the number of aquifers and their recharge and quality; high temperatures lead to high rates of evaporation; few perennial rivers; and the highest population concentration among the semiarid regions of the world which generates excessive pressure on water resources.

The region has a history of mistaken public policies. Up to the 1990s, these policies, when not completely absent, were based on the implementation of small reservoirs, highly vulnerable to dry seasons, and drilling of wells in the crystalline. Combined with misguided policies, the lack of water management contributed to the ongoing regional drought crises. As a means of alleviating the suffering of the affected population, only the most obvious measures were taken: barrel trucks for water transportation, and work opportunities to assure some income for sustenance. In summary, purely palliative measures.

After this era started a new philosophy, the Brazilian states support by the Water Law implemented: water resources plans for the states in general and the river basins in particular; establishment of management entities and basin organisms; and structural works programs. Compared to the other regions of the country, the greatest advances in the management of water resources have taken place in the northeast.

It is inconceivable to use canals and pipelines to supply water to the diffuse rural population, except for those close to existing infrastructure. Therefore cisterns, small reservoirs, wells and the use of desalination plants, and the maintenance of them should be expanded and improved.

Concerning the transfer of water from the São Francisco River, in order for it to effectively benefit the populations, considerable planning is required. The operational aspects of the project should be further studied, with a more global view toward integration of existing resources with the different scenarios of the expected climate changes.

Questions like reducing water flow loss in the water infrastructure and increasing efficiency, principally in irrigation where the consumption is greatest, should be thoroughly analyzed.

Thorough studies are also needed of issues such as distribution of land, crops to be irrigated, complementary infrastructure, and the logistics of connecting the farmers to the markets for both input and output since the experience of

agricultural production in the northeast proves that it is not only a lack of water that compromises regional development.

Similarly the projects already implemented in the São Francisco River basin, need to be studied taking a systemic view towards the future, because there are great pressures on the water resources of the river and the potential for conflicts of use are many: particularly with regard to irrigation, there are many more areas that could be irrigated than there is water available for the purpose.

As to revitalization of the basin, among other initiatives, the ecological water flow should be studied, and regimes of ecological flow, especially at the mouth of the river, should be established including operational rules for the dams supporting this flow.

The sanitation actions of the municipalities of the basin currently being implemented by the federal government and by the states, need to be complemented by territorial revitalization programs: reforesting, protection of sources, erosion control and other actions.

When water is as scarce as in the semiarid region of north-eastern Brazil water must be managed in a proactive manner.

Water management decisions should be based on an assessment of future water use, including the long-term effects of current activities and policies, in order to achieve a sustainable development of the region.

REFERENCES

Albuquerque, M. C.(2010). Novos paradigmas no semiárido brasileiro: a experiência da ASA na construção de novas modalidades de políticas públicas. São Paulo: Instituto Pólis, p. 144-17.

ANA – Agencia Nacional de Águas – Atlas (2015). Abastecimento Urbano de Água. Brasília, DF.

Bizikova, L. Semiarid Areas. Institute for Sustainable Development (IISD) (*Available:* www.iisd.org)

BRASIL. Ministério da Integração Nacional. Projeto de Transposição de Águas do rio São Francisco para o Nordeste Setentrional. Brasília, DF, 2015. 10v.

_____. Ministério do Meio ambiente – Secretaria de Recursos hídricos. Avaliação das Águas do Brasil. Brasília, DF, 2002. p.86.

_____. Ministério da Integração Nacional/SDR. Relatório Final do Grupo de Trabalho interministerial para redelimitação do Semi-Árido Nordestino e do Polígono das Secas. Brasília, dF, 2005. p.33.

Campello Neto, M. S. C. et al.(2007) Manejo integrado de água no semi-árido brasileiro. In: CIRILO, J. A. et al. (org.) o uso sustentável dos recursos hídricos em regiões semiáridas. Recife: ABRH – Editora Universitária UFPE, p.508.

Cardoso, L.C.V. (2015) A Transposição do Rio São Francisco - The San Francisco River Transposition. Cadernos de Estudos e Pesquisas - Journal Of Studies And Research, Vol. 19, Nº 42.

Cirilo, J. A. et al. (2003) Soluções para o Suprimento de Água de Comunidades Rurais Difusas no Semi-Árido Brasileiro. Avaliação de Barragens Subterrâneas. Revista Brasileira de recursos Hídricos, p.5-24.

Cirilo, J. A.(2008) Políticas públicas de recursos hídricos para o semi-árido. *Estudos Avançados*, *22*(63), 61-82.

_____. Integração das Águas Superficiais e Subterrâneas. In: CIRILO, J. A. et al. (org.) O Uso Sustentável dos Recursos Hídricos em Regiões Semi-Áridas. Recife: ABRH – Editora Universitária UFPE, 2007. p.508.

Costa , W. D. et al.(2000) Monitoramento das Barragens Subterrâneas no Estado de Pernambuco. In: v Simpósio de Recursos Hídricos do Nordeste ABRH/LARHISA, Natal, RN.

DIAS, T. F. et al.(2016) Water Resources Management Coexistence and Conflict in Semiarid Brazil. Desenvolvimento em Questão Editora. Unijuí • Ano 14 • N. 34 • Abr./Jun.

Hauschild, M.and Döll, P. (2000) Water Use in Semiarid Northeastern Brazil – Modeling and Scenario Analysis. Center for Environmental Systems Research University of Kassel.

INSA - National Institute for the Semiarid – (*Available:* www.insa.gov.br)

Malvezzi, R.(2007) Semiárido: uma visão holística. Brasília: Confea,140 p. (Pensar Brasil).

Medeiros, S. S. et al. (Orgs.) (2011) Recursos hídricos em regiões áridas e semiáridas. Campina Grande: Instituto Nacional do Semiárido.

Programa Água Doce - Ministério do Meio Ambiente
*(Available:www.mma.gov.br/**agua/agua-doce)***

.