Public Water Resources Policy for the Semi-Arid Region

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Introduction

For the use of natural resources to occur in a sustainable way, particularly soil, water, and vegetation, it is necessary that the process of development take place along with the preservation of the productive capacity of these resources. When they are misused, agricultural productivity is reduced, desertification processes advance, ecosystems and water sources become more fragile, sustenance of populations is reduced, poverty increases and there is an exodus to large cities. From a social point of view, therefore, adequate public policies are needed so that the creation of jobs and income occurs together with other policies that generally assure the rational use of water and other natural resources.

Thus in order for sustainability to occur a base of natural resources is required and the environment used in a manner such that soil productivity can at the least maintain itself, preferably being enhanced over time. Therefore, the various ways of using land and water should be subordinated to the principle that the use of these resources should not exceed their capacity for renewal.

The problem with water resources in the more inhabited semi-arid regions is a crucial question for overcoming obstacles to development. It is a fact that the governments of many semi-arid regions of the world are acting with the objective of implanting infra-structures capable of making available sufficient water to assure the supply for humans and animals and make irrigation viable. However, in a global sense this effort still is insufficient to resolve the problems originating from water scarcity, making regions continue to be vulnerable to dry periods, especially when speaking of the diffuse use of water in the rural environment. In any sense, the increase of and strengthening of the water infrastructure, with adequate management, constitute essential prerequisites for solution of the problem, serving as a basic element for the inland development.

The semi-arid Northeast

The expression semi-arid 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, vegetation which is characteristic of semi-arid regions, such as the steppes of Kazaquistan, for example, and caatinga which is present only in the Northeast of Brazil.

According to the description presented by Cirilo, et al. (2007, p.33), the Northeast Region of Brazil occupies the north-east point of the country, between 1º and 18º30’ latitude South and 34º30’ and 40º20’ longitude West of Greenwich. Its area, which is from 1,219,000 km², is approximately equivalent to a fifth of the entirety of Brazil, including nine states (Maranhão, Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe e Bahia). Living in the region are 18.5 million people, of whom 8.6 million are in the rural zone.

Considering the need for reevaluating the limits of the semi-arid region of the Northeast, a study developed by the Ministry of National Integration (Brasil, 2005, 2007) added to the 1,031 municipals incorporated within the limits then present an additional 102 new municipals framed within the established criteria of rainfall, index of aridity and risk of drought. Therefore, the area officially classified as semi-arid expanded from 892,309.4 km² to 969,589.4 km².

Figure 1 presents the limits of municipals inserted in the new delineation of semi-arid and sub-humid dry northeast.

The semi-arid Northeast is a region poor in surface drainage. This situation can be explained by the temporal variability of rainfall and the dominant geological characteristics, where there is a predominance of shallow soil on top of crystalline rocks and consequently low exchanges of water between the river and the adjacent soil. The result is the existence of a dense network of temporary rivers. The major exception is the São Francisco River. This large river, however, originates in the Canastra Mountains in Minas Gerais, and only after hundreds of kilometers of flow comes into the Northeast Region.

Other permanent rivers can be found in Maranhão, in Piauí and in Bahia, highlighted by the Parnaíba River. The rivers that are temporary in nature are found in the northeast portion that extends from Ceará to the northern region of Bahia. Among these the most prominent is the Jaguaribe, in Ceará, for its length and potential for exploitation: in its river basin can be found some of the largest reservoirs of the Northeast, such as Castanhão and Orós.

Regional water resource potential – surface water

Surface water potential is represented by the average output over a long period in a section of the river. This is an important indicator, since it makes possible a first evaluation of the lack or abundance of water resources in the spatial area of a given region.

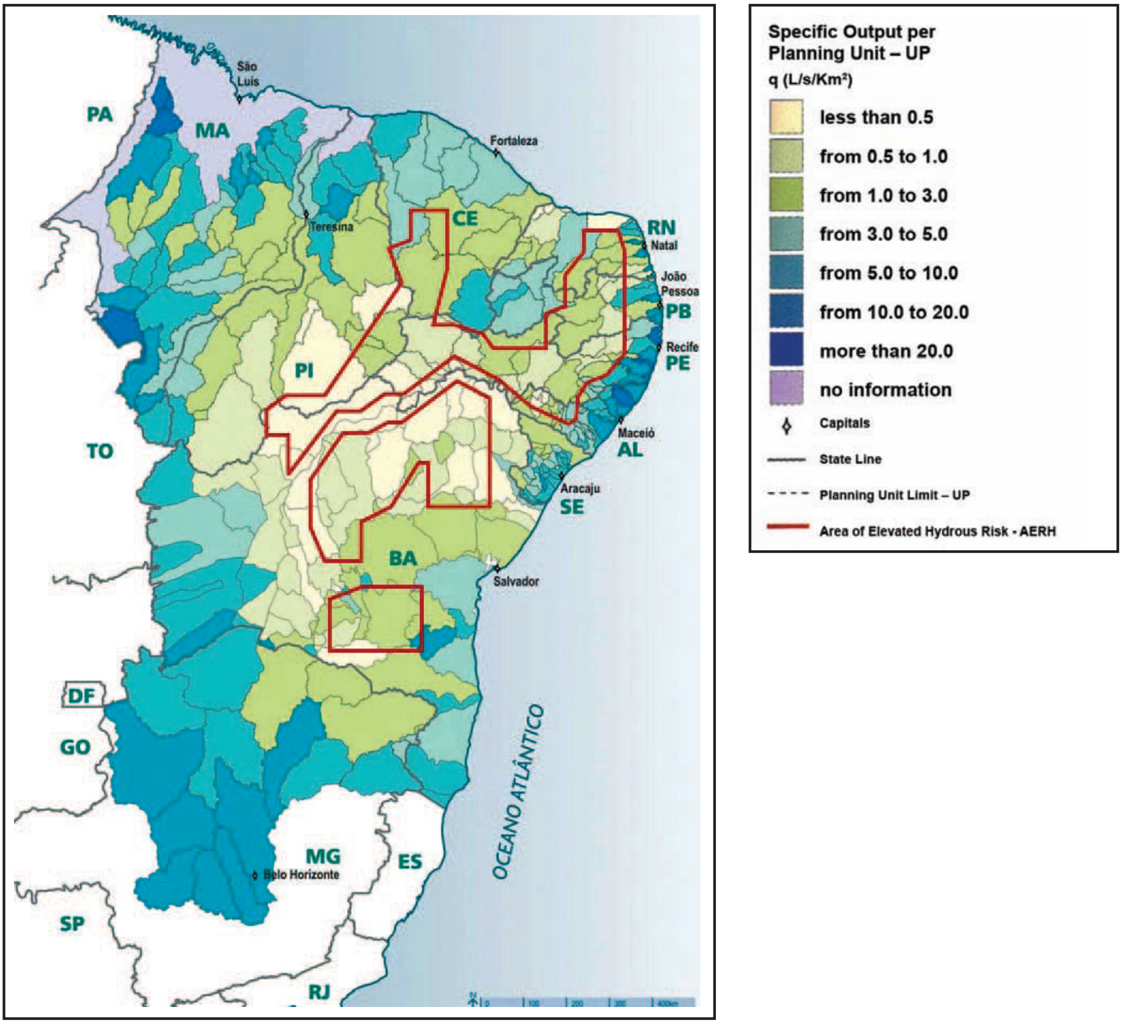
Figure 2 indicates the surface water potential, expressed by unit per area (indicated in liters per second per square kilometer), in the river basins of the region, as a result of hydrological studies developed for the work by ANA/MMA – Northeast Atlas – Urban Water Supply (ANA, 2005).

Source: Brasil (2005)

Figure 1
New coverage of the semi-arid and dry sub-humid region of the Northeast of Brazil

Regional water resource Potential – groundwater

According to Demetrio et al. (2007), aquifers are geological formations that have the capacity to store and release water in quantities that can be economically viable for human exploitation. For excellence, aquifers are composed of sandy sediment. In principle, crystalline rock would not create a good aquifer, since the minerals that constitute this rock are fused to each other, in other words, at least for the practical ends of water accumulation, there are no pores,. However, due to various kinds of tectonic forces these rocks break, forming fractures or junctures, and water accumulates in the open spaces of their structures.

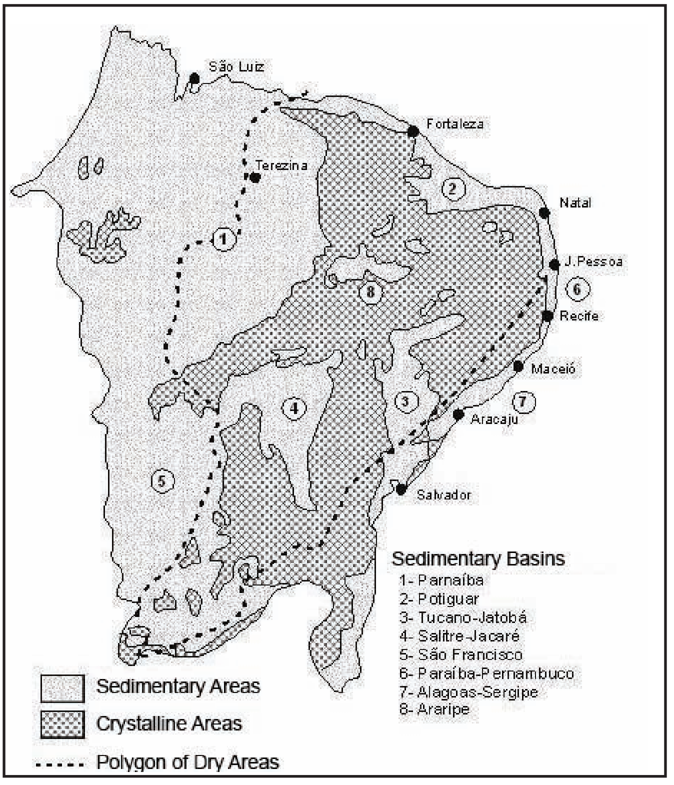


Source: ANA (2005).

Figure 2
Specific average flow of Northeast Brazil river basins

In what is referred to as an occurrence of groundwater, as the northeast territory is constituted of greater than 80% crystalline rock, has a predominance of water with an elevated salt level captured in low flow wells on the order of 1 m^3/h. The exception occurs in sedimentary formations, where the water is generally of better quality and where it is possible to exploit flow of the order of tens to hundreds m^3/h, continuously.

Figure 3 below shows, in schematic form, the occurrence of aquifers in the Northeast.



Source: Demetrio et al. (2007)

Figure 3
Distribution of sedimentary and crystalline rocks occurring in the area within Sudene's drought polygon.

Rebouças (1997), following previous studies, emphasizes that fresh groundwater reserves in the Northeast sedimentary basins allow the annual collection of twenty billion cubic meters per year, without putting existing reserves at risk. This volume is equivalent to 60% of the capacity of the Sobradinho Reservoir in Bahia (34 billion cubic meters), mainly responsible for normalizing the flow of São Francisco River, or triple the capacity of the Castanhão Dam (6.7 billion cubic meters). It may therefore be noted that it is a considerable volume of water. The peculiarities of these reserves, however, must be emphasized:

- spatial concentration (in the case of the semi-arid, Piauí and Bahia have the principal aquifers, in the remainder of the region the occurrences are sparse sedimentary formations);
- in many aquifers the depth enhances the cost of implementation and operation of the wells (in the Chapada of Araripe, municipal of Bodocó, on the Pernambucano side, there is a 950 meter deep well with a capacity of 140 m³/h, where the dynamic water level is more than 300 meters below the surface);

- there is considerable uncertainty about the mechanisms for recharging the sedimentary aquifers of the semi-arid, as well as the dimension of this recharge; for this reason, intense exploitation could put these sources at risk.

From previous explanation, groundwater of the semi-arid northeastern reserves should be used discerningly, with preference for supplying humans (various cities of the Northeast situated above or next to the sedimentary basins are supplied by these sources), and doesn't make sense considering that this potential will be capable of attending to regional demands, especially since great water transference would be necessary for that.

With the combining of surface water and groundwater potential, various studies, following PLIRHINE (Sudene, 1980), updated by the Projeto Áridas (1994) and collected by Rebouças (1997, p.144), present indicators of the quantity of water potential by inhabitant by year for the planning units in which PLIRHINE has divided the region. These indicators show particularly critical regions such as East Paraíba (1,030 m^3/ per capita /year), East Potiguar (997 m^3/per capita/year), Fortaleza (846 m^3/per capita /year) and East Pernambuco (819 m^3/per capita /year). By considering the parameter established by the UN of 1,500 m^3/per capita /year as the minimum potential quantity of water for the well-being and development of any region. In spite of the critical situation, semi-arid regions of the world with a lesser *per capita* quantity of water exist, such as Israel, where, again as in Rebouças (1997, p.144), only 370 m^3/ per capita /year are available, and yet the ongoing standard of agricultural productivity is greatly superior to the semi-arid of the Northeast, thanks to the efficiency obtained as a consequence of technological control, reuse of served water, recharging aquifers and other actions.

Certainly, good practices in these regions are examples to be followed. However, it is important to emphasize the physio-climatic differences in relation to the Northeast of Brazil. Basic differences, for example, are a regimen of more uniform rains and much lower potential evaporation, as is the case in regions of Europe, where the average rainfall is inferior to the semi-arid northeast; deeper soil and the possibility of natural or artificial aquifers recharge, as occurs in the American mid-west; a high level of sewage treatment and consequently much lower water pollution; existence of an infra-structure integrating the basins by hydraulic works, making possible improved territorial water distribution.

A good example of efficiency, in order to take advantage of the potentials described previously, is provided by the Salt River Project, in the American state of Arizona. Taking advantage of soils that extend to 500 meters deep and thawing water which runs at certain times of the year, intensive aquifer recharge in that project is promoted as much from the inundation as from the inversion of pumped water along the extension of the channels to allow water use throughout the year.

Figure 4 shows Salt River and the channels that derive from it.

Source: Google Earth

Figure 4
Damming on Salt River, channels derived from it and the aquifer recharge area.

Processes of desertification in the Northeast

The Convention of the United Nations for Fight against Desertification (UNCCD) conceptualizes *desertification* as the process of degradation of land in arid, semi-arid and sub-humid dry regions, owing to factors such as entropic action and climate changes. This degradation is the loss or reduction of economic or biological productivity of dry ecosystems caused by soil erosion, deterioration of hydro resources and loss of natural vegetation.

According to the study of the Ministry of the Environment (Brasil, 2002, p.42), the areas of the Northeast with extreme signs of degradation, known as "Nuclei of Desertification," are Gilbués (state of Piauí), Irauçuba (state of Ceará), Seridó, the frontier between the states of Paraíba and Rio Grande do Norte, and Cabrobó (state of Pernambuco). It is estimated that the process of desertification has been compromising an area of 181,000 square kilometers, deriving from diffuse and concentrated impact on the regional territory.

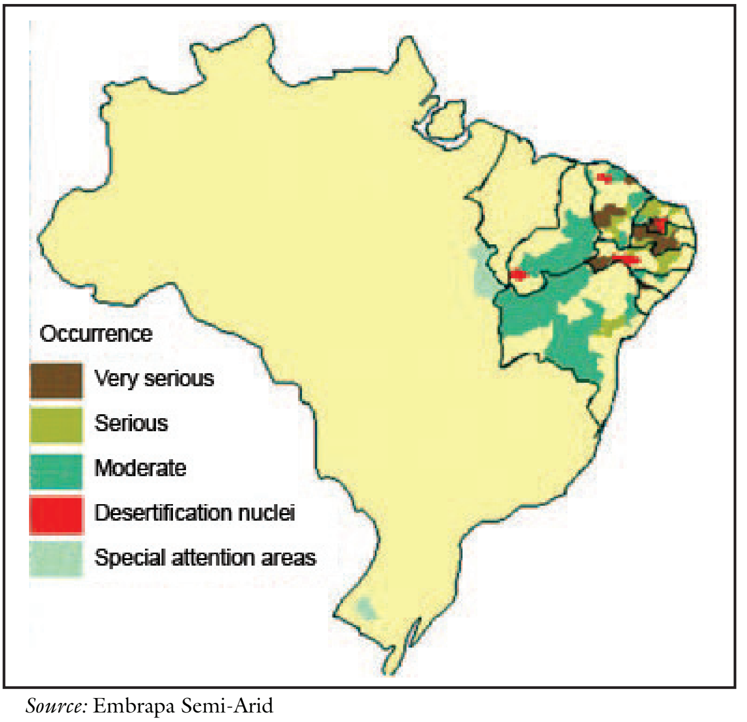
Box 1 indicates that the very seriously affected area is from 98,595 square kilometers which corresponds to approximately 10% of the semi-arid portion, and 81,870 square kilometers seriously affected. The other areas subject to the processes of desertification - 393,96 square kilometers –suffer moderate degradation.

Figure 5 represents, in the semi-arid polygon, the areas reached by the desertification process.

Box 1 – Areas affected by desertification in the Northeast

State	Total Area (km2)	Area affected in absolute terms (km2)		
		Moderate	Serious	Very serious
Alagoas	27,731	6,256	–	–
Bahia	561,026	258,452	10,163	–
Ceará	148,016	35,446	16,366	26,993
Paraíba	56.372	–	8,320	32,109
Pernambuco	98,307	–	28,356	22,883
Piauí	250,934	86,517	–	3,579
Rio Grande do Norte	53,015	5,154	18,665	8,337
Sergipe	21,994	2,071	–	4,692
Total	1,217,395	393,896	81,870	98,593

Source: Brasil (2002 p.44).



Source: Embrapa Semi-Arid

Figure 5 – Desertification: areas affected.

The over-exploitation of natural resources in this region has the medium term effect on the environmental quality in the region, where the predominant economic activities are subsistence, varied livestock and some irrigated agriculture projects. Many of the irrigated areas show signs of salination from deficiency or absence of soil drainage. In around 600 thousand irrigated hectares in the Northeast, signs of salination and/or soil compacting are registered in approximately 30% of the area.

Potential impact of climate change

Recent studies have demonstrated a high correlation between the occurrence of extreme events (droughts and floods) in different parts of the planet and the phenomena designated “El Niño” associated with the increase of the temperature of the water in the Pacific Ocean. In Brazil, “El Niño” provokes great floods in the South Region, in the river basins of Iguaçu, Itajaí, Uruguai and others, and causes more severe droughts in the semi-arid region of the Northeast. From this arises the discussion about the causes of extreme events, whether they are natural, or derive from human intervention.

The Intergovernmental Panel on Climate Change report, known as IPCC AR4 (available at the *site* http://ipcc-wg1.ucar.edu/) concerning climate change concluded that, with a certainty of more than 90%, global warming in the last fifty years is caused by human activities. According to Marengo (2007), the results of this study for South America indicate that the most intense climate changes for the end of the 21st century, in relation to the present climate, are going to take place in the tropical region, specifically Amazônia and the Northeast of Brazil. These two regions, moreover, are the most vulnerable of Brazil to climate changes.

In general within a warmer atmosphere more intense precipitation is predicted in the most humid regions as well as shorter summers and more frequent heat waves. In the semi-arid region the majority of climate change scenarios are a sign that, with the increase in temperature, the increase in evaporation of bodies of water and, consequently, flow reduction; reduction of aquifer recharge of up to70% by the year 2050 and, therefore of the base river flow; concentration during the rainy season within an even more reduced time frame with a reduction of precipitation (pessimistic scenario: temperature increase from 2 to 4° C and 15% to 20% less rain; optimistic scenario: 1 t0 3° warmer, 10% to 15% rain reduction); tendency toward “aridization” with more typical vegetation of arid regions such as cactus replacing “caatinga,” the natural vegetation of this region.

Water as a condition for Northeast development

History of regional public policy

The policy of accumulating water in dams, typical of the region, has been carried out in two ways. The first is in large reservoirs with the capacity for multiannual regularization in large scale river basins. This type of reservoir, with capacity on the order of a billion cubic meters, is present in several States of the region, although in small number. Figure 6 shows Cedro Dam, the construction of which began in 1873, under the aegis of Emperor D. Pedro II, and concluded in 1906. The second water accumulation policy accrues from the employment of *"barreiros"* or small reservoirs with the capacity on the order of a few thousands of cubic meters spread over the entire region. High indices of potential evaporation, on the order of 2,500 mm per year, bring a serious problem to the policy of water accumulation, especially to the small dams, which are not able to withstand the effects of prolonged drought.

In addition to the already cited reservoirs, which still constitute the most usual type of service for the diffuse rural population, rural wells and cisterns are the most common means of collecting and storing water in the region.

Photo: Secretary of Water Resources/Ceará

Figure 6 – Cedro Dam, in Ceará.

In the Northeast of Brazil it is estimated that nearly 100 thousand wells have been drilled. From the fact of the greater part of the semi-arid region of the Northeast being constituted of crystalline formations, the drilling of wells as a solution for the supply of the different needs is subject to the following limitations:

- low flow, in the majority of cases up to 2 m^3/h;
- salt percentage, in a significant portion of the wells, above recommendations for human consumption;
- high index of dry wells due to geological peculiarities.

The wells drilled in crystalline terrains have a depth on the order of 50 meters, while in sedimentary basins, where the depth varies, in the majority of cases, they are between 100 and 300 meters.

In a broader context, the recordings of cisterns and other direct forms of collecting and storing rain water, extending over 2000 years in regions such as China and the Negev Desert, today Israeli and Jordanian territory (Gnadlinger, 1999), have since passed through the pre-Columbian experiences of the Aztecs and the Mayans. Initiatives developed in China gave notice of the construction of a million cisterns in a specific region. Various initiatives of the States, municipalities, Country and governmental entities have multiplied the number of cisterns in the Northeast of Brazil. Figure 7 shows typical pane cisterns executed *in loco* in every part of the Brazilian semi-arid areas.

The cisterns, with a normal accumulation capacity between 7 and 15 cubic meters, represent a supply of 50 liters of water daily during 140 to 300 days, being filled by the end of the rainy season and without being refilled during the period. Taking the necessary care for cleaning of the roof, the cistern, gutters and tubing is a basic solution for satisfying the most essential needs of the diffuse rural population. While there are thousands of cisterns spread over the whole of the Northeast, the quantity is still low, by comparison to the needs of the rural population.

Photo Courtesy of the Author

Figure 7 – Pane cisterns and the system of collecting water from the roof.

In the middle of the 1990s successful experiments in the construction and management of small subsurface dams were implemented by Caatinga, an NGO in the municipality of Ouricuri (PE), providing support for family agriculture in the region. In 1997 the government of Pernambuco came to accept as one of its "Living with Drought" programs the construction of subsurface dams in the Agreste and Sertão regions of the State (Costa et al., 2000). With the implementation in the Northeast of the so-called productive work fronts due to the drought which devastated the region, nearly 500 reservoirs were constructed in Pernambuco and the results of which need to be evaluated and monitored. Parallel to technical activities, preparatory work among the population to be benefited is also necessary in order to make better use of the available water in these hydro works.

In Figure 8 the execution of underground dams is presented in the phase of waterproofing the dammed axis to retain the flow of water in the subsoil (Cirilo et al., 2003).

Photo Courtesy of the Author

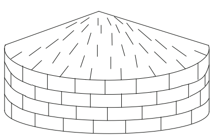
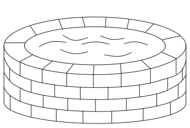
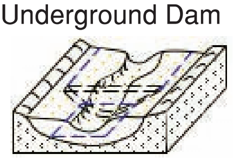
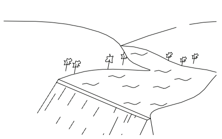
Figure 8
Construction of the underground dam –
excavation and placement of the waterproof cover.

Besides the governmental initiative cited, NGOs such as Caatinga, AS-PTA and Diaconia have been contstructing underground dams in partnership with the inhabitants of the rural zone of the Northeast, especially in Pernambuco.

Water desalination

Due to the bad quality of the water in existing wells in the northeastern semi-arid work reverse osmosis membranes are employed for desalination to remove a significant portion of the salt present in the water. Notwithstanding desalinators showing effectiveness for rendering water potable there are problems that need to be managed: destination of the refuse originating from the desalination, the high cost of maintenance and logistics of a complex operation. As to the destination of the refuse, some solutions have been adopted, such as: use of tanks with slim water blades designated for the increase in evaporation speed and consequently depositing of salt; accumulation in tanks for the breeding of fish such as the pink tilápia and salt-water shrimp; cultivation of the *Atriplex nummularia*, a plant with a great capacity for salt absorption, originating in Australia and successfully introduced in Chile, offering an excellent forage producer, which contains between 16% and 20% proteins and has a life span of up to twenty years (Montenegro & Montenegro, 2004).

Box 2
Options for obtaining water on small rural properties

Ways of capturing water	Estimated Capacity	Caracteristic	Uses suggested
Cistern 	20 to 30 m3 at the end of winter, with roof capturing and a mid-size house	Good quality.	Water for family drinking and cooking.
	Mid-size well of 1,000 l/h (crystalline well)	Generally brackish.	- Animal cleaning - Toilet usage
Underground Dam 	Depending on the width, extension and depth of the deposit.	- In general good; - Needs adequate management to avoid salinization; - Risk of agrotoxin pollution.	-Family Agriculture; -Agricultural Production.
	Average small dam of 10,000 m3 (on private properties)	- High losses from evaporation.	-Agricultural Production; -Family Agriculture.

Source: Campello Netto et al. (2007, p.491).

Reuse of used water

In a general way, the destination of sewage still continues to be bodies of water. 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 have raised the level of nutritional source and contributed to the flourishing of toxic algae known as cyanogens, which by themselves constitute a true 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.

Campello Netto et al. (2007, p.494) commented that, in certain countries, such as Israel, cultural reasons and hydro deficiency favor the application of soil residue as against disposal in bodies of water. The application of organic residue in agriculture has received more attention due to the cost and the environmental problems associated with disposal of residue, besides, as cited, the low availability of clean water for production processes. In the Northeast, the reuse of water for industrial activities has surged in sectors such as clothing production. It still is quite timid, practically limited to pilot projects, with regard to the reuse of sewage, treated or not, for agricultural activities.

Transporting water a great distance

In what is referred to as human storage in cities of the semi-arid regions which are not near fountains, the construction of aqueducts is the most adequate solution, whether starting from large scale reservoirs or from wells in sedimentary areas (with great restriction for what can be identified as the potential of these reserves, principally regarding the mechanisms for recharging) or even starting from more distant rivers and reservoirs, even in other river basins, configured in what is called transposition of water between basins

Major hydrous works of water transposition have been concluded, are in construction or are projected to supply cities of semi-arid regions and give support to productive activities in recent years. This is the case, for example, of the Integration Canal in Ceará, intended to conduct 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 kilometers (Figure 9). An other example is the 500 kilometers network of aqueducts in Rio Grande do Norte (Figure 10). In both cases it may be noted that the water reserves belong to each State.

Another situation being experienced today is the beginning of the work of transposing water from the São Francisco River (Brasil, 2000) to the states of Ceará, Rio Grande do Norte, Paraíba and Pernambuco (configuring only transposition of the portion of water destined for the area outside the basin in its case, since two thirds of Pernambuco's territory makes up part of the São Francisco basin).

According to the Minister of National Integration, the final stage of the project will have a continuing water withdrawal of 26.4 m^3/s of water, equivalent to 1.4% of the flow guaranteed by the Sobradinho Dam (1,850 m^3/s) in the stretch of the river where the collection will be made. This amount is intended for

Photo Secretary of Water Resources/Ceará.

Figure 9 – Integration Canal, Ceará.

Photo Secretary of Water Resources /Ceará.

Figure 10 – Rio Grande do Norte Pipeline Network

the consumption of the urban population of 390 rural municipalities and in the semi-arid region of four Northeast states. In the years in which the Sobradinho Reservoir surpasses its capacity for accumulation, the captured volume can be increased by up to 127 m^3/s, contributing to the increase in the guarantee of water offered for multiple uses. Figure 11 represents the general outline of the project, showing the North and East axes, the principal structures of the system, as well as the reservoirs that will receive the water and the approximate tracing of the aqueducts to be interconnected.

The North Axis was projected for a maximum capacity of 99 m³/s and should provide a continuous output of 16.4 m³/s, intended for human consumption. The excess volume transferred will be stored in reservoirs in existing basin receptors: Atalho and Castanhão in Ceará; Armando Ribeiro Gonçalves, Santa Cruz and Pau dos Ferros, in Rio Grande do Norte; Engenheiro Ávidos and São Gonçalo, in Paraíba; Chapéu and Entremontes, in Pernambuco.

In the state of Ceará, the reservoir storage system that supplies the Metropolitan Region of Fortaleza (Pacajus, Pacoti, Riachão and Gavião dams) are already interconnected with the Jaguaribe River through the Channel do Trabalhador (capacity of 5 m³/s). The Integration Canal (capacity of 22 m³/s), already cited, will connect Castanhão Dam to the basins of Banabuiú (largest tributary of the Jaguaribe River) and Metropolitanas.

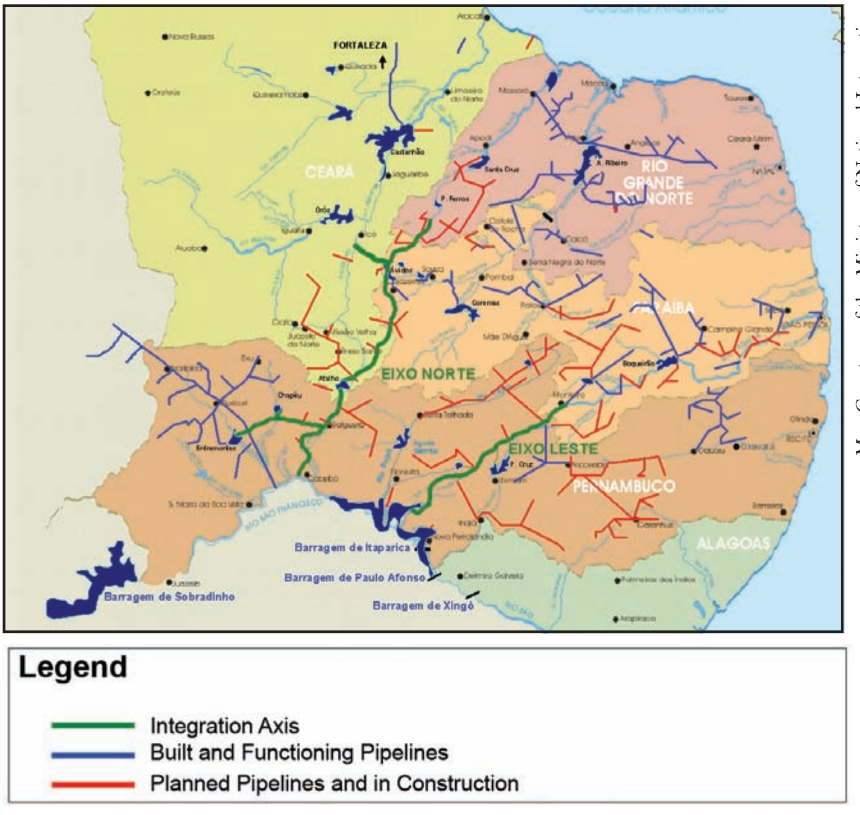
In the state of Rio Grande do Norte, the Armando Ribeiro Gonçalves Dam is responsible for the storage supply for a large number of municipalities in the basins of Piranhas-Açu, Apodi and Ceará-Mirim through four large operating aqueduct systems: Mossoró Branch, Sertão Central/Cabugi Branch, Serra de Santana Branch, and Middle East Branch. As a complement to the Upper West Branch when finished, it will satisfy the greater part of the municipalities in the basin of Apodi, capturing water in the Santa Cruz Dam, one of the reservoirs that should receive water from the São Francisco Project.

In the state of Paraíba, the East Axis of the São Francisco Project, according to data from the Minister of Integration, will permit the increase of the guaranteed offering of water to the various municipalities of the Paraíba Dam, supplied by the dams of the Congo, of Cariri, Boqueirão and Acauã. The North Axis will guarantee the supply for several municipalities of the Piranhas river basin, served by systems such as Adutora Coremas/Sabugi and Canal Coremas/Souza.

In the state of Pernambuco, the North and East Axes, crossing its territory, will serve as the water source for existing or planned pipeline systems, responsible for water supply of the populations of the west region: The West pipeline, already having the largest part of its operating system in the last bidding stage - this system can reinforce its capacity if integrated with the North Axis; Pajeú Pipeline, with the first phase of bidding initiated in 2008; Agreste/Frei Damião Pipeline, still in the planning stages, and Salgueiro Pipeline, which has been operating for nearly thirty years and which, from the growth in demand, is in present need of completion.

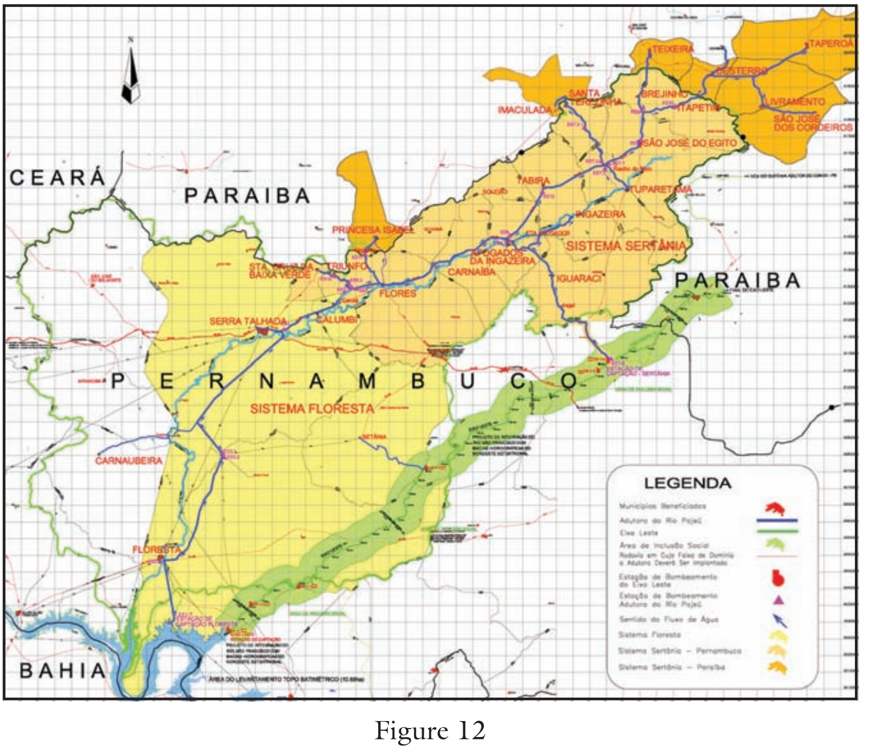
Figure 12 represents the Pajeú Pipelines, intended to offer 831 l/s for the nineteen municipal headquarters of Pernambuco, eight from Paraíba and various districts close to the dam tracing, and will have a length of approximately 600 km.

The Pipeline System of Agreste (Pernambuco, 2008) will have a length greater than a thousand kilometers and should transport around 6 m³/s to seventy municipalities and eighty locations in the Agreste Region of Pernambuco. This system is shown in schematic form in Figure 13.



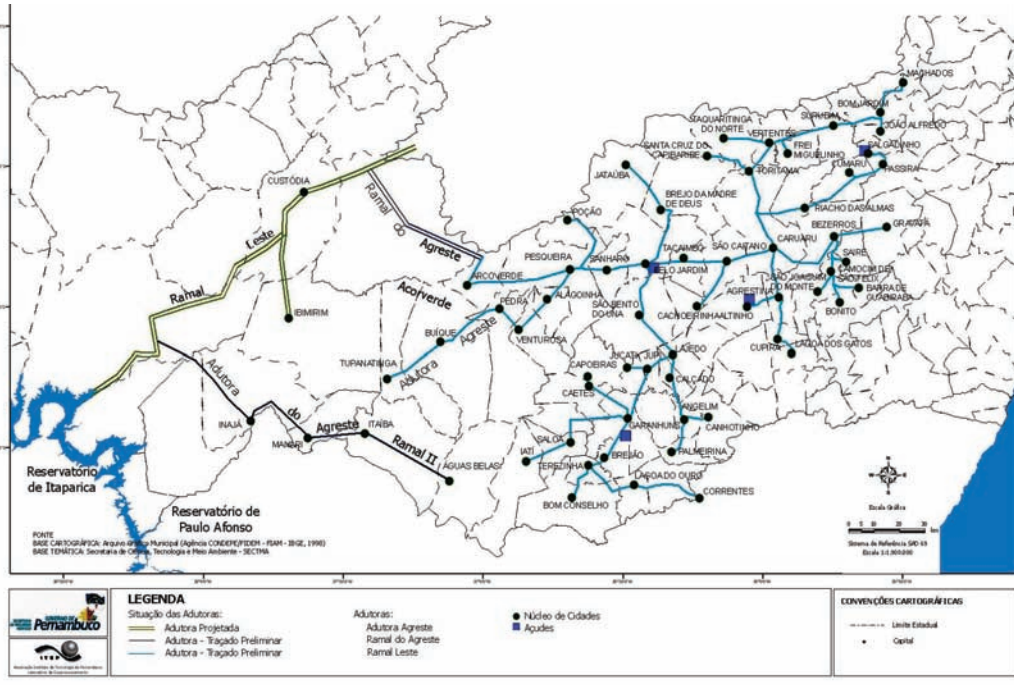
Map Courtesy of the Ministry of National Integration

Figure 11 – General conception of the project – axes, dams, reservoirs.



Source: Ministry of Integration / Dnocs

Figure 12
Anticipated Outline for the Pajeú Pipeline.



Source: Pernambuco (2008)

Figure 13
Outline for the project phase for the Agreste Pipeline System.

It is important to emphasize the controversial character of the São Francisco Project, over which hovers strong political and technical resistance from non-governmental organizations, river basin committees and from 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. The principal arguments refer to the priority the Union should give to revitalizing the São Francisco; to the lack of trust concerning the need for water in receptor basins and doubts concerning the economic viability of implementing future irrigation projects, facing the costs and possible losses of water in transport; the belief that there won't be social justice in the hydro-agricultural projects throughout the channels, with a greater concentration of income and land. There has not been much discussion as to the pertinence of transferring water from the São Francisco River to supply water to regions outside the basin, which raises much more opposition to the North Axis than to the East, given the priority of this axis for water supply. In turn, the major argument in favor of transposing the São Francisco water, aside from human supply, is that the reservoirs intended for irrigation within the project will have great synergistic gains, given that it will not be necessary to save water for dry periods and, therefore, will lose much less water due to evaporation

Conclusions

Brazilian semi-arid regions present conditions more difficult to overcome than other semi-arid regions of the world. For the most part the soil here is very shallow, with rock that is almost protruding, which compromises the existence, recharge and quality of aquifers; high temperatures lead to high rates of evaporation; few perennial rivers, and there is the highest concentration of population among the semi-arid regions of the world which generates excessive pressure on water resources.

Up to the 1990s the region has presented a history of mistaken public policy, when not absent, especially for having been based on the implementation of small reservoirs highly vulnerable to dry seasons and drilling of wells in the crystalline. Allied with these misconceptions, the lack of water management caused the ongoing regional crisis at each drought occurance. As a means of alleviating the suffering of the unassisted populations, the usual solutions: barrel trucks for transporting water, work fronts to assure some income for sustenance. In sum, purely palliative measures.

Starting from this era was a new philosophy, implemented in the states with the support of the Union and Law n.9.433/1997, known as the Water Law: control of use, by means of instruments such as water rights and the still incipient charge for raw water use; water resources plans for river basins and for the States; structuring of management entities and basin organisms; structural works programs. Compared to the remainder of the country's regions the greatest advances in the management of water resources have been taking place in the Northeast.

In order to attend to the need for water intended for multiple uses, it is important to understand the specificity of the solutions. It is unimaginable that major channels and pipelines can supply diffuse rural populations other than those close to the outline of the works. Therefore cisterns, small reservoirs, wells and the use of desalinators should be expanded and improved, particularly in operation and maintenance.

Concerning the transposition of water from the São Francisco River, there is no more room to add to the discussion "for or against," given that the work is irreversible. However, in order to make it effectively useful for benefiting the populations considerable planning is required. The operational questions of the project should be further studied, with a more global view toward integration of existing sources with scenarios of expected climate changes. Questions like reducing water flow loss and increasing efficiency, principally in irrigation where the consumption is greatest, should be thoroughly analyzed in the project. Thorough study is also needed for matters such as distribution of the land, crops to be irrigated, complementary infra-structure, and the logistics of production flow 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 or expected, in the São Francisco River basin itself, need to be studied within a systemic vision toward the future, because there are great pressures on the river water resources 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, or regimes of ecological flow, especially at the mouth of the river, and implementation of an operational plan of the dams addressing these conditions. The sanitation actions of the municipalities of the basin currently being implemented by the federal government or by the states need to be complemented by territorial revitalization programs: reforesting, protection of sources, erosion control and other actions.

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Abstract – The climatic, social and economic characteristics in the Brazilian semi-arid region requires specific technologies for water resources use and conservation. It is necessary to analyze alternatives for clean water acquisition for diverse uses. In contrast to traditional ways of accumulating water in small surface reservoirs and drilling of wells in crystalline terrains, alternatives have been sought such as wells of greater depth in sedimentary areas, methodologies for evaporation reduction and salinization control, destination and use of effluents. Finally, projects for integration of river basins and long distances water transport are starting to be built in the Northeast region. The approach of those water policies for the Brazilian semi-arid region is the purpose of this paper.

Keywords: Water resources management, Semi arid regions, Sustainable water policies.

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