

An Historical Perspective on the Administration of Water in Brazil

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Abstract: *This article focuses on two instruments of water resources management – charging for water and reallocation of water use through a water market. Charging for water in nature has been practiced for centuries in some cases. On the other hand, a culture of free access to water was dominant in most countries during ancient times. An historical review of the charging of water and its administration is presented. The article covers the time of ancient Rome to the present. A current example is the model practiced in the semi-arid region of Ceará State in northeast Brazil. Regarding water use reallocation by a water market, as an alternative to improve water efficiency, the experience presented comes from the south of Ceará State one century ago. Based on past experience, the article then presents a model to implement a water market bounded in space to an irrigation district, and in time to periods of water deficit in reservoirs. Six prerequisites of market-based transfers of water are analyzed, and it is shown that in the proposed model they can be addressed.*

Keywords: *Water charging, water management, water market, water administration.*

Introduction

“The day, the water, the sun, the moon, the night – these are things that I don’t need to buy with money,” wrote the Roman playwright Titus Mucius Plautus more than 2,000 years ago. The analogy made by Plautus among the five entities probably was based on the recurrent character of these events, which happened independently of people’s wills. The five entities are consequences of the cycles of rotation of the celestial bodies - sun, earth, and moon. However, the water entity has some particularities, its quantitative limitation and qualitative vulnerability, that were not perceived by Plautus at that time.

Many societies were developed based on Plautus’ vision. People lived close to water sources and drew it whenever they needed. However, in time, cities and populations kept increasing and, as a result, generated new problems and a need for new solutions. After the Industrial Revolution, the process accelerated. Water demands were multiplied. The increase in demand led to an insufficient supply during dry periods. The storage and transportation of water supply was intensified. To make this temporal transportation, big reservoirs were built, incurring huge costs. Bulk water began to have significant cost. Even though in the rivers, the waters stopped running only by nature’s force, humans had begun to strongly intervene in the terrestrial phase of the hydrologic cycle.

This evolution in water use resulted in the need for changing the way it was managed. Bodies of water, rivers, lakes, and reservoirs, began to receive pollution loads

in amounts beyond their purification capacities. The waters became more and more polluted. In order to consume this water, society was forced to pay high treatment costs. Pollution associated with environmental disasters made society realize the necessity of a new way of visualizing and managing water resources and the environment. The search for new paradigms was accelerated.

This article deals with the way water resources were managed in the past and with the search for a new way to manage these resources. In this new management strategy, the multidisciplinary approach proves to be very necessary. In the same way, it is shown that to create a better future for our common world, it is necessary to look to the past, all over the world, and learn from these experiences.

Water Administration - Old Times

Up to 440 years after the founding of Rome, the Romans’ water needs were satisfied by water they drew from the Tyber, from wells, or from springs. When the city grew, Romans built the first complex water distribution system registered in history. Instead of people going to the water, the water was run to the city in long aqueducts, such as Appian, Old Anio, Marcia, Tepula, Virgo, and Alsietina. To manage such a complex water system, the Romans had an administrative structure headed by a Water Commissioner selected by the Emperor (Frontinus, 1997).

Julius Frontinus IV was appointed Water Commis-

sioner of Rome by the Emperor Nerva Augustus. Trying to organize his administration, Frontinus wrote two books registering facts and describing the water system of Rome at that time. Frontinus' books have been the main source of learning from water administration of the past.

In ancient Rome, the water administration was under the jurisdiction of a Water Commission (*Statio Aquarum*), headed by the Water Commissioner (*Curator Aquarum*) and assisted by two Praetorians (*adjustotes*). The Water Commissioner was appointed for life by the Emperor, with the Senate's approval. The Water Commission maintained registers with double entries: one to evaluate water availability and the other to register attended demands (the modern concept of water rights concessions by the State).

In that bureaucratic water administration structure, there was the position of the water-man, who received water from the state to furnish it to the consumers. According to Frontinus, the water-men that managed the intake to Tusculan (the modern Frascati) used to divert water for their own profit. 'Commenting on Frontinus' statement, Lanciani (1880) wrote: "It is in the instinct of both ancient and modern water guards to commit such frauds." Even today, if one looks around, it is possible observe that this instinct is still alive in human nature.

The Free Water Culture

The ideas expressed by Plautus, as previously cited, were not original. They were old ideas, already incorporated in habits and laws, stated in an elegant way by the playwright. An historical retrospective allows the capture of parts of texts that ratify the culture and the right to free water access.

The Talmudic Law, written between the 5th and the 3rd century BC, established that rivers and streams that form springs belong to all citizens (*cives*). The Law also recognized the existence of public wells and access rights of aliens (*peregrini*). The Law of the Visigoths (Lex Visigothorum of the century VII AD) established free access for sailing, fishing, and other community uses in the largest courses of water (*flumina maiora*) (Caponera, 1992).

Evidence of Charging for Bulk Water

If there is evidence of free water culture throughout time, there is also evidence of civilizations in which water distribution was accompanied by state administration, with some changes. In ancient China, the Li-Chi established:

In spring, all life starts and rains of heaven fall on earth, and therefore, let the waters run and irrigate the fields. . . ; in the summer months, build dams and dykes and store the waters goes later consumption. . . ; in the winter months, life ceases and therefore hardship arrives, let inspection of work and collection of water rates and taxes be undertaken . . . punish offenders. (Caponera 1992)

Even in Rome, in Frontinus' time, although almost all water was distributed for public use, there was a part destined for the Emperor and Privates. Privates received water by a written permission (*epistula a principe*) and were charged a water tax (Frontinus, 1997).

Reasons for Charging for Water

Analyzing those text fragments on water administration during ancient times, some possible reasons for charging and not charging for water in different societies can be identified. The philosophy of Plautus referred to access to running waters in rivers or streams and spring waters. This was the predominant philosophy.

On the other hand, charging for bulk water in ancient China certainly did not have the same objectives that it has today. Even the word "tax" may have today a technically different meaning. But the fact is that there were situations where there were water charges. The water charges in Rome, to people who had the privilege of receiving water at home, is similar to our modern water distribution systems.

The experiences reviewed illustrate the following principles:

- People had free access to rivers and springs;
- In situations where water was distributed to people, they had to pay a tax;
- In situations where dams were necessary for irrigated agriculture, there was also a tax.

Many of the water administration situations faced in ancient times are found in modern societies, and similar procedures are being observed. A great difference between past and present procedures is the recent concern for the environmental impact of municipal and industrial effluents on the water quality of rivers and lakes.

The Post-Middle Ages Attitude towards Water

There was a period in history, Post-Middle Ages, in which people were afraid of water. During this time, people used perfumes liberally, and water was used with much parsimony. These practices made the strong scent generated by perfumes synonymous with prosperity. Clothes were not frequently washed either, perhaps twice a year.

In this context, it is obvious that no significant evolution of water administration took place. At the end of 18th century, hygiene habits changed. The birth of an associated water culture created an inflection point in the water consumption curve and also marked the beginning of accelerated degradation of water quality .

Contemporary Water Administration

The last decades were marked by an accelerated growth in water demand, which is rising today at a rate never experienced at any previous moment in history.

Human use of water has increased more than 35-fold over the past three centuries and four-fold since 1940 (Easter and Hearne, 1995).

The search for a new water administration policy has taken place worldwide. Many countries face growing problems of unbalanced demand/supply and degradation of water quality, and different models of water administration are being implemented. These models differ from each other in many aspects, due the diversity of the people, cultures, customs, history, and beliefs involved.

Two models are being widely discussed and recommended by various international organizations, water marketing and negotiation, based on successful experiences in the western part of United States and in France, respectively. Ideologically, they represent two opposite poles; the water market model is based on individual property rights, and the French model stresses collective negotiation rather than individual decision making (Kemper, 1996).

Brazilian Water Resources Administration

The French model exercised great influence in Brazilian water resources administration, but it is not evident that the implementation of this model in Brazil, a country completely different from France in cultural and geographic aspects, among others, would produce the same positive results.

To understand the complexity of adopting a single water administration model for such a huge country as Brazil, it is important to classify the geo-political situation at the site in which the process takes place. Areas are classified according to the amounts of water and pollution. Possible approaches for a site classification would be water availability and pollution activity level in the area. Using these approaches, three classes can be defined:

- areas with an abundance of water and little pollution activity;
- areas with an abundance of water and a lot of pollution activity;
- areas with a scarcity of water and some pollution activity.

Areas may also be defined with a scarcity of water and no pollution activity. These areas would be deserts, or semi-deserts, which have no reference to the present discussion. If the geo-political areas in Brazil were analyzed, three different "Brazils" would be found: Brazil #1, represented by the North Region (Amazon Basin); Brazil #2, represented by the South and Southeast Regions, where industrialization and water pollution have already reached high levels; and Brazil #3, represented by the Northeast Region, where recurrent droughts postponed industrialization for years, which is starting to concern water managers. Each "Brazil" has its own culture and method of handling water problems.

It would be very hard to make the Amazon people understand charging for bulk water in the Amazon River. Thus, charging for bulk water in Brazil #1 could only be considered realistic in the distant future. In Brazil #2, on the other hand, charging for bulk water use is already being discussed or has even been inserted in some states' water laws. In Brazil #3, in the State of Ceará, water changes have already been implemented.

Water Charging in Brazil

To understand the evolution of the process of charging for bulk water in Brazil, both in law and in habits, it is important to take a retrospective view.

Irrigation Law

The Irrigation Law (Law No. 6,662 of June 25, 1979) disposes in its Article 21 that the use of public waters for the irrigation sector will depend on remuneration established by regulation. This regulation (Art. 21 - Decree No. 9,496 of March 29, 1984) classifies the public waters as permanent or eventual according to following criteria:

- *permanent waters* are public waters correspondent to the minimum discharge in all seasons;
- *eventual waters* are the surpluses to the minimum discharges of the rivers.

In Article 24 it is established that the *authorized persons*, who receive eventual waters, will pay 50 percent of the values established for the *concessionaires*, who receive permanent waters. The law has already incorporated the principle of higher prices for higher supply reliability. However, only two levels of reliability were considered, the first associated with a supposed 100 percent reliability and the second with an undefined reliability. It is also clear that the law is not completely applicable to the three "Brazils."

Water Charging under a New Water Policy

The new approach of Brazilian water policy results from the influence of an ongoing European process, primarily in France. The Brazilian Water Resources Association, through its congresses and declarations, now constitutes the main institution to drive the new water policy.

A milestone of this process happened in 1997, with the National Water Resources Law (Federal Law No. 9,433). Water was recognized as a limited resource that plays an important role in economic and social development, and charging for water was understood as a fundamental instrument for its rational use and conservation.

Economic incentives such as charging are based on the main principle of economic theory, which assumes that an individual is rational, a *homo oeconomicus*, constantly trying to maximize his utility or satisfaction (Kemper, 1996). That a person's reaction to economical incentives is predictable is an important implication. A

buyer has interest in acquiring larger amounts of a certain product when its price lowers and he is taken to restrict or to reduce his consumption when the price rises. So it can be said in the water management field that the amount of water demanded tends to vary inversely with the price, and the demand curve has a negative slope (Winpenny, 1994).

Water charge in Brazil's law has three objectives: (1) to make the population recognize the water as economic good, (2) to provide an incentive for the rational use of water, (3) to get funds to finance programs in River Basins Water Management Plans. However, objectives one and two are not being considered. A recent study carried out in some states showed that the charging policy in Brazil is being implemented mainly to raise funds, rather than to ration water use (Ribeiro, Lanna, and Pereira, 1999).

The law also establishes the situations in which water is not subject to permits for withdrawal. They are:

- Satisfaction of the water needs of small population nuclei in rural areas;
- Insignificant derivations, receptions, and sewer releases;
- Insignificant water withdrawals.

It is not clear, however, if these situations are subject to water charges. There is no emphasis on the social role of water in the law.

Water Administration in Ceará, Brazil

From the beginning of this century up to the end of its third quartile, the water policy in Ceará, a region classified as a Brazil #3, was defined and executed by the Federal Government, through the National Department of Works to Overcome Droughts (DNOCS). Only in the past three decades has the state government started to influence and act directly in this sector. Due to this fact, the water policy and history in Ceará are presented in two parts: the first one referring to the first three quartiles and the second to the last quartile of the 20th century.

Water Policy in Ceará Until 1975

There have been situations in which bulk water was charged by the government since the beginning of this century.

Water Charging for Irrigation Purposes

Water regulated by reservoirs was used for irrigation purposes obeying the following criteria:

- channels were built on private property with the owner's permission;
- water payments corresponded to the amount of intended water use;
- water price was established by ministerial decree;
- a water guard (like the water-man in Frontinus' time)

at each reservoir was in charge of the release and volume of water adduced to the irrigation channels.

This policy was practiced for a long period. However, during high inflation times, the price always reached a very low level in a matter of months, and the bureaucratic structure did not always adjust it with the required speed. Many times, the cost to collect water taxes became higher than the money collected. This policy was then abandoned.

Water Charging for Power Generation

In the beginning of the hydraulic infrastructure establishment in the northeast region of Brazil, DNOCS would install small hydroelectric plants in its reservoirs. This was done in General Sampaio Dam, Pentecoste Dam, and Araras Dam, all of them in Ceará State. With the creation of the São Francisco Hydro-Electric Company (CHESF) and the establishment of a new policy for the electrical sector, power generation began to be considered exclusive to Eletrobrás, and DNOCS stopped using its dams' turbines. However, CHESF continued using the waters from Araras Reservoir, in Acaraú River, for hydroelectric generation during peak hours and paid DNOCS for the amount of water released.

In that way, it can be said that even under the old water policy there was already charging for bulk water in Ceará for hydro-electric generation purposes, a sector that very often argues that it does not consume water and, therefore, should not pay for its use.

The New Water Policy Since 1975

The current water policy in Ceará State emphasizes demand management, including water right formalization, water charging, educational campaigns, and decision decentralization through the incentive of users participation in basin committees.

Water Charging for Municipal Uses

The political process of charging for bulk water uses in Ceará is under the jurisdiction of the Secretariat of Water Resources (SRH) through the Company of Water Management of the State (COGERH), which has the authority to collect water taxes. Nowadays, COGERH has all its administrative costs covered by water taxes.

Treated water distribution service is provided by the State Water and Sewerage Company of Ceará (CAGECE). Before implementation of the Water Resources State Law (Law No. 11,996/92), CAGECE had the authority to manage reservoirs of water used for urban needs, mainly in Fortaleza, the state's capital. Bulk water costs were added to the treated water costs and transferred to the users. Under the cited law, COGERH has authority to supply bulk water to CAGECE. CAGECE treats and distributes it to the cities. The administration of the reservoirs was transferred to COGERH, and CAGECE pays one cent of

Brazilian Real (US\$0.005) for each cubic meter of water drawn from reservoirs.

Water Charging in the Industrial Sector

Water charging for the industrial sector in Ceará is very peculiar, as a consequence of the existent supply infrastructure and institutional topology. A great number of industries are concentrated in the industrial district of Maracanaú. Those industries were served by CAGECE through two different systems: one for treated water and another for bulk water (for those activities in which the water treatment chemicals were harmful). The price charged for both treated and bulk water was the same, BRR 1.20 (US\$0.60) per cubic meter. Some industries received, as a fiscal incentive, a reduction of 50 percent on the tariff.

Under the new water policy of the State, bulk water management is under the jurisdiction of COGERH, but the water distribution system still belongs to CAGECE. An agreement was made between these companies; the price of bulk water was set at BRR 0.67 (US\$0.34) per cubic meter, and CAGECE pays BRR 0.30 (US\$0.15) per cubic meter to COGERH.

Water Charging in the Agricultural Sector

In spite of the price of bulk water for agricultural purposes having already been established by law at BRR 0.67 (US\$0.34) per cubic meter (the same as for industrial purposes), great political and social resistance to the charging implementation in this sector is expected. To analyze the obstacles in the agricultural sector, one must separate the irrigators into two different categories: those situated along the river and those inside public irrigation districts.

For the first category it must be noted that there is not a tradition of charging irrigators for the water diverted directly from the stream. The second category, however, has the perception of already paying for water, through the tax called "K₂." This tax, US\$3 to 5 for 1,000 cubic meters, erroneously called a "water bill" by the farmers, covers only the operation and maintenance costs of the system.

It is also important to note that the effect of charging may be nullified by other arrangements. In public irrigation districts, water (or energy) bills are not charged to individuals. Bills are charged to a whole project, divided equally among irrigators. Charging in that situation has little influence on motivating changes in irrigation method or the reallocation of water to high-value crops. Obstacles to selling produce is another key factor in crop choice. If it is difficult to access the market for high-value crops, the safest option is low-valued subsistence cultures (rice, for instance), since they can be consumed by the family in case they are not sold.

A Water Charging Example

An interesting case related to water charging in Ceará

happened in Milhã, a small city in the state's central zone. The city's water supply was placed under the jurisdiction of the National Foundation of Health (FNS), which drew water from a small reservoir on Mr. Pedro's (fictitious name) property. In 1993, when the episode took place, the process of water charging was already the subject of a wide and excited discussion, frequently analyzed and debated by the local press.

In that context, Mr. Pedro perceived a heightened social interest in water and decided to charge FNS for drawing water from his reservoir. Mr. Pedro realized that his agricultural production would be harmed if FNS continued to withdraw water from his reservoir. Mr. Pedro had an idea: to charge for the water.

The process had an administrative solution in the ambit of Secretariat of Water Resources, and Mr. Pedro was paid for his "ceasing profits." Technically speaking, he was not paid for the water. But if semantics are set aside, Mr. Pedro did receive money for giving FNS permission to draw water from his reservoir, and from this point of view, Mr. Pedro can be considered the herald of the new policy of water charging in Ceará.

Water Market Backgrounds

"Those who rule the river consider the water that gives life to an arid, seven-state region, more a heritage or birthright than a commodity subject to the rough and tumble of the free market" (Brown, 1997). These words represent a cultural reaction of society, or part of it, to a new way of managing water. This could represent the reaction of the people in northeast Brazil, for instance, a region subject to recurrent droughts. In fact, this statement is attributed to those who live close to the Colorado River in the United States, where water market implementation is well established.

These words, written by Brown, do not relate exactly to what Plautus said. Likely, the words incorporate the same feelings of love for and strong dependency on water. This feeling is still alive in northeast Brazil for the same reasons. In the Ceará cultural context, implementation of a water market for water allocation and reallocation could be attempted only after a careful analysis and evaluation of its social impacts.

The Water Market in Ceará

In the past 25 years, the search for a water administration model that can drive both efficiency and environmental preservation has been a major challenge faced by humans. Water has been recognized as a scarce resource on a global scale and has been endowed with economic value. As a limited natural resource, water should be allocated by efficient techniques. Techniques developed in economics have penetrated the water resources field, an engineer's domain. Economists became important professionals in water allocation studies. The two extremes

in the economic field, market and centralized planning, started to have a great influence on the development of water allocation models.

Water management in Ceará State, the focus of the present article, has also been strongly influenced by new water resources paradigms. From 1988 to 1990, the Water Resources Department developed a Water Resources State Plan, in which a new philosophy of water policy was inserted. The Plan designed a new institutional framework, which has been implemented since 1992. In many aspects the history of water management in northeast Brazil is similar to the history of the western United States. The influence can be felt. Several water allocation models for Ceará State have been discussed, the water market being one of them.

Motivations and Prerequisites for Water Markets

Technically, the water market is a water allocation and reallocation instrument to provide an improvement over existent policies, especially with regard to water use efficiency. In practical terms, the negotiated commodity would be the right of water use; it would be transferred from the seller, who owns the water title, to the buyer, who would become the title holder. In terms of time, the transaction could be permanent or limited to a certain period. In terms of space, the application of this model could be limited to a country, a state, a watershed, or even to very a specific area, depending on cultural and legal constraints, and also on the available structures for transferring water.

Water allocation by market devices can be justified on the supposition that it produces a more efficient water use. The water market's premises are the same as in any regular commodity market. The model supposes that a user who can promote a more efficient water use is motivated to pay for the water right of another user who makes less efficient use of his right. The maximum value the potential buyer would be willing to pay should be limited to the incremental value of the profits earned by using the additional water. On the other hand, the minimum price that would be acceptable to the seller should be limited to the value that he did not gain by selling the water (Lanna, 1994).

There are some necessary conditions for considering water rights as a regular commercial commodity. Simpson (1993) presents six prerequisites that he considers desirable for the establishment of water markets:

- There must be a definable product. This product must be capable of being controlled, measured, and treated as a commercial commodity;
- There must be a demand for the product that exceeds the supply;
- The product must be capable of being provided when needed;
- The product must have sufficient mobility to be trans-

ferred from the place of excess supply to the location of the demand during the time of shortage;

- There must be societal acceptance of the market;
- There must exist some mechanism of administration and regulation to assure fairness and equity.

Simpson does not argue that the rigorous and total adherence to the six prerequisites above is an indispensable condition for market establishment. However, he argues that more complete adherence to these requirements implies a better operation of market mechanisms.

Difficulties for a State-Wide Water Market

Under the water allocation point of view, the adoption of the water market model in the northeast semi-arid area of Brazil would hardly pass the six prerequisites test. If the understanding of water phenomena appears complex in hydrology, the understanding of the right of its use is equally complex in law and in popular habits. Several of Simpson's prerequisites would be seriously endangered. It is very difficult for the society to perceive water as being a regular market good.

Charging for bulk water, very well understood by water resources technicians, has some difficulties in being accepted by society and law. Several examples of these difficulties were observed in Ceará in the past few years. On the other hand, the water market still does not have the acceptance of the majority of water resources technicians and is very far from being understood by society in general.

An analysis of the evolution of the water administration process in the State shows the lack of fulfillment of some prerequisites:

- During the Hydrological Drought of 1988, water was transferred from Jaguaribe River to "Canal do Trabalhador," but the discharge diverted from Orós Dam was much greater than necessary. Several unidentified users significantly increased their consumption when they noticed the higher flow in the river. This event shows that, generally speaking, even when water is understood as a well-defined product, it is still not capable of being controlled and measured in the whole State under the current structures. Thus, prerequisite number one is not fulfilled.
- In the semi-arid region with a high inter-annual and seasonal variability in its discharges, water demand is usually larger than water supply. Within the limits of time and quantity, which are difficult to quantify, the product "water" could be delivered. In a general sense there are some structures that allow limited water mobility. In this way, prerequisites two and three would be partly fulfilled.
- Society has not accepted charging for bulk water yet, and is very far from accepting water markets. Even in technical circles, the authors' experience is that the

great majority still has a great resistance to a widespread water market. Societal non-acceptance, by itself, can be considered a very strong obstacle to widespread water market implementation in Ceará.

A Water Market Limited in Space and in Time

A new secretariat was recently created in Ceará, which is in charge of organizing irrigated agriculture in the state territory, the Secretariat of Irrigated Agriculture (SEAGRI). Its main input is water. SEAGRI is building a water use policy based on, among other factors, demand management. The application of a water market inside restricted areas of SEAGRI's jurisdiction is being analyzed.

Limits in both space and time are now being researched for this model application. This new experience may represent one more step towards an efficient water allocation model.

Space should be analyzed in terms of the current organization of irrigation districts, and from that knowledge, limits of water market model applications should be sought. The organization of water delivery in those areas follows a plan, according to the adopted irrigation technology.

In the case of irrigation by gravity, the process of "turns," scheduling water deliveries to individual farms is used. Control mechanisms such as Neyrpic modules and constant level gates comprise the water administration. In sprinkler irrigation, water is distributed under pressure, and other control mechanisms such as gate valves are available.

Regardless of the type of irrigation technique adopted by irrigation districts, there are always administrative and hydraulics structures to measure and control the amount of water delivered. Hence, inside an irrigation district, water is a well-defined product, which can be controlled, measured, and traded as a commercial commodity. Thus, prerequisite number one is fulfilled.

According to the Water Permit Decree (Decree No. 23,067 from February 11, 1994), the maximum volume that should be allocated from a reservoir is 90 percent of its yield, with a reliability of 90 percent. During deficit periods, demand is only partly met. In this case there needs to be negotiation among users, or a government decision, to establish quotas of water for users in the watershed.

It has been a practice in the new way of managing water in Ceará to have annual meetings after the wet season, when the water stock for the next six months is defined. The reservoir operation for the rest of the year is decided at these meetings, which are organized by COGERH. In years of deficit, the available water is distributed among users obeying priority uses defined by law. At the end of the negotiation they reach the following conclusion. In normal years the irrigation district receives an amount of water, compatible with its needs, equal to x .

In dry years, the district receives only $k \cdot x$, with k being smaller than one. However, its demands are still x . Therefore there is a product, water, whose demand is greater than its availability. Thus, prerequisite number two is fulfilled.

In normal years it is supposed that there is planning for choosing crops to cultivate. It is also supposed that the process is not authoritarian and that the irrigators' wills are respected. Some irrigators will choose temporary crops, which need smaller initial investments, otherwise having smaller economic value in their commercialization. Others will choose perennial crops, with significant initial investments and larger economic values. The diversity of cultures and behavior surely will provide that depending on the existing market needs for agricultural products, a given crop be more in demand than another. Farmers with hydraulic and agricultural structures less adapted for that market scenario surely will stop producing their low value crops and allow other irrigators to use their allotted volume of water, with some financial compensation, of course. Under these circumstances, at the necessary moment, a critical period of supply, the product "water" is capable of being provided to the "buyer user," once it is no longer demanded by the "seller user." Thus, prerequisite number three is fulfilled.

Within the space limit analyzed, the water delivered by COGERH arrives at a reception point (pump station). Up to that point, the water is distributed by the district's distribution system. The dimensions of pipelines and channels are designed for the demand chosen for the respective irrigation section. Water that stops being supplied to a "seller user" can be delivered to a "buyer user" through the existent hydraulic infrastructure. In these circumstances, the product "water" has enough mobility to be transferred from the place of excess (where it stopped being necessary) to the place of shortage. Thus, prerequisite number four is fulfilled.

Since the irrigation districts comprise a relatively small number of persons sharing the same needs and feelings, a negative reaction to a reallocation mechanism in critical periods is not expected, especially since each transaction only happens by participants' will. Juridical obstacles are also not expected since once the transactions are made inside the district, they are viewed as an administrative decision. The society in which the market would be settled is expected to accept the model and have the perception that it only happens in their interest and by their willingness. Thus, prerequisite number five is fulfilled.

The district's administrative structure should simply be notified of the transaction and arrangements made for the water to be delivered to the "buyer user." In this context, the existent administrative mechanisms are enough to assure justice and transaction fairness in the proposed model. Thus, prerequisite number six is fulfilled.

The proposed market should be considered limited. On the other hand, it can be understood as a careful way of searching for an efficient water allocation mechanism

in Ceará. If we are not sure that a road will take us to a good port, why should we hurry?

A Successful Experience in Southern Ceará

The Cariri region is situated in the southeast of the state of Ceará. Since 1854, a very peculiar process of water allocation between private owners has been established. A complete description of this process is presented by Kemper et al. (1999).

Hydrological Aspects

The area is located at the bottom of the Araripe Plateau, which has an altitude of about 1,000 m. The upper part consists of a permeable sandstone layer, the Exu System, which meets the second layer, the Santana System, an impermeable rocky layer, at an altitude of about 700 m. The larger part of the rocky layer has a slight inclination to the north. Groundwater discharge from the system appears in the form of springs. Of a total of 307 springs, 256 appear in Ceará, 43 in Pernambuco, and eight in Piauí. Batateira Spring is the most important source, both in yield and in the way its users manage its water. The Batateira Spring forms Batateira River, a tributary of Salgado River, an affluent of Jaguaribe River.

The discharges are still measured in an old Portuguese discharge unit called "telha," which can be described as a tube with a diameter of 18 cm and an inclination of 1:1,000. One telha corresponds to 64.8 m³/hour (Kemper et al., 1999). In 1854, the average discharge of Batateira Spring was estimated at 23 telhas; in 1999, it was estimated at only five telhas, a substantial reduction.

Some Water Allocation Aspects

In the 19th century, when Cariri was a prosperous sugarcane growing region, the farmers decided to allocate a certain amount of water from Batateira Spring to each farm, in order to avoid possible conflicts over water use. A formal contract was signed in 1854, dividing 22 telhas among themselves, and leaving one telhas to maintain a minimum river flow.

Established in the rules were the possibilities of: (1) selling the water right in permanent character; (2) selling the right for a certain time and for certain volume; and (3) reducing water rights from downstream users to upstream users in the case of reduced discharge. In the subsequent 100 years, the process proceeded peacefully, without major conflicts.

An example of water selling for a limited time happened in 1925, when a farmer sold the right of using three telhas for 58 hours, every second week of the month, for the value of 2,000 rapadura loads (a sugarcane product). According to Kemper et al. (1999), there was just one case of judicial demand in which a farmer tried to recover his rights. The case was judged based on the 1854 contract agreement rules.

Similarities between Cariri's Model and the Proposed Irrigation District Model

The Cariri experience refers to a restricted area provisioned by a very defined and measurable discharge. The group involved in the negotiation is relatively small, and they made an agreement with simple rules that are easy to manage and control.

The main difference is the possibility of a permanent transference of water rights in the Cariri region. The Irrigation Law surely represents an impediment to permanent sales from individual irrigators to agro-industries in irrigation districts.

Conclusions

The way a society manages water reflects the political, cultural, and economic processes that take place within the society. This wise statement, by Perry and Vanderklein (1996), is represented in many ways in this article. It was shown that different societies, in different times, manage water in their own ways. In the past, as in the present, under some conditions bulk water is charged, while under other conditions it is not.

Some lessons and recommendations can be drawn from this historical search of Brazilian water administration. They are presented below, organized by topic.

Charging for Bulk Water

The process of charging for bulk water as an economic good is in its very beginning in Brazil. The new Brazilian water policy, based on the sustainable development paradigm, has only two years of implementation. Most of the articles of the law still exist only on paper. The implementation process is ongoing and still needs much institutional reformulation. During this process, there is much to learn and also a lot to teach about water management.

In Brazil, charging for bulk water has been conceived mainly with economic objectives. Under Brazilian law, two objectives of charging for water are related to economic motivations and just one to financial motivation. In Ceará State, the funds collected from water taxes have been applied to COGERH, the agency that manages the water in the state. That agency has improved water management and has attained a higher level of water use efficiency in the state.

Therefore, even though water charging has been used in a financial approach, it has been, indirectly, an instrument of rational use. This shows the relevance of economic instruments in the water management process.

Water Market

The water market as an economic instrument for widespread water allocation and reallocation has found opposition mainly in the cultural aspects of societies. In northeast Brazil, a region with severe water scarcity, this

opposition is particularly reasonable. There is no evidence yet that this situation will change in the near future. Cultural changes are necessary, and this takes some time.

However, in 1854, in that same place, in a bounded portion of land, a small group of farmers made an agreement among themselves to share a limited amount of water for irrigation purposes. That agreement, still in effect, has rules similar to water market rules. This shows that, even in a very similar cultural context, some situations can result in a very specific response regarding water management. It is important to study, in a multidisciplinary context, the real motivations of that response.

Policy Recommendations

Society can learn from other societies' success and failures, and modern society can learn from past societies. Some adaptation is always necessary. The success of a given management instrument in another part of the world should not be applied generally in all environments. On the other hand, the successful application of a given management instrument in another society should not be discarded due to the fact that the success occurred in another part of the world, in another culture.

In this search for a new paradigm, there is a balance: concentrated planning in the state on one side, and the utopia of the market as a panacea for all socioeconomic evils on the other side. The best course lies in the middle.

Thus, it is necessary to establish the applicability limits of each water management tool, respecting local cultural, historical, and political values. Water management is strongly connected to culture, and culture changes slowly.

Special care must be taken in implementing water charging. The perception that charging is just another fundraising mechanism unrelated to improving water use efficiency should be avoided.

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