EVOLUTION OF BRAZIL'S WATER RESOURCES MANAGEMENT SYSTEM

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INTRODUCTION

Brazil is a large country, covering about 8.5 million km^2, with a population of about 160 million. There has been a decrease in the overall population growth from 2.5% in the 70's to 1.9% in the 80's. However, due to internal migration, urban population rose from 2/3 in 1980 to 3/4 in 1991. Now there are 92 cities with population greater than 100,000, twice as much as in 1970, which puts an enormous burden for new urban services and shelter. The country is politically organized in a federal system with 27 states. The Constitution of 1988 calls for the implementation of a National Water Resources System, leaving the details of such system for a specific law, the "Water Law", which was approved by Congress in January 1997. Also, local legislation has advanced in states that either: (a) have industrialized and polluted urban areas, where clean water has become relatively scarce, like the State of São Paulo; or (b) are located in the drought-stricken Northeast, where water shortages are critical, like the State of Ceará.

Historically, water resources have been managed in Brazil not differently from most parts of the rest of the world: (a) bulk water has been provided virtually free to users; (b) almost all resources were raised by government through general tax revenues and borrowing; (c) management was centralized in a command and control system, in which government decided. This is called the "old" paradigm, as defined by the Dublin statement. Like elsewhere, this system has resulted on waste and unfair allocation of water resources. In Brazilian Northeast, the lobbying for the construction of new reservoirs with federal money and the operation of those already built in order to meet the interests of few powerful ones has been one of the more important sources of political power.

Lack of water resources in the Brazilian Northeast is a necessary but not sufficient condition for the occurrence of droughts. It is necessary to add lack of reservoirs and of hydraulic conveyance systems, lack of human resources, lack of proper institutions and lack of administrative continuity in order to transform a natural phenomena into a human disaster. Similar "lacks" explain why the rivers in Brazilian South/Southeast that run close to the large urban centers, often blessed with large natural discharges, are so polluted. Above all, if we had to pinpoint the most important cause for Brazil being historically unable to achieve rational use of water resources, at the river basin scale, this would be lack of institutional capability.

Hydropower has been an exception. Because 95% of electric energy is Brazil is produced by hydro plants, which is essential to industry, this sector was

kept under the control of government owned companies, that expanded and operated the system for several decades much more efficiently than any other water sector. Since the 50's, the large rivers of Brazil practically belonged to the power sector that decided alone where, when and how to build the big dams, as well as how to operate the reservoirs. The hydrometric network was almost entirely maintained by the sector, either directly by the companies or through DNAEE, the Government agency nominally in charge of regulating the power sector[2]. Since the late 70's, the riparian populations managed to convince the power sector, through political pressure, that the reservoirs should be operated not only to produce power but also to control floods (Kelman, 1987). However there was no multisectorial view of water resources. The power sector would not consider, in the economic and social feasibility analysis of a specific project, the eventual externalities caused to the other water sectors. Vice–versa for the other water sectors. For example, water permits for irrigation, that would decrease the power yield of plants located downstream, were issued by a sectoral federal agency without consultation with DNAEE.

The revival of democracy in Brazil, starting in 1986, fired an overall discussion about institutional re-organization of the country. Federal Government decided to retire from several sectors of the economy where private business could do better, including the power sector, in order to focus on the activities that are sole responsibility of Government.

In these years of institutional reform, the water technical community has been mobilized discussing possible new models. In particular, the Brazilian Association of Water Resources -ABRH- issued two relevant documents, the "letter" of Iguaçu (1989) and the "letter" of Rio de Janeiro (1991), both containing general principles that were latter confirmed by the Dublin statement. The Brazilian debate about the new "institutional architecture" has derived from the following water resources problems:

- lack of integration among water sectors (irrigation, hydroelectricity, water supply, ...) in planning and management water resources at the river basin scale.
- uncontrolled urbanization processes;
- occurrence of droughts in the Northeast;

Much has been accomplished in the last years in terms of the legal apparatus to improve Brazilian capability to deal with water and a few success stories about improving people's lives through better water resources management can already be told.

Water resources management at the river basin scale

In countries that do not adopt the Common Law, as Brazil, theory comes prior to practice. The legal structure starts with the Constitution of 1988, that calls for the establishment of the National Water Resources System, to be detailed in a Law. Before this Law was discussed in the National Congress, a Water Resources Law was approved by the São Paulo State Congress, in 1991. Many other states followed the lead and issued their respective laws, very much inspired on what was done in São Paulo. The result is a homogeneous set of State laws. However, this homogeneity does not mean that the diverse water problems at the country scale can indeed all be solved by the same set of tools. It means simply that all the discussion has occurred around the same hypothetical situations. In these circumstances, the wisest procedure was to avoid endless theoretical discussions by adopting some code with a reasonable internal coherence, as it was the case of the Law of São Paulo. Certainly application of the State Laws to real case would result on improvements on the legal texts. In fact, this has already been observed. For example, the Water Resources Ceará State Law, approved in 1992, relied heavily on the action of the State Government, through the agencies of the direct administration. However, pretty soon it became obvious that the direct administration is too much constrained (directors can not hire, can not fire, and have no incentives for seeking efficiency) to be capable of implementing something new -water resources at the river basin scale- that requires long term maturation. For this reason, in 1993 The World Bank used a program called PROURB to support the State of Ceará on the creation of a State Bulk Water Company –COGERH- to act as the river basin agency for all river basins in the State. The lesson is that the Ceará Water Law was barely one year old and real needs forced the creation of an entity not included in the Law.

The Brazilian Water Law (9433/97), that details the article of the Constitution, was approval after several years of intense debate in the National Congress and in the technical entities, particularly in the Brazilian Association of Water Resources - ABRH, that was pushing this theme since 1988. Along this process, several of the concepts that were surfacing from international meetings (United Nations, 1992; ICWRM, 1996) and from The World Bank policy paper (The World Bank, 1993) came to corroborate many of the new ideas intensely discussed at ABRH. As a result, the Brazilian Water Law adopts the following concepts:

- planning and management of water resources should be done at the scale of the river basin, with the participation of stakeholders;
- controlled issuance of water permits for intakes or for dilution of effluents is an essential tool for planning and for investment by the water users;
- bulk water is an economic good and as such should be charged in order to: (i) achieve rational allocation; (ii) create the financial resources necessary for the improvement of the river basin;
- human supply is top priority among competitive uses.

Planning and management of water resources should be done at the scale of the river basin because there is a "hydraulic connection" among bulk water users that share the water resources of a given river basin. The use of water in one State may affect users in other States, or in a reach of river belonging to the Union. This is what happens in the large rivers, as for example the São Francisco or the Paraná. For this reason, the Water Law calls for a coordinated system of water permits, either for consumptive use or for dilution of pollutants. When some river is of exclusive domain of a particular State, as it is the case of almost all rivers in Ceará,

the Law leaves to the specific State Government, and only to it, the business of issuing permits.

Pricing bulk water use, or alternatively, pricing the water permit, may generate a substantial cash flow. In order to counter balance any tendency to centralize the decision making process, the Water Law calls for the formation of river basin committees (the "water parliaments"), with members belonging to three classes: bulk water uses, Government officials - if necessary from the three levels of Government (Federal, State and Municipal) - and NGO's. The committees should be formed only in basins with water allocation conflicts, actual or potential, and where the stakeholders would be sufficiently committed to take water affairs on their own hands. If these conditions are satisfied, then a "water agency" should be created to function as executive branch of the river basin committee. These water agencies would be Brazilian equivalents of the river basin agencies in Germany or in France, or to the Water District in the USA.

This author was member of a task force that prepared a draft for a Presidential Decree that would make the Water Law operational. The task force was organized by the Water Resources Secretary of the Federal Government (SRH/MMA). Preparing this draft, the task force underwent through several debates, alive or through internet[3], dealing with all kinds of simulated situations. A few lessons were learned in this process, briefly stated bellow. Many other lessons will certainly surface when the theoretical phase is over and finally the whistle blows for the start of the real game.

a) The river basin scale is proper in most cases, but not in all. Hydroelectric power plants in different river basins can be electrically interconnected. When a drought strikes a particular river basin, sometimes for several years on a row, the system may be sustained by the power plants located in different river basins, apart from each other by thousands of kilometers. In these circumstances, the electric power sector will tend to plan and operate the reservoirs from the interconnected system perspective, rather than from the river basin perspective.

b) The proper mix of representatives in the river basin committee can make a big difference. Limited experience has shown that if the NGO's outweigh the users representatives (water-supply/sanitation companies, industries, irrigation districts, power companies...), decisions of river basin committees tend to become unfeasible because those that decide do not have to pay for their decisions. On the other hand, if decisions are left only to users, there is a risk that the environment would not be properly preserved for present and future generations. Also, the composition of the Committee often asks call for a large number of members, in case one adopts the political standpoint of accepting "the one man, one vote" concept. In order to avoid the associated transaction costs, the draft Presidential decree allows decisions process based on "weighted votes" for each category that should be represented in the river basin committees (similar to what happens in a assembly of shareholders of a private company). Decision inside each category are left to be decided internally.

c) One of the most awkward features of the Water Law is that it calls for another law (!) for the establishment of the criteria and juridical personality

of a water agency. While this new law is not processed[4], there is a vacuum. Some efforts are being developed in order to assure, under the present legal dispositions, the existence of a "technical office", that would temporarily perform the activities to be exerted in the future by the water agency. PROÁGUA, one of the programs financed by The World Bank has made financial resources available in order to bridge this transition, that would alleviate the "personality crisis" of some river basin committees that can not count with a "water agency". This is the case, for example of the Paraíba do Sul River Basin Committee (CEIVAP), that is experiencing a transient situation that can not last long because. Curiously, what seems to be giving better results is the opposite approach, as adopted in Ceara, and proposed to be adopted in Paraná. In Ceara, the State Bulk Water Company, COGERH, that plays the role of the water agency for all the river basins in the State, was created before the existence of any river committee. Only after COGERH could demonstrate positive results on managing the supply of bulk water, with the participation of the stakeholders (more will be said about this topic latter...), and after the water users were better organized at the reservoir scale, then COGERH proceeded to organize the river basin committees[5]. This historical evolution is contrary to the concept embedded either in the National or in the State Water Laws, that are "fenced" by several defenses against the capturing of the river basin committee by its water agency. Although this legitimate concern, incorporated into the Law is of significance, the Ceara example demonstrate how difficult it is to build a complete legal system at once. As already mentioned, it would be preferable to build the legal system through an iterative process, relying on the evidences of actual experience.

d) Water use permits should apply either to quantitative uses of water, such as irrigation/ urban supply, or to qualitative uses, such as dilution of industrial/urban waste. However, in most cases quantitative and qualitative permits are issued by different government agencies, which are often rivals. Ideally, both kinds of permits should be issued by the same agency. For this, the same yardstick should be adopted in order to reduce quantitative and qualitative uses to common ground. The parcel of river flow that each water user makes unavailable for the downstream users was the adopted yardstick. In case of quantitative (consumption) use, the parcel is just the quantity of water withdrawn from the river. In case of qualitative use, the parcel is the quantity of water necessary to dissolve the pollutant to an accepted concentration level, in the river. It may decrease going downstream due to the oxidation of some pollutants.

e) Pricing bulk water should not be a source of revenue for governments, as there is a widespread disbelief in Brazil about government capability to carry on new policies, such as the rational use of water resources. Instead, the corresponding river basin committee should preferably use the revenue in the same river basin where it originated. Ideally, revenue should decrease with time because the money raised with the water tariff should finance improvements for the river basin as a whole.

f) Pricing bulk water face resistance from sectors that believe that accepting lower environmental standards, which result in lower production costs, is the only hope for developing countries to compete within the global market.

g) River basin committees do not need to be established across the board. Committees should be formed only in basins, or sub-basins, which have some water conflict, actual or potential. Local problems may induce the formation of committees for some of the upstream sub-basins. In this case it is necessary to create a hierarchical relationship between basin and sub-basin committees. In the draft Presidential Decree this hierarchical relationship is based on the right of the committee of the larger basin to impose boundary conditions for the river flow, quantity and quality, leaving the sub-basin. This means that the sub-basin committees are free to decide matters internal to the sub-basin without external interference, provided that the boundary conditions are respected.

h) In the intermittent rivers of the semi-arid, continuous flow of water is assured for limited river reaches downstream from each dam. In these circumstances, it is more relevant to establish users association for each reservoir, rather than river basin committees.

i) When it comes to flood control, community participation in the selection of solutions is highly useful. However, because flood protection is a community benefit, rather than an individual benefit, government financing is unavoidable.

Coping with Urban Water Problems

The most important of these problems are water supply and sanitation to large cities, and flood control.

In urban areas of Brazil 88% of the population have access to treated water, 35% are served by sewage collection and only 8% of the sewage is treated (SEPURB/MPO, 1995). These numbers translate lack of efficiency from the water and sanitation companies, as well as the result of the relationship between consumers and companies. Water supply and sewage removal, if not provided, cause illness and discomfort to individuals, while sewage treatment, if not provided, causes discomfort to communities (most of the population does not perceive river pollution as a personal discomfort). Due to historical reasons, Brazilians are more prepared to defend their individual rights, acting collectively if necessary, than their community rights (this cultural feature explains, for example, why nepotism has been politically tolerated for centuries).

In general, public water and sanitation services or companies in Brazil, as well as in other developing countries, are not efficient, due to a number of reasons:

- Bad operational practices. In general, there is lack of proper planning and maintenance. Sometimes the physical losses reach 50% of the treated water. Figure 1 shows, as example, a pipeline crossing a polluted creek in Niteroi, Rio de Janeiro. It is wasting water through several holes. Besides, it has the wrong elevation, which will certainly cause upstream inundation during storms and may result on infiltration of the contaminated water of the creek into the pipe.

- Bad commercial practices. The general picture is that metering is applied to a small percentage of consumers, subsidies are implicit rather than explicit, and there is no cutting-of-water policy for lack of payment. In these circumstances, no wonder there is a high waste of water. Furthermore, because the poorest segments of society are not commercially attractive, due to the high percentage of unpaid bills, sometimes they are simply not connected to the water distribution system, even in cases where the connection would be technically feasible. Figure 2 shows a typical result of this blind policy. It is a photo of the "distribution system" adopted in the "favela" (slum) known as "Rio das Pedras", Rio de Janeiro, consisting of PVC pipes hanging from a bridge, in the most precarious way. The explanation for such awkward scene is quite simple. Since the water company does not deliver water to the poor households, desperate people seek individual solutions that result in the most inefficient, wasteful and dangerous "system" one could conceive. Each household, or small group of households, stretches its own PVC pipe to the manhole and simply steal water from it. One can notice that contamination in this case is almost a sure event, as several pipes are actually immersed in the polluted river. In addition, the hanging pipes form a "nest" that retains trash during storms, which blocks the river course and causes inundation.

- Lack of financial and administrative autonomy of the public companies. The board of directors of public companies in Brazil are usually severely constrained in their autonomy to run the business by complicated legal systems. They can not hire or fire personnel, sign contracts or equipment, as a private company would do. There are too many controls over their action and in the general these controls are focused on "processes" rather than on "results".

- Political interference - Directors of public companies are often selected based on their political connections to the ruling party, rather than on their technical or managerial abilities. Furthermore, and most importantly, tariff setting is often affected by macro-economical considerations, as for example inflation control. As a consequence, tariffs are disconnected from costs, resulting on no incentives for cost minimization.

- Lack of financial resources. It is estimated that it would be necessary to invest about US$ 3 billion annually, mostly on sewage collection and treatment, to raise Brazilian coverage to levels of developed countries, at the end of 15 years (SEPURB/MPO, 1995). This requirement is well beyond the public sector's financial capacity, which is going down: in the 80's, the mean annual investment on sanitation by FGTS[6] was US$ 1.3 billion (SEPURB/MPO, 1995); in 1996, it was US$ 0.8 billion; in 1997, only US$ 0.4 billion (BNDES, 1998).

As a reaction to the above problems facing public water and sanitation companies, which are common to most of the developing countries, the notion is spreading that the public sector should establish the legal and regulatory framework, and then allow public and private companies to compete for the mandate to provide service (Sri-Ram A., 1995).

Application of these principles in real life has been hampered by the conflict between the need to establish the legal and regulatory framework, which means the creation of new responsibilities for the public sector, and the prevailing trend for decreasing the size of governments. In a few cases, concessions of public services previously hold by public companies, that were loosely controlled by governments, are now being transferred to private companies, even before putting in place the regulatory framework.

This situation creates a risk for both, the population and the private companies that are getting the concessions, as the absence of rules may result on future lack of continuity of services or on decay of its quality. This would not be such a serious problem for some public services, in which recent technological breakthroughs have created the conditions for competition, as for example the telephone sector. But this certainly is not the case in the water supply and sanitation sector, that persists as a natural monopoly.

If competition for the service on a day to day basis is not feasible in natural monopolies, one can at least establish competition for the concession. However, because the universe of private companies competing for water and sanitation concessions is rather small, the formation of coalitions among these companies can not be ruled out. Again the presence of a vigilant regulator is essential.

The Brazilian Constitution says that locally provided public services are the responsibility of city governments, that may choose to operate and expand the system directly, or through a public or private company, by way of a concession contract. In Brazil there are about 5,000 city governments. 74% of them signed concession contracts in the 70's with the State water and sanitation company. Most of these contracts are now expired. Furthermore, in many cities, including most of the State capitals, the State company operates without any contract (BNDES, 1998). Therefore, there is a window of opportunity for new concessions. Nevertheless the pace of privatization of existing municipal companies, or new concessions for the private sector has been rather slow. Only 24 cities (total population of 3.3 million = 2% of the Brazilian population) signed contracts with private companies. 10 of these contracts were for full concession and the others were for BOT, water only or sewage only. SANEPAR, the water supply and sanitation company of the State of Paraná, was the only State company to go through a privatization process, although partial. There are several reasons for the slow pace:

- Ideological opposition from some of the governors and mayors, that believe that water supply and sanitation should remain in the public sector.
- Opposition from the workers of the publicly owned companies, who get benefits which are unthinkable in the private sector.
- Lack of clear solution on how to provide service to small and poor cities, that would not be attractive to private companies.

- Lack of agreement between State and city governments about how to share the benefits from the sale of State companies. Governors tend to think that the privatization of the State company is simply the sale of an asset that belongs to the State Government and to nobody else. Mayors tend to think that a State company has no value without the concession to provide public service, which can only be given by the municipality. Discussion between the parties is complicated by the legal restriction that stipulates what the city can do when a concession contract expires: the municipality may decide to take the service back or to procure for a new concessionaire, under very strict rules. It can not simply renew the contract with the existing concessionaire. Moreover, the municipality has to pay the leaving concessionaire for recent investments, not yet devaluated. In this context, the only possible path would be to combine into a single operation the sale of a State company with the bidding for the corresponding city concessions. This is simple to conceive, but extremely difficult to execute, given the political disputes.
- Lack of firm legal understanding of whom has the authority of the water supply and sanitation service in the metropolitan regions, where the same system serves several cities. Typically, the water treatment and the large hydraulic conveyance structures, as well as the sewage treatment plants may be shared by several cities, being impossible, or economically unfeasible, to separate the systems using the municipality as the unit for operation and planning. Rather, the river basin, covering several cities, is in general the most appropriated scale.
- Unrealistic tariff structure proposed by some city governments. Box 1 gives an example, for the case of a medium size city.

Box 1 – Privatization of Water Supply and Sanitation in Colatina

> Colatina is a city in State of Espirito Santo, with population of about 100,000. Due to financial problems, the municipality decided in 1988 to give in concession the water supply and sanitation service, that so far had been operated directly by the City Government, with good performance indices, as compared to other similar cities in Brazil. Although finance recovering was the main motivation, several other reasons were aligned as well for the transference of the service to the private sector. Because City Executive needed a substantial down payment, the City Legislative (Câmara Municipal) approved two laws, authorizing the Executive to: (i) sign the concession contract;; (ii) modify the tariff structure in order to make it more palatable to a potential private investor. This change of tariff structure was carefully crafted in order not to increase the bill to poor households. On the other hand, it would produce a dramatic rise, sometimes of 300%, on the bills to commerce and industry. Under the hypothesis of inelastic demand, which would be completely inappropriate in this case, present value of the concessionaire projected cash flow would increase significantly. The purpose was to induce the potential bidders to increase the down payment to the city treasury in exchange for the 25 years concession. Private investors did not buy the hypothesis of inelastic demand and there was no offer.

Box 2 describes how a combination of several problems has paralyzed the sale of CEDAE, the water and sanitation company of the State of Rio de Janeiro serving more than 10 million consumers.

Box 2 – Rio de Janeiro

The past administration of the State of Rio de Janeiro (1995-98) was firmly committed to sell CEDAE, the State owned water supply and sanitation company. In order to accomplish this goal, the State Government asked Federal Government and Bank's help to model the privatization process. Resources from a Bank supported program, PMSS, were mobilized to hire consultants who produced elaborated proposals. In 1997, a State regulation agency was created to take care of all public services, rather than only of water and sanitation. Although transparency and communication with the public about the reasons for selling CEDAE were very weak, resistance from CEDAE's workers, that opposed any change that would endanger their privileges, was forcefully confronted by Government. However, the battle was lost when the mayors of the metropolitan region stepped in the political arena. Their opposition to CEDAE's sale resulted from the State Government refusal to share with the city governments any substantial part of the cash flow associated to the sale.

This controversy took the format of a legal dispute, captured in the newspapers headlines, about who would be responsible for providing the service in the metropolitan region, the State or the cities. State officials argued that cities of the metropolitan region had nothing to say about privatization of CEDAE because, according to the Constitution, rivers may be a domain either of the Federal or of some State government, but never of a city government. This kind of argument has added heat to discussion, but no light. Bulk water, found in the streams, is only the input to a complex process that ends up with treated water being delivered to the houses of consumers. The management of bulk water, disputed in rivers and lakes by different sectors (urban water supply, hydroelectricity, irrigation, industrial consumption...) should follow the rules set by the Water Law (Lei 9433/97), which is unrelated to the issue of how to organize the service of delivering treated water to consumers.

This public service is a natural monopoly, usually exerted inside the limits of a single municipality. In this case, the Constitution assures that it competes to the City to implement directly or to give, under regimen of concession or permission, the public services of local interest (art.30).

The situation is not so clear in metropolitan regions, like Rio de Janeiro, where several cities share common facilities, for example water or sewage treatment plants. In this case, there is not a clear division between local and regional interest. The Constitution says nothing about which level of government would have the concession authority. Senator Jose Serra, presently Health Minister, has proposed a law (266/96), still under discussion, saying that the State Government, together with affected cities, would have the authority in the metropolitan regions. While this proposal is not yet a Law, or while the Supreme Court does not yield a clear interpretation of the Constitution, the deadlock will remain.

Mayors of the metropolitan region of Rio de Janeiro changed position, becoming favorable to CEDAE's sale, just before the change of the State Administration, at the end of 1998, when the Governor decided to share with the municipal governments, based solely on political negotiations, a substantial part of the financial income that would accrue to the State Treasury. But at that time it was too late. There were no political conditions for the sale, as the incoming Governor had been elected with a speech against the privatization.

As already said, only 35% of the population is served with sewage collection. This means that most of the contaminated effluents flow through the drainage network, composed of storm pipes or ditches, channels and rivers. Given this fact, it would be possible to adopt the unified system concept, in which contaminated stream flows would be always treated, except during floods (then the concentration of pollutants would be low anyway). However, this simple concept is not possible to be considered in Brazil because there is a law that stipulates that sewage can not flow through storm drains. The enormous distance between theory and practice has not yet prompted the legislators to change this Law that, as so many others, was conceived based on the understanding that the Brazilian economy would generate sufficient wealth to sustain countless obligations.

Sewage treatment and flood control are water problems that have to be dealt in the scale of the river basin. Because they benefit communities, rather than individuals, both responsibilities are better suited to some river basin authority, rather to any municipal water/sanitation/drainage service.

In most large Brazilian cities, the occurrence of floods is a major problem. The chaotic expansion of urban conglomerates, subjected to hot humid tropical climate, usually increase the inundation frequency. For example, there are several neighborhoods in the poor outskirts of Rio de Janeiro that, in the past were past seldom affected, are now inundated almost every year. That is, storms that in the past would cause minor problems, now cause major problems, with huge human suffering, due to:

- Increase of superficial flow, due to the impervious surface laid on top soil.
- Occupation of the flood proue areas by the poor, that do not have any other option;
- Clogging of rivers and channels with garbage, which is not properly collected neither disposed;
- Sedimentation of channels and rivers, as a result of erosion on the hillsides;

Usually State or municipal governments tend to deal with the consequences of these processes, rather than with the causes. They are prone to expend large quantities of money on costly engineering works, such as construction of channels, dikes and pumping stations, often engineered by construction companies lobbies, and very little on land use planning and management, as well as on maintenance of the existing infra-structure. Under these circumstances, an optimal engineering solution may not be the most recommended one. For example, this author refused to adopt a flood control solution based on the creation of a polder, that would be the optimal alternative in Holland, but that would not long last in the outskirts of Rio de Janeiro, due either to lack of maintenance of the pumps, or to uncontrolled settlement in the flood storage area.

In the last years, The World Bank has supported several important water projects in Brazil related to urban problems that have helped to advance the reform process. We will discuss three of them, belonging to relatively low loans, that focused on institutional issues: the Rio-Flood project, executed by the State of Rio de Janeiro, the PMSS (Modernization Program for the Sanitation Sector), executed by SEPURB/MPO (Secretary of Urban Policies, Planning Minister) and the PQA (Water Quality Program), also executed by SEPURB/MPO.

Rio Flood

In February of 1988, an intense storm left a destruction trace of deaths and diseases in the poor outskirts of Rio de Janeiro. This event motivated the State and Federal Governments to create an emergency project (Rio Flood Project) for restructuring the urban infrastructure of the affected areas, with emphasis on drainage. The project received the financial support of The World Bank, which was processed on an exceptional basis.

The implementation of Rio Flood helped the area but was not enough to heal decades of abandonment and chaotic urbanization. For example, if the same meteorological event observed in 1988 would occur again over the Iguaçu-Sarapuí river basin (the most densely occupied zone, covering six cities) the houses of 180,000 people would still be inundated. As in 1988 there were 300,000 people that had to evacuate their houses, some progress was achieved. Moreover, people that previously lived in risky areas along the banks of rivers were moved to new homes, built on more valuable land. Once the flood thread had been removed, they started to expand their houses, while businesses invested in construction and renewal. Tax revenue collected by the Municipalities raised, and opened up a new phase of economic and social development. (The World Bank, 1996).

The World Bank pushed the State Government to adopt the river basin scale for selecting priorities. This was the appropriated scale because the consequences of each action extrapolated city limits. For example, the removal of a narrow bridge, that would alleviate upstream river spills, could in turn cause downstream inundation.

A master plan was developed, considering structural and non-structural actions (flood zoning and institutional arrangement for operation and maintenance of the hydraulic structures), that should be undertaken over a long implementation period, far beyond the emergency actions launched by Rio Flood. One of the Plan results is a survey about willingness to pay. Each visited family would be asked if they would be willing to pay x reais monthly, in order to finance the construction works that would get rid of floods in their neighborhood. For each visited household, x was randomly sampled in the interval R$1 to R$20. 45% of the people that answered the survey said that they would pay nothing, because Government would pocket the money and do nothing. On the other hand, 30% of those that randomly selected x as R$20 (roughly 20% of minimum wage), answered "yes", meaning that their suffering with floods is so intense that they would be willing to trust whoever promises a solution.

Because good initiatives in the Brazilian public administration suffer from lack of continuity, it was decided from the beginning that the elaboration of the Plan would be supervised by a river basin commission, formed by associations and city government of all the affected municipalities. This commission worked closely with the technicians, including countless field trips that helped to redraw the maps. This success should be credited to the proximity between the planning group and the executive team, that was conducting the construction works of Rio Flood. This circumstance signaled to the Commission that the themes debated in the context of the Plan were not mere academic exercises. Quite the opposite, they could become

reality as the decision makers for things that were actually being built would listen to any suggestions about the new steps. At the Plan's completion, there was a strong sense of ownership among participants of the Commission. Unfortunately this enthusiasm has faded out, as no financial resource became available to implement any of the planned actions. Also, because private sector participation was no seriously considered, due to the free riders effect.

PMSS

PMSS has proposed a new institutional and regulatory set up for the sector which stimulates the participation of private companies and aims sustainability through full cost recover. It has produced a large number of good studies that were assembled in a eight volume collection. There is no doubt about the relevance of this work, which is a solid foundation for the implementation of the sector reform in a broader scale. Because the reform pace has been slow, due to the reasons previously explained, the effectiveness of the work still needs to be proved. The rule #1 for water reformers is to initiate it only when there is a powerful need and demonstrated demand for change (Briscoe, 1997). For many years Brazil, has had a powerful need for reforming the sector, but this was not perceived because of the relative success of the "old" model in the 70's and early 80's. In the 90's the model was exhausted, but not dead. One unexpected benefit from the current (early 1999) crisis is that now there will be a demonstrated demand for change.

PQA

PQA has adopted the river basin scale to evaluate how the activities that generate pollution affect the water quality in the streams. In order to achieve this goal, PQA has supported the elaboration of projects for cleaning and for controlling rivers of four capital cities: Curitiba, São Paulo, Belo Horizonte and Recife. In the case of Curitiba, PQA supported consultant services for elaboration of a proposal for organization of the water users in the metropolitan region and for the use of market mechanisms for the allocation of scarce water of the Iguaçu River[7] for the dilution of pollutants, mostly from industry. This proposal was discussed with the Federation of Industries of Paraná State, resulting on a Law which is presently close to be approved by the State Legislature.

PQA has also supported the development of a new institutional arrangement for management of water resources of the investment program for the Paraiba do Sul basin. This is a river basin shared by the three most important states, São Paulo, Rio de Janeiro and Minas Gerais. Water quality is a serious issue, as about 10% of the Brazilian industrial output is produced in this river basin. Approximately 15 million people depend on the water of the Paraiba do Sul: 5 million that live in cities of the basin plus another 10 million that live in metropolitan Rio de Janeiro, off the limits of the basin, but that depend on water from the Paraiba do Sul, which is diverted for electricity production and for water supply.

PQA impact has been very good. After lengthy negotiations, the three State governments and the Federal Government decided to create the river basin committee – CEIVAP - which is formed by 12 members from each State. Half of these members have to be water users ad the other half may be composed by representatives

of the State and of municipal governments and representatives of the NGO's. There are also three members of the Federal that sit in without vote right. Federal Government representatives in case it needs to act as a referee in some dispute among the states that could not be settled by the CEIVAP. CEIVAP has two technical bodies that have approved a meticulous investment program developed by consultants hired by PQA.

The investment plan for the Paraiba do Sul was elaborated with the support of a mathematical model that could estimate the positive impact on river water quality, as result of implementation of a potential project to be implemented in the basin. Several different types of projects were considered for each city, including a variety of sewage treatment options, trash collection and final disposal, industrial effluent treatment, reforestation, reduction of mining activities, and so on. The best projects, in terms of the relation cost/reduction-of-pollution, were detailed to allow a feasibility analysis. This level of accuracy is uncommon in most river basin plans available in Brazil, that usually are more detailed on the description of problems than on the evaluation of possible solutions.

Droughts in the Brazilian Northeast

The fertile spots in Brazilian Northeast, although not very frequent, would be more than sufficient to create wealth for supporting the present population of the region. In the Jaguaribe basin, for example, that corresponds to half of the State of the Ceará, there are studies identifying 178000 hectares as suited for irrigation. There would not be sufficient water in the basin to reliably irrigate all this area, not even ¼ of it. On other words, the scarce resource is water, not land. For this reason, the division of rural properties among brothers, along several generations, has resulted on narrow and long estates. The narrow part coincides in general with some water course, although intermittent. It is the noble part of the property. Walking in the direction of the long side of the property, moving away from the water course, one reaches areas of very little use and value. Any proposal of agrarian reform for the region has to take this reality into account.

Sticking to the Jaguaribe example, today there are about 22,000 hectares of irrigation (12% of potential), most of it producing crops of low value, for example beans, with the use of wrong technologies, that waste much water. Just the change on the crop choice would have a tremendous impact on the welfare of the region. Indeed, 1 hectare of irrigated beans produces annually about R$600,00, while the same planted area, for example with mango, would produce about R$3600,00. If it is thus, why somebody would go to plant beans, instead of mango?

There would be several aspects to be considered in the answer, but the most important one is lack of reliability on bulk water supply. To lose a beans harvest, that has short term maturation is a quite different situation than to see fruit trees dying after some years of care, even before the first harvest, due to water scarcity. Analogously, lack of reliability on bulk water supply inhibits industrial expansion in the region, despite the low cost of labor.

Distribution in time of rainfall in the Brazilian Northeast is rather uneven: in any given year, practically all precipitation falls during one semester and roughly

70% falls during just one quarter (centered on April). Annual coefficient of variation is typically 40%, which is rather high. Roughly, it means that the precipitation will be less than 5% of the mean value, for any particular site, on the average in one out of five years. Most of the rainfall in any given year can not be stored in the ground because, in general, the soil has moderate permeability and lies on top of an impervious crystalline substrate. Potential evaporation is very high, typically 2,500 mm, annually. The runoff coefficient is relatively low, typically 15%. Most of the runoff just flows to the Atlantic Ocean as flash floods, if they were not stored in reservoirs. In the State of Ceara, for example, there is only one river in Ceará that would be perennial, the Jaguaribe River. All the others would be intermittent.

When a sequence of dry years occurs, large portion of the population in the dry hinterland is left without water, even for drinking purposes. In these cases, trucks are used for carrying water for thirsty people; "emergency plans" are launched by the federal and State governments in order to provide jobs for the poor peasants that otherwise would starve to death. Large number of men and women are temporarily employed in the so called "working fronts", receiving in general an extremely low pay (in recent years of the order of US $ 30.00/month).

There are more than 20,000 dams and reservoirs of small size all over the region. Many of them have been built in the last decades by the working fronts, paid by Government. In general, these reservoirs are not associated with proper hydraulic conveyance structures and get dry every year, even in a normal year, because they are not deep enough to overcome the intense evaporation rate. Nevertheless, these reservoirs serve the purpose of transferring water from the rainy season to the dry season. In general, the reservoirs sites and sizes were chosen to satisfy the private interests of the local powerful land owners.

On the other hand, there are about 200 reservoirs with multi-year carryover capability. For these, the storage capacity ranges from 5 to 2,000 Mm^3. Although these reservoirs were properly built by DNOCS, a federal agency founded in 1909, they were designed mainly for providing water to public irrigation districts, generally located in the downstream reaches of river basins, close to the sea. This leaves large portions of the hinterland unserved by any water regulation system.

A water resources management system could change this situation. On the supply side, management would ensure proper maintenance and correct operation of the hydraulic structures (barrages, floodgates, valves, channels and pipelines). In Ceará, these activities have already started and are exerted by COGERH, the State wide bulk water company. Presently, COGERH's revenues come from selling bulk water to industrial companies, the Sate water (potable) supply company (CAGECE), and to very few irrigation companies. COGERH's strategy has been to "pick the low-hanging fruits first, one of the golden rules for reformers (Briscoe, 1997). Indeed, there was no resistance for paying for bulk water from the industrial sector, because this sector was already paying it to the water supply company, as it was potable. In the rural sector, COGERH is starting to price water for irrigation only along the Canal dos Trabalhadores, a 115 Km channel built in 1993 to bring water to the capital city Fortaleza, crossing a region that have never seen permanent water before. In this situation, it is easier to convince the new water users that water may be indeed a "a gift from God", but only when it rains in the distant river basin.

The operative decisions, as for example amount of water to be released from the large reservoirs (Orós and Banabuiú) in the Jaguaribe basin, are taken in assemblies of about 300 people, representing municipal governments, districts of irrigation, city halls and independent water services. In these meetings, COGERH brings along a decision support system that helps the stakeholders to understand the consequences of each possible decision. As it is always the case in reservoir operation, the crucial evaluation is how to balance the benefits of short term use of stocked water with the probability of droughts in the long term. Because these seminars are not formal meetings of river basin committees, which have not yet been formed, the seminar decision is not mandatory to COGERH. However, as the conclusion results from the application of a truly democratic process, with no skewness of information, COGERH has so far obeyed it.

On the demand side, practically all still needs to be done. The Water Law and associated State legislation provides two instruments: (i) issuance of water use permits by Government (Federal or State, depending on the case); (ii) pricing of bulk water. Several discussions are presently under way of how to use these mechanisms to assure a rational allocation of water during dry spells. The draft operational rules for the Water Law commented in Annex A call for the installation of a "rationing regime" in years when the discharge is smaller than the demand, either quantitative or qualitative. It admits the concept that, during droughts, the available water for economic production should be auctioned. Water for human and animal consumption would be set aside from the auction because, by Law, they are top priority for water allocation. Revenues from the auction could be used to compensate water users, particularly the poor ones, for not having access to water.

Nationally, the most important water resources theme in discussion is the proposed partial transposition of the São Francisco river to four states in the Northeast: Ceará, Rio Grande do Norte, Paraíba and Pernambuco. The project is still under preparation but has already stirred much controversy. People and politicians of the recipient region see the project as the definite solution for the region. They highly value a firm source of bulk water that would always be there, even when all local reservoirs would be empty due to a long sequence of dry years. Although the discharge capacity of the diversion scheme is relatively small, compared to the mean river flow[8], politicians of the donor basin dislike the proposal because they see it as a transference of natural resources from their region to another one, without due compensation to the problems that may occur in the donor region. Indeed, each m^3/s continuously diverted would imply a decrease of 22 GWh/year of the "firm energy", provided by a set of power plants located downstream from the diversion point, as well as a decrease of about 2,000 hectares of the potential area to be irrigated in the donor basin.

The application of the Water Law to the solution of this dispute would be an excellent show case to demonstrate that bulk water may be allocated in a rational way. The water users of the recipient region would constitute a lumped water user of the São Francisco basin, having a seat in the river basin committee just like the power sector or the big irrigation districts of the valley, with the same rights and obligations. In other words, the collective of water users of the recipient region would get a water permit and pay for the use of bulk water, particularly during drought periods in the São Francisco, when the unit water price would go up. In other words, power production, irrigation in the valley and irrigation in the recipient region would dispute for water in the market, and all would be admitted in the dispute. These conditions spell out that the water resources in the São Francisco are domain of the Union and consequently all Brazilians may dispute for water permits, regardless where the water is going to be used. In this setting, the power sector would probably reinforce its capacity to attend the energy demand by expanding the transmission line that brings electric energy from the Amazon basin (Tucuruí power plant) or by building new thermal plants close to the big load centers.

Water users in the recipient region would also have to pay for the electric energy used to pump up the diverted discharge, in order to overcome the hydraulic head of 160 m. This means that each water user in the recipient region would have to pay about US$0.015/$m^3$ of water, just to cover the energy bill. The total running cost, including the bulk water price of the São Francisco water (opportunity cost) and O&M of infrastructure could easily reach US$0.025/$m^3$ or about US$400/year for each hectare of irrigated land[9]. Only the high value crops presently being cultivated in the recipient region would be able to afford this kind of cost. This means that the project would not be sustainable if conceived just from the perspective of increasing supply in the recipient region. Before implementing it, or at least simultaneous with the implementation, it would be necessary to establish the water management system in the recipient region, in order to warrant the farmers the supply reliability they need in order to shift to more valuable, and more costly, crops.

The establishment of a water resources management system in the region has been intensely encouraged by three programs supported by The World Bank. All these three loans, although focusing heavily on questions related to implementation of the water resources management system, also have had an infra-structure component. This mix of hard and soft components has been quite successful. A stand along soft program on water resources, as adopted in Mexico, would not be very efficient in Brazil. Here the hard component has proven to be an important leverage factor of the new agenda for water resources management.

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2 In reality, DNAEE was entirely controlled by the power companies.

3 The draft has been available in the web page of SRH/MMA since mid 1998.

4 A draft is available.

5 So far, there are three river basin committees in operation in Ceará.

6 FGTS is a welfare fund, supported by private companies and their workers. FGTS is the major financing source in Brazil for investments on sanitation.

7 There are two rivers in this text that have the same name, Iguaçu, one located in Rio de Janeiro and the other in Paraná.

8 Mean river flow is about 2600 m3/s and the design under development is evaluating different alternatives for the diversion capacity, all of them centered around 80m3/s (only 3% of the mean river flow!). It is worth mentioning that one of the irrigation districts installed in the São Francisco basin (Jaiba) when fully implemented will consume the same discharge, 80m3/s

9 In reality, costs could be much lower if pumping from the São Francisco river could be halted when the spot prices of energy were high. Because the Brazilian system is predominantly hydro, these spot prices are close to zero most of the time, when reservoirs are close to full. Because there is a strong positive correlation between spot prices of energy and the opportunity value of water in the São Francisco river, this operation strategy would result in a double economy, of energy and of water (another example of the "pick the low-hanging fruits first" concept). Annex C expands these concepts.