INTEGRATED WATER RESOURCES MANAGEMENT IN BRAZIL SOME ISSUES

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INTRODUCTION

Table 1 provides an overview of the freshwater availability in the world. One can see that in Europe each million of cubic meters of water available per year is "shared" by 152 people, on the average. South America seems to be in much better shape, as only 25 people must share the same quantity of water.

Table 1 - *Availability of Water in the Continents*
(source: Luiz Veiga da Cunha, Recursos Hídricos da Europa, Lisboa, 1994)

Continent	Surface (10^3 km2)	Population (millions)	Runoff (km^3/year)	Availability (persons/$10^6 m^3$/year)	Availability (m^3/day/person)
Europe	10,500	498	3,210	152	18
Asia	43,475	3,108	14,410	211	13
Africa	30,120	648	4,570	144	19
N. and C. America	24,200	426	8,200	52	53
South America	17,800	297	11,760	25	108
Oceania	8,950	26	2,388	11	252
Total	**135,045**	**5,003**	**44,540**	**114**	**24**

According to a report recently approved by the UN Commission on Sustainable Development (1), "water stress can begin once the use of freshwater rises above 10 percent of renewable freshwater resources..." (paragraph 70). Scandinavia, Canada, most of the extinct Soviet Union, Australia, most of Africa, and all of South America are below this threshold level and, as such, could be classified as low water stress regions/countries. However, the information lumped at the continental level can not be considered sufficient to be used at the country level. Indeed, at country level the water availability indices span two orders of magnitude: the per capita water richest country in Europe is Norway, with roughly 10 persons/$10^6 m^3$/year, while the per capita water poorest country is Turkey, with roughly 1000 persons/$10^6 m^3$/year. Furthermore, depending on the size of the region/country and on the internal hydrological diversity, per capita availability may be a misleading concept. Brazil, for example, which covers roughly half of South America, has a per capita availability of 102 m^3/day (Table 2), which is more than 5 times the water availability in Europe. Nevertheless, scarcity of water is the major problem in the dry Brazilian Northeast, an area inhabited by more than 30 million people.

Table 2 - Availability of Water in Brazil

Region	Surface (km^2)	Population (millions)	Runoff (km^3/year)	Availability (persons/$10^6 m^3$/year)	Availability (m^3/day/person)
North	3,581	8	3,845	2	1,317
Northeast	1,544	44	186	228	12
Southeast	925	65	334	196	14
South	578	24	365	65	42
West	1,879	10	878	11	241
Total	***8,507***	***151***	***5,608***	***27***	***102***

Table 2 provides water availability indices for the Brazilian regions. Again, it varies over two orders of magnitude. The astonishing low figure of only 2 persons/$10^6 m^3$/year is due to the huge Amazon River, which flows through a barely inhabited territory. Inside Brazil, the worst case is the Northeast region, with 228 persons/$10^6 m^3$/year. Water per capita availability of this Brazilian region is comparable to what can be found in Greece or Spain. However, the drought spells that occur in the Brazilian Northeast, on the average once each five years, brings much more suffering than in any of these European countries.

Brazil is a large country, covering about 8.5 million km2, 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, which has been recently approved by the National Congress. 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) water resources were 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 the 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.

The revival of democracy in Brazil, starting in 1986, fired an overall discussion about institutional re-organization of the country. In particular, for matters related to water, the Brazilian Association of Water Resources issued two relevant documents, the "letter" of Iguaçu (1989) and the "letter" of Rio de Janeiro (1991). These two documents embody the general principles that were latter confirmed by the Dublin statement.

Lack of water resources is a necessary but not sufficient condition for the occurrence of a drought. It is necessary to add lack of reservoirs/hydraulic conveyance systems, lack of human resources and lack of proper institutions to transform a natural phenomena into a human disaster. Data as displayed in tables 1 and 2 are useful to provide a first description of the water availability. However, much more is necessary for actually solving freshwater allocation problems.

Even in those parts of the world which are indeed blessed with low water stress, often there are water related problems, as for example pollution. This is almost always the case in countries with low capability to cope with water management problems. Because income level is perhaps the most important reason for this low capability, the UN report has used it "as a rough measure of the ability of different groups of countries to deal with water issues. In general countries with higher per capita incomes are in a better position... as the financial resources and skilled people for management and development are more readily available" (1, paragraph 72). Still according to the UN report, a low income country has a per capita income of less than $795, and a high income country has a per capita income of more than $8,956 (there are two intermediate classes between these two extremes).

There are numerous countries that, despite being blessed with low water stress and with per capita income well above $795, still are unable to achieve rational use of the abundant water resources, due to lack of institutional capability. For the sake of this article, these countries will also be ranked as "low coping capability".

Water resources problems of "low coping capability" countries are usually related to the consequences of: (i) uncontrolled urbanization processes, (ii) occurrence of droughts, (iii) lack of integration among water sectors (irrigation, hydroelectricity, water supply, ...) in planning and management water resources at the river basin scale.

COPING WITH URBAN WATER PROBLEMS

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

Water Supply and Sanitation

The explosive growth of urban centers over the last 25 years, which continues unabated, is rapidly depleting previously bountiful freshwater resources. By the turn of the century, 21 megacities (ten-million-plus), 18 of them in developing countries and innumerable smaller cities and towns will have to satiate their thirst by drawing from ever more distant and degraded freshwater sources (2).

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

a) 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.

b) 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 shows 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 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.

c) Lack of financial and administrative autonomy of the public companies. The board of directors of public companies in developing countries 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".

d) 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.

e) Lack of financial resources. In Latin America alone, it is estimated that the region's countries need to invest an annual $5 thousand million in water supply and $7 thousand million in sewerage and sewage treatment over the next decade. These requirements are well beyond the public sector's financial capacity.

As a reaction to the above problems facing public water and sanitation companies, 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 (3).

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 some 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 state of affairs 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 state of affairs is supported by some people that oppose government intervention in the economy, even for controlling public services. They like to cite the obvious improvement of performance that could be observed in the telephone sector, after de-regulation. However, competition could be established in this particular sector (telephone), and others alike, because they are no longer natural monopolies, due to several technological breakthroughs (cellular phones, for example). In other words, competition inside a concession area could be established. Certainly this is not the case of water supply and sanitation, 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. It must be mentioned, however, that 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.

An alternative for public companies of developing countries, unfortunately rarely used, is the adoption of management contracts between government and the board of directors. These contracts would consist of well established economical and social targets, in exchange for financial and managerial autonomy.

Flood Control

The chaotic expansion of big cities in developing countries, subjected to hot humid tropical climate, is usually associated with a time increase of the flood frequency. For example, there are several neighborhoods in the poor outskirts of Rio de Janeiro that 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:

a) Occupation of the flood prone areas by the poor, that do not have any other option (Figure 3);
b) Clogging of rivers and channels with garbage, which is not properly collected neither disposed (Figure 4);
c) Sedimentation of channels and rivers, as a result of erosion on the hillsides;
d) Increase of superficial flow, due to the impervious surface laid on top soil.

Usually governments of developing countries 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, much because construction companies lobbies, and very little on land use planning and management, as well as on maintenance of the existing infrastructure. 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.

Experience has demonstrated that all these problems are greatly reduced whenever there is an active involvement of the stakeholders in the decision process. It has been proved in a real case (4) that the local population reacts quite positively when the decisions are taken with their involvement. In this specific case, 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.

DROUGHTS IN THE BRAZILIAN NORTHEAST

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. 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 supporting 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.

The new reservoirs designed to be built in the region, some with loans from the World Bank, will have multi-year carryover capability, proper hydraulic conveyance structures and will be located in these water

stressed regions. Also, these loans will help several of the existing reservoirs will be recovered and enhanced on their present capability for providing water to the nearby small urban communities.

INTEGRATED PLANNING AND MANAGEMENT OF WATER RESOURCES

A recent report by IDB (7) provides a comprehensive description of the lately changes on the treatment of water resources issues in Latin America, causing a shift from an emphasis on water resources development (supply-oriented) to water resources management (both supply and demand oriented) and a shift from a sub-sectoral approach to an integrated approach.

In Brazil, the new Brazilian Water Resources Law provides the legal basis for such shift. The law in itself is necessary -but not sufficient- condition for the implementation of a rational water resources management system. It will partially depend on the Administrative reform under discussion in the National Congress. This reform tackles one of the most important reasons for the country's underdevelopment, which is lack of efficient public institutions. Indeed, one of the most persistent problems in Brazil is the lack of administrative flexibility of governmental agencies that operate within the so called "direct administration". They are constrained by a complex legal apparatus that unfortunately has not changed much from the time Brazil was a colony of Portugal, in the last century. For example, it is virtually impossible to hire or to fire staff without going through an "authorization procedure" that takes several months (sometimes years) and several approval steps.

The key principles and instruments contained in the Brazilian Water Resources Law are in agreement with the new paradigm of water resources management, that emerged from some important international meetings and policy papers on water (2, 5, 6):

- 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;
- formation of basin committees ("water parliaments") with representation of the stakeholders (users, NGO's, Government);
- formation of basin agencies, controlled by the committees, with executive responsibilities;
- the supply of human populations should be given the highest priority in water resources use.

It has not been easy to bridge the gap between theory in practice. Some of the questions are:

The river basin scale is proper in most cases, but not in all. Countries that depend heavily on this source of electricity will tend to build very large reservoirs, with multi-year carryover capacity. This is the Brazilian case, as 95% of power production is hydro. When a drought strikes a particular river basin, sometimes for several years on a row, the system will be sustained by the power plants located in different river basins, apart from each other by thousands of kilometers. Hydroelectric power plants in different river basins are 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, which is appropriated for all the other water sectors. How to reconcile these two perspectives?

River basin committees do not need to be established across the board. On the contrary, as committees will only be formed in basins, or sub-basins, which have some water conflict, actual or potential[1]. In fact, the initiative to create a committee belong to stakeholders. Given the fact that (i) some Brazilian river basins are very large (hundreds of thousands of square kilometers), (ii) local problems will induce the formation of committees for some of the upstream sub-basins, and (iii) water resources management should take place at the lowest appropriate level; one can ask: what kind of hierarchical relationship should be established between basin and sub-basin committees?

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

[1] *Other conflicts, for example of economic and social nature, which are unrelated to water, would have better fora.*

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.

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.

How to make compatible the existing (and almost inoperative) environmental licensing system, which is based on the "command and control concept", with the issuance of water use permits and water pricing system, which is based on the "economical concept"?

Pricing bulk water should not be a source of revenue for governments, as there is a widespread disbelief in developing countries 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.

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.

What should be priced: the right to use water, or the water use?

River basi