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## The Guarapiranga Waterbasin Environmental Sanitation Program (São Paulo, Brazil)

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**GUARAPIRANGA WATERBASIN ENVIRONMENTAL  
SANITATION PROGRAM (SAO PAULO - BRAZIL)**

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**1. General information on the Guarapiranga Basin and on the Sao  
Paulo Metropolitan Area - SPMA**

The Guarapiranga watershed is a sub-basin of the Tiete river basin which collects most of the Sao Paulo Metropolitan Area - SPMA - storm run-off and wastewater.

Sao Paulo Metropolitan Area represents 52% of the population of the State and concentrates 60% of its industrial production. It accounts for 57% of final pollution discharges of the State, in which 53% proceed from industrial loads and 68% from domestic loads.

In a very short time the State of Sao Paulo changed from an economy based on agriculture to a predominantly industrial economy. From the small town of 30,000 inh, in 1872, the city of Sao Paulo jumped to 65,000 inh in less than 20 years, boasting 240,000 inh by the

beginning of the century. The actual population of Sao Paulo city is around 9.6 million inh (1991) and the Sao Paulo Metropolitan Area amounts up to 15.4 million.

The environmental situation in SPMA, even though it doesn't represent exactly the situation of other Brazilian cities because of its specific characteristics, is an example of what was done, or failed to be done, in order to protect the environment. Thus, in the metropolitan area, which concentrates 39 municipalities in 8,051 sq. km., the main environmental problems are:

- 92% of the population is served by public water systems, but only 65% is served by sewerage;
- only 22% of sewage collected is treated;
- 14,000 tons of domestic solid waste is generated every day;
- 7,000 tons/day of industrial waste, 3% hazardous waste (220 tons/day);
- 4,9 million automotive vehicles emit 4,000 tons of CO<sub>2</sub> every day;
- 33% of the families live in inadequate or precarious conditions ( 3 million inh living in "corticos" and 1 million living in slums).

SPMA had attracted for several decades a large number of inhabitants from all parts of the country. In the period 1970/80 more than 2 million people come to the city, but in 1980/91 this

process had been reverted, becoming negative (net migration had been of -274,000 people).

Although migration had reduced drastically, SPMA had been suffering the expansion of unemployment rates and poverty. This process had resulted in the expulsion of population from more centralized to peripheral areas, and from medium-income to low-income housing and slums.

The south zone of SPMA, where the Guarapiranga basin is located, is one of the regions that concentrates more low-income population.

By the time the reservoir was built, very few people lived in the catchment area. Because of its proximity to the city and its scenic beauty, a few high-income residential developments were built. Subsequently a low-income housing development started to establish itself towards the lower parts of the basin closer to the reservoir. More recently, slums started growing along the main transportation axis and streams.

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Area .....	637 sq. km.
Reservoir area .....	34 sq. km.
Volume .....	194 million m <sup>3</sup>
Average depth .....	5,3 m
Maximum depth .....	11 m
Average flow .....	10,6 m <sup>3</sup> /sec
Land use: urban area .....	90 sq. km.
horticulture .....	27 sq. km.
forestation .....	15 sq. km.
grassland/grove .....	383 sq. km.
natural forest .....	88 sq. km.
Population .....	550.000 inh
Municipalities: Sao Paulo, Embu, Itapeccerica da Serra, Embu-Guacu Cotia, Juquitiba, Sao Lourenco da Serra	

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**2. The strategical importance of the Guarapiranga Basin**

The Guarapiranga reservoir is one of the main water supply sources in the SPMA, accounting for almost 25% of total area consumption, providing water for 3 million inhabitants. Moreover, the reservoir is a recreational site.

The reservoir was built in 1906 for flood control and electric power generation. Later on, it became one of the most important and also cheapest water source to supply the SPMA.

The SPMA Water Supply System reveals that Guarapiranga Reservoir will supply up to 37% of the total area by the year 2010, due to the increase of transbasin water coming from rivers draining to the sea.

### 3. Why water quality conditions could not be preserved?

The urban network has progressively expanded itself into the lower part of the basin, near the reservoir. This occupation has taken place mostly through low-income settlements and slums, though with insufficient or inexistent sanitation infrastructure.

These activities induce high pollution loads into the reservoir. Therefore several algae blooms occurred at various seasons and with different algae species during the last 20 years.

SABESP, the Water Sanitation Authority, has addressed the problem by copper sulfate treatment on the reservoir itself and in the raw water conveyed to the water supply system. However the situation had been worsening every year for the following reasons:

- urban development has not been controlled but accelerated, inducing the formation of densely populated areas (up to 200 inh/ha) that are replacing vegetation and reducing new high income settlements;
- implementation of sewage systems has not accompanied these developments (only 40% of urban population in the basin is served by sewerage);

- solid waste collection and disposal had not been properly implemented, mainly in slums and low income areas (most of domestic waste of these areas are dumped directly in river banks);
- the rainfall deficit during last years increased the nutrients concentration in the reservoir.

**4. Why was the Springwater Protection Law not sufficient to preserve the Guarapiranga System?**

Since the seventies planners foresee environmental crises represented by the risks of pollution in the SPMA Water Supply System. Therefore the legal framework created by the Second Integrated Master Plan of SPMA (1974) relies mainly on the protection of springwater sources for SPMA, with several regulations for watershed occupation and management.

The Springwater Protection Law, created in 1975, gives the general basis for watershed protection and provides an important tool towards water resources managing. Despite of its basic importance for watershed protection the law was insufficient in policies and incentives to adequate activities to preserve the basin from illegal occupations due to the high pressure caused by population growth.



There is an abundance of laws and regulations at state and municipal levels concerning both the protection of the basin as an important water source for the SPMA and the land use. These laws and regulations lack a basic and common conceptual approach to facilitate the coordination among different levels of government to enforce their application. In fact the establishment of land use regulatory measures has apparently exerted a contrary effect. It turned out to stand as a perverse incentive to illegal occupation and slums development, and simultaneously more formal and environmentally sustainable urban development and economic activities feel no incentive to locate in the basin.

SPL has adequate restrictive measures but was not complemented with promotional instruments to induce an appropriate occupation of land: pollutant industries were not installed in the basin, but illegal low-income housing was not avoided, fiscalization was not capable to avoid the development of high density housing occupation and, most important, no economically feasible activities were implemented.

All these years of Springwater Protection Law had shown that the utilization of regulating and fiscalizing legal mechanisms were insufficient, even if based on a classical regional master plan. The main problem detected was that a master plan based exclusively on public actions, corrective and preventive, does not reach all the land use and occupation processes, being severely restricted by

managerial and financial limitations.

Thus the Guarapiranga Watershed Management demands a new institutional arrangement based on a higher technical knowledge that guarantees the transition between the actual framework and the future without risking protection objectives.

#### **5. Program design and main features**

Increasingly severe algae bloom events in 1989 and 1990 led to a joint action of State and municipal governments to prepare a program to be discussed with the World Bank. Thus, the Guarapiranga Program has been designed within the following premisses:

- the substitution of Guarapiranga reservoir as a water source is impracticable on a short and medium term analysis, considering the lack of other sources with the same characteristics of flow and proximity to the city and its importance as a passage reservoir for future transbasin utilizations, what claims for the urgency of its recuperation;
- the intense urbanization over watershed lands is irreversible considering the high social and economic costs of resettlement of these people;

- the integrated management of the watershed, involving government and society, is fundamental to protect and promote sustainability.

The main goal of the Guarapiranga Program is to assure the reservoir as a reliable source to supply the metropolitan area. Therefore the program structure is composed by corrective and preventive measures:

- **emergencial corrective measures** represented by projects concerning the recuperation of water quality through the improvement of life quality. These measures include investments in expansion of the sewage system, solid waste collection and rehabilitation of solid waste disposal areas, adaptation and rehabilitation of urban drainage system, construction of basic infrastructure for low income developments, slums re-urbanization, resettlement of people living in risky areas, forestation of river banks and public areas, and creation of parks and leisure systems;
- **medium and long term preventive measures** which include the drafting of a management strategy of the basin, combining corrective mechanisms with a long term prevention strategy based on the formulation of an Environmental Protection and Development Plan. The implementation of the watershed operational unit will be based on new instruments for management, by improving

fiscalization and monitoring activities, development of institutional capabilities and environmental education, and promotion of environmentally safe activities.

There is a consensus that corrective measures proposed by the Program are not sufficient to achieve the best environmental quality for the watershed, but they are the very basic measures that should have been implemented to ameliorate water quality. So there still is a large number of corrective measures that can be implemented in the future, based on evaluation and monitoring procedures.

These medium and long term preventive measures attempt mainly the implementation of an integrated management framework based on environmental degradation control and sustainable management mechanisms. To achieve this purpose it has been proposed several sectorial studies (housing, solid wastes, sewerage and drainage, mining, and water quality control) and a project to attract to the watershed private investments considered environmentally safe and economically feasible. These studies and projects will be combined in the Environmental Protection and Development Master Plan for the Guarapiranga Waterbasin.

This Master Plan will be composed by five main dimensions looking forward to achieve the instruments necessary to construct the new watershed management framework. These instruments are: a Geographic

Information System - GIS; a Water Quality Model which relates land uses and water quality in the reservoir; economical and financial instruments designed to sustain watershed assessment; technical directives for land use and infrastructure systems operation; and a legal and institutional framework for implementing and regulating the new watershed management system.

Program effectiveness will be measured by the improvement on water quality indicators, specifically through the reduction of phosphorus loads (average loads by the beginning of Program implementation was about 192kg/day and it is expected to be reduced to 87kg/day - 45 percent).

Though it is important to emphasize that Program monitoring is not restricted to water quality improvement verification, but also to operational and financial enforcement of the entities involved, understanding that this improvement is fundamental to the maintenance of adequate environmental quality and life conditions standards. Thus, it concerns to watershed sustainability through an efficient and realistic assessment.

The results expected from this new watershed management rely on the improvement of environmental quality standards based on an institutional framework reorganization and on water quality innovative policies and monitoring systems.

The continuous monitoring of the results of corrective measures will turn possible an evaluation of their efficacy which will lead to a constant revision of those corrective measures towards better solutions due to new economical, social and environmental conditions. The decision making process to be established by the new institutional framework will continue this constant evaluation and implementation of new corrective measures towards a more sustainable approach.

It is important to observe that preventive procedures in developing countries are more difficult to be implemented than in other countries, and corrective measures will always be necessary though with different designs and technologies.

#### **6. The Guarapiranga Basin Environmental Sanitation Program**

The Guarapiranga Program had started in January, 1993 after the loan agreement between the State of Sao Paulo and the World Bank was signed. Several measures have been taken to rehabilitate water quality of the reservoir and refrain the increasingly degradation process while bidding documents were been prepared and projects completed. Other important measures have been conducted in this

first year of Program implementation: institutional arrangements for the new watershed management agency and people resettlement plan.

The measures taken towards water quality improvement are twofold: corrective measures related to implantation of sanitation infrastructure and improvement of operational procedures; and preventive measures related to the implementation of a water quality control system.

The emergencial measures rely on the improvement of sewerage operational actions conducted by SABESP. The first one concerns the diversion of pollutant loads conducted by Guavirutuba and Itupu rivers from close to water withdrawing point, into the existing sewage system, representing a reduction of 20% of total loads carried into the reservoir. The other measure involves an operational optimization of the existing sewer system elevating it to a different operational standard.

A descriptive model of water quality was built during Program preparation based on the analysis of the existing data and unit pollution charges obtained in bibliographic sources. This model has been improved by the Program Management Unit towards a decision making model that will be completed by data collected and systematized by the GIS proposed in the master plan.

Other important measure taken at the initiation of the Program implementation was the development of a management framework for implementing the Program, involving a multitude of institutions at state and municipal levels.

The innovative characteristics of the Program, based on the integrated management of water resources, brought the necessity of implementing an institutional framework both for coordinating the Program implementation and as an consulting board to discuss more comprehensive problems affecting watershed environmental assessment.

The first institutional framework is represented by the UGP (project management unit) and the executing agencies: SABESP, water and sewage authority; ELETROPAULO, electric power authority, which owns the reservoir; CDHU, housing and urban development state company; SMA, environment state secretariat; and FMSP, Sao Paulo Municipality.

The consulting board is constituted by 42 institutions of state government, municipalities and social organizations. This board will anticipate the final institutional arrangement that will be created for the watershed integrated management.

Special attention has been given to the resettlement component resulting in a carefully designed plan for about 4,000 families that will be removed from slums and geologically risky areas to new



state-build housing projects or to houses bought in local market and financed by state. The project provides complete planning for all resettlement activities, including social procedures, the physical movement of the families to the new site and the construction of the housing projects.

#### 7. Difficulties on the Implementation of the Program

The Program implementation had found several difficulties for its launching as shown below:

- the institutional complexity of the conceived arrangement, although it was necessary and has been implemented with some success, leads to several problems concerned to each institution culture and know-how, therefore resulting in excessive lasting of preparation phases;
- changes on brazilian legal procurement procedures in the past years and persistent problems of compatibility with World Bank's procurement procedures delayed the launching of several bidding processes that are only now being started;
- political changes in both state and municipal levels, so as in many command posts in the executing agencies established discontinuities on the development of components;

- the long-lasting environmental licencing process of project actions which reflects the existing conflict between clean-up actions proposed by Guarapiranga Program and the actual legal framework (springwater protection law) which forbids the implementation of several of these actions.

#### **8. Prospective management systems and the Guarapiranga Basin case**

Brazilian New Constitution (1988) features a number of provisions to protect the environment, specifying, for instance, that economic activities must be subordinate to environmental preservation. In addition, ordinary federal legislation provides for environmental protection and includes statutory provisions such as National Environmental Policy, Water Code, Forestry Code and others. Provides also special evaluation of projects that might have significant impacts on the environment. There are also two important law proposals in discussion: Environmental Auditing and National Water Resources Policy.

State environmental laws are designed to regulate and enforce federal law (Law 6938/81), which is the basis of the National Environmental Policy (PNMA) and the updated policy objectives of the 1988 Constitution. The State of Sao Paulo has an ample legislation regarding the use of land and water in protected areas, particularly those of the SPMA (State Laws 898/75 and 1172/76).

The Sao Paulo State Constitution also includes a specific chapter on the environment, natural resources and pollution control. It features among other measures, a Water Resources and Environmental System.

A general reform was done in the Water Resources System and represents a modern approach of water management policies. The institutional configuration establishes the creation of watershed agencies. The decision making committee of the watershed includes local authorities, community leaders, universities, research institutions and NGOs. Also includes the payment of tax for the use of water and the creation of an Institutional Fund System to be utilized in the waterbasin assessment, as an innovation in brazilian legislation.

State legislation covers a multitude of regulations, many of them obsolete or unenforced, administrated by a plethora of agencies which address various problems as in the case of water resources. The Guarapiranga Project had its institutional framework created by the same time the new state water management plan was created and simultaneously gives support to the system approval.

#### **9. Consolidation of a Prospective Strategy**

The SPMA Master Plan (1993/2010) features two different sceneries

for the next decades: one conservative concerning no significant changes in the institutional framework; and one innovative, that foresees a real change in the institutional framework and activities of the metropolis.

In the first one SPMA will reach 2010 as a fragile and non-competitive metropolis, less important than now-a-days, with a population of about 18 million inhabitants. Working conditions will be worse and unemployment rates will be higher than today. The tertiary sector will be considerably more expressive than industry. The increasing problems associate to the continuous enlargement of the urbanized area will banish the industries, turning the economical basis weaker and reducing the employment opportunities. The informal economy will be larger and the average income of the population will be lower.

The environmental conditions will be lightly better but urbanization will have advanced in all directions, including springwater protected basins and geologically fragile areas. There will still be an housing deficit. Water supply system won't be anymore a problem but sewerage will still be insufficient and there will still be present the same risks to the springwater sources. The solid wastes collection, treatment and disposal will be as inadequate as now-a-days and the total domestic wastes generated will amount up to 16,500 tons/day. The big occasional floods will remain.

On the other hand, the innovative scenery features a better city, more important in the international and national economy. The metropolitan management and assessment system will be established and ruled, assuring the effective collective capacity to make decisions and trace directives for the SPMA.

The population will grow up to some 20 million inhabitants. The employment rates and average income will increase and income distribution will be less disparate. The tertiary sector will have established itself as the main employment opportunities generator. The industrial sector will still be significant and production will increase in productivity.

The environmental conditions will be considerably better and urbanization will have expanded towards east and northeast, predominantly, reducing the pressure over inadequate areas such as the springwater protected basins. The housing opportunities will be better. There won't be problems with water supply and sewage systems and solid wastes collection, treatment and disposal will be adequate to guarantee an higher life quality. The floods will be less frequent and will produce less impacts than today.

Though this innovative scenery will only be possible if several measures be implemented towards a new sustainable paradigm.

The protection of Guarapiranga reservoir requires an integrated

pollution control approach compatible to this innovative scenery for SPMA. The watershed management results, rather than technical aspects, require a new way of solving environmental complex problems: the guarantee of involvement of different levels of government and communities and the treatment of uncertainties in social issues.

The multiple social-cultural and ethical aspects also must be considered in the institutional configuration. The new paradigm involving environmental behavior requires new forms of management within conservation strategies for natural resources and water polices.

This new paradigm must focus a decision making process based on one hand a required environmental reference and on the other hand a possible environmental reference negotiated with public and private entities involved in watershed management. There must be a new methodological process which substitutes the pre-established directives to a more dynamic decision making process.

#### **10. General considerations**

In this methodological approach the planners should consider the political process of decision making inside the planning process, in order to guarantee the actions. It is also important to consider

that new social concerns and demands can appear during the process and the plan needs to answer to social dynamic inputs.

Integrated water management requires a coordination in a scale seldom achieved in human activities. The cooperation and forces required from a diverse population are usually achieved only during natural disaster or wars. This level of concentration on a single goal demands that socioeconomic and political barriers be crossed efficiently and effectively. Most current management strategies are not in a scale commensurate with issues due in the watershed. Essential condition for implementing new approaches in watershed projects is to consider that the scale of the issues requires unparalleled cooperation between industry, governmental agencies and academic organizations.

The increasing tendency to rely on technical solutions must point toward protection and conservation strategies in order to preserve fundamental components of the ecosystem and guarantee watershed sustainability. The complexity of informational management and the scope of experimental manipulations needed, often exceed the capacity of institutions, and intra and interagency inconsistencies in environmental regulations must be corrected. But fundamentally the human activities and educational behaviors are a key element of ecosystem protection.

In other words effective monitoring and comprehension of ecological

and social responses to manage decisions are seriously needed to complement technical solutions.

In this strategy also the role of Government requires new forms of relationship with different actors, in order to develop a partnership with the agents involved and guarantee the trade-offs necessary to the planning process. In those actions centralization and bureaucratic decision can promote failure in the global project strategy.

If not counteract in due time, water quality problems in urban areas may become unmanageable and this is particularly serious if the overall development rate remains as now. Considering that population growth and migration cannot be solved by water policies alone, regardless how they are defined, such problems require deliberate decisions to be made through national and regional policies and strategies.

Therefore those considerations the planning process linked to the watershed must be dynamic in order to articulate incentives and enforcement procedures, concerning the trade-offs with the private sector and other actors in the community.

Forestation, parks and protected areas creation must consider the role of private sectors and their involvement in operation and maintaining activities. Promotional and educative programs need to



be implemented in order to guarantee the community participation in the watershed policies as conservation of water resources, incentives to recycling, clean technologies and others.

## IVAN CARLOS MAGLIO

As a graduate in Civil Engineering, specialized in environmental planning and management, he has been acting for twenty years in this area in coordination and management activities, as well as in urban, regional and environmental planning.

In the urban planning area, he has coordinated and developed local plans and programs linked to the protection of water sources and natural resources by the time the "Sistema de Protecao aos Mananciais" (Drink Water Source Protection System) was implemented, as well as during the development and implementation of the "Plano Diretor de Mineracao da Regiao Metropolitana de Sao Paulo" (Management Plan for Mining Operations in Sao Paulo Metropolitan Region) from 1974 through 1981, and of the "Plano Diretor de Desenvolvimento Integrado da Regiao Metropolitana" (PMDI-I, Management Plan for the Integrated Development of the Metropolitan Region), in 1975.

In the regional planning area, he has coordinated the development and implementation of the so-called PLADEL II - Plano de Desenvolvimento do Litoral Paulista (Development Plan for the Coastal Area of Sao Paulo state), where in one could distinguish a program called "Regularizacao Fundiaria do Vale do Ribeira" (Organization of Farmland Use in the Ribeira River Valley [Southeastern Sao Paulo state]), as well as the Coastal Management of the state's southern coast, the fishing and regional understructure programs, and the establishing of parks and coastal environmental reservations such as the Nucleo Picinguaba, the Parque Estadual do Alto Ribeira, Estacao Ecologica da Jureia, and the Lagamar Iguape-Cananeia). Said activities were performed during the period from 1982 through 1986 in SUDELPA - The S. Paulo Agency for the Coastal Zone Development.

With Cetesb company (Companhia Estadual de Tecnologia e Saneamento Basico) and with the "Secretaria do Meio Ambiente" (State Department for Environment Protection), he has held the positions of Director and Coordinator of Environmental Planning, respectively, and there he established a "Departamento de Avaliacao Ambiental" (DAIA, Environmental Appraisal Department), a unit being accountable for the review and approval of E.I.A. - Environmental Impact Assessment in Sao Paulo State. Also developed under my coordination were the state plans for coastal management both of the southern as well as of the northern coast, and the organization and implementing of the so-called "Areas de Protecao Ambiental" (APAS, Environmental Protection Areas).

Under such programs, methodologies were implemented for the review of E.I.A. - Environmental Impact Assessment appraisal and for development of environmental zoning, being introduced further the application of geo-cartographic information systems G.I.S. in the environmental planning (1987-1997).

Still with the "Secretaria do Meio Ambiente", he has coordinated the environmental component of the "Programa de Recuperacao Ambiental da Bacia Hidrografica do Guarapiranga" (Program for the Environmental Sanitation Recovery of Guarapiranga Watershed), a model plan for the environmental management and recovery of river basins during the phases of program development and appraisal by World Bank, from 1991 through 1992.