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Trabalho de Bolsista:

Ecosystem Services in a Mega Metropolis: Water and Sanitation in São Paulo

Editorial

Esta edição especial do boletim Kenshu-in da ABJICA-SP, traz o trabalho desenvolvido pela bolsista Lais Yumi Nitta, que participou de curso de treinamento da JICA no Japão, em 2008. Um trabalho completíssimo sobre os aspectos de saneamento da cidade de São Paulo, com objetivo de reconhecer e valorizar projetos de bolsistas desenvolvidos após seu treinamento no Japão, demonstrar os resultados decorrentes dessas ações, divulgar esses trabalhos e possibilitar a troca de experiências entre técnicos, disseminando conhecimentos. Apresentamos a íntegra do relatório, em inglês, e no próximo número do Kenshu-in, voltaremos com as novidades e eventos relativos à cooperação técnica Brasil-Japão. Assim, continuamos com o nosso propósito de levar aos bolsistas da JICA, todas as informações sobre a cooperação técnica entre o Brasil e o Japão, assim como os eventos organizados pela Associação e pela JICA no Brasil. Lembramos que a ABJICA-SP realiza suas reuniões mensais na primeira terça feira de cada mês, às 19 horas, na sede da JICA. Estas reuniões são abertas a todos os bolsistas, participe.

Expediente

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Ecosystem Services in a Mega Metropolis:

Water and Sanitation in São Paulo

The Role of Ecosystem Services in Poverty Alleviation and Human Well-being

Lais Yumi Nitta - bolsista da JICA em 2008.

I. INTRODUCTION

"Water is the true wealth in a dry land; without it, land is worthless or nearly so. And if you control water, you control the land that depends on it".

Stegner, W. Beyond the Hundredth Meridian: John Wesley Powell and the Second Opening of the West, University of Nebraska Press, Lincoln, NB, 1954.

Based on the Millennium Ecosystem Assessment (MA) report, and on some of the Millennium Development Goals, such as poverty eradication, reducing child mortality combating disease and environmental sustainability, this paper aims to identify the role of ecosystem services in poverty alleviation and human well-being in one of the biggest cities in Latin America: São Paulo, Brazil. It is also intended to discuss how the degradation of ecosystem services impact on people's lives, mainly into the low-income parcel of population. The main topics referred in this paper are water and sanitation, two human rights that are strictly correlated. It is known that without water, there is no life. Plants and animals cannot survive and it is no different to human beings. Besides, humans also need water for other purposes, such as agriculture, industry, and domestic purposes. However, due to the population growth in the world and the non-alteration in water quantity on the planet, the demand of water enchained a water crisis, which results in water scarcity in some countries and the unequal water distribution among people. Statistics reveal that nearly 1.1 billion people have no access to improved sources of water. The problem of water scarcity, in Brazil, is not as concerning as in Asian or African countries, since the largest river in the world, the Amazon River, is situated in the country's territory and the sources of fresh water in the rest of the territory are abundant, although unequally distributed. The biggest human concentration resides in the south and southeast part of Brazil, where the water availability is 6 per cent, while the Amazon River basin is located in the north part, with 78 per cent of total water resources and a very low population density. Furthermore, biggest and urban areas receive more attention from politicians and decision makers, which favors an improvement in water distribution, what does not happen in smaller places and rural areas. The situation is worse for sanitation. Without proper sanitation, the freshwater sources can be affected and polluted, restraining even more the quantity of water available for distribution. It also contributes to the spread of diseases, lowering people's well-being and health. Nearly 2.4 billion people worldwide receive no improved sanitation services. This estimative is proportionally similar in Brazilian territory. Concerning drinking water, 97.7 per cent of most Brazilian cities are supplied with the service, according to 2000 census. However, only half of them are provided with sanitation services. Even though 94 per cent of population may have had improved sanitation by 2000 only 56 per cent had connections to sewer systems and nearly half of all municipalities in the nation had no sewerage. Moreover, 80 per cent of residues produced are directly thrown into rivers without any treatment. The poor are the ones who are affected the most by the lack of those services. They tend to live in distant areas, many times in illegal lands where attention is not paid and improvements are not made. Incapable of paying for health care and a proper alimentation, they are also more vulnerable to diseases that could be prevented by proper sanitation services and good quality water. Data collected by IBGE (Brazilian Institute of Geography and Statistics) show that in 2000, 800 thousand cases of dengue, malaria, hepatitis A, leptospirosis, typhoid and yellow fever were registered and 3 thousand children under five years old died of diarrhea. All those diseases are strongly connected to the water quality, to floods and lack

of sewage treatment and garbage collection. São Paulo is the biggest and richest city in the country. Services provided there are more developed than in the majority of Brazil's cities, but even so its population is not supplied by water and sanitation services in its totality. Firstly, explaining the water and sanitation problems in the world contributes to a better comprehension on the context in which São Paulo is inserted.

Secondly, in order to understand why São Paulo is not as developed as it should be, it is needed to know São Paulo's history, how it became as big as it is today and how the overpopulation and uncontrolled growth resulted in a lack of infra-structure to a big part of the population. These reasons are discussed in the second session of the paper. Finally, a detailed analysis on São Paulo's situation nowadays illustrates how the water and sanitation issues impact on poverty alleviation and human well-being.

II. THE WATER CRISIS IN THE WORLD

The planet earth is known by the abundance of water in its territory. However, 97 per cent of all this water is salty, which is unsuitable for drinking or growing crops. The remaining 3 per cent is fresh water, (or 35 million cubic kilometers volume). Yet almost all of this fresh water is effectively locked away in the ice caps of Antarctica and Greenland and in deep underground aquifers, far from human habitation. Less than 100,000 cubic kilometers - just 0.3 per cent of total fresh water reserves on earth – is found in the rivers and lakes that constitute the bulk of our usable supply (Moss, 1988). Similarly, freshwater bodies are usually small, relatively temporary, once they easily dry up, or freeze, as climate changes. Water is unequally distributed around the world: more than 40 per cent of river waters, reservoirs and lakes are concentrated in six countries: Brazil, Russia, Canada, United States, China and India. The Amazon itself, in Brazil, holds around 15 per cent of the usable water on Earth. All of Europe accounts for only 7 per cent of global runoff; all of Australia produces only 1 per cent. In Africa, 30 per cent of the total runoff comes from a single river basin, the Congo/Zaire. In terms of water availability for individual use, in North-America and Europe, for example, citizens have around 140 liters a day of water for their own use, while in developing countries of Africa there are only 10 liters a day per capita. Estimates inform that 1.5 billion people on this planet have already no access to safe potable water within easy reach of their homes. If no measure is taken to change this situation, it can result in water shortage to two thirds of humanity by the year 2025. Differently from other renewable resources, the total amount of water in the world can not be changed or increased. However, even if there is enough water to meet its demand, because they are not equally distributed, located in places where the access is difficult and its quality is compromised by wrong management, the humanity face a water crisis.

The use of water - The water is vital for any human activity: agriculture, industry, and domestic (municipal) purposes. At the same time that population grows, so does the demand for water. In the last decades, the population grew enormously, but the water availability remained the same. The supply of fresh water per capita is one-third lower now than it was as recently as 1970, a direct result of the nearly 2 billion people added to the planet since. Furthermore, as population grows, requirements for basic personal use rise proportionately. In 1996, the world's human population used an estimated 54 percent of all the fresh water contained in rivers, lakes, and aquifers. This percentage is conservatively projected (merely using population growth estimates) to climb to at least 70 percent by 2025. The figure will be more if per capita consumption continues to rise. By the year 2025, when the world is expected to have about 8 billion people, more than 70 percent of all accessible fresh water could be used by humanity (Postel et al., 1996). It is known that every human being needs an average of 1 liter of water a day to stay alive (with an adequate diet), and in order to grow an adequate supply of food for one person in a year, it takes around 300 tones of water.

Agriculture - Agriculture dominates global water use, accounting for 69 percent, or two-thirds of all annual withdrawals. Worldwide, irrigated agriculture contributes nearly 40 percent of total food production on 17 percent of the global cultivated area. The increasing growing in urban and rural population will demand a larger food production that, consequently, will require more irrigation. According to the International Water Management Institute (IWMI), 17 percent more water will be needed for irrigation by 2025 to meet food demand (IWMI, 2000). Agriculture is also the least efficient use of water. During irrigation process, about 70 to 80 percent of water is wasted, lost to the atmosphere or seep into the ground before reaching the fields (Falkenmark and Widstrand, 1992).

Industry - Industry accounts for about 23 percent of the water use. From this amount, it consumes only 4 per cent. Some examples of water used for industrial purposes are 100 liters for 1 kilogram of paper and 4500 liters for 1 tone of cement.

Unlike irrigation, where crops consume large volumes of water through evapo-transpiration (evaporation from the soil and transpiration by the growing plants), municipal and industrial uses return 70 percent or more as wastewater. Industries not only require water for the manufacturing process itself but also for cooling or cleaning. It is possible, then, to re-use the water, or use water with less quality. Storm water runoff from the streets also mixes with sewage in some urban settings. Much of this water can be recycled as it moves through the basin, it can be treated to remove harmful wastes. However, over 40 percent of cities with a population over 500,000 are located on coasts (WRI, 1996), which reduces the scope for reuse. Unless these cities take special measures to recycle water (e.g., through industrial recycling or use of treated sewage for peri-urban agriculture), their wastewater is discharged into the sea and lost. (Ruth Meinzen-Dick and Paul P. Appasamy, 2002). An option would be the utilization of sufficiently-treated sewage. Due to the continuously sewage discharge throughout the year, wastewater is an abundant source of water for industry. The need of water is different in agricultural and industry purposes. Much agricultural water use is seasonal while municipal and industrial water demands are year-round. In climates where rainfall or runoffs are seasonal, supplying water in the dry season requires storage, more commonly in groundwater reserves or surface reservoirs. At the same time that stored water is the most valuable (for agriculture as well as domestic and industrial uses), it is also the scarcest. Although industry uses much less water than agriculture, it causes more pollution. While it is used for cooling and cleaning, it is also often polluted with by-products of the manufacturing process and other waste material (Meibeck, 1989).

Domestic Use - At it most noble use, water for drinking can be classified as domestic use. It counts only as 8 percent of water consumption. People need water in their everyday life for other purposes such as cooking, showering, washing clothes and dishes, cleaning their homes. Water is also used in a wider way, to supply schools, offices, to street cleaning and for recreational activities. It is estimated that, each person needs at least 50 to 100 liters of water per day for domestic uses (including for food, bathing, laundry, basic hygiene and drinking). But if this quantity is not possible, at least a minimum of 20 liters per day is required in order to be healthy. This quantity must be available within a maximum walking distance of about 400 meters and it should be affordable, not reducing a persons' capacity to buy other essential goods. This means that essential amounts of water must sometimes be provided free (according to Right to the Water Program). Households in high-income groups connected to the water supply may consume more than 300 liters of water per person per day (NEDA).

Hands, food, utensils, floors, cooking surfaces and children are all less likely to be kept clean when water must be carried from any distance or when it needs to be purchased from vendors. Even if the distance is short, in case the water is not piped directly into a house or yard, it needs to be stored in containers. And so does it if the flow is not regular even when water is piped to the house. Both situations can provide a number of opportunities for contamination.

Quantity X Access X Quality - Although the human need for water is universal, its distribution is unequal. The differences can be between urban and rural areas, among cities but also among social classes. Megacities receive wider attention, and bigger investment from government and external donors, once they are more likely to exhaust their local water resources and to pollute their surroundings (People and the Planet, 1996). In the Amazon region, household access to water is relatively low. Out of 180 countries and territories in the world, the Amazonian countries rank among the thirty-three most water abundant (UNESCO-WWAP, 2003). In contrast, when it comes to safe access to this water for drinking, according to the UNDP index of human development (UNDP, 2004), the Amazonian countries are ranked between the 67th (Suriname), where sanitation servi-

ces are available for 93 per cent of its population, and the 114th (Bolivia) position, where 70 per cent of population is supplied by the same service. In urban and rural areas, there is a significant difference in basic services supply. In Brazil, in 2000, only 62.5 per cent of households located in urban areas of the Amazon (North region), were served with water, while in rural areas, those services were even lower if not often inexistent (UNICEF, 2004). Equally, several countries from other regions with high limitations to availability of water (less than 1,000 cubic meters per person per year) present similar or higher percentages of access to water and sanitation services (King, 2007). Notably, a country rich in water resources can face water scarcity. In these cases, it is caused either by acute spatial demand supply imbalances (e.g., Australia, Brazil, and China), poor water quality (Australia, Brazil, China, and South Africa), environmental constraints (e.g., Chine and India), or consumptive vs. non-consumptive conflicts due to recreational and in-stream needs (e.g., Australia and South Africa) and power generation demand (e.g., Chile). In these contexts, water scarcity is intimately linked not only to water quality but also to inter-sectoral and inter-regional allocation conflicts (Saleth and Dinar, 1999).

To supply everyone in the world (in both rural and urban areas) with the 60-100 or so liters a day considered necessary for health it would require roughly 220 cubic kilometers of water a year, or about 6 per cent of total withdrawals. A large share of the world's urban dwellers already uses more than 100 liters a day. If we consider that half of the world's urban dwellers need an average of 30 more liters of water a day, municipal water use would only need to increase by about 5 % to meet the 100 liter target. Knowing that, it is possible to conclude that supplying people with adequate water to meet basic needs does not contribute seriously to the threat of water stress. Unfortunately, due to the inequality of distribution, while a part of the population consumes twice the minimum required, the other part consumes less than half of it. The total withdrawal of water by the low-income group is less than one-third of the high-income groups.

Water pollution and the need of sanitation - From 1950, the water consumption worldwide tripled. The average water consumption per habitant increased around 50 per cent and, to each 1000 liters of water used by men, 10,000 liters of water return to earth polluted. It means that at the same time demand for water increases, so does the wastewater production. In the late eighties, a city dweller in North America produced 826 kilograms of waste every year on average, while a Japanese city dweller produced 394 kilograms and a Western European 336. By contrast, townspeople in developing countries produced between 150 and 200 kilograms. Nowadays, the human being produces, daily, in the world's cities, more than 2 million tons of excrement, 98 per cent of which are dumped into rivers, streams, water bodies, without any treatment. The quantity of wastewater discharged globally can reach 450 cubic kilometers. In order to dilute and transport the waste water before it can be used again, 6 thousand cubic kilometers of clean water are needed. This amount equals about two-thirds of the world's total available runoff. If current trends continue, the world's entire stable river flow would soon be needed for pollutant transport and dilution (FAO, 1990). For all that, the water quality of rivers, lakes, and sea can be compromised. Municipal wastewater or sewage from houses contains organic compounds, nitrogen, and solids that are only removed through sewage treatment. When it does not happen, the water bodies into which it is discharged can endanger public health and aquatic ecosystems. If municipal wastewater containing human faeces is discharged untreated into the sea, the seawater gets contaminated with pathogens that consequently get into the fish and other kinds of seafood that when is consumed by people, cholera and other gastro-intestinal epidemics develop. Unsafe water is responsible for 80 per cent of diseases, affecting 1.2 billion people and 33% of deaths. Waterborne diseases account for more than 4 million infant and child deaths annually and compromise the physical and mental development of tens of millions more. UNICEF estimates that fifteen children in every thousand die before reaching the age of five from diarrhoeal disease. The availability of adequate water of good quality is important not only for health (drinking water supply and sanitation), but also for productive activities such as agriculture, fishing, industry, shipping and energy (hydro power), for recreation and for the preservation of ecosystems and biological diversity. So, rapidly growing and industrializing countries such as Brazil, China, India, Indonesia, Mexico and Nigeria, where pollution sources and demands upon water resources expand and multiply with equal speed, become a threat to water quality. Only 10 out of 60 countries in this category have established effective laws, regulations, and enforcement infrastructures to cope with new and growing pollution problems. What took over a hundred years to appear in Europe in terms of water pollution occurs in such rapidly developing countries in less than one generation. Rivers, lakes and ground water aquifers are contaminated with biological and chemical wastes. The men actions on massive water developments have destroyed many of the world's most productive wetlands and other aquatic habitats. As if it was not enough, expected changes in global climatic conditions will change future water supply, demand and quality. In developing countries approximately 90 to 95 percent of all domestic sewage and 75 percent of all industrial waste on average is discharged into surface waters without any treatment. Adding to this the agricultural chemicals and pesticides, the consequently actual shortage of water is due not only to the scarcity itself, but to the poor quality of the remaining water resources. Once the water is polluted, not much can be done to recover it. Preventing the problem, instead, is much easier, cheaper and more effective. The more we minimize pollution, the less we have to clean up. Unfortunately, this has not been the traditional approach (Stauffer, 1998). The best solution to protect water is to provide a proper sanitation system. In other words, hygienic removal and treatment of excrement and waste water can avoid water pollution. Polluted water can damage other natural resources. For example, toxic wastes released in a freshwater stream may impair ocean fisheries and air pollutants discharged from one industrialized city may damage air quality for hundreds of kilometers downwind (UNEP IETC, 1996). However, water is not the only thing that can be damaged by lack of sanitation. In densely-populated areas such as cities with a relatively high water table, on-site sanitation (latrines, septic tanks) can create the risk of serious groundwater contamination due to the disposal of excrement and the drainage of waste water into the soil. When the permeability of the soil is poor, drainage problems occur, what makes the connection of houses to a sewer system the only solution available. Having a sewage system can be also complex. Good sanitation needs good quality provision at home (e.g. the toilet), the immediate surrounds (e.g. connection to a sewer or to a pit or septic tank that does not contaminate the groundwater or other people's water) and the neighborhood (provision to ensure there will be no human contact with excreta and to make sure that wastewater is removed safely). To be effective, everyone must use it.

Sanitation and health - The quality of the living environment in cities such as water and soil depend on the drainage of storm water, the removal of solid waste, like domestic, street and market waste, construction waste and industrial waste. But in developing countries, as storm water is usually conducted away by a system of open drains, there might be the danger of waste water to be released in case of non-existence of closed underground sewers. Due to the deficiencies in the solid waste disposal system, solid waste is also sometimes dumped in these drains. This leads to clogging and flooding, with adverse consequences for the environment and for public health (NEDA 1998). So, it is clear that sanitation is an important factor to avoid good quality water contamination that can lead to human health deterioration. Sanitation facilities can prevent human faecal contamination of water and soil, and consequently, the transmission of faecal-oral diseases, besides being particularly effective in controlling worm infections. The main victims of diarrhoea and other faecal–oral diseases are children, who are also the most likely source of infection. Child-friendly toilets, and the development of effective school sanitation programmes, are important and popular strategies for promoting the demand for sanitation facilities and enhancing their impact (WHO, 2000).

Diseases - The poor are more likely to suffer from water-borne and water-washed diseases especially diarrhoeal and skin diseases, because they're more vulnerable to lack of access to sufficient water. Besides, the bad quality of the water that they many times consume, can lead to both bacterial and chemical contamination, whose consequence is also disease. Many of these illnesses could be avoided simply by washing hands with soap or proper bathing, but once people don't have taps in their own property, needing to pick it up in distant sources or even pay high prices for that, they are more likely to prioritize the use of water for drinking and cooking purposes, forgetting about washing and taking care of their hygiene. An example of that is trachoma, the leading cause of

preventable blindness. More than 6 million people worldwide are irreversibly blinded and more than 150 million people are in need of treatment just because of improper hygienic habits. Millions of people die every year from water-related diseases such as typhoid, cholera and malaria, which is one of the most important killers of children under 5 years of age, accounting for 20 per cent to 30 per cent of childhood deaths. Globally, it is estimated to be 120 million clinical cases of malaria each year with roughly 300 million people carrying the parasite. Half of all cases recorded come from India and Brazil, and about one-fourth of reported cases originate from Thailand, Sri Lanka, Afghanistan, Vietnam, China and Myanmar, which are all developing countries. In the Americas, where malaria incidence increased dramatically from 270,000 cases in 1974 to 1.1 million in 1989, 52 per cent of the cases are in Brazil. Within Brazil, the Amazon region recorded 97 per cent of all cases. Aside from malaria, mosquitos may transmit several other diseases, such as yellow fever, dengue fever, filariasis, and dozen of lesser-known maladies. Diarrhoeal diseases cause 6000 deaths a day, mostly among children under five. The micro-organisms which cause these diseases can be water-borne, or transmitted when faecal matter can enter the mouth. It can be among the most serious health problems in cities where water supplies and provision for sanitation are inadequate. Children are most affected by sanitation-related diseases not only because of their lower immunity to pathogens, but also because of their behavior of playing and exploring and having less appreciation of hygiene. They are then more likely to come into contact with excreta and other pathogens. In the Brazilian city of São Paulo, the incidence of diarrhea resides in the lowest socioeconomic stratum, showing 13.1 cases per 100 children compared with 9.6 cases in the next stratum and 3.6 episodes in the upper stratum. Each year, 250 million new cases of waterborne disease are reported worldwide, resulting in roughly 10 million deaths, 75 per cent of which occur in tropical countries, where disease is spread due to the combination of poor state of water supply and sanitation infrastructure. In developing countries, it is estimated that 80 per cent of all diseases and one-third of all deaths are caused by the consumption of contaminated water resulting in loss of at least 10 per cent of productive man-hours.

Some statistics on water-related diseases worldwide

- **Diarrhea –** around 4 billion cases a year, cause 2.2 million deaths, mostly among children under the age of five, which is equivalent to one child dying every 15 seconds, representing approximately 15 per cent of all child deaths under the age of five in developing countries. Water, sanitation, and hygiene interventions reduce one-quarter to one-third the cases of diarrhoeal disease. Diarrhoea is the most important public health problem affected by water and sanitation and can be both waterborne and water-washed. If water is available through a house or yard connection people will use large quantities for hygiene, but consumption drops significantly when water must be carried for more than a few minutes from a source to the household.
- **Intestinal worms -** reaches about 10 per cent of the population of the developing world and can be controlled through better sanitation, hygiene and water supply. Intestinal parasitic infections can lead to malnutrition, anemia and retarded growth, depending upon the severity of the infection.
- **Trachoma -** 6 million people estimated to be blind from it and 500 million at risk. Providing adequate quantities of water can reduce the median infection rate by 25 per cent.
- **Schistosomiasis –** infection caused by a parasite worm infecting 200 million people in the world, of whom 20 million suffer severe consequences and still found in 74 countries of the world. The cases could be reduced in 77 per cent with well-designed water and sanitation interventions. (WHO, 2000). If the supply of safe drinking water was combined with adequate sanitation, hygienic behavior, and environmental management aimed at disease vectors, it would result into a considerable reduction of costs in health services. In Brazil, each US$1 invested in water and sanitation services saves US$5 in health care.

The problem of increasing population - The uncontrolled population growth resides in bad human well-being conditions of the population besides bringing environmental problems, once it demands more natural resources and infrastructure. Rapid industrialization puts pressure on water resources, helping the increase in industrial effluents, which can threaten the water quality. This issue is even more worrying in countries lacking adequate environmental controls, where there is larger risk of chemical spills and accidents. The major urban centers in the developing world have increasingly become centers of industrial concentration, where industrial pollution problems have arisen. Already a fact, the developing world accounts for nearly two-thirds of the planet's urban population and for over 90 per cent of population growth. At current fertility rates, populations in sub-Saharan Africa, the Middle East, and parts of South Asia will double in 20 to 40 years. At projected growth rates, by the year 2050 the global population is expected to be 9.4 billion, of which 8 billion will live in developing countries (UN Population Division, 2001)". Therefore, the fast unplanned growth has created several problems such as lack of land, housing, and employment; inadequate services; shortages of resources and qualified personnel; non-coordinating national and regional urban policies; costly imported finance; which made difficult for many governments to provide infrastructure and service to the population, as well as preserving the environment for a better life condition. If this growth continues to happen disorderly, the number of people lacking these services will also increase. All of these forces combine to create a serious imbalance in the overall quality of life between developed world urban dwellers and their developing world counterparts – especially those living on the economic margins of society (Hewitt, 1999). Not exclusive to mega cities, the process of urbanization will continue in towns and secondary cities. With that, more food will be necessary, demanding more water for food production from both agriculture and aquaculture. Presently, agricultural irrigation accounts for 70 to 80 per cent of all water use. As a consequence, the world will be unable to stretch the limited freshwater resources to provide to these people, resulting in an inevitable water crisis. Notably, expansion of water supply systems will be required. This expansion can be difficult even if the city is situated on or near a river. In an early stage of development, the withdrawal of water from a river facilitates exploitation and a dwindling supply or to degradation of water quality. Currently, however, many urban areas must import some water from more remote, water-rich regions (Gleick, 1993).

Water crisis and environment degradation - Recent studies have shown that water prices will double, if not triple, in the next few years because of the commodity's increasing scarcity. This will disproportionately affect the urban poor, and their plight in turn will exacerbate the urban environmental crises. According to one estimate, the cost of pollution problems alone in developing countries exceeds 5 per cent of their GDP. Clearly, improving the situation of the urban poor is an essential precondition for reducing urban environmental hazards (Uitto, 2000). It is important to stress that water-management strategy will only work if measures to slow population growth were taken, such as family-planning and reproductive health services. In the developing world, at least 100 million married women (and millions more unmarried women) do not currently use contraception. If a better reproductive health care is provided, so people's ability to manage limited supplies of water could be improved. According to studies, a person's ability to manage natural resources, particularly water and land, depends in part on his or her level of education and overall health status. Furthermore, the treatment of waterborne wastes will need more attention. Urbanization in developing countries can be positive, however, when it is seen as an engine of economic growth, with great potential to reduce poverty. To realize this potential, cities also need water for industries and to ensure a decent quality of life for all their citizens (Meinzen-Dick and Appasamy, 2002). Considering that most developing countries today would put development before environmental concerns, in order to prevent further degradation in fast growing countries, urban planning is required, along with environmental education. The industrialization and urbanization processes happened differently in developed and in developing countries. In developed countries, the cities grew more slowly, what made possible the execution of an urban planning in order to build an adequate infrastructure to population. For example, in Paris, the increase of population of half a million inhabitants to 3 million lasted around a century, or three generations, while the same growth in Third World cities would take less than one generation. Because of the unplanned urbanization, developing countries face worse poverty and environmental problems, such as extensive air, water, land and noise

pollution, which have and will continue to have major impacts on the health and welfare of urban dwellers in the developing world for many years. The problem has been further compounded by increasingly skewed income distribution, which is continuing to worsen with time, high rates of unemployment as well as underemployment, corruption at all levels, and high crime rates (Uitto, 2000).

The increasing demand of water - The growth in water usage has been followed by the population growth. Besides that, between 1950 and 1980 cities in Latin America such as Bogota, Mexico City, São Paulo and Managua have tripled or quadrupled in population, and cities like Nairobi, Dar es Salaam, Lagos and Kinshasa have increased over sevenfold.

Because of that, some of the largest cities are unable to provide an adequate quality of life for their citizens, including clean drinking water and sanitation services. Urbanization and economic development stimulates improvement in living standards that demand even more water. Even though the highest population growth happened in developing countries, they use far less water per capita than developed ones. Rising living standards, which bring such amenities as running water to homes, dramatically increase per capita water consumption. In regions where water scarcity is existent, like the African countries, the average consumption of water per person is 19 cubic meters per day, or 10 to 15 liters per person. In New York, instead, someone could spend 2000 liters per day. Following the same theory, the increase in water consumption produces more waste. This is why the production of waste in developing countries is lower than in industrialized countries. However, this waste produced by untreated or partially treated municipal sewage, industrial poisons, and harmful chemicals that leach into surface and ground water during agricultural activities is dumped into rivers and water-bodies shrinking the already scarce supply of freshwater. This chain reaction can limit the economic development of the countries in which this procedure is practiced. The concern in developing countries is not the production of waste itself, but how its lack of treatment impacts on environment and on human well-being. In other words, population growth demand more water, produces more waste that are freely dumped into freshwater resources, shortening its availability. Then, the water left to continue on supplying the population can be the cause of diseases, deteriorating people's health. There are some possible solutions to the increase of water demand. Since population will not suddenly stop growing, the principal options are to demand reduction through rationing, improving distribution of available supplies, increased efficiency of water use, restructuring of societal activities, such as cultivating low-water use crops, and avoiding water pollution as human activities.

Energy - The supply and use of both water and energy resources are intricately connected. The production of useful energy and electricity uses and contaminates fresh water resources at the same time that the pumping, cleaning, and transport of fresh water require the use of energy. In the last few decades, the availability of both resources has been limited. But if in one hand increasing energy use in developing countries through traditional expansion of fossil fuel combustion will lead to severe environmental problems and enormous increases in the consumptive use of water, in the other hand, improvements in health, economic conditions, and our overall quality of life will require better access to clean drinking water, sanitation services and water for other activities. Another concerning point is that limitations on the availability of fresh water in some regions of the world may restrict the type and extent of energy development, whose limitations on availability would make difficult the provision of adequate clean water and sanitation services to the thousands of millions of people who lack those basic services. The use of large quantities of water for energy production in water poor regions can lead to changes in natural hydrological and ecological systems, besides increasing the pressure for inter-basin transfers of water. Furthermore, absolute constraints on water availability will limit choices of sites and types of energy facilities in some places.

The situation of the poor and Human well-being - Due to intense immigration, unplanned birth and the inability of the work market to absorb the excess of people, the number of urban poor has been increasing. In spite of the bad conditions in the city, the immigration still continues because, compared to rural life, the urban life is attractive due to the easier access to education, leisure, health and life quality. Nonetheless, the cities' infrastructure has not been able to follow this enormous growth, which resulted in a lack of adequate access to shelter and services such as water supply, sewage systems, low-cost housing, education and public health. The inadequacy of basic services exacerbates and sustains urban poverty. Moreover, the provision of such services is essential to the growth and vitality of urban economies (Cheema, 1988). With the change of this chart, if the poor can obtain access to basic sanitary facilities, potable water, shelter, transportation, health and educational services, find employment or sources of credit to start small businesses, it would be possible to increase their productivity and income to generate and sustain economic growth. Pushed to find low-cost habitation in cheaper lands, farther to the city center, the urban poor deprived from adequate sanitation, are, many times, forced to do open defecation. This activity is extremely hazardous to the health of those who practice it as well as to people living nearby. If some members of a community continue to defecate in the open, then the whole community is at great risk of diarrhoeal diseases, worm infestations and hepatitis. Eighteen per cent of the world's population – 1.2 billion people – is practicing open defecation, and 13 per cent of them live in urban areas. Similarly, in many developing countries, young children defecate either in or close to home, or in diapers and potties. Infant and child excreta often ends up contaminating soil, drains and water bodies, either through direct disposal or defecation, through the washing of diapers and potties, or due to areas without safe wastewater disposal. Unsafe disposal of child excreta, similarly to open defecation, poses a health risk to anyone living or playing in the surroundings. When left in the open, child faeces, which may carry a higher pathogen load than adult faeces, pose a particular risk for young children, whose play areas frequently overlap with disposal areas. Safe disposal of children's faeces is therefore at least as important as stopping open defecation (WHO, Unicef 2008). The difficult access to water brings not only vulnerability to water-borne diseases but to other threats, such as spinal injuries for carrying heavy loads of water through long distances and physical attack while collecting water. As women and children are usually the ones who execute this activity, they miss both work opportunities and school, which unable them to change their economical situation. To illustrate it better, in 1990, 1.23 million people lacked access to clean drinking water, and 1.74 million people lacked access to adequate sanitation services. According to the United Nations estimative, by the turn of the century, population growth alone will increase these numbers by nearly 900 million people, and there is no clear plan for how to satisfy these additional water needs. Water, sanitation and hygiene are three intertwined determinants of the water/ill-health/poverty spectrum, with hygiene to be considered in its broadest sense, including environmental as well as personal hygiene. Having one's basic needs in terms of water met and being able to rely on a sustainable livelihood are crucial elements of social well-being, contributing substantially to physical and mental well-being. The diseases generated by the lack of those basic services are not only felt in the world today, it also affects the potential of future generations. The intestinal helminth infections, hygiene-related disease affecting school-age children, aggravate malnutrition since these parasites consume nutrients, retard children's physical development and result in poor school attendance and performance. They destroy the well-being and learning potential of millions of children. Each year 19.5 million people are infected with roundworm and whipworm alone, with the highest rate of infection among school-age children. Schistosomiasis (bilharzia) is estimated to affect 118.9 million children under fifteen years. Rich people are environmentally more dangerous or risky than poor people, because poor people do not have the means to pollute in the same way. But poor people suffer more severely from environmental deficits; a lack of clean drinking water or adequate sewer systems creates serious health hazards. The risks for rich people are more indirect, and this may explain their low willingness to pay for more investment in the environment. However, to achieve sustainable development, the first essential step is to discover a way out of poverty that will protect the environment. By using new wealth to provide the services necessary to maintain public health, it might be possible to maintain ecological balance.

Water helping in poverty alleviation - How to improve the well-being of the poor? Water for drinking and sanitation is not the solution alone. Even though it is extremely important to avoid diseases, there must be a changing in education and hygiene measures. People need to learn not to keep polluting water bodies with their wastes and a better water

management by the government must be provided, to ensure protection of water sources from pollution. The society, tired of waiting for government's solutions, has taken one step further: non-governmental organizations have already taken a strong role in initiating service delivery programmes in many Third World cities, and their role is likely to grow (Cheema, 1988). Improvements in the drinking water supply and in sanitation reduce the costs of curative health care (treatment of water-borne diseases) and the costs of reduced labor productivity resulting from these diseases. They can also produce direct economic benefits and therefore improve living standards. The availability of treated water at home won't require people to boil water before consuming it, reducing air pollution and the costs in energy that can reach 11 to 29 per cent of household income, a significant amount to low-income population. Finally, sanitary facilities also enable waste and waste water to be recycled, bringing economic benefits.

How to increase water supply by recycling water - Due to recent problems of water scarcity and population growth, it is necessary to think about the options for increasing water supply. There are some, such as building new dams and water-control structures, inter-basin transfers, and non-conventional sources like desalination, and water harvesting. Access to unexploited water from distant sources, although possible, is becoming more difficult and expensive. Taking water from another use becomes, then, appealing. In many cities of developing countries, 50% of the water consumed is wasted through leakages, theft or problems in the distribution system. Solving these impediments first the use of water can be optimized. Secondly, reuse and recycling can be an option, since many forms of water use do not consume the whole quantity withdrawn. In fact, much is eventually returned to the hydrologic system, though at a reduced water quality. Wastewater can be reused and recycled at various levels from the household to the city. "Grey water" from sinks or showers is often used for home gardens or can be diverted to soak pits to recharge the ground water. Treatment and recycling of wastewater for non-potable uses can be taken up in large buildings. Several cities have attempted to use treated sewage for urban agriculture or for industry, though there are concerns with the accumulation of salts and heavy metals that can harm the soil or human health. Industries that recycle their wastewater simultaneously reduce their water requirement as well as the effluent discharged (Maizen and Appasamy, 2002). Thirdly, the water saved from agriculture could meet most urban demands. The only constraint is that while irrigation use is seasonal, urban requirements are year-round, demanding storage. In climates with seasonal rainfall (as in many developing countries), ensuring such supplies generally requires stored water, which leads ground water and reservoirs to play the largest role in supplying municipal water. It would only be practical if farmers close to cities provided water transfers. In the other way around, using wastewater to agriculture can increase food security in rapidly growing urban areas. Not only this practice brings environmental but also economic benefits, because it avoids direct pollution of surface water, conserves water and the nutrients in it, which reduces the need for chemical fertilizer, lowers costs of municipal wastewater and it provides a reliable water supply to farmers. In the other hand, irrigators, communities and consumers can endanger their health during prolonged contact with wastewater, once the groundwater can be contaminated with nitrates, heavy metals while chemical pollutants can be accumulated in the soil. Moreover, habitats for mosquitoes and other disease vectors can be created, limiting the marketing options for agricultural products exportation. Some may think that the solution appears simple: to treat the wastewater before use and disposal. Even though excellent treatment methods exist, they are too expensive for those who need it the most: the developing countries. The cost of providing wastewater treatment facilities for all cities is so high, that two-thirds of the urban wastewater generated in the world receives no treatment at all. Apart from that, even if the resources were available, improved water quality is not guaranteed. Many of the existing wastewater treatment plants are not functioning properly because local authorities often prefer high-technology solutions to more appropriate, lower-cost alternatives. Most conventional treatment methods remove the nutrients in wastewater, reducing economic benefits to farmers (Van der Hoek, 2001). To conclude, the collaboration of society through public information spread by the media or consultation with user groups could provide education on water scarcity, water conservation methods, habits, and measures to avoid water waste and deterioration. School programs to educate young people about the issue of water conservation and sanitation can play an important role in the long-term.

Men altering environment - In the process of civilization, human settlements were established close to water bodies, due to human needs requiring water. That is why the surroundings of the rivers Nile, Euphrates-Tigris and Indus are scenarios for the first civilizations. Once the men began to raise animals and deal with agriculture, they realized the importance of water not only to human but for all kinds of life. Humans have used rivers for transport and navigation, water supply for domestic uses, for industrial uses, for agriculture and other sources of food, for waste disposal, and for recreation. For their own convenience, men have massively altered waterways by building dams, levies, canals, water transfers, and even reversing the direction of flows in entire river stretches. Physical alteration, habitat loss, water withdrawals and diversions, pollution, over harvesting and the introduction of non-native species are widespread across the world and have taken a heavy toll on freshwater biodiversity (Revenga and Kura, 2003). As a consequence, today, freshwater species are, in general, at higher risk of extinction than those in forests, grasslands, and coastal ecosystems (WRI et al., 2000). The construction of large dams in river basins, although insuring a steady water supply, can threat freshwater species because of its environmental impacts that can vary in extent and gravity. Dams disconnect rivers from their floodplains, interrupt fish migrations and flood cycles, and alter the temperature and velocity of in-stream flow, changing flood essential feeding and breeding habitats for many aquatic and terrestrial species. There are several dams being constructed, currently, in developing countries: forty-six in the Yangtze Basin in China, which accounts as the highest number of dams under construction, followed by twenty-seven in La Plata basin in Brazil and Argentina, and the Tigris and Euphrates basin in Turkey, Syria and Iraq with twenty-six. Other factors like contamination, lack of access to potable water, or bad management help generating ecological, economic and environmental disturbances with serious risks for the environment, health and human well-being. All of them are results from men alteration in the environment. Another important point is the disposal of wastewater and other wastes from large urban centers that threatens natural ecosystems. It can be a major problem in countries in which population grows most rapidly, and because waste is expensive, it can be even worse for developing countries, once they have limited budget to spend in wastewater treatment. Concerning the water cycle on earth, the water evaporated from irrigation returns to the rivers either heavily eutrophicated, loaded with agricultural chemicals or both, requiring expensive treatment to purify it for further consumption. Once again, the poor are the ones to suffer the most with ecosystem degradation. Poor rural populations have fewer development alternatives, depending directly, in most cases, on ecosystems for their livelihood. Inland fisheries, for example, are in many instances the employment of last resort when other economic opportunities are lost (King, 2007). In order to achieve civilization, men have also changed landscape to build cities. Deforestation resulted from that added to combustion of fossil fuels can generate greenhouse gases, in a process in which a sink for carbon dioxide is removed and CO2 is released into the atmosphere when forests are burned. To worsen, growing populations and growing energy use will make it difficult to prevent climatic changes, even if many actions are taken to reduce the emissions of such gases. These climatic changes will, in turn, greatly affect fresh water resources. Higher temperatures will increase evaporation, change snowfall and snowmelt patterns, and lead to alterations in water demand. Changes in rainfall will affect water availability in rivers and lakes, hydroelectricity generation, and agricultural productivity, while rising oceans will contaminate coastal fresh water aquifers (Moss, 1998).

Investment in water/ Economy -Water also determines the economic growth of a country. The better its quality, the more social, cultural, economic, and environmental functions it can perform. So water scarcity is more than just a simple non-availability of water. (Turton and Warner, 2002). It is then important for developing countries to invest more money on improving water quality. Unfortunately, the investment in developing countries is much less than the required. According to an estimative made by the Global Water Partnership in 2000, developing countries should dispose US$13 billion per year for drinking water, US$17 billion for sanitation, US$70 billion for municipal waste water treatment, and US$30

billion for industrial effluent treatment, totalizing US$130 billion per year. Oppositely, the current investment is around US$35 billion.

Solutions - The first step to avoid worse consequences to water pollution and demand of water for human use is to find a way to control population growth and uncontrolled urbanization. If it still continues, in a long or short term, it will lead to the establishment of squatter and slums that have no basic infrastructure as water supply and sanitation system, leading consequently to more poverty and precarious health conditions, rising rates of urban morbidity and mortality. Moreover, the amount of water that will be required to urban areas is enormous. To access drinking water, migrants will be forced to buy water from street vendors at prices up to ten times the price paid by citizens supplied by water authorities. The process of over-urbanization will compete for reliable water supplies with farmlands that provide food to population. Several regions of the world with rapidly population growth are moving towards unsustainable conditions due to growing pressures on limited renewable fresh water availability (Gleick, 1993). This is the reason why the protection of water resources from further degradation should become an immediate focus of international efforts. For instance, better agricultural practices, a decreasing emphasis on pesticides, the recycling and reuse of wastewater and more careful water development, once becoming central to water and resource planning, would avoid or shorten water scarcity problems. If provided with good quality water, a country is able to invest in the health of its population and its environment. Instead, the fact of treating individual waterborne diseases, like cholera or malaria, rather than addressing questions of widespread poverty, adequate water supply, illiteracy, and community health is a mistake, because those diseases are preventable and would represent less costs if they were avoided instead of cured. Another example is trying to preserve selected species of endangered fish rather than the entire ecosystem that is being modified or destroyed. In order to achieve development, massive hydroelectric facilities are built without proper attention to the social, cultural, and ecological ramifications that such projects inevitably bring. A change in actions is required urgently. Concerning water supply and sanitation in rapidly growing urban areas, two crucial measures must be implemented: leaks in the distribution system must be repaired to reduce losses and to prevent polluted ground water from entering the system as well as providing safe water, or better said, unpolluted water to the population on the urban fringes.

III. THE HISTORY OF SÃO PAULO - In order to understand why São Paulo city became as big as it is today with its present problems, it is also needed to understand its history. São Paulo city was officially funded in 25 January 1554, with the name of São Paulo de Piratininga village as a Jesuitical mission to the first habitants, the indigenous people. The city remained as a small village for centuries, until mid nineteenth century, when São Paulo was benefited by the railway that connected the country side to Santos port that is now a suburb of São Paulo, just as in the past, Yokohama became a suburb of Tokyo. With the new transportation facility, the coffee production expanded, demanding help from workers, who came to São Paulo from other parts of the country and some foreign immigrants, especially Italians. The city started to grow economically and the first industries began to settle. Because of that, the number of habitants that were around 30 thousand people in 1870 grew enormously to 240 thousand in 1900. It was the beginning of its uncontrolled growing. At that time, the urban expansion to other areas beyond the center started towards fertile valleys and river terraces, where the railways were installed. During 1901 and 1912, 188.7 kilometers of railway lines were implemented. Previously empty spaces were then occupied by factories and laboring quarters, reaching other cities and resulting in a fusion of an only metropolitan region. The city's structure couldn't handle this process and as a result, problems such as habitation, transportation and basic sanitation firstly emerged. Initially the water that supplied the city was captured from Pedra Branca brook, in Serra da Cantareira (a farther region in São Paulo city) and in 1907, the domestic water supply at Sé neighborhood was released with the construction of Araçá Reservoir.

The transformation of the city - In just fifty years São Paulo changed from a provincial city to an important increasing urban centre, enriched by the coffee economy and by the industrial boom that happened during World War I (1914-1918). In 1920's census, the city was already the biggest industrial producer of the country, responsible for 32 per cent of the production. From mid twenties, in the new expansion areas of the cities, public services supplies such as tram transports showed some problems. The new neighborhoods were supplied by buses and by the increasing number of cars that became cheaper. The population reached the number of 700 thousand people. Among them, a concentration of poorer habitants, mainly composed by immigrants and laborers, who lived in bad conditions in the periphery area with scarce access to many public services. From 1930's, São Paulo's population began to increase far more rapidly than the country's. At the same time, the city's old landscape of curving rivers started turning into straight water courses, fitted into flooding plains. After World War II, it was necessary to replace imported goods and supply the war effort. New immigrants arrived from Japan, China and Korea, so did new intern migrants, from the northeast of the country, who were attracted by the diversified work opportunities in durable consuming goods industry (cars and house goods), intermediate goods (iron and steel industry, paper, petrochemical and rubber) and capital goods (machines and equipments). From 1940 to 1950 the population of São Paulo city increased in a 5.2 percent rate per year, 73 per cent of which was due to migration. There were 4.876 industries in the city in 1940 that represented 54 per cent of the State's Industrial Production Value. The development process pushed the expansion even more to the periphery territory, where the natural characteristics were inappropriate to occupation, once there were fragile soils, susceptible to erosion and more declivous relief. As the new comers didn't have financial conditions to pay the rent in central areas, those families settled in distant suburbs whose rent they could afford. The periphery became, then, the house of working class. Meanwhile, the centre region was "verticalized" (tall buildings were built). In order to solve flooding problems, several engineering works were executed, such as streams canalization and the construction of new avenues over them. Gradually though, old fertile valleys were being occupied and the soil water proof process compromised the natural capacity of rain water absorption, allowing floods to become one of the most serious problems of the city. In the same period, while the geometrical rate growth of the city declined, the population increased in the periphery of Great São Paulo (ABCD – Santo Andre, Sao Bernardo do Campo, São Caetano, Diadema - Osasco, Guarulhos, Santo Amaro), as a consequence of the growing industries displacement to those areas. The area of Great Sao Paulo grew in population from 2.7 million to 12.7 million from 1950 to 1980, increasing its industrial employment from 600 thousand jobs to approximately 1.4 million jobs over the same period. In 1960, the city was responsible for 52 per cent of the State's industrial production and 28 per cent of the country's. In 1967 its participation fell to 42 per cent and then to 24 per cent. Between 1970 and 1980 the process of deindustrialization of the central area was intensified as a consequence of several factors such as localities and economy, because of the soil price, metropolitan law restrictions, trade union organization capacity, fiscal incentives, etc. An industrial park polarized between two different profiles remained in the city: in one side, old industrial establishments, specially the old consume goods industry, and in the other side the newer industrial segments – electric sector and telecommunications – where smaller places predominated with bigger technological requisite, low environmental impact and bigger labor qualification. Once the financial services groups were established, the metropolis was no longer an industrial city, becoming the country's financial centre, with the growth of the tertiary sector (commerce and services). Nonetheless, a big part of the working population dismissed from industry was not absorbed by this sector, which, together with the economic crises of the eighties, resulted in high rates of unemployment and in the emergence of informal market (camelôs). Between 1961 and 1995 the municipality of São Paulo tripled in size, from 3.7 million to 10.2 million while the greater São Paulo region increased from 4.7 million to 16.3 million people. With the population growth, problems such as lack of housing, pollution, transportation, traffic jams, lack of public services (health care, education, policing) and so forth worsened. From the seventies onwards the income concentration process was intensified and the emergence of shanty towns around the city's periphery demonstrated, clearly, the poor's territorial exclusion. In 1973, 1 per cent of the population lived in slums. This number increased to 4 per cent in 1980, to reach 8 per cent in the early nineties, due to the economic crises that caused an enormous rate of unemployment.

Contemporary city and its environmental problems - Following

the previous decade, the growth of population continued to decrease during the nineties. Nowadays, the Greater São Paulo is the most important industrial producer of the country. São Paulo City is responsible for 18 per cent of the national GDP and for 20 per cent of Brazil's industrial production, besides being South America's financial center. Even though the economy of São Paulo generated around US$80 billion or 10 per cent of the National GNP, which included around 5 million working people, the unemployment rate was 18 per cent in 1999. The twenty first century started with a metropolis in crisis, branded by the social exclusion of the majority of their habitants and by the intense degradation of its urban environment. The population is spread unequally inside the city's territory. The historic centre of São Paulo comprises 3.5 per cent of the population; the expanded centre of the city comprises 27.5 per cent and the periphery 69 per cent. However, it is possible to find high-income developments on the periphery as slums in decaying inner areas of de city. The city's total area of 1509 square kilometers is 870 square kilometers urbanized, where 65 per cent of its population lives. Nonetheless, 70 per cent of this population presents difficult access to habitation, which results in shanty towns, slum tenements, and invasion to illegal lands that compose the real city. It is estimated that in the city of São Paulo there is an area of 311,474.774 square meters of land illegally occupied and developed. The legal city, however, is the one that presents zoning laws, and soil occupation use.

Sao Paulo can then be divided in two. One is inhabited by higher income groups with full access to basic infrastructure and services, presents low rate of population growth, and has significant concentration of residential buildings and satisfactory levels of health care. The other city is made of peripheral areas characterized by a high rate of population growth, a low level of income, and poor health conditions combined with serious infrastructural problems. This social-spatial segregation results in further problems such as more time needed from home to work by those living on the periphery. The environmental problems, however, arise mainly from the precariousness of services and the failure of the public authorities. Nonetheless, residents of poor areas frequently do not act cooperatively to address the problems, or do not organize themselves to reduce their impact. Those among the population who are provided with infrastructure are not necessarily aware of the problems, and those who are badly supplied have very little means of solving the problems generated by environmental degradation. The pollution of water sources from careless dumping of household wastes can be seen as examples of individual interests taking over the city's quality of life as a whole.

Population Growth and Migration - Even though Brazil is a country in which vegetation is abundant and land is good for agricultural purposes, millions of Brazilians still want to move to the big cities. This is due to the economic opportunities, in both formal and informal sectors, besides better access to schools, health care, cultural attractions and other public facilities that are not available in smaller cities or in rural areas. Nonetheless, the high in-migration brings problems of unemployment, since not all migrants find jobs in the formal sector immediately, remaining outside the domain of tax system. Consequently, the migrants demand more urban infrastructure without contributing significantly with the costs of its maintenance and its construction. Along with that, the new-comers are pushed to live in distant lands which are the only ones they can afford, where infrastructure is not provided. Illegal connections to water and electricity are made, while piped sewerage systems are not. This contributes, then, to the spread of infectious diseases and environmental degradation. It is not surprising that there are more urban poor than rural poor nowadays, since urban poverty is likely to increase with the continued population growth of urban areas. Between 1970 and 1991, the population of metropolitan region of São Paulo almost doubled from 8.1 million to 15.4 million, with growth rates at 5 per cent per annum in the 1970s, while in the eighties it was reduced to three percent per annum. Migration from other parts of the country, mainly from the northeast, but also from other cities of São Paulo State has been the main source of metropolitan population growth. By 1980, 57 per cent of the habitants of metropolitan region of São Paulo were immigrants. Nonetheless, over the last two decades, there has been a significant slowing down in population growth rates in that region. During the 1990s, the rate of 1.6 per cent per annum was close to the rate of natural increase, so there was no net in-migration. This reduction in growth rate can relate to a reduction in the region's attractiveness to new investment and to fertility fall, which, has resulted in a reduction in the average family size and in the average number of individuals per dwelling.

Habitation: Favelas, Slums, Illegal lands - According to the latest Global Report on Human Settlements, 31.6 per cent of the world's total urban population live in slums. The total number of slum-dwellers in the world increased by about 36 per cent during the 1990s, and if no concerted action to address the challenge of slums is taken, in the next 30 years, the global number of slum dwellers will increase to about two billion, while in 50 years, they can turn into three billion.

UNHabitat defines slums as "a wide range of low-income settlements and/or poor human living conditions". They are further characterized by showing lack of basic services, illegal and inadequate building structures, overcrowding and high density, unhealthy living conditions and hazardous locations, and poverty and social exclusion. Besides that, for not having legal recognition, it is very difficult to estimate the number of slum dwellers and its habitants. They may not be included in censuses. In Brazil, illegal sub-divisions are the result of unofficial sale of plots of private land. In order to be approved and registered by the municipal government, legal sub-divisions must firstly have basic infrastructure such as water, sewage system, and drainage and road access. However, the high cost of installing the infrastructure, and the burden of registering the sub-division with the authorities, may encourage many landowners to sell the land cheaply but illegally. This process makes the land more accessible to lower-income families. This is how most illegal sub-divisions in São Paulo, located on the city periphery, sheltered low-income settlements. In the city of São Paulo, almost two million people live now in 1,855 shanty towns subscribed by SEHAB (Secretaria Municipal de Habitação – Municipal Habitation Secretary), 65 per cent of them are settled in municipal areas that were originally reserved to green areas implementation. Around 3.5 million people live in tenement houses, another 812,000 in favelas, and approximately 2.5 million people live in precarious self-built houses in settlements developed in the illegal plots, a 500 square kilometers area. Therefore, in the course of the last decades, there has been a significant reduction of vegetation, which influences the metropolis' life quality. Besides that, it is estimated a number of 1,128 irregular plots, 241 urbanized nucleus (urbanized favelas waiting for regulation) and 1887 cortiços (house shared among families) in central areas. In accordance to the different degrees of urbanization, 0.78 per cent of favelas are found in the city area, 47 per cent in the intermediate belt and 52.2% in the suburban belt (Jacobi, 1994). According to studies of the São Paulo Prefecture, the number of slums stopped increasing recently, although the population in this kind of habitation has not. What happens is that by the time the members of the families increase, they build another floor in their existent house. The plots where the houses are built have no infrastructure and besides being settled in inappropriate areas to occupation, in fragile soil lands, susceptible to erosion and high declivity, hill slopes or nearby stream banks, they also cause environment degradation. Their major impact is on the life quality of its own inhabitants, who are kept without basic living conditions. Moreover, the illegal plots burden the green areas twice; once they remove almost all the original vegetation at the same time that no new areas will be designated as green areas according to the law (only fifteen per cent of the total plot is separated for green areas). The first significant increase in the number of favelas started with the migrants that occupied risky areas such as valley bottoms and steep hills. This was and continues to be one of the housing alternatives for migrants recently arrived from rural areas. Nonetheless, the current increase in the number of favelas is a consequence of social exclusion caused by the Brazilian development process, in which the regulatory actions of the Government have less power than the real estate market. Apart from these problems, there are overflows in 400 different spots of the city every year. The central areas are disturbed by "heat islands" that bring thermal discomfort, by air pollution, mostly caused by millions of cars and by the pollution of the springs, consequence of the disordered occupation. The creation of 15 thousand tons of garbage per day, the contamination of lands by illegal industrial residues ousting and urban patrimony degradation are other serious problems that the city's habitants need to face. Even with the bad conditions of habitation and well-being, migration from rural areas have

not totally stopped because there are still better infra-structure, more job opportunities and higher possibility of life improvement in the city than in the country side. The population growth, though, was larger in favela areas than in the total of the city. Between 1973 and 1987 the total population of the municipality increased from 6.6 million to 9.2 million, or 61%. In the favela population, it counts for 1,040% of population increase. The following tables can show the increase of precarious habitation and population in São Paulo city.

Table 1.1. Population growth in favelas

Year	Nucleus	Tenement houses	Habitants	% of total population
1957	141	8,488	50,000	-
1974	525	14,500	72,000	1,1
1975	-	-	117,237	1,6
1980	-	-	439,721	5,2
1987	-	150,000	812,764	8,9
1991	585	146,892	711,032	-
1992	1805	-	1 million	11.3
1993		378,683	1.9 million	19.8

Source: IBGE and Demographic Census

Table1.2. Evolution of favela population in Sao Paulo city, 1973-2000.

Year	Total						
Population of Sao Paulo	Population Sub-normal (2)	Favela					
Population	% of favela Pop.	Period	Growth rate in favelas	Growth rate of total pop. in SP			
1973	6,560,547	-	71,840	1.1%	-	-	-
1980	8,558,841	375,023		4.4%	1973-80	20.16%	3%
1987	9,210,668	530,822	812,764	8.8%	1980-87	8.97%	0.82%
1991	9,644,122	647,400	891,673	9.2%	1987-91	1.03%	0.51%
2000	10,338,196	896,005	1,160,597	11.2%	1991-00	2.9%	0.78%

Source: IBGE 2000, SEADE Foundation 1973 and 1987, SEHAB 1987.

During 1991 and 1996, from 343 thousand new dwellers in São Paulo, 176 thousand were slums (52 per cent), especially in the periphery, according to IBGE. The south zone favelas are situated in environmental protection areas next to dams and in the north zones, around Cantareira mountain range. The environmental degradation is visible on polluted springs, vegetation deterioration, and increase in erosion. A 1990 study shows that 50.7 per cent of slums are built in the streams' edges making 17.9 per cent of the slum dwellings more susceptible to flooding, presenting danger to the whole community, besides showing loss of vegetation, springs contamination and soil impermeabilization. According to Census data, while in 1980 only 15 per cent of the dwellings were supplied with water, this number increased to 89.7 per cent in 1991. In favelas, only 25.1 per cent of homes were connected to public sewage network. In 1973, the garbage collection reached 15.1 per cent of homes, raising to 63.3 per cent in 1991. Due to the narrow streets and the demographic density of around 400 habitants per hectare, the collection becomes difficult and the garbage accumulates. Also in 1973, 65.8 per cent of slum dwellers had no bathroom or their habitants shared a collective one. In 1991, this number decreased to 12.6 per cent and then to 7.5 per cent in 1993. With the tables 3 and 4 it is easier to compare the infrastructure available in the city and in favela habitation.

Table 2. Infrastructure in favelas

Year	Water supply (%)	Sewage system (%)	Garbage collection (%)	No bathroom or shared one (%)
1973			15.1	65.8
1980	15	-	-	-
1991	89.7	25.1	63.3	12.6
2000	96	49.2	82	-

Table 3. Infrastructure in the city

Year	Water supply (%)	Sewage system (%)	Garbage collection (%)
1991	98.3	81.2	95.2
2000	97.6	87.2	96.5

Environment and Human well-being in the city

São Paulo is a city of contrast. The investment is bigger in central areas, where ironically the population growth has decreased due to the high prices of land. While that, the periphery area, where basic infrastructure is lacking, continues to grow without any attention from the government. Poor people have to travel long distances to their work; they have no access to leisure, education, health care, basic sanitation. Furthermore, they're exposed to high crime rates, violence and are also deprived from security. The urban violence in São Paulo is related to the persistence of widespread structural poverty. Concerning the environmental aspect, the increase of population not only in the entire city but especially in the periphery, is worrying, once the garbage generated is not collected as often as it should. Each habitant generates around one kilo of trash daily, in which recyclable and non-recyclable materials are mixed. The recycling programs and selective collection are still being slowly implemented and these activities are not perceived as urgent and needed by big part of the population yet. Besides, in periphery areas, at the same time that the access of trash trucks is difficult, the government does not give the region adequate attention, so their trash and sewage is dumped open air or accumulated next to their houses. It helps increasing the number of water-borne diseases and other illnesses related to lack of hygiene. Consequently, the rates of mortality and contamination are higher in this part of the city than in well-structured neighborhoods. When it rains, the trash and sewage are led to the main water sources of the city, polluting them. In addition, the Great São Paulo's rivers, for example, are densely contaminated by directly disposed sewage and effluents from 1.250 industries, which are responsible for 90 per cent of the water pollution in the city. Due to the bad public transportation system, the high-income population prefers using cars; which can be illustrated by the 800 new cars that start circulating in São Paulo each day. As a consequence, the air that is breathed presents so many pollutants that the city ended up in the 5th position in a rank of world's most polluted cities. Each vehicle emits around four tons of carbon monoxide per year and the emissions get worse with traffic jams. Environmental problems are also the result of consumption patterns of a small medium and high income group. Poor people however, are at greatest risk from air and water pollution, flood and hillside erosion, and other forms of urban congestion and pollution because they tend to live in more polluted and inhospitable environments, besides the fact that they are not able to afford paying to protect themselves from the impacts of pollution or to receive treatment once they have been harmed. Seeing as how, the poor typically consume and benefit less from the products, materials, and services that typically generate the greatest congestion and pollution. Another thing to be concerned is the land use in São Paulo which has followed a pattern of densification and verticalization resulting in increased impermeability of soils. It resulted in increased flooding, that, consequently contaminate all available water supplies and may be associated with epidemics of dysentery or other waterborne and water-washed diseases. Outbreaks of leptospirosis (usually caused by drinking water infected by rat urine) have been associated with floods in São Paulo, putting in risk those living in poor quality settlements at risk of flooding, with high levels of overcrowding and inadequate provision for garbage collection (or living close to garbage dumps).

Infrastructure: sanitation/ sewage - In São Paulo, 97.4 per cent of population receives adequate water supply and 99.9 per cent of houses are supplied with electricity. In 6.31 per cent of houses there are shared sanitary installations and 0.57 per cent of them have no bathroom at all. In the periphery area, around 7.7 percent of houses share their bathrooms and 7.5 per cent of dwellings throw their wastes directly into ditches or rivers. About nine thousand tons of solid wastes are produced daily in the Metropolitan Area of São Paulo. Among those, about a hundred tons are Hospital solid waste, about 29 hundreds tons are industrial solid residues, of which 130 tons are highly lethal. Only 10 per cent of this solid waste is collected and treated, while a large proportion remains in open-air deposits, some of which near water supply sources and most in areas uncontrolled by public authorities. São Paulo's habitants can be also victim of periodical flooding in areas where drainage system is absent and due to inadequate control of rivers crossing the region. Adequate infrastructure could reduce adverse environmental impacts within the city and its surroundings besides improving the health of its residents. The sewage system reaches about three quarters of the residents but 75 per cent of the sewage collected is not treated. Forty cubic meters per second of raw sewage and effluent from industries are discharged into the Tietê River, the main river of the city, which has become entirely devoid of oxygen. Access to basic sanitation can reduce spread of diseases and improve people's lives. In São Paulo, improvements in basic sanitation between 1975 and 1978, when 3.1 million more people in the metropolitan area gained access to piped water, increasing from 58 to 90 per cent of the population supplied by this service, have resulted in a significant reduction in infant mortality rates: a decline from 88 to 26 in the average number of deaths per thousand births. However, this rate is unequal depending on the area of the city. Deaths among children less than one year old vary according to the area they live, either central or peripheral areas. In the areas where families with higher income levels live, the rate for infant mortality is about twenty-nine per thousand births, while in the poorest areas this number increases to sixty-one. As the availability of piped water declines, the incidence of cases of diarrhea, largely caused by polluted water, becomes one of the principal causes of infant mortality.

IV. IN BRAZIL - Brazil is the country with the largest volume of freshwater in the planet. The greatest river system in the world, the Amazon River, is mainly located in the country, and it accounts for 16 per cent of the annual global river runoff. Together with the other five largest river systems in the world, the Ganges with the Brahmaputra, the Congo, the Yangtze and the Orinoco, they account for 27 per cent of the world's water resources. Besides that, Brazil's water resources exceed 20 per cent of all global renewable water resources, nearly twice as much as the water resources of the Soviet Union, which is second among the other countries with 10.6 per cent. China and Canada hold third and forth place, possessing 5.7 per cent and 5.6 per cent of water resources respectively. Still, other countries suffer from water scarcity because of the inequality of water distribution around the world. While in Brazil there is an availability of 46,000 cubic meters of water per person, in Kuwait, there is only 75 cubic meters per person. But as previously said, even within Brazil the distribution of water is unequal. This abundant amount of water per person counts mostly to the population in the Amazon River basin area, while in other regions of Brazil there is a serious problem of drought, as in the northeast region. In Brazilian Federal Constitution of 1988, in the Environment Chapter, it is established that "everyone has the right to an ecologically balanced environment, which is goods of people's common use and essential to a healthy quality of life..." (article 225). In an urban environment, good conditions to all population, such as water supply, sewage systems, collection and treatment of solid residues and urban draining, could be translated as good environmental sanitation. Even though the environmental sanitation conditions have been improving in the last twenty-five years in the country, it has not yet reached the ideal and consolidated levels in water supply systems, sewage systems, collection and treatment of solid residues. Instead, the urban draining services have been worsening. There has been an increase of floods and overflow points, which have damaged people's health and security. In most large cities a high proportion of the population lives in shelters and neighborhoods with little or no provision for supplying water or for ensuring the safe disposal of solid and liquid wastes. Provision for drainage, both storm and surface runoff, is often deficient. In addition, a large proportion of the urban population live in poor quality housing, and many of those are located on land subject to periodic floods, landslides or some other natural hazard.

Urban areas in general show other problems such as environment-related diseases and injuries that can cause or contribute to disablement and premature deaths among children and adults that become, in many cities and most poor urban districts, the main cause of death and illness. In many poor city districts, children are forty to fifty times more likely to die before the age of one than in Europe or North America, due to environment-related problems. Over 600 million urban citizens in Africa, Asia and Latin America, which includes Brazil, live in unsafe conditions because of insufficient or low quality water, overcrowded and dangerous shelters, inadequate or no sanitation, no drains and garbage collection, dangerous land sites, risks of flooding and other environment-related factors. Most

of the diseases caused by that are preventable at low cost.

Besides that, serious environmental degradation affects soils, crops, forests, freshwater aquifers and surface water, fisheries and other natural resources. They are caused by demands for natural resources, changes brought to water flows, as well as air and water pollution and solid wastes generated by urban enterprises and consumers. Unfortunately industrialization and development brought environmental problems with evolution. If there were more planning, most such environmental degradation could be also prevented or much reduced at relatively reasonable cost. Both national and urban governments have failed in most Third World nations on measures such as enforcing appropriate legislation related to environmental health, occupational health and pollution control; ensuring adequate provision for water supply, solid and liquid waste collection and treatment systems; and ensuring adequate health care provision to treat environment-related illnesses along with implementation of preventive measures. The policies and government actions concerning urban environment have profound impacts on the health and well-being of urban citizens, which is also related with the ecological sustainability of cities. The water issue is important because without water there is no possible life. And the fact that this natural resource is becoming scarce; it is needed to find a way of using it responsibly, and at the same time, to preserve the remaining sources.

The total volume of water required by a city depends on population size, living standards, the climate and the demand from industries and that is why population growth is a pertinent concern. The demand for high-quality water is increasing rapidly in Third World cities, straining existing sources as rivers, lakes and groundwater, which requires massive investment in treatment plants and distribution networks. When withdrawals from existing sources are excessive, they can result in further environmental problems. Given that, if there is a lack of maintenance of water production and distribution systems, there will be a loss of vast quantities of water before it arrives for consumption. In addition to inadequate coverage, short-term solutions that can bring effects in a long term basis (e.g. soil infiltration from pit latrines), poorly designed and inadequately maintained water supply and sewerage systems can lead to further environmental problems, especially water pollution.

In urban Brazil, approximately 86 per cent of population is supplied with water and 49 per cent is covered with sewerage, which is one of the worst among Latin American countries. Around 97 million people are not supplied by this service. In the Southeast region, urban water coverage reaches 96 per cent of population, while sewerage covers 52 per cent. About 48 million Brazilians still use pits. In rural areas, the sewerage collection is provided to only 4 per cent of the population. The sewage treatment is done in only 31.5 per cent of dwellings that have sewerage collection, in accordance with Sistema Nacional de Informações sobre Saneamento (SNIS – National System of Information about Sanitation), 2005. This scenery can be due to the investment directed to sanitation matters. In the last four years about 0.22 per cent of PGD was used for sanitation, while it should be 0.63 per cent. To each US$1 invested in sanitation, US$4 is saved from health expenses. The Program of Growth Acceleration (PAC), launched by the Federal Government in the beginning of 2007 foresees expenses of R$40 billion (around US$20 billion) in sanitation until 2010.

Health in Brazil - Seven children die every day of diarrhea in the country and other 700 thousand are hospitalized each year in public hospitals due to lack of sewerage treatment and collection, according to Sistema de Informações Hospitalares (SIH- Hospital Information System) and Sistema Único de Saúde (SUS – Unified Health System). Besides that, 65 per cent of hospitalization of children under 10 years old are caused by lack or non-existence of sewage system and clean water, as said by Banco Nacional de Desenvolvimento Social (BNDES – National Bank of Social Development). The human development is affected by sanitation issues: 60 per cent of children between zero and six years old are absent at schools due to diseases related to lack of sanitation (source: Pesquisa Nacional por Amostra de Domicílios (PNAD – National Research by House Sample) do Instituto Brasileiro de Geografia e Estatística (IBGE – Brazilian Institute of Geography and Statistics) 2006).

Approximately 46 thousand people died from infectious and parasitary diseases in 2004, the same as 3.833 people per month or 126 per day, on the report of Sistema de Informações de Mortalidade (SIM - Mortality Information System) from Ministry of Health. Four to six million people in Brazil suffer from schistosomosis, as stated in the Brazilian Society of Parasitology, while Sistema Único de Saúde (SUS – Unified Health System) spend annually around US$150 million with the treatment of diseases related to lack of hygiene.

Population Growth - Cities are the areas of greatest environmental transformation, since many natural landscapes had to be modified for its construction. Along with urbanization, major modifications to the hydrological cycle also occurred. Urban growth initially involves the removal of vegetation and soil erosion and the release of a large volume of sediments that fill drainage channels. Further construction leads to increased storm peaks which generated flooding, a serious problem in many Third World cities nowadays. In those cities, such transformations have been particularly dramatic given the rapid rates of physical and demographic growth, besides the large number and continuing expansion of already huge mega cities. Eighteen out of the twenty-one mega cities with more than 10 million habitants in the nineties were in Developing Countries. Environmental problems in those places have increased by the lack of resources and investment in urban infrastructure and services. Beyond, cities affect the environment at the local level because of pollution, congestion and destruction of natural habitats. A city absorbs energy and raw materials, discharging wastes. Anyhow, the tendency is that the world's population will be mainly urban. The UN predicts that within the next 30 years the global urban population will increase at almost three times the rate of the total population reaching 4.9 billion people (60 per cent of the world's population) in 2030. During this time period approximately 190 thousand people will be added to cities around the world daily. Most of this population growth will be in cities of the developing world. Although there is the thought that economic growth helps on poverty reduction, it stresses the environment, once it demands more environmental resources. Given that the poor are most susceptible and least capable of responding to deteriorating environmental conditions, economic growth can confine them to a vicious cycle of poverty from which they are normally imprisoned in. Likewise, the larger the city, the more dependent it becomes on external ecosystems, due to higher consumption, and the fact that the internal capacity for food and energy production is reduced. Without a good management on ecosystem services use, those can be damaged, also impacting on human well being. The major problem is not population growth itself, but consumption, particularly when it is unsustainable. So, it is important to minimize waste generation, and optimize the use of energy and other resources in order to make a city environmentally sustainable.

VI. IN SÃO PAULO - Water supply - São Paulo becoming this mega-city is not a merely coincidence. Its growth was influenced by the freshwater resources it had. This factor attracted industries that were consequently established there, attracting migration. The history of water supply in São Paulo changed with the city's development. During the whole colonial period (from 1500 to 1822), the city's population used sources that spouted in the hill's slopes and the left shore of Anhangabaú valley. People used to pick up water in brooks and wells built in their backyards. For agriculture and animal feeding purposes, the water was picked in the region's rivers and streams, specially Anhangabaú stream and Tamanduateí and Tietê Rivers. The population was also supplied by some fountains distributed in the city and installed by the authorities.

By the time the city started growing, the water supply turned into a problem to the local authorities. Sources and fountains, and Tamanduateí River's water, whose quality was already damaged, were not enough to supply a growing population, so, in 1877, the Companhia Cantareira de Águas e Esgotos (Water and Drain Cantareira Company) was created in order to supply the city's population. The water was captured in Cantareira mountain range, which was a bit far from the urban centre. In 1892, the State Government took control over this company and in 1893 they created Repartição de Águas e Esgotos - RAE (Distribution of Water and Sewer), whose responsibility was to supply water to the city. The city of São Paulo was strategically funded between Tamanduateí and Tietê Rivers,

being located in the region's hydrographical system. The city was always supplied by its several rivers and brooks. However, due to the failure of the public power in solving the supply problem stimulated the entry of the private initiative into the sector. Cantareira Company didn't manage solving the supply problem in a growing city. The creation of the Repartição de Águas e Esgotos-RAE (Distribution of Water and Sewer) meant the entry of the public power into the sector in an organized way. Created in 1908 by Light with the aim of regulating Tietê River's outflow and keeping the operating conditions of Parnaíba Plant, it became one of the main public supply systems of São Paulo. After all, in 1954, through Law number 2.627 from January 20th, RAE got extinct and Departamento de Águas e Esgotos - DAE (Department of Water and Sewer) was created, an autarchy with autonomous administration on cities as São Paulo, Guarulhos, São Caetano, Santo André and São Bernardo do Campo. While RAE was created to mainly supply the city of São Paulo, DAE was concerned about supplying water to the main cities on the surroundings of São Paulo, which would later become the metropolitan region of São Paulo. DAE worked together with SABESP (Companhia de Saneamento Básico do Estado de São Paulo – Basic Sanitation Company of Sao Paulo State), created in 1973 with the objective of "planning, executing and operating the public services of basic sanitation in the whole São Paulo State's territory". One of its major responsibilities were to cover the metropolitan region of São Paulo, where 31 cities operate, besides selling wholesale water to seven cities that operate the water distribution and sewer collection by themselves. Together with Secretaria Estadual de Recursos Hídricos, Saneamento e Obras (State's Hydrographical Resources, Sanitation and Renovation Secretary), SABESP is responsible for production, collection and treatment of Metropolitan Region's water, even though it does not distribute it to all the cities inside the region. Nowadays, SABESP also develops projects in São Paulo city to supply treated but not potable water to industries. With that, significant amounts of high quality water would not be used in activities that do no require such pureness, like in steam production or equipment refrigeration. Recently in São Paulo city, the water supply system reaches almost all the houses. Among the population of 10.886.518 (in 2007), 10.800.000 habitants, or 99.2 per cent, were supplied by water. Those that are not supplied are the ones located in slum houses or illegal land divisions that do not possess illegal water connections. Three producer systems are responsible for the city's water supply: Alto Tietê, Cantareira and Guarapiranga, those last ones distribute water to around 30 per cent of the population. Interruptions of services only happen when there are distribution problems or producer's lack of capacity.

Water Management - São Paulo's water management and environmental agencies are the best equipped in the country, if we consider technical, human, and financial aspects. The São Paulo State Environment Agency (Companhia de Tecnologia de Saneamento Ambiental, CETESB) was one of the first environmental protection agencies created in Brazil, during the 1970s and has become widely respected in Brazil and abroad for its technical competence. It is responsible for all kinds of pollution control, but the company's command-and-control regulations have been mostly limited to the state's largest industries and worst polluters, which resulted in weaker regulation and enforcement by water and sanitation companies. CETESB also lacks instruments, parameters, and procedures related to controlling diffuse sources of pollution, which are particularly important in the Greater São Paulo area because of the irregular and environmentally destructive character of urbanization. The first Brazilian law on pollution control was created in 1977 and included the monitoring and control of water quality, whose main concern was on the physical-chemical conditions to assure that the water would be suitable for drinking. At the same time, polluters would be penalized but this law was never fully enforced considering the political resistance within the government on penalizing state-owned sanitation companies, since domestic wastes were by themselves the main pollution source.

Waste of water - Even though São Paulo is the biggest and richest city in São Paulo, water shortage is a real problem nowadays. The water resources collected from springs are getting each time more polluted. Besides that, the water waste in the city is very critical. The consumption of water in São Paulo city is the average of 221 liters per day (UN considers 110 liters per habitant per day the ideal consumption) and in order to supply the city's population of around 10.8 million, 3.4 billion liters of water are produced per day, around 2.4 billion liters of which are consumed. This is the total amount counting all the Water Treatment stations of the São Paulo region, coming from Cantareira, Guarapiranga/ Billings, Rio Claro and Alto Tietê Systems. Public water supply companies waste 30.8 per cent of the water collected from springs, which is equivalent to 1 billion liters of water per day. Over 4 million people could be supplied with this quantity, which is the result of leaking and frauds, or better said, illegal water collection. Individuals can also waste water when they let a tap leaking: a drop each 5 seconds results in 20 liters of water per day, or 600 liters per month. Flush leaking results in 500 liters lost per day or 15000 liters per month. The water consumption is not equal in every part of the city. Some rich neighborhoods can reach 500 liters/day while unprivileged neighborhoods show 100 liters/day consumption. So, the 9 per cent of people living in the best areas consume five times more water per capita than the 41 per cent of people living in the worst areas.

Besides that, 10 per cent of the total population of the city or over 1 million people, living in irregular houses or slums, whose living conditions are really precarious, have irregular electric and water systems. These irregular water connections count as 14 per cent of the total water consumption (around 337 million liters of water per day). Normally made in precarious ways, with low-durability and low-security materials, such connections represent a big risk for the population. The canalizations are exposed to contamination sources, while the drain is normally open air and close to water pipes. The population is also guilty for misusing the water. Some people, instead of sweeping the sidewalk in front of their houses, they just clean it with water jets while others wet their home's walls with water during summer time to cool them. All of this is reflected in the loss of approximately 6.14 billion liters of water in the main capitals of the country or the same as 45 per cent of water collected from springs to supply those capitals. It can be compared to 2.457 Olympic swimming pools (with dimensions of 50x25x2m) of water lost per day. This same amount would be enough to supply 38 million people per day (source: SABESP, 2007).

Threats to the water - The disordered development of cities, combined with the occupation of spring areas and the population growth provokes the shortage of water resources forcing people to withdraw water in more distant places. The scarcity is the result of a bigger consumption, of the misuse of natural resources, of deforestation, pollution, waste, lack of policies that stimulate the sustainable use, the participation of society and the environmental education. Mega-cities, with more than 10 million residents are growing fast, and while water-related problems in these cities are already enormous, further degradation is expected. Water shortage is a growing problem and delivery of safe drinking water cannot be assured. To solve this problem efficient regulations and actions to stop further population growth are required, so is, in the water sector, the need to develop novel environmentally friendly and economically efficient methods of water conservation and treatment. Along with that, lifestyle, social and central structures, educational and research programmes are needed.

A shortage of water adds greatly to the problem of disposing of wastes – especially liquid wastes from industries and sewage, because wastes are diluted by large volumes of water making them much less dangerous. Half of the potable water distributed in São Paulo comes from neighbor hydric basins which are disputed by other populations. The São Paulo Metropolitan Region (SPMR) is in a critical situation in view of the fact that its already high population density is still increasing - especially in peripheral areas. At the same time the city's huge industrial park has been continuously demanding more water. Some reservoirs are being highly taxed and some city districts have been experiencing water shortages in some periods. Water import measures have been taken, especially from the Piracicaba, Capivari and Jundiaí watersheds. However, this solution is no longer deemed feasible, since those regions have already experienced an increase in their own water needs, causing a regional competition. An alternative is the use of Billings's reservoir for drinking water purposes, although several conflicts have to be dealt with in order to allow this kind of use. One of them comes from the necessity of pumping water from the polluted Pinheiros River to maintain reservoir level for hydroelectric power

generation, which was prohibited in 1992. The recent energy crisis, though, has raised the issue again. The waste of water is also a big concern. Resulting from the bad use of water and the lack of sanitarian education, the waste happens mostly in domestic uses. The lack of maintenance on water supply systems can lead to leaking and network rupture. This loss is also due to the lack of investment in water reutilization programmes for industrial and commercial uses, given that the treated water, after used, is returned into the rivers without any treatment, as effluent, sewage and then, polluted. Irrigation by canal or aspersion is one of the activities that wastes water the most, because its methods are inefficient and outdated. Besides that, since the use of pesticides in Brazil is large, agriculture is one of the main water polluters in the country. Conjointly, for centuries the rivers were used as city's sewage and effluent receptors from industries that produce a large volume of toxic products and heavy metals. It resulted in the death of important and huge rivers, such as the Tietê River that cross the state from east to west, with 1,100 kilometers of extension. The 60 thousand industries located in the state of São Paulo, produce, annually, about 20 million tons of wastes, of which 1 million consist of toxic wastes according to the Technological Company of Environmental Sanitation of São Paulo. Apart from the direct pollution from sewage disposal, lack of effluent treatment systems and sanitation, there is also the diffused pollution that happens with garbage, residues and all sorts of solid materials that are dragged into rivers during rain. When the rain washes the atmosphere, it brings dust and gases to the water bodies. The waste disposal into freshwater resources might be one of the most concerning issues related to water pollution. The production of waste, though, is not that worrying; once cities in developing countries produce an average of 0.4 to 0.9 kilos of domestic waste daily. In the other hand, in developed countries cities the production is around 0.7 to 1.8 kilograms of daily waste per person. The almost 2 million people, mostly with low-income, living in two of the main spring basins of the metropolitan area of São Paulo (Guarapiranga and Billings), in informal settlements and favelas, are the direct cause of those reservoirs' pollution, which suffer with the garbage, detritus carried by river water and sanding. The water pollution can also be caused by storm and urban runoff in addition to agricultural runoff. It is often an urban problem since water sources drawn by urban centers may be polluted with dangerous levels of toxic chemical from fertilizer and biocides. In the Third World cities, the sources of water pollution are bigger than in the North cities by virtue of the lack of sewers and the inadequacies in garbage collection services. If sewage and storm drainage system were effective and abundant, it would be much easier to control water pollution because the wastes collected by this system are treated before returning to rivers, lakes, estuaries or sea. Nonetheless, most rivers in Third World cities are literally large open sewers. As human and animal sewage may also contain micro-organism which are pathogenic (disease causing) in humans, the spread of diseases is a consequence. Lack of safe water and sanitation in Brazil's urban areas is estimated to cause about 8,500 annual cases of premature mortality and additional morbidity. The costs of saving one life through investments in urban water supply are estimated around US$17,000-115,000. Required investments in sewage secondary treatment (which removes more than half of the organic pollution load) for 96 per cent of Brazil's urban population would be on the order of US$ 11 billion (not including previous investments in collection systems). Even so, the befits of a universal requirement of secondary treatment would be limited, since it removes neither bacteria nor nutrients and would clean up many water bodies that have only limited use. When it comes to pollution caused by industries, there are many options for reducing emissions through pollution prevention and waste minimization at a cost much lower than treatment of either sewage or industrial effluent. Unfortunately, they are insufficient to solve water pollution problems considering that industrial emissions account for less than 15 per cent of total organic load in most municipalities. The surface water pollution reduces the recreational value of many water bodies, resulting in lost income from tourism and ecosystem damage. In order to avoid the problem and to improve the water to bathing quality, it would be required a total cost of US$ 300 million per year, if 3.6 million families were willing to pay US$7 monthly.

Waste Disposal - The daily average amount of domestic solid waste collected in São Paulo city is 10,715 tons, which almost 95 per cent is disposed of as land fill with less than 5 per cent incinerated and/or transformed into fertilizer, and just two tons going to a recycling plant Source: São Paulo Prefecture). Nonetheless, landfills do not have the provision to prevent the contamination of ground water and surface water through run-off and leaching. City landfills are now at the limit of their useful capacity while not all solid waste collection is under the control of public authorities, due to 348 points of illegal dumping solid waste disposal. For the purpose of providing an effective solution to the problem of solid waste it would be important to educate people not to dump waste in vacant lots and ditches.

Tietê River - The three most important rivers serving the Sao Paulo Metropolitan Region (SPMR) are affected by urban sewage and industrial wastewater that result in high levels of fecal coliform, BOD (biochemical oxygem demand), nitrogen, and phosphorous, while the two key reservoirs have excess dissolved oxygen, toxic substances and fecal coliform counts;

The Tietê River receives, daily, 700 tons of sewage, which only 12 percent is treated (WHO, 1992), including chemicals and heavy metals, and every once in a while it is victim of toxic spillage from truck accidents on the road that runs in parallel to the river. It started being polluted in the thirties, once urban and industrial sewage started being disposed there. Before that, the river was used for recreational purposes besides holding some rowing competitions. The pollution of the river is connected to the industrialization process added to the huge population growth. The number of habitants increased from around 2 million in the forties to over 6 million in the sixties. In 1955, all sewage networks were interlinked and the waste generated by all industries in the city began to be disposed into the river. In the early eighties, the river was dead.

In 1992 the state government of São Paulo launched a US$4 billion programme of environmental improvement in the Tietê River, called the Tietê Project that aims to halve the pollution and to restore 'biologically dead' sections of the Tietê back to life. The Project, financed by the Inter-American Development Bank (IDB), was broken down into three phases, focusing actions in two areas: Basic Sanitation, to increase regional sewage collection and treatment; and Industrial Pollution Control, to improve control of industrial effluents discharged into the sewer system or water courses. The first phase, from 1995 to 1998, aimed to enlarge total sewer extension, increasing the percentage of urban population served from 63 per cent, in 1992, to 83 per cent, in 1999; to enlarge sewage treatment capacity of the SPMR from 20 per cent to 60 per cent; and to improve water pollution control in 1,250 priority industries. The second phase intended to increase the amount of treated sewage through increased connection of sewers to treatment plants and to control the discharges of further 290 industries. So far, the sewage collection increased from 80 per cent to 84 per cent and the treatment rate has changed from 62 per cent to 70 per cent in the metropolitan region of São Paulo. This phase began in 2002 and is currently getting finalized. The third phase will be defined in the future. In the beginning of the programme, only 20 per cent of the collected sewage was treated in the metropolitan region of São Paulo, but in 2004, this percentage increased to 63 per cent, including primary and secondary treatments. It is expected, in the end of the project, for this rate to reach 90 per cent. Other than having a bad aspect, smell and not being a good freshwater resource to the city anymore, the pollution of the river was an inducing factor to the floods occurring in the area. The roads along the river were built on the river's fertile valleys that were naturally subject to flooding. Supplementary to that, the disordered growth in the city made the Tietê basin soil waterproofed, stopping the rain water to be absorbed. The flooding affects not only the people living nearby, spreading diseases or causing damage to their houses and cars, but also the economy of the State and the country. The main roads to access the connecting roads from the South part of Brazil to the North one are located along the Tietê River, in addition to the access to the international airport of São Paulo and the Santos port, the country's most important port. Stopping the traffic in that area means stopping the public transportations, the supply of products, the industry's production and so on. When the river's flooding area is clean, without bushes, garbage or slums dwellings the flooding happens but it does not invade the road's area. In the latest decades the

maintenance of the river's gutter has not being properly made by the governors. Between 2002 and 2006 the State's governor concluded a project, in cooperation with the Japanese Government and financed by Japan Bank for International Cooperation (JBIC), on lowering and urbanizing the Tietê's river gutter. The work that had been done since 1980, kept the roads away from flooding from 2001 to 2004.

Sewage system - Compared to other states and cities in Brazil, São Paulo is the one who provides more sanitation to its population. The sewage system reaches about three quarters of the residents and only 25 per cent of the sewage collected is treated. Even though the deficit in sanitation among the poor has been reduced from 47 per cent in 1981 to 30 per cent in 1989, the city still needs to improve the sanitation system to keep pace with the population growth. The large proportion of the people not served by sewers and garbage disposal services adds greatly to land and water pollution problems.

If urban access to piped water were increased in 10 percent, the average mortality rates for both infants and children under the age of five would be reduced by almost 3 percent. It would also be reduced to 2 per cent if urban access to sewerage rose 10 per cent. SABESP, which is also responsible for collecting sewerage, covered about 65 per cent of population in 1991, expanding to 90 per cent in 2000. Most of the city's slums are not supplied by this service, even though they're located in areas where the sewage system is available because companies responsible for providing piped water, sanitation and drainage may be reluctant to install the needed infrastructure in illegal settlements or may be prohibited from doing so. Furthermore, treating the sewage is even more important that only collecting it. The lack of treatment on sewage systems causes the pollution of the hydrographic resources. It can also be a serious risk to the public health when there is flood. Nowadays, the sewage collected in São Paulo are taken to four ETEs (Estação de Tratamento de Esgoto – Sewage Treatment Station). The uncontrolled growing in São Paulo's population brought other water-related problems. Drainage systems are often damaged by uncontrolled developments, including land clearance and deforestation, which greatly increase the accumulation of sediments blocking drainage channels. Likewise, as small towns grow into cities, urban run-off increases and reaches water bodies faster and with greater force – which also often means heavier sediment loads.

As a consequence, there might be flood, which can also be caused by heavy rain falling on large urban areas, producing large and rapidly flowing volumes of water that might not be drained if the drainage network cannot cope with them. This is the reason why a city with a good sewerage, drainage and garbage collection system is better able to reduce the risk of flooding. Good quality housing and infrastructure also reduces risks of collapse in case of occurring flooding. In Brazil, outbreaks of leptospirosis, usually caused by drinking water infected by rat urine, have been associated with floods in Rio de Janeiro and São Paulo, creating more vulnerability to those living in poor-quality settlements at flood risk.

Investments - Due to the scarcity or pollution in the nearby water sources and the need o finding new sources in distant areas, the cost of developing new water resources is increasing. Anyhow, the costs of providing services to densely populated cities is lower than to marginal areas, where access is problematic, or to small towns, where the population is more spread out. In order to expand the services to the poor (whose consumption habits and revenues to pay are lower) the profit achieved by the supplier would be also lower unless perverse tariff structures were reformed. Along with that, as population increases, the volume of wastewater would also grow, stressing the capacity of the environment to dispose it naturally, which would require a costly expansion and improvement of wastewater collection, transportation, and treatment capacity. In Brazil, more than R$ 2 billion is spent per year on water supply and sanitation, but these allocations do not aim to improve services for the poor or to promote more efficient service delivery. For that, there would be needed investments of about R$44 billion (around US$22 billion) in a ten-year period to meet the universal service goals for water supply and sanitation proposed by the government. Given that, generating the required funding and to allocate funding to promote improvements in efficiency and financial viability are huge challenges.

Urban Drain - Urban drain is still the biggest problem in environmental sanitation in São Paulo. The cities' rivers, estimated to be 1,500 kilometers long, had around 413 kilometers of canalization until 1993. In 1990, 24 kilometers of floodable area were mapped. The main causes of São Paulo's floods are the occupation of the fertile valleys by illegal settlements and the waterproofing of the soil. These problems were established due to intensified constructions in the city after 1930. The fertile valleys are rivers' natural flood areas during rainy seasons. Since they were not previously preserved, they have been occupied and they are the most affected areas during floods. When the water proof is not established and there is tree cover in the surroundings, the soil is able to retain even 90 per cent of the rain water. But without them, all the rain water goes directly to rivers once the infiltration capacity is almost zero in most of the urban area. Worse than that, the urban area's periphery is full of decomposed rocks soil, with big declivity and is susceptible to erosion. In those rocky soils, the inadequate occupation provokes erosion that brings sediments to rivers, shortening their outflow capacity because of sanding. Aiming to prevent these floods, there should be an improvement in the cities' drain system, which also prevent overflow in the lowest areas. With the development of a roadway system and the fast draining of rain water, security and comfort could be provided to population. However, some might say that the only efficient way of solving the flood problem, would be a "refoundation" of São Paulo. Since it is not possible, one of the predicted measures to minimize the flood problem is to lower Tietê's river gutters, which is being done by the State's Government. Given that São Paulo's Metropolitan Region is located in Alto Tietê Basin, all water rain and all its rivers run to Tietê River. Another important measure to control flood is the construction of big pools, in vacant lands located near the main Tietê River's tributaries. The big pools are temporary water rain reservoirs, which delay their arrival in the main rivers. Sao Paulo's Prefecture has already built six big pools. There are some issues that still have to be revised such as the non-dropping of sewage and garbage into the rivers or into pluvial water galleries, the cleanness of culverts, and the maintenance of galleries. There should be also the recovering of permeable areas, by the fertile valley preservation as green areas, re-urbanization projects or by the opening of new land divisions.

Pollution - The same trend can be observed in the industrial activities, whose development was not accompanied by the adequate measures for industrial pollution control. The estimated daily BOD (Biochemical Oxygen Demand) discharge related to industrial activities is about 40 tons a day. Together with the figures of phosphates, coliforms, the disposal of chemicals show the excessive level of organic pollution. The State Environmental Agencies in charge of water pollution fail in monitoring and controlling the pollution because they have not sufficient coercion instruments, either financial resource to enforce water regulation measures, which led the water users to have low incentives to engage in water pollution control activities or to practice rational water use.

Human Well-Being - The fact of living in precarious households not provided with adequate infrastructure, that are also constantly at risk from floods, landslides, or other natural hazards are more likely to put the habitants at risk from psychological disorders. Of course, psychosocial disorders are associated with other non-environmental factors – for instance insecure tenure for the inhabitants (if they are squatters or tenants) and inadequate or unstable incomes. Nonetheless, psychosocial and chronic diseases are becoming a major cause of death and morbidity among adolescents and young adults in many urban areas or in particular districts within urban areas. In 1986, homicides were responsible for 5 per cent of all deaths in São Paulo City. The physical characteristics of the housing and living environment can influence the incidence, along with severity of psychosocial disorders through stressors such as noise, over-crowding, poor sanitation and garbage collection, and inadequate maintenance. The high incidence of infectious diseases amongst the urban poor is connected to the relationship they have with ecosystem services such as: water scarcity and the contamination of drinking water; the accumulation of human wastes and the presence of stagnant waters which acts as vector breeding grounds; and poor shelter conditions that involve overcrowding, poor ventilation, exposure to heat, noise, dust, rain, insects and rodents. Even though many households have illegal connec-