PAPERS DO NAEA

ISSN 15169111

PAPERS DO NAEA Nº 207

THE QUESTION OF WATER IN THE AMAZON

Luis E. Aragón

Belém, Dezembro de 2007

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Paper 207
Revisão de Língua Portuguesa de responsabilidade do autor.

THE QUESTION OF WATER IN THE AMAZON[1]

Luis E. Aragón[2]

Abstract:

This paper summarizes results of the research conducted by several scholars and published by UNESCO on *Issues of local and global use of water from the Amazon* under the auspices of the South-South Cooperation Programme for Ecodevelopment of UNESCO/MAB, UNU and TWAS. Nine main issues concerning the use of fresh water from the Amazon are discussed in the book: (1) ethics, (2) anthropogenic impacts on the water cycle, (3) pollution, (4) transportation, (5) hydroelectric dams, (6) geopolitics, (7) legislation, (8) management, and (9) international cooperation (Aragón and Clüsener-Godt, 2004; 2003). The paper presents a synthesis of the main conclusions of the studies, relating them to the current basic human needs for water and human wellbeing, and the drivers of change related to water management in the Amazon.

Key words: Amazon. Water. Human needs. Management.

Resumo:

Este trabalho resume os resultados dos estudos realizados por vários pesquisadores e publicados pela UNESCO no livro *Problemática do uso global e local da água da Amazônia*, sob os auspícios do Programa de Cooperação Sul-Sul para o Ecodesenvolvimento da UNESCO /MAB, UNU e TWAS. Nove questões principais relativas à utilização de água doce da Amazônia são discutidas no livro: (1) ética, (2) impactos antropogênicos no ciclo da água (3), poluição, (4) Transporte, (5) hidrelétricas, (6) geopolítica, (7) Legislação, (8) gestão, e (9) cooperação internacional. O artigo apresenta uma síntese das principais conclusões dos estudos, relacionando-as com as atuais necessidades básicas de água e de bem-estar da humanidade, e os indutores de mudanças relacionadas à gestão das águas na Amazônia.

Palavras-chaves: Amazônia. Água, Necessidades humanas, Gestão.

If Jesus returned to Kana today,
we would ask him to turn wine into water
(Wadin Awawdê, Mayor of the city of Kafr Kana, ancient city Kana of Galilea; Cf. Mendes, 2001).

[1] Paper presented at the International Workshop Water and Ecosystems: Water Resources Management in Diverse Ecosystems and Providing for Human Needs. Hamilton, Canada, 14-16 June, 2005. UNU-INWEH/UNESCO-MAB-IHP.

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Presentation

This paper summarizes results of the research conducted by several scholars and published by UNESCO on *Issues of local and global use of water from the Amazon* under the auspices of the South-South Cooperation Programme for Ecodevelopment of UNESCO/MAB, UNU and TWAS. Nine main issues concerning the use of fresh water from the Amazon are discussed in the book: (1) ethics, (2) anthropogenic impacts on the water cycle, (3) pollution, (4) transportation, (5) hydroelectric dams, (6) geopolitics, (7) legislation, (8) management, and (9) international cooperation (Aragón and Clüsener-Godt, 2004; 2003). The paper presents a synthesis of the main conclusions of the studies, hoping to cover most of the aspects indicated in the terms of reference for this workshop.

Introduction

Water is one of the most scarce and unevenly distributed natural resources: 97.5% of the existing water on Earth is salty water, and only part of fresh water (2.5% of the total) is useable (1%); the Amazon holds around 15% of this percentage. On the other hand there exist extensive areas of the planet with severe shortage of water. If urgent measures are not taken, 2/3 of humanity will encounter water shortages by the year 2025. What measures are needed in order to solve the problem and what is the role of the Amazon in this process, as the question of water is becoming one of the most relevant geopolitical issues of our times? How to conciliate the economic value and the vital character of water in a region extremely abundant of this resource?

Up to recent years, technicians had quick answers for accessibility of water: Build big dams, remove the salt from seawater, transfer water through aqueducts from humid areas to dry areas. Nowadays, such solutions are not easily accepted, as they are very costly from the environmental and economic points of view. As a result solutions are being sought to diminish the demand, including the privatization of services which market could be regulated by the World Trade Organization (WTO). Some talks suggest the creation of an international water market through which countries with shortages of water could buy water from countries with abundance; or even the creation of an Organization of Water Exporting Countries.

But can water be treated in similar terms as other natural resources? Is water really the “blue gold” of our times with strategic value similar to the one of petroleum in the 20th century, and can it be marketed in similar terms? Fragile ecosystems such as the Amazon are regulated by the abundance of water and its hydrologic cycle. Studies suggest that alteration of this cycle affects the entire life of the region with serious climatic implications in other parts of South America and other continents (Salati, 1983). Public policies, however, are almost exclusively directed towards solving problems of areas with scarcity of water leaving aside problems related to areas of abundance. In the final analysis, management should be mainly concerned with accessibility of the resource. In dry areas some privileged people have access to more water than they need, while in humid areas many

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underprivileged people suffer thirst, or sickness from consuming unsuitable water. That is the real dilemma to be solved.

The Amazon Region

Amazonia is a complex region difficult to be defined and analyzed. Actually the term Amazonia means so many different things, that a unique definition can only be possible if considering the region as an immense area containing several Amazonias, the so called Greater Amazon Region; which includes the areas covered by the Amazon River basin and the tropical rainforest (Gutiérrez, Acosta and Salazar, 2004). Although there is no consensus, the extension of this area is approximately 8 million square kilometers, of which some 6,878,000 belong to the Amazon River basin (Dominguez, 2004). Approximately 28 million people are estimated to be living in the Greater Amazon Region around 2000, including about 1 million Amerindians. More than 60% of the population lives today in urban areas. Eight countries and a French Department share the region: Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname, Venezuela and French Guyana (Aragón, 2005a).

The Amazon Region is one of the largest, diverse, complex and rich natural domains of the planet. The area of the entire Amazon Region corresponds to 1/20 of the surface of the earth, 2/5 of South America, 3/5 of Brazil; contains 1/3 of the Tropical Forest, and only a tiny portion of the world population (Becker, 1990). The relief includes valleys, plateaus (Brazil and Guyanas) and high mountains (Andes); and the hydrography includes rivers of different type of waters, lakes and the Atlantic coast. About 30% of all animal and plant spices of the world are found in the Amazon region. The diversity existing in the Amazon is expressed in different ways. In the Peruvian Amazon, for example, was registered the largest concentration of species of trees in the world, 300 species per hectare; in 2 km^2 were found 630 species of vertebrates, including 353 species of birds, and 232 species of butterflies; and 5,000 species of insects in just one tree (CDEA, 1992).

Huge abundance of fresh water, tick tropical rain forest, and biological and cultural diversity are common features of this enormous region, and its functioning is intimately related and dependent of each one of those factors. Fresh water is certainly the most important natural resource in the present century, and the Amazon shall play an important role in the conservation and distribution of this strategic resource. The river system Amazonas-Solimões-Ucayalli represents the longest river in the world, with 6,671 kilometers and the whole basin is constituted by more than 1,000 rivers (CDA, 1992). As the Amazon River approaches the Ocean the sediments accumulate to an estimated quantity of 1 billion tons per year that the river discharges in the Ocean (Botto, 1999). Such sediments are dispersed along the coast up to the Orinoco Delta, making this area rich in soils for agriculture (Lima, Tourinho and Costa, 2000), but also a very fragile ecosystem diverse in fauna and flora dependent of the mixture of sea and fresh water (Prost and Mendes, 2001).

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Those characteristics could lead to the conclusion that problems related to fresh water shouldn't exist in the region. This is exactly the problem: to associate water issues just to the scarcity of the resource. Regions with abundance of water are in many cases neglected by public policies because of that misperception. In the Amazon everything is associated to and depends on great quantity of water. Contamination, little accessibility to potable water, or bad management can generate ecological, economic and environmental disturbances with serious risks for the environment, health and human well-being. Although most environmental changes in the Amazon are natural processes, human intervention has accelerated those changes. The following are some of the problems emerging today, which demand urgent solutions, before becoming catastrophic and irreversible.

Current basic human needs for water and relationships to human well-being

Why there is so much water in the Amazon and what is its origin?

The existence of water in the Amazon obeys to the geologic history of Earth and its hydrologic cycle in the global scale, but its amount and distribution in the region obeys also to regional and local factors.

The Earth's hydrologic cycle incorporates several elements including energy exchange, transportation of water vapor, precipitation, drainage, infiltration, and a variety of water storage mechanisms; all of which depend on weather, ecosystems and other factors. Water vapor in the atmosphere regulates Earth's temperature by a natural greenhouse effect: Temperature near the surface is around 30^{o}C beyond what would be expected purely from radioactive effects of solar energy on Earth without the humidity of the troposphere (Souza, Rocha and Cohen, 2004).

The Amazon Region is located within the Inter Tropical Convergence Zone (ITCZ), a high precipitation latitudinal zone around the equator where vapor produced in neighboring zones converges at low levels and rises, producing widespread cloud coverage, and a predominance of precipitation over evaporation originating high precipitations along the year. The Andean mountain range interferes in the longitudinal distribution of water by blocking the transportation of humid air from the Atlantic Ocean producing, as a consequence, high precipitation rates on the Amazonian side of the mountains (Souza, Rocha and Cohen, 2004).

From the bio-geophysical point of view, the Amazon water cycle has been considered to have been in balance over the last few centuries. How does such balance work? Among data needed to understand how local hydrological resources are maintained or changed are information on spatial distribution of vegetation types, liquid surfaces, soil moisture contents, surface runoff, subterranean water flows, air humidity and temperature, precipitation, and other gas fluxes to the atmosphere. Research is ongoing on these issues and although much research is still needed to fully understand the

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determining factors of the water cycle in the Amazon, at regional level, some conclusions have already been reached, including: (1) fifty percent of the water vapor existing in the Amazon is transported westward by the winds coming from the Atlantic Ocean, the other 50% comes from evapotranspiration of the forest itself (Salati, 1983); (2) precipitation varies in the region among other reasons because of the barrier of the Andean Mountains, and the location of the Region in the Northern as well as in the Southern Hemisphere, which produces a difference of rainy and dry seasons (Souza, Rocha and Cohen, 2004); (3) the geological characteristics of the places of origin of the rivers, the type of soils of the basin and the type of vegetation generate different types of water rich or poor in sediments and nutrients. The so called black waters are extremely poor in relation to white waters (Junk, 1983).

In synthesis it is possible to conclude that the Amazon does not present deficit of water for human needs. In fact more than 15% of freshwater in the world is located in the region and the countries that share the region are among the ones with very large amount of water resources. In a rank of 180 countries and territories that goes from an availability of 10,767,857 cubic meters of water per person per year in Greenland (1 of the rank) and 1,563,168 in Alaska (2 in the rank) to 10 in Kuwait (180 in the rank), the Amazonian countries are among the first 33 (UN, 2003). Those figures allow reinforcing the issue of accessibility of water. According to the UNDP index of human development (UNDP, 2004), the Amazonian countries are ranked between the 67th (Suriname) and the 114th (Bolivia) position; the access to improved water sources goes from 80% of the population in Peru to 94% in Guyana, and to sanitation services from 93% in Suriname to 70% in Bolivia. Those figures reflect principally the condition in urban areas, but they hide significant regional differences. In Brazil, for example, at the national level in 2000, only 62.5% of households located in urban areas of the Amazon (North region), were served with water, 46.7% had sanitary installations of any kind, and 77,6% had adequate conditions of garbage collection. Such indices are the lowest in relation to other regions of the country at regional level. In rural areas those services are much lower or inexistent (UNICEF, 2004). In the other hand, several countries with severe limitations of the quantity of water (less than 1,000 cubic meters per person per year) present higher or similar percentages of access to water and sanitation services than the Amazonian countries (Table 1).

Table 1: Water availability and accessibility to water and sanitation in Amazonian countries and selected countries with scarcity of water

Country	**Human Development Index* (2002)**	**Water Availability****	**%Population with sustainable access to* (2000)**

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	Rank	Index	Rank	M^3/p/year	An improved water source	Improved Sanitation
Amazonian countries						
Suriname	67	0.780	6	229,566	82	93
Venezuela	68	0.778	23	51,021	83	68
Brazil	72	0.775	25	48,314	87	76
Colombia	73	0.773	24	50,635	91	86
Peru	85	0.752	17	74,546	80	71
Ecuador	100	0.735	33	34,161	85	86
Guyana	104	0.719	5	316,689	94	87
Bolivia	114	0.681	16	74,743	83	70
French Guyana	-	-	3	812,121	-	-
Selected countries with less than 1,000 m^3 of water per person per year						
Libya	58	0.794	174	113	72	97
Saudi Arabia	77	0.768	173	118	100	95
Jordan	90	0.750	170	179	96	99
Tunisia	92	0.745	162	482	80	84
Algeria	108	0.704	163	478	89	92
Egypt	120	0.653	156	859	97	98
Morocco	125	0.620	155	971	80	68

Sources:
* UNDP – United Nations Development Programme. *Human Development Report-2004.* New York: UNDP, 2004.
** UN – United Nations. *Water for people, water for life: World water development report.* Paris: UNESCO, 2003.

Available water resources and reliance on water regulation ecosystems

Ecosystems in the Amazon depend on abundance of water and its hydrological cycle. Although the hydrologic cycle of the Amazon is considered in equilibrium, serious disturbances have been introduced by human activities showing already indication of alteration of the cycle at local scale, such as the following:

Deforestation and substitution of vegetation affect the water cycle among other things by (a) reducing the retention of humidity in the soil's top layer; (b) facilitating sudden evaporation of water previously retained in the forest canopy producing as a consequence a new balance in surface radiation; (c) increasing reflectiveness (albedo) and temperature; (d) local studies have demonstrated the occurrence of widespread convection in deforested areas with the formation of shallow cumulus clouds that usually do not evolve into nimbus clouds and thus may not produce rain; (e) on a medium and long term basis, removing the forest results in a decrease in the humidity in both the soil and in the air, resulting in a decrease in the concentration of condensation nuclei and in the cumulonimbus clouds that the region's water cycle so depends on (Souza, Rocha and Cohen, 2004).

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The common slashing and burning processes used in the region suddenly increase the concentration of aerosols estimated from 200cm^{-3} to 20,000 cm^{-3}. This increase of concentration of aerosols per cubic centimeter in the air during biomass burning generates an immense evaporation and convection of air mass from the surface heated by fire, causing, in a short run, more potential cloud coverage and precipitation. By the end of August 2002, the NOAA-12 Satellite had detected around 10,300 fire sites by month in the Amazon region. The state of Mato Grosso in the Brazilian Amazon registered 26,400 fires in the first eight months of that year. It is estimated that 900,000 tons of aerosols and gases are sent into the atmosphere annually in the Mato Grosso region alone. With such burning activity scientist believe that the release of monoxide, dioxide and other gases into the atmosphere could increase the greenhouse effect in the region (Souza, Rocha and Cohen, 2004).

Serious damages for the forest and soils are followed. Bare soil loses porosity by compaction and increase of rain may cause faster rainfall drainage, erosion and silting of the rivers and banks (Souza, Rocha and Cohen, 2004). Studies revised by Souza, Rocha and Cohen (2004) have demonstrated that even when soil is recovered by small bushes or grass, significant micro-climatic changes in the surface emerge. Comparing forest and pasture areas in the Brazilian Amazon, scholars found, among other, the following results: (a) forest areas absorbed 11% more solar radiation than pasture areas; (b) average albedo in forest areas was 13.4% and in pastures areas was 18%; (c) average temperature during the day on the soil of forest areas was around 24.1^{o}C, while in the pastures areas was 33^{0}C; (d) daily temperature of soil varies with depth; at 20cm depth, in forest areas such variation did not exceed 2,8^{0}C, but in the pasture areas the variation was of 8^{0}C; (e) volumetric moisture contents within the upper first meter beneath pastures areas were generally 15% smaller than under nearby forests at the same depth interval. At about 2 meters, the soil moisture beneath pastures may exceed the corresponding values of 0.36$^{m3/m3}$ found under the forests. Down to 4 meters depth, the forest roots and leaf systems are always more effective in pumping water to supply the transpiration of vegetation, than pastures. Those results allowed the conclusion that by removing the forest, humidity in the air above surface will be reduced (estimated in 20 to 30%), and that the large-scale deforestation would reduce precipitation by 5 to 20%.

Projections of water availability & habitat destruction

Today, the most serious environmental treat in the region is deforestation. Regardless of the efforts of governments, NGOs and other actors, deforestation in the Amazon continues, especially in the Brazilian Amazon. When the National Institute of Spatial Research (INPE) announced in June 2003, the deforestation of 25,500 km^2 in the Brazilian Amazon between 2001 and 2002, which represented an increase of 40% in relation to the previous period, the reaction of scientists, NGOs, the media, and even politicians was of indignation, and debates, conferences, discussions and other events occurred at different levels and parts of the country. Shortly, the government announced a Plan of

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Action to Prevent and Control Deforestation in the Amazon (PR, 2004). According to INPE´s report, the increase of deforestation elevated to 631.369 km^2 the total deforested area of the Brazilian Amazon, or 15.7% of the area of the region. Some 25% of this area is abandoned or sub-utilized and in many cases degraded. Contradicting all expectations of the government, deforestation of the Brazilian Amazon increased between 2003 and 2004. According to INPE, during this period 26,130 km^2 were deforested, 50% of which within the State of Mato Grosso, one of the largest soybeans producer states in the country. This figure elevated the total deforested area of the Brazilian Amazon to about 680,000 km^2, or approximately 17% of the region. Numeric models suggest that large-scale deforestation in the Amazon can diminish superficial drainage between 10 and 20% and increase temperature of the air near the surface between 0.6 and 2.0^0C prolonging also the periods of draught in the region and altering as a consequence the regional water cycle (Souza, Rocha and Cohen, 2004; Dias, 2003; Souza, 2003).

Associated to deforestation are the increase of fires and the expansion of soybeans cultivation, cattle rising, and illegal timber exploitation (PR, 2004). Other environmental risks are contamination of water, especially in large cities of the region given to lack of sanitation facilities, and also caused by mining in other areas. Agro toxics, mercury, arsenic, and other contaminating substances have been found in the Amazonian rivers (Fenzl and Mathis, 2004; Ruivo, 2003; Braz, 2003). With the increase of population, urbanization, building of roads, dams and infrastructure complexes, extensive agriculture, oil exploitation, mining (especially by using mercury) and implementation of unsustainable development plans, disturbances of the Amazonian ecosystems have been intensified at the local level affecting biodiversity, micro climates and quality of water resources, potentially intervening in the hydrological cycle of the region.

Drivers of change: population, development patterns, increase demand, environmental change

Although population has increased in the Amazon region and is growing at a higher rates (around 3 percent per year) than in the respective countries, population numbers do not represent a problem considering the amount of water existing in the region, even if the demand for water increase in the future. The issue here is to allow access to potable water and sanitation services to all inhabitants of the region. Environmental education and management are also extremely important in the Amazon considering the misperception of population who perceives water as an unlimited resource, when observing the hugeness of rain, humidity, rivers and lakes. Studies have already demonstrated the death of rivers in cities, the contamination of fish and humans by mercury and the elevation of contamination of river beaches turning them inappropriate for human use during certain periods of the year (Fenzl and Mathis, 2004; Braz, 2003).

Even though environmental awareness has increased in the world reaching the highest levels of governments, plans for sustainable development of the Amazon region have not jet fulfilled the expectations (Aragón, 2002). Allied to the increase of deforestation, emerge the facts of accelerated

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urban growth, expansion of agriculture and industrialization, all of which pressure for more consumption of water. Even recognizing that many cities in the world, especially those located in developing countries are already suffering water crisis, those places are the ones with better access to potable water in relation to poor rural areas. This is also true in the Amazonian countries. Therefore, the demand for water tends to increase with more people living in cities. In addition, the so-called productive use of water (in agriculture and industry) is rising as industrialization progresses and the demand for agricultural products increases. So the competition among different uses of water has become more intense, affecting the accessibility for human consumption, and at the same time rising the economic value of water.

Integrated management of water resources, ecosystems, human well-being and ecosystem services – current progress and problems

It is clear that issues related to the use of water in the Amazon are mainly related to management and public policies since: (1) there is no lack of fresh water resources in the region; (2) the region does not need to waste water with irrigation; (3) more than 80% of the forest is still preserved or has suffered little intervention; (4) most of the rivers of the basin cross two or more countries, but there are no serious conflicts between the countries; (5) there is no problem with population numbers. Population density of the region is around 4.0 people per square kilometer (Aragón, 2005a; Becker, 2004).

In spite of those natural advantages and though all Amazonian countries have legislation concerning the use and management of water, public policies are mainly directed towards issues related to arid areas. In Brazil, the law considers the basin as the management unit, and advocates for decentralization and the participation of local communities (Saletti, 2004). These principles have been applied in some areas, but very little in the Amazon.

It is clear then, as Becker (2004) pointed out, that issues of local use of water in the Amazon are very specific. While global problems are mainly characterized by lack of supply or availability and great increase in consumption, in the Amazon the problems are related mainly to solving the paradox of abundance of water and limited accessibility principally because of the lack of access to water distribution services and sanitation facilities.

What measures are needed to overcome those problems making the best possible use of water of the region for the well-being of the people of the region, the Amazonian countries and the world. New strategies of management are needed in these areas to tackle specific local problems. Although all Amazonian countries have their own national systems of water resource management, there are little explicit measures for humid areas. In Brazil, for example, the National Water Agency (ANA)

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was created in 2000 to reinforce the law on water resources approved in 1997 (Setti, 2004). This law determines among other things: (a) water is a public good; (b) water is a limited natural resource which has economic value; (c) when there is shortage of water resources, priority is given to human consumption and the provision of water for animals; (d) the management of water resources must always allow for the multiple uses of water; (e) the water basin is the territorial unit for the implementation of policies and management; (f) water resource management must be decentralized and should involve the participation of the government and that of users and communities.

Nevertheless those regulations, the Amazonian countries tend to follow the world tendency of privatizing water supply services. Many justify this trend because of the limited supply of this natural resource. It is thought that individuals are more inclined to save water if they are made to pay for it. Although this idea is open to debate as concerns irrigation and the argument may be valid for the use of water for industrial purposes, it is contentious to argue about the commercialization of potable water for human consumption and domestic uses. For ethical reasons, access to water must be guaranteed to all human beings. It is unacceptable in the 21st century that thousands, even millions of people do not have access to potable drinking water, even in areas extremely abundant of this resource, and that so many children die due to consumption of unsuitable water (Dias and Aragón, 2004).

There exists strong debate concerning that issue. In Cochabama (Bolivia), just to mention a case in an Amazonian country, Bechtel, a large San Francisco based firm, received a concession to operate water services. In December 1999, the firm doubled the price charged for water. The population protested which led to death of demonstrators. The government revoked its water privatization legislation and Bechtel is now suing the Bolivian government for 40 million dollars (Dias and Aragón, 2004). Today the whole country is in a political turmoil demanding nationalization of enterprises and services.

Production and exportation of energy is another big issue in the Amazon. The question is: hydroelectric dams why, for whom and at what cost. It is recognized the immense hydrological potential of the Amazon and several dams have been already constructed and others are planned in the Brazilian Amazon. This energy serves many places and industries located outside the region while the region remains deficient in electrification, especially in rural areas. Some advocate compensation payments for the construction of such dams, others argue to look for other sources of energy considering the high environmental costs involved building dams (Machado and Souza, 2004; Rocha, 2003).

Gaps and capacity development: institutional, managerial, human, technological capacity

Building regional capacity at all levels will be one of the key elements to overcome problems related to accessibility of potable water, sanitation and the improvement of quality of life in the

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Amazon region. Although environmental awareness is increasing in the Amazonian countries the challenges of implementing policies within the vision of development without destruction have been very difficult to implement. Even if the Amazonian countries manage to reach the goals of UN Millenium Program, the Amazon region will hardly do so at the same time (UN, 2005), in spite of recent efforts made in that direction, such as the following:

In 1978 the Amazonian countries signed the Amazon Cooperation Treaty "to undertake joint actions and efforts to promote the harmonious development of their respective Amazonian territories in such a way that these joint actions produce equitable and mutually beneficial results and achieve also the preservation of the environment and the conservation and rational utilization of the natural resources of those territories" (MRE, 1978). The Amazon Cooperation Treaty Organization (OTCA) was created in 2000 and reinforced by the parliaments of all countries in 2002, as a multilateral agency with permanent Secretariat in Brasília, responsible for the formulation and coordination of the Program of the Treaty. This Organization represents the ideal instrument for identifying the true potential of the region and to formulate and implement programs and actions that serve the entire Amazon and should lead to sustainable development. OTCA will also serve as a catalytic organization for actions carried out by NGOs, universities, research institutes and governmental organizations at all levels. It is the best attempt for sub-regional integration in the history of the Amazon, making possible for countries to agree on the principles that will guide the development of the region. Many rivers of the Amazon basin are international rivers so legislation, use, management, pollution control, transportation, and many other issues related to water in the region should be treated by OTCA. In 2004, all countries approved the Strategic Plan of the Treaty for 2004-2012 (OTCA, 2004). This program reflects a new approach of development valuing the forest, biodiversity, cultural diversity, water resources and many other factors in search of sustainable development.

One of the main areas of the programme refers to water resources. In this matter, OTCA is implementing since June 2005 the ambitious GEF Project *Integrated and Sustainable Management of Transboundary Water Resources in the Amazon River Basin*, which main objective is "to strengthen the institutional framework for planning and executing, in a coordinated and coherent manner, activities for the protection and sustainable management of the land and water resources of the Amazon River Basin in the face of ongoing climatic changes being experienced in the Basin. The proposed project endeavors to realize a shared vision for the sustainable development of the region, based upon the protection and integrated management of transboundary water resources and adaptation to climatic changes". The five-year project is in the preparatory phase. According to the project, this preparatory phase will produce, among other, the following outputs: (1) conduct of intra-Basin traineeships, cooperation activities, and institutional arrangements; strengthening and integration of the information systems within the Basin; design and operation of a shared hydrometeorological/hydroclimatological monitoring and warning system; preparation of strategies for

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integrated management and action plans for aquatic biodiversity and ecosystem protection to address "hot spots" within the shared Basin; conduct of a vulnerability analysis to determine the impacts and potential response of ecosystems and communities likely to be affected by climatic change within the Basin; development of common analytical protocols for water quality monitoring and management; design and execution of environmental education, public involvement and stakeholder participation and technical exchange programs; and, identification and selection of pilot demonstration projects; (2) a public participation plan and stakeholder involvement program; (3) identification of a group of concrete demonstration projects to qualify critical topics and areas, capable of being executed during the period of the formulation of the Framework of the Strategic Action Plan (SAP), that will provide information and experience in the integrated management of the water resources of the Basin, their costs, feasibilities, and ability to adapt in response to the changing climatic, hydrologic, and ecological conditions, to be in the Framework SAP (OTCA, 2005).

Parallel to OTCA's activities but coinciding in objectives, other initiatives are underway in the Amazon to build regional capacity (Aragón, 2005b). Among these initiatives are those implemented through the Association of Amazonian Universities (UNAMAZ) involving all the Amazonian countries in the areas of science and higher education (Acevedo, 2003). It is important also to emphasize that the number of graduate programs comprising the environmental aspects of the Amazon has increased over the last few years. Among these, the graduate program on sustainable development of the humid tropics of the Center for Advanced Amazonian Studies of the Federal University in Belém focuses on the whole Amazon region; and the masters and doctorate degree programs on Fresh Water Biology and Interior Fishing offered by the National Institute for Amazonian Research in cooperation with the Federal University of Amazonas in Manaus, offer great potential for expansion to all Amazonian countries. Another example is the Masters course on Coastal Ecosystems at the Federal University of Pará in the city of Bragança. Also, the Center for Development Studies of the Central University of Venezuela established a Masters course on health and environment based upon Amazonian issues. In terms of research, the Program for Tropical Coastal Ecosystem Studies (ECOLAB), which gathers researchers from institutions in Suriname, French Guyana, and Amapá, Pará and Maranhão states in Brazil to study and monitor environmental change along the Amazonian coast (Prost, 2003). Other relevant examples include the Program Processes of Change in the Amazon Estuary due to Anthropogenic Activities and Environmental Management (MEGAM); the Program Management and Dynamics in Mangrove Swamp Areas in Northeastern Para (MADAM) developed by the Federal University of Para at Bragança, and the Program Natural Resources and Anthropology of Maritime, Riverbank and Estuarine Societies (RENAS), coordinated by the Goeldi Museum in Belem. It should be mentioned also the Amazonian Initiative, a network of institutions of the Amazonian countries gathered to study and develop agricultural and related sciences (Aragón, 2005b); the South-South Cooperation Program for Ecodevelopment implemented jointly by UNESCO/MAB, UNU and TWAS which has supported important projects in the region such as the use of water from the Amazon, management of coastal ecosystems, comparative research on agriculture in the humid tropics, comparative analysis of Biosphere Reserves in the Amazon and other Humid Tropical Areas,

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and the study of population dynamics and its relation to environmental change in the Amazon (Clüsener-Godt, 2004); and the Large-Scale Biosphere Experiment in Amazonia (LBA), an international research initiative coordinated by the National Institute of Amazonian Research of the Ministry of Science and Technology of Brazil (INPA), designed to create knowledge needed to understand the climatic, ecologic, bigeochemic, and hydrologic functioning of Amazonia, the impact of land use change on these functions, and the interactions between the region and the Earth system. LBA is sponsored by NASA and other agencies and includes more than 240 research and higher education institutions from Brazil, other Amazonian countries, Europe and the United States totalizing more than 1600 scholars and students and more than 120 research projects. Of the total institutions involved in the LBA Program, more than 100 are Brazilians, and more than 40 are located in the Amazon region (Luizão, 2005).

Conclusions

It was necessary to see Earth from the cosmos for men becoming aware of the unity and limits of the Planet. It was finally noticed that Earth is finite and that natural resources can end. Nature was recognized as a scarce resource and as a consequence the struggle for control and appropriation of reserves of natural resources before considered free was intensified. In this scenario, the enormous natural capital of the Amazon is in question. Possessing immense quantities of fresh water, biodiversity, forest, sun energy, and winds, the Amazon has reached the highest levels of the scientific and political world, being, in many cases, the sovereignty of the Amazonian countries over the region questioned in the name of the common good, or the environmental health of the Planet (Becker, 2004).

The relative scarcity and uneven distribution in the globe, have transformed water into an increasable economic valued good by the mercantilization of natural resources until recently considered of free access because vital for human survival, becoming, therefore one more commodity, and a very lucrative one. Associated to that issue, the brutal social, economic and regional disparities in most developing countries restrict the access of water for the poor, limiting the universal right of water for all, proclaimed by the United Nations. Such situation leads to the paradox of people living in countries with little reserves of water having more access to potable water than countries with abundance of the resource. Water is therefore not only a natural or technological issue, but also a political, social, economic and cultural one (Costa, 2003).

There is no doubt that in that scenario those regions and countries with abundance of fresh water present extraordinary advantages and will play an important role in future developments around

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the world concerning the geopolitics of water. But the original questions remain: Can water be treated in similar terms as other natural resources? Is water really the "blue gold" of our times with strategic value similar to the one of petroleum in the 20th century, and can it be marketed in similar terms? In the final analysis, the critical issue concerns with the property of water from an economic perspective, or from the market which see this resource as merchandise and consequently regulated by the market (Castro, 2003). On the other hand the debate continues in the sense of whether such a rare resource in the world as fresh water should be treated as a public good, as belonging to humanity, or should it be subjected to commercial rules. Where is the limit between ethics and economics?

Concerning the Amazon, it is essential to recognize that issues related to the use of water in the region are very specific. Therefore, special measures to attend the local needs in humid regions are necessary. How to deal with problems related to abundance of water in tropical areas such as (among others) the spread of tropical diseases that occur and disseminate at a very high speed (Yarzábal, Espinal and Aragón, 1992); floods that kill many and produce large economic damages especially in highly populated tropical humid countries; environmental changes affecting precipitation and climate in the Amazon and other areas; and improvement of water quality for consumption (Fenzl and Mathis, 2004). The main problem in the region, however, concerns accessibility and not availability of the resource. At the end the question for debate is how to use water from the Amazon for human well-being without depriving local population needs, the environment and the sovereignty of the countries sharing this region.

References

Acevedo, Rosa Elizabeth Marin. *UNAMAZ: Um projeto de cooperação pan-amazônica.*

ISSN 15169111

Belém: UNAMAZ, 2003.

Aragón, Luis E. Até onde vai a Amazônia e qual é a sua população? In Aragón, Luis E. (Org.) *Populações da Pan-Amazônia.* Belém: NAEA, 2005a, pgs. 13-23.

Aragón, Luis E. Cooperação Sul-Sul para o desenvolvimento científico e tecnológico da Amazônia. *Parcerias Estratégicas.*Vol. 20, 2005b, pgs. 767-794.

Aragón, Luis E. Há futuro para o desenvolvimento sustentável na Amazônia? In Mello, Alex Fiúza de (Org.) *O futuro da Amazônia: Dilemas, oportunidades e desafios no limiar do Século XXI.* Belém: UFPA, 2002, pgs. 33-53.

Aragón, Luis E.; Clüsener-Godt, Miguel (Eds.) *Issues of local and global use of water from the Amazon.* Montevideo: UNESCO, 2004.

Aragón, Luis E.; Clüsener-Godt, Miguel (Orgs.) *Problemática do uso local e global da água da Amazônia*. Belém: UNESCO/NAEA, 2003.

Becker, Bertha. *Amazônia.* São Paulo: Ática, 1990.

Becker, Bertha. Inclusion of the Amazon in the geopolitics of water. In Aragón, Luis E.; Clüsener-Godt, Miguel (Eds.) *Issues of local and global use of water from the Amazon.* Montevideo: UNESCO, 2004, pgs. 143-166.

Botto, Manuel Picasso. The Amazon Cooperation Treaty: A mechanism for cooperation and sustainable development. In Biswas, Asit K., et. al. (Editors) *Management of Latin American River Basins: Amazon, Plata and São Francisco.* Tokyo, Japan: United Nations University Press, 1999, pgs. 68-100.

Braz, Vera Nobre. Poluição dos recursos hídricos da Amazônia: Aspectos urbanos. In Aragón, Luis E.; Clüsener-Godt, Miguel (Orgs.) *Problemática do uso local e global da água da Amazônia*. Belém: UNESCO/NAEA, 2003, pgs. 153-158.

ISSN 15169111

CDEA – Commission on Development and Environment for Amazonia. *Amazonia without myths.* Washington, D. C.: IDB/UNDP/PACT, 1992.

Castro, Edna. Geopolítica da água e novos dilemas à propósito da Amazônia e seus recursos naturais. In Aragón, Luis E.; Clüsener-Godt, Miguel (Orgs.) *Problemática do uso local e global da água da Amazônia.* Belém: UNESCO/NAEA, 2003, pgs. 321-342.

Clüsener-Godt, Miguel. Implementing Agenda 21: Nature conservation and sustainable development in the humid tropics. *Tropical Ecology*, 45 (1): 183-186, 2004.

Costa, Wanderley Messias. Valorizar a água da Amazônia: Uma estratégia de inserção nacional e internacional. In Aragón, Luis E.; Clüsener-Godt, Miguel (Orgs.) *Problemática do uso local e global da água da Amazônia.* Belém: UNESCO/NAEA, 2003, pgs. 299-320.

Dias, Nelson Luís. Comentários sobre "impactos antropogênicos no ciclo hidrológico da Amazônia," de Souza, Rocha e Cohen. In Aragón, Luis E.; Clüsener-Godt, Miguel (Orgs.) *Problemática do uso local e global da água da Amazônia.* Belém: UNESCO/NAEA, 2003, pgs. 95-105.

Dias, Marco Antonio; Aragón, Luis E. Amazonian co-operation for knowledge on water resources and for the sustainable use of these resources in the region. In Aragón, Luis E.; Clüsener-Godt, Miguel (Eds.) *Issues of local and global use of water from the Amazon.* Montevideo: UNESCO, 2004, pgs. 219-237.

Dominguez, Camilo. The importance of rivers for the transportation system of the Amazon. In Aragón, Luis E.; Clüsener-Godt, Miguel (Eds.) *Issues of local and global use of water from the Amazon.* Montevideo: UNESCO, 2004, pgs. 77-100.

Fenzl, Norbert and Mathis, Armin. Pollution of natural water resources in Amazonia: Sources, risk and consequences. In Aragón, Luis E.; Clüsener-Godt, Miguel (Eds.) *Issues of local and global use of water from the Amazon.* Montevideo: UNESCO, 2004, pgs. 57-76.

Gutiérrez Rey, Franz; Acosta Muñoz, Luis Eduardo; Salazar Cardona, Carlos Ariel. *Perfiles urbanos en la Amazonia Colombiana: Un enfoque para el desarrollo*

ISSN 15169111

Sostenible. Bogotá: Instituto Sinchi, 2004.

Junk, Walfgang Johannes. As águas da região amazônica. In Salati, Enéas; Shubart, Herbert

Otto Roger; Junk, Wolfgang; Oliveira, Adélia Engrácia de. *Amazônia: Desenvolvimento, integração e ecologia.* Belém: Museu Paraense Emílio Goeldi, 1983, pgs. 45-100.

Lima, Rubens Rodrigues; Tourinho, Manoel Malheiros; Costa, José Paulo Chaves da.

Várzeas Flúvio-Marinhas da Amazônia: Características e possibilidades agropecuárias. Belém: Faculdade de Ciências Agrárias do Pará, 2000.

Luizão, Flávio J. Interações biosfera-atmosfera na Amazônia: contribuições do projeto

LBA ao conhecimento e ao desenvolvimento sustentável da região. *Parcerias Estratégicas.* Vol. 20, 2005, p. 681-708.

Machado, José Alberto da Costa; Souza, Rubem César Rodrigues. Determining factors

in the construction of hydroelectric power plants in the Amazon: Reasons for claiming damage payments. In Aragón, Luis E.; Clüsener-Godt, Miguel (Eds.) *Issues of local and global use of water from the Amazon.* Montevideo: UNESCO, 2004, pgs. 101-142.

Mendes, Armando Dia. *Amazônia: Modos de (o)usar.* Manaus: Valer, 2001.

MRE – Ministério das Relações Exteriores/Brasil. *Tratado de Cooperação Amazônica.*

Brasília, D.F.: MRE, 1978.

OTCA – Amazon Cooperation Treaty Organization. *Strategic Plan of the Amazon*

Cooperation Treaty Organization (2004-2012). DOC/XII ACC-ACTO/04. Brasília, D. F.: OTCA, 2004.

OTCA – Global Environment Facility – Project Document. *Integrated and Sustainable*

Management of Transboundary Water Resources in the Amazon River Basin. PDF Document. Internet site: www.otca.info. 2005.

PR – Presidência da República/Casa Civil. *Plano de ação para a prevenção e controle do*

ISSN 15169111

desmatamento na Amazônia Legal. Brasília, D. F.: Grupo Interministerial para a redução dos índices de desmatamento da Amazônia Legal, 2004.

Prost, Maria Thereza. ECOLAB – Laboratório de ecossistemas costeiros. In Aragón Luis E.

(Org.) *Conservação e desenvolvimento no estuário e litoral amazônicos.* Belém: NAEA/UNESCO, 2003, pgs. 69-82.

Prost, Maria Thereza; Mendes, Amílcar Carvalho (Orgs.) *Ecossitemas costeiros: Impactos*

e gerenciamento ambiental. Belém: Museu Paraense Emilio Goeldi, 2001.

Rocha, Gilberto de Miranda. Usinas hidrelétricas, apropiação dos recursos hídricos na

Amazônia e desenvolvimento regional. In Aragón, Luis E.; Clüsener-Godt, Miguel (Orgs.) *Problemática do uso local e global da água da Amazônia.* Belém: UNESCO/NAEA, 2003, pgs. 253-269.

Ruivo, Maria de Lourdes Pinheiro. Uso da água na Amazônia: Fontes de poluição, riscos,

Conseqüências e alternativas. In Aragón, Luis E.; Clüsener-Godt, Miguel (Orgs.) *Problemática do uso local e global da água da Amazônia.* Belém: UNESCO/NAEA, 2003, pgs. 143-151.

Salati, Enéas. O clima atual depende da floresta. In Salati, Enéas; Shubart, Herbert Otto

Roger; Junk, Wolfgang; Oliveira, Adélia Engrácia de. *Amazônia: Desenvolvimento, integração e ecologia.* Belém: Museu Paraense Emílio Goeldi, 1983, pgs. 15-44.

Setti, Arnaldo Augusto. Legislation and institutional systems for water resources

management in Brazil and their relevance to the Amazon. In Aragón, Luis E.; Clüsener-Godt, Miguel (Eds.) *Issues of local and global use of water from the Amazon.* Montevideo: UNESCO, 2004, pgs. 167-201.

Souza, Eliane Lopes de. Comentários sobre "Avaliação dos impactos antropogênicos no

ciclo da água na Amazônia," de Souza, Rocha e Cohen. In Aragón, Luis E.; Clüsener-Godt, Miguel (Orgs.) *Problemática do uso local e global da água da Amazônia.* Belém: UNESCO/NAEA, 2003, pgs. 107-114.

Souza, José Ricardo Santos; Rocha, Edson José Paulino; Cohen, Júlia Clarinda Paiva.

ISSN 15169111

Evaluation of the anthropogenic impacts on the water cycle in Amazonia. In Aragón, Luis E.; Clüsener-Godt, Miguel (Eds.) *Issues of local and global use of water from the Amazon.* Montevideo: UNESCO, 2004, pgs. 37-56.

UN – United Nations. *Water for people, water for life: World water development report.* Paris: UNESCO, 2003.

UN – United Nations. UN Millennium Project 2005. *Health, Dignity, and Development: What will it take?* Task Force on Water and Sanitation.

UNDP – United Nations Development Programme. *Human Development Report-2004.* New York: UNDP, 2004.

UNICEF – *Ser criança na Aamazônia: Uma análise das condições de desenvolvimento infantil na Região Norte do Brasil.* Belém: UNICEF, 2004.

Yarzábal, Luis; Espinal, Carlos; Aragón, Luis E. (Eds.). *Enfoque integral de la salud humana en la Amazonia.* Caracas: UNAMAZ, 1992.

ISSN 15169111