The Amazon River Basin

CE 397 – Transboundary Waters

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INTRODUCTION

The Amazon Basin is the largest river basin in the world, and is not only of importance to the seven countries across which it spreads, but to the entire world through its effect on global climate. The drainage basin covers an area of over 6,100,000 km^2, and covers over one-third of the South American continent. The discharge from the Amazon River, about 220,800 m^3/s, comprises over twenty percent of the total discharge from all global rivers. In fact, the discharge from the Amazon exceeds the combined discharge of the world next seven to nine largest rivers. The basin has far reaching effects, altering the color and salinity of the Atlantic for almost 200 miles, and producing about twenty percent of the Earth's oxygen.

BASIN COMPOSITION

The Amazon Basin includes land from seven different countries: Brazil, Peru, Ecuador, Bolivia, Colombia, Venezuela, and Guyana; although the Amazon rainforest extends further and includes Suriname and French Guiana. The basin consists of at least fifteen sub-basins, containing over 200 tributaries. Sixty-four percent of the sub-basins, by area, are international sub-basins, highlighting the largely international nature of the Amazon Basin. The majority of the basin, approximately sixty-nine percent, is located within Brazil, although Bolivia is the country most covered by the basin, owing about sixty-six percent of its area to the Amazon Basin, followed closely by Peru at sixty percent.

TABLE 1. SUB-BASIN MAKEUP OF THE AMAZON BASIN

Basin	Basin area (km^2)		Discharge (m^3/s)	Countries	Category
Amazonas	6869000	100%	220800	Brazil, Bolivia, Peru, Colombia, Ecuador, Venezuela and Guyana	International
Tributaries					
Madeira	1380000	20%	31200	Brazil, Bolivia and Peru	International
Tocantins	757000	11%	11800	Brazil	National
Negro	696808	10%	28060	Brazil, Colombia, Venezuela and Guyana	International
Xingu	504277	7%	9680	Brazil	National
Tapajós	489628	7%	13540	Brazil	National
Purus	375000	5%	10970	Brazil and Peru	International
Marañón	358050	5%	ND	Peru and Ecuador	International
Ucayali	337510	5%	ND	Peru	National
Caquetá-Japurá	289000	4%	18620	Brazil and Colombia	International
Juruá	217000	3%	8420	Brazil and Peru	International
Putumayo-Içá	148000	2%	8760	Ecuador, Colombia, Peru and Brazil	International
Trombetas	133930	2%	2855	Brazil	National
Napo	115000	2%	ND	Peru and Ecuador	International
Uatumã	105350	2%	1710	Brazil	National
Orinoco	880000	13%	33000	Venezuela, Colombia	International
Other	82447	1%	ND		

CLIMATE EFFECTS

The Amazon rainforest and, consequently, the Amazon Basin, are of huge importance to the local and global climate. In a normal year, the rainforest consumes nearly two billion tons of carbon dioxide. The forest not only acts as a carbon sink but a heat sink, absorbing the equatorial radiation from the sun and using it to grow, as well as to power its evapotranspiration, which in turn releases the energy in the form of tropical storms which recycle between one half and two-thirds of the regional rainfall. These tropical storms also serve to re-distribute this heat throughout the globe. Seventy-five percent of the energy that drives atmospheric circulation is derived from the heat released during tropical rainfall.

The forest not only reduces temperatures both in the region and throughout the globe, but also regulates local temperatures, reducing both the atmospheric and soil temperature fluctuations considerably when compared to pasture land.

The self-regulating Amazon Basin is still strongly affected by major weather patterns, however, as evidenced by the effects of El Niño and La Niña. These weather phenomena, characterized by higher (El Niño) or lower (La Niña) than normal temperatures in the Equatorial Pacific, dramatically alter rainfall

in the basin, with the former resulting in droughts and the latter, floods. These occurrences have far-reaching consequences, affecting economic activities such as hydropower generation, agriculture, and fishing, as well as mechanisms of environmental importance such as sediment transport, forest growth, and ecosystem alteration. The Amazon's susceptibility to the fluctuations of El Niño should serve as a warning of the possible effects global climate change could have on the basin, in addition to the effects the basin could have on global climate change.

ECONOMIC IMPACTS

The Amazon Basin, though comprising a significant portion of its home countries' area, contributes a disproportionately small amount to their economies. For example, in 1990, the Brazilian Amazon contributed 3.5% of the country's gross domestic product (GDP), despite covering over 45% of its area.

Economic exploitation of the Amazon is difficult due to the many tradeoffs inherent in any use of the land. Dams to provide hydropower inevitably harm the fishing industries, by interrupting fish migration and replacing river habitats with lakes. Dams have also been observed to harm upstream Brazil Nut collection and agriculture through its flooding of forested or developed lands. Although dams have been touted as "green" energy sources, recent studies suggest that they are in fact significant greenhouse gas emitters, with one study claiming that the emissions from hydroelectric production of the Curuá-Una Dam in Para, Brazil, were 3.5 times higher than if the electricity had been produced though fossil fuel burning methods instead. Equitable division of the electricity produced from such dams is also difficult if not impossible to achieve, due to the dearth of national rivers and sub-basins. Mining has been demonstrating its ability to damage the environment through the release of mercury and arsenic into the rivers, resulting in high mercury levels in local fish and the people who consume them, as well as by releasing excessive silt into water bodies, which in Oriximiná, Pará, almost destroyed Batata Lake through extensive silting. Commercial and industrial fishing techniques have harmed the indigenous fish populations, through mechanisms including over exploitation of some species and introduction of alien species. Timber extraction and agriculture of course result in deforestation, which destroys habitats and has significant impacts on the climate, but the largest contributor to deforestation is actually cattle ranching. Cattle ranching is a major economic activity in Brazil, the world's largest beef exporter, and has devastating impacts on the environment through deforestation and methane production. Rates of deforestation have been shown to correlate with international commodity price fluctuations of beef and soya, demonstrating the important role of economy in the Amazon's fate. Leslie Taylor, in *The Healing Power of Rainforest Herbs*, claims that this battle between the environment and economic returns is not inevitable, and that sustainable development of the Amazon can in fact be more profitable than cattle ranching or lumber production.

TABLE 2. DAM DISTRIBUTION IN THE AMAZON BASIN

Dam	Country	Basin	River	Capacity (MW)	In Service Since	Flooded area (km^2)
Samuel	Brasil	Madeira	Jamari	216	1989	560
Balbina	Brasil	Trombetas	Uatumã	250	1989	4447
Curuá-Unã	Brasil	Xingu	Curuá-Una	30	1977	78
Tucuruí	Brasil	Araguaia-Tocantins	Tocantins	8370	1984	3000
Lajeado / Luis Eduardo Magalhães	Brasil	Araguaia-Tocantins	Tocantins	903	2001	626
Peixe Angical	Brasil	Araguaia-Tocantins	Tocantins	452	2006	294
São Salvador	Brasil	Araguaia-Tocantins	Tocantins	241	2009	104
Cana Brava	Brasil	Araguaia-Tocantins	Tocantins	450	2002	139
Serra da Mesa	Brasil	Araguaia-Tocantins	Tocantins	1275	1998	1784
Rondon II	Brasil	Madeira	Comemoracao	74	2009	23
Guaporé	Brasil	Madeira	Guaporé	120	2003	4
Guri	Venezuela	Orinoco	Caroní	10325	1986	4250
Pucará Pisayambo	Ecuador	Pastaza	El Tambo, El Roncador, El Milín, Quillopaccha, Agualongopungo, Talatag	73	1977	8
San Francisco	Ecuador	Pastaza	Pastaza	230	2007	N/A
Agoyán	Ecuador	Pastaza	Pastaza	156	1987	N/A
Abanico	Ecuador	Santiago	Abanico	38	2005	N/A
Paute Molino	Ecuador	Santiago	Paute	1075	1983	N/A
Yuncán	Perú	Ucayali	Paucartambo	130	2005	N/A
Yaupi	Perú	Ucayali	Paucartambo	108	1957	N/A
Yanango	Perú	Ucayali	Yanango, Tarma	43	2000	N/A
Chimay	Perú	Ucayali	Tulumayo	153	2000	N/A
Mantaro	Perú	Ucayali	Mantaro	1008	1973	N/A
Machupicchu	Perú	Ucayali	Vilcanota	90	1964	N/A
San Gabán II	Perú	Madre de Dios	San Gabán	110	1999	N/A
Yanacachi Norte	Bolivia	Beni	Taquesi	51	2002	N/A
Chojlla	Bolivia	Beni	Taquesi	37	2002	N/A
Santa Isabel	Bolivia	Mamoré	Corani, Santa Isabel	93	1973	N/A
Corani	Bolivia	Mamoré	Corani	54	1966	N/A

CLOSING REMARKS

The Amazon Basin is, without a doubt, of global importance and a key component of the carbon cycle, giving it an important role in the prevention or progression of global climate change. However, is it the responsibility of the Amazon countries to sacrifice their economic potential for the greater good of all? Should the international community somehow compensate for or contribute to the maintenance of the Amazon Basin? After all, most first world countries have deforested much of their own land. Or is it possible for the Amazon countries to progress economically with only sustainable development of the Amazon? It is clear that the international market ultimately plays a large role in the Amazon's worth, and that until the health of the Amazon does not have to be traded for economic development, we can never expect the Amazon Basin to be truly protected, and.

QUESTIONS

- Is it truly possible for countries to sustainably harvest from the Amazon in a way that is not less profitable than alternative methods?
- If not, is it the responsibility of the Amazon countries to sacrifice their economic potential for the good of the rainforest?

REQUIRED READING: This reading provides a background on some of the individual rivers in the Amazon Basin and their economic activities.

BARTHEM, R.B.; P. CHARVET-ALMEIDA; L.F.A. MONTAG & A.E. LANNA. 2004. **Amazon Basin, GIWA Regional assessment 40b.** Sweden, University of Kalmar/UNEP, pp 17-18.

Full report available online (http://www.unep.org/dewa/giwa/areas/reports/r40b/giwa_regional_assessment_40b.pdf) but required sections excerpted below for convenience:

Rivers of the Andes

Ucayali and Marañón rivers. The Inca Empire was the most famous civilization of the Ucayali River. Its capital, Cuzco, was established on the Apurimac River, in the Basin's headwaters. The mountains have a long history of human alteration extending thousands of years, but the valley and the lowlands are well preserved. Fishing is an important economic activity in the lowlands, mainly around the cities of Pucallpa and Iquitos. The Marañón River was the principal connection between the Peruvian Amazon and the Pacific in the recent past, and now it is the main pipeline route for the export of oil. In addition to oil extraction, numerous copper, zinc, iron, mercury, antimony and gold mines occur in the headwaters of these rivers (Goulding et al. 2003).

Madeira River. The Madeira River, composed of Mamoré, Beni and Madre de Dios rivers, is the main source of sediments of the Amazon Basin. The foothills of the Andes exhibit a sequence of habitats that change from snowfall streams to the large rivers at the base of the mountains. Although the biodiversity increases downstream, the chemical processes and species endemic to the high altitude reaches of these rivers make them an important area for the Basin. The confluences of the Andean rivers and the rivers of the Brazilian Shield is observed along a succession of rapids and falls located above the city of Porto Velho. Below this point, the River is calm and navigable. The largest floodplain areas are located in Bolivia, in the flooded savannahs. These areas are inundated with the floods of the rivers and by local rainwater (Goulding et al. 2003). One of the largest alluvial gold mines within the Amazon Basin is located along the Madre de Dios River (Núñez-Barriga & Castañeda-Hurtado 1999).

Putumayo-Içá and Caquetá-Japurá. Although, these Andean rivers may have the most preserved catchments in the entire Amazon Basin, the foothill region has been altered in areas where communities, primarily of indigenous people, have expanded along the road and cocoa production has increased. Fishing is an important activity in the lower river, mainly in the Caquetá River and gold exploitation occurs along the Colombian and Brazilian border (Férnandez 1991, Goulding et al. 2003).

Purus and Juruá rivers. The Purus and Juruá rivers are different from other white-water rivers in the Andean region because their headwaters are situated below 500 m altitude, although, in the past, they were connected with the Andes. As a result of geological changes these rivers now drain a desiccated landscape formed by an older alluvium deposit and carry large quantities of suspended solids (Clapperton 1993). These rivers have one of the largest floodplain areas of the Amazon Basin, which is explored by professional fishermen from Manaus (Batista 1998, Petrere 1978). In the headwaters, inhabited by Indians and small communities, several areas have been designated for ethnic groups and are protected from extractive activities (Goulding et al. 2003).

Rivers of the Old Shields

Guyana Shield

The Guyana Shield is located in the north of the Amazon Basin and is shared by Brazil, Venezuela, Guyana, Suriname and French Guiana.

Trombetas, Jari, Araguari and other rivers. Most of the drainage area of these rivers is located in the Guyana Shield, which is characterised by the falls and headwaters of small streams. Large industrial operations, such as the extraction of bauxite in the Trombetas River, the extraction of kaolin and paper production in the Jari River and the extraction of manganese in the Araguari River occur in these basins (Barthem 2001).

Negro River. The Negro River is the largest tributary of the Amazon River located in the Guyana Shield. Several floodplains in the catchment that are flooded by overflow from the Negro River are important, such as the Anavilhanas archipelago in the Negro River and the unnamed archipelago, between Padauari/Demini and Branco rivers (Goulding et al. 1988). In addition, forests in the catchment are periodically flooded by the rain and, as a consequence, creates another type of flooded environment that covers large contiguous areas close to the margins of the Negro and Branco rivers as well as in the

headwaters of its tributaries. In the Branco River, the savannah that is periodically flooded by rain is an environment that favours cattle and rice cultivation and, moreover, it is an area prone to fires during dry periods. The falls and headwaters of the rivers are areas subjected to more severe environmental impacts, such as mining. Conservation depends on the enforcement of an environmental law, which is hindered by the expansion of mining activities in this area (Barthem 2001).

Brazilian Shield

The Brazilian Shield is located in the southern Amazon Basin and is located entirely within Brazil.

Tocantins River. The catchment of the Tocantins River is one of the most altered areas of the Amazon Basin. This region possesses two large hydroelectric dams, one at Tucuruí in the lower Tocantins River, and the other at Lageado, in the upper Tocantins River, and the construction of 25 more is predicted (Leite & Bittencourt 1991). Moreover, its headwaters are altered by agricultural activities to the south of Pará and north of Tocantins, as well as by present and past mining activities.

Xingu River. The ichthyofauna of the Xingu River above the waterfall at Altamira is completely different from that of the lower sections of the River. The fauna and the ecology of this system are not sufficiently known and the main impacts are related to mining and agricultural activities in its headwaters.

Tapajós River. Of the rivers that drain the Brazilian Shield, the Tapajós River is the most altered by mining activities in its headwaters and also by dredging. Unfortunately, knowledge of the ichthyofauna and ecology of this drainage system is still insufficient to evaluate the dimension of the impact of this activity (Barthem 2001).

The tributaries of Madeira River. The headwaters of the Madeira River are located in the Andean slopes, but its tributaries drain the Brazilian Shield. The main impacts in this area are caused by mining, construction of Samuel's Hydroelectric Dam on the Jamari River, and intense agricultural activity in its headwaters. Information on the fauna and ecology of these tributaries is lacking. The Madeira River area and regions close to its tributaries have been studied more often. However, mercury contamination is known in the area and the disturbances of the mining dredges on the migration of the great catfishes have been mentioned by local fishermen.