



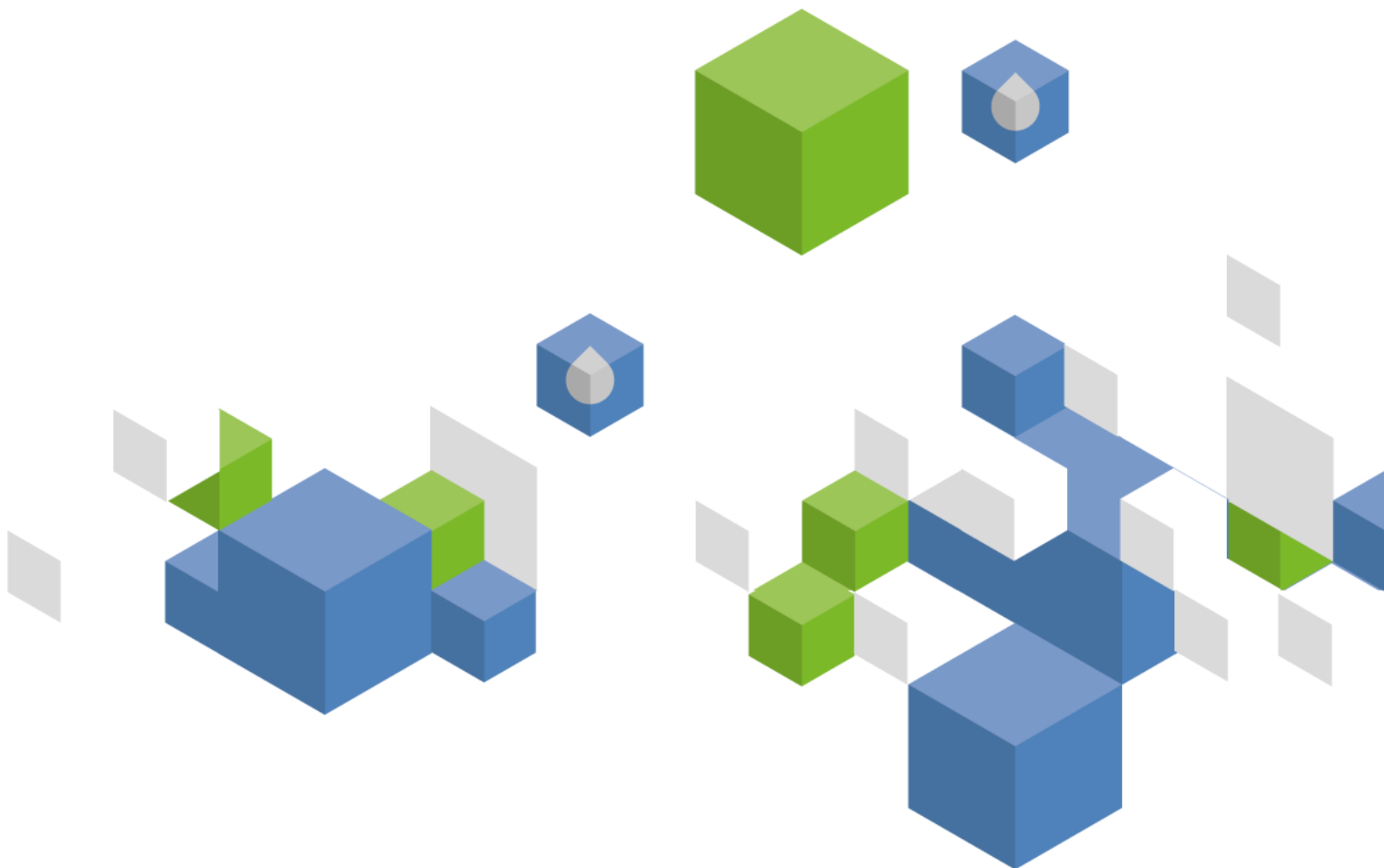
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# Transboundary River Basin Overview – Amazon

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# Amazon transboundary river basin

## GEOGRAPHY, CLIMATE AND POPULATION

### Geography

The Amazon river basin is a transboundary basin, situated between approximately 50°W and 80°W longitude and 5°N and 17°S latitude. It has a total area of 6.15 million km<sup>2</sup>, distributed between Brazil (63.9 percent), Peru (15.6 percent), the Plurinational State of Bolivia (11.7 percent), Colombia (5.6 percent), Ecuador (2.1 percent), the Bolivarian Republic of Venezuela (0.9 percent) and Guyana (0.2 percent) (Table 1 and Basin map). It is by far the largest river basin in the world and occupies more than one third of the Southern America region, lying to the northeast of the Andes mountain range and extending from the Guyana Plateau in the north to the Brazilian Plateau in the south.

About 75 percent of the total area of Peru is located in the Amazon basin, followed by the Plurinational State of Bolivia (66 percent), Ecuador (51 percent), Brazil (46 percent), Colombia (30 percent), the Bolivarian Republic of Venezuela (6 percent) and Guyana (5 percent).

TABLE 1  
Country areas in the Amazon river basin

Basin	Area		Countries included	Area of country in basin (km <sup>2</sup> )	As % of total area of the basin	As % of total area of the country
	km <sup>2</sup>	% of Southern America				
Amazon	6 154 000	35	Bolivia (Plurinational State of)	721 000	11.7	66
			Brazil	3 935 000	63.9	46
			Colombia	342 000	5.6	30
			Ecuador	132 000	2.1	51
			Guyana	11 000	0.2	5
			Peru	958 000	15.6	75
			Venezuela (Bolivarian Republic of)	55 000	0.9	6

While in some literature the Tocantins-Araguaia river basin, located entirely within Brazil, is included in the Amazon river basin, it is not included in this profile (see detailed basin map). Table 4 of the AQUASTAT Brazil country profile shows the basins provided by Brazil's National Water Agency ANA, which considers the two to be different basins since they both have their own outlet to the sea (ANA, 2009).

The Amazon river basin contains a complex system of vegetation, including the most extensive and preserved rainforest in the world with an estimated area of 5.5 million km<sup>2</sup> (550 million ha), of which more than 60 percent, around 3.6 million km<sup>2</sup>, is located inside Brazil (Rodrigues, 2008). The rainforest, known as the Amazon Rainforest or Amazonia, is not confined to the Amazon river basin but also extends into the Orinoco basin to the north and other small basins located between the mouths of the Orinoco and Amazon rivers to the northeast. In addition, extensive areas of scrub-savannah dominate the headwaters of the Brazilian and Guyana shields (i.e. Precambrian geologic formations), while the regions of the basin situated at high altitude in the Andes are characterized by tundra-like grassy tussocks called the Puna (GIWA, 2004). The Amazon river basin contains the highest biodiversity in the world.

Figure 1  
Amazon River Basin



The basin has widely varying topographic characteristics, with elevations ranging from sea level at the river's mouth to an altitude of 6 500 m in the Andes (Braga, Varella and Gonçalves, 2011). Most of the Amazon basin does not exceed an altitude of 250 m, and the main humid zones are located below an altitude of 100 m (GIWA, 2004).

### Climate

The Amazon river basin has a hot and humid tropical climate. Temperature variation over the entire basin is relatively small with annual mean temperature varying between 24°C and 26°C. In the mountainous areas, the annual average is below 24°C, while along the Lower and Middle Amazon the mean temperature exceeds 26°C. The homogeneity of temperature is probably due to the relatively uniform topography of the basin, the abundance of tropical rainforest, and its location in the north and centre of South America (GIWA, 2004).

There are approximately 250 days of rainfall per year, totalling about 2 500 mm (ACEER, 2013). However, the rainfall is not homogeneously distributed throughout the basin or during the year. In some areas and/or during some months, rainfall can be very low leading to occasional shortages of freshwater. Mean annual rainfall generally oscillates between 1 000 mm and 3 600 mm, but exceeds 8 000 mm in the Andean coastal region. At the mouth of the Amazon river annual rainfall exceeds 3 000 mm, while in the less rainy corridor, from Roraima through Middle Amazon to the State of Goiás in Brazil, it varies between 1 500 and 1 700 mm. In the west, rains are relatively evenly distributed over the year, in the north the highest rainfall takes place in the middle of the year and in the south maximum precipitation occurs at the end of the year. More than half of the total precipitation is recycled by evapotranspiration in the Amazon rainforests, which maintain the rainfall patterns and the hydrological cycles in the region. Average annual evapotranspiration ranges from almost 1 000 mm in the proximities of the Juruá and Purus rivers to more than 2 600 mm close to the mouth of the Amazon river (GIWA, 2004).

The basin is strongly affected by climatic factors taking place in the Pacific Ocean, such as “El Niño” and “La Niña” that dramatically alter rainfall in the basin. “El Niño” is characterized by higher than normal temperatures in the Equatorial Pacific resulting in droughts, while “La Niña” is characterized by lower than normal temperatures resulting in floods. The “El Niño” event of 1997 caused a very intense drought in the region, while the drought during 2005 affected large sections of the central and western Amazon basin.

### Population

In recent decades, there has been an accelerated process of immigration into the Amazon river basin. In 1999, the Amazon population was estimated at 23 million inhabitants, of which 49 percent in Brazil, 30 percent in Peru, 15 percent in Bolivia, 3 percent in Colombia and 3 percent in Ecuador (McClain, 1999). Population in the Amazon river basin parts in Guyana and the Bolivarian Republic of Venezuela is not known, but is negligible compared to the above countries. At present, the population of the Amazon river basin is estimated at approximately 28 million inhabitants, which is 9 percent of the total population in the above five countries varying from about 2 percent of the total population in Colombia to 40 percent in the Plurinational State of Bolivia. People are mostly concentrated in urban areas along the river and its main tributaries (Iquitos, Leticia, Manaus, Río Branco, Porto Velho, Boa Vista, and Macapa, among others) (ACTO/GEF/UNEP, 2015). In the entire basin there are five cities with more than 1 million inhabitants each and an additional three with more than 300 000 people each.

Population density in the Amazon river basin is very low. In Brazil, for example, the average population density in the basin is around 3-4 inhabitants/km<sup>2</sup>, which is considerably lower than the average density of 23 inhabitants/km<sup>2</sup> in the entire country (GIWA, 2004).

In the upper, Andean, part of the basin a high percentage of the total population consists of indigenous communities settled mainly along the banks of the river (Braga, Varella and Gonçalves, 2011).

The quality of life of the population in the Amazon river basin, based on indicators such as basic sanitation (provisioning of water, sanitary exhaustion and garbage collection) and incomes, is characterized by accentuated lack of infrastructure and social investments (GIWA, 2004).

While no data are available at the basin-level, at country-level in 2015 access to improved water sources varied from 87 percent in Ecuador and Peru to 98 percent in Brazil and Guyana (Table 2).

TABLE 2  
Access to improved water sources (Source: JMP, 2014)

Country	Access to improved water sources (% of population)		
	National	Urban	Rural
Bolivia (Plurinational State of)	90	97	76
Brazil	98	100	87
Colombia	91	97	74
Ecuador	87	93	76
Guyana	98	98	98
Peru	87	91	69
Venezuela (Bolivarian Republic of)	93	95	78

## WATER RESOURCES

### Surface water

The headwaters of the Amazon river are in the Andes Mountains of Peru, 190 km from the Pacific Ocean to the west of Southern America. From there the river runs east and northeast until it finally empties into the Atlantic Ocean at Belém in Brazil in the northeast of Southern America. The Amazon river, with a total length of about 6 400 km, is the world's second longest river after the Nile with a total length of 6 650 km. However, debates over the true sources of both rivers and thus their entire length are ongoing and some studies consider the Amazon to be the longest river with a length of 6 990 km and the Nile the second longest with 6 850 km. The Amazon river is the widest and deepest river and has by far the largest flow of water and drainage area. No bridge crosses the Amazon.

The depth of the river reaches 100 m in some areas (Fenzl and Mathis, 2004). The lowest water levels occur in the months of August to September, and the highest levels occur in April and May. The water level in the Amazon river can fluctuate by as much as 12 m. When the water is at its highest point the river can be as wide as 560 km (ACEER, 2013).

The Amazon river is made up of over 1 100 tributaries, 16 of which are longer than 1 600 km (ACEER, 2013). The Amazon river originates mainly from two rivers, the Ucayali and the Marañon, both originating in the glaciers of the Peruvian Andes in the south-eastern part of the basin.

The Madeira river, with branches originating in the Plurinational State of Bolivia, and the Negro river, with branches originating in Colombia and around the borders with the Bolivarian Republic of Venezuela and Guyana, are the most important tributaries of the Amazon river, contributing more than one fourth of the total water discharge (GIWA, 2004).

The Madeira (Madera in Spanish) river originating in the southwest of the Amazon basin has the largest catchment within the Amazon basin, both in terms of drainage area and in discharges of water and sediment load. It originates from the Beni and Mamore rivers in the Plurinational State of Bolivia and the basin is shared with Brazil and Peru. Other important tributaries of the Madeira river are the Dos Araras, Ribera and Abuna rivers. Two important tributaries of the Beni river are the Madre de Dios and Orthon rivers, while the Mamore river has three important tributaries, the Itenez (Guapore), Grande (Guapay) and Ichilo rivers.

The Negro river originating in the northeast of the Amazon basin drains parts of Brazil, Colombia, the Bolivarian Republic of Venezuela and Guyana. The Negro river connects with the Orinoco river by the Casiquiare canal in southern Venezuela, which is a natural canal that links two different river basins (Orinoco and Amazon). Depending on the water level and flood conditions, the water can flow in either

direction. The Negro river has two main tributaries: Vaupes river which arises in Colombia and Branco river which is enriched by many streams from the Tepui highlands where the Bolivarian Republic of Venezuela, Guyana and Brazil meet. The Rio Negro flows into the Solimoes river to form the Amazon river south of Manaus. Solimoes is the name often given to upper stretches of the Amazon river from its confluence with the Negro river upstream to the border of Brazil and Peru, with Putumayo, Japura, Jurua and Purus rivers as important tributaries. See the detailed river basin map showing the most important tributaries of the Amazon river system.

The discharge of the Amazon river of approximately 226 000 m<sup>3</sup>/s (7 150 km<sup>3</sup>/year) exceeds the combined discharge of the world's nine next largest rivers (ACTO/GEF/UNEP, 2015). The Amazon river discharge contributes more than 15 percent of the total discharge of all rivers of the world. Table 3 below shows the contribution by country to the annual discharge of the Amazon river system.

TABLE 3  
Mean annual runoff in the Amazon river basin (by country) (km<sup>3</sup>/year)

Country	Contribution to basin flow	
	(km <sup>3</sup> /year)	(%)
Bolivia (Plurinational State of)	291	4
Brazil	4 167.3	58
Colombia	755	11
Ecuador	140	2
Guyana	n.a.	-
Peru	1 739.5	24
Venezuela (Bolivarian Republic of)	60	1
<b>Amazon river basin</b>	<b>7 152.8</b>	<b>100</b>

*n.a.* = not available, but considered to be negligible

Explanatory notes to Table 3:

- The contribution of the Plurinational State of Bolivia to the Amazon basin is considered being equal to the outflow to Brazil (Madeira river system), which is 550 km<sup>3</sup>/year, minus the inflow into the country in the Amazon basin, which is equal to 259 km<sup>3</sup>/year coming from Peru through the Madre de Dios river.
- For Brazil, of the total Internal Renewable Surface Water resources, 4 167.3 km<sup>3</sup>/year is generated within the Amazon river basin.
- The contribution of Colombia to the Amazon basin is equal to the flow to Brazil from the Japura river system (430 km<sup>3</sup>/year), the Negro river system (124 km<sup>3</sup>/year), the Vaupes river system (76 km<sup>3</sup>/year), and the Putumayo river system (250 km<sup>3</sup>/year minus 125 km<sup>3</sup>/year contribution from Peru 110 km<sup>3</sup>/year and Ecuador 15 km<sup>3</sup>/year).
- The contribution of Ecuador to the Amazon basin is equal to the flow from Ecuador to Peru, which is the Santiago river system (60 km<sup>3</sup>/year), the Napo river system (65 km<sup>3</sup>/year) and the Putumayo river system (15 km<sup>3</sup>/year considered to be generated in Ecuador).
- The contribution of Peru to the Amazon basin is equal to the flow of the main Amazon river system (1 470 km<sup>3</sup>/year), the Jurua river system (5.5 km<sup>3</sup>/year), the Purus river system (20 km<sup>3</sup>/year), the flow of the Putumayo to Colombia (125 km<sup>3</sup>/year minus 15 km<sup>3</sup>/year from Ecuador to Peru), the flow to the Plurinational State of Bolivia (259), minus de flow from Ecuador to Peru (125 km<sup>3</sup>/year from Santiago 60 km<sup>3</sup>/year and Napo 65 km<sup>3</sup>/year).
- The contribution of the Bolivarian Republic of Venezuela to the Amazon basin is equal to the Casiquiare system (60 km<sup>3</sup>/year).

The flow of the Amazon river into the Atlantic is so strong, that its water does not even begin to mix with the ocean water until it has flowed 230 km into the Atlantic Ocean (ACEER, 2013).

## Groundwater

The enormous volume of precipitation recharges a widespread and complex aquifer system, the so-called Amazonas Aquifer. Although there is little scientific knowledge of its full extent, geological data suggest that the Amazonas Aquifer could be the largest cross-border groundwater system in South America, covering an area of nearly 4 million km<sup>2</sup> in Brazil, the Plurinational State of Bolivia, Colombia, Ecuador, Peru and the Bolivarian Republic of Venezuela (Braga, Varella and Gonçalves, 2011).

## WATER-RELATED DEVELOPMENTS IN THE BASIN

### Water use

Pressure on water resources in the Amazon river basin is very low, as a result of a combination of high availability of water and low demand due to low population density (ANA, 2009). Considering a population of 28 million, the water resources per capita are equal to 255 000 m<sup>3</sup> per year or 700 000 litres/day.

In Brazil, the water withdrawal in the Amazon basin in 2006 was an estimated 2 108 million m<sup>3</sup>, which represents 3.6 percent of the total withdrawal of the country. Agriculture and livestock accounted for 53 percent of the total water withdrawal in the basin, municipalities for 33 percent and industry for 14 percent (ANA, 2009). In Peru, total water withdrawal in the Amazon basin in 2008 was an estimated 2 360 million m<sup>3</sup>, which is 17 percent of the water withdrawal of the entire country.

In urban centres water is generally collected from neighbouring rivers and distributed to residents by local water companies, while the rural populations usually take water directly from the rivers or from shallow water wells (GIWA, 2004).

The economy of the Amazon region is primarily dependent on the extraction of exportable minerals, oils and forest products. Products from timber, mining and petroleum exploitation are the most important products exported from the Amazon river basin (GIWA, 2004). The basin comprises some of the world's largest known reserves of bauxite (roughly 15 percent of the world total), and industries within the basin are some of the largest suppliers of iron and aluminium ore and steel to world markets (Braga et al, 2011).

Rivers are also used for transport in the Amazon basin, much of which remains roadless. Products and people move by river. The ports located in Iquitos (Peru) on the Amazon river and Porto Velho city (Brazil) on the Madeira river receive ships that travel more than 3 500 km along the rivers. While not all rivers of the Amazon basin are navigable by commercial ships, it is estimated that more than 40 000 km of waterways within the basin are navigated (GIWA, 2004).

### Dams and hydropower

Table 4 shows the main hydroelectric and irrigation dams in the Amazon river basin.

Brazil has a great hydropower potential in the Amazon basin, yet the major urban centres in the basin are supplied by thermoelectric plants. Brazil is planning to build 34 additional hydroelectric facilities in the Amazon by 2021 in an effort to increase Brazil's national energy output by 50 percent or more (Richardson, 2013). Among these dams, Brazil is currently constructing the Belo Monte dam on the Xingu river, what would be the world's third-largest hydroelectric project, and the San Antonio and Jirau dams in the Madeira river. The Belo Monte Complex is expected to be operating at full capacity in 2019 with a total capacity of 18 662 MW. The Santo Antonio dam and the Jirau dam will have a total installed capacity of 3 580 MW and 3 900 MW respectively (Braga et al, 2011). Main concerns expressed by many are that these projects threaten the livelihoods of thousands of indigenous tribes and farmers that are dependent on ecosystems which would likely be destroyed by these projects (Maisonet-Guzman, 2010). In addition, dams are being planned on the Tapajós, Teles Pires, and Juruena rivers of the Tapajos river basin, which would flood national parks, reserves and indigenous lands.

The steep gradients of Amazon rivers in the Andes make them enormous potential sources of hydroelectric power. The Peruvian Amazon is facing a series of planned dams on the Inambari, Ene, and Marañón rivers, upstream from Brazil.

Colombia, Guyana and the Bolivarian Republic of Venezuela don't have important dams in the Amazon basin.

TABLE 4

**Main hydroelectric and irrigation dams in the Amazon river basin** (Sources: Lynch; Osinerg, 2005; AQUASTAT, 2015)

Country	Name	Basin	River	Year	Capacity (MW)	Reservoir capacity (million m <sup>3</sup> )	Main use *
Bolivia (Plurinational State of)	Corani	Mamoré	Corani	1988	54	168	H
	La Angostura	Mamoré	Sulty	1939	-	75	I
	Zongo	Beni	Coroico	-	-	3	H
	Vila Chururuni	Beni	Khala kalani	-	-	3	H
	Santa Isabel	Mamoré	Corani	1973	93	--	H
	Yanacachi Norte	Beni	Taquesi	2002	51	--	H
	Chojlla	Beni	Taquesi	2002	37	0.05	H
Brazil	Balbina	Trombetas	Uatumã	1989	250	19 959	H
	Curua- - Una	Xingu	Curua- - Una	1977	30	530	H
	Rondon II	Madeira	Comemoracao	2009	74	478	H
	Guapore	Madeira	Guapore	2003	120	31	H
	Samuel	Madeira	Jamari	1989	216	4	H
Ecuador	Paute	Santiago	Paute	1983	1 075	120	H
	San Francisco	Pastaza	Pastaza	2007	230	--	H
	Agoyan	Pastaza	Pastaza	1987	156	4	H
	Pucara Pisayambo	Pastaza	El Tambo, El Roncador, El Milin, Quillopaccha, Agualongopungo, Talatag	1977	73	--	H
	Abanico	Santiago	Abanico	2005	38	--	H
Peru	Lago Junin	Ucayali	Mantaro	-	-	300	H
	Pasto Grande	Ucayali	Tambo	-	-	205	I
	San Gaban II	Madre de Dios	San Gaban	1999	110	36	H
	Chimay HP (Tulumayo dam)	Ucayali	Tulumayo	2000	153	2	H
	Yuncan HP (Huallamayo, Uchuhuerta dams)	Ucayali	Paucartambo	2005	130	2	H
	Mantaro	Ucayali	Mantaro	1973	1 008	--	H
	Yaupi HP	Ucayali	Paucartambo	1957	108	--	H
	Machupicchu	Ucayali	Vilcanota	1964	90	--	H
	Yanango HP (Tarma dam)	Ucayali	Yanango, Tarma	2000	43	--	H

\* I = irrigation; H = Hydropower

## Agriculture

In the 19<sup>th</sup> century, the agricultural cycle in the basin was progressively replaced by more permanent production of coffee, cotton, sugarcane and cacao. Later, an increasing demand for rubber promoted several private incentives and government investments in the area. Rubber became the main product of the Amazon river basin until the beginning of the 20<sup>th</sup> century. Low competitiveness of the extraction process and a fungal plague in the plantation caused the decline of rubber production around 1950. Since the 1970s, there has been a spatial expansion of crops as well as the raising of bovine cattle (GIWA, 2004). Ranching is by far the most extensive form of land use. In the Brazilian Amazon, for example, cattle pastures occupy approximately 75 percent of the total area deforested. While productivity per area is low, extensive cattle pastures are popular because they guarantee a steady flow of income and require minimal investments of labour or capital (USAID, 2005).

Rice, cassava, maize and beans are the main subsistence crops grown, while soybean, coffee and cacao are grown as commercial crops. Rainforest soil is nutrient poor and highly acidic due to the rapid life cycles and abundant rain. Swidden-fallow, or slash and burn, agriculture is one of the few ways to prevent the long-term degradation of the natural forest resource. This traditional practice has been implemented by the indigenous Amazonians for millennia without any obvious signs of environmental degradation. The swidden-fallow technique first clears and burns a field, which adds nutrients to the soil via ash and organic matter. The 'young' swidden fields are primarily planted with maize and rice. 'Early successional' swidden fields contain plantains, manioc, other root crops, and papayas. Finally, 'late-

successional' swidden fields are planted with fruit trees or left fallow (Larson, 2011). Brazil's soybean production has increased in recent years in the Amazon basin.

Irrigation doesn't play an important role in the economies of the Amazon river basin. In Brazil, the area equipped for irrigation in the basin is an estimated 127 000 ha in 2010, or 2.4 percent of the total area equipped for irrigation in Brazil, compared to 81 000 ha in 2006 (ANA, 2012). In Ecuador, in 2000 only 614 ha or 0.07 percent of its total irrigated area was located in the Amazon region (MAGAP, 2011). In the Andes area of the basin, there are abundant water resources but the infrastructure for irrigation is poor and rudimentary, and agriculture consists mainly in small schemes of subsistence agriculture.

## ENVIRONMENT, WATER QUALITY AND HEALTH

The main environmental problems of the Amazon basin are deforestation, water pollution, changes in the hydrologic cycle and anthropogenic pressures (OAS, 2005).

More than 14 000 km<sup>2</sup> or 1.4 million ha of forest have been cleared since the 1970s in the Amazon rainforest. An even larger area has been affected by selective logging and forest fires. Conversion for cattle grazing is the biggest single direct driver of deforestation. In Brazil, more than 60 percent of cleared land ends up as pasture. Industrial agricultural production, especially soybean farms, has also been an important driver of deforestation since the early 1990s. However, since 2006 the soy industry has had a moratorium on new forest clearing for soy. Mining, subsistence agriculture, dams, urban expansion, construction of roads, agricultural fires, and timber plantations also result in significant forest loss in the Amazon (Butler, 2010). Current Amazonian deforestation rates are estimated at more than 20 000 km<sup>2</sup> or 2 million ha, per year (Larson, 2011), which is equal to 0.4 percent per year of the total area estimated 5.5 million km<sup>2</sup>. The Amazon rainforest is of huge importance to the local and global climate.

Water pollution and water quality degradation in the Amazon river basin result mainly from the indiscriminate use of agricultural pesticides, illicit crops, dumping of solid wastes, mining and inadequate treatment of wastewater from populated areas. The pollution of existing water supplies has a high but localized impact in small streams or stretches located close to the urban centres (e.g. Belém, Santarém, Manaus and neighbourhoods), due to the absence of adequate sewage treatment systems. On the other hand, the high rainfall intensity and the scarce large urban centres make this impact local and of low significance to the entire basin (GIWA, 2004).

In general, government companies are responsible for the treatment and distribution of drinking water in the cities. However, recently some of these enterprises were privatized. In the urban centres, the pollution of existing water supplies may cause chronic public health problems with incidences of diarrhoea that predominantly affect children living in low-income areas. This problem, considered serious, is more related to urban centres of the Amazon region (GIWA, 2004).

There are only a few industrial areas established near the cities. Manaus is the only city in the Amazon that has a duty-free industrial area. Most of the individual components are imported, thus the industrial effluents produced during the manufacture of those components are not present in Manaus and, as a result, the assembly industry is considered a "clean industry" (GIWA, 2004).

Changes in the hydrological cycle are associated with changes in the global climate and exacerbated by the alteration of the Amazonian forests due to the fires and the droughts. Higher temperatures in the tropical Atlantic due to climate change reduce rainfall across large extents of the Amazon, causing drought and increasing the probability of fires. Much of the Amazon could transition from rainforest to savannah, especially in the southern parts of the region, which could have dramatic economic and ecological impacts (Butler, 2010).

The geological structures where the waters originate determine the types of water in the Amazon, which are classified as white, clear or black according to their colour. White-water rivers originate in the

Andean slopes and are highly turbid rivers that carry a great amount of material in suspension, such as the Amazon, Napo, Marañón, Tigre, Jurua, Purus and Madeira rivers. Clear-water rivers are generally transparent and originate in the Guyana and Brazilian shields where the processes of erosion yield few particles that are transported in suspension. These waters have a low conductivity. Black-water rivers are characterized by a high amount of humic acid in colloidal form, such as the Negro and Urubu rivers.

The Amazon river transports an average of 600 to 800 million tons of sediment annually, with the majority of the sediment coming from the Solimoes (62 percent) and Madeira (35 percent) rivers originating in the Andes. Seasonal flooding brings soil and minerals from the mountains to the flood plains along the river, enriching the nutrient-poor soil.

## TRANSBOUNDARY WATER ISSUES

The Amazon Cooperation Treaty (ACT) was signed in 1978 by Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela. The basic scope of the ACT is to promote harmonious development of the Amazon, in order to allow an equitable distribution of the benefits, to improve the quality of life of its people and to achieve the full incorporation of their Amazon territories to the respective domestic economies. The member countries found the ACT to be a valuable framework for promoting binational cooperation in border areas. The following bilateral agreements were signed (OAS, 1993):

- In 1979, Colombia and Ecuador signed an Agreement on Amazonian Cooperation, and in 1985 issued the Declaration of Rumichaca, in which they confirmed their decision to cooperate on the integrated development of their border area. On the basis of these instruments, they approved the terms of reference for the Physical Planning and Management of the San Miguel and Putumayo river basins.
- In 1979, the Colombian-Peruvian Treaty on Amazonian Cooperation was signed to accord priority and dynamism to a policy of Amazonian cooperation. In 1987, the Joint Commission on Amazonian Cooperation was created, to which the preparation of the Plan for Integral Development of the Putumayo River Basin was assigned.
- In 1979, Brazil and Peru signed the Cooperation and Friendship Treaty. In July 1987, both countries signed the Declaration of Rio Branco and the Puerto Maldonado Action Programme, and established the Joint Brazilian-Peruvian Commission on Amazonian Cooperation. In 1988, it was decided to implement the Integrated Development Programme for the Peruvian-Brazilian Border Communities (Iñapari and Assis-Brazil).
- In 1981, Brazil and Colombia signed the Agreement on Amazonian Cooperation. In 1987, the countries approved the preparation of the Colombian-Brazilian Model Plan for the Integrated Development of the Border Communities in the Tabatinga-Apaporis Axis.
- In 1988, Bolivia and Brazil issued a declaration in which they stressed the need for constant attention to environmental issues in the Amazon region. A Joint Action Programme was approved.

In 1995, the eight countries of the ACT decided to create the Amazon Cooperation Treaty Organization (ACTO) and a Permanent Secretariat for the ACT, reasserting the principles and the objectives of the ACT and considering the importance of the Amazon as an essential source of raw materials for the food, chemicals and pharmaceuticals industries, recommending the formulation of plans and strategies for environmental conservation and the promotion of the region's sustainable development (GIWA, 2004). ACTO acquired its legal validity in 1998, when the member countries signed the Amendment Protocol to the ACT which established the creation of ACTO and the installation of its Permanent Secretariat which was later established in Brasilia in 2002.

ACTO has the Meeting of Ministers of Foreign Affairs as its maximum body, supported and assisted by the Amazon Cooperation Council (ACC) and by the Coordinating Commission of the Amazon Cooperation Council (CCOOR). At national level, the member countries have Permanent National

Commissions (PNC) responsible for applying the ACT in their respective territories and implementing the decisions adopted by the ACC and Ministers of Foreign Affairs meetings (ACTO, 2010).

In 2004, ACTO published a strategic plan for the years 2004 - 2012 in the Amazon river basin. The plan defines a number of areas or themes for development, including the sustainable management of the region's water and soil resources (ACTO, 2013).

In 2005, after the approval of a US\$ 700 000 grant by the Global Environment Fund (GEF), ACTO, the Organization of American States (OAS) and the United Nations Environment Programme (UNEP) agreed to sign a project brief to carry out the preparatory phase of the "Integrated and Sustainable Management of Transboundary Water Resources in the Amazon River Basin Considering Climate Variability and Change" Project, called the GEF Amazonas Project. After the preparatory phase (2005-2007), the proposed project was divided into three four-year phases: the first for planning and development of institutional capacity, the second for implementation of jointly identified strategic activities, and the third for strengthening sustainable and integrated water resources management in the Basin.

In 2009 the member countries issued a Declaration on ACTO with the mandate to endow the Organization with "a new and modern role as a cooperation, exchange, knowledge and joint projection forum to face the new international challenges that lie ahead". Consequently, the member countries approved in 2010 the present new Amazonian Strategic Cooperation Agenda with an 8-year implementation horizon. The New Strategic Agenda includes the vision, mission and strategic objectives of ACTO based on two axes: (i) conservation and sustainable use of renewable natural resources and (ii) sustainable development (ACTO, 2010).

In 2010, the GEF Amazonas Project was signed, prepared by the 8 ACTO members countries to formulate a consensual Strategic Action Programme based on the needs and objectives of Amazonian stakeholders (ACTO/GEF/UNEP, 2015).

Table 5 lists the main historical events in the Amazon river basin.

TABLE 5  
Chronology of major events in the Amazon river basin

Year	Plans/projects/treaties/conflicts	Countries involved	Main aspects
1978	Amazon Cooperation Treaty (ACT)	Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela	ACT was signed to promote the harmonious development of the Amazon
1979	Agreement on Amazonian Cooperation	Colombia and Ecuador	-
1979	Treaty on Amazonian Cooperation	Colombia and Peru	The treaty was signed to accord the priority and dynamism to a policy of Amazonian cooperation
1979	Cooperation and Friendship Treaty	Brazil and Peru	
1981	Agreement on Amazonian Cooperation	Brazil and Colombia	Agreement signed
1985	Declaration of Rumichaca	Colombia and Ecuador	Declaration that confirmed their decision to cooperate on the integrated development of their border area
1987	Joint Commission on Amazonian Cooperation	Colombia and Peru	The commission was created. Assigned to the commission the preparation of the Plan for Integral Development of the Putumayo River Basin.
1987	Declaration of Rio Branco, Puerto Maldonado Action Program and Joint Brazilian-Peruvian Commission on Amazonian Cooperation.	Brazil and Peru	Declaration and Action Program signed. Joint Brazilian-Peruvian Commission on Amazonian Cooperation signed
1987	Colombian-Brazilian Model Plan for the Integrated Development of the Border Communities in the Tabatinga-Apaporis Axis.	Brazil and Colombia	Preparation of the plan approved
1988	Integrated Development Program for the Peruvian-Brazilian Border Communities	Brazil and Peru	Program implemented

TABLE 5 (Continued)

**Chronology of major events in the Amazon river basin**

Year	Plans/projects/treaties/conflicts	Countries involved	Main aspects
1988	Declaration on environmental issues in the Amazon region	Bolivia and Brazil	Both countries stressed the need for constant attention to environmental issues in the Amazon region. A Joint Action Program was approved.
1995	Decision to create the Amazon Cooperation Treaty Organization (ACTO) and a Permanent Secretariat for the Amazon Cooperation Treaty	Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela	The aim of the decision was to reassert the principles and the objectives of the Amazon Cooperation Treaty (ACT)
1998	Creation of the ACTO	Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela	The ACTO acquired its legal validity, when the member countries signed the Amendment Protocol to the ACT which established the creation of the ACTO and the installation of its Permanent Secretariat
2002	Permanent Secretariat of the ACTO	Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela	Permanent Secretariat established in Brasilia
2004	Strategic plan for the years 2004 - 2012 in the Amazon river basin	Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela.	Strategic Plan published by ACTO
2005	Integrated and Sustainable Management of Transboundary Water Resources in the Amazon River Basin Considering Climate Variability and Change Project (GEF Amazonas Project)	Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela	GEF, ACTO, OAE and UNEP signed a project brief to carry out the preparatory phase, of the GEF Amazonas Project. After the preparatory phase (2005-2007), the proposed Project was divided into three four-year phases.
2009	Declaration on ACTO	Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela	With the mandate to endow the Organization with "a new and modern role".
2010	Amazonian Strategic Cooperation Agenda with an 8-year implementation horizon.	Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela	Consequently to the Declaration on ACTO of 2009 the member countries approved in 2010 the present new Amazonian Strategic Cooperation Agenda with an 8-year implementation horizon.
2010-2015	GEF-Amazon project	Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela	GEF-Amazon project was signed to formulate a consensual Strategic Action Program

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