

**MINISTRY OF MINES AND ENERGY**  
**NATIONAL DEPARTMENT OF WATER AND ELECTRIC ENERGY**  
**GENERAL COORDINATION OF WATER RESOURCES**  
**USE OF HYDRAULIC ENERGY**

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## **HISTORY**

Water is a renewable natural resource that appears in Brazilian territory coming from three main origins:

- a) atmospheric precipitation over the surface of the country, forming superficial basins and subterranean reservoirs;
- b) the rivers that flow in from or are shared with neighboring countries, notably the basins drained by the Amazon, the Paraguay and the Uruguay rivers.
- c) the natural coasting water resources, formed by the waters of the Atlantic Ocean along approximately 8.500 km of the sea-shore, together with the estuaries, lakes and other points of river discharge.

The hydrological cycle, by which the water drains off and then returns successively, happens in eight great hydrographic basins. The availability of water in the different significant points of this cycle is measured by a national hydrographic network, planned, coordinated, and operated by the National Department of Water and Electric Energy - DNAEE, an organ which is part of the Ministry of Mines and Energy, aiming the exploitation of hydroelectric energy as its fundamental objective.

## **GENERAL DATA**

The total volume drained by rivers, in Brazilian territory, is estimated at 257,790 m<sup>3</sup>/s in terms of average discharge over a long period of time. Most of the 92% of this figure is in the six great hydrographic basins, with the following average flow according to DNAEE: The Amazon 209,000 m<sup>3</sup>/s, the Paraná (including Iguaçu) 11,000 m<sup>3</sup>/s, the Paraguay 1,290 m<sup>3</sup>/s, the Uruguay 4,150 m<sup>3</sup>/s, and the São Francisco 2,850 m<sup>3</sup>/s.

In the basins of the oceanic slope, smaller rivers appear, but which have great economic and social importance. The following Rivers merit special mention: the Parnaíba (800 m<sup>3</sup>/s), Jaguaribe (133 m<sup>3</sup>/s), Mundaú (30 m<sup>3</sup>/s), Paraíba (27 m<sup>3</sup>/s), Paraguaçu (113 m<sup>3</sup>/s), in the Northeast region, the rivers Doce (1,140 m<sup>3</sup>/s), Paraíba do Sul/Guandu (900 m<sup>3</sup>/s), UpperTietê/Cubatão (60 m<sup>3</sup>/s), with reversion of 50%, Ribeira do Iguape (540 m<sup>3</sup>/s), Itajaí (270 m<sup>3</sup>/s), and Guaíba (1,740 m<sup>3</sup>/s), in the Southeast and Southern Regions.

In the Amazon River Basin very large affluents are found, draining hydrographic basins of low level soil occupation and little economic utilization of the water: Negro (28,400 m<sup>3</sup>/s), Madeira (31,200 m<sup>3</sup>/s), Tapajós (13,500 m<sup>3</sup>/s), and Xingu (9,700 m<sup>3</sup>/s).

In table nº 1 the hydrological resources available in the country are indicated, as determined by the National Department of Water and Electrical Energy of the MME. The information mentioned, as well as rain fall information is confirmed in maps of water resource availability and isohyets (annexed) and were obtained from the National Hydrographic Network, operated by DNAEE.

Table I enables the verification of great diversity in situations, with abundance of water in the North and Central West and scarcity in the Northeast regions and in some developed states such as Rio de Janeiro and São Paulo.

## **THE DOMINION AND GRANT OF USE OF WATER RIGHTS**

Since water resources, according to constitutional precepts, are in the dominion of the Union or in dominion of the States, the granting of their use is issued by the Federal Government or by the government of each State, depending on the case. For the case of granting water rights use (concessions) for the generation of electrical energy, DNAEE is the responsible Agency to do this for state rivers as well as for federal rivers, since all hydraulic potential is in the dominion of the Union, independently of the dominion of the river.

## **WATER CLASSIFICATION**

The conservation of the quality of Brazilian water resources was regulated according to technical patterns according to classifications established by Resolution Nº 20 of National Council of the Environment (CONAMA), of June 18, 1986. Water was divided into sweet, brackish, and saline characterized by nine quality classes.

## **THE USE OF WATER**

The use of water as an **ENERGETIC POTENTIAL** is the main form of its non-consumptive use and in Brazil it presents itself as of the highest relevance since nearly 92% of the production of electric energy is of hydraulic origin. Hydroelectric energy has advantages not only in function of its reduced operational costs but above all because it produces less negative effects on the environment.

It is relevant also to emphasize the importance of the use of water for agriculture, through **IRRIGATION**. The search for solutions to the serious problem of insufficiency of agricultural production, is a great challenge to promote and expand irrigated agriculture as a means of increasing agricultural productivity.

The Brazilian farmers will be less and less dependent on rain, since irrigation, during the dry season, could supply water to the crops in the right proportion. So, it results in a better use of the land, increases

the offer of elements and decreases the agricultural investments, all this, enabling the rural workers to remain on the farms.

Currently in Brazil there is an irrigated agricultural area of close to ~~three~~ million hectares, which implies a water demand of 3.000 m<sup>3</sup>/s.

Besides AGRICULTURE and POWER GENERATION, other uses of water should be emphasized such as: PUBLIC WATER SUPPLY, INDUSTRIAL SUPPLY, NAVIGATION, RECREATION, WATER PLACES FOR FEEDING ANIMALS, LANDSCAPE HARMONY, DILUTION OF WASTE WATER, etc.

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**HYDROLOGICAL AVAILABILITY IN BRAZIL**

HYDROGRAPHIC BASINS	DRAINAGE AREA	AVERAGE LONG TERM DISCHARGE		PRECIPITATION	EVAPORATION
	10 <sup>3</sup> km <sup>2</sup>	m <sup>3</sup> / s	l/s/km <sup>2</sup>	mm / year	mm / year
1. TOTAL BASIN BASIN IN BRAZILIAN TERRITORY	6.112 * 3.900	209.000 120.000	34,2 30,8	2.460 2.220	1.382 1.250
2 - TOCANTINS	757	11.800	15,6	1.660	1.168
3 - ATLANTIC-NORTH/NORTHEAST NORTH (SUB-BASINS 30) NORTHEAST (SUB-BASINS 33 TO 39)	76	3.660	48,2	2.950	1.431
	953	5.390	5,7	1.328	1.150
4 - SÃO FRANCISCO	643	2.850	4,5	916	774
5 - ATLANTIC - EAST SUB-BASINS 50 TO 52 SUB-BASINS 54 TO 59	242	680	2,8	895	806
	303	3.670	12,1	1.229	847
6 - PARANÁ AS FAR AS FOZ DO IGUAÇU	* 877	11.000	12,5	1.385	989
6b - PARAGUAY AS FAR AS FOZ DO APA	* 368	1.290	3,5	1.370	1.259
7 - URUGUAY UNTIL FOZ DO QUARAI	* 178	4.150	23,3	1.567	832
8 - ATLANTIC SOUTH-EAST	224	4.300	19,2	1.394	789
WATER BRAZILIAN PRODUCTION	* 8.512	257.790			

CAPTION: \* AREA IN BRAZILIAN TERRITORY.

(TABLE Nº 1)

## **CRITICAL HYDROLOGICAL SITUATIONS**

### **EXCESS - SCARCITY - QUALITY**

In some Brazilian river basins, there exist serious problems related to aridity as well as flooding. In order to mitigate those problems, they should be approached with structural and non-structural measures. As a government organ executing its non-structural duties, DNAEE already operates a System of Hydrological Alert, benefiting the most critical basins of the country subject to this phenomenon, for example the Amazon basin, the São Francisco basin, the Paraíba do Sul basin, the Iguaçu basin, the Uruguay and Pantanal (wet lands). DNAEE also operates a System of Hydrological Alert for the countries of the Prata basin, according to a treaty signed under the auspices of the Ministry of Foreign Affairs.

In more developed countries, where the problem of sewage treatment has already been solved, the great problem of water pollution is from diffuse superficial drainage from urban areas. Being a function of basic sanitation situation, what is being faced at the present in the country is the treatment of site pollution. It should be kept in mind, however, that diffuse pollution continues to act jointly with site pollution.

The problem associated with diffuse pollution of water is that of its contamination with agricultural defenses, heavy metals, toxins, and fertilizers. Considering that the estimate of average soil loss on Brazilian territory is several million tons per year and that does not exist a rigid control over the use of fertilizers and agricultural defenses, the immediate consequence of which is the contamination of the fluvial flora and fauna and the eutrophia of the lakes and reservoirs.

### **HYDROLOGICAL MONITORING NETWORK**

In order to deal with the water problems, previously related, with emphasis on the utilization of hydraulic energy, it becomes necessary to operate in the country a Network of Hydrological Monitoring, modern, efficient, and with quick answers to the user. Within this context, DNAEE currently operates a network of approximately 4.000 stations all over the national territory, among pluviometric, fluviometric, sediment and quality of water, being already more than fifty years of historical series available for users. To operate this network, annually nearly 1.100.000 km are traversed, or the distance equivalent to 28 circuits around the Earth. The annual cost of operation, maintenance, consistency of data, and advice for users, is on the order of \$10.000.000 dollars. Apparently this is an high cost, but if it is considered that just the electric sector has invested in the country \$120.000.000.000 dollars in hydroelectric installations, the cost of the mentioned network is insignificant. It is outstanding that all the hydroelectric installations in the country had as fundamental support, the basic hydrological information furnished by DNAEE.

### **MULTIPLE INTEGRATED USE OF WATER**

The multiple integrated use of water as well as the mitigation of environmental impact resulting therefrom, is an old aspiration of the Brazilian hydrologic community. Several treaties, committees and commissions aiming at this are already in operation, and the process should culminate in the editing of a Law for the National Policy on Hydrological Resources and the Management of Water Resources.

### **WATER: AN ECONOMIC AND STRATEGIC GOOD**

Water was conventionally considered an **ECONOMIC GOOD**, in the International Conference on Water and the Environment, held in DUBLIN, Ireland, 1992. Considering that water is a **MINERAL GOOD** and that in certain conditions of nature it is also an **ENERGETIC GOOD (HYDRAULIC POTENTIAL)**, it assumes a Strategic Role for the Countries, especially in Brazil.

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