History of studies on Belo Monte hydroelectric power plant

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(With 4 figures)

The first technical and scientific surveys about the natural attributes of the region of the Hydroelectric Power Station - HEPS Belo Monte started in the 1970's, with studies of the Hydroelectric Inventory of the *Xingu* River Basin.

At that time, 47 places for the damming were identified, which converged to 14 places that underwent more detailed investigations about the hydroenergetic potential of Xingu River. The hydroelectric inventory studies were completed in 1980 and, in the first years of this decade, there was a reorientation of the studies for the viability of Altamira Complex with emphasis on Belo Monte HEPS (Eletrobras, 2009). Several hydroenergetic alternatives were investigated that had the area of Volta Grande do Xingu as main place, due to unevenness of the stretch (gross head of approximately 94 m) and great volumes of water of Xingu River (average annual flow of 8,600 m^3/s), (Figure 1).

Thus, Altamira complex (formerly Babaquara) and Belo Monte (formerly Kararaô) were recommended, with the former, as holding about 70% of the potential for the production of energy, being indicated for the viability studies, the total production of which at the time was of 17.000 MW (Eletronorte, 1980).

Kararaô HEPS, chosen as a priority due to its technical, economic and environmental characteristics, had its studies maintained, while those on Babaquara HEPS were interrupted for review of the fall of Xingu River Basin, mainly due to environmental problems. Based on Resolutions CONAMA 01/86 (Brasil, 1986) and 06/87 (Brasil, 1987), in 1988 the first Study of Environmental Impacts were consolidated with consideration of methodological and scientific guidelines of SESPA – Secretary of Health of the State of Pará that was the organ in charge of the environmental license of the project and followed the elaboration of studies and technical multidisciplinary seminars for its achievement (CNEC, 1988).

Field surveys were begun in 1985 and concentrated on the following environmental aspects: physical environment (geology, geomorphology, grounds, hydrology, climatology), forest and floristic inventories, ground fauna, aquatic fauna, limnology and water quality, aquatic invertebrate and ictyofauna. A comprehensive diagnostic of the area was consolidated and, at that time, an agreement with the Brazilian Academy of Science (ABC) was established for surveys on the fauna, with specific campaigns performed in the years 1986 and 1987. The following institutions participated in the fauna and flora studies: Museu Paraense Emílio Goeldi - MPEG (flora, primates), Smithsonian Institution (mammals, birds, reptiles, amphibians and water insects), University of California and Universidade de Campinas (amphibians) and Museu de Zoologia de São Paulo (fish).

In 1994 a work group was created with Eletronorte, Eletrobrás and DNAEE technicians to update and complement the viability study and propose the modification of the arrangement of Hydroelectric Utilization - HEU Kararaô. This change meant the deviation of the dam 70 km upstream (Ilha Pimental), anticipating the creation of two delivery canals and reduction of the reservoir of 1,225 km^2 to about 500 km^2, with consequent reduction of interference in indigenous lands (Eletrobras, 2009), Figure 2.

Resumption of studies of viability of Belo Monte HEPS, considering the current arrangement, occurred in 1999, and was possible due to the formalization of agreements among Eletrobrás, private companies and institutions of teaching and research. Due to the date of the first studies of the hydroelectric inventory of the Xingu River Basin (from 1975 to 1980) and the legislation in force at the time, the review of those inventory studies became necessary, incorporating the proposed solution for the HEU Belo Monte on the 2nd stage of its Studies of Viability and restudying the use on the stretch upstream of Xingu River.

In this context, according to the Manual of the Hydroelectric Inventory of 1997 River Basins – ELETROBRAS/DNAEE guidelines (Eletrobras, 1997), the various Units of Conservation (UC) and Indigenous Lands (IL) present in the river basin should be considered as environmental determinants, thus being necessary to define a fall partition for Xingu River, considering not only the energetic and economic aspects, but also, and above all, those inherent to social and environmental questions.

Therefore, the second stage of the technical viability studies of the project began in the beginning of year 2000, when new field surveys on local social and environmental conditions were performed (Eletrobrás, 2002). However, before these studies were completed, in 2001 the Public Prosecutor's Office filed a judicial motion. The studies were resumed only in the middle of the year 2005, with the beginning of elaboration of an EIS (Environmental Impact Study) and RIMA (Environmental Impact Report) according to the Project Concept Anticipated in the Viability Studies (Eletrobras, 2002, 2007) of the year 2001 that maintained its utilization considering 90 meters of unevenness all over 150 km of the region of Volta Grande do Xingu. With an installed total capacity of 11,233.1 MW and the prediction of formation of two reservoirs, one on dry land and the other on the channel of Xingu River, the differential of the proposed arrangement for Belo Monte HEPS is based

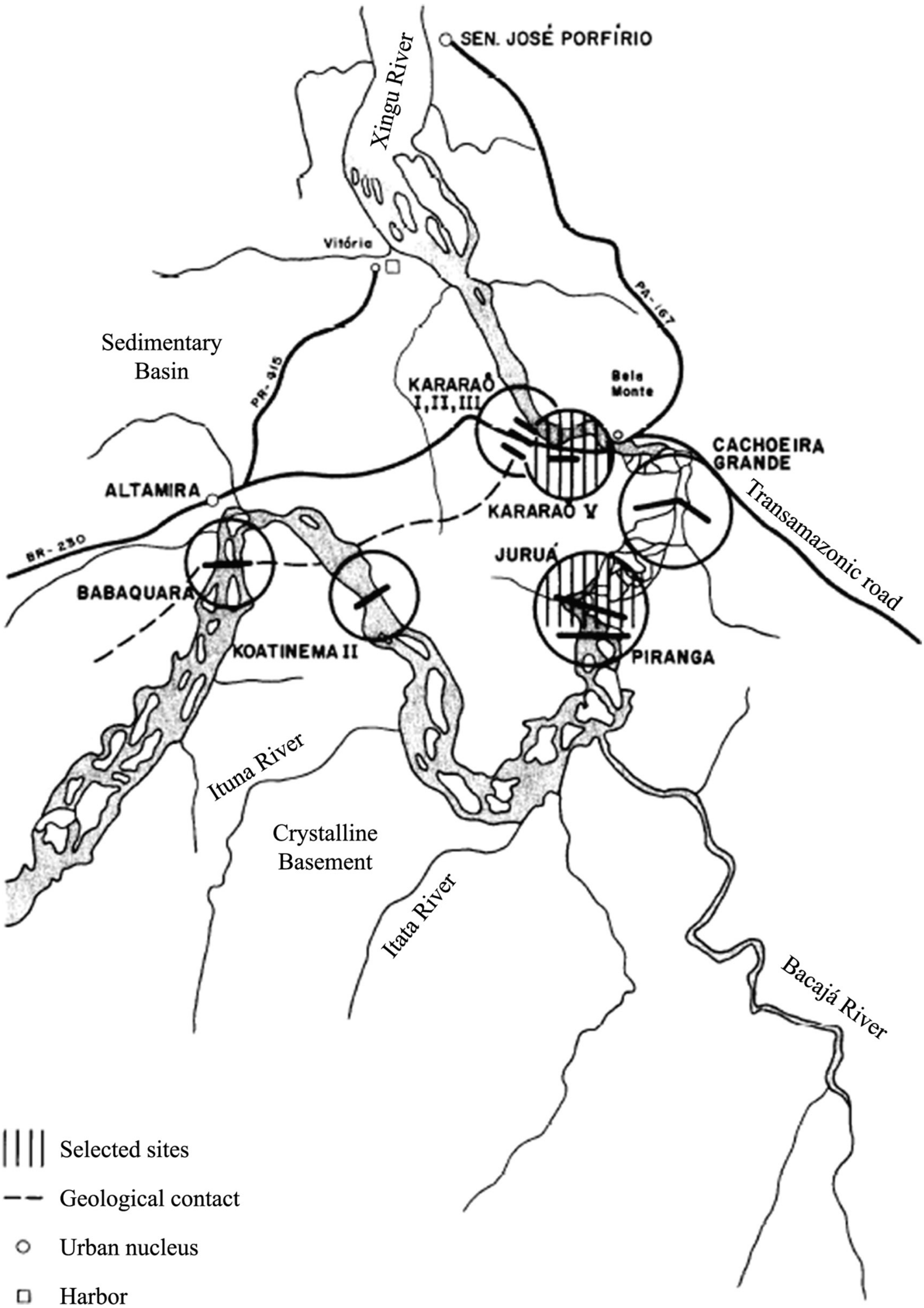

Figure 1. Indication of selected sites for the study of the first EIA elaborated in 1988 (Source: CNEC, 1988).

on a run-of-the-river power station, with no capacity for water reserve. Two powerhouses are being installed: the main one at Belo Monte has an installed power of 11,000 MW composed of 18 Francis turbines, and the supplementary powerhouse, in the site of Pìmental, with a generation capacity of 122.1 MW, with six generating units of Bulbo type.

The maximum normal water level designed for both reservoirs is of 97 meters and the total area is of almost 500 km^2, with half of this area corresponding to the natural channel of Xingu River (Figure 3). Xingu River diversion will be made by a delivery canal of 20 km of length, which will form the Intermediate Reservoir on dry land. The water will be given back to the river 100 km downstream in Belo Monte, and the stretch with reduced flow – RFS in the region of Volta Grande will have monthly flows to keep system sustainability.

In the years 2005 and 2006 several interruptions in the studies took place due to legal actions proposed by the Public Prosecutor's Office, and its continuity was authorized after the revocation of the preliminary injunction in December 2006. In the following year, IBAMA published a Reference

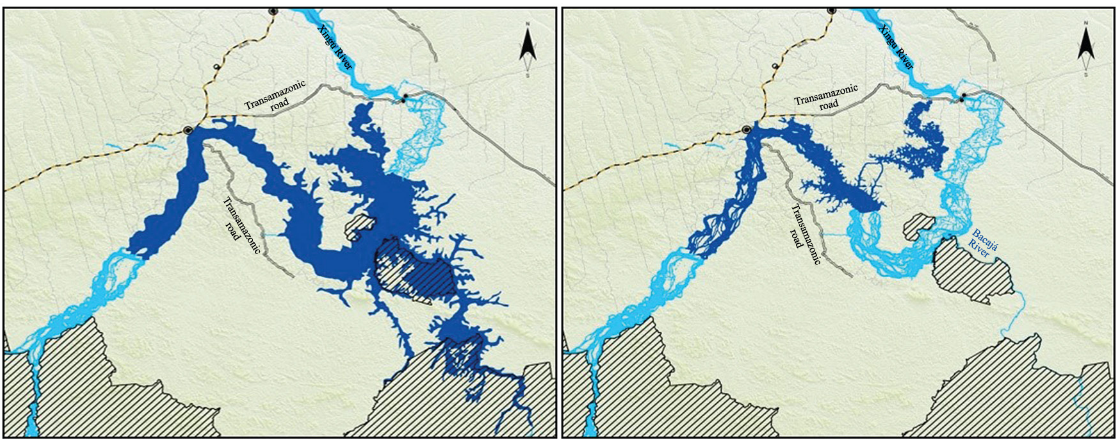

Figure 2. The illustration on the left indicates the proposal of Kararaô arrangement (of 1989) with an estimated area of flooding of 1,225 km^2 for 500 km^{2-} indicated on the right illustration, current arrangement of Belo Monte HEPS. The grey hatching areas are in Indigenous Lands (Source: Norte Energia, 2011).

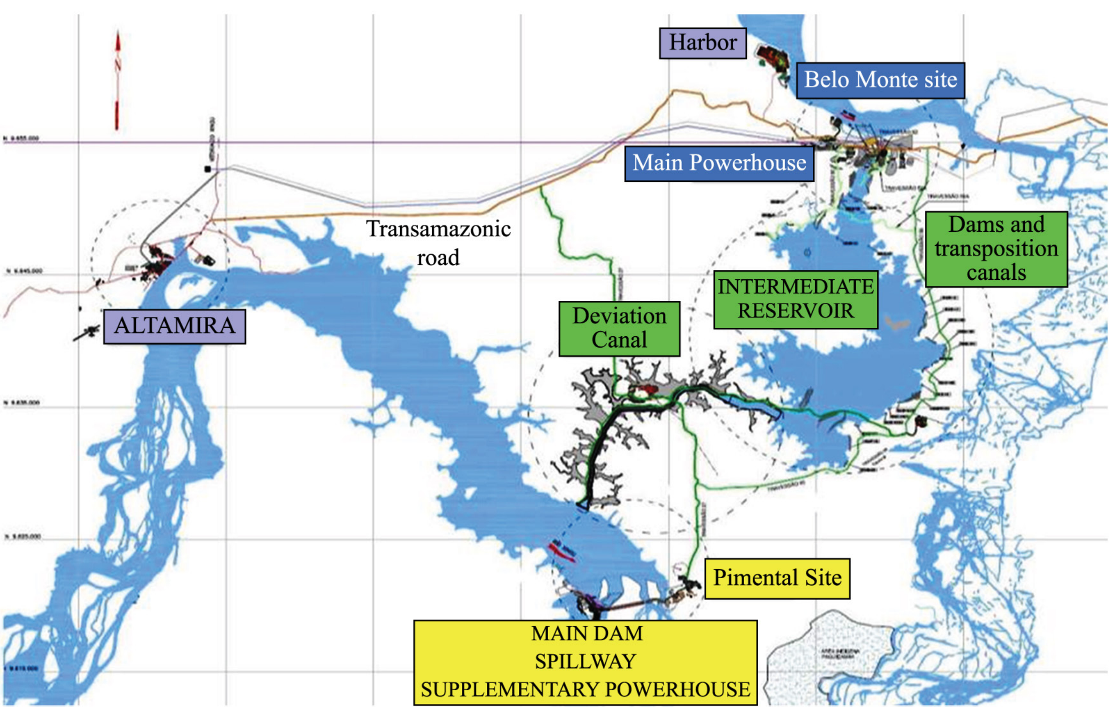

Figure 3. Global view of the main sites of Belo Monte HEPS and two reservoirs that will be formed, as well as the stretch with reduced flow.

Term for the elaboration of the EIS and of the RIMA of Belo Monte HEPS.

The development of environmental studies of the project considered four coverage areas: directly affected area - DAA, area of direct influence - ADI, area of indirect influence – AII (Figure 4) and a regional coverage area - RCA, with the primary surveys of the biotic and physical environments being performed under the scope of the first three. DAA consists of constructive sites, reservoirs, stretch of reduced flow. The regional coverage area involved all the Xingu River basin and was characterized based on secondary surveys.

To make the region diagnosis, field inspections and complementary topographic, bathymetric, and hydrosedimentometric surveys, surveys of regional and local geological-geotechnical conditions were performed, forming a database that allowed the physical characterization of the region. Surveys of the fauna, flora, ictyofauna, as well as limnologic studies and those of water quality were part of the environmental diagnosis and of the resulting assessment of environmental impacts focusing important biological aspects. Besides the environmental studies, energetic studies on the development of the arrangement, as well as global costs and corresponding benefits, were performed. Based on a broad and robust diagnosis the development of prognosis and analyses of environmental impacts was made possible. The strategy for study conduction, the involvement of institutions of scientific and technical excellence allowed the elaboration of a complete and robust document, whose contribution for knowledge of the region natural resources has helped on decision making on the part of the entrepreneur and of the institutions involved in the implementation of Belo Monte HEPS.

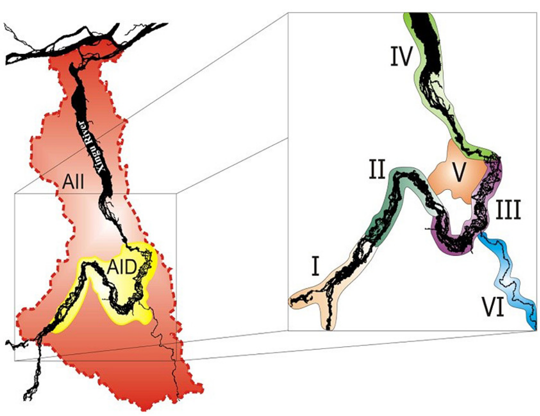

Figure 4. Areas of indirect (in red) and direct (in yellow) influence and the river classification in sectors to guide water fauna and flora data surveys.

EIS/RIMA that concluded for the social and environmental viability of the project was consolidated in December 2008 and protocoled at IBAMA in February 2009. On February 1, 2010 the Previous License – LP No. 342 was issued, and on June 6, 2011, after the analysis and approval of the Basic Environmental Project – BEP, the LI No. 795 was issued by IBAMA, which authorized the installation of the main constructions of Belo Monte HEPS. The BEP was structured on 117 projects that provide the monitoring and development of studies to focus on the three environments: physical, biotic, and social and economic, intending to control, mitigate, and compensate the impacts caused by the implementation of Belo Monte HEPS.

In 2011 the monitoring of various zoological and flora groups was started, as well as the studies involving hydrologic, hydric and hydraulic aspects of the region for project insertion. Nowadays, it is possible to indicate the existing biological and ecological patterns, such as wealth, diversity, similarity, among others. These patterns will help to confirm or not the impact analysis results performed under the scope of the EIS, as well as the establishment of measures for mitigation, control and even compensation of these impacts.

More than 30 institutions are involved in the process of implementation of the project, both from private and public initiatives, focused on the generation of technical and scientific knowledge. Table 1 exemplifies the progress of knowledge on the wealth of species over time, demonstrating the effort applied to date to know the region of insertion in the Belo Monte HEPS.

For invertebrates, it was not possible to compose a comparison of species wealth, since the groups that are monitored in BEP, drosophilides and native bees, were not a target of previous surveys. However, it is important to highlight that 89 species/morphospecies of drosophila have already been inventoried in the region of the project and

Table 1. Progress of knowledge about the total wealth of species for the fauna groups studied in the three following occasions: 1988 EIS, EIS consolidated in 2009 and the results of BEP, after three years of specific monitoring.

Component studied*	EIS/88	EIS/2009	BEP/2015
Flora	1,190	1,067	1,291 (estimated)
Terrestrial mammals	48	42	48
Chiroptera	58	72	78
Birds	260	461	545
Reptiles	Not specified	75	114
Amphibians	Not specified	64	102
Fish	94	387	458

*only the biotic components that were inventoried in the three occasions, 1988 EIS, 2009 EIS and monitoring studies of BEP were considered.

133 species/morphospecies of native bees. Currently, the species that indicate both the vertebrate and invertebrate fauna are being established to integrate the set of attributes to be considered in the analysis of environmental sustainability of the region during the project operation.

Finally, several new species have been collected in the region and are under a process of description, highlighting fish species, cave-dweller organisms and plant species. In this case, about 15% of the 1,291 species are considered new for science and are under a process of identification by the national and international scientific community, partners in the project.

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