Photo: Luciana Aparecida Magalhães

Biodiversity Report
2014

Companhia Energética de Minas Gerais – Cemig

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Message from the Corporate Sustainability Superintendence

With a predominantly renewable energy matrix, there is an intrinsic relationship between Cemig and natural resources. The Company's operations cover two terrestrial *hotspots* (highly threatened areas that are biologically very important to the entire planet): Cerrado and Atlantic Forest and the aquatic environment where we are responsible for the management of 2,148.5 km² of fresh water in our reservoirs.

Recognizing, evaluating and responsibly managing environmental impacts in the design, implementation and operation phases of enterprises are processes that Cemig has improved since the company's founding. Thus, there is synergy between the research, innovation, and practice of solutions, which aligned with competence, add value to the company and biomes where we are present.

The Company operates in distinct businesses, and for each enterprise, specialized studies are conducted that characterize, evaluate and establish environmental programs aimed at the mitigation, compensation and control of negative impacts while maximizing the positive ones, according to their nature.

As a result of our sustainable actions, we are very proud to have been included once again in the Dow Jones Sustainability World Index - DJSI World. The Company has participated for 15 consecutive years, which represents the global recognition of our sustainable management practices in their social, economic and environmental dimensions. Cemig's recognition as a sustainable company is also apparent by our inclusion in the Corporate Sustainability Index (ISE) for the 9th consecutive year, which we have participated in since its creation in 2005.

Luiz Augusto Barcelos Almeida

Message from the Environmental Management Superintendence for Generation and Transmission

In the 62 years since Cemig was founded, it has established itself as a nationally and internationally recognized company and become a reference in the electricity sector in all of its areas of operation.

The Cemig brand is a reference of quality for the whole society. In addition, within the context of the environment and sustainability, Cemig is a pioneer with a robust portfolio of achievements, which make it one of the leading companies in the world as shown by its 15th consecutive year in the Dow Jones Sustainability World Index and 9th consecutive year in the Corporate Sustainability Index - ISE/BM&FBOVESPA.

Even before environmental legislation was implemented in Brazil, Cemig had already been developing actions related to environmental protection and biodiversity such as projects to rescue fauna when filling reservoirs and the voluntary deployment of conservation areas like Peti, where environmental studies and methodologies have been developed in collaboration with professors from various institutions, and today, form the basis for generating knowledge adopted in environmental licensing.

Cemig is one of the largest generators of environmental scientific knowledge in its area of operations. In developing environmental studies for licensing, Cemig studies the social, physical and biotic aspects of the environment in partnership with educational and research institutions, providing the whole society with valuable information about the world we live in.

By deploying conservation areas, we protect important ecosystems and preserve local biodiversity.

By developing various environmental programs and actions, in addition to recovering and conserving ecosystems, we improve local and regional socioenvironmental conditions.

Furthermore, we practice citizenship by working on these issues and interacting with all social segments involved.

Enio Marcus Brandão Fonseca

1. Biodiversity

Biodiversity or biological diversity is a topic that has gained attention ever since the World Conference on Environment and Development (CNUMAD or Rio-92), which brought together thousands of people representing governments and people from hundreds of nations. The CONVENTION ON BIOLOGICAL DIVERSITY (CBD), a global basic framework for addressing the issue, was signed during the event. It is recognized that the concept of biodiversity varies in different sectors; however, according to the CBD, there is always emphasis on *the variability of live organisms of any origin, including, among others, land, marine and other aquatic ecosystems and ecological complexes composing them*. *This also includes the diversity of each species, among species and ecosystems.* Depending on the sectors involved in the discussion, it should be noted that biodiversity is seen as a resource, a property of life or a fundamental factor for human survival itself.

Did you know that the word Biodiversity, also known as biological diversity, means "variety of life" and encompasses a wealth of species and large number of existing ecosystems? This term is widely used in the area of biology to indicate a large quantity of microorganisms as well as existing fauna and flora on planet Earth.

The Convention aims at the conservation and sustainable use of biological diversity and fair and equitable sharing of benefits that arise from its use. Some of the commitments made by the signatories include the development of strategies, plans, programs and relevant sectoral and intersectoral policies, in addition to the adoption of economically and socially rational measures that promote conservation and sustainable use of biological diversity.

As the absolute champion of terrestrial biodiversity, Brazil brings together nearly 12% of all natural life on the planet. It concentrates 55,000 species of higher plants (22% of all that exist in the world), and many of them endemic, 524 species of mammals, more than 3,000 species of freshwater fish, between 10 and 15 million insects (the vast majority yet to be described), and more than 70 species of *Psittacidae*: macaws, parrots and parakeets (www.conservation.org.br). Brazil and other tropical countries are home to areas considered biodiversity *hotspots* in the world. (Myers *et al*., 2000). A mere 17 countries account for nearly 70% of the planet's biodiversity, and among them, Brazil and Indonesia are the two largest mega-diverse countries in the world (www.megadiversidade.com.br/Brasil.htm). Cemig operates in two main hotspots: Cerrado and Atlantic Forest, and in 2,148.5 km^2 of freshwater.

After extensive consultation with the company, the Brazilian Ministry of the Environment (MMA) elaborated legal framework for biodiversity management in Brazil called the National Biodiversity Policy (NBP), a process that resulted in the publication of Decree No. 4.339 of August 22, 2002.

The main objectives of the NBP are to promote the integration of policies between the national government and the company, foster interinstitutional and international cooperation to improve the deployment of biodiversity management actions, know, conserve and

appreciate biological diversity, protect important natural areas, promote sustainable use of biodiversity, respect, preserve and encourage the use of knowledge, innovation and practices of traditional communities.

In order for these objectives to actually be implemented and to fill gaps in biodiversity management in the country, between 2004 and 2005, the Brazilian Ministry of Environment in conjunction with the country's management sectors of biodiversity coordinated the formulation of the- Priorities and Guidelines for the Action Plan to Implement the NBP (PAN-Bio). The application of the PAN-Bio is based on seven basic components, which take into account the different ways of approaching the biodiversity situation in Brazil.

1 – Knowledge on biodiversity

2 – Biodiversity conservation

3 – Sustainable use of biodiversity components

4 – Monitoring, assessment, prevention and mitigation of impacts on biodiversity

5 – Access to genetic resources, associated traditional knowledge, benefit sharing

6 – Education, public awareness, information and dissemination on biodiversity

7 – Legal and institutional strengthening for biodiversity management.

2. Introduction

Cemig is one of the most important and solid groups in the electricity sector in Brazil with the responsibility for the operation of consortia and 70 of its own plants. A public company controlled by the state government of Minas Gerais, Cemig has 115,000 shareholders in 44 countries. The Cemig group has more than 200 companies and 17 consortia. Its shares are traded on the stock exchanges of São Paulo, New York and Madrid. Today, the company is a reference in the global economy and recognized for its sustainable operations. It is in its 15th consecutive year in the *Dow Jones Sustainability World Index (DJSI World),* and its 9th year in the Corporate Sustainability Index.

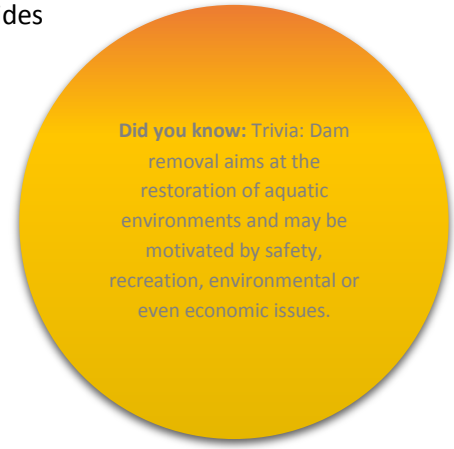
Cemig's generation park (MW)						
Stage	**HPP**	**SHP**	**Aeolic**	**Solar**	**TPP**	**Total**
Operating	6.721	194	70	1	184	7.170
Under construction/Contracted	1.126	29	105	1	-	1.261
Under development	7.068	191	1.271	36	1.500	10.066
Total	14.915	414	1.446	38	1.684	18.497

HPP – Hydroelectric Power Plant
SHP – Small Hydroelectric Plants
TPP – Thermoelectric Power Plant

Table 1. Cemig's generation park

To create strategies that are more effective and support environmental conservation programs, Cemig establishes partnerships with research centers. The objective is to obtain scientific knowledge about biology, ecology, physiology, water quality, behavior of native fish species, control of invasive species, and the preservation and restoration of riparian vegetation. For this to happen, Cemig encourages an ongoing exchange of experiences between its technical teams and universities, and provides logistical support and resources for conducting research.

Some of the projects are developed together with the research and development (R&D) program at the National Electric Energy Agency (ANEEL) and others with the company's own resources. The R&D program was regulated to encourage the search for innovation and face the technological challenges of the electricity sector.



3. Cemig's Biodiversity and Environmental Policies

In 2010, Cemig published it biodiversity policy in order to formalize the principles that have guided the company's actions concerning biodiversity conservation. To develop the policy, the company opted for a participatory process with its stakeholders in order to involve them in the formulation of its business strategy, and in which various workshops were conducted to consolidate it.

The policy is based on the United Nations (UN) Convention on Biological Diversity and includes topics such as the protection of vulnerable areas, endangered species and engaging stakeholders in the development and implementation of programs focused on biodiversity conservation.

Cemig's commitment and response to biodiversity conservation are structured in the order below to allow the company to identify, control and mitigate the impacts of its current and future ventures: Policy, Planning, Program, Projects, Management and Monitoring.

This commitment also involves its environmental policy in which the efficient use of natural resources is its basic premise. Thus, the company uses its biodiversity and environmental policies to guide environmental management in all of its operating units so that in the analysis of its environmental impacts, actions can be implemented for natural resource and biodiversity conservation.

Did you know: The biggest responsibility for the preservation of biological diversity rests on the seventeen megadiverse countries, which together, are home to approximately 70% of the living species on the planet. They are represented by the following countries: South Africa Australia, Brazil, China, Colombia, Ecuador, United States, Philippines, India, Indonesia, Madagascar, Malaysia, Mexico,

The Biodiversity Report represents the materialization of Cemig's commitment to transparency toward its stakeholders by publishing the company's actions concerning biodiversity conservation.

4. Main environmental impacts of hydroelectric plants on aquatic and terrestrial ecosystems

As previously mentioned, hydroelectric power represents 96.6% of Cemig's installed capacity. However, water is a resource that is extremely sensitive to climate variations, vulnerable to the consequences of exploitation of other natural resources, deeply affected by anthropic activities and subject to a regulatory environment, which makes the management and conservation of this resource highly important to the company.

The Brazilian electricity sector has faced various environmental issues affecting aquatic ecosystems during the planning, deployment and operation of hydroelectric projects. We can highlight that the main impacts on aquatic fauna are related to the loss and degradation of habitats, overexploitation of species, pollution, and introduction of exotic organisms. The shift from a lotic to lentic environment, reduction in nutrient concentrations, and increase or decrease in water clarity affect the structure of the fish community with the gradual replacement of commonly found species for fish better adapted to the lake environment formed. Dams constitute a barrier to migratory species when they move upstream in the river searching tributaries and lagoons to reproduce. These environments serve as a nursery for fish eggs and larvae to allow them to grow and develop. Furthermore, when there is an elevated density of fish in the discharge tailrace, maneuvers performed in the power plants (for example, turbines startup / stop) may present a risk of fish kill. Downstream of dams, there is gas supersaturation due to the merging of atmospheric gases from the operation of the spillway and turbines, changes in water flow, impact on some fish species as a result of turbine and spillway operations, interception of fish migratory routes, increased predation near dams due to the flood control regime and high density of fish that accumulate in the area.

Did you know: That: Brazil focuses around 12% of the world's fresh water available in rivers and home to the largest river in extent and volume of the planet, the Amazon. In the systematic management of water resources, aspects of quality and quantity can not be separated, since the concentration of pollutants is directly related to the flow of the water body.

Another important aspect for the deployment and operation of hydroelectric power plants is the need to convert large areas into reservoirs with the task of diverting water from the river to the intake structures of the machines, as well as ensuring the drop needed to produce energy.

In this process, vast areas of vegetation, whether native or cultivated, need to be removed, because otherwise, flooding in these areas and the future decomposition of a large volume of

organic material can lead to eutrophication, which comprises water quality causing death to aquatic fauna in addition to the unfeasibility of its use for water supply, irrigation, and bathing.

Vegetation removal causes a reduction in the genetic variability of forest species and increases the edge effect on surrounding massifs. For terrestrial fauna, their habitats are reduced causing them to be driven out and/or relocated to surrounding areas, which puts pressure on resources and leads to food shortages and increased predation, therefore reducing displaced populations.

Aware of the impacts caused by their activities, Cemig has created programs in line with the guidelines of the company's biodiversity policy to monitor, manage and conserve species, whether aquatic or terrestrial, and create strategies that are more efficient for their conservation.

5. Monitoring, management and conservation programs

5.1. Aquatic Ecosystems

Fundamental to maintaining biodiversity, all natural cycles, and preserving life itself, water has become an increasingly strategic resource for humanity. Aquatic biotas have great genetic diversity and play a very important role as energy transfer links in food chains, biogeochemical cycles, and processes of fragmentation and decomposition of organic material. They also contribute by indicating changes in the structure and dynamics in the metabolism of water systems.

Apart from participating in basic processes, some groups (algae, macrophytes, rotifers, and macroinvertebrates) are sensitive to environmental changes and have been proposed and used as bioindicators. Other groups even include vector species that transmit waterborne diseases and invasive species such as the mytilid mussel, golden mussel (*Limnoperna fortunei*) and various macrophyte species that cause significant ecological and economic impact.

Fish are also important in the aquatic environment given that they indicate changes in the structure and biological composition of the environment. Consumers of various food sources such as zooplankton, phytoplankton, zoobenthos and even macrophytes, fish survival depends on maintaining the integrity of aquatic environments. In addition, many fish species are highly sensitive to changes in the water's physicochemical parameters and disappear from some polluted or contaminated rivers.

Interactions between groups of aquatic organisms and limnological conditions of watercourses reinforce the importance of Cemig's environmental programs in preserving the environment. The ongoing management of monitoring programs is considered an essential tool in the identification and collection of information to evaluate and control environmental impacts in all stages of their ventures - from concept design to operation.

Thus, through its monitoring, conservation and management programs and research projects, Cemig has contributed to:

- Inventory biodiversity around their ventures
- Minimize environmental impacts that reflect negative effects on biological diversity

- Ensure that there are minimization and/or compensation measures for species of fauna affected by the company's activities and those at risk of national or global extinction.
- Assist in interpreting data collected and informing environmental agencies of imminent or serious risks of damage to biological diversity
- Establish relevant technologies and methodologies through research and development projects in order minimize loss of biological diversity
- Restore populations of ecologically relevant aquatic organisms, affected negatively by the developments, through restocking
- Maintain the operation of efficient systems that ensure genetic exchanges between individuals through communication between upstream and downstream populations.
- Recommend the transfer of biological resources from natural habitats for the purpose of *ex situ* conservation in order to prevent threats to in situ ecosystems and populations of species
- Make an information system available on the water quality of Cemig's reservoirs (Siságua) that allows gathering, operationalizing and providing information collected during monitoring.

The programs developed at Cemig promote wide access to data and information on aquatic biota in a free and open manner, thus encouraging the consolidation of an integrated information network on biodiversity in Brazil.

Furthermore, they allow for the conservation of aquatic resources and adoption of important restoration measures for communities in view of the responses obtained from executing the programs. Investments made by the company have brought significant results in the prevention and mitigation of environmental risks, mainly due to careful evaluations and intensive activities on different environmental aspects.

5.1.1. Water Quality Monitoring Program

Currently, Cemig monitors the water quality of the reservoirs at its hydroelectric plants with a sampling network with more than 200 collection points. This monitoring system integrates physical and chemical aspects, which provide momentary information about the system, as well as biological aspects that reflect the ecological integrity of the ecosystems and respond to a range of disturbances. The system summarizes the history of environmental impacts.

An integrated approach to these methodological aspects have made it possible to diagnose and measure the physiochemical changes in the water in addition to changes that take place in the composition and structure of aquatic communities in temporal and spatial scales resulting from changes in the environment.

At the same time, routine monitoring promotes the inventory of aquatic fauna and flora, which contributes to a better understanding of the occurrence and distribution of species in phytoplankton, zooplankton and benthic macroinvertebrate communities.

The Siságua database assures differentiated management in publishing monitoring data, as well as the generation of fast, accurate and especially useful information. This information system has made historical data dynamic by allowing for the acquisition, storage, handling, integration, and display of water quality results, especially physiochemical information. These results are available on the Internet.

Siságua is configured in a proposal of relevant socioenvironmental and strategic importance since it allows all users of the watersheds where Cemig has power plants to monitor projects in a fast way with regular updates, and even have access to the history of monitoring data. In addition, it allows researchers and environmental agencies to have easy access to data generated while monitoring Cemig's water quality. It enables potential partnerships to preserve water bodies and conserve fishing resources in line with the population's growing demand for water.

To search on Siságua and learn more, simply click: www.cemig.com.br > Cemig and the Future > Sustainability > Water Resources > Water quality in Cemig's reservoirs > Siságua or simply type www.cemig.com.br/sag.

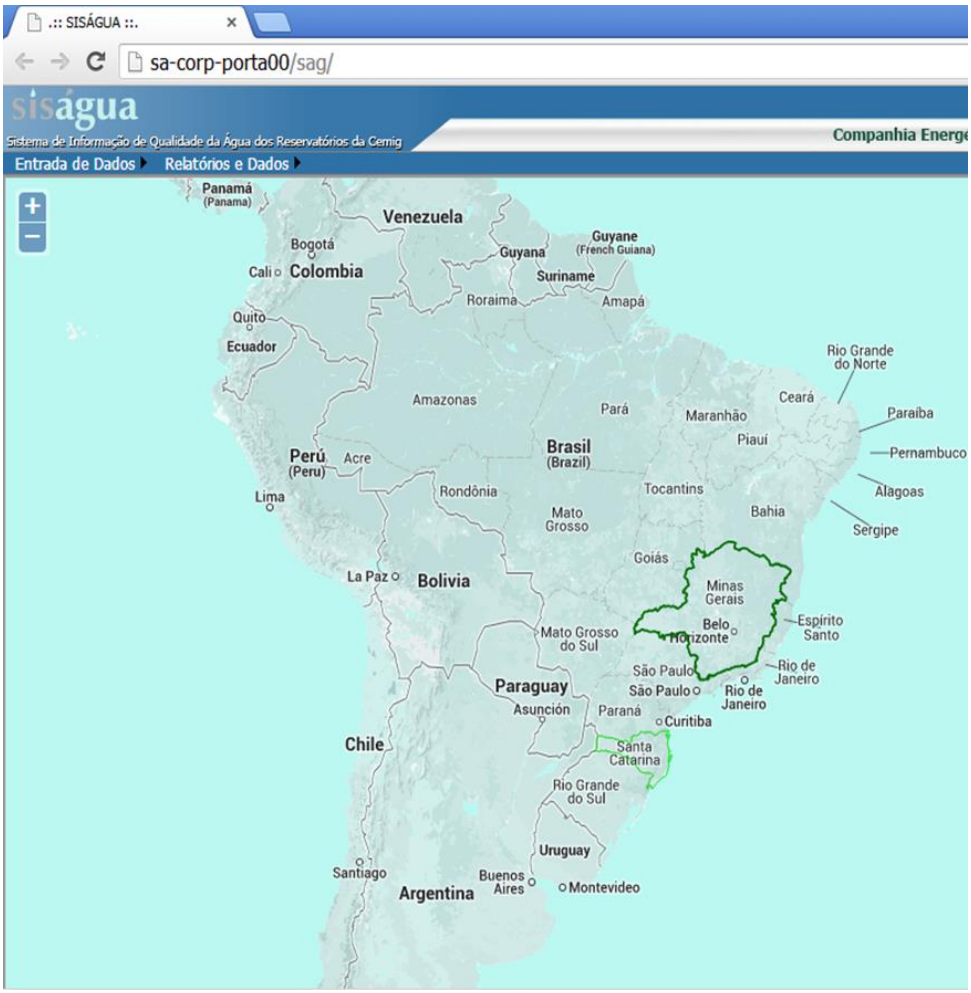


Figure 1. Illustration of the home page for access to Siságua

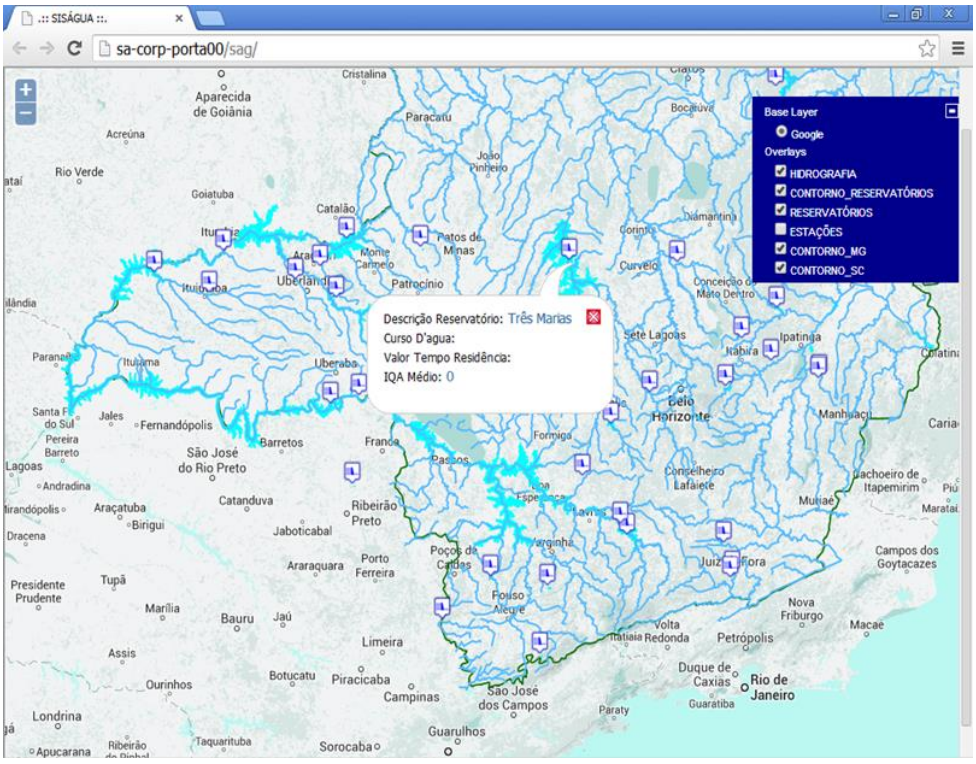
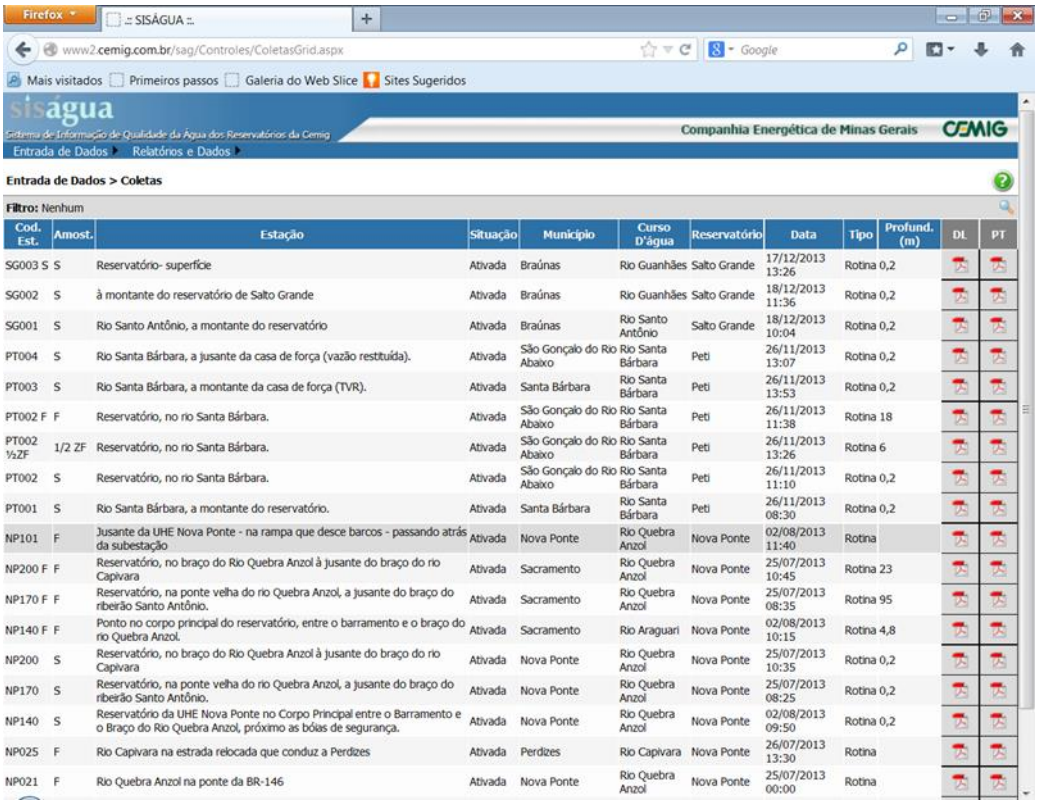


Figure 2. Interactive search map showing Cemig's reservoirs



Cod. Est.	Amost.	Estação	Situação	Município	Curso D'água	Reservatório	Data	Tipo	Profund. (m)	DL	PT
SG003 S	S	Reservatório- superfície	Ativada	Braúnas	Rio Guanhães	Salto Grande	17/12/2013 13:26	Rotina	0,2		
SG002	S	à montante do reservatório de Salto Grande	Ativada	Braúnas	Rio Guanhães	Salto Grande	18/12/2013 11:36	Rotina	0,2		
SG001	S	Rio Santo Antônio, a montante do reservatório	Ativada	Braúnas	Rio Santo Antônio	Salto Grande	18/12/2013 10:04	Rotina	0,2		
PT004	S	Rio Santa Bárbara, a jusante da casa de força (vazão restituída).	Ativada	São Gonçalo do Rio Abaixo	Rio Santa Bárbara	Peti	26/11/2013 13:07	Rotina	0,2		
PT003	S	Rio Santa Bárbara, a montante da casa de força (TVR).	Ativada	Santa Bárbara	Rio Santa Bárbara	Peti	26/11/2013 13:53	Rotina	0,2		
PT002 F	F	Reservatório, no rio Santa Bárbara.	Ativada	São Gonçalo do Rio Abaixo	Rio Santa Bárbara	Peti	26/11/2013 11:38	Rotina	18		
PT002 ½ZF	1/2 ZF	Reservatório, no rio Santa Bárbara.	Ativada	São Gonçalo do Rio Abaixo	Rio Santa Bárbara	Peti	26/11/2013 13:26	Rotina	6		
PT002	S	Reservatório, no rio Santa Bárbara.	Ativada	São Gonçalo do Rio Abaixo	Rio Santa Bárbara	Peti	26/11/2013 11:10	Rotina	0,2		
PT001	S	Rio Santa Bárbara, a montante do reservatório.	Ativada	Santa Bárbara	Rio Santa Bárbara	Peti	26/11/2013 08:30	Rotina	0,2		
NP101	F	Jusante da UHE Nova Ponte - na rampa que desce barcos - passando atrás da subestação	Ativada	Nova Ponte	Rio Quebra Anzol	Nova Ponte	02/08/2013 11:40	Rotina			
NP200 F	F	Reservatório, no braço do Rio Quebra Anzol à jusante do braço do rio Capivara	Ativada	Sacramento	Rio Quebra Anzol	Nova Ponte	25/07/2013 10:45	Rotina	23		
NP170 F	F	Reservatório, na ponte velha do rio Quebra Anzol, a jusante do braço do ribeirão Santo Antônio.	Ativada	Sacramento	Rio Quebra Anzol	Nova Ponte	25/07/2013 08:35	Rotina	95		
NP140 F	F	Ponto no corpo principal do reservatório, entre o barramento e o braço do rio Quebra Anzol.	Ativada	Sacramento	Rio Araguari	Nova Ponte	02/08/2013 10:15	Rotina	4,8		
NP200	S	Reservatório, no braço do Rio Quebra Anzol à jusante do braço do rio Capivara	Ativada	Nova Ponte	Rio Quebra Anzol	Nova Ponte	25/07/2013 10:35	Rotina	0,2		
NP170	S	Reservatório, na ponte velha do rio Quebra Anzol, a jusante do braço do ribeirão Santo Antônio.	Ativada	Nova Ponte	Rio Quebra Anzol	Nova Ponte	25/07/2013 08:25	Rotina	0,2		
NP140	S	Reservatório da UHE Nova Ponte no Corpo Principal entre o Barramento e o Braço do Rio Quebra Anzol, próximo as bóias de segurança.	Ativada	Nova Ponte	Rio Quebra Anzol	Nova Ponte	02/08/2013 09:50	Rotina	0,2		
NP025	F	Rio Capivara na estrada relocada que conduz a Perdizes	Ativada	Perdizes	Rio Capivara	Nova Ponte	26/07/2013 13:30	Rotina			
NP021	F	Rio Quebra Anzol na ponte da BR-146	Ativada	Nova Ponte	Rio Quebra Anzol	Nova Ponte	25/07/2013 00:00	Rotina			

Figure 3. Monitoring data that can be viewed in PDF files

5.1.2. Peixe Vivo Program

Cemig launched the Peixe Vivo program in June 2007 and has been active in expanding and creating more effective measures for the conservation of ichthyofauna in river basins where the company's power plants are installed. This benefits the communities that use water resources as a factor in development. With the help of various segments of the community that have helped in planning prevention alternatives to

Cemig's environmental policy, the Peixe Vivo program operates on three fronts: programs for the conservation of ichthyofauna and watersheds, production of scientific knowledge to support these programs, and promotion of community involvement in planned activities.

In addition to promoting the growth of scientific research and knowledge on ichthyofauna in Brazil, the Peixe Vivo program values biological diversity and seeks to conserve natural environments. These important objectives are established in the National Biodiversity Policy. Adopting scientific criteria for decision making, establishing partnerships with other institutions and modifying practices adopted with the information generated are the principles that the team of the Peixe Vivo program use as a guide for their work. Moreover, it is very important to disseminate the information generated for the company in order to ensure transparency in the program and create opportunities for the community to voice their concerns and provide feedback. Below are environmental programs that the team of the Peixe Vivo program run and/or support.

5.1.2.1. Native Fish Stocking Program

Cemig's fish stocking program includes activities carried out by three of its own fish culture stations, Volta Grande, Itutinga and Machado Mineiro, and in 2012-2013, three partner stations, Gorutuba, Tres Marias (partnership with CODEVASF) and Epamig of Leopoldina.

During the 2011-12 and 2012-13 harvests (harvest corresponds to the period from November to October of the following year), Cemig's stocking program produced the following species:

Fish Culture Stations	Species
Estação de Piscicultura de Volta Grande	Curimba (*Prochilodus lineatus*) Piracanjuba (*Brycon orbignyanus*) Piapara (*Leporinus elongatus*)
Estação de Piscicultura de Itutinga	Curimba *(Prochilodus lineatus*) Dourado (*Salminus brasiliensis*) Piapara (*Leporinus elongatus*) Piracanjuba (*Brycon orbignyanus*)
Estação de Piscicultura de Machado Mineiro	Curimba (*Prochilodus hartii*) Piabanha (*Brycon* sp.) Piapara (*Leporinus* sp.) Piau (*Leporinus* sp.)
Estação de Piscicultura da Epamig de Leopoldina	Curimba (*Prochilodus vimboides*)
Centro Integrado de Recursos Pesqueiros e Aquicultura de Três Marias e Gorutuba	Curimba verdadeira (*Prochilodus argenteus*) Matrinxã (*Brycon orthotaenia*)

Table 2. Species produced in 2011-2013

In total, 35,693.91 kg and 2,249,633 fingerlings (Figure 5) were released in 205 fish stocking operations in 62 municipalities with the participation of around 6000 people.

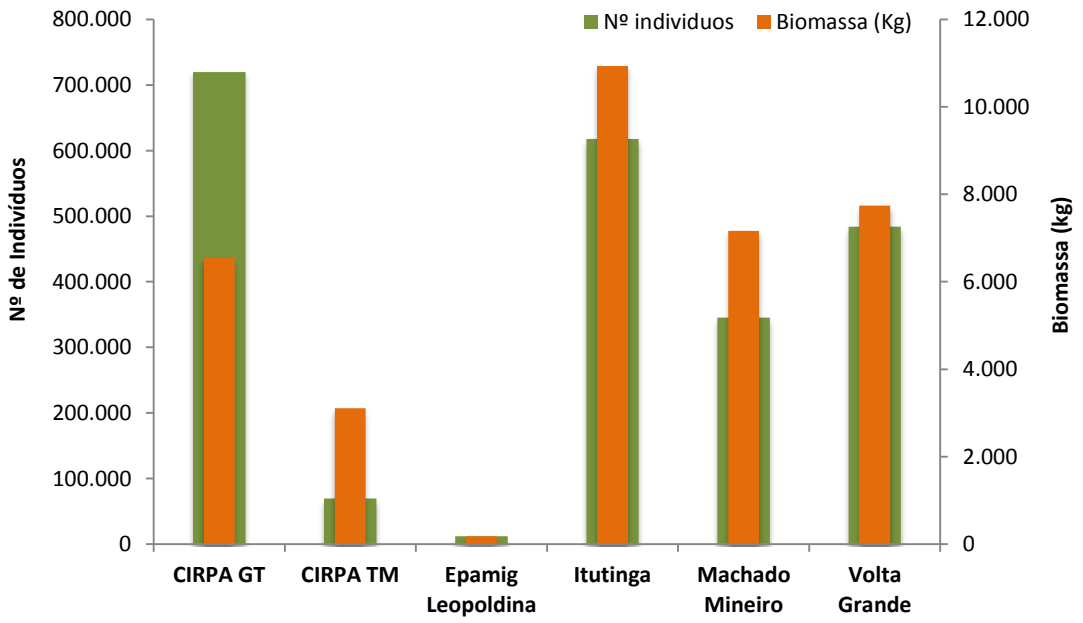


Figure 4. Biomass and nº of individual fingerlings released through Cemig's stocking program

Peixe Vivo Indexes	Before Peixe Vivo	After Peixe Vivo					
	2007	2008	2009	2010	2011	2012	2013
Attending Public during the Fish Stockings	Not determined	Not determined	3044	3302	2428	3461	2570

Table 3. Public present in fish stocking operations between 2009 and 2013

Figure 5. Community participation in fish stocking operations

Figure 6. Community participation in fish stocking operations

The **Volta Grande Environmental Station (VGES)** was created in January 1976 to meet the legal requirement for the repopulation of hydroelectric reservoirs with different species of fish. Located downstream from the Volta Grande Hydroelectric Power Plant on the banks of the Grande River, the station currently has a 390-hectare forest reserve, a seedling nursery designed to produce urban and riparian species and a fish culture station.

The stocking program coordinated by the Volta Grande Fish Culture Station used to operate in six reservoirs in the Grande (Volta Grande and Jaguara), Araguari (Nova Ponte and Miranda) and Paranaíba (Emborcação and São Simão) river basins. However, in September 2011, the

presence of the gold mussel, *Limnoperna fortunei,* an invasive species, was identified (Dunker, 1857) in the supply and fish culture station itself. Since then, fish stocking operations have been limited to the reservoirs of the Volta Grande HPP and Jaguara HPP since this invasive species has already been reported there.

During the harvests of 2011-12 and 2012-13, the VGES carried out 113 fish stocking operations in around six municipalities in which the following species were released: curimba (*Prochilodus lineatus*), piracanjuba (*Brycon orbignyanus*) and piapara (*Leporinus elongatus*). The 484,000 individuals produced totaled 7,742 kg of fish.

Figure 7. Volta Grande Fish Culture Station

The **Itutinga Environmental Station** was inaugurated in July 1994 on an area of on 35.26 hectares. It is located in the municipality of Itutinga on the banks of the reservoirs of the Itutinga and Camargos hydroelectric power plants. The infrastructure consists of a seedling nursery and fish culture station.

The stocking program coordinated by the Itutinga Environmental Station covers all areas of influence of the hydroelectric power plants of the Central South Generation Assets Maintenance Management Unit (MG/CS) in southern Minas Gerais, whether through reservoirs or tributaries in the Grande River Basin, in stretches of the Upper Grande River. In most of the fish stocking operations organized by the Itutinga Environmental Station, participation comes from the local community represented by officials and students from public and private schools. The participants attend a short lecture on the environment and fish farming at the location where fish will be stocked and actively participate in releasing the fingerlings.

Stocking for the 2011-12 and 2012-13 harvests in the Grande River Basin involved 4,487 participants in addition to those who visited the Itutinga Environmental Station (ITUES) and had the opportunity to get to know the fish culture laboratory during educational activities. There were 52 fish stocking operations covering 28 municipalities to produce piracanjubas (*Brycon orbignyanus*), piaparas (*Leporinus elongatus*), curimbas (*Prochilodus lineatus*) and golden dorados (*Salminus brasiliensis*), totaling 61,000 individuals and almost 11,000 kg of fish.

Figure 8. Itutinga Fish Culture Station

The **Machado Mineiro Fish Culture Station (EAMM)** was established in November 1997 along with the Machado Mineiro Hydroelectric Power Plant in Águas Vermelhas and São João do Paraíso in northern Minas Gerais. This station has some of the equipment and tools needed to reproduce catfish; however, they have not been reproduced due to the low success in capturing the species, therefore a lack of reproducers and matrices at the station.

The stocking program coordinated by the Machado Mineiro Fish Culture Station currently covers the Irapé and Machado Mineiro reservoirs, located respectively in the Jequitinhonha and Pardo River Basins, as well as perennialization dams. In most of the fish stocking operations organized by the station, participation comes from the local community represented by officials and students from public and private schools. The participants attend a short lecture on the environment and fish farming at the location where fish will be stocked and actively participate in releasing the fingerlings. There were 22 fish stocking operations, 8 in the Pardo River Basin and 14 in the Jequitinhonha River Basin, with the participation of 421 people in 9 municipalities.

For the 2011-12 and 2012-13 harvest periods, 345,515 fingerlings (7,170.52 kg) of the following fish were produced: curimba (*Prochilodus hartii*), piau (*Leporinus* sp.), piabanha (*Brycon* sp.) and piapara (*Leporinus* sp.).

Figure 9. Machado Mineiro Fish Culture Station

After reforms to the **Integrated Center of Fisheries and Aquaculture Resources (ICFAR) of Tres Marias**, the station returned to production for the 2010-11 harvest. A new contract was signed in August 2010 between Codevasf and Cemig GT in which, in addition to this center, there will also be the Integrated Center of Fisheries and Aquaculture Resources (ICFAR) of Gorutuba.

Figure 10. Integrated Center of Fisheries and Aquaculture Resources (ICFAR) of Tres Marias

The **Integrated Center of Fisheries and Aquaculture Resources (ICFAR) of Gorutuba** is a working unit that belongs to Codevasf, located on the irrigation perimeter of Gorutuba, in the municipality of Nova Porteirinha, Minas Gerais.

In the 2011-12 and 2012-13 harvests, the ICFAR of Tres Marias and ICFAR of Gorutuba produced 790,000 individual curimba (*Prochilodus argenteus*) and matricinhã (*Leporinus obtusidens*) totaling 9,652 kg of fish.

Figure 11. Integrated Center of Fisheries and Aquaculture Resources (ICFAR) of Gorutuba

In 2011, an agreement was signed between Cemig GT and the **Agricultural Research Corporation of the State of Minas Gerais (Epamig)** with the objective of increasing research activities and fish culture production, limnology and fisheries biology in the Zona da Mata region, Paraiba do Sul River Basin, in the state of Minas Gerais, through combined efforts between Cemig GT and Epamig. The **Experimental Farm of Leopoldina (FELP)** encompasses the Fish Culture Station, which has an extensive structure for research in fish farming, fingerling production, and diffusion of technology, and operates in the Paraiba do Sul River Basin. The only result from this agreement was the reproduction of the 2011-12 harvest.

During the term of the agreement (August 2011 to January 2013), 12,000 curimba (*Prochilodus vimboides*) fingerlings with a biomass of 180kg were produced and released in two fish stocking operations in the municipality of Rio Novo with the participation of 242 people.

Figure 12. Epamig Experimental Farm

5.1.2.2. Operational Support in Power Plants

During the planning, deployment and operation of enterprises, the Brazilian electricity sector has faced various environmental issues, among which we highlight the impact on aquatic fauna, especially on fish. The team for the Peixe Vivo program evaluates potential risks to ichthyofauna from the operation of hydroelectric power plants through periodic monitoring and monitoring prior to maneuvers in order to assess fish density and environmental conditions downstream from hydroelectric plants. In addition to being used to compose a database, this information supports corrective and operational actions related to the environmental safety procedures taken. Aspects of the biology of the fish species most affected by maintenance procedures on generating units (GU) are also evaluated to better understand the relationship between biological factors and the presence of these species downstream from the power plants.

From January 2009 to December 2013, 226 maneuvers (an average of 45 maneuvers per year) were monitored. The most frequent maneuvers were turbine dewatering (39.4%) and start-ups (30.1%) of GUs. The other maneuvers total 23.5% including the following: *black start*, speed no load operation, perennialization tests, commissioning, closing spillway gates, synchronous, control room, load variation, depletion and neap tide tests.

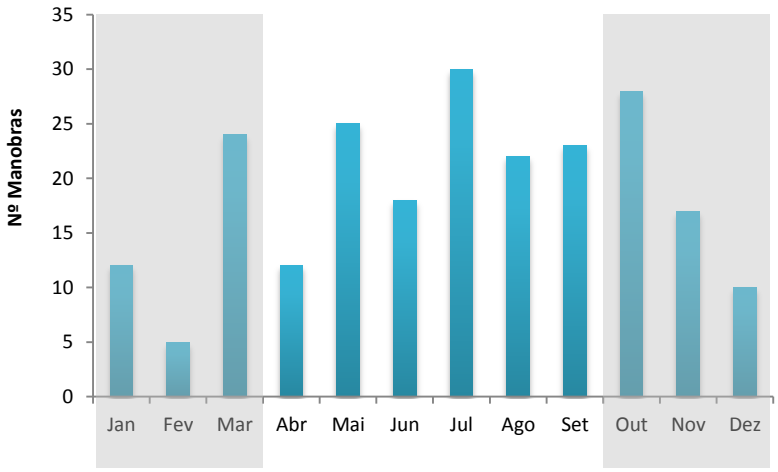


Figure 13. Number of maneuvers monitored per month (A), shaded area represents the period of greatest risk in most hydroelectric plants due to spawning

With the systematic application of the methodology developed to assess the risk of fish kills, it was possible to learn more about the composition of the fish community downstream from the company's fifteen largest hydroelectric power plants. Characiformes was the order with the highest number of species while Siluriformes was the one with the highest abundance. The most abundant species in the draft tube of the company's hydroelectric plants is the yellow mandi (*Pimelodus maculatus*). This species may form large schools concentrated near the entrance to the machines at certain times of the year and enter the draft tube when the water discharge decreases. This behavior significantly increases the risk of performing maintenance maneuvers and operational testing during these times since the potential is high for fish to be injured in these situations. The program's team provides Cemig's operators and management with this information in real-time to assess the risks of performing maneuvers during these periods using a linear regression model to evaluate the potential quantity of fish that may be affected by the operation. Various operation maneuvers have been postponed over the last three years due to this environmental risk assessment.

The team for the Peixe Vivo program also work in providing support to operation and maintenance teams during draining procedures performed in the draft tube and sump wells of the hydroelectric power plants. The development and use of risk assessment methodology on ichthyofauna has ensured that average number of dead fish fell from 592.9 kg/month (measured from January 2001 to May 2007) to 138.2 kg/month (measured in June 2007 to December 2013) at the company's hydroelectric power plants. This reduction corresponds to 77% and demonstrates the efficiency of the method used and the possibility of its replication in virtually any power plant that presents challenges to living with the native ichthyofauna.

The results obtained in partnership with the Federal University of Minas Gerais (UFMG) using methodology to assess the risk of fish kills are in final review and will be published in a book on the Peixe Vivo series to be released in 2015.

Figure 14. Fish collection

Figure 15. Fieldwork

5.1.2.3. Ichthyofauna Monitoring

Ichthyofauna monitoring in Brazilian reservoirs is a recent practice with wider dissemination after the implementation of new environmental legislation aimed at licensing ventures that may potentially affect the environment. This monitoring aims to detect any variations in the abundance, richness and composition of fish fauna, and in our context, aims to relate these variations to impacts from the construction of dams that gave rise to the reservoirs. Thus, it serves as an important tool for decision making on possible management strategies aiming to reduce the impacts inherent to dam systems.

Did you know that: Migrator is one fish swimming long distances in the river to find streams or lagoons where they breed.

For many years, Cemig has been monitoring the ichthyofauna of their reservoirs. Many of these monitoring operations have been carried out due to demands by environmental agencies, so that over time, the negative impacts of dams could be analyzed. In order to improve the quality of monitoring reports issued, the program team recently developed technical specifications containing the most appropriate guidelines for studies at each enterprise.

Figure 16. Photo taken from monitoring reports of Cemig Group power plants

Figure 17. Photo taken from monitoring reports of Cemig Group power plants

Figure 18. Photo taken from monitoring reports of Cemig Group power plants

Figure 19. Photo taken from monitoring reports of Cemig Group power plants

In addition, the Peixe Vivo program will have a project to develop a database with all of the information available from monitoring operations that have already been performed in the company as well as current operations.

5.1.2.4. Fish Transposition Systems

One of the management measures adopted by the Brazilian electricity sector is the deployment of Fish Transposition Systems (FTSs). These mechanisms aim to mitigate impacts on ichthyofauna caused by the construction of dams, which stop the free migration of fish in search of breeding sites and food. However, despite widespread use, few technical criteria have been adopted in deciding the feasibility of FTSs, which are generally designed to only allow fish to migrate from downstream to upstream. Among the criteria, ecological conditions of the fish community in the area of a dam to be deployed, or which has already been deployed, should be evaluated to determine the objectives of the future FTS and ways to monitor and manage the results of its operation.

There are several types of FTSs that allow fish to move upstream such as ladders, locks, lifts, lifts with trucks and tanks, and natural and semi-natural channels. The choice in the construction of each type of mechanism depends on the conditions of the enterprise such as the location of the tailrace, height of the dam, etc. These characteristics should determine whether the system will attract fish, the distance that will be covered, and what water flow rate the fish will have to face to overcome the obstacle. All of these aspects have a direct influence on the analysis of the system's efficiency.

Figure 20. Fish ladder system at the Salta Moraes Hydroelectric Power Plant

Figure 21. Fish ladder system at the Igarapé Thermal Power Plant

5.2. Terrestrial Ecosystems

Cemig's main hydroelectric generation facilities are located in the central region of Brazil, especially in Minas Gerais state, which has a landscape dominated by savanna vegetation and patches of vegetation characteristic of Atlantic Forest that cover valleys of rivers, creeks and streams and are a defining characteristic of the vegetation in these areas. The transition between the Cerrado and Atlantic Forest biomes exposes very different environmental conditions, serves as a modulator of the landscape as a whole, and reveals unique biotic conditions in addition to environmental variations.

The Cerrado is a tropical landscape consisting of undergrowth vegetation, shrubs and trees that coexist with herbaceous species. It encompasses the floristic and physiognomic aspects of vegetation, over acidic soil and a gently undulating relief intersected by an extensive water network, forming a unique and distinctive savanna landscape.

Eleven main types of vegetation are described for the Cerrado biome, classified into four forest types (riparian forest, gallery forest, dry forest and Cerradão), four savanna types (Cerrado senso strictu, Cerrado, Palmeiral and Vereda) and three grassland types (Campo sujo, Campo limpo, and Campo rupestre).

On the other hand, fragments of Atlantic Forest found in the area where the company operates are secondary forests, classified as montane and submontane semideciduous seasonal forests. The ecology of this type of vegetation is dependent on seasons with dual climates: a tropical climate with heavy summer rains followed by pronounced droughts and a subtropical climate with no dry season, but a physiological drought from the intense cold of winter. These forest types are found at altitudes above 500 m in elevation.

The physiognomy of seasonal forests feature canopy tops at 4 m (in the case of high-altitude forests on shallow or lithic soil), 25 m (in deeper soils), emergent trees reaching 40 m, and thick understory. They also feature intermediate deciduousness (20-70%) of the canopy leaf mass in the coldest / driest season and a lower abundance of epiphytes and ferns, in addition to a variable density of lianas and bambusoides (taquaras and bamboos).

Due to a long history of anthropic occupation, often before the installation of ventures, yet influenced by them, it appears that the stage of vegetation degradation is significant. This degradation can be linked to several factors, among which stand out the indiscriminate removal of timber, extensive livestock farming and the use of fire, which are characteristic of land use.

The combination of these factors has led to large consumption of the vegetation, which today, is made up of fragments, some vegetation in good condition and others with a greater degree of change. These anthropogenic disturbances pose a major threat to
biodiversity, especially in regions where the fragmentation process has begun several decades ago.

Biodiversity provides a wide variety of valuable goods and services for human societies. Some of these are irreplaceable. Therefore, promoting the conservation of flora, and consequently associated fauna, is essential for the conservation of its main input. Protecting biodiversity is the greatest challenge of all time.

In addressing this issue, the company has developed important actions including urban forestry, reforesting riparian areas, reclamation through the collection and production of quality seeds and seedlings, promoting research and maintaining protected areas. Concurrently, management and conservation actions such as the ASAS and PROFAUNA programs continue and are associated to fauna monitoring at some enterprises.

5.2.1. Programs for the Conservation of Flora and Fauna

5.2.1.1. Premiar

Launched in March 2009, the main objectives of the Special Program for the Integrated Management of Trees and Networks - Premiar - are as follows:

- ✓ Facilitate a partnership between the utility and city administration to seek solutions for coexistence between urban tree planting in Belo Horizonte and distribution networks serving the municipality
- ✓ Promote innovation in procedures for urban tree management and the professionalization of affected activities
- ✓ Improve the quality of electricity supply by adapting the physical structure of networks and urban tree management.

Figure 22. A resident planting on a public road

Figure 23. Network replacement to promote coexistence with large trees

Premiar works to remove trees that pose a risk to the company's electrical system, and subsequently, plant seedlings of species appropriate to the urban environment, thus directly contributing to the reduction of costs from system shutdowns and improvement in quality scores and consumer satisfaction.

One of the main activities of the program was to develop a system to guide management activities. This system called Geoarvores has modules to manage pruning, tree removal and tree planting services. It has been integrated as a company tool and a database to guide management.

Cemig is conducting an inventory in partnership with the municipality of Belo Horizonte of urban trees in the municipality to obtain data on the number and characteristics of trees in squares, medians, sidewalks, roadways and areas inside lots, in addition to a risk assessment of existing trees. The inventory thus far includes 177,139 trees. 382 species have been recorded.

With the proposal to discuss best practices in arboriculture, in addition to improving the work of professionals involved in urban planning, power distribution and tree planting, Cemig promotes the Urban Tree Planning Circuit that passes through cities in the state of Minas Gerais. Seven events have been promoted involving various public audiences related to environmental management. The circuit provides an opportunity to present and discuss the best practices and procedures for planting trees in the urban environment. Since March 1999, the Company has adopted the Protected Distribution Network (RDP) as a minimum standard for urban service. It ultimately replaces bare conventional networks making the company a pioneer in the practice in Brazil. Currently, Cemig owns 27% of protected distribution networks.

Figure 24. Tree Planting Circuit in Montes Claros - 2013

Figure 25. Tree Planting Circuit in Teófilo Otoni - 2013

5.2.1.2. Riparian Reforestation Program

The company's Riparian Reforestation Program began in the 1990s through an agreement with the Federal University of Lavras (UFLA) and deployment of a seedling production nursery at the Itutinga Environmental Station in the city of Itutinga, Minas Gerais, which was further extended to the nursery at the Volta Grande Environmental Station in 1991.

Figure 26. Recently germinated seedlings in the nursery at the Itutinga Environmental Station

The initial goal of the program was to develop technology for the restoration of riparian vegetation around the company's reservoirs, from the selection of species to the development of methodologies, for collecting and processing seeds, seedling production, fertilization, planting and forest management.

Figure 27. Nursery at Volta Grande Environmental Station

With the development of this project, Cemig's Laboratory of Tree Seeds was created in 1996. It is located in Belo Horizonte, supplies seeds to the company's nurseries, and has a production capacity of 1000 kg per year. This project works with parent tree identification, collection, processing, storage and distribution of seeds to tree nurseries, environmental agencies and municipal governments.

Figure 28. Processing seeds of the silk floss tree – *Ceiba speciosa*

The company's tree nurseries were remodeled and expanded to handle a production capacity of approximately 600,000 seedlings / year among native species geared towards restoring riparian forests and species targeted for urban tree planting (50,000). Seeds and seedlings of approximately 60 tree species are produced.

Nurseries at the Itutinga (200,000) and Volta Grande (400,000) Environmental Stations are responsible for the production and distribution of seedlings for the entire state of Minas Gerais.

The Center for Excellence in Riparian Vegetation (Cemac) was also created with UFLA. The overall objective is the implementation and development of activities that promote scientific knowledge on the preservation and restoration of protection forests, involving teaching activities, research, extension, consultancy and services.

The work developed from research resulted in the publication of several doctoral dissertations, master's theses, articles in scientific journals, as well as the presentation of hundreds of papers in various national and international scientific events.

In order to disseminate the knowledge from this partnership, Cemig and UFLA conducted the 1st Seminar on Riparian Forest, held in Belo Horizonte in 2000, in the presence of the public, scientific community and company technicians. Due to the success of this event, the 1st Seminar of Recovery of Permanent Preservation Areas - PPAs was held in 2010, with the goal of updating the knowledge gained thus far.

The first areas recovered through this agreement were concentrated in the reservoirs of the Itutinga and Camargos HPPs, and the action was carried out in conjunction with research projects from UFLA. These early projects were crucial to the establishment of techniques to be adopted by the company and in the preparation of the Riparian Forest Deployment Manual, a document that has reinforced all projects carried out since then.

Projects developed by Cemig are always carried out in partnership with farmers from around the reservoirs, since these areas are not owned by the company. In general, Cemig promotes the supply and deployment of seedlings while the owners provide the areas and are committed to their maintenance. In the Volta Grande HPP reservoir, this effort has accomplished the largest revegetated areas, mostly in partnership with sugarcane mills.

The complex domain of technologies involved in the establishment of a native forest with a considerable degree of biodiversity is a goal yet to be achieved. Therefore, new research projects are being initiated that will evaluate reforestation operations deployed in these last twenty years assessing their capacity for regeneration and sustainability in the long term, as well as the ability to attract and retain new species of flora and fauna in the surroundings.

Figure 29. Riparian vegetation in the Volta Grande HPP reservoir

Figure 30. Deployment area for riparian reforestation at the Rosal HPP

In total, around 1000 hectares of PPAs have already been reforested with 488 hectares alone in the Volta Grande HPP reservoir. Currently, the main projects are being developed at the São Simão, Emborcação and Jaguara HPPs in the Mineiro Triangle region, and at the Rosal HPP on the border between the states of Rio de Janeiro and Espírito Santo.

5.2.1.3. Degraded Areas Recovery Program

The deployment of large infrastructure projects necessarily involves the degradation of large tracts of land related primarily to earthmoving activities,
and taking sandy / loamy material, as well as rocks and soils from work site areas, in order to build structures.

In the deployment of hydropower projects, this reality is no different, and to mitigate the impacts caused by land degradation, Cemig deploys and maintains Degraded Areas Recovery Programs (DARPs) at their own and consortium plants.

Examples of DARPs installed by the company can be found at the Emborcação and Irapé HPPs, which because of their large size, they will represent the execution of this program at other plants. Construction began in 1976 on the Emborcação HPP, which has an earth / rockfill extending 1611 m long and 158 m high. In order to construct the plant, 220 hectares surrounding the area needed to be exploited, mainly to provide earth materials for its construction. On average, 5 m of soil was removed to construct the dam exposing the B and C-horizons, which are highly susceptible to erosion and unsuitable for establishing vegetation.

This area was stabilized and revegetated with grasses after construction, and in 1987, it was sold to the former owners to be used for cattle raising. However, as is currently known, an area exposed to this type of exploitation is no longer suitable for agricultural and livestock activities, and as a consequence of this inappropriate exploration, there was further deterioration of the area with soil exhaustion, loss of vegetation, soil exposure, emergence of 28 large erosion gullies, and subsequent watercourse silting.

As a result of the erroneous management policy of the recovered area, Cemig was forced to repurchase it and execute a new reclamation project.

Figure 31. Environmental degradation in the area of Pedra Branca headwater - Emborcação HPP

Thus, a new DARP was deployed in 2000 resulting in the stabilization of the erosion gullies, reconformation of soil, deployment of surface and underground drainage (green and concrete channels), and the installation of water retainers and dissipation structures, culminating in subsoiling and revegetation of the area with herbaceous vegetation.

Over the past 14 years, maintenance and conservation operations on the structures have been carried out, which has provided stabilization to the area.

Figure 32. Operations for deployment of the degraded areas recovery plan (PRAD) – Emborcação HPP

Currently, a research and development project is being contracted with the Federal University of Ouro Preto (UFOP) to develop floristic enrichment techniques and activate natural processes of ecological succession, with the goal of accelerating the natural recovery of this area, increasing the species richness of flora, attracting fauna, and establishing gene flows, thus contributing to the area returning to its original condition.

In the deployment of the Irapé HPP, eight DARPs were implemented including borrow pit areas and disposal areas. These areas were recovered at the end of the plant's deployment phase and are still targeted for new intervention measures. Since the HPP is located in a region with irregular rain, long dry spells hinder the establishment of vegetation in areas worked on, thus

facilitating the emergence of new erosion gullies in the rainy season, which indicates the need for constant monitoring and intervention in recovered areas.

Figure 33. Maintenance activities in degraded areas recovery plan for Irapé HPP

5.2.1.4. Headwater Recovery Program

The Headwaters Recovery Program is the result of a partnership between Cemig and UFLA that began with a study on methodologies for recovering riparian forest.

It began with the “Integrated Study of Riparian Vegetation around Headwaters, Rivers and Reservoirs” (Covenant Cemig/Aneel/UFLA No. 039, 2001-2005), which was conducted from 2001 to 2005 covering 50 Headwaters in the recovery process, located in the Upper Grande River region in the state of Minas Gerais.

The action consisted of enclosing selected Headwaters, enriching vegetation by planting seedlings of species adapted to moist environments and monitoring the degree of recovery.

This has resulted in the consolidation of methodology to be used in projects undertaken by Cemig to recover Headwaters, in addition to the preparation of a primer titled “Headwaters - The True Treasure of Rural Property”, which is distributed in environmental education

programs and on the company's social media with the aim of raising public awareness on the importance of preserving this patrimony.

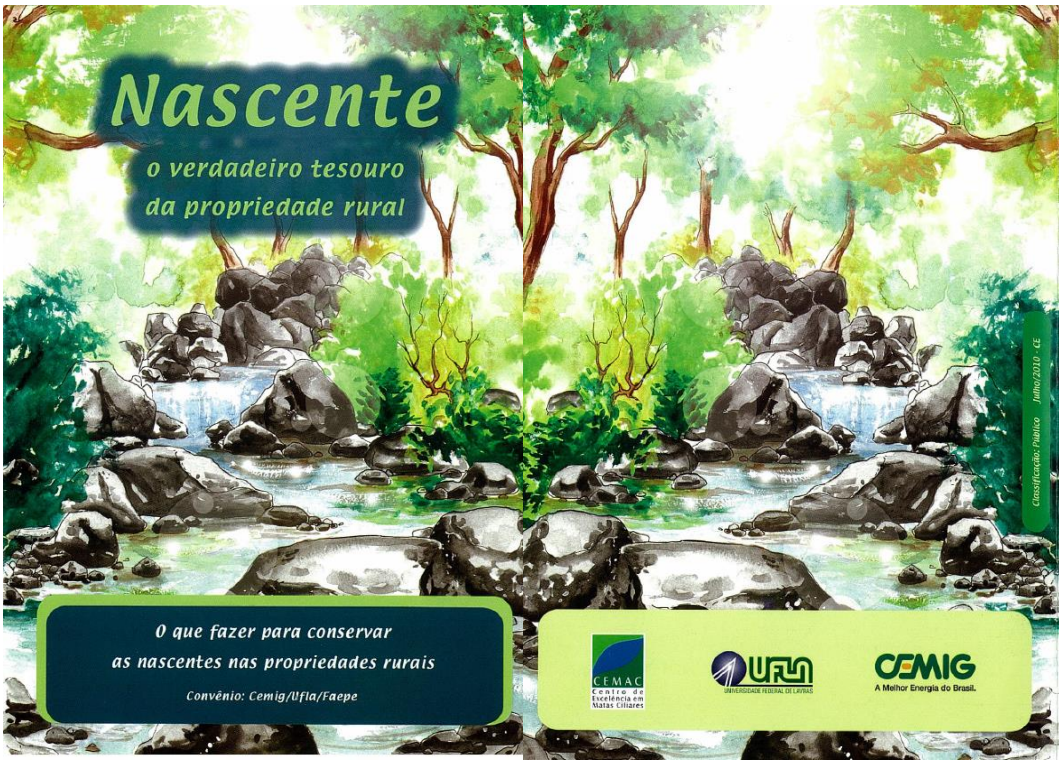


Figure 34. Primer "Headwaters - The True Treasure of Rural Property"

5.2.1.5. Conservation Units Program

For biodiversity conservation, Cemig maintains some areas of highly conserved forest remnants that are important to the biomes where they are inserted. Federal Law No. 9985/2000, which establishes the National conservation units System (NCUS), classifies three of these areas as Private Reserves of Natural Heritage (PRNH) and five other areas are called Environmental Stations internally, since they have not been considered as official conservation units.

PRNH Fartura

The PRNH Fartura was created in Dec. 23, 2004 as part of the requirements for environmental licensing of the Irapé HPP, due to its ecological importance and for representing an important remnant of Atlantic Forest in the region.

It is located in the municipality of Capelinha, having been initially acquired for the resettlement of 25 families from the communities of Jacuba and Bocaina, both in the municipality of Turmalina, who were affected by the formation of the Irapé HPP reservoir, and who chose to be resettled on the property.

During the environmental licensing process to obtain authorization for forest operations, there was an understanding between state environmental agencies that part of the Fartura farm should be transformed into a PRNH, due to the richness of the flora and fauna present. Thus, only 10 families were resettled on the farm. The others were sent to other resettlement areas in the same municipality.

The farm has 1,455 hectares of semideciduous seasonal forest in an advanced stage of regeneration. It is bisected by the Santa Quitéria River, which is part of the Jequitinhonha River Basin. In recent analysis, 72 species of plants, 53 species of birds, 25 species of mammals, 20 species of amphibians, 17 species of reptiles and 6 species of fish have been identified.

Figure 35. General view of the Fazenda Fartura Environmental Station

PRNH Galheiro

This conservation Unit (CU) was created on June 5, 1996 to meet legal requirements for environmental licensing of the Nova Ponte HPP with the aim of remaining areas dominated by Cerrado vegetation and diverse fauna in the project area.

It is Cemig's largest (CU) coving 2,847 hectares and is located in the municipality of Perdizes, Minas Gerais, at the confluence of the Quebra-Anzol and Galheiro rivers, within the reservoir of the power plant.

72% of its area is covered with natural vegetation and a significant drainage network, which supports a population of 624 plant species, 264 bird species, 53 reptile species, 36 mammal species, 20 amphibian species and 78 insect species, according to inventories conducted in 1994.

The main projects developed on the PRNH are linked to environmental education for elementary and secondary school students in public and private schools in the region, as well the reintroduction of wildlife and biodiversity conservation.

Figure 36. PRNH Galheiro

PRNH Jacob

Established on Aug 5, 1998 in compensation for the formation of the Miranda HPP reservoir, located in the municipality of Nova Ponte, on the banks of the Araguari River, it has an area of 358 hectares of Cerrado vegetation in good condition.

The inventory of fauna carried out in 1996 identified 206 species of birds, 53 species of mammals, 19 species of reptiles and 12 species of amphibians.

Specimens of cacheiro hedgehog and black-tufted marmoset from the fauna rescue operation during the filling of the hydroelectric plant reservoir were translocated and monitored by radio telemetry. The station carries out research on native flora and fauna and promotes environmental education and preservation work through its auditorium, environmental exposure and interpretive trails.

Figure 37. General view of PRNH Jacob

Igarapé Environmental Station

Located in the municipality of Juatuba, Minas Gerais, it was established voluntarily by the company in 1992 to promote the development of programs in environmental education, preservation and recovery of local flora and fauna. The station's flagship is the fish ladder built along the water catchment dam of the Igarapé Thermoelectric Plant. It was the beginning of work on capturing and marking fish, in partnership with UFMG, in the Paraopeba River.

It has an area of 105 hectares of vegetation characteristic of the transition zone between Cerrado and Atlantic Forest. In addition to the fish migration system, the station has a wild animal nursery used for the reintroduction of fauna and an environmental education center that receives students and teachers from public and private schools in the region.

Figure 38. Environmental Education Center – Igarapé ES

Itutinga Environmental Station

It was established in 1994 to continue the environmental protection work developed by Cemig in the region. The work began in 1980 with the Riparian Reforestation Program.

It is located in the municipality of Itutinga, on the banks of the Grande River and has an area of 35.26 hectares. Its main goal is to develop activities in the areas of riparian reforestation and fish farming. The station houses a fish culture station and the company's first forest seedling nursery, established in 1990, in partnership with UFLA.

Figure 39. Seedling nursery of the Itutinga ES

Figure 40. Itutinga Environmental Station

Peti Environmental Station

This was Cemig's second environmental station and was established in 1983. It is considered as one of the most important ecological reserves in the country by researchers at UFMG, who over this entire period have written numerous scientific papers, identifying 556 species of insects, 502 species of plants, 256 species of birds, 39 species of mammals, 26 species of reptiles, 24 species of amphibians and 10 species of fish.

Among the endangered species include the red-ruffed fruitcrow, a bird that has turned into a symbol of the station, the maned wolf and the puma.

Four species identified are new to science, including the dragonfly, which received the scientific name of *Heteragrion petiense* and the cinnamon tree, *Licaria triplicalyx.*

The inventory enabled the deployment of a management center and the reproduction of wild animals to translocate and reintroduce species in environments including the company's environmental areas. Especially noteworthy is the project to produce, raise, and manage solitary tinamous and wattled curassows.

In addition to the studies on terrestrial and aquatic ecology, the station develops work on environmental education and is a pioneer in the deployment of a trail for the visually impaired. Anchored by flagged ropes, the path is intertwined with information in Braille and the disabled have access to the seeds and leaves so that they can feel the texture of the local vegetation. The work was developed in partnership with Instituto São Rafael.

During recent studies at the environmental station, UFMG researchers discovered a new species of insect of the family of wasps, bees and ants, giving it the scientific name of *Stauropoctonus leotacilioi sp*.

Figure 41. Peti Environmental Station

Machado Mineiro Environmental Station

Inaugurated in 1997, the station is located on the banks of the Pardo River, downstream from the Machado Mineiro SHP, in the municipality of Ninheira in the northern region of Minas Gerais. It was deployed for developing research and producing fingerlings in the basins of the Pardos and Jequitinhonha rivers.

Projects in the area of fish farming are being developed in partnership with Escola Agrotécnica Federal de Salinas (EAFSAL) including induced breeding of species such as the piau, piapara, curimba and piabanha. It has a laboratory for breeding fish, incubating eggs and a storage tank unit.

Figure 42. Fish Reproduction - Machado Mineiro ES

Volta Grande Environmental Station

Cemig's first environmental station, it was established on Jan. 14, 1976 in the remaining area of the Volta Grande HPP, in the lower reaches of the Grande River. It occupies an area of 391 hectares, located in the municipalities of Conceição das Alagoas, Minas Gerais and Miguelópolis, São Paulo.

Its creation was conceived primarily for conducting studies on water quality and developing techniques for the management and reproduction of native fish species in the Grande River Basin. Today, it is home to one of the most important fish culture centers in the country.

In 1991, the station incorporated a seedling nursery to meet the needs for the recovery of degraded areas, riparian reforestation, and urban tree planting. 45 plant species, 168 bird species and 25 mammal species were identified. Some of them are threatened with extinction such as the maned wolf, giant anteater and ocelot.

Figure 43. Volta Grande Environmental Station

5.2.2. Fauna Monitoring Program

In order to mitigate the impacts on fauna as a result of the deployment of hydroelectric plant reservoirs, notably displacement and crowding in surrounding areas, the company maintains wildlife monitoring programs at Emborcação, Irapé, Jaguara, Queimado and São Simão HPPs.

In the case of Irapé HPP and Queimado HPP, the program was divided into three stages, including species monitoring during the pre-fill phase covering the areas of influence of the hydroelectric power station and its reservoir. The program works to identify the species affected, potential escape routes and rescue needs. It is of utmost importance to plan cleanup operations in the reservoir area and areas where it is filled.

During the filling phase, monitoring is crucial for tracking the displacement of species and identifying the preferred areas of refuge so that these areas can be protected. In addition, the capacity to support these areas are identified, as well as possible impacts of overexploitation of resources available.

During the operation phase, monitoring becomes a tool to manage the surrounding area of the reservoir because it allows the company to monitor the establishment of the new balance of species in the surrounding areas, identifying if any mitigating measures taken were effective in order to ensure the maintenance of populations, in addition to identifying and alerting governmental agencies about new pressures to fauna resulting from new uses of the surroundings.

In the case of the Queimado HPP, after 12 years of monitoring, it was possible to identify that the species of swifts that inhabited the waterfall at Queimado did not abandon the location even with the reduction of water flow of the Preto River, which was diverted by the dam. Monitoring operations indicate that birds continue to frequent the rocky walls of the waterfall and have even increased in population. The same has happened with the species of crocodilians monitored. Moreover, new species were identified inhabiting the area after the construction of the dam, but they pose no harm to the species that had been identified previously.

In the case of the Emborcação, Jaguara and São Simão HPPs, monitoring is only being performed in the operation phase of the reservoir in order to distinguish the company's actions in the Riparian Reforestation and Environmental Education programs. The program even contributes by assessing the structure of the communities that frequent the reservoir's surroundings.

6. Environmental Education

Cemig has provided environmental education since the 1980s, when it started receiving elementary and secondary students from public or private schools, and even university students seeking information from professionals about what we have done for the preservation and conservation of biomes where the company operates.

Did you know: That: In recent years human activity has increased a thousand times the extinction rate. In the twentieth century, all the hundreds of known extinctions of species of vertebrates, as well as the alleged thousands of extinctions of species of invertebrates, were caused by human (Primack and Rodrigues, 2001).

Cemig has created new spaces to host projects that develop environmental education with schools and the community. In Três Marias, for example, the Eng. Mário Bhering Permanent Education Center brings together cultural and educational environments in order to serve the public with events, exhibitions, meetings and multiple dialogs, creating opportunities for wonder and entertainment through the arts as well as exposure to ideas.

Figure 44. Lecture on flood control, in Três Marias

The center was delivered with the administration to be under municipal representatives in the areas of culture, environment and tourism. The group organizes the auditorium schedule and validates the works on display in the art gallery. Two other spaces are used for the River Guardians project, developed in partnership with Universidade Estadual de Montes Claros (Unimontes) and NGOs working in the region.

At the Volta Grande Environmental Station, in Conceição das Alagoas, in the Triângulo Mineiro, Cemig is building the Volta Grande Center for Excellence in Ichthyology. The center will have areas to serve visitors, including schools in the region, and will have an area of 1,000 m². The two-story building will house an auditorium and a classroom with audiovisual resources, computer room, library, cafeteria, exhibition area and informative panels.

Figure 45. Presentation in the plant's control room – Três Marias

The highlight will be two large aquariums, the largest in Brazil with freshwater fish, in a semi-natural style like a lake, with a viewing area at the top and sides of the tanks. The aquariums will have adult and fingerling specimens of species native to the Paraná River basin.

In 2001, Cemig collaborated with Fundação Biodiversitas to create the Terra da Gente (Our Land) Program, which aims to provide didactic-pedagogic support in environmental education to educators of the Minas Gerais school network in the regions of the Triângulo Mineiro, Alto Paranaiba, southern Minas Gerais, and Campo das Vertentes, with emphasis on the protection, conservation and restoration of biodiversity in the Cerrado and Atlantic Forest.

At the end of 2012, the program registered 174 new partner schools, 51,827 new students involved and more than 3,000 teachers trained with the material provided. Since its inception, Terra da Gente has contributed to raising the environmental awareness of more than 300,000 elementary school students in the state of Minas Gerais.

Cemig even conducts a socioenvironmental education program in environmental stations and specialized centers located on the company's enterprises. In 2012, more than 7,700 people were involved in technical visits, lectures, courses, and recreational activities in all regions where Cemig operates.

Another form of environmental education promoted by Cemig is Environment Week, which is part of the business calendar. In this opportunity, themes related to the preservation and conservation of natural resources is addressed with internal and external audiences. Cemig produces educational material for the dissemination of its work and use in various environmental education campaigns.

Figure 46. Disclosure material used in environmental education campaigns

Environmental education projects are developed in partnership with universities or research centers and inserted in R&D programs.

In R&D 399, reading material was produced to not only promote the teaching-learning process, but also to raise awareness and influence attitudes in favor of nature preservation. The material presents content and educational activities related to the theme of water and is applied to primary and secondary education. Among the strategies used for the production of

the material, especially noteworthy is the use of the contextualization of content with current themes, as well as the use of dynamics and games with playful aspects. The material consists of 1 book, 8 booklets and 8 games that address content and problems related to water such as exotic species, golden mussels and macrophytes, cyanobacteria, waterborne diseases, zooplankton, zoobenthos and general knowledge about water.

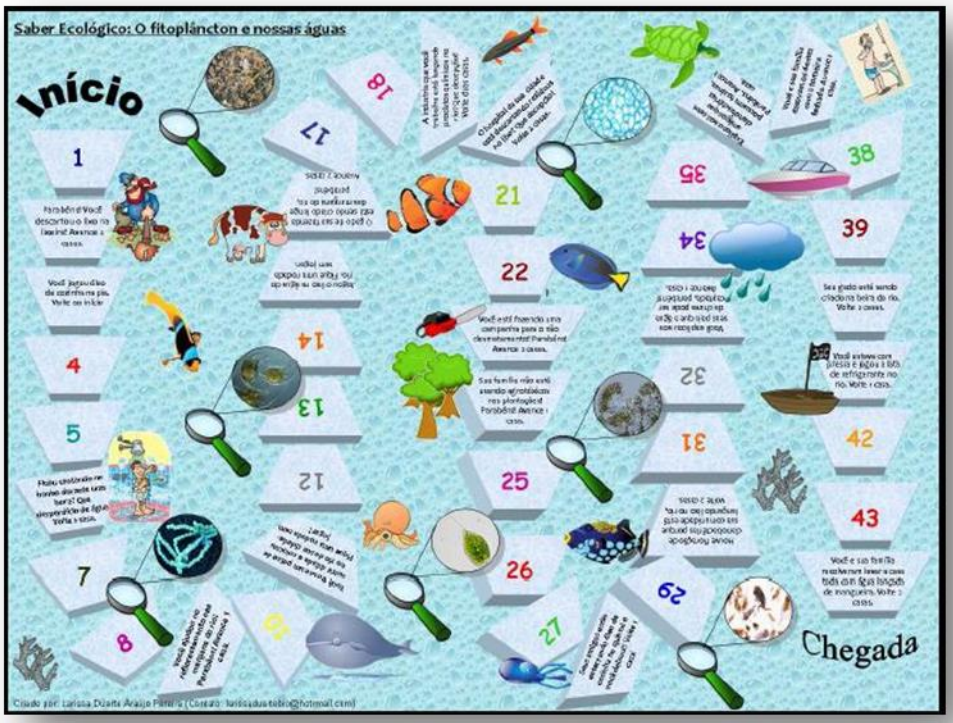


Figure 47. Board game "Ecological Knowledge: Phytoplankton and our Waters"

Figure 48. Example of cards used in the game

QUESTION – What does cyanobacteria mean?
QUESTION – Is there more salty or fresh water on the Earth surface?
QUESTION – What care should we take when using tap water to brush our teeth?

Figure 49. Students playing "Ecological Knowledge: Phytoplankton and our Waters"

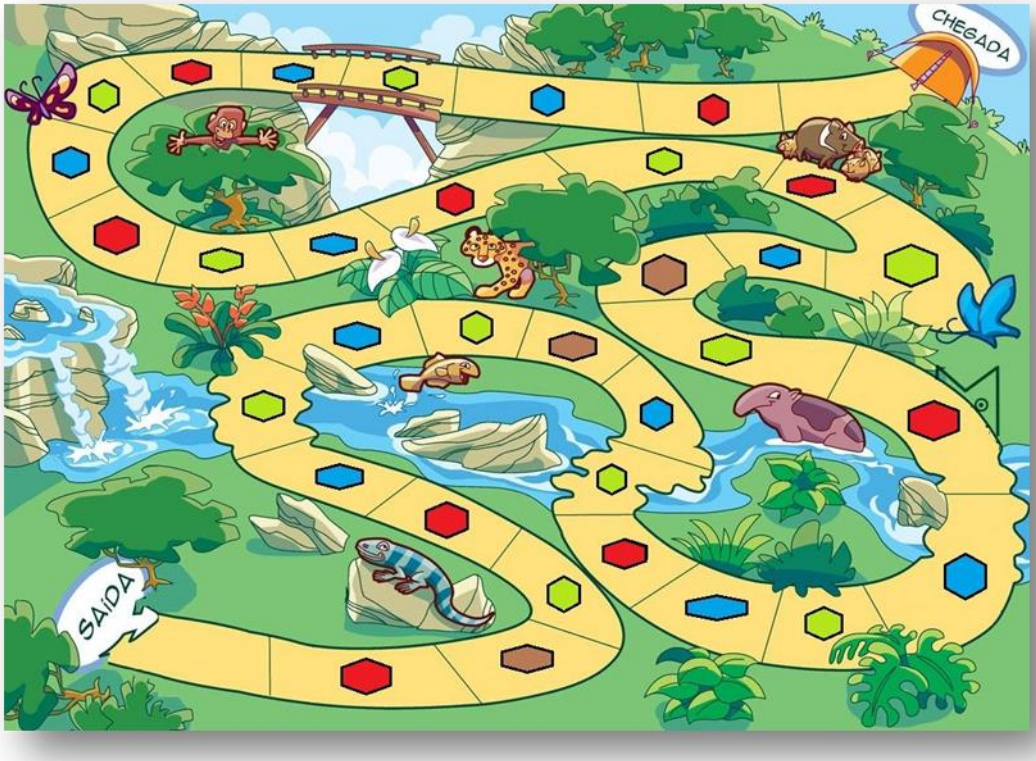


Figure 50. Board game - Biodiversity in a Cup of Water

Figure 51. Representation of ecosystems in the game Biodiversity in a Cup of Water: a) balanced ecosystem, b) polluted ecosystem

6.1. Fishermen of Knowledge Project

Initiated in 2011, the Fishermen of Knowledge Project was implemented through a partnership between the Fish Ecology Laboratory at the Federal University of Lavras (UFLA) and Cemig's Peixe Vivo program. The objective was to stimulate curiosity and observe continental aquatic environments through educational practices in the public schools of Lavras, Minas Gerais and in the region. The target audience were elementary school children (Grades 1 to 5), aged between 6 and 11. The work was conducted throughout the school year in bi-weekly visits to school classes.

The objectives of the project were as follows: sensitizing the community by raising awareness of local environmental problems, providing support for knowledge of the components and mechanisms governing natural systems, stimulating curiosity and observing nature. In particular, the objectives included providing information on aspects related to the conservation of rivers and Headwaters in the region, as well as their associated fish fauna, addressing the great importance of water to life and awakening social responsibility in individuals since it is they who are protagonists of change in the environment. This contributes to the development of conscious and participatory citizenship and environmental ethics.

In 50-minute classes, the following themes were addressed: water and watershed, electricity, garbage and sewage, aquatic biodiversity and relationships with nature. Fish were the focal point for learning. By the end of the school year, there is a great return on the part of students and their families, who have reported acquiring new habits linked to environmental preservation. In 2012, the project participated in World Environment Day, which took place in Lavras. The Fishermen of Knowledge project ended in 2013. The result was that the program served four schools in the municipality of Lavras (MG), one school in the municipality of Ribeirão Vermelho (MG), and reached an audience of 1,123 students.

Year	Schools	Nº of classes	Nº of students
2011	E. E. Cristiano de Souza E. E. Firmino Costa	16	377
2012	E. E. Tiradentes E. M. Manuel Pereira Ramalho*	17	384
2013	E. M. Itália Cautieiro Franco	15	362
TOTAL	**5 schools**	**48**	**1123**

Table 4. Schools, number of classes and students served during the three years of the Fishermen of Knowledge project

S. S. = State School; M. S. = Municipal School; * School located in the municipality of Ribeirão Vermelho.

Figure 52. Students participating in the Fishermen of Knowledge Project

Figure 53. Students participating in the Fishermen of Knowledge Project

7. Research and Development Program

Cemig's research and development program (R&D) aims to encourage the constant pursuit of innovation and technological challenges of the electricity sector. In this context, Law 9.991 of July 2000, stipulates that concessionaires and licensees of electricity distribution, generation and transmission annually apply part of their net operating revenue to the Research and Development Program of the Electricity Sector, regulated by the National Electric Energy Agency (Aneel). Cemig's R&D program has existed for more than ten years, and in 1999, even before Law 9.991 was in force, the program had a portfolio of seven projects totaling R$ 680 million in investments. In addition to the program regulated by the National Electric Energy Agency (Aneel), Cemig receives funds from other sources of financing such as Finep, Fapemig, Funttel, and others in order to increase investment in research.

The R&D program is a management tool that allows or enables Cemig to identify opportunities for improvement and deploy innovations referenced by best practices reported in the world. The goal is to establish partnerships with research centers to develop practices that provide the company with greater security in the face of multiple scenarios of probable risks relating to environmental issues. The results of these research activities are fundamental in the pursuit of methodological innovations and solutions for adaptations and mitigations to the impacts caused by the enterprise with the aim of minimizing environmental risks and promoting biodiversity while seeking the sustainable management of water resources.

Fish Transposition and Migration Studies

There are many projects carried out in partnership with universities aimed at evaluating migratory behavior and genetics of fish species. In addition to providing information for the creation of a database, these studies also favor the assessment of the need to deploy a Fish Transposition System (FTS) at the Cemig Group's power plants. From Law No. 12.488 of 1997, which requires the deployment of a mechanism to transpose fish at power plants in the state of Minas Gerais, several partnerships with research institutions were formed to study migration and reproduction of the species. Using mark-recapture techniques on specimens or advanced procedures like telemetry, it is possible to evaluate the migratory behavior of fish and verify reproduction in the study area. Knowledge of swimming capacity of the species of interest also favors the establishment of a more efficient FTS, which can be obtained by laboratory or field tests. It is important to note that R&D 094, completed in 2006, proved that it would not be necessary to deploy a fish transposition mechanism at the Gafanhoto HPP by showing the relevance of studies like this one.

- R&D 040 - Fish transposition in hydroelectric reservoirs: behavior and mortality
- R&D 082 - Motorization of fish ladders

Figure 54. Experimental fish ladder project

- R&D 094 – Diversity of ichthyofauna as a model to assess the construction of a fish transposition system and impact of exotic fish in reservoirs.

Figure 55. Sampling of fingerlings in lagoons

Figure 56. Gafanhoto Power Plant

- R&D 200 - Development of technology to evaluate swimming characteristics of migratory ichthyofauna in Brazil.

Figure 57. Separation of specimens for marking

- R&D 483 - Migration, spawning sites and initial development of two potentially migratory species in the Jequitinhonha River: support for assessing the need for transposition at the Irapé HPP.

Figure 58. Tests with equipment for tracking fish

Figure 59. Equipment for processing telemetry information

- R&D 455 - Development of applied technology to maintain the stock of native populations of migratory species in the area of influence of the Três Marias HPP: study on genetics and breeding migrations.

Figure 60. Installation of receiver antennas

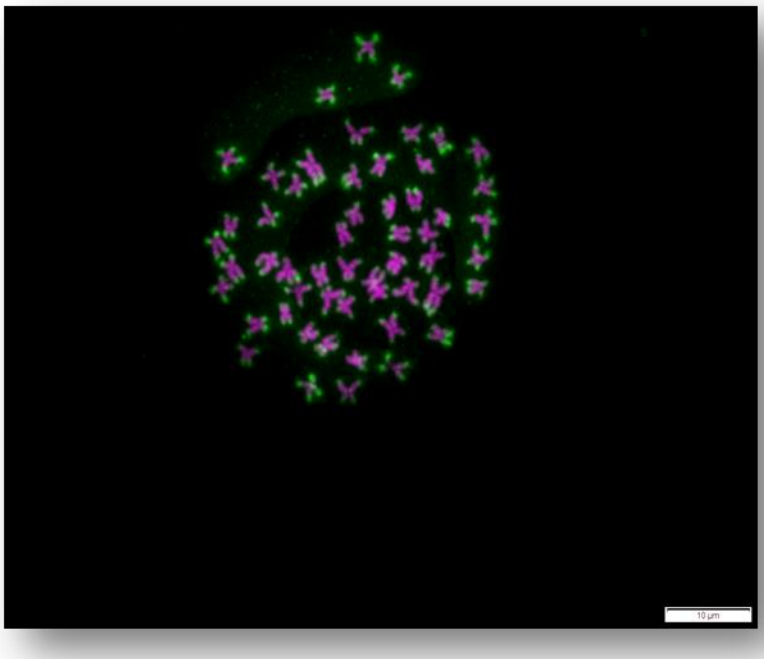
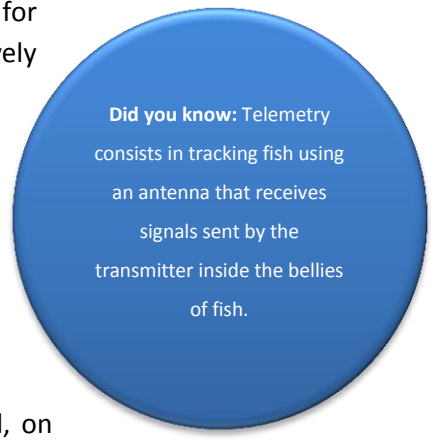


Figure 61. Chromosomes of fish marked for viewing

Risks in operation of hydroelectric power plants

The protection of the ichthyofauna in the construction and operation of hydroelectric power plants is one of the most important environmental issues for Cemig directors. Implementing solutions that effectively ensure the protection of ichthyofauna has demanded great knowledge about the behavior of fish downstream and upstream of the plants. Furthermore, adapting internal procedures is also essential to ensure maneuvers such as the start-up / shutdown of generating units are performed without causing fish kills and to reduce the potential negative effects of controlling the flow downstream. Thus, Cemig has invested and continues to invest its own resources, as well as resources from Aneel, on various research projects in order to minimize the impacts on fish from the operation of power plants and ensure environmental safety when performing maintenance maneuvers. The deployment of fish screens at Três Marias HPP, for example, has prevented fish from entering the suction pipe. Ever since they have been deployed, there have been no fish over 10 kg killed during machine start-ups, i.e., there has been a reduction in the biomass of fish affected during maneuvers at the power plants.



- R&D 041 - Impacts of generators on the ichthyofauna
- R&D 080 - Studies of electric barriers to prevent fish from entering into hydraulic turbines

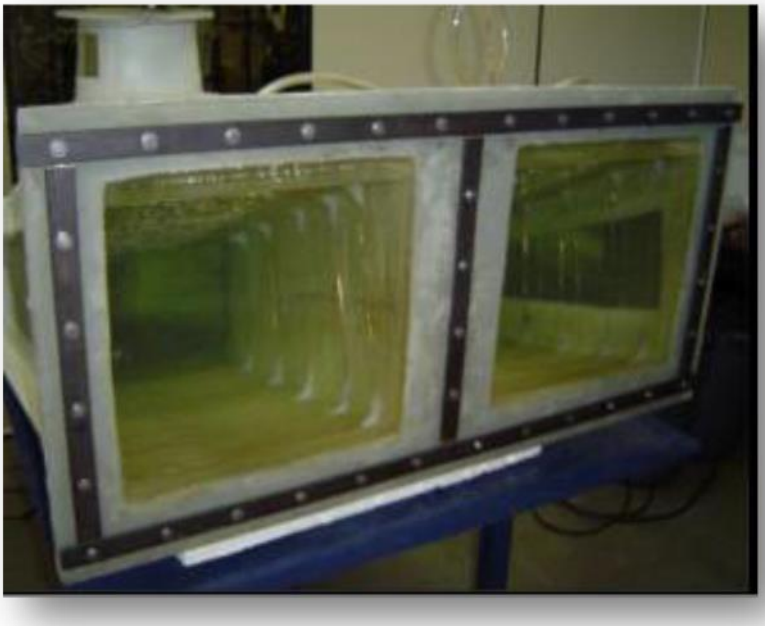


Figure 62. Tailrace prototype

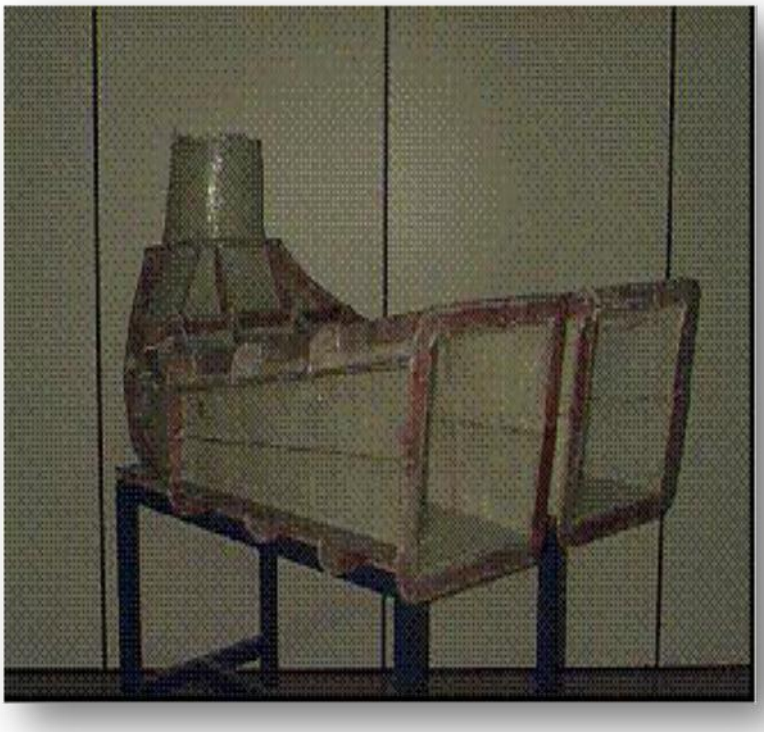


Figure 63. Structure of experimental channel

- R&D 142 - Operating modes of hydroelectric power plants that minimize the impact on ichthyofauna

Figure 64. Experimental structure for laboratory testing

Figure 65. Experimental structure for laboratory testing

- R&D 203 - Development of methodology for determining ecological flow by bioindicators

Figure 66. Trap used collect benthic macroinvertebrates

Figure 67. Fish sampled with gillnets

- Project 229 – Risk assessment of fish kill in Cemig power plants

Figure 68. Release of fish after capture and biometrics

Figure 69. Previous monitoring using cast nets

- Project 334 - Behavior of fish downstream of dams

Figure 70. Record of data obtained in field

Figure 71. Mark used to track fish

- Project 985 – Validation of fish protection protocols at Cemig power plants

Figure 72. Monitoring fish downstream of dams

Figure 73. Monitoring fish with cast nets

- Fish screen installation project at Três Marias HPP

Figure 74. Fish screens at Três Marias HPP

Figure 75. Insertion of fish screens at Três Marias HPP

Fish Stocking

Repopulation is a measure used to mitigate the impact of dams on rivers. In Brazil, the action has been employed since 1970 primarily to restore, maintain or increase fisheries production. However, little is known yet about the effectiveness of this measure, since there are no studies

that prove the survival of the parent stock released or the genetic variability of these fish. Thus, Cemig has invested in partnerships with universities and research centers to understand the effectiveness of fish stocking and define the continuity of this action as a mitigator of environmental impacts. Using mark-recapture techniques on specimens to study populations and molecular markers for genetic analysis, knowledge has been gained about the species commonly used for repopulation, thus favoring the release of sturdier specimens that contribute to the genetic variability of wild populations. It is important to note that in 2013, an application was submitted to the National Industrial Property Institute (INPI) for a patent on methods for determining paternity of piracanjuba (*Brycon orbignyanus*), the result of R&D 345.

- R&D 208 - Development of breeding techniques and larviculture of Siluriformes at the Volta Grande Fish Culture Station.

Figure 76. Capture of parent stock in tanks for breeding

Figure 77. Oocyte collection for breeding at the fish culture station

- R&D 345 - Development of molecular tools (DNA) for environmental monitoring of fish and fish breeding stocks.

Figure 78. Capture of parent stock ready for breeding in aquariums

Figure 79. Results of DNA amplification on target fish

- R&D 549 - Fish stocking program of the Volta Grande Fish Culture Station: proteomic and genomic evaluation of *Prochilodus lineatus.*

- Project 274 - Evaluation of the effectiveness of restocking at Nova Ponte and Volta Grande dams.

Figure 80. Marking fish

Figure 81. Release of fingerlings

Conservation

The impoundment of water is a factor that determines changes in its physical, chemical and biological characteristics. It directs the implementation of actions to evaluate and monitor these changes in order to promote the sustainable use of resources. Therefore, exploration and production factors are balanced and optimized from a more integrated perspective for appropriating resources, without harming the economy and minimizing environmental degradation.

In this sense, some of Cemig's projects have evaluated the environmental quality of its power plants reservoirs. They have used innovative methodologies that contribute to broaden the approaches adopted to evaluate and monitor bodies of water and innovate technologies to support the management of water resources and approaches in dealing with the problems associated with the use of these resources.

All projects presented below are considered unique in Brazil because in addition to exploring areas that have little information, they adopt techniques and strategies used internationally.

- Project 259 - Development of biotic integrity indices for environmental quality assessment and support for habitat restoration in areas where fingerlings are released.

Figure 82. Collection of plants for analysis of benthic macroinvertebrates

Figure 83. Collecting fish using a trawl

- Project 191 – Support for conservation and management of the ichthyofauna of the Jequitinhonha River Basin.

Figure 84. Surubim from the Jequitinhonha River

Figure 85. Use of gill nets to sample fish

- R&D 550 - Development of methodology for evaluating the feasibility of decommissioning a small hydroelectric plant (SHP).

- R&D 477 - Spatial variations of medium term and reservoir fish assembly index as indicators of habitat quality in Cemig's hydropower enterprises in Minas Gerais.

Figure 86. Fish collection for R&D 477

Figure 87. *Leporinus friderici*

- R&D 478 - Biotic integrity indices based on Fuzzy Logic, as an indicator of water quality for the state of Minas Gerais.

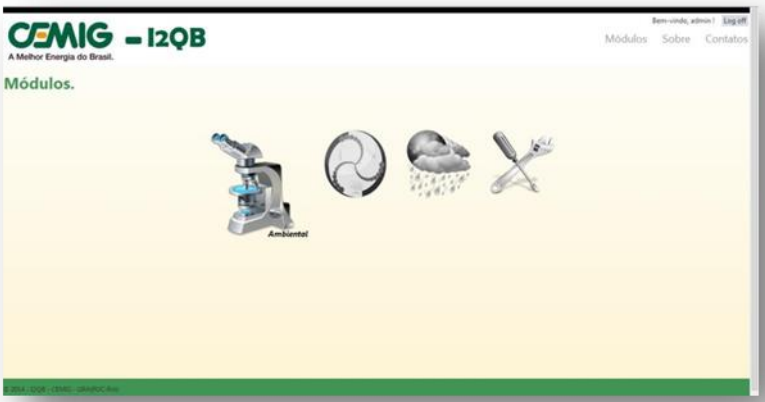


Figure 88. Software developed in R&D 477 using Fuzzy Logic concepts

- R&D 479 - Using the Ecological Integrity Index to rank the quality of aquatic environments in Minas Gerais.

Figure 89. Collection from the Cajuru SHP reservoir

Figure 90. Collection from Velhas River

Figure 91. Herborization samples of plant communities

- R&D 481 - Development of Biotic Integrity Indices: stream fish as indicators of water quality in river basins of Cemig's hydroelectric enterprises in Minas Gerais.

Figure 92. Fish collection - R&D 481

Figure 93. Fish collection - R&D 481

- R&D 485 - Research and water quality control of the Grande River Revitalization program.

Figure 94. Construction of research vessel

Figure 95. São Francisco River in the town of Pirapora

- R&D 486 - Research and water quality control of the Grande River Revitalization program.

Figure 96. Macrophytes in the Volta Grande HPP reservoir

Figure 97. Volta Grande HPP reservoir

- R&D 487 - Development of Biotic Integrity Indices: benthic macroinvertebrates as indicators of water quality in river basins of Cemig's hydroelectric enterprises in Minas Gerais.

Figure 98. Application of physical habitat assessment protocol

Figure 99. Measurement of physicochemical variables

Cyanobacteria

The eutrophication of aquatic environments is mainly caused by anthropogenic activities and changes in the trophic level directly impact the structure of communities and health conditions of environments.

Did you know: Cyanobacteria of the genus *Spirulina spp*. are used in the food industry for the composition of supplements due to their high concentration of vitamins and minerals.

One of the consequences of eutrophication is the proliferation of cyanobacteria forming blooms. The increase in algal biomass can cause problems such as oxygen depletion and subsequent fish kills, foul odors and unpalatable water. The most serious problems, however, are associated with the fact that some species of cyanobacteria can produce toxins - the main ones classified as hepatotoxins, neurotoxins, cytotoxins and dermatoxins.

- R&D 037 - Problems caused by water quality in the maintenance of hydropower plants - Subproject 3 - The contribution of phosphorus and presence of cyanobacteria in the reservoir of the São Simão HPP.

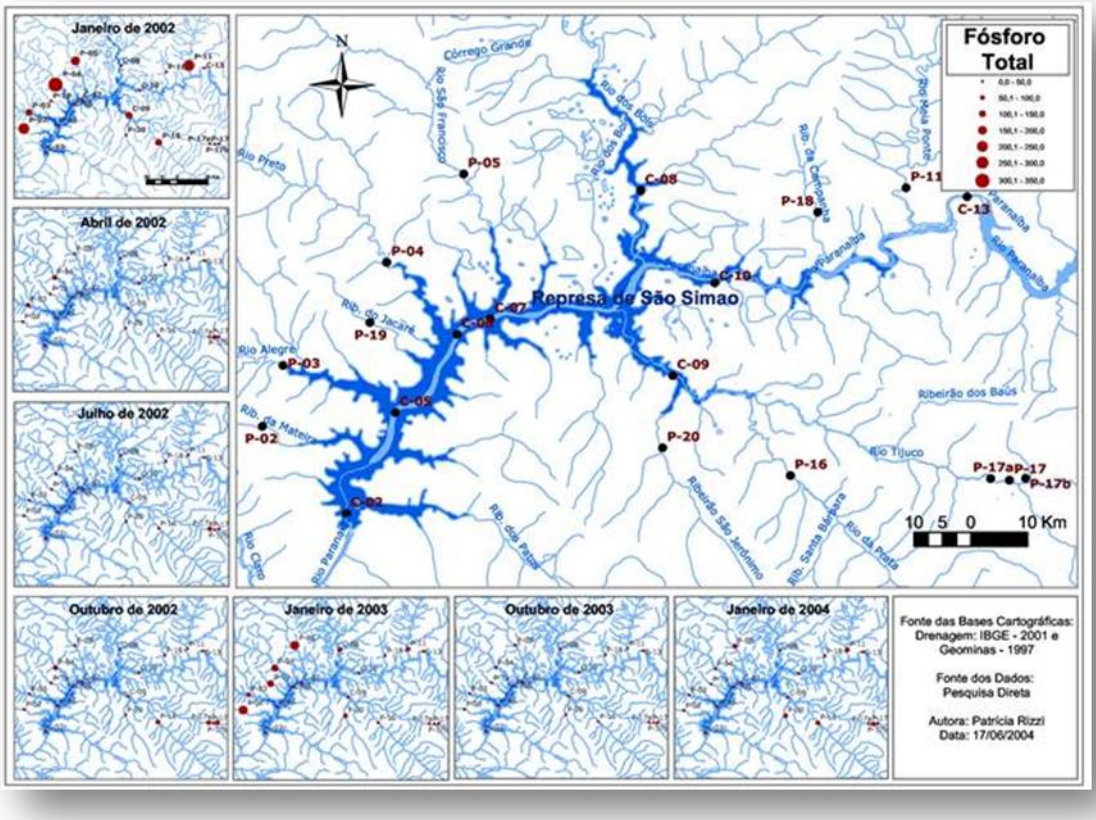


Figure 100. Collection points in the reservoir of the São Simão HPP

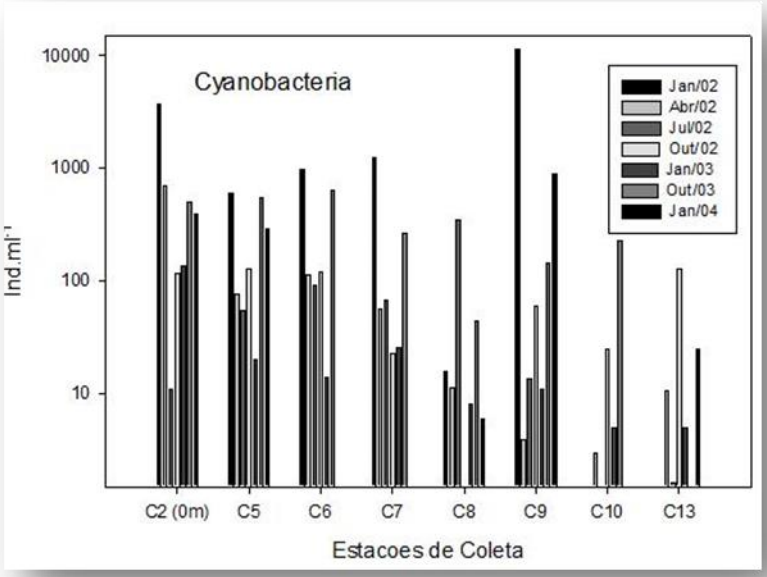


Figure 101. Density of cyanobacteria at collecting stations of São Simão HPP

Figure 102. Blooming of cyanobacteria at São Simão HPP

- R&D 346 - Development of new methodologies for the evaluation of the spatio-temporal distribution of cyanobacteria and cyanotoxins and its deleterious effects on fish and human populations in the Volta Grande reservoir.

Did you know: That the boiling water does not remove or destroys the toxins of cyanobacteria?

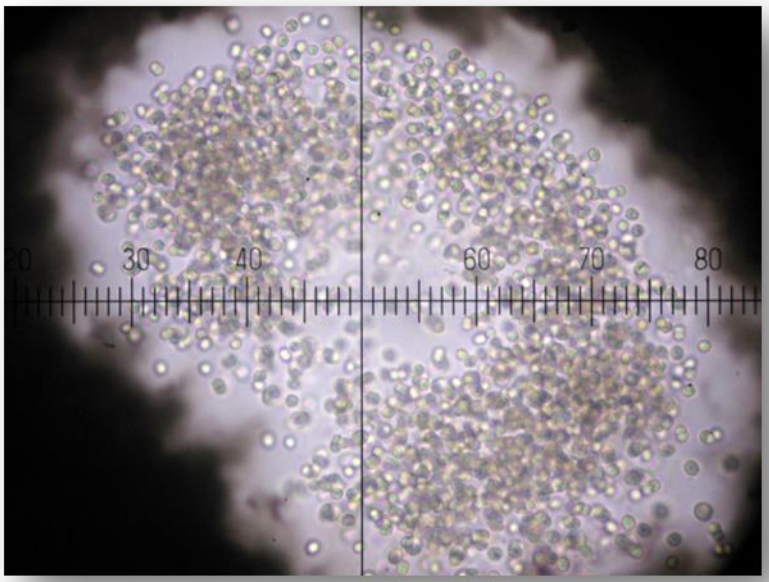


Figure 103. ***Microcystis protocystis***

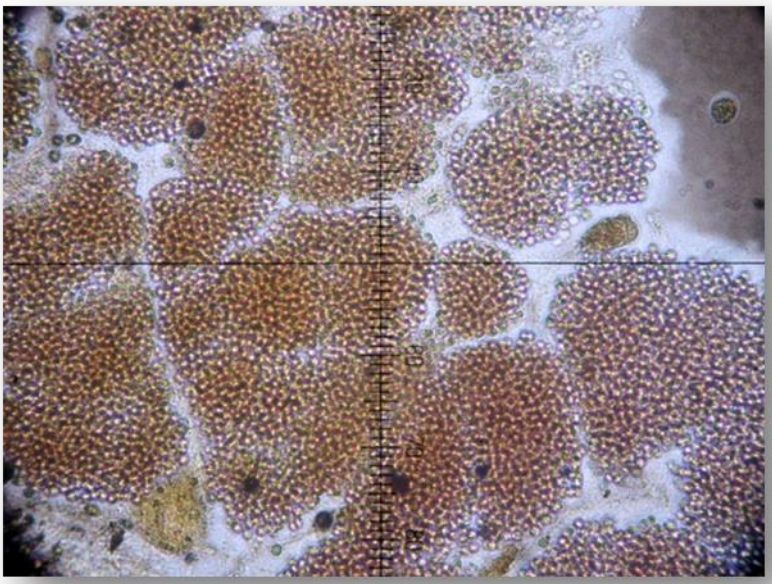


Figure 104. ***Microcystis icthyoblabe***

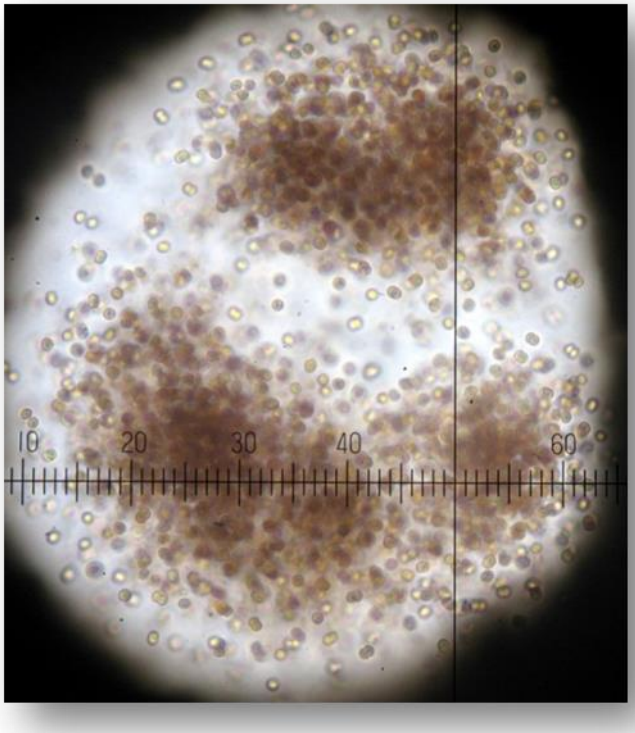


Figure 105. ***Microcystis novacekii***

Figure 106. ***Microcystis aeruginosa***

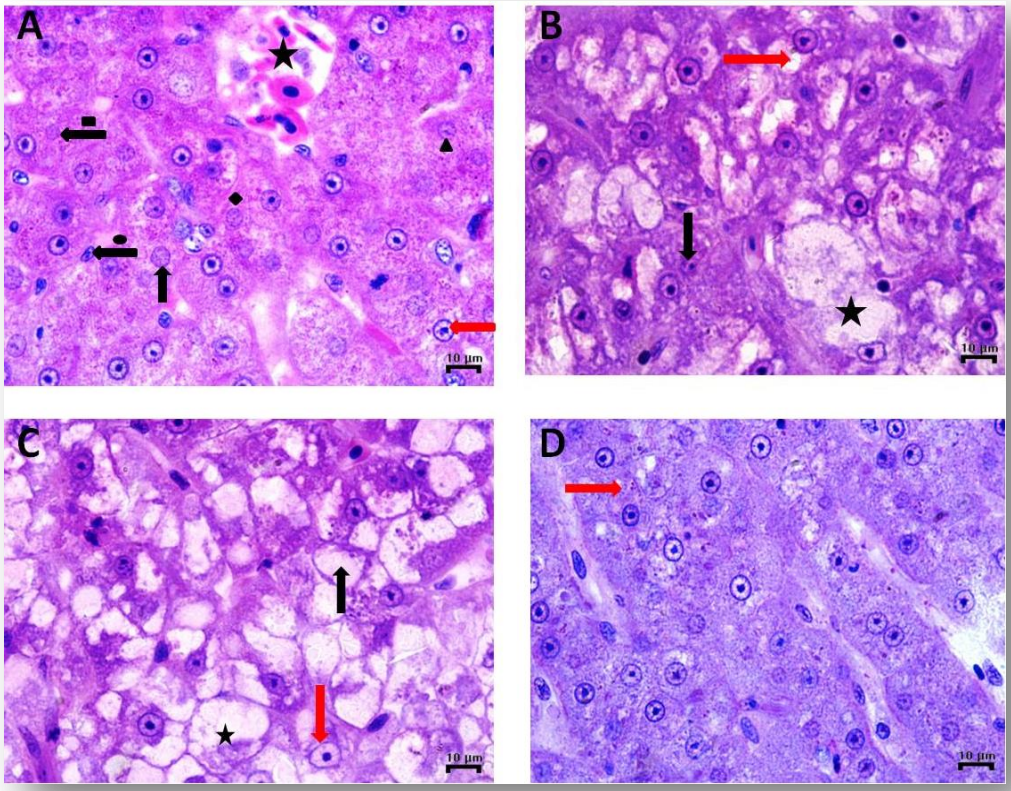


Figure 107. Hepatic histopathology of *Leporinus friderici* collected in the reservoir of the Volta Grande HPP (moderate to severe damage)

A: Blood congestion and nuclear degeneration; B: Cytoplasmic degeneration and deformation of the nuclear contour; C: Cellular hypertrophy and nuclear hypertrophy (red arrow); D: Eosinophil granules (red arrow).

Invasive species

Biological invasions are among the worst ecological problems of today and are considered by the IUCN (International Union for Conservation of Nature) as the second largest source of biodiversity loss on the planet.

Did you know: The UN International Maritime Organization estimated that approximately 2,214 species had been introduced into new ecosystems during the period from 1980 to 1998, through ballast water. In Brazil, ballast water was responsible for the transport of golden mussel larvae (*Limnoperna fortunei*) from regions in Asia.

In view of this information, it is important to emphasize that biodiversity conservation is not just a matter of saving species and their habitats. It involves a combination of factors related to natural ecosystems and human society, thus making it an extremely complex practice. Therefore, the effective conservation of biodiversity in a region requires strategies that integrate knowledge and the factors that threaten it, as well as the identification of innovative solutions to environmental problems.

One of the exotic species that Cemig in recent years has directed its efforts to combat is *Limnoperna fortunei*, commonly known as the golden mussel. The species has been affecting the integrity of natural communities, due to its high adaptability and absence of natural predators.

Through research and development projects, studies have been initiated on the species. In R&D 132, knowledge of the mussel's biology was sought after since there was little knowledge about this organism in Brazil. Through R&D 343, the Bioengineering Center for Invasive Species in Hydropower Plants (CBEIH) was created. The center looks for solutions to mitigate ecological, economic and industrial impacts caused by invasive species. The center operates in the areas of control, prevention and knowledge. This project has achieved innovative results such as the Rapid Detection and Immediate Response (RDIR) program, which is based on the Early Detection program by the Bureau of Reclamation, a North American government institute responsible for combating invasive species in the United States.

- R&D 132 - Development of methodology and research on the ecosystem and plants at hydroelectric power plants in order to control the spread of golden mussels.

Figure 108. Individual adult of *Limnoperna fortunei* – golden mussel

Figure 109. Manual cleaning of heat exchanger with the presence of individual *L. fortunei*

- R&D 343 - Golden mussel control: bioengineering and new materials for applications in ecosystems and hydroelectric power plants.

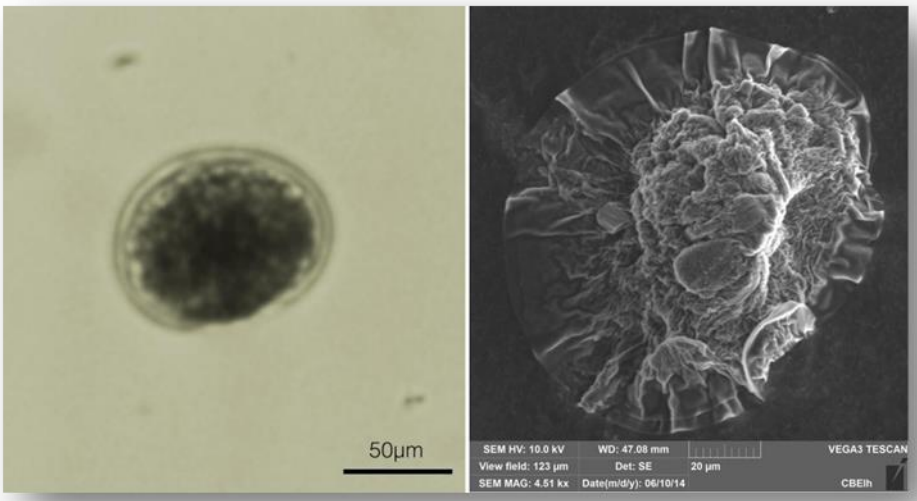


Figure 110. Optical microscopy and scanning electron microscopy of larvae detected in samples collected in hydroelectric plants and reservoirs

Figure 111. General diagram of CBEIH

Figure 112. Adult *L. fortunei* collected in the Paranaiba River downstream of the São Simão HPP

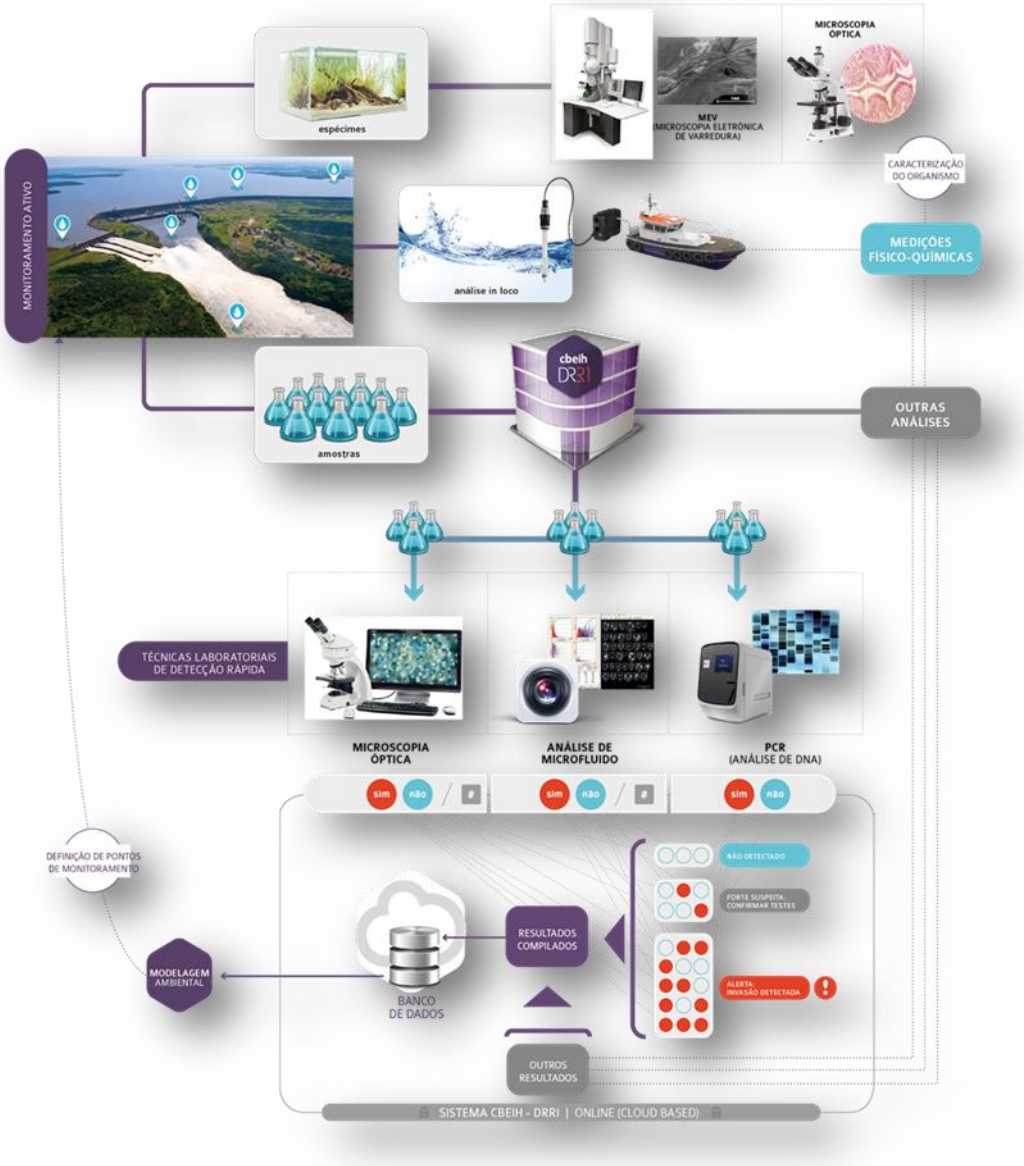


Figure 113. General diagram of the Rapid Detection and Immediate Response program

Conservation of Flora

The vegetation of surrounding water bodies is fundamentally important to the conservation of water resources. It features a set of ecological functions that are extremely important to quality of life, in particular to local human populations and the watershed. It is also essential for the conservation of terrestrial and aquatic plants and animals native to the region. Riparian forests influence water quality, water regime regulation, the stabilization of riverbanks, and reduce silting of the river channel. They are influenced by floods, nutrient supply and bordering aquatic ecosystems (Castro Pragnya, 2012).

The Brazilian forest code (Law No. 12.651 of May 25, 2012) determines the obligation to preserve the native vegetation on the banks of rivers, Headwaters, lakes and reservoirs in order to mitigate soil erosion, form a protective strip along water resources, protect fauna and flora of scientific or historical value, and ensure conditions of public welfare.

Did you know: Riparian forests are considered by the Brazilian forest code as Permanent Preservation Areas (PPAs).

Given the importance of vegetation to water resources, the R&D projects cited below deal with the recovery, preservation and conservation of flora, as well as assess the effectiveness of the revitalization efforts that Cemig has carried out over the years.

- R&D 484 - Effectiveness and sustainability of riparian forests of the Volta Grande reservoir on the conservation of ecological processes and biodiversity.

Figure 114. Partial view of the riparian forest at the Volta Grande HPP

Figure 115. Bird fauna monitoring - Volta Grande HPP

- R&D 456 - Phytogeographical model as the basis for revitalizing permanent preservation areas of the Grande River Basin.

Figure 116. Flora monitoring – Grande River Basin

Figure 117. Flora monitoring – Grande River Basin

- R&D 551 - Characterization of the reference ecosystem and deployment of recovery models of degraded areas in PRNH Fartura.
- R&D 365 – Integrated Vegetation Management.
- R&D 196 - Development of methodologies for revegetation and vegetation coverage to control erosion on steep cut slopes.

Você sabia que: O equilíbrio ecológico só é possível, de fato, com o manejo adequado das florestas e matas e preservação do meio ambiente.

Others

- R&D 198 - Environmental assessment of the Paraibuna River downstream of the Paciência SHP reservoir, after bottom discharges.

This project was completed in 2013 and developed research to evaluate, with the use of tracers and related techniques, environmental impacts such as advection, dispersion and sedimentation rate from bottom discharge disposal into watercourses downstream of the Paciência SHP reservoir on the Paraibuna River, in addition to assessing the environmental impact on its biological aspects, using the aquatic zoobenthos community present in this stretch as a bioindicator.

Figure 118. Application of tracers to evaluate bottom discharge of Paciência SHP

Figure 119. Flushed water with tracers downstream of the Paciência SHP

- R&D 399 - Development of georeferenced indices of water quality and socioenvironmental characterization of the region of cascade reservoirs: Volta Grande and Jaguara.

The little understanding of the environmental impacts of cascade reservoirs was the motivating factor of this project, which seeks to develop indicators for better

Did you know: Riparian vegetation fulfill the important function of corridors for fauna, as it allows wild animals to move from one region to another both in search of food and for mating purposes.

management of these impacts. These indicators should reflect the socioenvironmental conditions of the region.

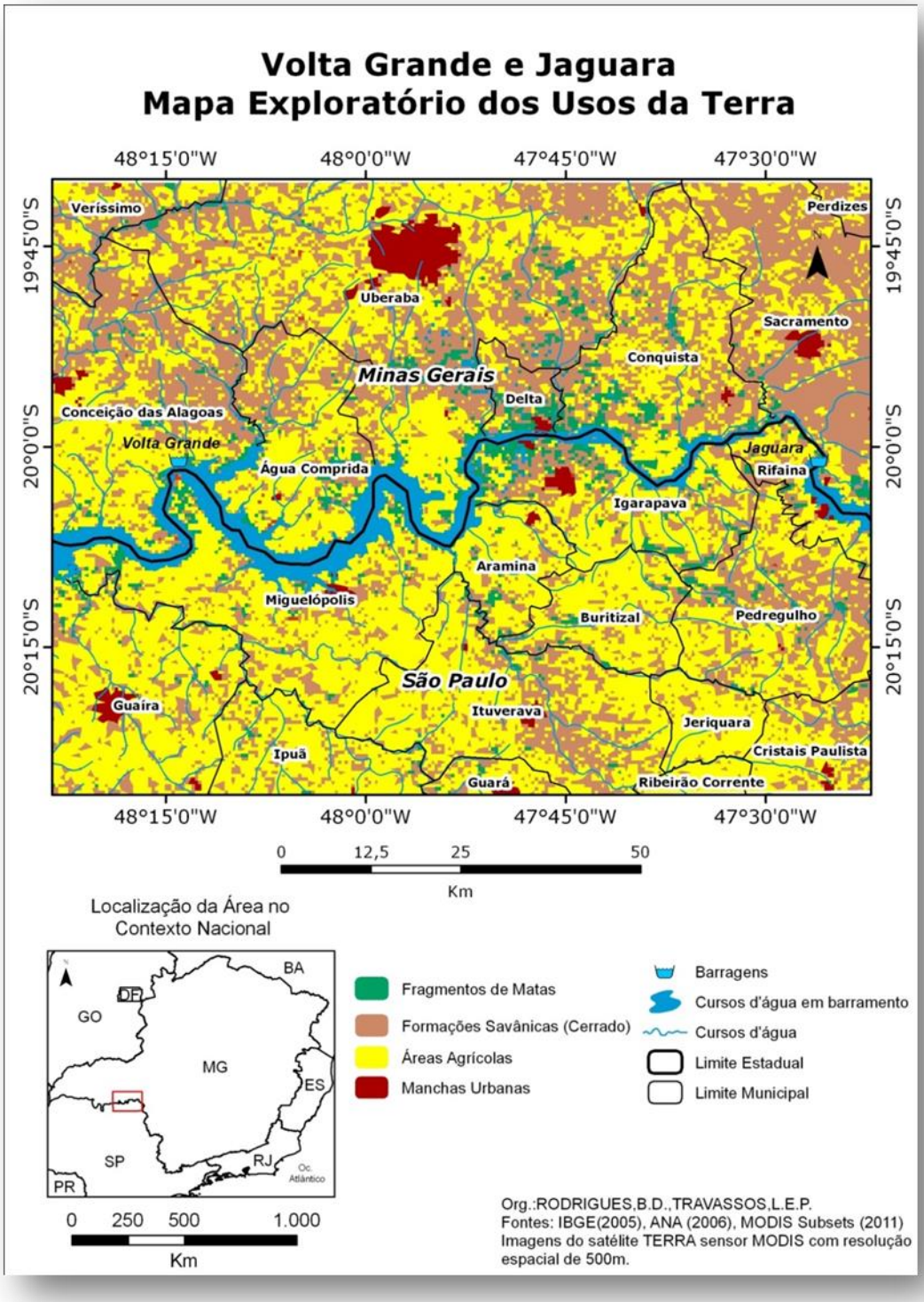


Figure 120. Exploratory land use map of Volta Grande and Jaguara reservoirs

Exploratory Land Use Map

Area Location in a National Scope

- Forest Fragments

- Savannah Formations (Cerrado)
- Agricultural Areas
- Urban Spots
- Water dams
- Watercourses damming
- Watercourses
- State border
- Town border

- R&D 402 - Application of multivariate chemometrics methods in watershed management.

Siságua, Cemig's database on water quality, is one of the evidence points on the Dow Jones Sustainability Index. It plays a key role within this project, which develops algorithms for the analysis of data stored in Siságua, which will be integrated with statistical software R to perform the BI (Business Intelligence) for the system. This innovation in data analysis, including the automation of graphics generated, will bring greater agility for Cemig to respond to environmental agencies and society.

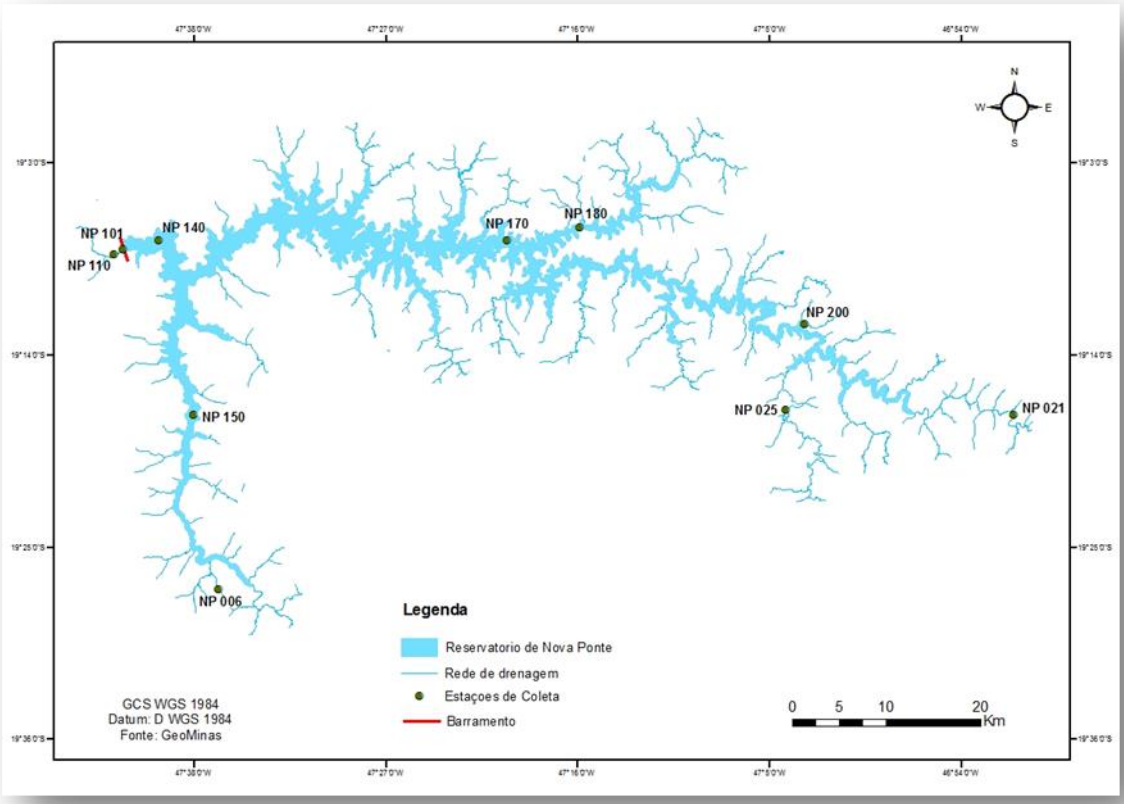


Figure 121. Evaluated collection stations in the Nova Ponte reservoir

7.1. Scientific Production

We emphasize the importance of the studies conducted on R&D programs for knowledge, conservation and restoration of biodiversity. The table below accounts for all of those involved directly or indirectly with the research as well as the scientific production generated from Cemig-financed R&D projects. The number of collaborators includes undergraduate (undergraduate research), master's and doctoral students, in addition to researchers who coordinate and work on the projects. The training of human resources is a pillar of extreme relevance for Cemig since students involved in these projects will be developing future scientific studies in the area, working in environmental agencies, NGOs and companies.

Scientific Production	
Search	**Total**
Scientific activities (students)	97
Master (students)	45
Doctoral (students)	21
Researchers	172
Scientific production	99
TOTAL	317

Table 5. Total scientific production undertaken in Cemig/ANEEL R&D projects

7.2. R&Ds in numbers

P&D Number	Investment	Study Development Area	Partner Institutions	Status
345	R$ 459.050,37	Estação de Piscicultura de Volta Grande	UFSJ	In progress
549	R$ 1.095.197,11	UHE Volta Grande	UFMG, UFV e UFVJM	In progress
550	R$ 1.447.611,98	PCH Pandeiros	UFLA, UFMG, Unimontes e UFPEL	In progress
483	R$ 2.316.858,95	UHE Irapé	Fundação Biodiversitas, LAPAD/UFSC, UFT e UFSJ	In progress
985	R$ 4.092.905,48	UHEs Amador Aguiar II, Camargos, Emborcação,	UFMG	In progress

		Funil, Itutinga e Três Marias e a PCH Pai Joaquim		
334	R$ 1.771.046,00	UHE Três Marias	UFLA, UFMG e CEFET-MG	In progress
274	R$ 1.999.968,73	UHEs Jaguara e Volta Grande	UFMG, UFV, UFSCar e UFSJ	In progress
191	R$ 793.938,60	UHE Irapé	Unimontes, PUC Minas e UEL	In progress
Anti-shoal grids	R$ 6.636.850,20	UHE Três Marias	-	In progress
343	R$ 6.361.230,03	-	CETEC	In progress
399	R$ 2.933.158,80	UHEs Jaguara, Volta Grande e Igarapava	PUC Minas	In progress
402	R$ 1.340.779,47	-	UFMG	In progress
477	R$ 790.231,85	UHEs Volta Grande e Nova Ponte	PUC Minas	In progress
479	R$ 3.058.770,50	PCHs Peti e Cajuru	SENAI FIEMG	In progress
481	R$ 339.902,39	UHEs Nova Ponte, Três Marias, Volta Grande e São Simão	UFLA	In progress
485	R$ 2.629.438,00	Bacia do Rio São Francisco	UNESCO-HidroEX	In progress
486	R$ 1.674.303,90	UHE Volta Grande	UNESCO-HidroEX	In progress
487	R$ 2.997.357,84	UHEs Nova Ponte, Três Marias, Volta Grande e São Simão	UFMG	In progress
484	R$ 2.611.127,95	UHE Volta Grande	UFOP	In progress
456	R$ 5.290.015,66	Bacia do Rio Grande	UFLA	In progress
03746	R$ 1.060.330,74	RPPN FARTURA	UFVJM	In progress
365	R$ 1.200.000,00	-	DOW AgroSciences, CGTI e Bueno&MAK	In progress
200	R$ 1.389.570,33	UHEs São Simão, Marimbondo e Jaguara	UFMG	Finalized
094	R$ 170.983,28	UHEs Gafanhoto e Volta Grande	PUC Minas	Finalized
203	R$ 797.975,08	UHE Itutinga	UFMG, UFLA e CEFET	Finalized
142	R$ 1.198.634,63	UHE São Simão	PUC Minas, UFMG e UNIFEI	Finalized
208	R$ 435.243,55	UHE Volta Grande	PUC Minas e UFTM	Finalized
455	R$ 7.512.693,36	UHE Três Marias	UFV, UFMG e UFLA	Finalized
040	R$ 238.036,60	UHEs Volta Grande e Jaguara	PUC Minas e UFMG	Finalized

041	R$ 70.000,00	UHE Nova Ponte	UFMG	Finalized
080	R$ 189.810,40	-	UFMG	Finalized
082	R$ 171.917,20	UHE Igarapava	UFMG	Finalized
229	R$ 2.289.270,78	UHEs São Simão, Amador Aguiar II, Três Marias, Camargos, Emborcação, Itutinga e Funil, e PCH Pai Joaquim	UFMG	Finalized
259	R$ 2.227.280,53	UHEs Nova Ponte, Três Marias, São Simão e Volta Grande	UFMG, UFLA, CEFTE-MG, PUC Minas	Finalized
037	R$ 886.997,00	UHE São Simão	CETEC, PUC Minas, UNESP e UFMG	Finalized
132	R$ 1.200.548,74	-	CETEC	Finalized
198	R$ 469.401,40	PCH Paciência – Rio Paraibuna	CETEC, CDTN	Finalized
346	R$ 2.066.864,99	UHE Volta Grande	UFMG, UFSCar	Finalized
478	R$ 1.399.974,82	-	PUC Rio	Finalized
196	R$ 274.145,79	-	UFV e CBCN	Finalized

Table 6. Summary of R&Ds

8. Team responsible for preparing the Biodiversity Report

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Environmental Engineer
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