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Reasons to Approve and Deny Hydropower Projects in Brazil

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Abstract: This paper reviews and discusses how the concept of environmental viability is applied by the Brazilian federal environmental agency, IBAMA, for decision purposes regarding the issuance of previous licenses for hydropower plants. It presents the main justifications used in EIAs and by the licensing body to certify the environmental viability or to deny the application for a Previous License. A survey was carried out based on the review of federal environmental licensing processes of hydropower plants that underwent a previous licensing phase. We highlighted the following as arguments to justify environmental viability at EIA Reports: possibility of minimizing negative impacts predicted by the adoption of environmental programs and mitigation measures, followed by possibility of income generation and dynamization of the region's economy. We frequently observed IBAMA's requests for adjustments to the project to subsidize the issuance of previous licenses, most of which were issued. When no alternatives were envisaged to make the project viable, the license was denied and the environmental non-viability was declared. We identified the criteria used by IBAMA to subsidize an environmental viability decision.

Key words: impact assessment, environmental licensing, environmental acceptability, hydropower plants

1. Introduction

Brazil has electricity generation matrix of predominantly renewable origin. Hydroelectric generation responded for 64% of the electricity supply in 2015 [1]. The Ten-Year Energy Plan 2026 under public consultation provides for the implementation of 15 new hydropower plants within a 10-year horizon [2].

According to Brazilian government, this is the best option for electricity generation because it is cheaper [3], emits lesser greenhouse gases than fossil fuel thermal plants [4-7]; has great potential to be explored [8], renewable and capable of inducing local socioeconomic development, especially during installation [9], although increased municipal revenues are not always reflected better social indicators [10].

However, hydroelectric power plants have significant environmental impacts, which are very often irreversible [11]. The environmental impacts could be even more relevant if the hydropower plant is to be developed in environmentally relevant or sensitive areas [12, 13].

In Brazil, EIA is carried out in order to provide elements for environmental licensing instrument provided by Law no. 6.938/1981.

Brazil's EIA procedure has 3 (three) stages with specific licenses: (i) prior license, when the project's environmental viability is discussed, as detailed below; (ii) installation license, when the work is authorized to start; and (iii) operating license, when the enterprise is authorized to operate, which includes filling the reservoir and power generation start-up in the case of hydroelectric plants (Law no. 6.938/1981);

In the first stage or prior to licensing stage, the project is assessed in terms of location and concept,

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based on EIR (Environmental Impact Assessment Report) analysis.

The decision on the issuance of environmental licenses is discretionary of the IBAMA President, who, according to IBAMA Normative Instruction no. 11/2010, may request the expert advice of the Environmental Licensing and Evaluation Commission, in case of high complexity projects.

The document which supports this decision-making body is the conclusive technical evaluation opinion of Environmental Impact Study prepared by a technical team and designated to conduct the project's licensing. When the aforementioned Commission is convened, in addition to the technical opinion, a Report of the Licensing Process, RPL, is drafted.

For the issuance of previous licenses, the environmental agency must, according to the CONAMA Resolution no. 237/97, "certify the environmental viability" and, if so, establish the main conditions for performing the activity, the basic requirements to be detailed, and the installation and operation stages.

However, the concept of environmental viability has not been legally defined, nor is there a theoretical and practical consensus on how this concept should be applied.

According to Sánchez (2013) [14], the concept of environmental viability does not have a single interpretative form, "it is not univocal". Its conceptualization must be a "product of a specific process, always considering the nature and the size of the activity or project and the environment where it is intended to be implemented" [15].

According to Montano and Souza (2008)[16], the characteristics of the environment (physical, biotic and anthropic) and the (technological) characteristics of the activity or project to be implemented compete for environmental viability, considering the level of environmental quality established for the moment of implantation and that required over time. The analysis should take into account not only strictly environmental aspects, but also social and economic issues, and should be based on the EIA, although this is not binding [17] or decisive for decision-making [18, 19].

In a simplistic analysis, environmental viability is assessed by verifying whether all procedures set out in the previous licensing step have been completed, and whether the execution of an activity could result in a breach of law or other legal provisions. The assessment of environmental viability should not, however, be restricted exclusively to formal analyses, which are intended solely to identify procedural problems. It is also necessary to take into account the evaluation of alternatives, impacts, risks, prognoses and mitigating and compensatory measures.

In general, environmental viability analyses should be the result of impact assessments, which should be carried out within the scope of EIAs. Impact assessments can be qualitative or quantitative. Several techniques were developed to perform this evaluation: intuitive methods, weighted matrices, multicriteria analysis etc. Depending on the technique, different results can be obtained, and therefore different conclusions can be reached about the viability of a same project.

However, we consider that impact assessments, even if quantitatively represented, are the result of techniques invariably based on subjective assessments [20], since, in order to compare impacts, it is necessary to establish decision weighing standards or judgments of value for each impact [14]. As stated by Bim (2014) [17], the weighing to be attributed to each element analyzed is not cartesian and the decision, as the fruit of complex pondering, "is far from being a mathematical account".

In order to apply impact assessment techniques, it is necessary to compare impacts with completely different characteristics and coverages, positive and negative aspects, short, medium and long term, reversible or irreversible consequences, mitigable or non-mitigable. As the result of a same impact assessment, different conclusions can be reached on the degree, importance and magnitude of impacts and, as a consequence, on the environmental viability of a project.

The environmental viability analysis should also evaluate the effects induced by anthropic actions, so as to verify their compatibility with the environment's ability to assimilate such effects without affecting the productivity of environmental systems [21]. It is necessary to evaluate whether the environment can withstand the impacts caused by the activity. Despite the advantages that a project may bring, there are inadmissible consequences that should not be accepted (such as extinction of species). Thus, it is necessary to assess the maximum limits for the occurrence of negative impacts and the resilience of the environment to high-impact impacts.

This paper aims at discussing how the concept of environmental viability or sustainability has been applied by The Brazilian Environmental Institute (IBAMA) to support the issuing of environmental permits of hydropower plants. Reasons and criteria to approve and deny environmental licenses for hydropower plants will be presented and discussed here.

2. Material and Methods

Data was collected by reviewing 24 (twenty-four) out of all the 29 (twenty-nine) federal environmental licensing processes for hydroelectric plants that had been through the prior licensing phase. Part of survey results was published by Andrade and Santos (2015) [22]. This article will focus and present reasons and criteria to approve and deny environmental licenses for hydropower plants, and present research results not published in the mentioned study.

The documents were obtained during a review of the physical processes available in IBAMA’s Environmental Licensing Board archives and by consultation in the SISLIC, Federal Environmental Licensing System, IBAMA on-line platform, which makes available the documents of administrative procedures. The information was collected between January 2013 and November 2014.

In 5 (five) cases, it was not possible to obtain a complete information since the processes had not been digitized and were not available in the archive of the Environmental Licensing Board.

It is worth explaining that most hydropower plants currently in operation in Brazil did not undergo a previous environmental licensing process since they began their construction before the establishment of the National Environmental Policy and the federal environmental licensing regulation carried out by the Decree no. 99274/90 and the CONAMA Resolution no. 237/97. There are currently 93 (ninety-three) IBAMA hydropower plant processes. However, in only 29 (twenty-nine) processes, an environmental viability assessment was carried out.

A list of all process analyzed was included in Annex 1. When reviewing federal environmental licensing processes for hydroelectric plants, we looked for the most important criteria adopted in the EIA when discussing viability and the reasons to declare a project environmentally unsustainable.

3. Results

In diagnosing licensing processes for hydroelectric plants where environmental viability was discussed, we found no pattern in both the EIA and the licensing body technical opinion in practice to determine enterprises environmental viability and to evaluate EIA’s quality.

Based on the EIRs, the main reasons to justify the environmental viability include the possibility of minimizing negative impacts forecast by adopting environmental programs and mitigating measures; the possibility of generating income and boosting the region’s economy (Fig. 1). Reasons to justify the environmental viability in the EIRs for each process analyzed are shown in Annex1.

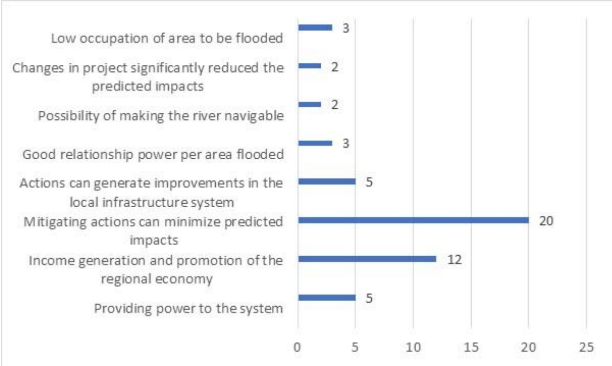

Fig. 1 Reasons to justify the environmental viability at EIRs.

Diagnosis and prognosis are very often non-conclusive, so that licensing institution frequently resorts to the precautionary principle as justification for environmental license request rejection, or the need for additional information to complement the study.

In the survey, we verified that in 67% of the cases, IBAMA returned EIAs/RIMAs because of lack of presentation of a minimum content as required by the Terms of Reference. In 79% of the cases, IBAMA requested additional information. There were cases in which up to 4 versions of EIA/RIMA were registered in IBAMA (HPP Uruçui).

The time taken to obtain previous licenses and the need to submit additional information is much criticized. However, it is important to consider that environmental impact assessments are not simple and require, in most cases, in-depth and seasonal studies on the state of the environment.

Based on well-prepared diagnoses, it is possible to predict the effects of actions arising from planning, installation and operation of projects. Without the necessary information and based on the principle of prevention, the agency eventually requires additional information, which contributes to the delay in the issuance of environmental licenses [23].

IBAMA's final decision is often qualitative, subjective and discretionary even though based on environmental studies. Some criteria were used to check if the hydropower project was environmentally viable or sustainable:

- if project installation or operation would result in the violation of any law or legal rule;
- if the best locational and technological alternatives for the project are proposed;
- if the most significant environmental impacts are mitigated, reversible or temporary;
- if the environment can withstand the impact of installation and operation of an enterprise maintaining minimum environmental quality;
- if there is positive balance between gains and environmental costs;
- if the scenario under installation and operation of the project is more promising than the one in which the project is not built.

The determination of criteria was the result of an interpretative analysis of IBAMA's internal documents, since we found that there was no model, standard or technical procedure to be followed by technical opinion reports and internal dispatches that subsidized the issuance or rejection of licenses.

There were also cases in which the arguments for the issuance or rejection of Licenses as adopted by IBAMA diverged from the criteria and justifications presented in EIAs, corroborating with the results of a survey carried out by Cashmore et al. (2004) [19], who concluded that EIAs are not always determining in deciding whether or not to implement a project, and also in cases where more than one criterion was used to support decision-making.

In order to illustrate the technique used to identify criteria, Table 1 lists examples of justifications pointed out by IBAMA for decision-making, and the criteria used.

In the survey, we also sought to identify the reasons for the rejection or suspension of previous license applications. We found that the previous license is normally denied for more than one reason. Among the reasons for the rejection of an application for a previous license or suspension of proceedings, we identified the possibility of direct interference with integral protection areas or areas aiming animal breeding, the possibility of interference with indigenous lands and the possibility of increasing the risk of extinction of endemic or threatened species (Fig. 2).

Table 1 Examples of the use of criteria to define environmental viability.

Examples of justifications pointed out by IBAMA for decision-making	Criteria for assessing viability
HPP Marabá - process suspended in face of the prediction of flooding of indigenous lands, which would be contrary to the Article 231 of the Federal Constitution, which has not been properly regulated.	verification if the installation or operation of the project would result in the violation of any law or legal rule
HPP Itaocara - EL initially rejected due to social impacts of high magnitude. An alternative was presented and the project, which initially provided for the construction of a dam, was divided into two, which resulted in the reduction of the area expected to be flooded by 59% (from 64.47 km² to 38.39 km²). By applying changes, the locations of Formiga/MG and São Sebastião do Paraíba/RJ were outside the future area of the reservoir, and the project had its environmental viability attested by IBAMA	evaluation if is being proposed the better locational and technological alternative for the project
HPP Serra do Facão - EL issued upon verification that the main impacts could be minimized by the adoption of environmental programs considered relevant	assessment if the most significant environmental impacts are mitigated, reversible or temporary
HPP Couto Magalhães - Despite the EIA predicted an equivalence between positive and negative impacts and having concluded positively for environmental viability, the EL was denied by IBAMA, as the proposed ecological flow for the reduced flow section would not allow the maintenance of aquatic ecosystems	review if the environment can withstand the impact of the installation and operation of an enterprise and maintain a minimum environmental quality
Use of the ratio Firm Energy/Flooded Area as an indirect parameter for the cost/benefit assessment. It subsidized the issuance of ELs of the HPPs Santo Antônio (7.89 MW/km^2), Jirau (7.36 MW/km^2), Belo Monte (8.85 MW/km^2) and Simplício (11.99 MW/km^2), which have a relatively small flooded area compared to the energy to be generated. On the other hand, it also subsidized IBAMA to declare the environmental unviability of the Ipueiras (0.45 MW/km^2) and Uruçui HPPs (0.48 MW/km^2), which among other factors presented an unfavorable firm energy/flooded area ratio.	assessment if there is a positive balance between gains and environmental costs;
Belo Monte HPP - Although the EIA predicted highly significant and irreversible environmental impacts, the installation of the project was seen at the time as an opportunity for the implementation of a series of actions, projects and programs under the responsibility of the entrepreneur and the federal government (in the PDRS Xingu - Xingu Sustainable Regional Development Plan), which were designed to improve the environmental quality of the region and to promote the institutional strengthening of municipalities, while the scenario envisaged for the region, without the installation of the project, pointed to an increase in deforestation, landgrabbing, disorderly occupation, and depreciation of public services.	assessment if the scenario that considers the installation and operation of the project is more promising than the scenario in which the project is not built

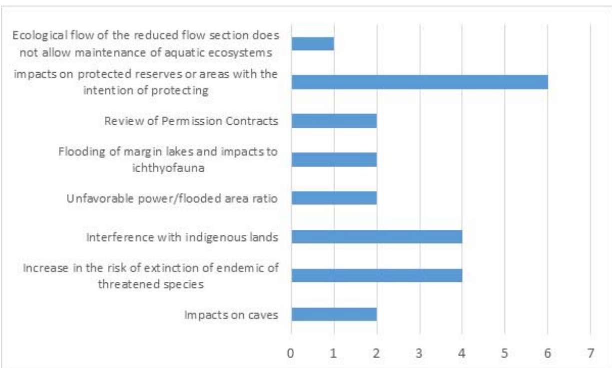

Fig. 2 Reasons to deny prior licenses or declare a project unsustainable.

By the diagnosis of the processes that underwent environmental viability assessments in IBAMA, we verified that in 85% of the processes of hydropower plants that received previous licenses, significant environmental gains were identified.

The gains covered all the measures foreseen in the mitigation hierarchy. Thus, measures to avoid, minimize, recover and compensate for predicted environmental damages were taken into account. The details of environmental gains identified in each case are presented in Annex 2.

5. Conclusions

In this study, we discussed the main reasons, justifications and criteria used in EIAs and by the IBAMA for the definition of the environmental viability of hydropower plants. Different views and approaches were verified on how this concept is applied for the purposes of decision-making regarding the issuance of previous licenses.

In such studies, we highlighted as arguments to justify environmental viability: possibility of minimizing the negative impacts predicted by the adoption of environmental programs and mitigation measures, followed by the possibility of income generation and dynamization of the region’s economy.

We frequently observed an IBAMA’s request for adjustments to the project to subsidize the issuance of previous licenses, most of which were issued. When no alternatives were envisaged to make the project viable, the license was denied and the environmental unviability was declared. In such cases, the reasons for the rejection of licenses were clearly justified and listed in this study.

We found that the IBAMA’s decision to declare environmental viability is not always clearly and explicitly justified. The following criteria were identified: compatibility of the project with the law, verification of the presence of a locational and technological alternative, economically and environmentally viable for the project, and whether proposed mitigating measures corresponded to the identified impacts, assessment of whether the most significant environmental impacts are mitigable, reversible or temporary, verification of the capacity of support for the environment against the impacts of the project, assessment of the occurrence of a positive balance between environmental gains and costs, and comparison between future scenarios for the region, considering the installation or not of the project. In many cases, more than one criterion was used to reach a decision.

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Annex 1 Reasons to justify environmental viability at EIAR.

No.	Hydropower	Reasons to justify environmental viability at EIAR
1	Aimorés	Entrepreneurship will generate positive ecological and economic impacts to motivate the preservation and creation of other planned options of use and exploration in the area, which minimizes negative impacts.
2	Batalha	Implementation of the enterprise can accelerate the economy dynamics in the region; negative effects should be minimized by implementing environmental programs proposed in the EIA
3	Belo Monte	Pressure for deforestation of the region will continue to occur in the event of non-installation of the development; (PDRS - Xingu, contributing to the sustainable development of the region, anticipatory actions in support of local infrastructure can minimize the effects of expected migration, environmental compensation actions may contribute to the protection of areas Changes in design and proposed mitigating measures are able to reduce most of the predicted impacts and the energy to be generated will be quite significant.
4	Cachoeira	Possibility of generating income and local development, energy to be made available to the system and mitigating measures can guarantee environmental quality of the region. Programs to mitigate impacts on the population can result in improvements to population affected
5	Castelhanos	Possibility of generating income and local development, energy to be made available to the system, and mitigating measures can guarantee environmental quality of the region. Programs to mitigate impacts on the population can result in improvements to population affected
6	Couto Magalhães	Change in project considerably reduced the environmental impacts of the project. positive impacts arising from the generation of energy and dynamism of the local economy, possibility of reducing the environmental impacts predicted through the adoption of proposed mitigating measures
7	Davinópolis	Region where the enterprise will be inserted is a fairly anthropized area, impacts may be minimized, possibility of the enterprise boosting the region's economy, construction of the enterprise will increase the water availability for the Davinópolis AHE region and will provide multiple use of river
8	Estreito (Parnaíba)	Possibility of generating income and local development, energy to be made available to the system, mitigating measures can guarantee environmental quality of the region, programs to mitigate impacts on the population can result in improvements for the affected population
9	Estreito (Tocantins)	Possibility of improvements for the region's population in health, education, resettlement infrastructure, increase of revenue for municipalities, possibility of mitigation and compensation of foreseen impacts
10	Foz do Chapecó	EIAR not available
11	Ipueiras	EIAR not available
12	Itaocara	With the adoption of mitigation programs and measures, it was not envisaged the occurrence of impacts of great relevance
13	Jirau	Good relation reservoir/power area, possibility of building locks to make river navigable in the stretch, possibility of mitigation of the most significant adverse impacts, positive impacts considered relevant
14	Pai Querê	Mitigating measures and environmental programs are able to mitigate predicted environmental impacts
15	Ribeiro Gonçalves	Not specified
16	Santo Antônio (Jari)	Alteration of the project resulted in a significant decrease in the magnitude of the impacts, vegetation to be suppressed and the reduction of habitat imposed will not be limiting for local fauna preservation, especially if it is considered the continuous widths of similar vegetation in the area of influence, waterfall to be affected already represents a natural obstacle to fish migration, few families to be relocated.
17	Santo Antônio (Madeira)	Good relation reservoir/power area, possibility of building locks to make river navigable in the stretch, possibility of mitigation of the most significant adverse impacts, positive impacts considered relevant
18	São Manoel	Sparsely populated region; Possibility of local development and generation of jobs, possibility of minimizing environmental impacts through the adoption of mitigating measures and environmental programs
19	São Salvador	Possibility of minimizing the negative impacts and relevant positive impacts from the socioeconomic increase of dynamism of the region
20	Serra do Facão	Possibility of minimizing negative impacts, suggested environmental programs can improve the region's environmental quality, relevant positive impacts resulting from the availability of energy and construction of two bridges over the reservoir to facilitate access
21	Simplício	Positive impacts resulting from the availability of energy and socioeconomic dynamism of the region, most of the adverse impacts are temporary and can be mitigated through the execution of mitigation actions.
22	Teles Pires	Positive balance between negative and positive impacts resulting from the project, low human occupation of the area directly affected, excellent power / flood ratio, possibility of minimizing negative effects arising from the installation of the project.
23	Tijuco Alto	Changes in the project have reduced the negative impacts and can generate positive impacts (control of floods in the river valley, possibility of navigation in the reservoir and use of the lake for tourism purposes), an enterprise can induce regional economic development, predicted impacts can be mitigated through implementation of environmental programs
24	Uruçui	Possibility of generating income and local development, energy to be made available to the system, mitigating measures can guarantee environmental quality of the region, programs to mitigate impacts on the population can result in improvements for the affected population

Annex 2 Identified environmental gains.

No.	Hydropower	Environmental Gains Identified
1	Aimorés	Increased ecological outflow, inclusion of a support program for fishermen, protection of forest area (7.72 ha), creation of negotiation forums with the community
2	Batalha	Not identified
3	Belo Monte	Decrease in flooded area, change in the maximum quota and reservoir configuration, implementation of anticipatory actions for infrastructure adequacy, execution of a drift channel to enable fish migration, reconfiguration in some canal reservoir arms to reduce risk of reservoir eutrophication, ecological hydrogram with flood discharge in the TVR of 8,000 m^3/s capable of promoting the maintenance of hydrological pulses, flooding of stony river courses, and partial flooding of alluvial forests;
4	Cachoeira	New programs: implementation of transposition systems and re-population of fish within the influence area, creation of a negotiation forum with the affected community, support program for the migrant population and training of local labor, monitoring of groundwater, installation of canal locks, construction of screening centers of wild animals
5	Castelhanos	New programs: implementation of transposition systems and re-population of fish within the influence area, creation of a negotiation forum with the affected community, support program for the migrant population and training of local labor, monitoring of groundwater, the installation of canal locks, construction of screening centers of wild animals
6	Couto Magalhães	Decrease in the reservoir quota by 647 m, flooding area from 647 km^2 to a reservoir at the 623 m quota, flooding area of 9.11 km^2
7	Davinópolis	Not identified
8	Estreito (Parnaíba)	New programs: implementation of transposition systems and re-population of fish within the influence area, creation of a negotiation forum with the affected community, support program for the migrant population and training of local labor, support for extractive activities, monitoring of groundwater, installation of canal locks, construction of screening centers of wild animals
9	Estreito (Tocantins)	Reduction of the reservoir level from the quota 158 to the 156, decrease in the area to be flooded by 70 km^2, new programs to support river transport in the reservoir, monitoring of beaches and promotion of tourism, germplasm recovering, upstream fauna enrichment, fish transposition system, reforestation of the EPA
10	Foz do Chapecó	Not identified
11	Ipueiras	Prior license denied
12	Itaocara	Change in project design, which previously provided for 1 dam and was changed to 2 dams. The change reduced by 59% the flooded area (from 64.47 km² to 38.39 km²). Locations of Formiga (Estrela Dalva, MG) and São Sebastião do Paraíba (Cantagalo, RJ) are no longer completely flooded.
13	Jirau	Change in project with prediction of construction of two dams instead of one, reduction of flooded area, establishment of an EPA 500 m from the banks of the reservoir, the construction of a fish transposition system, support program for local infrastructure
14	Pai Querê	Prior license denied
15	Ribeiro Gonçalves	New programs: transposition and re-population of fish within the influence area, creation of a negotiation forum with the affected community, support program for the migrant population and training of local labor, monitoring of groundwater, installation of canal locks, construction of screening centers of wild animals
16	Santo Antônio (Jari)	Change in the arrangement of the project (location of the powerhouse) in order to preserve waterfalls; increase in the ecological flow (favoring the maintenance of the biota and the scenic use of the Santo Antônio do Jari waterfall), inclusion of a program to support local infrastructure and creation of negotiation forums with the community
17	Santo Antônio (Madeira)	Change in project with prediction of construction of two dams instead of one, reduction of flooded area, establishment of an EPA 500 m from the banks of the reservoir, anticipation for the construction of a fish transposition system, support program for local infrastructure
18	São Manoel	Downstream ichthyofaunal repopulation program, construction of a canal lock, change in the location of the axis to avoid interference with the Kayabi indigenous land
19	São Salvador	Inclusion of a program for resettlement of owners, inclusion of actions to reinforce basic sanitation infrastructure
20	Serra do Facão	Not identified
21	Simplício	Change in project settling and decrease in the normal maximum level to preserve the urban area of three rivers, increase in ecological flow, construction of dams and change in the structure of the reservoir to reduce the risk of eutrophication, installation of devices to maintain a remaining flow of tributaries, inclusion of a program of re-adaptation of fishing activity, construction of collection and treatment systems of the TVR removed from the Anta landfill
22	Teles Pires	Not identified
23	Tijuco Alto	Withdrawal of the bottom dump in order to contain sediments with a high metal content; reduction of the depletion height of the reservoir from 55 m to 5 m, aiming to reduce erosive processes on the marginal slopes of the reservoir; elevation of the water outlet from 220 m to 272 m: this change affects directly the downstream water quality of the dam, resulting in a higher quality due to the removal of water from the upper quota column, with higher levels of dissolved oxygen; elimination of the reduced flow section: with this change, once the reservoir is filled, the flow of the river downstream from the dam will undergo much less significant changes, without sections with a reduced flow; 1 m reduction in water blade height: reduces the flooded area and, consequently, the area affected by the project.
24	Uruçui	Prior license denied