

## Attributes and Magnitude of the Socio-Environmental Impacts in Environmental Impact Study and Environmental Impact Report (EIS/EIR) of two small Hydroelectric Power Plants

Atributos e magnitude dos impactos socioambientais em EIA/RIMA de duas pequenas centrais hidrelétricas

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### ABSTRACT

This study aimed to evaluate the approach used to describe the socio-environmental impacts - through the analysis of attributes and magnitude of impacts - of these two projects and for this, consultations were carried out on the Environmental Impact Studies presented by the consultants of the activity, as well as the technical opinions available on the website of the Federal Authority responsible for environmental licensing. Both Small Hydroelectric Power Plants selected for this study, the Cabuí (southeast of Minas Gerais State) and Caiçara (northern Minas Gerais state) are located in low-income regions. It was verified that the socio-environmental approaches of the SHPs differed in some aspects. The Cabuí, whose previous license was deferred, used more attributes to describe the socioeconomic impacts and the explanation of the impact assessment was more detailed and easy to understand, while the EIS of the Caiçara SHP (previous license rejected) was more succinct in its attributes for the description of the socioeconomic impacts, not adequately presenting the valuation and meaning of its impacts. There is also evidence of the need to improve public participation in both projects.

**Keywords:** Small Hydroelectric Power Plants (SHPs); Environmental Impact Assessment; Environmental Licensing

### RESUMO

Este estudo teve como objetivo avaliar a abordagem utilizada para descrever os impactos socioambientais - por meio da análise de atributos e magnitude dos impactos - desses dois projetos e, para isso, foram realizadas consultas sobre os Estudos de Impacto Ambiental apresentados pelos consultores da atividade, bem como as opiniões técnicas disponíveis no site da Autoridade Federal responsável pelo licenciamento ambiental. As Pequenas Centrais Hidrelétricas selecionadas para este estudo, a Cabuí (sudeste de Minas Gerais) e Caiçara (norte de Minas Gerais) estão localizadas em regiões de baixa renda. Verificou-se que as abordagens socioambientais das PCHs diferiram em alguns aspectos. O Cabuí, cuja licença anterior foi deferida, usou mais atributos para descrever os impactos socioeconômicos e a explicação da avaliação de impacto foi mais detalhada e fácil de entender, enquanto o EIA da PCH Caiçara (licença anterior rejeitada) foi mais sucinto em seus atributos pela descrição dos impactos socioeconômicos, não apresentando adequadamente a valoração e o significado de seus impactos. Também há evidências da necessidade de melhorar a participação pública em ambos os projetos.

**Palavras-chave:** Pequenas Centrais Hidrelétricas; Avaliação de Impactos Ambientais; Licenciamento Ambiental

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## 1 INTRODUCTION

Brazilian National Environmental Policy (Law 6938/81) lists Environmental Impact Assessment (EIA) as one of its instruments and establishes the competence of the National Environmental Council (CONAMA) to create norms and criteria for the licensing of effective and/or potentially polluting activities. Through the Resolution No. 237/1997 of CONAMA provides guidelines for the environmental licensing of activities with potential to pollute and degrade the environment. The EIA is recognized as the most widely used environmental planning and management tool in the world, as almost all United Nations member countries use it for project-level decision-making (MORGAN, 2012). Due to the increasing demand for the use of natural resources, EIA has been required by environmental agencies to assist in decision making and to protect the environment.

In this context, the Environmental Licensing (through Law 6938/81) was instituted in Brazilian legislation, which is an instrument granted by the State, under the terms of the regulation, authorizing the location, implementation and operation of potentially polluting enterprises and activities, through the licenses. The refereed licenses are the PL (Preliminary License), IL (Installation License), OL (Operation License), as described in Conama Resolution 237/1997. This law establishes the relationship between environmental licensing and the Environmental Impact Study (EIS), so that these instruments allow the protection of the environment, as well as favouring sustainable development.

Thus, the CONAMA Resolution 001/86 provides in its Article 2 an illustrative list of activities that requires the elaboration of the EIS and respective environmental impact report (EIR), highlighting that the need for EIA will depend on the requirements of the Environmental Authority responsible for the environmental licensing. In such illustrative list there is an item VII that hydraulic plants which exploit water resources, such as dams for hydroelectric purposes (with power generation above 10 MW) are activities that degrade the environment causing environmental impact and, therefore require the preparation of the EIS in the environmental licensing process. Through this resolution, the implementation of Small Hydroelectric Power Plants (SHPs) in Brazil should regularly undergo this type of study in order to support the decision on its authorization.

According to the National Electric Energy Agency (ANEEL, 2015), a SHP is any enterprise that produces electricity whose power is greater than 3 Megawatts (MW) and equal to or less than 30 MW and has an accumulation reservoir area of up to 13 km<sup>2</sup>. Although SHPs are a source of clean energy and are linked to the conception of economic growth, their construction faces major obstacles due to their social and environmental impacts, generating conflicts between society and the proponents of these projects (GOMES; SILVA, 2017a). According to Zhou (2011), these conflicts are highly criticized among the parties that are in favour of SHPs insertion projects, as well as those who defend and support society and the environment due to the impacts caused by SHPs.

The study by Gomes and Silva (2017a) showed that conflicts between SHP project proponents and society are not commonly related to the instrument's disability (EIS), but rather to poor management of environmental impact assessment for these projects, mainly related to the establishment of the involved scenario. The scenarios involving the Cabuí and Caiçara SHPs (both located in Minas Gerais) are regions of extreme environmental relevance because they are inserted in bi-regional watersheds and located in low-income regions.

According with Silva et al. (2016), the environmental licensing is one of the factors to be prioritized in the decision-making process, aiming to guide the policies formalization. Zarfl et al. (2015) highlighted that one of the major impacts of these activities are the social impacts, such as the replacement of local population.

Gomes and Silva (2017b) studying environmental Licensing Conflicts of SHPs in Brazil pointed out some issues as the lack of documents in the licensing process; poor divulgation of public hearings; contradiction considering the population opinion; and negligence about the negative impact in the tourism sector in the area affected.

The planned site for the installation of the Cabuí SHP is on the Paraibuna River, located in the border of Minas Gerais State with Rio de Janeiro State, consisting of an 18 MW plant with a reservoir of approximately 1.09 km<sup>2</sup>. The Caiçara SHP has a predicted location on the Carinhanha River on the border of the states of Minas Gerais and Bahia with an installed capacity of 19.50 MW and has no accumulation reservoir, as it is of the "run of the river" type. CONAMA's Resolution No. 237/97 provides in its article 4, item II, that IBAMA (Brazilian Institute of Environment and Renewable Natural Resources) is the responsible authority for licensing activities that are located or developed in two or more states, as the cases of the SHPs in this study.

SHP Cabuí had its preliminary license (PL No. 467/2013) granted by IBAMA and SHP Caiçara had its license denied according to technical opinion No. 000036/2014 (Analysis of the Concession of PL-SPH Caiçara) also from IBAMA. Considering that the EIS should include discussions about impacts on the physical, biotic and social environment, we opted for the analysis of social and environmental impacts, because these are widely discussed and extremely relevant in this type of project (SHP). Thus, the present study is based on the evaluation of the EIS of two SHPs, SHP Cabuí and SHP Caiçara, which were submitted to the IBAMA for analysis of environmental viability and obtaining the necessary environmental licenses for its operation.

Thus, the objective of this work was to compare the characterization of the EIS of these two enterprises regarding the attributes of the adopted social and environmental impacts, as well as the magnitude of the impacts and the general approach used to justify the classification of these impacts. To this end, we compared the environmental impact interaction matrices presented, as well as the magnitude of the impacts of both projects.

## 2 METHODOLOGY

### 2.1 Methodological Strategies

Firstly, guiding questions were formulated aiming at orienting the research: “How are social and environmental impacts being addressed in Environmental Impact Studies of Small Hydroelectric Projects? What were the attributes and magnitude of the social and environmental impacts pointed out by both projects?”

There were some criteria for the choice of the case studies, being delimited first: a) the selection of a unique typology of enterprise; b) prioritization of projects located in a nearby region, being located at least in the same state; c) be available for consultation at a federal agency (IBAMA); d) present opinion of the licensing authority (IBAMA) about the elaboration of the EIS. Considering the described criteria, there were selected as case studies two projects of implementation of Small Hydroelectric Plants (SHP) located in the State of Minas Gerais, SHP Cabuí and SHP Caiçara.

The documents consulted for the preparation of this research are described in Table 1. The Environmental Impact Studies (EIS) and Environmental Impact Report (EIR) of the two SHPs were analysed. Both EIS/EIR were submitted to the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) by the company responsible for the preparation and are available for public consultation through the website <http://licenciamento.ibama.gov.br/>. The EIS/EIR were prepared in accordance with the Terms of Reference (TR), called “Terms of Reference for the Preparation of the Environmental Impact Study and the respective Environmental Impact Report - EIA / RIMA”, and only the TR from SHP Caiçara was currently available on the website.

The SHP Cabuí EIS consulted had a division with 13 sections and aimed to diagnose the physical, biotic, social and cultural environment, as well as to present the environmental prognosis of the area to be affected by the enterprise. The SHP Caiçara EIS has six volumes, and only the volume I was used for this study, which is composed of 5 chapters, organized in order to present the studies and other analyses in an orderly manner, aiming at a better understanding of the main socio-environmental aspects of the study area. In addition to these analysed documents, technical advice from the IBAMA licensing authority was also consulted, as can be seen in Table 1. Other case studies were also used for comparison.

Table 1 – Documentation consulted for research

Documentation	IBAMA Case Number
Cabuí SHP Environmental Impact Study (EIS)	02001.008406/2009-01
ENVIRONMENTAL IMPACT STUDY - EIS. Caiçara Small Hydroelectric Power Station. Volume I.	02001.011484/2009-84
Term of Reference for the Preparation of the Environmental Impact Study and the respective Environmental Impact Report - EIS / EIR - of the Gavião, Catumbi and Caiçara SHPs	02001.011484/2009-84
Technical Opinion: Analysis of the EIS/EIR and related documents of the SHP Cabuí project, aiming at positioning regarding the environmental viability.	000179/2013
Technical Opinion: Verification of the compliance of the EIS/EIR of SHP Gavião and SHP Caiçara to the Term of Reference for the elaboration of the Environmental Impact Study and Environmental Impact Report - SHP of Gavião, Catumbi and Caiçara	25/2012
Technical Opinion: Verification of compliance with the TR and Acceptance of Environmental Impact Studies and Environmental Impact Reports of SHP Gavião (02001.011481 / 2009-41) and SHP Caiçara (02001.011484 / 2009-84)	000028/2013
Technical Opinion: Preliminary License analysis. Process 02001.011484 / 2009-84 - SHP Caiçara	000036/2014

The information search strategy was based on the difference detected between the attributes of the environmental impacts used in SHP Cabuí and SHP Caiçara EIS. The SHP Cabuí EIS used the attributes “phase of occurrence, scope, nature, form of incidence, possibility of occurrence, time of occurrence, duration, importance, reversibility, possibility of mitigation, possibility of potentiation, magnitude, synergy and cumulativeness”. On the other hand, the Caiçara SHP EIS presented the attributes “phase of occurrence, scope, nature, form of incidence, duration, reversibility, magnitude and final value of the impact”.

The consulted processes were confronted with the analytical criteria proposed for their elaboration, in order to verify if there was the expected adherence. The appraisal process was made by the researchers, and at the end of the process, the analysis of each one was discussed by the team aiming at standardizing the appraisal.

## 2.2 Study Area

The Cabuí SHP, with an output of 18 MW, will be installed in the Paraibuna River at the confluence with the Preto River, in the Paraíba do Sul River sub-basin (Figure 1) (BRASIL, 2014; EDUARDO; SILVA, 2010). It is located in the southeastern region of Minas Gerais state with border with the state of Rio de Janeiro, at coordinates 22°00'71 south latitude and 43°32'67 west longitude. All the structures of the project are located on the border between the municipalities of Simão Pereira and Belmiro Braga, both located in the state of Minas Gerais, near the municipality of Comendador Levy Gasparian, in the state of Rio de Janeiro (AMBIOTECH, 2012). According to the EIS, the project will have a drainage area of 3,734 km<sup>2</sup>, a flooded area at the normal maximum water level equivalent to 1.09 km<sup>2</sup> and a reservoir with an area of 109 ha with 40 years of useful life.

Figure 1 – Location of Cabuí SHP (Site 1) and Caiçara SHP (Site 2), Minas Gerais, Brazil



Adapted from: Governo do Estado de Minas Gerais (<https://www.mg.gov.br/>)

The area of indirect influence for the socioeconomic environment was defined considering the municipalities along the Paraibuna River, six in Minas Gerais (Simão Pereira, Belmiro Braga, Matias Barbosa, Santana do Deserto, Chiador and Juiz de Fora) and two in Rio de Janeiro (Comendador Levy Gasparian and Três Rios). For the area of direct influence of the socioeconomic environment were considered the municipalities affected by the reservoir, powerhouse and the dam, being the municipalities of Simão Pereira and Belmiro Braga in Minas Gerais and Comendador Levy Gasparian in Rio de Janeiro (BASTOS, 2013; AMBIOTECH, 2012).

The Caiçara SHP is located in the Carinhanha River basin on the border between the states of Bahia and Minas Gerais. The Carinhanha River is a tributary of the São Francisco River, which is one of the most relevant watercourses for the country as well as its economic and historical contribution to the region (Figure 1) (BORGES, 2009). The Caiçara SHP is located in the municipality of Bonito de Minas, in the state of Minas Gerais, and Cocos, in the state of Bahia. The venture has a drainage area of 4,224 km<sup>2</sup> and a reservoir area at the maximum water level equivalent to 10.1 km<sup>2</sup> with a useful life of 200 years (ANA, 2014; LIMIAR, 2013a).

The area of indirect influence for the socioeconomic environment was defined according to the municipalities near the Carinhanha River, with four municipalities in Minas Gerais (Montalvânia, Cônego Marinho, Januária and Bonito de Minas) and three municipalities in Bahia (Coribe, Feira da Mata and Cocos). For the area of direct influence of the socioeconomic environment, the urban headquarters of the municipalities of Bonito de Minas and Montalvânia, both in the state of Minas Gerais, and in the municipality of Cocos, in the state of Bahia, were considered. There was also considered as an area of direct influence are the rural riverside villages near the venture, such as Novo Horizonte, Sumidouro and Cachoeira do Gibão (located in the state of Minas Gerais), Lodo and Lages (located in the state of Bahia), and Porto Cajueiro (located in the state of Bahia and Minas Gerais) (LIMIAR, 2013b).

### 3 RESULTS

#### 3.1 Social-environmental impacts raised in the EIS

The consultations to the previously described documentation allowed to list the social and environmental impacts addressed by each of the studied enterprises (Table 2). It is noticed that the amount of impacts listed by each EIS was quite similar, but differing in content. The SHP Cabuí EIS had a wide range of negative impacts on the population (around 10 impacts), such as relocating residents, expropriating land, backwater areas hit, job losses, overburdening public and private services, increased traffic, among others. In the SHP Caiçara EIS, only 7 negative impacts were presented, some of them: pressure on public services, introduction of endemics, increased traffic, loss of wildlife.

Table 2 – Lists of socioenvironmental impacts addressed in the EIS of the Cabuí and Caiçara SHPs

SHP's EIS	Socioenvironmental Impacts
Cabuí	Resettlement of residents and compulsory disposal of all or part of the areas.
	Expropriation of lands located on the Islands used for leisure.
	Backwater areas affected by the safety strip and the formation of APP.
	Expectation of the population regarding the enterprise and its effects on the environment.
	Political mobilization of the local population.
	Loss of formal or informal jobs.
	Generation of direct and indirect jobs in the various stages of the venture.
	Overload of public and private services.
	Increased traffic and deterioration of surrounding roads.
	Degradation of the natural landscape.
	Impacts on fishing
	Risk of uncontrolled use and occupation of reservoir margins.
	Impacts on archaeological heritage.
Caiçara	Generation of expectations at the local level.
	Expansion of the job offer.
	Allochthonous population influx - Pressure on public services in areas of direct and indirect influence
	Allochthonous population influx- Tertiary sector increment.
	Introduction of endemics.
	Increased vehicle traffic on the access roads to the works.
	Run over and loss of wildlife.
	Improvements and extensions to the local road network.
	Interferences in the daily life of the local rural population.
	Dispersion of Traditional Communities and Loss of Raw Materials - Loss of Cultural References.
	Employment contraction- Efflux of people from the region.
	Increased municipal revenue.
	Accident risks for the user population
Change of local landscape	

#### 3.2 Social-environmental impacts raised attributes

The SHP Cabuí EIS described its social and environmental impacts and analyzed the meaning of each impact by judging its attributes. The SHP Caiçara EIS determined and attributed values to the effects of social and environmental impacts caused during all stages of the project. Table 3 presents the characteristics considered for each attribute, as described in the EISs.

Table 3 – Characteristics of the attributes described in the SHP Cabuí and SHP Caiçara EIs

Attributes	Characteristics	Venture
Phase	Planning (P) / Implementation (I) / Operation (O)	SHP Cabuí; SHP Caiçara.
Coverage	Local (L) / Regional (R) / Undetermined (U)	SHP Cabuí; SHP Caiçara.
Nature	Positive (P) / Negative (N)	SHP Cabuí; SHP Caiçara.
Form of incidence	Direct (D) / Indirect (I)	SHP Cabuí
Possibility of occurrence	Right (R) / Uncertain (U)	SHP Cabuí
Time of occurrence	Immediate Start (IS) / Short Term (ST) / Medium Term (MT) / Long Term (LT)	SHP Cabuí; SHP Caiçara.
Duration	Temporary (T) / Permanent (P) / Cyclic (C) / Recurrent (R)	SHP Cabuí
Importance	Big (B) / Medium (M) / Small (S)	SHP Cabuí
Reversibility	Reversible (R) / Irreversible (I)	SHP Cabuí; SHP Caiçara.
Possibility of mitigation	Mitigable (M) / Not Mitigable (NM)	SHP Cabuí
Potentialization Possibility	Potential (P) / Not Potential (NP)	SHP Cabuí;
Magnitude	Low (L) / Medium (M) / High (H)	SHP Cabuí; SHP Caiçara.
Synergy	Synergistic (S) / Non-synergistic (NS)	SHP Cabuí;
Cummulativity	Cumulative (C) / Non-cumulative (NC)	SHP Cabuí;
Final Value	Significant (S) / Moderate (M) / Not significant (NS)	SHP Caiçara.

Source: Adapted from AMBIOTECH (2012); LIMAR (2013a)

The assessment of impacts magnitude in SHP Cabuí EIS was a combination of attributes such as scope, incidence, duration, reversibility, potentiality and importance. Therefore, the authors of the SHP Cabuí EIS assigned numerical values for these attributes, enabling a quantitative assessment of an impact in relation to the others, as shown in Table 4. It is noteworthy that the possibility of reversal only applies to negative impacts and the possibility of potentiation only applies to positive impacts.

Table 4 – Attribute value scale adopted in SHP Cabuí EIS

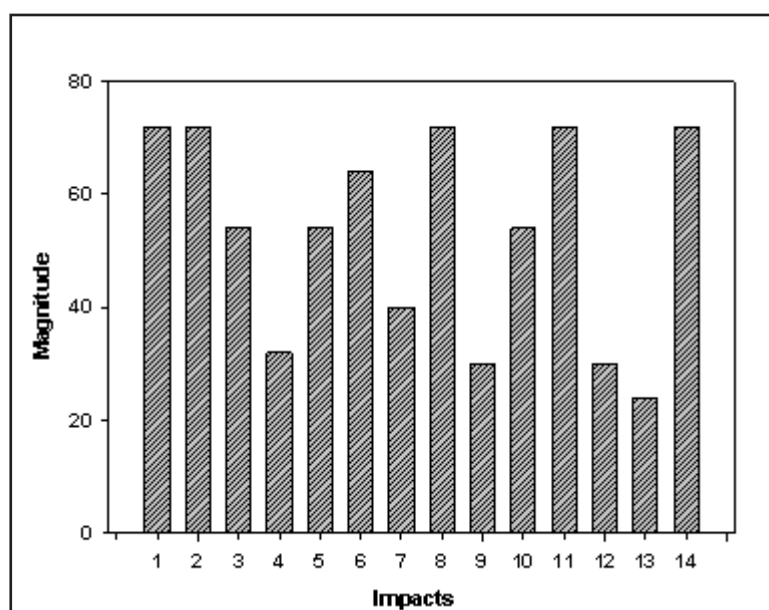
Regardless	Attributes	Value
Scope	Local	1
	Regional	3
	Undetermined	2
Incidence	Direct	3
	Indirect	1
Duration	Temporary	1
	Cyclic or Recurrent	2
	Permanent	3
Importance	Small	2
	Medium	3
	Big	4
Reversibility	Reversible	1
	Irreversible	3
Potentiation Possibility	Potential	3
	Not Potential	1

Source: Adapted from AMBIOTECH (2012)

SHP Cabuí EIS, after presenting the value scale, describes the equation used to calculate the magnitude of each impact for the project:  $Magnitude = 2 \times (\text{Scope} + \text{Form of Incidence} + \text{Duration} + \text{Reversibility or Possibility of Potentiation}) \times \text{Importance}$ .

The result found in this calculation was classified into the following classes: a) Low magnitude: results below 40; b) Average magnitude: results between 40 and 63; c) High magnitude: results between 64 and 88. Table 5 illustrates the characterization made for all socio-environmental impacts in the SHP Cabuí EIS. The calculated magnitude values presented in the EIA SHP Cabuí are illustrated in Figure 2 below.

Figure 2- Graphical representation of the magnitude of the impacts of the socioeconomic environment. Impacts: (1) Relocation of residents; (2) Land expropriation; (3) Backwater areas affected; (4) Invasion of properties during drought; (5) population expectation; (6) Political mobilization of the population; (7) Loss of jobs; (8) Generation of direct and indirect jobs; (9) Overload of public and private services; (10) Increased traffic and abrasion of surrounding roads; (11) Degradation of the natural landscape; (12) impacts on fishing; (13) Risk of uncontrolled use and occupation of reservoir margins; (14) Impacts on archaeological heritage.



It can be seen that the impacts with higher magnitude in the SHP Cabuí EIS (magnitude value = 72) were the relocation of residents and compulsory total or partial alienation of the areas; expropriation of land located on the islands used for leisure; generation of direct and indirect jobs in the various phases of the enterprise and degradation of the natural landscape. On the other hand, regarding the calculation of the magnitude of impacts on the SHP Caiçara EIS, it was found that there was no description of the methodology used for the consideration of the magnitude. The valuations of the social and environmental impacts of SHP Caiçara are presented in Table 6.

As stated by Sanchez (2013), an impact can generate several other impacts, which are called secondary and tertiary impacts. Impacts "Expansion of job vacancies" and "Contraction of job vacancies" as provided by the SHP Caiçara EIS are described as main impacts that lead to several other impacts. Some examples of impacts generated by the "Job Supply Expansion" are: the influx of the allochthonous population (generating pressure on public services and introduction of endemics), increase of the tertiary sector (generating increase of municipal collection), increase of vehicle traffic (generating loss of fauna elements and interference in the daily life of the rural local population).

The impact "Dispersal of traditional communities and loss of raw materials and cultural references" was considered direct and indirect regarding its form. The impact is indirect when it is related to population re-settlement and direct when considering the reservoir filling. The execution of SHP Caiçara installation works will require the removal of residents from the project's direct influence area and the filling of the reservoir will hinder access to raw material sources, such as clay, used in the local manufacture of ceramics and there will also be a loss of copies of the "architecture of the earth" in the area.

The impacts considered positive in the SHP Caiçara EIS were: "Influx of allochthonous population, generating increase in the tertiary sector"; "Increased vehicle traffic, responsible for improvements and extensions in the local road network"; "Increased municipal collection" and "Alteration of the local landscape".

### 3.3 Environmental feasibility of the projects based on the EISs

IBAMA Report No. 000036/2014 states that SHP Cabuí EIS met the minimum requirements requested in the TR and that some dubious information could still be clarified and corrected later without interfering with the final analysis of the project's environmental viability. IBAMA's technical team stated that the project is environmentally viable and granted the preliminary license (PL) to proceed with the environmental licensing process.

Table 5 - Characterization of the social and environmental impacts described in the SHP Cabuí EIS

Impacts	Phase	Scope	Nature	Form	Possibility of occurrence	Time of occurrence	Duration	Importance	Reversibility	Possibility of mitigation	Possibility of Potentiation	Magnitude	Synergy	Commutativity
Relocation of residents and compulsory disposal of all or part of the areas.	I	L	N	D	R	IS	P	B	I	M	-	H	S	NC
Expropriation of lands located on the Islands used for leisure.	I	L	N	D	R	IS	P	B	I	M	-	H	S	NC
Backwater areas affected by the safety strip and the formation of permanent preservation area (PPA)	I	L	N	D	R	IS	P	M	I	M	-	M	S	NC
Expectation of the population regarding the enterprise and its effects on the environment.	P/I	R	N/P	D	R	IS	T	M	R	M	P	M	S	NC
Political mobilization of the local population.	P/I	R	P	I	R	IS	T	B	-	-	P	H	S	C
Loss of formal or informal jobs.	P/I	L	N	D	R	ST	T	B	R	M	-	M	S	NC
Generation of direct and indirect jobs in the various stages of the venture.	P/I/O	R	P	D	R	MT	T	B	-	-	P	H	S	NC
Overload of public and private services.	I	L	N	I	R	MT	T	M	R	M	-	L	S	NC
Increased traffic and abrasion of surrounding roads.	I/O	L/R	N	D	R	IS	P	M	R	M	-	M	S	NC
Degradation of the natural landscape.	I/O	L	N	I	R	ST	P	B	I	M	-	H	S	C
Impacts on fishing.	I/O	L	N	I	R	MT	P	M	R	M	-	L	S	C
Risk of uncontrolled use and occupation of reservoir margins.	I/O	L	N	I	U	MT	P	S	R	M	-	L	S	NC
Impacts on archaeological heritage.	I	L	N	D	R	IS	P	B	I	M	-	H	S	NC

Legend: refer to Table 3

Source: Adapted from AMBIOTECH (2012)



IBAMA Report No. 000179/2013 assessed that SHP Caiçara EIS met the minimum requirements requested in the TR, but it was not clear enough about the methodology used to weight and integrate the indicators and also assessed that data were omitted to generate some indicators (no explanation for magnitude calculation, for instance). These factors compromised the fidelity of the scenario built to represent the socio-environmental weaknesses of the region where the future venture will be inserted. The IBAMA technical team realized that the delimitation of the project's direct area of influence was wrong, as populations that felt affected were not mentioned in the EIS; there was mixed information about the number of jobs that would be created; gaps in communication were found regarding those affected; no bibliography was presented in relation to the socioeconomic environment, besides other problems related to the physical and biotic impacts. Therefore, the environmental viability of the SHP Caiçara project could not be attested.

Table 6 - Characterization of the social and environmental impacts described in the SHP Caiçara EIS

Impacts	Phase	Nature	Form	Coverage	Duration	Reversibility	Magnitude	Final Value
Local Expectation Generation								
	P	N	D	L	C	R	H	S
Expansion of job offer								
Allochthonous population influx- Pressures on public services	I	N	I	R	C	R	M	M
Allochthonous population influx- Tertiary sector increment	I	P	I	R	C	R	M	M
Introduction of endemics	I	N	I	R	C	R	M	M
Increase in vehicle traffic - trampling and loss of wildlife	I	N	D	L	C	R	M	S
Increased vehicle traffic-Improvements and expansions in local road network	I/O	P	D	R	L	I	H	S
Interference in the daily life of the local rural population	I	N	D	L	C	R	M	M
Dispersion of Traditional Communities and Loss of Raw Materials - Loss of Cultural References.	I/O	N	D/I	L	L	I	M	M
Job offers								
Flow of people from the region	O	N	D	R	L	R	M	M
Increased municipal revenue	O	P	D	L	L	R	H	S
Accident risks for the user population								
	O	N	D	L	L	R	L	NS
Local landscape change								
	O	P	D	L	L	I	L	NS

Legend: refer to Table 3

Source: LIMIAR (2013a)

## 4 DISCUSSION

Candiani *et al.* (2013), describing the socioenvironmental aspects of the Small Hydroelectric Power Station (SHP) Queluz - SP (São Paulo state), in the Paraíba do Sul River basin, detected the list of the following impacts: interference in reservoir authorization and mineral concession areas; initiation or acceleration of erosive processes; changes in aquatic fauna upstream of the dam; compromise of migratory routes; creating expectations; changes on municipal collections; changes in the labor market; traffic intensification; increased supply of electricity to the region; interference with leisure and road infrastructure. It can be seen that the common impacts presented in the SHP Cabuí and Caiçara EIS with the SHP Queluz-SP EIS were the generation of expectations by the population, changes in municipal revenues, changes in job supply, traffic intensification and improvement

in road infrastructure. Candiani *et al.* (2013) emphasized that the environmental programs suggested by the entrepreneur are technical, which is positive, but do not include social and cultural actions, such as environmental education programs and specific projects to reduce secondary or tertiary impacts on the population. The authors also pointed out secondary impacts such as increased violence due to population increase, impact that had not been evaluated in the EIS and could be included.

Cardoso *et al.* (2014), analyzing the environmental fragility of the Pardo river basin, in the state of Rio Grande do Sul (RS), in relation to the installation of SHPs in the water stream, also listed some impacts related to this type of project, and these are similar to the provisions of both SHP Cabuí and Caiçara EIS, for instance: increased demand for local goods, services and products and saturation of sectors such as housing, health, transportation, food, leisure and public safety.

Regarding the attributes of impacts, CONAMA's Resolution No. 001/86 describes in its article 6, item II, that the assessment of environmental impacts should consider the following attributes: beneficial or adverse impacts; direct or indirect impacts; immediate, medium or long term impacts; temporary or permanent impacts; reversible or irreversible impacts; cumulative or synergistic properties of the impacts and distribution of burdens and social benefits arising from the enterprise. As Sánchez (2013) describes, there is no universal formula for assessing the significance of the impacts of a project and it is therefore important that the EIS clearly presents the significant impacts of the project and justifies this decision.

The valuation of the "scope" attribute in the attribute value scale adopted by the SHP Cabuí EIS is in accordance with the project typology, since a local scope should have a lower value (lower impact, value = 1) and a regional scope should have a higher value (higher impact, value = 3). The undetermined range value was stipulated between the two previous values (Value = 2), since the SHP do not generate impacts in larger ranges than the regional ones.

Regarding the valuation of the "Form of incidence" adopted in the SHP Cabuí EIS, it is clear that it was the same as the one adopted for the incidence of the impacts of the Itaocara Hydroelectric Power Plant (HPP), as provided by the proponents of the EIS (Ecology and Environment do Brasil, 2011). Both projects presented value equal to 3 for direct incidence and value equal to 1 for indirect incidence.

The "importance" attribute adopted by the SHP Cabuí EIS was also the same as that used by the Itaocara Hydroelectric Power Plant (HPP), with a small value of 2, a medium value of 3, and a large value of 4. However, it was also used by the EIS of Itaocara Hydroelectric Power Plant (HPP), the "very small importance" with a value of 1, and the "very large importance" with a value of 5. The values of the "reversibility" attribute were slightly different from Itaocara Hydroelectric Power Plant (HPP) EIS, which presented values of 1 for reversible characteristic and 2 for irreversible characteristic, while the SHP Cabuí EIS adopted values of 1 and 3, respectively.

It is believed that the lack of values for the table of characterization of social and environmental impacts described in the SHP Cabuí EIS (Table 5) is justified by the presence of graphs indicating the magnitude of the impact of the project, as it indicates a broader result, considering other variables (scope, incidence, duration, reversibility or possibility of potentiation and importance), according to the calculation of the reported magnitude.

Regarding Table 5 (Characterization of the social and environmental impacts described in the SHP Cabuí EIS), the impact "Expectation of the population regarding the enterprise and its effects on the environment" was considered negative and positive as to its nature. It is positive when considering the improvement in the economy and the way of life of the population and negative regarding the injustices in the process of expropriation or in situations of environmental degradation. The "Impacts on fishing" was considered to be of low magnitude and IBAMA questioned this classification in its Report No. 000179/2013, as this impact alters the living conditions of the population that has their dietary supplement with fishing. Many people were interviewed and reported declining fish population in the region due to three other dams that were recently built, considering that building another reservoir will aggravate the already existing bad situation. IBAMA also disagreed as to the importance and magnitude given to the impact of "risk of runaway use and occupation at the reservoir margins" which was small and low, respectively. This impact is very important as it demands constant soil control at the margins and can generate other severe negative impacts. Of the 13 socioenvironmental impacts listed, only 3 were considered positive and with potential for potentiation: "Expectation of the population regarding the enterprise and its effects on the environment"; "Generation of direct and indirect jobs in the various phases of the enterprise" and "Political mobilization of the local population". Regarding the cumulative impact of other buses in the region, three cumulative impacts were considered: "Political mobilization of the local population"; "Natural landscape degradation" and "Impacts on fishing".

The high magnitude impacts on the SHP Cabuí EIS were: "relocation of residents and compulsory full or partial alienation of areas"; "Expropriation of land located on the islands used for leisure"; "Generation of direct and indirect jobs in the various stages of the enterprise" and "degradation of the natural landscape". In the EIS of the Simplício Hydroelectric Development (AHE) project (MG/RJ states) the impacts of high magnitude were: improvements in living conditions; changes in population migratory flows; compulsory transfer of the affected population (ENGEVIX, 2004). In the Foz de Chapecó HPP project (SC/RS states) the high magnitude impacts listed in the EIS were: change in the real estate market and compulsory population displacement (DESENVIX, 2000).

In SHP Santa Rosa I (MG/RJ) the impacts of high magnitude were: land appropriation; pressure on the housing market; influx of people by the possibility of jobs (LIMIAR, 2001). And in the Itaocara HPP project (MG/RJ) the impacts of high magnitude were: alteration of the quality of life; compulsory displacement of families (Ecology and Environment do Brasil, 2011). Thus, it is clear that the compulsory displacement of the affected population is the most present high impact among the analysed enterprises.

IBAMA 's technical team disagreed in the Report No. 000036/2014 on the valuation of two impacts described in SHP Caiçara EIS. The impact "Accident risks for the user population" was considered reversible and insignificant by the EIS team, while IBAMA understands that the impact is irreversible and significant, as the formation of the lake increases the flooded margins available for use and recreation, increasing the risk of accidents. The impact of "Local landscape change" was considered to be minor in the EIS, but IBAMA considered that this impact is significant due to the modification of environments considered natural tourist attractions, which are preserved and can be destroyed, in addition to the visual impact that a 33 meter high dam causes in the landscape.

Regarding the impacts considered positive in the SHP Caiçara EIS, it is not appropriate to consider the impact "Change of local landscape" as positive. However, the EIS argued that the change in the market value of the properties around the lake that would be formed may enhance new opportunities for the development of economic activities, especially those related to recreation and leisure.

The analysed EIS showed slightly different approaches to each other. While the SHP Cabuí EIS took a more elaborate approach giving more attributes to impacts, the SHP Caiçara EIS was more succinct in its attributes, not presenting the valuation and significance of its impacts as well. According to Sanchez (2013), statements describing environmental impacts should always be synthetic, self-explanatory and describe the meaning of the changes.

From the analysis of the two EIS, it is observed that the nomenclatures of SHP Caiçara's social and environmental impacts are more synthetic, making communication more effective with the EIS readers. On the other hand, SHP Cabuí EIS socio-environmental impact nomenclatures are vaguer as "fishing impact" and "impact on archaeological heritage", not having a logical meaning and, consequently, requiring a reading in the text that clarifies this denomination. Although the SHP Caiçara EIS nomenclature is clearer and more concise than the SHP Cabuí EIS, the way in which the valuation of SHP Cabuí impacts have been explained is more detailed and easier to understand, while in the SHP Caiçara EIS the arguments are vaguer and a little inductive. The EIS of both SHP show little participation by the population in building and designing their approaches throughout the environmental licensing process, as much information is not truly exposed. One of the biggest challenges for the environmental agency is to expand society's participation in the environmental management process, seeking to replace the public hearing pattern with another model that is closer to society, because audiences tend to favor confrontation rather than negotiation (ASSUNÇÃO et al., 2010). According to MPF (2004) another major deficiency Brazil EIS is the unsatisfactory knowledge in the ways of life of singular sociocultural collectives and their intercommunity networks and this is mainly due to the lack of popular participation.

The SHP Caiçara EIS showed many divergences in relation to the socioeconomic environment with the results obtained in the field by the IBAMA technical team, which exposed this information in its Report No. 000036/2014. IBAMA through technical opinions No. 000179/2013 and No 000036/2014 argued the need for a Strategic Environmental Assessment (SEA) for both projects, as they are inserted in river basins where there are already other projects of this type. The installation of another SHP in these watersheds brings more physical, biotic and social impacts to the regions where they will be deployed, requiring a global assessment of these impacts rather than just punctual ones. According to Costa et al. (2009) SEA proposes a more systemic view of impacts, while EIA focuses on specific project outcomes.

Regarding the main observations made by the licensing body (IBAMA) in relation to SHP Cabuí, the low magnitude indicated in "Impacts on fishing" was highlighted, as this impact considerably alters the living conditions of the population complements their alimentation with fishing. It was also questioned the "Risk of uncontrolled use and occupation on the reservoir margins" which was indicated as small and low, respectively. According to the agency, this impact is very important, as it demands constant soil control at the margins and can generate other severe negative impacts. Already in the opinions about SHP Caiçara the "Risks of accidents for the user population" were highlighted as incorrect description, since for the agency, the impact is irreversible and significant. "Local landscape alteration" is also cited as a significant impact due to the modification of environments considered natural tourist attractions, which are preserved and can be destroyed, in addition to the visual impact that a 33-meter-high dam has on the landscape.

## 5 CONCLUSION

From the analyses performed, it can be concluded that the social and environmental approaches of the SHP's were quite different. It was noticed that SHP Cabuí used more attributes to describe socioeconomic impacts and the explanation of impact valuation was more detailed and easy to understand, while SHP Caiçara-

ra EIS was more succinct in its attributes for describing socio-economic impacts, neither well presenting the valuation and significance of its impacts, nor the methodology used for the consideration of magnitude. It was concluded that in the analyzed EISs, both SHP Cabuí and SHP Caiçara, some impacts were described with smaller magnitude than they actually represent for the affected community. Regarding public participation, both EIS of the two SHPs showed little participation of the population in building and elaborating their approaches throughout the environmental licensing process. There was also a need for a Strategic Environmental Assessment (SEA) for both projects, as they are inserted in watersheds where other works of this type already exist, bringing greater physical, biotic and social impacts to the regions.

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