

## 1 Introduction

Sustainability and environmental preservation are topics whose debate has been taking place in several areas of knowledge, such as engineering (Han *et al.*, 2014), management (Engert, Rauter, & Baumgartner, 2016), economy (Cardenas; Carpenter, 2006), philosophy of science (Ziegler & Ott, 2011), and public policies (Robert & Broman, 2017) among others. The relevance of the subject is recognised, above all, when assessing environmental degradation, population growth, issues related to global warming, and the search for alternatives that ensure reasonable living conditions for current and future generations.

In this context, mobilizations by countries and international organizations have systematically taken place, in order to promote reflections on environmental preservation, such as with *RIO + 20* and *COP 21*. It is also possible to mention some emblematic documents on such reflections, like “*Our common future*” (Wced, 1987). Notwithstanding the discussions at a global level, it is recognized that the paths to sustainability and environmental preservation begin with collective and individual decisions, materialized in cooperative attitudes with a view to ensuring collective well-being (Robert & Broman, 2017). Based on this premise, this paper discusses individual decisions and their unfolding consequences for sustainability from the perspective of game theory and behavioural economics. The proposed scenario for this discussion refers to the context of professional fishermen, subsisting on fishery for food and marketing directly from the Itaipu hydroelectric power plant reservoir.

For this research, the reservoir was considered a public good and the fisherman as an agent directly impacted by the decisions made by the plant and other stakeholders. In order to foster cooperation among individuals, some authors suggest the use of economic incentives, such as reward and punishment mechanisms (Fehr; Gaechter, 2000; Balliet, Langer; Mulder; 2011), while others refer that historical factors and the individual’s dependency on the public good will determine their behaviour (Bo; Fréchette, 2018). In view of the above, the research problem can be described as: How do the fishermen cooperate to the preservation of the reservoir from which they derive their livelihood, considering the influence of economic incentives in the form of punishments and rewards?

This investigation is configured as a research opportunity, since, in the preliminary literature review, few studies have simultaneously addressed the issue of preservation of hydroelectric dams and the cooperation of local professional fishermen from the subsidies of behavioral economics. Fishermen represent a group whose decisions that benefit them in the short term may override decisions aimed at long-term cooperation, albeit at the expense of preserving the public good. This research differs from most literature studies that use the public good game to assess cooperation: most of them are concentrated predominantly in groups of students, with superficial relations with a fictitious public good. This research defends that the cooperation of this group for the reservoir preservation can be guided by different motivations, which will go beyond the material payoffs, being that the context in which the fishermen are inserted assumes a determinant role in the decisions of resource allocation.

The next section presents the theoretical framework used, followed by the description of the methodological procedures, and the presentation of the findings. Subsequently, the final considerations are presented, along with the limitations of the work, and the suggestions for future research.

## 2 Theoretical Background

### 2.1 Game Theory and Behavioural Economics

Game theory is usually applied to the analysis of cases of interaction between two or more agents, so that the result obtained by each depends of their decision and also on the decision of the others. For this theory, the individuals will make decisions guided by selfish interest, for maximizing immediate material gain, even to the detriment of others (Croson; Gachter, 2010). Such is the decision-making conduct in the dominant strategy unique to the Nash equilibrium situation, representing the “best strategy” *vis-à-vis* the assessment of how the other individuals will make their decisions (Maskin, 2011).

In general, in these situations, the end result for the group as a whole will not be satisfactory, in the sense that the option for the best individual choices will not result in the best for the group (Fiani, 2009; Croson; Gachter, 2010). The problem of cooperation is best illustrated by the Prisoner’s Dilemma. In this dilemma, the non-cooperative strategy is dominant, so it is more advantageous from the individual point of view not to cooperate, independently of how many people chose to do so.

In the Prisoner’s Dilemma, if two deny their guilt, both will spend 2 years in prison (a); if they decide to accuse each other, both will face an 8-year sentence (d); if one accuses his colleague and the other does not, the accuser will be free and the other will stay in prison for 10 years (b e c). Considering Prisoner 1, the sequence of the best decisions would be:  $b > a > d > c$ . However, decision ‘a’ implies cooperation of the other prisoner, something that Prisoner 1 cannot be sure of. In this sense, decisions ‘b’ and ‘d’ guaranty benefits regardless of how the other prisoner behaves. Therefore, acting egotistically is the best decision (Alencar & Yamamoto, 2008), as shown in the figure 1:

		Prisoner 2	
		neither accuses nor confesses	Accuses the other
Prisoner 1	neither accuses nor confesses	a	c
	Accuses the other	b	d

Figure 1: Prisoner’s Dilemma illustration

Source: Adapted from Alencar and Yamamoto (2008).

Behavioural Economics, in turn, constitutes a theoretical alternative to Game Theory for the study of how agents make their decisions (Camerer, 2011). Taking in consideration the theoretical developments and empirical discoveries in the fields of human and social sciences, it goes on to point out that decision-making is not guided exclusively by egotistic/personal interests. In the words of Kao and Velupillai

investigates how the results regarding strategic interaction deviate from the orthodox game theoretic predictions in the light of some behavioural assumptions regarding decision-making in strategic situations. The psycho-logical and social explanations such as guilt aversion and fairness criteria are incorporated into the traditional models. (2015, p.245-246).

Evidence from economic experiments show that individuals make decisions in the most varied social conditions, not being exclusively guided by material interests, so that factors such as reciprocity, altruism, and respect to social norms also have an influence (Henrich *et al.*, 2005) in the decisions of individuals. In the conception of this author, no requirement for reasoning ability is presumed, other than the immediately necessary for living through everyday social contexts.

Cooperation for the preservation of the environment can be considered a social dilemma (Soest, Stoop, Vyrastekova, 2016) in the interpretation of all the involved could be better off if the cooperated in order to preserve the environment. However, if everyone did, another agent would be in an even better position to appropriate the effort of others, envisaging individual well-being (Andreoni, 1988; Zeng; Chen, 2003). In the context of sustainability, the number of agents involved with environmental issues is considered high, and some experimental games have been developed to discuss the relevance of economic behavioural literature in the face of environmental problems and resource sharing.

Among the experimental games, we highlight the game of sharing common resources (*Common Pool Resource Game*) and the game of public good (*Public Goods Game*). While the first assesses appropriations/rights of use of resources in non-linear functions, the second assesses the contributions and gains in linear functions.

These games can provide subsidies for understanding cooperation between two or more agents, as well as show which factors and conditions can interfere in decisions to undertake cooperative action.

## 2.2 Public goods game and economic incentive

In general, experimental research on public goods games shows that contributions are relatively high in one-shot games (40%-60% of the donation amount) and are reduced over time in games with repetitions (Soest, Stoop, Vyrastekova, 2016). This decline during the rounds is due to social preferences, learning effects (from trial and error), strategic considerations, or cooperation (Andreoni, 1988), reciprocity effects (Gintis, 2008), in addition to the desire of individual benefit, even at the expense of other's contributions (Soest, Stoop, Vyrastekova, 2016). In this context, in order to foster cooperation between individuals, some authors suggest the use of economic incentives such as reward mechanisms (for individuals who cooperate) and punishing ones (for those who do not) (Fehr; Gaechter, 2000; Balliet, Langer; Mulder; 2011; Bó; Fréchette, 2018).

With regards to punishment mechanisms, Reuben and Riedl (2013) suggest that differences in contribution to the public good may result from the type of punishment, in a way that, if there is no punishment all involved converge to free-riding behaviour. Some authors argue the magnitude of the punishment, recommending that – to be effective – punishment must be high, in a 1:3 ratio or higher (Sefton *et al.*; 2007; Nikiforakis; Normann, 2008).

The reward mechanisms, in turn, consist of an alternative for promoting cooperation in games of more than one round (Walker; Halloran, 2004; Sefton; Shupp; Walker, 2007), and when the cost of promoting is less than the benefit of the recipient (Vyrastekova; Soest, 2008; Drouvelis, 2010), individual use being recommended and in games of more than one round (Walker; Halloran, 2004).

### 2.3 Fishermen context: cooperation and dependency on public goods

Several authors consider that the context in which the individual is inserted can interfere in the decisions made in an experiment, particularly in field experiments, in which the players are immersed in their routine environment (Cardenas, 2000; Cardenas; Ostrom, 2004; Henrich *et al.*, 2005; Cardenas; Roriguez; Jonhson, 2015). To Cardenas (2011), when carrying out field experiments, it must be considered that the real context of the participants may play a role in the game itself. Therefore, it becomes relevant to learn more about the interactions between social norms in existence before the experiment, and those that manifest during the experiment.

Henrich *et al.* (2005), in turn, claim that factors related to the economic and social structure at the group level statistically explain much of the variation between groups in experimental games, so that there may be a relation between behaviour during the game and everyday life patterns on these locations. For the authors, “[...] if there is a high level of cooperation at work or in the community, people can expect others to behave similarly, cooperatively in brand new situations, such as those provided by experimental games” (Henrich *et al.* 2005, p. 813). Another factor related to this context refers to participant’s experiences which can interfere in the way decisions are made during the experiment (Bó; Fréchette, 2017).

To Langry (1994), not all *stakeholders* can benefit from the preservation of a public good in the same way, whether due to dependency relationships, or their varying levels of interactions (Ackermann; Eden, 2011) with the public good. In the case of hydroelectric plants’ reservoirs, Morimoto (2013) highlights the strong dependence on water by riverside communities, especially fishermen. To Walter (2000) and Mauryama *et al.*, (2009) among the possible activities to be developed, fishing represents one of the main sources of income, and sometimes the only source of high quality of animal protein for the riverside dwellers. Studies assessing the economic conditions of riverside communities have already been made, following the installation of several hydroelectric power plants (Pereira & Arévalo, 2013), and demonstrating de same dependency of this group on the reservoir.

In this regard, Cardenas, Rodriguez e Johnson (2015) analysed the role of the geographical location of individuals in hydrographic basin as an influencing factor in the provision and appropriation of water, and in consequence in cooperation. The authors observed that the site affects supply and distribution of water, and that reciprocity and trust are fundamental motivations for upstream and downstream cooperation. The higher the position (upstream), the greater the incentive to cooperate, and differences in ease of access to water can compromise cooperation.

On the other hand, it is understood also that this dependency relationship decreases as communities are located closer to urban centres, due to the expansion of the possibilities for consumption, and access to other products and markets, causing less dependency on natural resources (Murrieta *et al.*, 2008; Costa *et al.*, 2013).

### 3 Methodological Procedures

For the collection of data, the public goods game was proposed, adapted from Fehr and Gächter (2000), and from Sefton, Shupp and Walker (2007), naming it this time as ‘*reservoir game*’ (as a source of subsistence for the fishing activities in the region), once the public good



under analysis was the Itaipu power plant's reservoir. The choice was made due to the fact that Itaipu hydroelectric power plant is the world's largest energy producer, with 20 units generating 700 MW each, besides having a history of over a decade of joint work with the local fishermen in the area by means of its sustainability programs (monitoring the ichthyofauna, campaigning to clean the reservoir), and its reservoir providing water to the cities of the western region of the state of Parana. The sample chosen for the research consists of 68 professional fishermen, and the experiments were carried out at the headquarters of the fishermen's colonies. The experiments were carried out in the year 2018.

With the purpose of evaluating the cooperation of the fishermen, the experiment called the public good game was used. This game, as a concept, consists of an experiment in which the agents (players) receive a certain amount of money, being able to contribute with the purpose of maintaining the public good or taking the money for themselves (for their own advantage). None of the agents can be excluded from enjoying the benefits that the public good offers. The amount donated is usually doubled (or multiplied by another pre-established index) and redistributed equally to all players, regardless of individual contribution. The game presupposes the existence of a dilemma for the individual or group, with the possibility of contributing or not contributing and making use of a public good (Soest, Stoop, Vyrastekova, 2016). The benefits derived from the game represent a linear function of the subjects contribution and, therefore, the aggregated returns are maximized if each individual invests all assets in the public good. Thus, the amount contributed to the public account represents a measure of the voluntary cooperativity of the participant (Cardenas, Carpenter, 2006).

Adopting the experimental methodology as the core of the data collection strategy, the game of public good (reservoir game) was carried out in places adapted for this purpose, with the support of intermediaries (in order to avoid the experimenter's previous contact with potential players, according to Henrich *et. al.*, 2005). In order to select the participants, recruitment was organized by the intermediaries and, after acceptance and confirmation of the date the locations for the application of the experiment were defined. On all occasions, it was emphasized that participation in the experiment was voluntary and informed about the possibility of financial gain, without mentioning the amount. As a rule, to proceed with the data collection, the researcher and the support team travelled to the cities near Foz do Iguaçu during the morning period. The longest distance travelled to carry out an experiment was 450 kilometers (round trip).

On the scheduled dates, the experimenter, with the support of two or three assistants, presented the game and guided the participants on the driving dynamics, duration, the possibilities of choice (decision), and the context in which the game would take place. In addition to the oral explanation, visual resources (multimedia projector) were used, containing standard texts in Word and photographs (in pdf). The operationalization also had the support of envelopes previously identified to facilitate the allocation of coins in donations and appropriations, in addition to envelopes identified for the application of punishments and rewards, depending on the treatment.

Before the start of the game, the experimenter used a simplified spreadsheet in order to show simulations and provide explanations in conventional / informal language about the development of the experiment. Pre-tests were carried out in order to verify the participants' understanding of the presentation about the dynamics and rules (Croson, 2002), such as the

prohibition of communicating, being absent or using the cell phone. Only the experimenter and the assistants knew the identity of the players, as they were identified exclusively by numbers, and it was not possible for the others to associate the number with their game partner (Howe, 2016). During the development of the experiment, Excel spreadsheet was used for tabulation.

In addition, all clarifications were always repeated in the words of the intermediary of each group. This procedure was trained so that both, the experimenter and the intermediary, could send the same message to the experiment's group. Before the beginning, the possibility of asking questions was opened and for every answer the experimenter and the intermediary made sure that the individuals had understood the instructions. In order to explain how the allocation of resources would occur, coins in two piles were made visible to everyone to serve as example. One of them represented the preservation of the reservoir and was folded and divided equally for everyone, as a way to help understand the destination of the gains resulting from the preservation of the reservoir. It should be noted that the research was screened by the University's Ethics Committee before the experiment was initiated, and the fishermen signed the consent form for participation.

### 3.1 The experiment application

With each round, the players received 2 envelopes and 10 coins of R\$1,00 each, choosing how many coins to allocate to a 'public account created for the conservation of the reservoir' (first envelope), and how many coins to allocate to their respective 'private accounts' (second envelope). Unlike the allocation of coins to the individual account of each player, those donated for the reservoir conservation are summed, and right after multiplied by 2 (representing the benefits resulting from the conservation of the reservoir) and redistributed equally among all players, to illustrate the characteristics of a public good (non-exclusive and non-competing). The results were presented in a projector, round by round, so that each player could take note of their gains, and the gains of the other players.

After 6 rounds, the possibility of one player punishing (treatment 1) or rewarding (treatment 2) another was introduced. For this sequence (another 6 rounds), an extra envelope was handed out. In this envelope the player could write the number of the player he/she would like to punish (or reward) and with how many coins. In addition to the rest of the rules, for each coin the player used to punish (or reward), the punished player lost (or received) 4 coins, representing a high punishment (or reward) as suggested in the specialized literature (Sefton *et al.*, 2007; Nikiforakis and Normann, 2008; Vyrastekova and Soest 2008; Reuben and Riedl, 2013). At the end of the 6 rounds, there was a draw for each player and – in that lot – the player would keep all the money.

The data was analyzed in order to contrast the differences in the amount received by the reservoir and the appropriations of the individual accounts in the groups. In order to compare the average of resources destined to the reservoir and the appropriations, 4 analyses of variance (ANOVA) with one factor were carried out (type of game, with 4 levels: control that precedes punishment (CP), punishment (P), control that precedes reward (CR), and reward (R)) in a completely randomized experimental design. The differences between factor levels were ensured by the Tukey test. Significant values of  $p < 0,05$  were considered. Shapiro–Wilks test was performed to test for normal data distribution and a Bartlett test was used to test for

homogeneity of variance. When necessary, square-root transformations were used to approximate the normal distribution of residuals and to reduce variance heterogeneity.

As for the experiment design, the design between groups was chosen, in order to establish comparisons from the aggregated data of each group. In this experimental alternative, the researcher assumes that any unexpected incongruences/contradictions are balanced between the subjects, considering that the result of the group is what matters (Johnston; Pennypacker, 1993). This option is also defended by the fact that the experiment takes approximately 1 hour and 20 minutes to perform, so that, at the end, participants may be tired, unwilling to restart (a situation that could undermine the quality of decisions). Professional fishermen from the cities of Foz do Iguaçu, Santa Helena, Itaipulândia, Pato Bragado, and Mercedes participated in the experiments.

After the statistical analysis, and with the results, we returned to the field to conduct in-depth interviews with four people considered relevant to understanding the context of the fishermen groups. The choice for complementing data collection from interviews has been reported in some experimental studies. The interviews can take place with the experiment participants themselves (Henrich *et al.*, 2005) or with other people considered relevant to the community where the experiment took place (Cavalcanti; Schlöpfer; Schmid, 2010). Another attribute of the interviews concerns the possibility for the researcher to verify whether the experiment was - in fact - understood (Henrich *et al.*, 2005). List (2011) argues that field experiments, as they offer a distinct source of empirical evidence, can be reconciled with evidence from non-experimental methods, such as qualitative methods. The interviews were conducted with three presidents of the respective professional fishermen colonies in the region, and an Itaipu manager responsible for contracts with the fishermen colonies.

## 4 Presentation of the Findings

### 4.1 Profile and behaviour of the fishermen

The fishermen formed a group of 68 players, of whom 37 participated in the control/punishment experiment, and another 31 in the control/reward experiment.

The mean and standard deviation as regards age and income for the 2 treatments is similar, as shown on table 1:

Table 1:

Mean and standard deviation of age and income of the fishermen

Treatment	Mean: Age	S.D.: Age	Income Range (Mode)
Punishment	50.32	±11.85	from R\$ 800,00 - R\$ 1.200,00
Reward	54.19	±9.41	from R\$ 800,00 - R\$ 1.200,00
Sample universe	52.01	±10.90	from R\$ 800,00 - R\$ 1.200,00

Source: based on primary data.

The fishermen showed no differences in the way they donated for the preservation of the reservoir in the different rounds of the punishment and reward games, and hence the economic incentives had no significant effect on the donations. Despite the quantitative differences between treatments with regards to the amount of donations, these differences were not significant (rounds of control and treatment [ $p=0.59$ ] for punishment and [ $p=0.44$ ] for reward). It is worth mentioning that the data follows homogeneity of variance and gaussianity

of residues after transformation. The next figure presents the donations trajectory in each experiment.

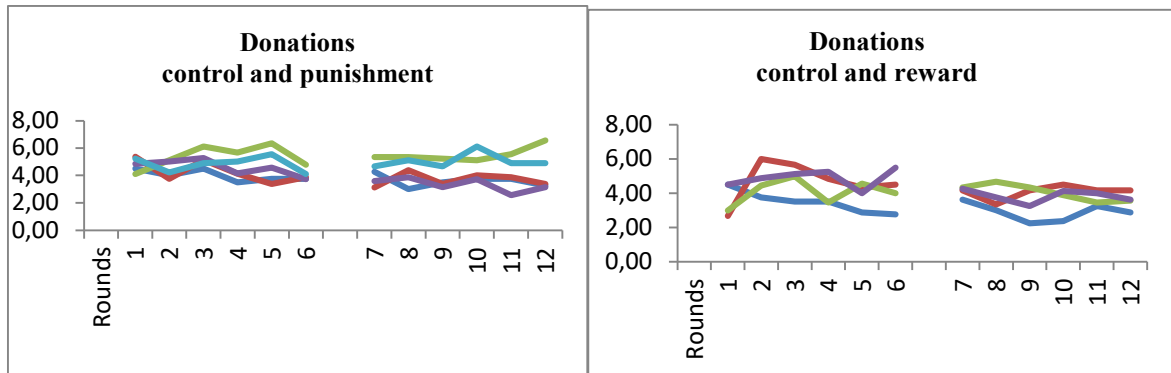


Figure 2: Donations trajectory in each experiment.  
Source: based on primary data.

#### 4.2 Evaluation of the efficiency of economic incentives to foster cooperation

Contrary to what was expected in some of the literature (Balliet *et al.* 2011; Chaudhuri 2011; Travers *et al.* 2011; Bowles; Reyes, 2012), the incentives in the form of punishment and reward did not cause the fishermen to increase their donations to preserve the reservoir. Previous research has related the lack of effect of punishment in promoting cooperation with societies where trust is low (Balliet; Van Lange, 2013) and groups where antisocial punishment is used (Herrmann *et al.*, 2008). As for the possibility of rewarding and being rewarded, the fishermen also remained indifferent, showing no variation in their way of playing. The findings are presented in the following table:

Table 3:  
Donations and number of punishments and rewards

Without Incentives (R\$)	With punishment (R\$)	n. of punishments used	With reward (R\$)	n. of rewards used
4,44	4,24	14	3,71	94

Source: based on primary data.  
Note: The donation could reach R\$ 10,00.

It is worth stating that, although economic incentives have no effect on the fishermen, the percentage of their donations to the public good was similar to that reported in the literature for field experiments, even considering the potential differences resulting from experimental designs.

Table 4:  
Comparative of donation percentages

Authors	Country	Participating Groups	Donation (% of amount)
Barr (2001)	Zimbabwe	Rural communities	48%
Carpenter <i>et al.</i> (2004)	Vietnam	Slum dwellers	72%



	Thailand	Slum dwellers	61%
Ensminger (2000)	Kenya	Nomadic shepherds	58%
Henrick; Smith (2004)	Russia	Rural communities	52%
	Peru	Rural communities	23%
	Chile (Mapuche)	Rural communities	33%
	Chile (Huinca)	Rural communities	58%
<b>This research</b>	Brazil (Paraná)	Fishermen	44%

Source: prepared by the author, following the table model of Cardenas and Carpenter (2008).

Based on these topics, open interviews were conducted, as detailed in the methodology. The next figure contains the responses of the interviewees, as well as the analysis undertaken.

Topics covered	Fishermen	Theoretical discussion
1 - Factors that guide decision-making	<p>“Disputes over fishing areas that are considered more productive, which even cause conflicts between fishermen who occupy nearby fishing spots and claim to be "owners" of the area or spot” (interviewee A);</p> <p>“I believe this behaviour is related to the extractive fishing activity itself, where whoever first gets the best available resources ‘gets lucky’ ” (interviewee A);</p> <p>“It doesn’t surprise me. These are people with very poor education, little purchasing power, and in general, socially vulnerable. They have always lived with marginality and deprivation: ‘when the flour is scarce, my <i>pirão</i> comes first’ ” (interviewee B);</p> <p>“The problem is that there is always someone who wants to own the fishing spot, wants to boss everyone around, and is only there just to pester the others” (interviewee C)</p> <p>“Failure of actions that depend on the community, such as the abandonment of ‘community abattoirs’ installed in some fishing spots. Fishermen claim that they do not want to share water or energy bills, or yet to clean up after others. In their view, it is not fair to share expenses, as the use of structures is disproportionate” (interviewee C);</p> <p>“Lack of success of cooperatives, where there is conflict and formation of subgroups within entities” (interviewee C);</p> <p>“This occurs so much that one of the causes we were unable to agree to a fish gutting-cleaning point is the individualism of the class. In this case, one fisherman doesn’t clean up because another only gutted his fishery but didn’t clean up after himself, or I pay the energy bill but that one just uses it and doesn’t pay” (interviewee D).</p>	<p><b>Individualism (egotism) illustrated by the daily behaviour of the fisherman</b></p> <p>Evidence that the behaviour of individuals is guided by particular interests, strongly overlapping with collective interests (Cardenas, 2011). In addition, there is some mistrust in the behaviour of other members, discouraging cooperation (Cavalcanti; Schläpfer; Schmid, 2010).</p> <p><b>Failure of actions that require cooperation</b></p> <p>Similar results on the class’ individual attitude (linked to impatience) and the negative perception of the behaviour of other fishermen, in Northern Brazil, were obtained by Fehr and Leibbrandt (2008). Guevara and Schluter (2016) found a strong correlation between results of the public goods game applied to fishermen and their daily context, showing that cooperation within the group is weak.</p>
2 - Characterization	<p>“The activity of artisanal fishing depends a lot on the individual work effort. Traditionally, the fishermen places his fishing gear in the water, later checks it out</p>	<p><b>Individual work dynamics, independent of others</b></p>

<p>of the work of the fishermen</p>	<p>to collect the caught fish, and cleans up and packages his fishery, besides doing the maintenance of own gear and own boat and engine. Around 65% of fishermen have a close relative, wife or son, as aid and they're mainly involved with gutting the fish and cleaning up, but they do not usually work in a team. In the strictly labour issue, thinking of fish as a resource of which the owner is the person who catches it, or catches more of it, the less colleagues around, the more fish will be available" (interviewee A);          "Artisanal fishing is a solitary activity, usually performed by a 'holder' fisherman and an aid, usually the wife. It consists of placing fishing gear on strategic place(s), doing maintenance of the same, carrying out maintenance of your boat and engine, when you have one; check fishing gear from time to time, when it is in the water, removing fish from the gillnets/longlines, gutting, cleaning, and selling the fish" (interviewee B);          "Few fishermen fish together, and when they do, the partner is the wife. But this is the most they do in togetherness. They compete a lot for space, and it is common for them to have enmity at the fishing spot" (interviewee C);          - "Usually, fishing alone, sometimes a person helps to remove the net (more in the case of the fisherwoman)" (interviewee D);          "Artisanal fishing as an economic activity that does not depend on a group. The collective is more important, representing a class entity, what can generate benefits or aid, as in the case of distribution of <i>staple food baskets</i> or ophthalmological and medical consultations that are carried out in some dam bordering municipalities, for the group of fishermen. Another time when the group is decisive is in obtaining documentation – historically, the documentation was only requested by fishermen colonies" (interviewee C);          "Fishermen depend on the group and on their colonies when they need to obtain documentation (fishing license / rural producer invoice / contact the Town Hall). They also depend on the group for representation in discussions of significant guidelines for the activity (such as ordinances and other legal instruments). They still depend on their network of contacts to obtain training, subsidies, participate in fairs, and the like, obtain improvements in the infrastructure of the fishing spots [...] Although most fishermen underestimate the importance of the group, in many instances they are only heard because they are a numerically significant group" (interviewee B)</p>	<p>Observation that the fishermen participating in the experiments bring their preferences and beliefs that they acquired in past daily situations (Henrich <i>et. al</i>, 2005; Bó, Fréchette, 2017), as well as the exercise of their work. In this perspective, there is no reason to cooperate with the others, since their livelihood depends entirely on him.</p>
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<p>3 - The importance of the reservoir</p>	<p>“As fishing resources complete their development in the reservoir, this is essential for fishing. It is the working place for this class, and even if fishing is not very profitable, it complements the families’ income” (interviewee A)</p> <p>“In terms of class, your colleagues are essential, as the group of fishermen gives weight to the entity being represented” (interviewee B)</p> <p>“Approximately 800 professional fishermen operate in the reservoir, and they fish – on average - 10 kg of fish per day, with an average income of 1,5 minimum wages a month (R\$ 8/kg of fish times 22 fishing days per month). Many say that they went into the profession because they had no other alternatives, due to poor education” (interviewee C).</p> <p>“It represents survival for many families. It all comes from there: food, housing; nobody is surviving from anything else, most survive from there; it means sustenance for the family” (interviewee D).</p> <p>“I think it’s because most of us survive thanks to it, so people want to preserve it. Some even live there, some adopt it as our home” (interviewee D)</p>	<p>At this point, it was observed that the fishermen deposited coins in the reservoir preservation account due to their high dependence on the same (Mitchell, Agle, Wood,1997), and not because it is a common good to others.</p> <p>They recognize the reservoir as relevant for providing their daily sustenance, so that its preservation is directly connected to their subsistence.</p> <p>Guevara and Schluter (2016), analysing a community of fishermen in Colombia, found a correlation between donations to the public good and the dependence on the natural resource under analysis.</p>
<p>4 – Little use of the punishment mechanism</p>	<p>“Because they are in the border between society and the reservoir, this group is rather shy. I believe that part of the results were due to fear of retaliation; that is something common in their daily lives. On the other hand, I think that some groups did not really want to punish their colleagues for being more united groups” (interviewee A).</p> <p>“This seems to be the manifestation of the fishermen’s class consciousness and empathy. I didn’t follow the game’s dynamic, so I don’t know if they would have the opportunity to retaliate if they were punished by a colleague. That would be an inhibiting factor. If it is not the case, I think that the attitude stands for "I wouldn’t want to be fined myself" (interviewee B).</p> <p>“When the fishermen are together, they fear each other’s opinion. They change their speech when they are together from when they are alone. Together, they fear the opinion of the other... and when in doubt ‘it is better not to expose yourself ‘” (interviewee C).</p> <p>“one protects the other, one helps the other, one doesn’t want to screw up” (interviewee D)</p>	<p><b>Fear of retaliation and punishment</b></p> <p>It is observed the influence of the group’s social norms, implicit, and related to the form of individual behaviour in the face of actions of appropriation by others. The fishermen are capable of following shared norms that can reduce their individual and group payoffs due to fear of retaliation.</p> <p>It denotes their willingness to waive material payoffs, in order not to deviate from implicit social norms (Cardenas, 2011): the fear of retaliation and the fishermen’s attitude towards other colleagues can be interpreted as an external regulator (Cardenas, 2011), which overrides any material gains resulting from the adoption of an alternative stance.</p>

<p>5 – Use of the reward mechanism</p>	<p>“At this point, I think it is a matter of reducing the "guilt" for not donating, as in ‘I didn’t donate because I needed to keep more money, but I recognize the guy that did more to preserve the reservoir” (interviewee A);        “In the treatment with reward, the fishermen donated expecting to receive a greater reward from the others, like to “look good in the photo” with the others and receive more reward” (interviewee B).        “I think the normal thing would be for nobody to reward nobody, if no one was watching” (interviewee C).        “Because, we survive by helping each other a little, doing things for each other, that’s how it works, and those that don’t live that way are already out of our group... in the group that you played the game, most of us, we do our part” (interviewee D).</p>	<p><b>When they didn’t donate, those who did were rewarded</b>        At this point, we can observe an aversion to guilt, in the sense of rewarding others as a compensatory measure for not having allocated their coins for the preservation of the reservoir (Dufwenberg, Gächter; Hennig-Schmidt, 2011). This way of compensating the guilt for not having donated, is one of the ways of obtaining manifest usefulness in this group (Fehr; Schmidt, 1999).</p>
<p>6- Indifference to treatments</p>	<p>“They are used to seeing that inspection is inefficient, at least from the environmental agencies at the reservoir. So much so that in the socioeconomic registration, this has always been one of the main problems [...] They sense that inspection doesn’t really work [...] and also there is a certain indifference as regards the reservoir [...]. One other thing, they are used to the inspection of the fishing activities to involve navigation, etc. etc., but the guys (inspectors) are hardly seen in the water [...]. Nobody sees if your vest has expired... the environmental agency doesn’t inspect illegal fishing... they know that many do wrong things, and so what” (interviewee B)        “Their thing is the less exposure, the better... they do their utmost not to expose themselves; one observed how the other was playing .., and probably tried to copy”. (interviewee C)</p>	<p>There are signs that, for the group of fishermen, economic incentives do not interfere in the group’s behaviour, as the literature predicts (Balliet <i>et al.</i>, 2011) for most experiments. Regarding indifference to punishment, Balliet <i>et al</i> (2011) related this lack of effect in promoting cooperation in societies whose trust is low. It should be noted that the low effectiveness of punishment has also been identified in Turkish and South-African societies, places where antisocial punishment was used (Herrmann <i>et al.</i>, 2008).</p> <p>Previous research on the use of punishment to promote cooperation between small-scale societies discovered that punishment is more frequently used to support cooperation in societies with a strong market economy, or with a greater number of members of society adopting a world religion (Henrich <i>et al.</i>, 2010)</p>



<p>7- Age and reward</p>	<p>“The older ones are those who have less interaction with the group, act more alone, and have less contact with the others... They are the ones that (when they started) worked in total dispersion, with less contact” (interviewee B).          “I believe that because the situation at the lake is more difficult, she is already tired of fishing, and she can no longer give money” (interviewee D).</p>	<p><b>The older the fisherman, the less times he will use the reward.</b>          Realization that the history of experiences can interfere in decision-making (Dal Bó, Fréchette, 2017).</p>
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Figure 1: Main topics covered in the interviews and the corresponding analysis.  
 Source: Based on primary data.

## 5 Final Considerations

This research aimed at understanding how the cooperation between fishermen to preserve a reservoir from which they derive their livelihood occurs, considering the influence of economic incentives such as punishment and reward. This cooperation was verified based on a dilemma posed to the fishermen, illustrated by the possibility of obtaining economic gains by taking advantage of the benefits generated by the contribution of others, or by contributing less than others.

A public good problem was addressed, and it was noted that the determinants for the donations (cooperation) for the fishermen were not related to the use of rewards or punishments, but that there are other factors, linked mainly to the dependence this group has on the public good in question. It appears that the possibility of punishing or rewarding does not exhaust the potential for explaining cooperation, confirming the argument of Henrich *et al* (2005), Cardenas (2011) on the need to consider the context of each group.

It was observed that this finding was due to the group's disbelief in the forms of monitoring and inspection in place and the inefficiency of penalties and fines for disrespecting the rules, as a result of their life experiences of inspections without practical effect on behavioural changes in their milieu. In addition, it was found that the group's reduced use of punishment was controlled by fear of retaliation (common among the fishermen), fear of exposure, and that in future that fisherman could also break one or other rule (or act selfishly) wishing not to be punished for that.

This research also reinforces the arguments of Ba-Ei and Tobol (2013), who conducted a game of contribution to a real (not fictional) public good, as in the case of the current research, in which groups showing greater dependence contributed more than other groups. Cardenas, Rodriguez, and Johnson (2015) also state that, when the players understand the impact of a real public good on their routine, they tend to play more reliably than they would in reality.

The player's behaviour (materialized in the decisions to allocate coins to the public good preservation account) was guided by social norms (Henrich *et al.* 2005; Cardenas, 2011); historical issues of the group and their past experiences (Henrich *et al.*, 2005; Dal Bó, Fréchette, 2017); matters related to dependency on the public good (Mitchell *et al.*, 1997; Guevara; Schluter, 2016); perception of the consequences of decisions made in favour of a public good (Zeng; Chen, 2003), reciprocity and aversion to guilt (Dufwenberg *et al.*, 2011); and expectations about the behaviour of the other members of the group (Gächter, 2007; Cavalcanti, Schläpfer & Schmid, 2010).

From a practical perspective, this study contributes to the debate on the challenge for states when trying to adopt policies aimed at the preservation of a public good, and to business enterprises that develop joint projects with these groups. The idiosyncrasies of these individuals should be taken into account, both in the phases prior to the development of projects, and during their execution if they wish to count on the cooperation of these individuals.

From the theoretical perspective, the findings in the current research raise reflections on the efficiency of economic incentives, and on how the decisions for cooperation are made by a relevant group from the social perspective, and present in the analyses involving stakeholders from the Brazilian electricity sector.

This research was limited to investigating only the group of professional fishermen living near one reservoir alone. It is recognized that there are other relevant groups which could be studied for a more thorough analysis, such as local farmers, indigenous, pig farmers, and others. The limitations underlying field experiments can also be added when compared with lab experiments (Cardenas, 2000; Roe, Just, 2009; Camerer, 2011).

This research opens up other avenues of investigation, such as measuring the impact of each factor in the decision to cooperate, from the use of other statistical methods, and the evaluation of the impact of implementation of new public policies with the participation of these groups. It should also be noted that this research did not discuss the results from the appropriation of resources, rather was restricted exclusively to the study of donations for the preservation of the public good. The exploration of the data related to the appropriations to the individual accounts of the players, and the analysis of their free riding behaviour, which was observed in some of the experiments, constitutes another research opportunity.

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