Does scarcity exacerbate the tragedy of the commons? Evidence from fishers' experimental responses

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Abstract

Economic Experimental Games (EEG) have challenged the theoretical prediction showing that individuals balance own and collective interests when making decisions that deviate away from suboptimal Nash equilibrium. However, few studies have analyzed whether these deviations from Nash equilibrium towards social optimum are affected as the stock of resource changes. Performing EEG with real fishers we test the hypothesis that behavior of participants –measured as relative deviations from Nash equilibrium- differs under a situation of abundance versus a situation of scarcity. The design of our EEG is based on a profit maximization model that incorporates intertemporal effects of aggregated extraction. Our findings show that in a situation of scarcity players over extract the resource making decisions above the Nash equilibrium, obtaining less profit, mining the others-regarding interest, and exacerbating the tragedy of the commons. This result challenges previous general findings from the EEG literature. When individuals face abundance of the resource, however, they deviate downward from the individualistic and myopic behavior prediction. This phenomenon of private inefficient over exploitation is corrected when management strategies are introduced in the game, which underlines the importance of institutions.

1 Introduction

Fisheries are the typical case of common-pool resources (CPR), in which the impossibility of exclusion and users' rivalry result in their degradation and depletion. To this respect, Gordon (1954) argued that resources that are considered "free", specifically fish, would not be extracted at its proper time since, for fishermen, fish in the sea are valueless as there is no guarantee to find them in the future if they are not extracted today. More than ten years later, Hardin (1968) used the expression "the tragedy of the commons" to describe the overuse and consequent depletion and exhaustion to which CPR would arrive as a result of the individualistic behavior of resource users. Since 1968, the tragedy of the commons has been used to describe and explain several situations related with CPR and environmental degradation.

Conflicts associated with CPR have been widely studied in the economic literature including game theory and behavioral and experimental economics. In particular, the tragedy of the commons has been formalized using non cooperative game theory in which communication among players is not allowed and all players have complete information about the payoffs associated with their decisions (Dawes 1973, 1975 in Ostrom, 1990). Prediction from non-cooperative game theory establishes that in a CPR situation, players selecting their best individual strategies will not reach a Pareto-optimal outcome and that individual rational decisions from players will lead them to outcomes that are collectively irrational; paradox known as the prisoner's dilemma (Ostrom, 1990). In other words, individuals facing CPR dilemmas will make decisions that lead them to a suboptimal Nash equilibrium, instead of pursuing strategies leading to a social optimum (Cardenas, Ahn, & Ostrom, 2003).

In the case of fisheries, the tragedy of the commons and prisoner dilemma paradox can be observed when fishermen make individual extraction decisions that lead them to reach collectively a steady state characterized by excessive harvest effort, low availability, low catch per unit of effort, and null benefits.

Evidence from economic experimental games has challenged the above theoretical prediction showing that individuals may deviate from Nash equilibrium towards social optimum (Ostrom & Walker 1991), making CPR extraction decisions that balance own and collective interest (Davis & Holt 1993, Kagel & Roth 1995, Cardenas 2004), even when they are not allowed to communicate (Cardenas, 2000; Cardenas, Stranlund & Willlis, 2000). For example, in experimental games conducted in three rural villages in Colombia, Cardenas et al. (2000) calculated individual deviations from Nash strategies to analyze the balance between self-regarding and others-regarding behavior and found that when individuals are not subject to any rule, their decisions are neither Nash strategies nor social optimal but something between these two outcomes. In addition, when individuals faced internal regulation, through communication, their decisions were collectively superior being closer to socially efficient choices and moving further away their private Nash equilibrium (Cardenas, Stranlund and Willlis, 2000). Cardenas (2000) presents similar findings relative to Nash deviations.

Despite of the abundant literature on those issues, few studies using economic experimental games (EEG) have included the inter temporal effects associated with CPR; In addition, those studies have not analyzed whether deviations from Nash equilibrium are affected by changes in the stock of the resource as a result of extraction decisions.

Dynamic effects may exacerbate CPR problems as individuals might not consider the full impact of their current decisions about extraction on their own and others future extraction costs. Herr et al. (1997) used laboratory experiments to analyze time-independent and time-dependent externalities in non-renewable commons and found that individuals' myopic behavior not only exacerbates CPR problem, but also that even individuals who take into account current and future effects of their extraction decisions might enter into a race for resources, if they believe others may be acting myopically. Herr et al. (1997) state that when inter-temporal effects (time dependent externalities) are included in a CPR experimental game, efficiency from the use of the resource will be lower than that obtained in a similar time-independent game. In addition, those authors show that in practice the efficiency in a time dependent game is even lower than that predicted in theory because of *temporally* myopic behavior that is present only when time is an ingredient of the game, making the solution process more difficult.

The hypothesis that tragedy of commons might be intensified has been analyzed by Corners & Sandler (1983) in a static framework. These authors analyze the role of non-zero conjectural variations on hybrid behavior of fishers. Corners & Sandler (1983) define hybrid behavior as "*the maximizing behavior predicated on conjectures that one exploiter holds with respect to the way in which the other exploiters will respond to his own fishing efforts*". They argue that those conjectures are absent in standard CPR models and that under the presence of non-zero conjectural variation about what one exploiter thinks will be the effect of his extraction on the others extraction efforts, individuals responses will deviate negatively or positively from Nash equilibrium. To include conjectures, authors make firm's benefits dependent on –in addition to own firm's fleet size- the expected response (hybrid behavior) about the size of industry fleet, which is taken as given in the standard model. As a result, if conjectures are positive, meaning that firm's own increased fishing effort is expected to induce other firms to follow, the optimal fleet of the firm and the tragedy of commons will be less than that predicted by the standard solution. In contrast, under the presence of negative conjectures, the optimal fleet size of the firm will be greater than the Nash prediction and "*the tragedy of the commons is intensified*". In the later case, the Nash equilibrium represents a less pessimistic prediction about exploitation of resources (Corners & Sandler, 1983).

Corners & Sandler's (1983) paper leads us to another issue related to CPR games that has also been scarcely analyzed: CPR game responses above Nash equilibrium. In a CPR experimental game, individuals have to choose their level of extraction from an established range. The Nash equilibrium determines the private efficient level of extraction. Deviations below Nash equilibrium might be reflecting collective behavior or other-regarding preferences as they might be incorporating collective interests in their individual extraction decisions. That is, individuals do not necessarily play purely self interested strategies, as predicted by theory (Cardenas et al., 2002). Conversely, when individuals extract more units than those predicted as the Nash strategy –deviation above Nash equilibrium- the conclusion is that they are being very inefficient as they are making decisions that affect their own private returns.

Although, in general, findings from experimental games show that individuals tend to deviate more towards socially efficient outcomes than towards privately inefficient ones, literature that analyzes this later behavior is scarce, at least in the case of CPR experimental games. Cardenas et al. (2002) explore the role of economic inequality in the "provision" of local environmental quality performing experimental games in rural villages in Colombia. In the experimental game, individuals had to choose the number of days they will spend collecting firewood from forest and the number of days they will spent in alternative market activities. In order to analyze the role of economic heterogeneity, these authors test two treatments: in the first treatment, individuals in a group face symmetric returns to the alternative market while in the second treatment (asymmetric game), players face different returns to market options (high wage players and low wage players). Of interest, for our discussion here, is that although individual Nash equilibrium in the symmetric treatment is also symmetric, the Nash equilibriums of the asymmetric game vary: the players with more valuable alternative market activities (high-wage players) are predicted to spend fewer days exploiting the local forest compared with low-wage players. Surprisingly, authors find that during the first five rounds of the first phase of the game (no rules applied), the average deviations from best-responses of high-wage players are negative, indicating that high wage players spend more time collecting firewood than what is privately optimal. Authors conclude that these decisions are very inefficient not only because they are not optimal in the private sense but also because they are "*more environmentally damaging than their Nash strategies*" (Cardenas et al, 2002).

Some studies have analyzed the private inefficiency associated to individuals' under-contribution in public-good games, which, in the mirror case of CPR games would be over-extraction or over exploitation decisions (deviations above Nash-predicted equilibrium). In linear public-good games, the maximizing private benefit strategy (the predicted Nash equilibrium) is to allocate zero units to the public good and all of them to the private activity. However, findings from experimental games contradict these theoretical predictions as individuals tend to make important contributions to the public good or activity. This finding is robust among treatments where linear game designs do not allow for negative contributions. To analyze the possibility of under-contribution in public game experiments (deviations below Nash equilibrium), some authors have modified the payoff structure to allow for interior solutions –or partial contributions-, defining payoff functions that are non-linear either in the private or in the public good (Keser, 1996; van Dijk & van Winden, 1997, Isaac & Walker, 1998; Willinger & Ziegelmeyer, 2001). Findings from those studies have been ambiguous: while Isaac and Walker (1998), assuming a non linear pay off structure in the public good, find that over-contribution is not significant for high levels of equilibrium contribution and, as opposite, individuals tend to under-contribute, Keser (1996) and van Dijk (1997), assuming non linear payoff functions in the private good, found that over contribution is significant.

Literature appears to support the idea that the level of the predicted equilibrium contribution plays an important role in contribution decisions and affects the existence of under contribution as well as its magnitude. Willinger & Ziegelmeyer (2001) analyze the strength of the social dilemma on the contribution behavior, testing four levels of equilibrium (low, medium, high, and very high) and assuming a quadratic payoff structure in the private good, where the dominant equilibrium is a unique interior solution. The authors reduce the strength of the social dilemma by moving the equilibrium contribution to the social optimum and find that over-contribution was only significant at the low level of equilibrium contribution, confirming Isaac and Walker's (1998) findings, which show that average over contribution is reduced when equilibrium level moves towards Pareto optimum.

Despite of having similar findings about over contribution with Willinger and Ziegelmeyer's (2001), Isaac and Walker (1998) find that subjects do tend to under contribute when facing high levels of equilibrium contribution. Specifically, Isaac and Walker (1998) evaluate Nash deviations testing four treatments: the first, based on a boundary Nash solution and the other three, based on interior Nash equilibriums at three different levels. Under-contribution was present in results: in treatments exhibiting the two highest levels of Nash equilibriums, average investments in the public good are below the Nash prediction, being this finding more pronounced in the overall highest equilibrium level. However, under contribution was not observed neither in the treatment based on the corner solution nor in the treatment where the interior solution corresponds to the lowest equilibrium level tested. It is important to bring to this discussion some results from the authors' analyses on individual mean investments: they found that in the highest predicted Nash equilibrium treatment, 41 percent of subjects' mean investments in the group deviated up the Nash equilibrium and that the percentage of subjects *always* investing above the Nash equilibrium, for the same treatment, was 27 percent. These findings suggest that "*within the same experimental group, some individuals follow investment strategies that are highly 'cooperative' while others follow strong 'free riding' strategies, which might be explaining the under contribution observed in the treatments with highest predicted equilibrium levels*." Another important finding from Isaac and Walker (1998) is that upward and downward biases are not the result of pure error.

In the real world, private inefficiency as well as the hypothesis of the possibility of exacerbation of tragedy of commons may be reflecting what is known as Malthusian overfishing. This expression was introduced by Pauly (1988, 1990) to describe the over-exploitation of fisheries by poor artisanal fishers in an effort to maintain their income, leading to a spiral of destruction of marine resources, declining extraction and increasing poverty (Teh & Sumaila, 2006). Malthusian over-fishing concept includes that over exploitation of fisheries that is characterized by three elements: i) poverty, ii) population growth and ii) rigidity in income-generating activities (Teh & Sumaila, 2006). Although degradation of fisheries as a CPR has explanations on their own characteristics (non-excludability and rivalry), it might be exacerbated when Malthusian over fishing conditions are present and resource is being depleted and becoming scarce. In developing tropical countries, fisherman communities are characterized by low incomes, low levels of education, the use of non-appropriate (neither permitted) fishing methods, and rigidities in labor and capital markets that impede them to pursuit other income-generating alternatives, making the case of Malthusian overfishing an explanation of their behavior.

Given the previous review of the state of the art, which approaches social and private inefficiency in the use of public goods and common-pool resources, we address our contribution to test the following hypothesis: in dilemmas associated with the use of a CPR, specifically fisheries, individuals that face abundance of the resource tend to cooperate (under-extract), even where no rules are applied; however, individuals reduce cooperation and might even be privately inefficient when they face scarcity of the resource, moving into a race to the bottom in the extraction-profit pattern. This hypothesis could be seen in other terms: the social dilemma associated with the use of CPR becomes weaker as the private maximizing-solution level is moved towards the social (Pareto optimal) solution, where the lower level of Nash equilibrium is the result of changes in the stock of the resource.

Based on this hypothesis, the objective of this paper is to investigate, performing EEG with real fishers, how the behavior of agents facing CPR dilemmas –measured as relative deviations from Nash equilibrium-, differs under two scenarios: abundance and scarcity of the resource, which in turn are the result of the aggregated extraction decisions.

If our hypothesis is tested and accepted, those results would imply that under scarcity (low availability of the resource) individuals will tend to over extract the resource, even if this is an inefficient behavior, implying over effort and higher pressure on ecological systems. In that case, the tragedy of the commons would be exacerbated.

The paper is organized as follows: in the second part we describe the theoretical model that support the analyzes, in third section we will explain how we develop economic experimental game in eight communities habiting in the influence zone of a national natural park in Colombia, to arrive to the fourth section, in which we will present and discuss the main results; and finally, in the last section some implications and preliminary conclusions are exposed.

2 Theoretical model

To accomplish our objective, we adopt the dynamic model of profit maximization postulated by Moreno & Maldonado (2008), which not only captures the social dilemma of common pool resources, but also incorporates intertemporal effects of aggregated extraction.

The model is based on an individual fisher benefit function which is non-linear in both the level of private extraction (*x*) and the level of resource stock (*S*). The benefits (and costs) that he/she obtains from the extraction activity are, in turn, divided in two parts: i) the private benefit *f(.)* that depends on the level of extraction (*x*) but whose costs depend on the availability of the resource (*S*), and ii) the collective benefits or costs *g(.)*, that are the result of extraction decisions make by all the fishers using the resource and that affect the availability for other fishers[1]. This benefit function represents the profits from a common-pool resource (CPR) characterized by non exclusion and rivalry when fishers decide to extract fish:

$$\pi_{i,t} = f(x_{i,t}, S_t) + g(\sum_i x_{i,t}) = \alpha x_{i,t} - \frac{\beta x_{i,t}^2}{2S_t} + \gamma \sum_{i=1}^{n} (e - x_{i,t}) \,, \tag{1}$$

where $\alpha > 0, \beta \geq 0, \gamma \geq 0$ are parameters. $\pi_{i,t}$ indicates the benefits that fisher *i* obtains in period *t* from extracting the resource. The private part of benefits, *f(.),* is assumed to be a quadratic function of extraction, in order to capture decreasing marginal benefits of extracting, and non-linear in the stock of the resource, assuming reserve-dependent cost (cost increases with reduction in stock but not linearly). Function *f(.)* represents a profit function whose revenues depend on a parameter α (the price of the resource in the market) and whose costs depend directly on extraction and inversely on stock. The

[1] It is assumed that $f_x \geq 0, f_{xx} \leq 0, f_S \geq 0, f_{SS} \leq 0, g_x \leq 0, g_{xx} \geq 0$

collective part of benefit, the function *g(.),* is assumed to be linear in the level of extraction; function *g(.)* represents the effect of joint extraction on individual benefits: the parameter *e* represents the maximum amount that each fisher can extract, which is assumed equal for all fishermen and that, aggregated for *n* fishers –*ne*-, reflects the availability of the resource that is possible to extract. In this way, the expression $\sum_{i=1}^{n}(e - x_{i,t})$ shows the availability of the resource after extraction done by *n* fishermen, while the parameter γ, represents the proportion in which this common-pool resource availability affects individual benefits (Moreno & Maldonado, 2008).

On the other hand, the resource stock changes according to the evolution equation in expression (2):

$$S_{t+1} = S_t - \sum_{i=1}^{n} x_{i,t} + \theta S_t (1 - \frac{S_t}{K}). \tag{2}$$

The evolution equation states that the amount of the resource in period *t+1* will equal the stock at the beginning of period *t,* minus the extraction of all fishers during that period, plus the net growth function –that in this case depends on the parameters θ and *K*[2].

Following Moreno & Maldonado (2008), the Nash equilibrium of this model is obtained by the maximization of each fisher's benefits through time subject to the evolution equation:

$$x^{p}{}_{i,t} = \frac{S_t}{\beta}(\alpha - \gamma - \delta\lambda_{t+1}) \tag{3}$$

This expression represents the Nash equilibrium for the game and shows that the optimum private extraction depends positively on the stock and the parameter α (the price

[2] The growth function can be assumed as a logistic function where the parameter θ represents the implicit growth rate and the parameter *K*, the carrying capacity of the resource.

of the resource), and negatively on the parameter associated to costs of extraction (β), the impact of aggregated extraction (γ) and the discounted inter-temporal price of the stock of the resource ($\delta\lambda_{t+1}$).

To obtain the level of extraction that maximizes the social welfare, a central planner would aggregate the benefits of all individuals, in this case the *n* fishermen, subject to the evolution equation of the stock (Moreno & Maldonado, 2008):

$$\begin{aligned} &\max_{x_{i,t}} \sum_{i=1}^{n} \sum_{t=0}^{T} \delta^t \pi_{i,t} = \sum_{i=1}^{n} \sum_{t=0}^{T} \delta^t \left\{ \alpha x_{i,t} - \frac{\beta x_{i,t}^2}{2S_t} + \gamma n e - \gamma \sum_{i=1}^{n} x_{i,t} \right\} \\ &s.t. \quad S_{t+1} = S_t - \sum_{i=1}^{n} x_{i,t} + \theta S_t (1 - \frac{S_t}{K}) \end{aligned} \tag{4}$$

The Pareto optimum resulting from the first order condition with respect to the extraction would be:

$$x^{soc}{}_{i,t} = \frac{S_t}{\beta}(\alpha - n\gamma - \delta\lambda_{t+1}) \,. \tag{5}$$

Expression (5) shows that the social level of extraction must be lower than that in expression (3), as the proportion in which the availability of CPR affects benefits (γ) must be aggregated for the total number of fishers -*n*- in order to capture the full costs of extraction decisions (Moreno & Maldonado, 2008).

This model, therefore, shows that private extraction decisions should differ from social optimum decisions and that they can range on an ample spectrum depending on the value of parameters and, particularly, on the level of stock. Lower levels of resource should lead to lower levels of extraction as an efficient private decision.

3 Empirical Model

Model simulation and pay-off structure

With the purpose of constructing a pay-off structure that recreates the conflict between collective and private interests represented in expression (1), Moreno & Maldonado (2008) assigned specific values to the parameters in expressions (3) and (5). The parameters used are: α = 100; β = 800; γ = 20. In addition, authors choose the range of plausible extraction equal to [1, 8] and e = 8, following previous field experiments conducted by Cardenas (2004).

The dynamic model proposed by Moreno & Maldonado (2008), where changes in stock affect individual benefits, yields many (and unmanageable in practice) Nash equilibriums for each level of stock resulting from each possible aggregated extraction. In order to make the game practical, easy and understandable for real fishers, the researchers simulated solutions for only two levels of stock: high level (abundance) and low level (scarcity), making necessary to construct just two payoff tables, one for each of these stock levels. The pay-off tables show the benefits that each individual obtains from different combinations of individual and aggregated extraction (annex 1). From these payoff tables it is possible to observe that as individual *i* increase his/her extraction, his/her payoffs increase (at a decreasing rate), but as the aggregate extraction increases, *i*´s payoffs decrease, which emulates the social dilemma between individual and collective interests.

Notice that the dynamic setting of the model generates two implications on player's decisions: First, the effect of aggregated extraction in period t on resource stock at period $t+1$, and second, the effect of the inter-temporal discount rate on the individual path of extraction decisions. Therefore, even assuming just to levels of stock, the model still would yield several private Nash equilibriums, depending on the individual´s discount rate. If we assume that the player does not take into account the inter-temporal effects of her decisions, the model predicts that in her private extraction decision the term $\delta\lambda$ converges to zero[3]; then expression (5) becomes:

$$x^{p}{}_{i,t} = \frac{S_t}{\beta}(\alpha - \gamma). \qquad (6)$$

Expression (6) is equivalent to a myopic Nash equilibrium and we used it to calculate the theoretical benchmarks and payoff tables used in the experiment. Utilizing parameters mentioned above and assuming stock under abundance S_H = 80, we arrive to a Nash equilibrium of 8 units, which is a corner solution as the range of plausible extraction is [1,8]. In order to simulate scarcity of the resource (low level of stock) we assume S_L = 40[4] and, *ceteris paribus,* we obtain a Nash equilibrium –under low stock- of 4 units, which corresponds to an interior solution. Notice that although under scarcity of the resource, Nash equilibrium is four units, individuals could still extract any amount between one and eight units. So, in this case, players may deviate from Nash Equilibrium not only downward but also upward. Given that cost function is reserve-dependent, benefits under abundance are higher than those under scarcity, at each level of extraction. Figure 1 illustrates average benefits a player can obtain under the two states.

In addition to myopic Nash equilibriums –low and high-, other private solutions can be obtained from this model if it is assumed that individual deviate in different degrees from that complete myopic behavior. Gillet et al (2007) incorporate inter temporal effects in lab experiments by simulating two extreme scenarios: optimal forward looking, where individuals incorporate completely future effects on current decisions, and myopic behavior, where players maximize current period benefits in each and every period, without taking future consequences into account. Our assumption is similar to Gillet et al

[3] This is equivalent to a discount rate (ρ) converging to infinite.

[4] We performed games with groups of five players. Notice that a level of stock equal to 40 units allows each of the five players to extract the maximum eight units of the resource.

(2007), but we do not define an *optimal*-forward looking (or complete-forward lookingness) scenario, where player has perfect forecast of future implication of current actions on total current and future benefits. Instead, we assume that any deviation from complete myopic behavior incorporate some kind of forward-looking behavior. In this way, Table 1 summarizes the equilibriums for the model.

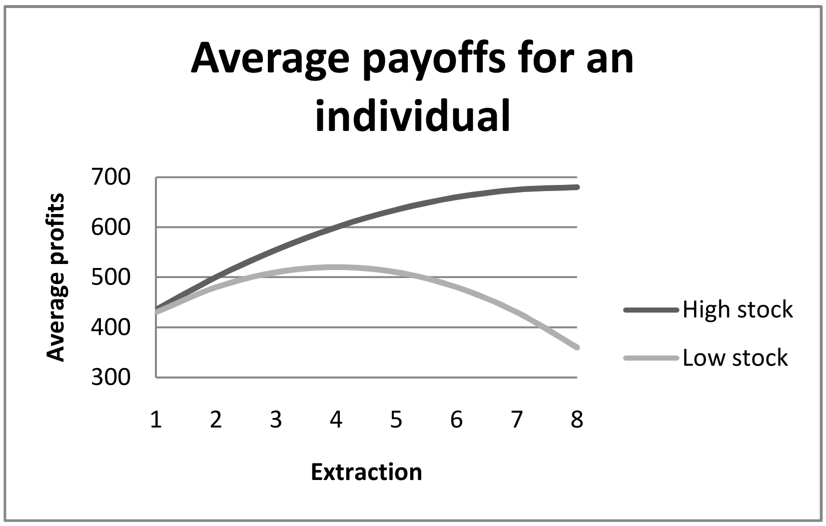

Figure 1. Average payoffs obtained by players under different resource stocks.

Deviations below Nash equilibriums imply that individuals either incorporate collective interest in individual decisions or incorporate future consequences of present actions on current decisions, or both. In the case of low stock, deviations above Nash imply private and social inefficiency, as individuals would be making extraction decisions that represent less benefits than those associated with Nash equilibrium (less extraction) and they would be acting more resource-harmful than what theory predicts, exacerbating the tragedy of fisheries.

Finally, using the same parameters, Moreno and Maldonado (2008) adjusted the social optimum equal to one unit[5] which will be also used for our analyses.

Table 1. Nash equilibriums for the model.

Stock level/ discount rate	Complete myopic behavior $\rho \to \infty \Rightarrow \partial = 0$	Forward looking $0 < \partial < 1$
High (abundance of the resource)	8	< 8
Low (scarcity of the resource)	4	< 4

Experimental design

Based on the theoretical model, we design a CPR economic experimental game (EEG) in two phases, both of them made up by ten rounds of decisions. Individuals were organized in groups of five participants and at every round, each player must decide privately a level of extraction from one to eight units of the resource. Player's extraction decisions generate points, convertible into monetary units. On average US$ 50 were paid per group of players (US$ 10 /person, which is equivalent to a typical daily wage/person in the region). Pay-off tables (annex 1) reflect equation (1): the higher the individual extraction, the higher the points a player obtains, but a decreasing rate. However, the higher the group extraction the lower the points an individual obtains for each extracted unit.

The inter-temporal effect of aggregated extraction is captured by the fact that group's extraction in one period will affect stock level in the following period. For simplicity, in our design individuals could arrive just at two different stock levels: high level or

[5] Although parameters generate a theoretical social optimum of zero units, we followed Cardenas (2004), who argues that it is convenient to eliminate the zero extraction option to avoid conflicts in conducting experiments that arise because there is strong aversion by villagers towards prohibitions to use resources. In addition, in the NNP-CRSB fishermen are allowed to extract resources for "self-consumption".

abundance and low level or scarcity. In practice, the dynamic part of the game was designed as follows: if in round *t* the aggregated extraction (five-person group extraction) exceeded 20 units, in next round (round *t+1)* individual will face scarcity of the resource (low availability). Under scarcity, every unit of extraction is paid with fewer points as low availability of the resource implies more effort per unit of catch, which in turn generates, *ceteris paribus,* lower benefits. Conversely, if the extraction by the whole group in period *t* was less than or equal to 20 units, players in period *t+1* will face an abundant resource (high availability), which requires less effort per unit of catch, and so higher returns to the activity. These two levels of stock are associated with two different pay-off tables according with the benefit function in expression (1).

During first phase individuals did not face any rule while during second phase, players face three different rules: internal regulation, external regulation, and a combination of both. Analysis of management rules were carried out in Moreno & Maldonado (2008) and therefore this paper will not address the issues related with performance of rules independently but jointly in order to concentrate analysis efforts on the over extraction hypothesis. Figure 2 shows the dynamic components of the experiment.

Recall that according to the profit maximization model, the expected Nash equilibrium of the game under abundance (scarcity) and assuming completely myopic behavior is a level of aggregated extraction of 40 units (20 units), implying 8 units per player under high stock and 4 units per player under low stock. The social optimum is a level of aggregated extraction of 5 units (1 unit each).

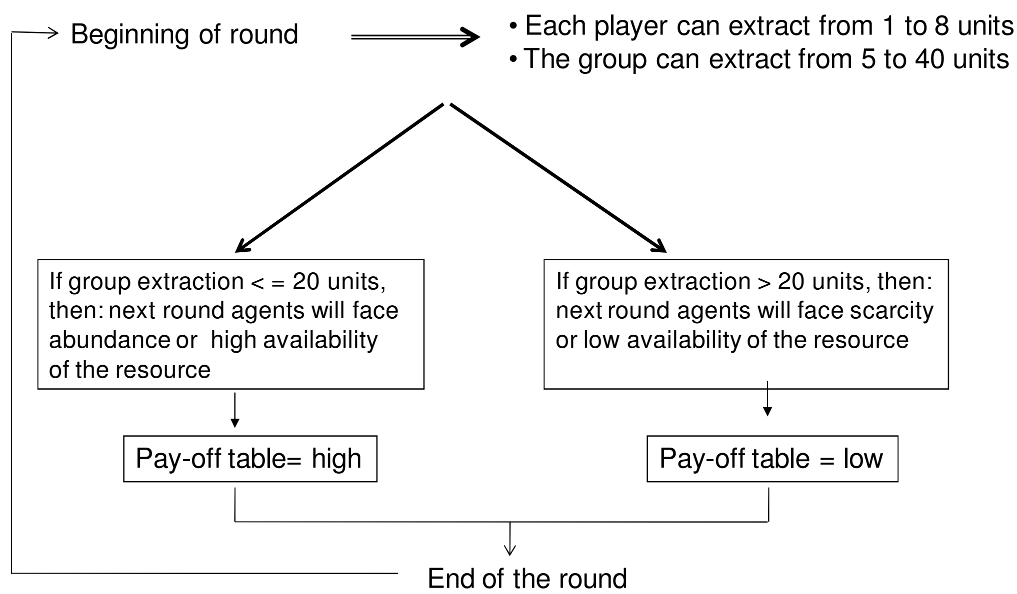

Figure 2. Dynamic components of economic experimental games

The players

Economic experimental games were performed with 230 individuals from eight fisherman communities located in the influence zone of the National Natural Park Corales del Rosario y San Bernardo (NNP-CRSB) in the Colombian Caribbean.

Operative procedures

As mentioned above, at every location fishers were organized in groups of five individuals and seated back to back in order to guarantee anonymity and confidentiality of individual decisions. In addition, a supervisor monitored and controlled that games rules were understood and accomplished. The supervisor was also in charge of collecting pieces of paper (decision cards) where fishermen wrote extraction decisions that they privately made at every decision round.

On the other hand, before starting the game, experts on environmental education with communities explained the game to the fishermen using different visual aids such as drawings, pictures and posters. As a complement and in order to guarantee individuals had understood the game, we performed three practice rounds before starting the actual game.

Every player received the following material for the game: i) decision cards, where they write their individual and confidential extraction decision, ii) Scarcity pay-off table, iii) Abundance pay-off table, and iv) Individual accounting sheet.

4 Analytical methods and results

In order to analyze the behavior of participants in the EEG and to address the research question, the methodological approach proposed is based on some basic steps:

1. To analyze the frequency of individual extraction decisions and deviations from Nash at every resource state and to classify those decisions according to their relationship with theoretically predicted equilibriums. The differences are tested statistically. From this analysis, we look for patterns on decisions that help to explain the behavior, particularly when players decided to extract above Nash equilibrium. Categories of individual behaviors are drawn from this analysis.
2. To analyze the frequency of group extraction decisions and deviations from Nash equilibriums at every resource state, classify these decisions and test statistically the differences. Similar to individual decisions, to search for patterns on group decisions, especially when these decisions fall above Nash equilibriums. Categories of groups are also constructed.
3. To look for relationships between individual behavior and group behavior to analyze the patterns of extraction and the effect that groups can have on individuals.

4. To run a preliminary econometric model to explain differences in extraction decisions and deviations from Nash as a function of socioeconomic, resource state, among other variables.
5. To analyze how rules included in the EEG alter individuals' behavior.

Individual decisions

The first step is to analyze the frequency of extraction decisions at every state. Figure 3 shows that under high stock is more frequent to observe extraction decisions of more than five units, and that 8-unit extraction is the most frequent decision. However, in the same figure it is observed that when players faced scarcity, extraction distribution is more uniform along the whole range of extraction possibilities. Given that Nash equilibrium at low stock is interior, at this level there are extractions that should not be observed (those colored in red in the graph), as they are decisions that generate lower benefits than those obtained at a level of extraction of four units. So, these extractions are inefficient both privately and socially, as resource is being overexploited without any marginal benefit (even with a marginal loss). From this figure, it also can be deducted that most of rounds (60 percent) occurred at low level of stock (blue and red bars), while 40 percent of rounds are played at high level (green bars). From all the rounds, 15 percent of decisions coincided with Nash equilibriums, 46 percent were below Nash equilibrium, 27 percent were inefficient (above Nash equilibrium), and 10 percent at optimum (socially) levels.

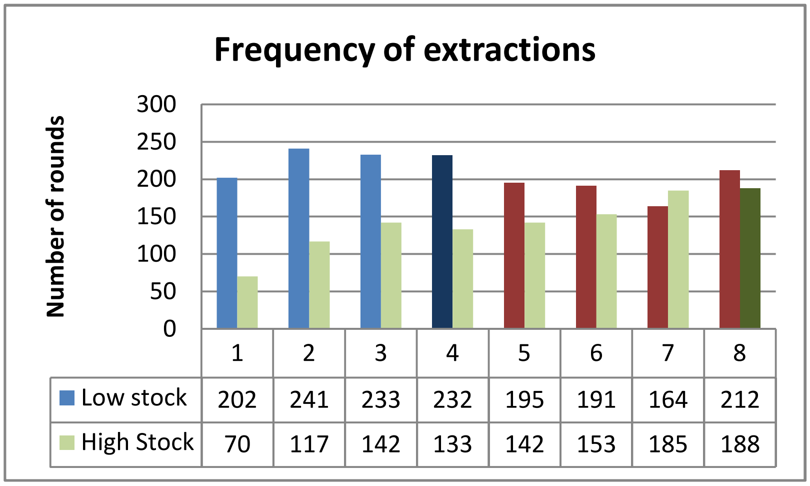

Figure 3. Frequency of different extraction decisions at high and low stock.

Recall that Nash equilibrium at low stock equals four units, while under high stock it equals eight units. In order to compare extraction decisions under the two levels of stock, we calculated the difference between actual extraction and expected private Nash equilibrium. This measure is what we call deviations from Nash. If individuals extract above the Nash equilibrium –inefficient and exacerbating extraction- the deviation is a negative number; if they extract below Nash –others-regarding preferences- the deviation is a positive number; and if they extract at Nash equilibrium –privately efficient decision- the number is zero. Figure 4 shows those deviations and their frequency at both high and low stocks. Since deviations are calculated with respect to different Nash equilibriums, signs of absolute deviations are more important than magnitudes for analytical purposes.

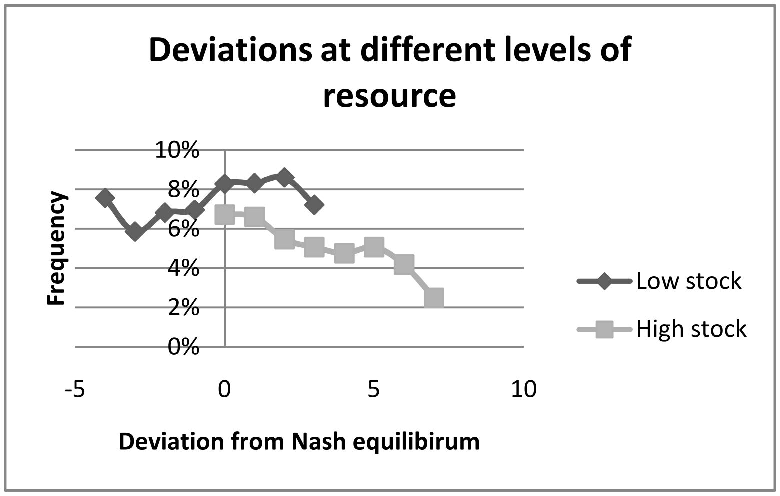

Figure 4. Deviations from Nash at every state of the resource.

These deviations are classified in groups according to their relationship with Nash private decisions: Figure 5 shows that under high stock, 83 percent of decisions were below Nash, implying either others-regarding preferences or forward looking behavior. When facing low stock, 86 percent of decisions were made out of Nash equilibriums, but only 40% of them were below Nash, implying lower others-regarding preferences or forward looking behavior.

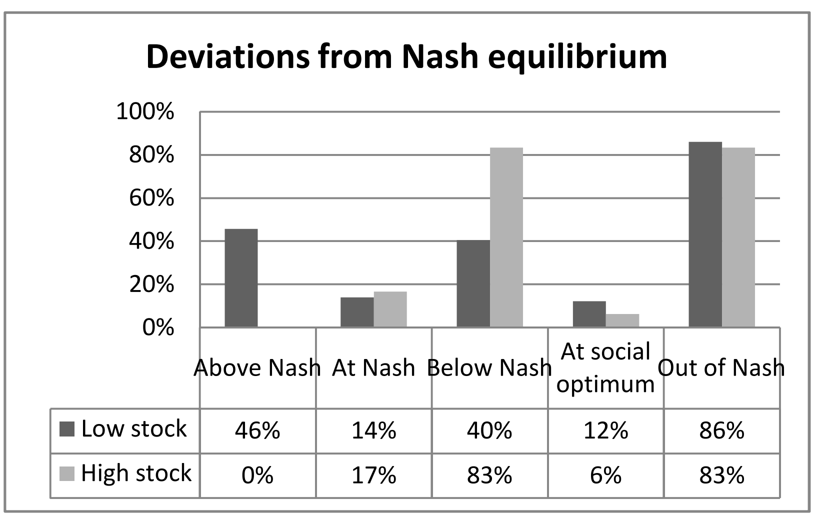

Figure 5. Classification of deviations from Nash equilibrium at every state of the resource.

At high stock, 17 percent of decisions were done at the Nash equilibrium ($x = 8$), while 6 percent of them were observed at the social optimum ($x = 1$). On the other hand, at low stock 14 percent of decisions coincided with Nash equilibrium ($x = 4$), and 12 percent were observed at the social optimum. Besides, at low stock was possible to observe decisions above Nash: 46 percent of the total decisions under that stock availability were made above private Nash equilibrium, and obviously above the social optimum.

In summary, when facing scarcity individuals tended to extract using inefficient strategies in almost half of the rounds, exacerbating the tragedy of the commons by extracting not only more than the social optimum but also more than the private Nash equilibrium.

Those findings would lead to several implications of importance:

- When scarcity appears, collective action or forward lookingness is reduced;
- The greater the "distance" between Nash equilibrium and the social optimum, the less likely players arrive to the optimum. Under low stock, players' Nash is closer to the social optimum, so they are more likely to make optimum decisions; and
- A central result: under low stock, players decided to over extract in 46% of the rounds, even knowing that this is an inefficient behavior in terms of over effort (private) and impact on the resource (social).

These results coincide with some economic literature using models with interior solutions, which have found that individuals could deviate up or down from Nash equilibriums, particularly in the case of public goods. Isaac and Walker (1998) show that at high optimal private levels of contribution to a public good, individuals tend to under contribute even if this behavior is inefficient. Similarly to those authors, we have found, for the mirror case of a CPR, that in a situation of scarcity, players over extract the resource, making decisions above the Nash equilibrium, obtaining less profits, mining the others-regarding interest, and exacerbating the tragedy of the commons.

There is an interesting way of explaining this behavior: Small-scale fishers in tropical developing countries are usually poor and lack alternative employment opportunities, i.e. once they start fishing they are forced to continue, even if the resource declines precipitously (Pauly, 1994). *Malthusian overfishing* is what occurs when these poor fishers, lacking the usual alternative of 'traditional' fishers (e.g. a small plot of land or seasonal work on nearby farms or plantations), are faced with declining catches and induce wholesale resource destruction in their effort to maintain their incomes (Pauly, 1994).

In order to validate these results, it is necessary to test statistically whether there are significant differences between decisions at different state levels; in this case, we have two resource stocks –low and high. Table 2 shows statistics in three variables: individual extraction decisions, individual deviations from Nash, and individual deviations from Nash as a fraction of theoretical Nash equilibrium. Statistical differences analysis is only valid for the later variable, as the other two are not comparable. Three statistical tests are used: First, a t-test on averages, assuming that variables are normally distributed. If there are no underlying assumption about the distribution of the variables, two alternative tests are used: Mann Whitney test, which tests the null hypothesis that two independent samples are from populations with the same distribution (Wilcoxon rank-sum test); and Fisher's test on median, which performs a nonparametric K-sample test on the equality of medians; it tests the null hypothesis that the two samples were drawn from populations with the same median.

Table 2. Statistical analysis of differences in individual decisions at both levels of stock

Variable	Individual extraction	Individual deviation from Nash	Individual percent deviation from Nash
Low stock	4.357	-0.357	-8.9%
High stock	5.035	2.965	37.1%
Difference			-46.0%***
Mann Whitney z			-20.98***
Prob(v1>v2)			0.268
Fisher´s test (Pearson chi^2)			208.7***

* significant at 10% ** significant at 5% *** significant at 1%

Under all tests, the differences between individual percent deviations from Nash under low and high states are highly statistically significant, showing that decisions under high stock differ systematically from those under low stock. Besides, it is observed that both mean and medians are different under both states and, as can be observed in the table, under low stock individuals over extract the resource.

This behavior, however, may be associated to some particular individuals and not to the whole set of players. To test this hypothesis, we divided the sample according to the number of rounds that participants played above the Nash equilibrium. That is, we calculated the number of rounds that every participant played above Nash. In Figure 6 can be observed, for example, that 25 percent of players decided not to extract above the Nash during the whole 10 rounds, 14 percent of the players extracted above Nash one out of ten rounds, and so on. It is evident that there exist differences in the behavior of participants.

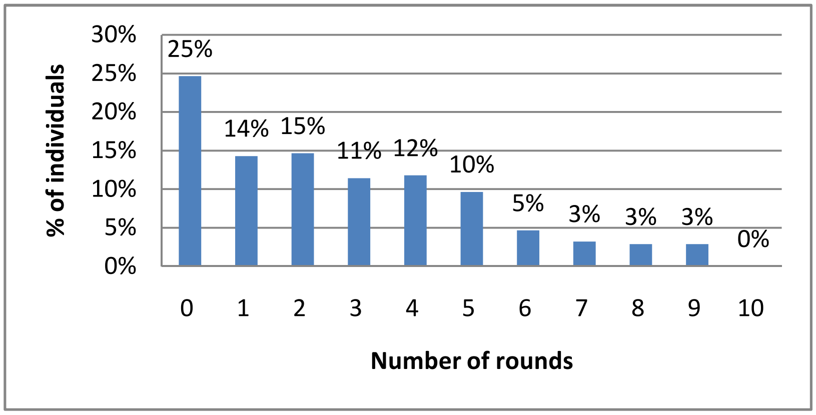

Figure 6. Frequency associated to the number of rounds that individuals played above Nash

Based on this observation, participants were categorized depending on the average number of rounds that they decided to play above Nash: some never played above Nash, some played less than half of the times above Nash, and some played more than half of the rounds above Nash. Results are presented in Figure 7. Results show that besides the one quarter of participants that never played above Nash, almost another quarter played above Nash more than half of the rounds, and about a half of them played less than half of the times above Nash, but at least once.

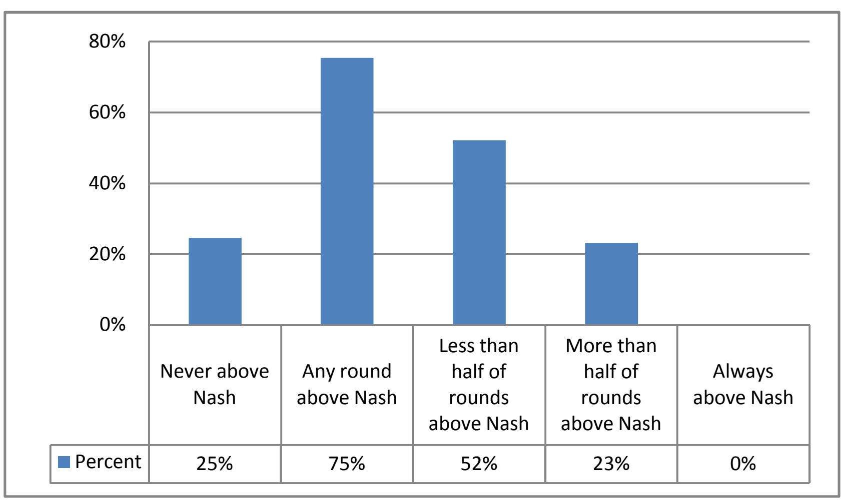

Figure 7 Categories of players according to their behavior with respect to Nash equilibriums

Those findings imply that, individually, some players may have pro-social attitudes ("good guys" in social and environmental sense), some may have individualistic attitudes, and some may have exacerbating attitudes, even if they are having economic losses by doing that ("bad guys" in social and environmental terms).

A further question is whether this individual behavior is influenced by group behavior. Therefore, a group analysis is performed.

Group decisions

Similar to the individual analysis, the first step is to observe whether group behavior differs depending on the state of the resource, comparing group extraction, group deviations from Nash (Group Nash equilibrium is 20 units under low stock and 40 units under high stock), and group deviation as a proportion of expected Nash. Results for these variables and statistics tests for the later variable are presented in Table 3; the group decisions vary significantly depending on the state of the resource, and they tend to deviate upward the Nash equilibrium when group faces low availability of the resource, while they deviate downward the Nash equilibrium when stock is abundant. Under low stock, mean group extraction was about nine percent above the Nash equilibrium (20 units), while under high stock, mean group extraction was about 37 percent below Nash equilibrium (40 units).

Similar to individual analysis, group behavior can be categorized according to their deviation about Nash. Categories for group deviations from Nash are presented in Figure 8: under low stock, 57% of the times, group decisions were made above the 20-unit group Nash equilibrium, 35 percent of the times below Nash equilibrium and only eight percent of the times at the Nash equilibrium of 20 units. Under high stock there were neither group decisions at 40 units (Nash equilibrium) nor group decisions at social optimum (five units).

Table 3. Statistical analysis of differences in group decisions at both levels of stock

Variable	Group extraction	Group deviation from Nash	Group percent deviation from Nash
Low stock	21.784	-1.784	-8.9%
High stock	25.173	14.827	37.1%
Difference			-46.0%***
Mann Whitney z			-37.35***
Prob(v1>v2)			0.085
Fisher´s test (Pearson chi^2)			1,400.0***

* significant at 10% ** significant at 5% *** significant at 1%

Under low stock and analyzing the data from the group perspective, the exacerbating behavior is more frequent, showing that under scarcity cooperation is difficult to achieve.

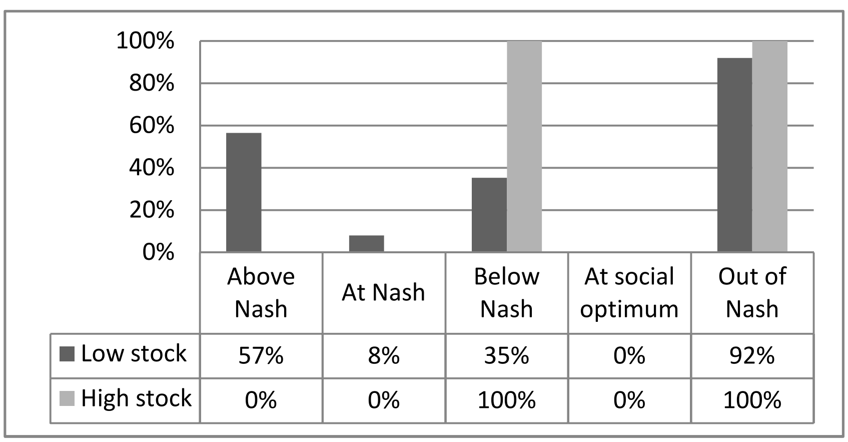

Figure 8. Groups classification according to their deviation from Nash equilibrium

In the same sense as in the individual case, the following question is whether this behavior is consistent among all the groups or if some of them tended to cooperate while others tended to exacerbate. Therefore, groups are analyzed according to the number of rounds that they played above Nash. Results are presented in Figure 9: 23 percent of groups never played above Nash; that is, they consistently cooperate with the use of the resource. It is also notorious that 13 percent of groups played 9 out of the ten rounds above Nash equilibrium.

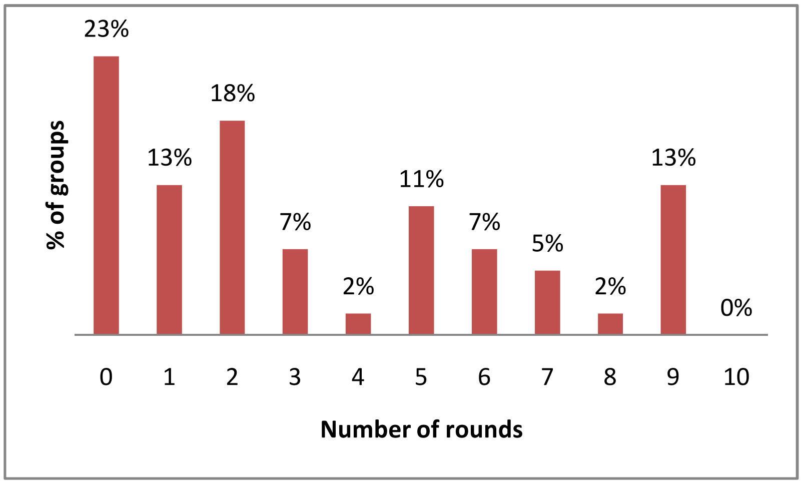

Figure 9. Frequency associated to the number of rounds that groups played above Nash

These behaviors are categorized to define attitudes of groups: some groups acted during this part of the game cooperatively and sustainably, as they never extracted above Nash, some others moved switching between decisions above and below Nash equilibriums, and some others most of the rounds played above Nash equilibrium. These groups are presented in Figure 10.

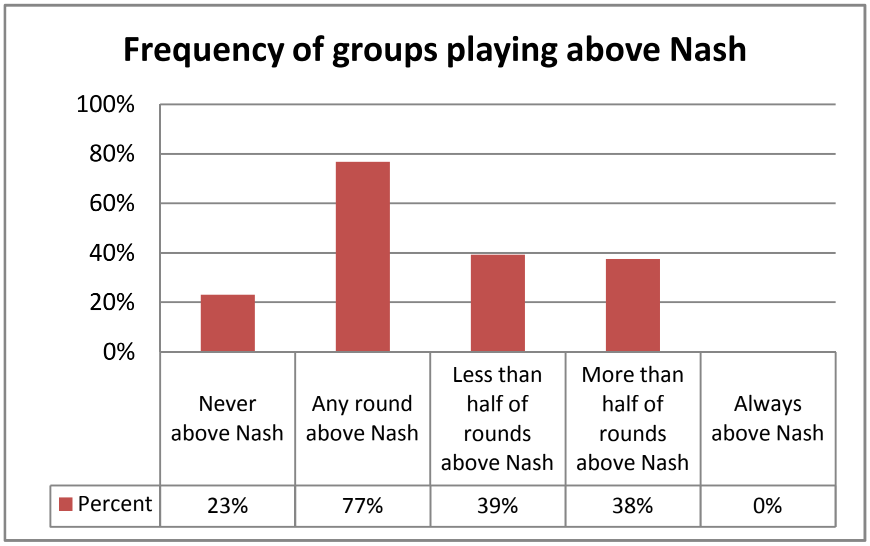

Figure 10. Categories of groups according to their behavior with respect to Nash equilibriums

Three quarters of the groups played at least once above Nash equilibrium; about half of the groups played less than half of the rounds above Nash, and half of the groups played below the Nash equilibrium. Near one quarter of groups played never above Nash equilibrium. That is, some groups consistently behave cooperatively by never extracting above Nash ("good" groups in social and environmental terms); some groups exhibit behaviors closer to the Nash equilibrium, and some groups repeatedly extract in an inefficient way ("bad" groups in social and environmental terms).

Relationships between individual and group decisions

Given that there are individuals that behave inefficiently along the game and individuals that exhibit pro-social behavior consistently along the game, and groups that show similar pattern, the question is whether "good guys" belong to "good" groups or not. In Figure 11 is observed that good players and good groups coincide in a high proportion of rounds related with good groups; similarly, bad groups and bad guys coincide in more than 60 percent of the cases associated to bad groups.

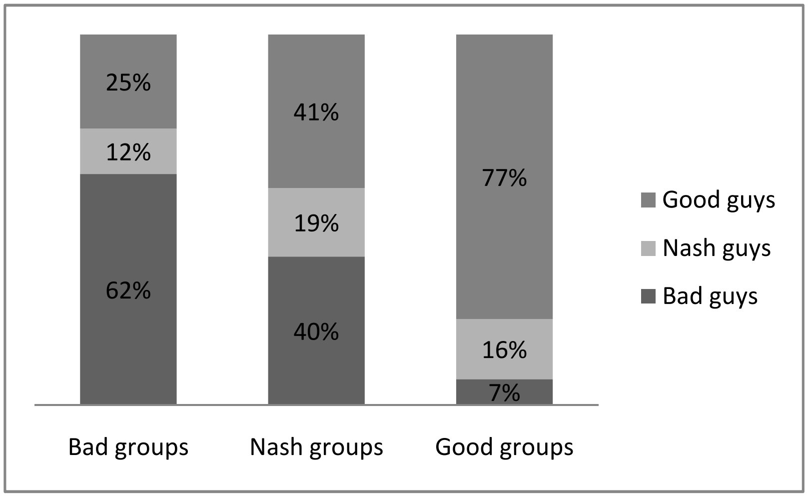

Figure 11. Relationship between individual and group decisions with respect to Nash equilibriums

Interestingly, 25 percent of players in groups that exacerbate the use of the resource are "good guys", in the sense that they made an effort for not over extracting the resource. They are consistently trying to reduce the group extraction, but their effort is vanished for the inefficient behavior of the rest of the group. As a result they fall in low stock most of the times, and their profits are reduced. Conversely, seven percent of the players belonging to "good" groups, consistently over extract during the game, make profits from it, and the pro-social behavior of the group maintain them in high stock availability obtaining greater profits. They are free riders of the groups that maintain high resource availability by efficient and pro-social decisions made by the rest of the group.

Those free riders may erode the pro-social behavior and induce good players to start playing inefficiently. On the other hand, good players in bad groups may send signals –through their behavior- to the other players to reduce the over extraction. To analyze if these cases are observed, we calculated the average extraction decisions of players categorized according to these three groups: pro-social or good guys, neutral or Nash guys, and inefficient or bad guys. Results are presented in Figure 12. It can be observed that there is no clear evidence that behavior of individuals was affected by the behavior of the group, although for Nash guys (those that extract at least once above Nash equilibrium but less than half of the rounds) a reducing trend is evident. These results imply that pro-social players behave efficiently independent of belonging to good or bad groups; the same, unfortunately, is true for inefficient players.

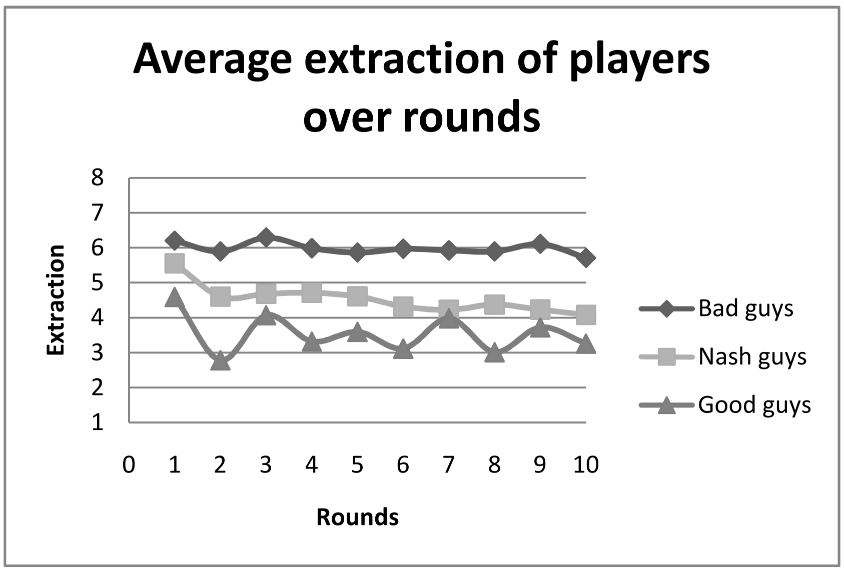

Figure 12. Average extraction of individuals according to Nash categories

Effect of rules on decisions

The second part of the game involved the introduction of rules aimed to increase the collective action and the efficiency in the behavior, by reducing the extraction of the resource and increasing the sustainability of it. These rules included external regulation (fines), internal regulation (communication), and a combination of them (co-management). It is not intended to present all the details of these treatments, as they are amply analyzed in Moreno & Maldonado (2008), but in general is observed that all of the rules are effective reducing extraction, although the effect depends greatly on the location of the community analyzed, the treatment introduced, and other socioeconomic characteristics of individuals.

In Table 4 is shown that extraction reduced, in average, from 4.6 to 3.1 units, being more significant under high stock. This change in the pattern of behavior implied that under abundance (high stock) players moved closer to the social optimum, by changing the deviation from Nash from 2.97 units to 5.02 when treatments are included.

Table 4. Comparison of individual responses as a result of introduced rules

Variable	Individual extraction		Individual deviation from Nash		Individual percent deviation from Nash	
	Without rules	With rules	Without rules	With rules	Without rules	With rules
Total	4.630	3.093	0.984	4.054	9.6%	52.0%
Low stock	4.357	3.496	-0.357	0.504	-8.9%	12.6%
High stock	5.035	2.984	2.965	5.016	37.1%	62.7%
Difference					-46.0%***	-50.1%***

* significant at 10%   ** significant at 5%   *** significant at 1%

Most interesting is the case when players faced scarcity: the average deviation from Nash moved from -0.4 to 0.5, reducing somehow the exacerbating behavior. As a proportion of Nash equilibrium, the average deviation changed from 9 percent above Nash to 13 percent below it, under low stock.

These results imply that phenomenon of private inefficient over exploitation is corrected when management strategies (external and internal regulation and joint management) are introduced in the game, which underlines the importance of institutions in the management and sustainability of a common pool resource. However, the deviations under scarcity that determines the collective or others-regarding behavior, continued being low and statistically different from the behavior when individuals faced resource abundance.

Econometric analysis

The results concerning to the hypothesis that under scarcity, individuals exacerbate the tragedy of the commons by making decisions above the private Nash equilibrium is formalized through a parametric analysis.

Our hypotheses are that individual decision about extraction (percent deviation from Nash) is explained by conditions on game (current round´s stock level, group extraction and own extraction), the type of group every participant is playing with (Good groups, Nash groups, or Bad groups), demographic and socioeconomic conditions (age, education and income earnings), and perceptions about the protected area. In order to test these hypotheses, we conducted a survey to players, after game finished, to collect the needed data to perform an econometric analysis. We run a regression of individual deviations from Nash as a proportion of Nash equilibrium against several variables. Given that ten-round decisions for every individual are not independent, a panel data structure is adopted so that error associated to rounds within a particular player could be separated from error associated to the between-individuals variation. As the model uses lagged variables, information about first round are dropped. Results are presented in Table 5.

To interpret the coefficients we follow a simple rule: positive coefficients imply that an increase in the independent variables will result in greater pro-social attitude by the player and vice versa. Conversely, negative coefficients mean that an increase in the independent variables will result in more private or even inefficient behavior.

Main findings show that resource stock in current round demonstrates a positive relationship with relative deviation. It implies that if current round exhibits abundance, current individual extraction decision will have a greater percent deviation from Nash, moving towards the social optimum. On the other hand, every additional unit of individual extraction in previous round results in a downward deviation on current round, confirming that "bad guys" tended to keep being "bad" along the game. At the same time, the greater the extraction by the other members of the group in a previous round does not incite group mates to deviate down from Nash.

Table 5. Panel regression to explain individual deviations from Nash.

Dependent variable: Percent deviation from Nash	Coefficient	Std. Err.
Resource stock current round (1 high, 0 low)	0.059*	0.032
Own extraction previous round (1-8 units)	-0.056***	0.005
Other members' extraction previous round (4-32)	0.005*	0.003
Belonging to bad group (1 bad group, 0 no bad group)	-0.294***	0.042
Belonging to good group (1 good group, 0 no good group)	0.202***	0.043
Age (years)	0.001*	0.001
Education (years of education)	0.018***	0.003
Per capita income (monthly minimum wages)	-0.168***	0.042
Has received info about protected area (1 yes, 0 no)	0.068***	0.024
Willingness to collaborate with park management (1 yes, 0 no)	0.074***	0.022
Constant	-0.086 ^{ns}	0.096
Observations	2,164	
Groups	196	
R-sq within groups	0.142	
R-sq between groups	0.765	
R-sq overall	0.379	
Wald Chi-sq(k)	1,313	

* significant at 10% ** significant at 5% *** significant at 1% ^{ns} not significant

Two categorical variables are also used to capture intra group behavior: one of them takes the value of one if the group is categorized as a good group (in the sense above mentioned), the other one takes the value of one if the group is categorized as bad group. The coefficients are significant and the signs are the expected: being in a good group is associated to deviations toward the social optimum, while being in a bad group is associated with deviations downward the Nash equilibrium. Those results confirm the conclusion that most of “good guys” pertained to “good” groups, as well as “bad guys” pertained to “bad” groups.

With respect to demographic variables is observed that age and education increase deviation from Nash, that is, older and more educated players tended to extract towards social optimum.

Per capita income shows a negative relationship with proportional deviations from Nash, implying that richer individuals extract closer to Nash equilibrium or above it. This result challenges the usual assumption that poorer people impact more heavily the natural resources, and also challenges the assumption about Malthusian over fishing. However, further analysis is needed as the correlation between bad guys and income has not been explored yet.

Other two interesting variables are those related with the perception of players about the protected area and the meaning of conserving its resources. Players that declared to have received some information (training, workshops, etc.) about the importance of the protected area, or those that are willing to collaborate with environmental authorities in the management of the park, are more likely to deviate downward from Nash equilibriums. That is, they are more interested in reducing extraction and moving toward social solutions.

Although these are very interesting results, this research is currently going on, so the results and analysis presented in this working paper are preliminary and further research is being performed around them.

5 Conclusions

Evidence from economic experimental games performed with communities from the influence zone of the national natural park “Corales del Rosario y San Bernardo”, suggest that under scarcity the tragedy of the commons may be exacerbated, as individuals tend to over extract above the private Nash equilibrium in a “race to the bottom” that is not only inefficient privately but also inefficient socially and dangerous for the sustainability of a common pool resource. We found that in a situation of scarcity, players over extract the resource above the Nash equilibrium, obtaining less profits, mining the others-regarding interest, and exacerbating the tragedy of the commons.

Those results imply, on one hand, that when scarcity appears either collective action is mined or forward lookingness by individuals is reduced, suggesting an increase in the inter temporal discount rate. One possible way to explain this behavior is what Pauly (1994) called *Malthusian overfishing,* observed when fishers are subject to rigidities in effort, few alternative sources of income and low standard of living; however, for our results there is no evidence that Malthusian overfishing becomes a full explanation of the phenomenon.

Similar to previous studies, we find that the “distance” from the theoretical social optimum to the private Nash equilibrium is important in defining the chances of arriving to the social optimum. Under scarcity, private Nash is closer to the social optimum and therefore, is more likely to observe individuals making decisions at that optimum.

Although there is a tendency to over extract under scarcity, not all of the players behave in that way. Some players may have pro-social attitudes (“good guys”), some may have individualistic but privately efficient attitudes ("Nash guys"), and some may have exacerbating attitudes, even if they are having economic losses by doing that ("bad guys"). Data shows that near 25 percent of players never made decisions above Nash equilibrium.

Similarly, there are groups that arrive to pro-social outcomes, while others do the contrary. That is, some groups consistently behave cooperatively by never extracting above Nash ("good" groups); some groups exhibit behaviors closer to the Nash equilibrium, and some groups repeatedly extract in an inefficient way ("bad" groups).

Crossing individual and group behavior is observed that although good guys and good groups coincide most of the times, as well as bad groups and bad guys, about one quarter of players in groups that exacerbate the use of the resource are "good guys", in the sense that they try consistently not to over extract the resource. As a result, they obtain low levels of profits and sustain gains of the others members of the group.

On the contrary, seven percent of the players associated to "good" groups, consistently over extract during the game, even though the group keeps them in high stock availability obtaining greater profits. They are free riders of the "good" groups that maintain high resource availability by efficient and pro-social decisions.

When rules are included in the game, a significant part of the inefficient behavior is vanished. That result highlights the importance of different institutions in the role of managing the resources and controlling the threat of the tragedy the commons, or even worse, the exacerbation of this conduct.

Preliminary result show that there are key variables affecting the decision of over extracting a resource: i) resource abundance induces individuals to greater deviation downward from Nash; ii) higher extraction in previous rounds are associated to consistent higher extraction in following rounds, confirming that "bad guys" tend to keep being "bad" players along the game.

Socio economic and demographic variables also may shape the pattern of over extraction: Older and more educated players tended to extract at levels close towards social optimum. Analysis of the impact of income challenges the assumption that the poorest exert more damage on the environment leading to no evidence about the hypothesis of Malthusian overfishing. However, statistics about income variable show that most of the players are under the poverty line and the variance among individuals is low.

Variables associated to perceptions about the importance of the natural park show an important role in defining the decisions on use of the CPR: players that have received some training about the protected area and players that are interested in collaborating with the management of the protected area tend more to deviate downward from Nash equilibriums.

These results, although highly interesting deserve further analysis. Lab experiments to check for differences between real fishers and college students might illustrate the nature of some of the decisions. Different designs of the game may enhance the information about decisions.

Although preliminary, those results offer much information to propose management strategies for common pool resources and to understand behavior of individuals when they face scarcity of the resources, even beyond traditional rules as command and control, which are too frequent in protected areas but more and more times less efficient.

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Annex 1. Pay-off tables

Green pay-off table for HIGH resource availability and pink pay-off table for LOW resource availability

Green Pay off table or HIGH availability		My own level of extraction (fish catch)							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Their level of extraction (rest f the group)	**4**	795	860	915	960	995	1020	1035	1040
	5	775	840	895	940	975	1000	1015	1020
	6	755	820	875	920	955	980	995	1000
	7	735	800	855	900	935	960	975	980
	8	715	780	835	880	915	940	955	960
	9	695	760	815	860	895	920	935	940
	10	675	740	795	840	875	900	915	920
	11	655	720	775	820	855	880	895	900
	12	635	700	755	800	835	860	875	880
	13	615	680	735	780	815	840	855	860
	14	595	660	715	760	795	820	835	840
	15	575	640	695	740	775	800	815	820
	16	555	620	675	720	755	780	795	800
	17	535	600	655	700	735	760	775	780
	18	515	580	635	680	715	740	755	760
	19	495	560	615	660	695	720	735	740
	20	475	540	595	640	675	700	715	720
	21	455	520	575	620	655	680	695	700
	22	435	500	555	600	635	660	675	680
	23	415	480	535	580	615	640	655	660
	24	395	460	515	560	595	620	635	640
	25	375	440	495	540	575	600	615	620
	26	355	420	475	520	555	580	595	600
	27	335	400	455	500	535	560	575	580
	28	315	380	435	480	515	540	555	560
	29	295	360	415	460	495	520	535	540
	30	275	340	395	440	475	500	515	520
	31	255	320	375	420	455	480	495	500
	32	235	300	355	400	435	460	475	480

Red Pay off table or LOW availability		My own level of extraction (fish catch)							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Their level of extraction (rest f the group)	**4**	790	840	870	880	870	840	790	720
	5	770	820	850	860	850	820	770	700
	6	750	800	830	840	830	800	750	680
	7	730	780	810	820	810	780	730	660
	8	710	760	790	800	790	760	710	640
	9	690	740	770	780	770	740	690	620
	10	670	720	750	760	750	720	670	600
	11	650	700	730	740	730	700	650	580
	12	630	680	710	720	710	680	630	560
	13	610	660	690	700	690	660	610	540
	14	590	640	670	680	670	640	590	520
	15	570	620	650	660	650	620	570	500
	16	550	600	630	640	630	600	550	480
	17	530	580	610	620	610	580	530	460
	18	510	560	590	600	590	560	510	440
	19	490	540	570	580	570	540	490	420
	20	470	520	550	560	550	520	470	400
	21	450	500	530	540	530	500	450	380
	22	430	480	510	520	510	480	430	360
	23	410	460	490	500	490	460	410	340
	24	390	440	470	480	470	440	390	320
	25	370	420	450	460	450	420	370	300
	26	350	400	430	440	430	400	350	280
	27	330	380	410	420	410	380	330	260
	28	310	360	390	400	390	360	310	240
	29	290	340	370	380	370	340	290	220
	30	270	320	350	360	350	320	270	200
	31	250	300	330	340	330	300	250	180
	32	230	280	310	320	310	280	230	160