Common-Pool Resources – A Challenge For Local Governance

Experimental Research in Eight Villages in the Mekong Delta of Cambodia and Vietnham

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Abstract

We use field experiments as a method to study underlying strategic actions Cambodian and Vietnamese natural resource users take in regard to voluntary contribution to a public good and appropriation of common-pool resources. Two games were implemented in the two countries, investigating the importance of communication, leadership and monitoring on natural resource users' strategies.

This paper will present findings in regard to cooperation levels of players in eight villages in Cambodia and Vietnam. We will compare results between the countries, draw conclusions from the experimental outcomes and make suggestions for further research.

Keywords*: field experiments; public goods; collective action; natural resource management; Cambodia; Vietnam*

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1 Introduction

A functioning natural resource base plays a significant role for the livelihoods of people in Cambodia and Vietnam, as people living in the Lower Mekong Delta rely heavily on agriculture and fishing. However, sustainable resource management in Cambodia and Vietnam faces severe challenges. Different land laws are in practice, traditional and new land rights sometimes overlap, de jure and de facto rights on resources often contradict, property rights are seldom enforceable or not defined at all. Significant parts of the natural resource base are confronted with open access situations at least during wet season. Thus, these resources are rapidly degrading not only threatening income streams of local users, contributing to rural poverty, but also affecting the region's ecosystem. Water and land resources are mainly shared by different neighbouring communities with a tendency of overuse as excluding intruders or limiting appropriation rights of existing users is difficult to enforce. As a consequence of negative experiences with command and control systems and in an attempt to reduce the fiscal burden of the central state, policy makers propagate to hand over governance responsibility to local user groups as a remedy to achieve sustainable resource management. In both countries, decentralisation efforts are under way in order to empower communities and improve the management of local to regional public goods. This is done although the underlying patterns of resource users' interaction and the effects of external intervention have not yet been fully understood in the policy arena.

In order to better understand users' strategies and interaction in natural resource management settings, game theory analyses and describes actions of individuals in a situation where the outcome for each individual is not only dependent on his or her own decisions but also the decisions of other players. Experimentalists create decision arenas for participants either under controlled laboratory conditions or through field experiments, whereby experiments in the field are always less controllable compared to a lab environment. In this paper we analyze the results of two games that are very similar in their structure: A public good and a common-pool resource game. In a public good game, players decide whether to contribute part of their initial endowment to their private account or to a public account that will generate an interest to the whole group. In the common-pool resource game, players decide whether to extract from a common-pool resource for their direct private gains or to let the common-pool resource generate an interest to the whole group. Both games were conducted in Cambodia and Vietnam and aim to analyze natural resource users' strategic behaviour under different measures. Played in the villages under local conditions, all games were framed to the local situation in order to mirror the decision situation that villagers face in regard to their natural resource use as close as possible. With these settings, we aim to better understand local actions and draw conclusions concerning natural resource use and preservation in Cambodia and Vietnam.

In the following chapter we present the field context within which the games were introduced and explain our assumptions about the players' behaviour. In the third chapter, the experimental design of both games is described. Chapter four analyses the findings of each of the games with regard to the assumptions made earlier. The last chapter compares the two games and summarises the findings.

2 Field Context and Theory

The public good games were introduced in six Cambodian and two Vietnamese villages. The target provinces in Cambodia were Kampong Thom, Kampong Cham, Prey Veng and Takeo. In Vietnam, both villages are in Can Tho province. Only one of the Vietnamese villages is a catholic community, in all other villages, Buddhists form the majority. Villagers know each other, not only because the communities are rather small (between 95 and 400 households), but also because most of their daily life happens outside and in co-operation with others. Most villagers are farmers and name rice cultivation as their most important income stream (80%). Fishing is common in all villages, whereby most of the villagers fish within their own rice paddies, common canals or reservoirs. In addition to the importance for daily food consumption, the natural resource basis plays a significant role for other income generating activities but also as energy source, as building material and so on. Thus, villagers' livelihood and well-being is heavily influenced by a functioning natural resource base.

Four of the eight villages (two in Vietnam and two in Cambodia) are involved in a community-based aquaculture project, whereby fish and other aquatic resources are cultured in the rice fields during the wet season. The project fosters local level cooperation for fish production and villagers contribute money to the community-based project in order to purchase fish seedlings. The more money is contributed, the more fish fingerlings will be purchased and can be cultured. After the harvest, fish is sold either to the project members or to the market with profit shared among community members. The projects face free-riding problems as the resources are difficult to be monitored continuously due to remote and large project areas. This leaves free-riders with the opportunity to extract fish illegally for private profit only. The experiences with the community-based aquaculture project differ between the villages as they have been implemented at different times of the year. In the Cambodian villages, fish production was only introduced right after the experimental research was implemented. At the time of this research, the Vietnamese villages both had gained one year experience with community-based aquaculture. One of the hamlets already decided not to continue the project after the first harvest[1].

Four of the eight villages (Cambodian villages only) are not engaged in the aquaculture project at all. Nevertheless, all research villages face similar decision problems concerning the delivery of public goods or the appropriation of common-pool resources, like road constructions or fishing, where decisions of other villagers always have an influence on the outcomes of fellow villagers. During wet season, water from adjacent rivers crosses property boundaries and fishing becomes allowed to every one in any place as private boundaries disappear under the water masses. Problems of resource degradation and overexploitation are well known in the research sites. 38% of the participants reported that natural resources in their village are in a bad condition. Villagers also have a clear understanding of local public goods

[1] Reasons for the decision were manifold and complex. Participants named poaching by group and non-group members, free-riding in regard to working time contributions and a low profit as main reasons. Other reasons may lie in the lack of support from other institutional levels as well as a strong top-down approach of the implementing institutions with rather low participation by group members in important decisions.

as individual contributions to these goods are well-known by villagers and it is common to contribute to dike, street or school building activities. In the last 12 months, 85% participants reported to have been engaged in such activities. Thus, although these villages are not engaged in the community-based aquaculture project, they face similar problems concerning the appropriation of common-pool resources or the contribution to public goods.

The described appropriation and provision problems are found in most public good and common-pool resource settings worldwide, they are often complex and interrelated (Ostrom et al. 1994, Steins & Edwards 1999). Within this study, we use game theory in order to focus on specific aspects of the complex situation at a time and thus separate the contribution and the appropriation problem. Then, we analyse the effects of communication and leadership on the contribution behaviour to a public good. In the second game, we test the effects of punishment on appropriation of common-pool resources.

In game theory, a public good is costly to provide but once it is provided it is not possible to exclude individuals from using it regardless of how much an individual contributed for the good. The impossibility to exclude individuals from its use leaves each individual with incentives to free-ride on the contributions of the other players. Standard game theory assumes self-interested players and predicts that no individual will contribute anything to the public good as the dominant Nash strategy (Ledyard 1995). The social optimum, where every individual contributes the same for the public good, is never reached. Empirical data contradicts standard economic theory. Public good experiments revealed that individuals neither contribute Nash nor social optimum. Isaac, Walker and Thomas (1984) as well as Isaac and Walker (1988), for example, find in their public good games that good provision is higher than predicted. In their lab experiments, Fischbacher, Gächter, Fehr (1998; 2001) show that free riding does exist, but that there are also 50% of "conditional co-operators"[2]. With regard to voluntary contributions, experimentalists found that players do contribute a significant amount of their initial endowment to the delivery of public goods, but that in repeated games these contributions decline over rounds (Ledyard 1995; Houser & Kurzban 2000). The assumptions of standard game theory are thus not proved and it is rather likely that players will cooperate at least in some way.

The same is true for common-pool resources. Many analysts would describe the situation of resource management in the research villages as a common-pool resource dilemma as individuals are jointly appropriating from their limited natural resource base without being able to prevent free-riding. Hardin (1968) with his highly controversial hypotheses, states that self-interested individual behaviour will lead to the "tragedy of the commons" and that local users are not able to manage their natural resources sustainable. According to this and other theories, it is assumed that there is no solution to prevent the dilemma and that individual rationality leads to an outcome that is not rational for the group This corresponds to the assumptions of standard game theory. Here it is stated that players are self-interested and that the individual will always favour the private account over the public account.

[2] Conditional co-operators are individuals who are willing to cooperate when they assume others will cooperate as well, even if the opportunity for free-riding is given.

However, this does not explain cooperative behaviour observed in many experiments and yet there is no consensus on what is really happening in common-pool resource games (Schlager et al. 1994). Many scholars found, contradicting to non-cooperative game theory, that various communities are able to adopt strategies that prevent the dilemma and enable sustainable natural resources management (Ostrom et al. 1994, Gardner and Keser 1999).

Findings from experimental economics with minimal institutional configurations in public goods and common-pool resource games mainly report suboptimal outcomes for groups. Under different institutional settings the strategic behaviour of players and resource users can change; experimentalists test these institutions and their effects through different designs of the games and through implementing different treatments. Ostrom (1990) developed eight design principles that are relevant to natural resource users to prevent the dilemma. Communication as well as monitoring and sanction systems are, according to Ostrom (1990), essential measures to reduce resource exploitation. Again, non-cooperative game theory predicts that communication alone is inessential and does not change the cooperation level as long as there is no third-party enforcement of agreements. However, many other studies find that communication possibilities for players, especially face-to-face communication, increase cooperation significantly- even without external enforcement agents (e.g. Isaac & Walker 1988; Ostrom & Walker 1991; Hackett et al. 1994; Ostrom et al. 1994; Ledyard 1995; Cardénas 2003).
Other experiments find that monitoring and sanctioning decreases free-riding substantially and that these measures lead to socially more profitable outcomes, even when punishment is costly for players (e.g. Ostrom et al. 1994; Fehr & Gächter 2000; Masclet et al. 2003). As hierarchies are a governance mechanism to achieve coordinated behaviour, experimentalists also tested the influences of leadership on group outcomes and find that leadership can also increase contributions to the public goods (Levati et al. 2005; Van der Heijden et al. 2006).

In this study we used framed field experiments instead of lab experiments as we aimed to adapt the decision situation in the experiment to decision situations the Cambodian and Vietnamese participants already know from their real life. As this research tries to understand local users' behavioural patterns, we used fishing and contribution to a dike construction project for our study. The treatments introduced were "monitoring", "communication" and leadership" and also mirror real life experiences. According to the results presented by experimentalists and game theorists, we formulate the following hypotheses for the results from the two games:

1) ***Contributions*** *will neither be at Nash equilibrium nor at social optimum. A substantial amount of initial endowments will be invested in the public good, but they will decrease over time.*
2) ***Communication*** *will significantly increase cooperation.*
3) ***Leadership*** *will increase cooperation.*
4) ***Extractions*** *will neither be at Nash equilibrium nor at social optimum. A substantial amount will be left on the public account. Over time, extractions will increase.*
5) ***Monitoring and sanctioning*** *will significantly decrease free-riding and thus increase group outcomes.*

3 Experimental Design

Two games were played with 32 participants in each of the eight villages (n= 256 players), whereby 16 participants were assigned to the 'Voluntary Contribution Game' (VCM) (128 in total) and 16 villagers were assigned to the 'Extraction (or Appropriation) Game' (128 in total). Four-member groups were formed by selecting different coloured papers like in a lottery. Thus, four sessions with each consisting of four players were run for both games in eight villages.

Each game consisted of 20 rounds, where contributions/appropriations as group totals only were announced after every round. After ten rounds, different treatments were introduced and another five to ten rounds were played with the new external rules, whereby the subjects were unaware about the amount of rounds played with each rule or about any rule change before rules were introduced. However, they were informed that the game will last about two hours.

Subjects were aware of the identity of the other group members and they knew each other as players were all selected within the village. However, in both games decisions were made in private, individually and were kept confidential even after the game ended. Earnings averaged 8.8 US $ and each experiment lasted one to two hours.

Experiment instructions were presented orally in Khmer or in Vietnamese accordingly. The facilitators in Cambodia and Vietnam remained the same for all sessions. Players knew the number of people attending the session as well as the incentives from investing the token in the private account or in the group account. The instructions included examples of possible actions and outcomes. A post-experiment questionnaire was given to collect basic demographic information as well as to assess the understanding of the experimental design and decision tasks.

Both games were framed according to the local situation. This was to assure that (a) confusion about subjects and intentions within participants was minimized and that (b) illiterate participants had equal opportunities to participate. Additionally, all games were arranged in a manner that reading and writing was not necessary for participation. Appendix A provides the instructions used for the games in English only.

For the public good game, we used a typical linear VCM experiment, whereby players were asked to contribute to a public good (dike construction). For each round, players were given an endowment of ten tokens (1000Riel/10.000VND)[3] that could be kept in a private or invested in a public account (Isaac et al. 1984). Tokens kept in private account were immediately "private property", whereby contributions to the public account yielded a return to each group member, regardless of individual contribution levels to all players in the amount of 0.5 tokens.

[3] 1.000 Riel = 0,25 USD, 10.000 VND = 0,66 USD

Summarizing, the individual payoff function is:

$$g(x_i) = \frac{2(\sum_{j \neq i}^{n-1} x_j + x_i)}{n} + x_i$$

Thus, the marginal return from contributing a token to the public account is less than the value of a token kept in the private account, but the sum of the marginal returns to the group is greater than the value of a token kept. Thereby, the individual has a dominant strategy to free-ride. This represents a social dilemma where the Nash equilibrium is formulated in a way that nobody contributes anything and where total earning would be 4 x 10= 40 tokens. The Pareto-dominant, welfare-maximizing outcome, however, is realized when everyone contributes his or her entire endowment to the public account. This is represented when all players contribute 10 tokens and total group earnings would be 40 x 2= 80 tokens.
After ten rounds, communication was introduced for the following ten rounds. Players were informed that they have the opportunity to communicate for four minutes before each decision. The facilitator informed the group when the four minutes were over and decisions were then made like in the first ten rounds. Players did not know for how long they will play with the new rule. After another five rounds, a leader was chosen from the group. This was done with a lottery indicating the new leader with a different coloured paper. The group was then informed that communication still is possible like in the rounds before, but that the leader will have the opportunity to set a rule after the four minutes of communication and before the decision. However, like in all rounds, players were told again, that individual decisions will be made independently, in private and kept confidential.

As the second game, we used a common-pool resource game ("Extraction Game" hereafter) (Ruffle & Sosis 2002), whereby people extracted fish from a common pond. Each round the pond was endowed with 40 units of fish and players decided to extract units of fish to the private account or leave it to the public account. Tokens extracted into the private account were immediately private gains, whereby fish units left in the common pond also yielded a return to each group member. Regardless of extraction levels of individual players each fish unit left was rewarded by the amount of 0.5 tokens. If the group total extracted was more than 40 units of fish, no player received any reward.
Accordingly, the individual payoff function in the Extraction Game is:

$$g(x_i) = \frac{2(40 - \sum_{j \neq i}^{n-1} x_j - x_i)}{n} + x_i, if \sum_{i=1}^{n} x_i < 40$$

$$g(x_i) = 0, if \sum_{i=1}^{n} x_i > 40$$

In this experimental setting as well, free-riding is the dominant strategy. Because the private rewards of extracting from the public good is higher than the private rewards from the public good, individual (Nash) incentives to extract dominate. However, at

the social optimum, all players would be better off if none of the players extracts any unit.

After ten rounds, a monitoring system was introduced. Players were told that the new rule is to extract zero units, because this is the best strategy for the group as a whole. After each decision and the announcement of the group total a dice was thrown and with the probability of one to six an external monitoring of all players occurred. Every player who extracted more than zero units from the common pond received a fine of four times the units he or she extracted. These units were then subtracted from the players' total payoffs. Sanctioned players also did not received shares from the common pond in the respective round. One unit extracted thus was punished by four units, two units by eights units of fish and so on. After 20 rounds, the end of the game was announced and players received money for each token they gained during the game, whereby one unit of fish was equal to 100 Riel or 1.000 Vietnamese Dong.

4 Analysis and Results

In this chapter we analyse and present the results from both games. We thereby focus on a comparison of results from Cambodia and Vietnam and investigate how introduced treatments have changed strategic behaviour of the participants. We validate each hypothesis introduced in the second chapter with our data. Payoffs in each round were calculated according to the daily income of a rural family. A game lasted around two hours with an additional 30 minutes interview afterwards. For each player it was possible to earn 20 times of a daily income, when social optimum would have been played all the time. In each round, players decided about a fourth of their daily income. For all 64 games with a total of 256 players 2256.50 US $ were spent.

4.1 Contribution Game

For the Contribution Game the total payoff for all participants was 882.5 US $, whereby the Cambodian players earned five US $ on average and the Vietnamese participants 12.50 US $ on average, which is also due to higher initial endowments in the Vietnamese games as average rural daily incomes in Vietnam are higher than in Cambodia.

Result 1: Contributions are neither at Nash equilibrium nor at social optimum and do not decrease over time.

Figure 1: Mean contributions by country

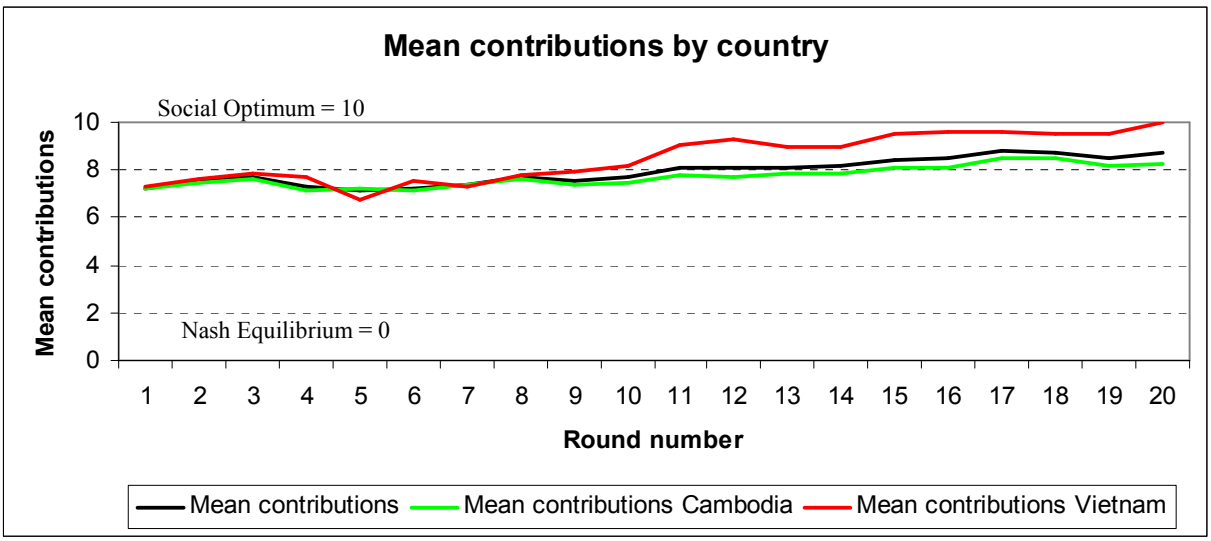


Figure 1 shows the mean of tokens players contributed in Cambodia and Vietnam. The mean contributions are neither at Nash equilibrium (0 tokens) nor at the social optimum of ten tokens. The mean contributions of all 20 rounds are surprisingly high and equal 7.93 tokens. The results show that contributions in our settings are very close to the social optimum. The standard deviation is 2.65 for both countries, 2.56 for Cambodia and 1.63 for Vietnam.

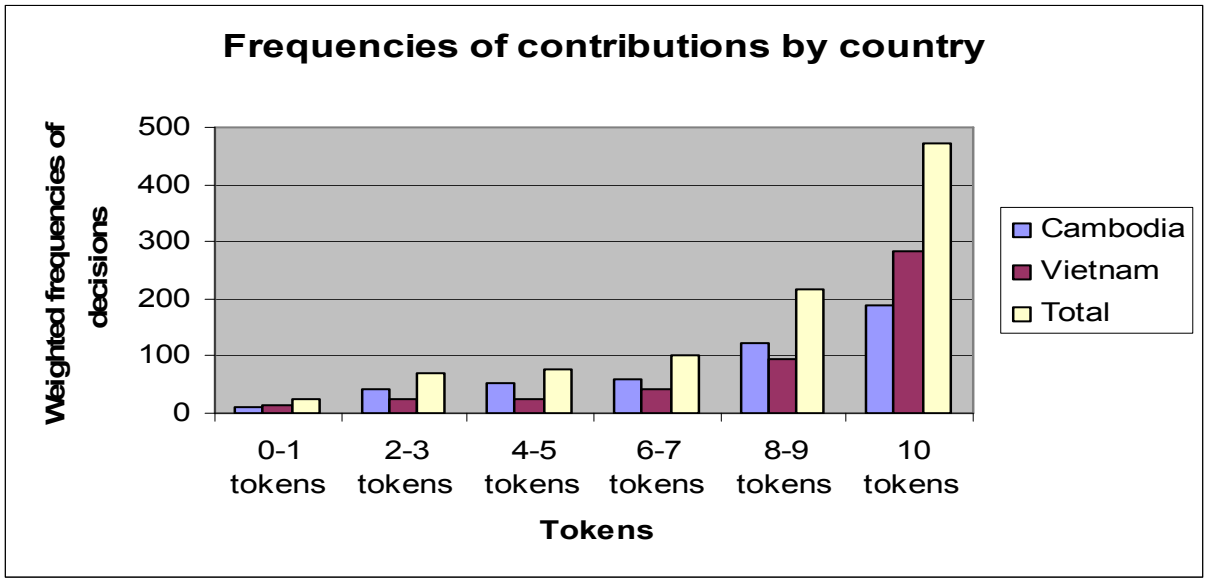
In Table 1 the amount of rounds where social optimum or Nash was played is shown. In total the groups managed to reach the social optimum in 111 rounds, which represents 17.3 percent of all rounds. The Cambodians played the social optimum in 64 out of 480 rounds (13.3 percent), the Vietnamese in 47 out of 160 rounds (29.4 percent). The Nash equilibrium was never played in the Contribution Game, meaning in every round, at least one player invested at least one token in the public account.

Table 1: Totals and % of rounds social optimum and Nash played in Contribution Game

	Social Optimum		Nash equilibrium	
	Total	%	Total	%
Cambodia	64	13.3	0	0
Vietnam	47	29.4	0	0
Total	111	17.3	0	0

Figure 2 shows how often a specific amount of tokens was played. Here, it becomes obvious, that individual contributions were also much more often at a social optimum than at the Nash equilibrium. Out of the 128 players, five decided to always contribute all tokens of the initial endowment and an additional 68 players always contributed more than 50% to the public good.

Figure 2: Frequencies of contributions by country



The Vietnamese participants played closer to the social optimum (9.47 tokens on average) and contributed 1.74 tokens more on average than the Cambodian participants (7.73 tokens on average). The difference between the countries is, however, only significant for round 11 till round 20 (Kruskal-Wallis test 0.0001).

Result 2: Communication significantly increases contributions

Figure 3 and 4 separate the contributions for round 1-10 “no communication” and round 11-20 “communication”. Plotting the frequencies of contributions in a histogram shows that means over all rounds are not normally distributed. Testing the null-hypothesis that contributions in both parts of the game are the same, the Wilcoxon signed ranks test results in a significant value of 0.000 or 0%. Thus, the null-

hypothesis needs to be rejected and communication has a significant effect on the contributions by individuals.

Figure 3: Frequencies of mean contributions in round 1-10

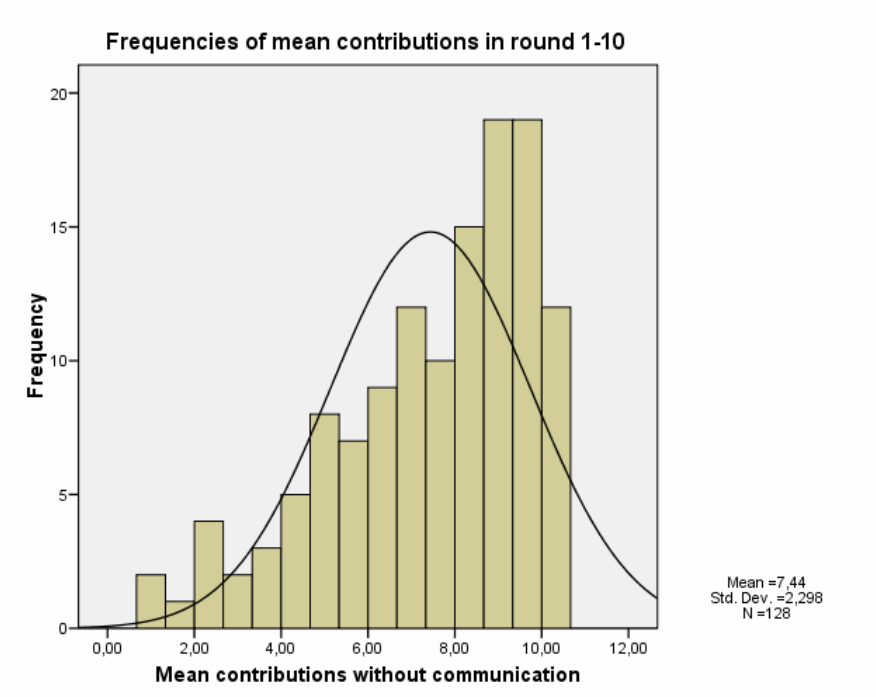
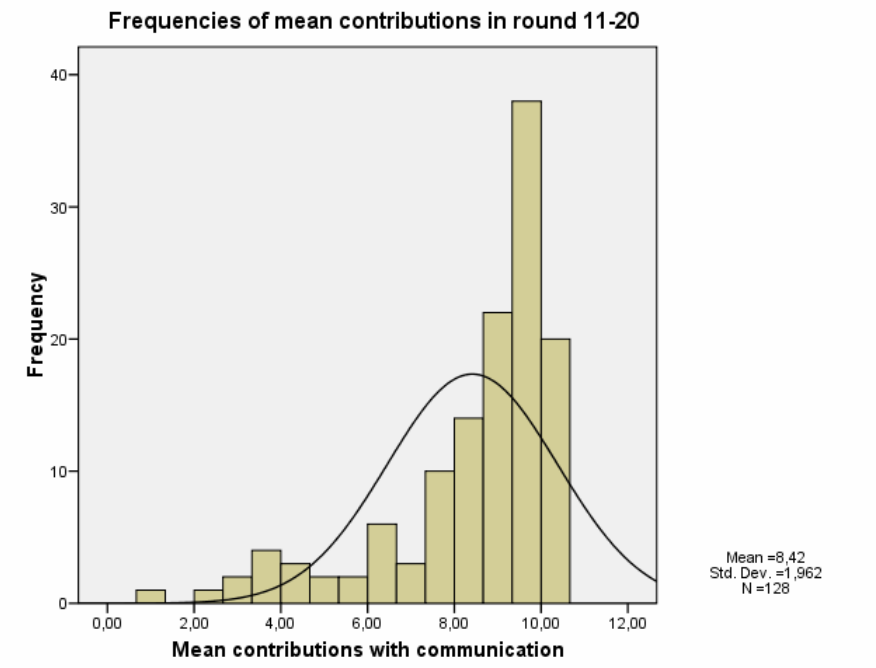


Figure 4: Frequencies of mean contributions in round 11-20



Result 3: Leadership increases contributions

For leadership the null-hypothesis also needs to be rejected and one finds a significant difference in the distribution of contributions when comparing the two treatments. In rounds 11 to 15, people communicated but did not have selected a leader. We compare this setting with rounds 16-20, where people communicated but

also had a leader who set a rule on how much to contribute to the public good. Noteworthy, the mean contributions do not change as much as when introducing communication. However, the standard deviation does. Thus, having an amount of tokens announced by the leader leads to a lesser dissemination of contributions. Figure 5 and 6 show the distribution of mean contributions in comparison.

Figure 5: Frequencies of mean contributions in round 11-15

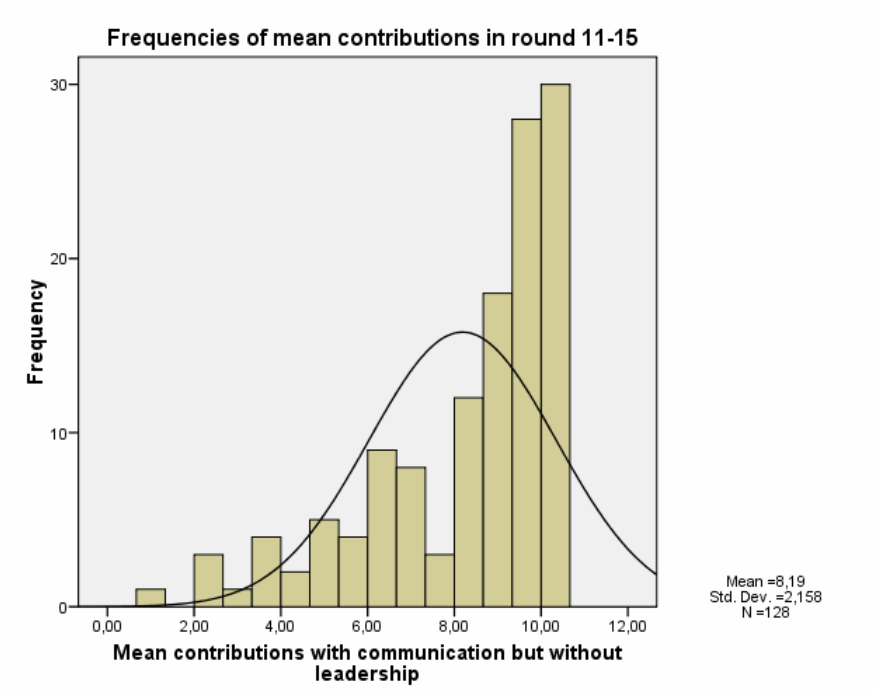
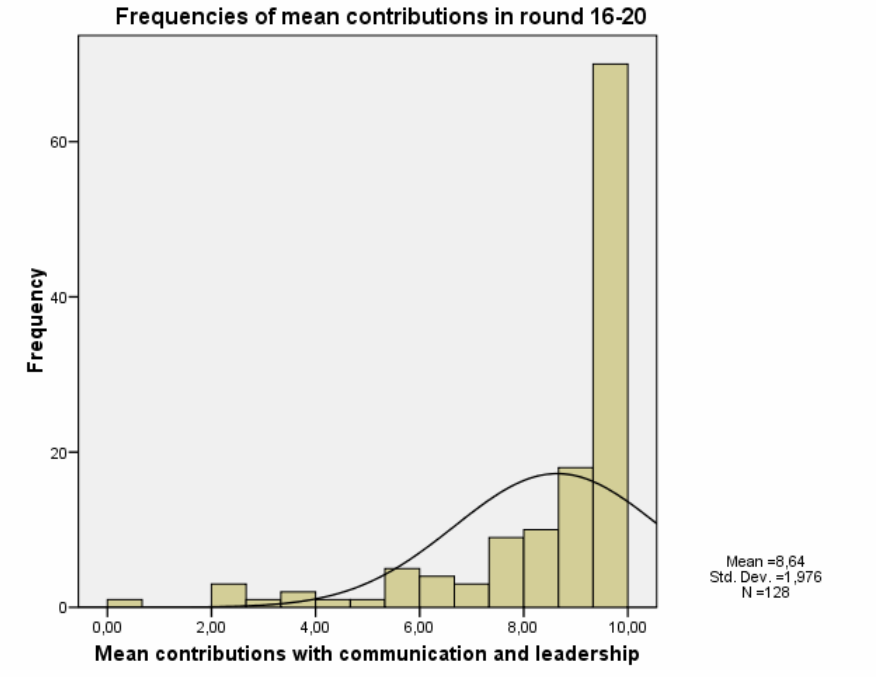


Figure 6: Frequencies of mean contributions in round 16-20



4.2 Extraction Game

For the Extraction Game total payoff of all participants was 1374 US $, whereby the Cambodians earned 6.70 US $ on average and the Vietnamese 22.80 US $ on average.

Result 4: Extractions are neither at Nash equilibrium nor at social optimum and do not increase over time

Figure 7: Mean extractions by country

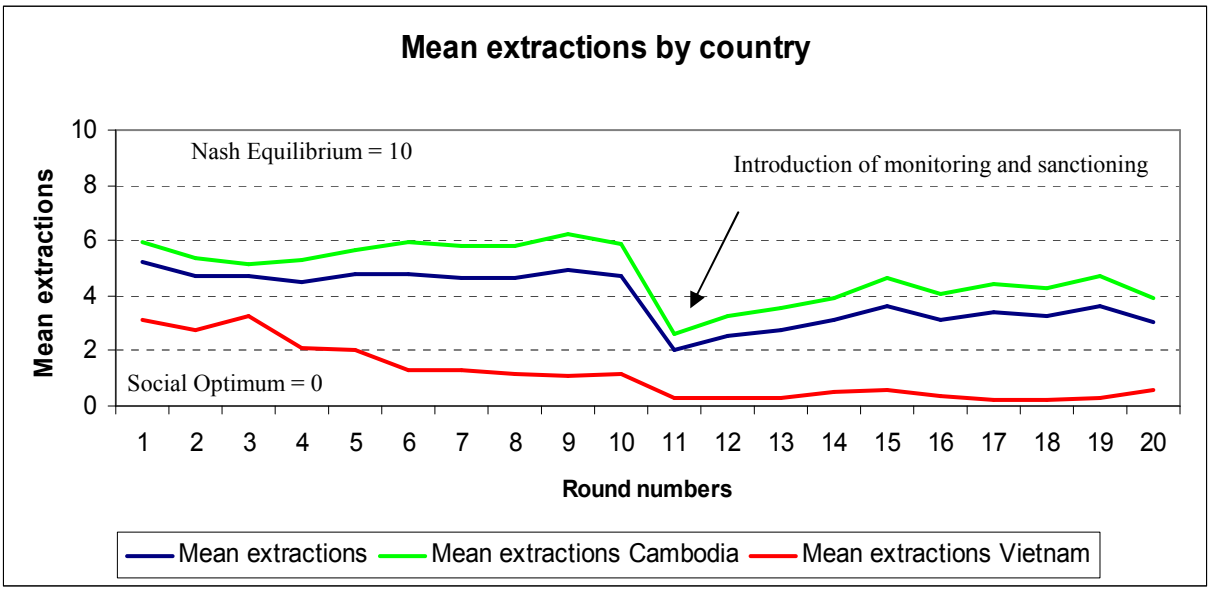


Figure 7 shows the mean extraction of all players for both countries and separately for Cambodia and Vietnam. Again, the mean extractions are between the Nash equilibrium (10 tokens) and the social optimum (0 tokens) and are 3.9 tokens. The standard deviations are 4.47 (both countries), 4.56 (Cambodia) and 2.75 (Vietnam).

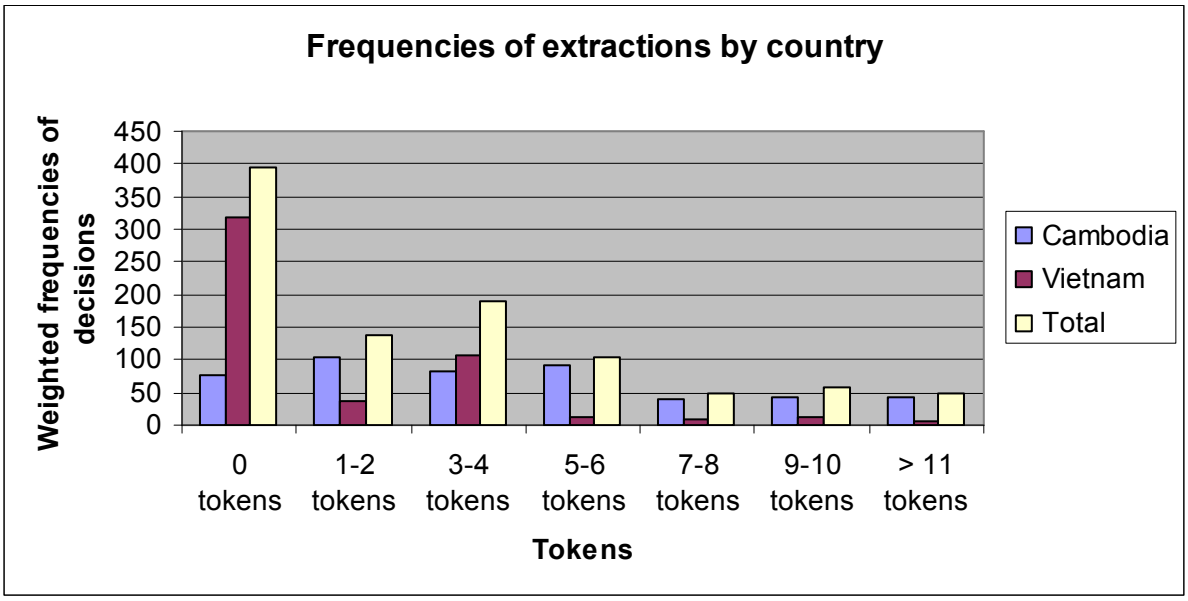
Table 2 summarizes the cases when social optimum, Nash equilibrium and over-extraction occurred within the groups. In ten percent of all rounds (n= 640 rounds) a social optimum was reached. On the other side, the Nash equilibrium was played in only 2.7 percent of all rounds. Over- extraction (more than 40 tokens played as group) occurred nine times in all games and thus represents only 1.4 percent of the total rounds.

Table 2: Totals and % of rounds social optimum, Nash and over-extraction played in Ext. Game

	social optimum		**Nash equilibrium**		**over-extraction**	
	Total	%	Total	%	Total	%
Cambodia	9	1.9	17	3.5	8	1.7
Vietnam	55	34.4	0	0	1	0.6
Total	64	10	17	2.7	9	1.4

In Figure 8 the frequencies of tokens played are shown. Like in the Contribution Game, individuals extracted more often at the social optimum level than at the Nash equilibrium. However, only five players (out of 128 players) never extracted any tokens from the common good and thus played continuously at the social optimum. However, free-riding occurred and 179 times (in 2560 decisions) people extracted even more than ten tokens.

Figure 8: Frequencies of extractions by country



We find significant differences between the extraction levels in all rounds when comparing Cambodia and Vietnam (Kruskal-Wallis test 0.0001). The Vietnamese participants play much closer to the social optimum (1.15 tokens on average) and extracted 3.67 tokens less in average than the Cambodian players (4.82 tokens on average). Also, the frequency of zero tokens played is much higher in Vietnam than in Cambodia.

Result 5: Monitoring decreases extractions

In Figure 7, the change in extractions between round 10 and 11 already shows how much monitoring effects people's extractions levels. The means of tokens extracted before monitoring has been introduced are 4.76 for both countries, 5.7 tokens for Cambodia and 1.94 tokens for Vietnam. The respective means after monitoring was implemented are as follows: 3.05 tokens (both countries), 3.94 tokens (Cambodia) and 0.37 tokens (Vietnam). In Vietnam, the mean contributions after introduction of monitoring move very close to the social optimum. Also, the Wilcoxon signed ranks test comes to the conclusion that the effect of monitoring to extractions is significant. Figure 9 and 10 show again the differences in the distribution, the shift of the mean and the reduction of the variance.

Figure 9: Frequencies of mean extractions in round 1-10

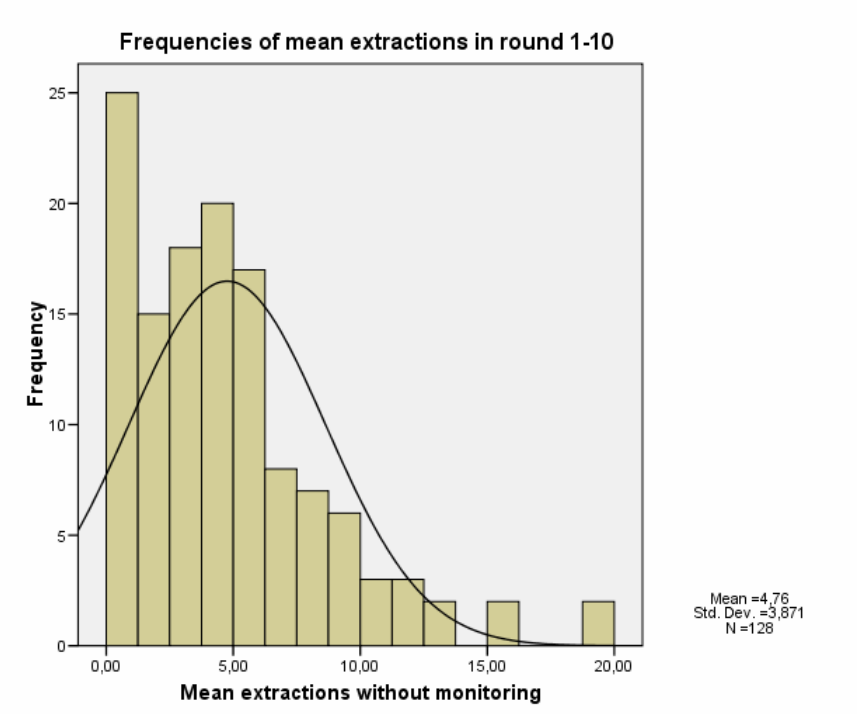
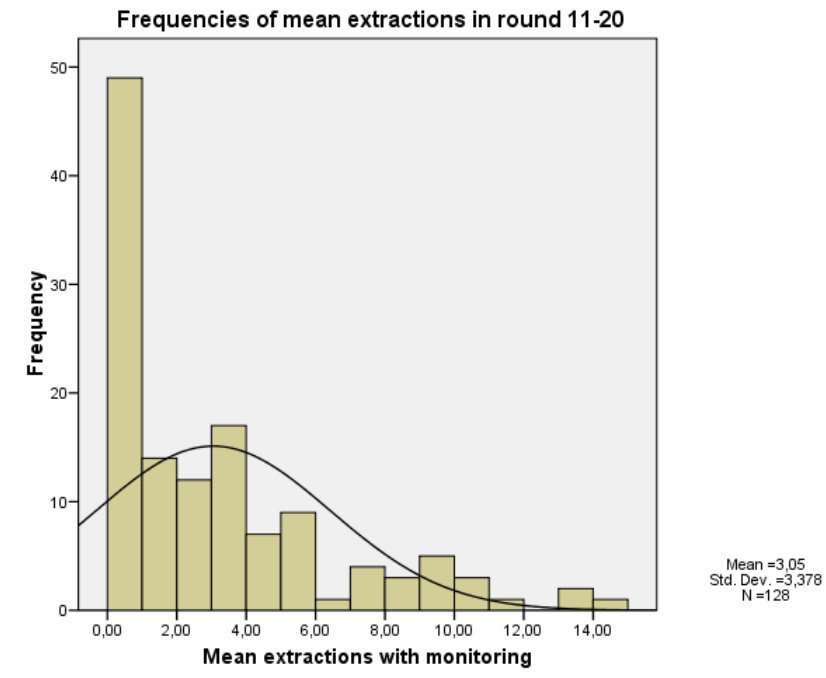


Figure 10: Frequencies of mean extractions in round 11-20



The assumptions made in the beginning were tested against our results. Contributions and extractions are both neither at Nash nor at social optimum. However, we could not find that contributions decrease and extractions increased over time as suggested by other studies. Introduced institutions all had significant effects. Communication and leadership increase contributions and monitoring significantly decreases extractions. All institutions improve group incomes. We also find differences between the contribution/extraction levels in Cambodia and Vietnam.

Vietnamese players play more cooperative from the very beginning of the Extraction Game, but especially after the introduction of monitoring measures with penalties. At the end of the Contribution Game, Vietnamese players nearly reach social optimum in all groups.

5 Summary and Conclusions

Being a local user of natural resources in Cambodia and Vietnam, ones' own decision always influences fellow villagers. In return, the decision of others always influence ones own livelihood. Cooperation in natural resource management is thus essential, especially within the local village context where livelihoods are almost exclusively assured from the daily use of natural resources. Cooperation is also essential in regard to the provision of public goods as common efforts are necessary to ensure e.g. water provision through the construction of irrigations systems or market access through road construction projects.

The games played actively aimed to give players the possibility to relate their decision problems to real life situations. For the community-based aquaculture project, participants had to contribute money as investment into dike constructions and fingerlings. When the group harvests the fish at the end of wet season, the fish has had a sufficient amount of time to grow and has yielded a higher profit. Extracting earlier is free-riding on the costs of other group members. For non-participants, the game settings were well-known as well as they also use common-pool resources in their every day lives or contributed money and working time to public goods.

The findings of our research show results that are in line with earlier research on common-pool resources and public goods. Our hypotheses were all supported by the analysis, except for the surprising fact that free-riding did not increase over time. This leads to the assumption that our groups were learning how to reach a higher group and thus a higher individual outcome and improved their cooperation over time.

It seems as if the game type (contribution vs. extraction or public good vs. common-pool) did not have a large effect on the cooperative behaviour of participants. However, it is striking that in the Contribution Game, Nash equilibriums never occurred. On the other hand, groups did reach Nash equilibriums in the Extraction Game, but over-extraction of the fish pond did not happen very often and groups easily accepted the initial endowment as the upper bound. Over-extractions occurred only when players had to make their first decisions and were still searching for the right strategy to allocate the tokens.

In the Contribution Game surprisingly high contribution rates were reached. The post-game interviews showed that most participants are familiar with contributing for religious ceremonies, the pagoda/church or to other community members in need. In Cambodia and Vietnam, religious traditions play a significant role and are one important source for social norms and pro social behaviour. It is also common to contribute directly (financial and working time) to community projects rather than trough taxes paid earlier. We assume that these circumstances influenced the amount of direct contributions in our game setting.

In addition, the results concerning the impact of introduced monitoring measures into the game are noteworthy. Players reacted sensitive on the threat of being punished. In both countries, reactions might be related to the recent history of (civil) war as most people are still traumatized and fear punishment.
On the other hand, monitoring and sanctioning are rather random and insufficient enforced and people are not really used to get punished for offending behaviour in regard to natural resources. This is more evident in Cambodia as current natural resource management government structures in Cambodia often are not able to address negative natural resource management practices.
The differences between Cambodia and Vietnam can also be due to the fact that in Vietnam both communities were already involved in community-based projects. However, one of the villages also decided not to continue common fish culture, because of already experienced free-riding (e.g. poaching) within the group. Other reasons for the different appropriation and contribution levels might derive from demographic variables such as lower education levels in Cambodia and different amount of years lived within the communities.

Further research in the region concerning the users' behaviour is necessary in regard to different monitoring regulations, also including if people would be willing to contribute money to monitoring activities. It would also be appealing to investigate what institution people would be preferred, if they could choose. As appropriations as well as voluntary contributions usually include larger numbers of individuals, further research in the Lower Mekong area could also take into account, how group size influences people willingness to cooperate.

The Cambodian as well as the Vietnamese government aims at decentralizing natural resource management to lower jurisdictional levels in order to provide more effective and sustainable governance. New institutional arrangements, such as community-based forestry or fisheries are now being promoted by the governments with the aim to give decision power and fiscal means to the local communities that live with and from the natural resources. To ensure, that these measures contribute to a better and more sustainable resource management, it is required to understand people's behaviour towards natural resources. It is necessary to understand the challenges natural resource users face in regard to the management to better adjust policies and give essential support from higher jurisdictions when needed. With this research we aimed at understanding people's strategies in order to better evaluate planned and implemented policies in the region. We find that co-operation in the communities is definitely present and that community-based management is promising. However, it became also obvious, that different institutional measures or rules can increase cooperation levels. This should be taken into consideration when planning decentralisation measures in order to support communities in their rather difficult task of sustainable resource management.

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Appendix

1) General instructions before each game

Thank you all for taking the time to come today. Today we want to play a game with you and we will also ask you to fill out a small questionnaire after the game.
This game may take 2-3, so if you think you will not be able to stay that long without leaving please let us know now. Before we begin I want to make some general comments about what we are doing here today and explain some rules that we need to follow. We will be playing a game for real money that you will take home. You should understand that this is not _____ (NAME OF RESEARCHER) own money. It is money given to him/her by her university to use to do a research study, which will eventually be part of a book. _____ (NAME OF RESEARCHER) is working with the _____ (NAME OF INSTITUTION) and she/he is students. She/he is not the one taking decision about any money or any project for the village. _____ is working together with many other students who are carrying out the same kind of games all around the world.
Before we proceed any further, let me say something that is very important. Many of you were invited here without understanding very much about what we are planning to do today. If at any time you find that this is something that you do not wish to participate in for any reason, you are of course free to leave whether we have started the game or not. But if you know now already, that you will not be able to stay for the rest of the day, then let us know now, because otherwise we can not use the results. If you have heard about a game that has been played here in the past you should try to forget everything that you have been told. This is a completely different game. We are about to begin the game. It is important that you listen as carefully as possible, because only people who understand the game will actually be able to play it. We will run through some examples here before we start the real game.

The first rule, which is very important, is:
You cannot ask questions or talk about the game while we are here together.
This is very important and please be sure that you obey this rule, because it is possible for one person to spoil the game for everyone, in which case we would not be able to play the game today. Do not worry if you do not completely understand the game as we go through the examples here in the group. Each of you will have a chance to ask questions in private to be sure that you understand how to play.

2) Instruction for the Contribution Game

This game is similar to a situation in which a group of people is asked to contribute to a development project. For this game, assume that you and 3 other villagers have to decide on a dyke construction project. Each of you can decide how much money he/she wants to allocate to the project and how he/she you would like to keep for him/her. The dyke will keep the fish in the fields and, thus, improves your life as you may catch more fish but also the lives of the other players because they might catch more fish too. The development project thus will generate you and your fellow players extra gains that translate into payoffs for you. So you have to decide about how much money you get in each round. The reason why we use a dyke construction project in this game is to represent real life situations in which your economic decisions will bring yourself monetary consequences. You will play several rounds.

The BOX and ENVELOPE

To be able to play you will receive a box where you can store the money from each round. [GIVE A BOX TO EVERYBODY], then you receive an envelope [GIVE AN ENVELOPE TO EVERYBODY]. This is used for exchanging money between us and you. We will explain this later.

The rules of the game are as follows:
Each of you gets 1.000 Riel/10.000 Dong per round as initial endowment. Now, in each round you have to decide how much out of the 1.000 Riel/10.000 Dong you would like to contribute for the dyke construction. You are only able to contribute in steps of 100 Riel/1.000 Dong. You can contribute 0, 100, 200, 300, 400, 500, 600, 700, 800, 900 or 1000 Riel/0, 1.000, 2.000….or 10.000 Dong; this is your own decision. The money you want to contribute, you put into the envelope, the money you want to keep you put into the box. It is very important that we keep in mind that the decisions are absolutely individual, that is, that the amount of money you put into the envelope and the amount of money you put into the box are private and that you do not have to show them to the rest of the members of the group.

When all 4 players made their decision, the envelopes will be collected and put into a pot. This pot will be opened in public and you will know how much money will be invested for the dyke construction. Still, you will not know how much the other players have put into their envelopes. This money will be doubled by a development project. As the dyke serves everybody this amount will be distributed equally among all players, so each player gets the same amount of money out of the project no matter how much he/she contributed.
At the end of the round you will have the money you kept plus an equal share of what has been invested after it was doubled.
We will announce, when the game is over. Then the game money you earned during the game (so the money in the box in front of you) will be changed into real money.

Here are some examples. During the game you can decide on your own, how much money you would like to contribute for the development project.

Let us see how the game works with an example: [...MONITOR: show poster with the EXAMPLE...]

Example 1: Player A contributes 0 Riel/0 Dong, player B contributes 200 Riel/2.000 Dong, player C contributes 500 Riel/5.000 Dong and player D contributes 100 Riel/1.000 Dong. Together there are 800 Riel/8.000 Dong in the pot for the development project. Now this amount is doubled to 1600 Riel/16.000 Dong. The 1600 Riel/16.000 Dong are now divided in 4 equal shares of 400 Riel and distributed to the players. After the round the players earned this:
Player A has 1000/10.000 initial endowment minus 0 contribution plus 400/4.000 out of the project is 1400 Riel/14.000 Dong
Player B has 1000/10.000 initial endowment minus 200/2.000 contribution plus 400/4.000 out of the project is 1200 Riel/12.000 Dong
Player C has 1000/10.000 initial endowment minus 500/5.000 contribution plus 400/4.000 out of the project is 900 Riel/9.000 Dong
Player D has 1000/10.000 initial endowment minus 100/1.000 contribution plus 400/4.000 out of the project is 1300 Riel/13.000 Dong

Let us see another example:
Example 2: Player A contributes 300 Riel/3.000 Dong, player B contributes 600 Riel/6.000 Dong, player C contributes 0 Riel/0 Dong and player D contributes 300 Riel/3.000 Dong. Together there are 1200 Riel/12.000 Dong in the pot for the dike construction project. Now this amount is doubled to 2400 Riel/24.000 Dong. The 2400 Riel/24.000 Dong are now divided in 4 equal shares of 600 Riel/6.000 Dong and distributed to the players. After the round the players earned this:
Player A has 1000/10.000 initial endowment minus 300/3.000 contribution plus 600/6.000 out of the project is: 1300 Riel/13.000 Dong
Player B has 1000/10.000 initial endowment minus 600/6.000 contribution plus 600/6.000 out of the project is: 1000 Riel/10.000 Dong
Player C has 1000/10.000 initial endowment minus 0 contribution plus 600/6.000 out of the project is: 1600 Riel/16.000
Player D has 1000/10.000 initial endowment minus 300/3.000 contribution plus 600/6.000 out of the project is: 1300 Riel/13.000 Dong

One more example […]

Let us look how the game works in each round. Your decisions in this round will NOT count at the end. They are just for you to see how the game works.
Exercise round: We start with the contribution of 1000 Riel/10.000 Dong to each player. Every player puts as much game money into the envelope as he wants to contribute to the project. It is very important to clarify that nobody, except for the monitor, will be able to know the amount that each of you decides give or keep in the round. The only thing announced in public is the total amount of money, without knowing how each participant in your group contributed. And we will not tell anyone later. It is totally secret.

The objective of the game is to get as much money as possible at the end of the game. This will then be converted into real money for your household.

How is it played: In each round, you must decide how much money you want to contribute for the dike. The game money you earn in each round depends on your decision and the decisions of the rest of the group, according to the explanation we gave you.

Steps to play in each round:
We will contribute the initial endowment now.
Decide how much money you want to contribute to the project now. Put this amount into your envelope. I will go round to collect it.
Wait for the monitor to calculate the total amount contributed. We will announce the TOTAL AMOUNT CONTRIBUTED, THE DOUBLED AMOUNT AND THE AMOUNT EACH OF YOU WILL RECEIVE OUT OF THE PROJECT.
Then you receive your envelope back and the amount each of you earned from the project.
Let us play another round. Start all over again from point 1.

Game starts
Let’s start the game now. All the gains you receive from now on will be exchanged to real money, which you can take home. Now your decisions matter.

Each of you gets 1000 Riel/10.000 Dong per round as initial endowment.
Now you have to decide how much money you would like contribute to the project. Please put the amount you want to contribute in the envelope and the rest into the box in front of you. _____ will go around collecting the envelopes.

[Behind the blind the researchers notes how much each player sent and put the money into the pot. This pot is then displayed and the money is counted in front of the group.]

You have altogether contributed _____ Riel/Dong. This amount is doubled to _____ Riel/Dong. Each one of you will get _____ Riel/Dong out of the project.

[The amount is distributed in public to the players, as well as the envelopes are given back at the same time]

Please put the money in the box in front of you.

[After the 10 rounds are played]
Rule B: COMMUNICATION
Besides the rules described in the instructions that we just explained, there is an additional rule for the participants in this group from now on. The only change is that you are now allowed to talk for 4 minutes to each other. You can talk about anything you like including the game. After the 4 minutes have passed you are not allowed to communicate till the end of the round. You will take your own decision again in private and secret. The rest of the rules stay the same.

Now we start the game again. Please feel free to communicate. You have 4 minutes
[The students will take notes on the communication.]

[After 4 minutes] Now the time is up, please stop talking.
You now have to decide, how much money you want to contribute to the project.

[After 5 rounds with communication]
Rule C: LEADERSHIP
Now there is another rule: There will be a group leader from now on. He /she will be chosen through a lottery. He is allowed to set a rule, how much you have to contribute. However, all rules stay the same and your decisions will be made in private, so no one will know how much you contributed. You are still allowed to communicate for 4 minutes before each round before the leader sets a rule.
[Go around and let the players draw from a lottery]
Player number ___ has been chosen to be your leader.
Now the time to communicate for the group starts. [The students will take notes on the communication.]
[After 4 minutes] The time is up now. Please stop talking again.
[To the leader] You can now talk to the other group members and announce the rule, how much the players have to contribute.
[To all] Now you have to decide, how much money you want to contribute to the project. Please put the amount you want to contribute in the envelope and the rest into the box in front of you. _____ will go round to collect the envelopes.

[Behind the blind the researchers note how much each player sent and put the money into a pot. This pot is then displayed and counted]

You have altogether contributed _____ Riel. This amount is doubled to _____ Riel. Each one of you will get _____ Riel out of the project.

[The amount is distributed in public to the players, as well as the envelopes are given back at the same time]

Please put the money in the box in front of you.

[After the 20th round]
Now the game is over.
Player 1 please come one by one behind the blind to get the money changed.
Player 2 please come one by one behind the blind to get the money changed.
Player 3 please come one by one behind the blind to get the money changed.
Player 4 please come one by one behind the blind to get the money changed.

3) Instruction for the Extraction Game

This exercise is similar to a situation in which a group of people has to make decisions on how to use a natural resource together. For this game, assume that you and 3 other villagers have to use one fish pond together. Each of you can decide how many entities fish you want to take out of this water resource. So you have to decide about how many units of fish you want to make in one fish harvest, which is one round. The fish you gained in the game will be exchanged to money right after the session. The reason why we use a fish and a pond in this exercise is to represent real life situations in which your economic decisions will bring yourself monetary consequences. You will play several rounds equivalent to periods such as harvest rounds.

You can collect unit of fish in the box in front of you and at the end of the exercise; we will sum the total number of fish and give you money for it. We will personally hand that to you in cash. One unit of fish is equal to 100 Riel/1.000 Dong.
The BOX and ENVELOPE

To be able to play you will receive a box where you can store the fish from each round. [GIVE A BOX TO EVERYBODY], then you receive an envelope [GIVE AN ENVELOPE TO EVERYBODY]. This is used for exchanging GAME CARDS and FISH between us and you. We will explain this later.

GAME CARD
Then you also receive GAME CARD like the one I am about to show you now. These are used to indicate the units of fish you want to extract from the resource. This amount of fish is equal to an amount in real money. In each round, we have one fish pond with 40 units of fish here in the middle of the room. Each round we start with 40 units in the pond and each of you has to decide how much of the fish you want to extract. This needs to be written down on a game card. You can write down 0 units of fish, 1, 2, 3 units of fish or 15, 16 and so on, how much you want. The game card is then handed in to us. This all happens in secret. Remember one unit of fish is equal to 100 Riel/1.000 Dong, 2 units is 200 Riel/2.000 Dong and so on.

It is very important that we keep in mind that the decisions are absolutely individual, that is, that the amount of fish you write down in the game cards are private and that you do not have to show them to the rest of the members of the group. I will collect the envelopes with the game cards from all participants, and will add the total of amount of fish the whole group decided to extract. Then I announce the group total. To know how much fish is left in the pond, we subtract the group total from 40 units. If there is fish left and only then, we will double the fish that is left in the pond. This amount will then be divided equally by all of you. At the end, you will get the fish you indicated in the game card plus the rest in the pond times two divided by five. However, if the group total of units is higher than 40 units it is not possible to extract any fish from the pond for any of you.

Let us explain this with an example.

Each of you must decide in each round how much fish you want to take out of the pond. You give us your decision in secret and we add it up. For instance, “PLAYER A” decides to extract 20 units, “PLAYER B” 6 units, “PLAYER C” 10 units and “PLAYER D” 0 units then the total of the group is 36 units of fish.
[...MONITOR: show poster with the EXAMPLE...]

Remember in the pond were 40 units. Now we subtract the 36 units of the group from 40 units in the pond and have 4 units left.

We will double this amount of fish and divide it by all members. In this example it is 4 units left, we double it to 8 units and thus everybody receives 2 units of fish.

At the end, you will have the units of fish you indicated in the Game Card plus 2 units we gave to you.
Let’s see what every player gained:

“PLAYER A” receives 22 units
“PLAYER B” 8 units
“PLAYER C” 12 units
“PLAYER D” 2 units

Let us look at another example in the poster.
“PLAYER A” extracts 5 units
“PLAYER B” extracts 2 units
“PLAYER C” extracts 12 units
“PLAYER D” extracts 10 units

The group total is then 29 units. 40 minus 29 is 11. 11 times two is 22. 22 divided by 4 player is 5.5 units. So the individual gains are

“PLAYER A” receives 10.5 units
“PLAYER B” 7.5 units
“PLAYER C” 14.5 units
“PLAYER D” 15.5 units

Now, there is one restriction. If the group total is more than 40 units of fish, then nobody will get anything. This means, the sum of units of fish each player can be over 40 and then nobody will get any unit of fish at all. Let's see an example.

"PLAYER A" extracts 3 units
"PLAYER B" extracts 18 units
"PLAYER C" extracts 22 units
"PLAYER D" extracts 15 units

The total of this round would be 58 units. Nobody will get any fish units in this round. You also will not get the units you wrote down.

Let us look how the game works in each round.

We start with 40 units of fish in the pond. Every player writes down, how much fish he wants to take out of the pond. It is very important to clarify that nobody, except for the monitor, will be able to know the number that each of you decides in each round. The only thing announced in public is the group total, without knowing how each participant in your group extracted. And I will not tell anyone later. It is totally secret.

Let us repeat the steps with a new example. [...MONITOR: Repeat with the other two examples, writing the numbers in the posters hanging in the wall...]

It is important repeating that your game decisions and earnings information is private. Nobody in your group or outside of it will be able to know how many points you earned or your decisions during rounds. We hope these examples help you understand how the game works, and how to make your decisions to allocate your units in each round of the game. If at this moment you have any question about how to earn fish in the game, please raise your hand and let us know.

It is very important that while we explain the rules of the game you do not engage in conversations with other people in your group. If there are no further questions about the game, then we will assign the numbers for the players and the rest of forms needed to play.

Preparing for playing:

Now write down your player number in the GAME CARD. In the following poster we summarize for you the steps to follow to play in each round. Please raise your hand if you have a question.

Finally, to get ready to play the game, please let us know if you have difficulties reading or writing numbers and one of the monitors will sit next to you and assist you with these. Also, please keep in mind that from now on no conversation or statements should be made by you during the game unless you are allowed to. We will have first a few rounds of practice that will NOT count for the real earnings, just for your practicing of the game.

Example round

The objective of the game is to get as much fish as possible at the end of the rounds. This will then be converted into cash for your household.

How is it played: In each round, you must decide how many units you want to extract from the common water resource. The points you earn in each round depend on your decision and the decisions by the rest of the group, according to the explanation we gave you.

1) Steps to play in each round:
Using the GAME CARD, decide how many UNITS you will play. Hand in the game card to me.

Wait for the monitor to calculate the total from all the cards in the group. We will announce the TOTAL GROUP UNITS, THE AMOUNT OF FISH UNITS LEFT IN THE POND AND THE AMOUNT DOUBLED AND THEN DIVIDED BY ALL MEMBERS.

Then you receive your units of fish earned in the round by you. This is the fish you extracted, plus the additional fish you get from the fish that was left in the pond.

Let us play another round. Start all over again from point 1.

Let's start the game now. All the gains you receive from now on will be exchanged to real money, which you can take home. Now your decisions matter.
PLEASE REMEMBER, THERE IS THE Rule that THERE IS NO COMMUNICATION WITHIN THE GROUP. Please do not make any comment to another participant or to the group in general.

[FOR TEN ROUNDS]
Now you have to decide how much fish you want to extract. Please write the amount of units on the card. I will go around collecting the cards.

[Behind the blind the researchers note how much each player extracts and announces the group total]

You have altogether extracted _____ units. In the pond were 40 units. 40 units minus _____ units is _____ units, which are left in the pond. This amount is doubled to _____ units. Each one of you will get _____ units from the fish units left.

[The cards indicating the gained units is distributed in public to the players, as well as the envelopes with the fish cards]

Please put the fish in the box in front of you. You will hand this in later.

[After the 10 rounds]

Rule B: MONITORING OF MEMBERS
Besides the rules described in the instructions that we just explained, there is an additional rule for the participants in this group from now on. This new rule is for ensuring to obtain the maximum fish possible for the group. Let us try to guarantee that each player in your group does not extract any of the fish, meaning all players

extract 0 units. The decisions will still be private and individuals do not know how much other players extracted. If a player still wants to extract fish we will impose a penalty. However, it would be very difficult to inspect the members of a community all the time. Thus, after each round we will throw a dice, which everybody can see. Whenever the number 6 appears on the dice, we will monitor the whole group. This means, there is a 1:6 chance that the whole group is monitored. Every player who extracted fish then, must give it back and additionally has to pay a penalty of 4 units of fish. The rest of the rules stay the same.
[SHOW WITH EXAMPLE]

Let's start
[FOR FIVE ROUNDS]
Now you have to decide again how much fish you want to extract. Please write the amount of units on the card. I will go around collecting the envelopes.

[Behind the blind the researchers note how much each player extracts and announces the group total]

You have altogether extracted _____ units. In the pond were 40 units. 40 units minus _____ units is _____ units, which are left in the pond. This amount is doubled to _____ units. Each one of you will get _____ units from the fish units left.

Now, we will throw the dices.
If six appears: Everybody will be monitored. If you extracted fish, you will not get it, but you will get a fine for not following the rule. And you will also not get any shares from the common pond. Everybody who played according to the rule will get the fish from the common pond and no fine.

If one to five appear: nothing happens and we pay back all fish earned in this round.
[The cards indicating the gained units is distributed in public to the players, as well as the envelopes with the game cards]
Please put the cards in the box in front of you. You will hand this in later.
[After 20th round]
The game is over now.
Player 1 please come behind the blind and bring your box and the envelope, so we can change it into real money.
Player 2 please come behind the blind and bring your box and the envelope, so we can change it into real money.
Player 3 please come behind the blind and bring your box and the envelope, so we can change it into real money.
Player 4 please come behind the blind and bring your box and the envelope, so we can change it into real money.