Helpless in fighting free-riding
The influence of exogenous factors on collective action for small-scale aquaculture in the Mekong Delta of Cambodia and Vietnam

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ABSTRACT

A collective approach for small-scale aquaculture was implemented by The WorldFish Center in the Mekong Delta of Cambodia and Vietnam in order to test whether such a community-based approach can be a successful measure to improve food security and to reduce poverty in the respective communities. Research was conducted during and after the implementation of the project in order to understand the factors enabling or disabling successful collective action. Action Research was applied in four case study villages, a socio-economic survey was implemented and three field experiments were conducted during the field work in 2006 and 2007. In three of the four case study sites, the fish culture project was discontinued after the first trial. In the discontinuance analysis, several reasons for the reluctance to continue were detected, including technical and natural reasons as well as free-riding by non- and project members. The survey reveals that the project is implemented in an institutional environment that does not necessarily support those kinds of collective approaches. Finally, the field experiments show that the farmers, compared to a control group, do actually cooperate and trust each other and it must be concluded that it is rather the exogenous factors including property rights, rules of resource use and technical reasons why the project turned out not to be sustainable.

Key words: Collective Action, Free-riding, Cambodia, Vietnam, Field Experiments, Action Research

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INTRODUCTION

People in the Mekong Delta of Cambodia and Vietnam are highly dependent on fish resources for income and animal protein intake. Due to several developments like population pressure and newly built structures, the fish resources and therewith the livelihoods are more and more under pressure. Thus, in 2005, The WorldFish Center initiated a five year research project (2005-2010) in the Mekong Delta called "CGIAR Challenge Program on Water and Food: Community-based Fish Culture in Irrigation Systems and Seasonal Floodplains".[2] The underlying assumption was that seasonal waterbodies can be communally managed by all stakeholders under equitable and sustainable sharing arrangements. The project's main activity was to integrate the culture of fish and other living aquatic resources into existing water use systems. Within this context, research on technical as well as on institutional options for community-based aquaculture was undertaken (WorldFish 2005).[3]

Often, HHs in the research area culture fish individually in small private ponds on their homestead. However, here the intent was to increase the productivity of seasonal occurring floodwaters through the stocking of fingerlings in larger (public) waterbodies that are accessible by different users. Suitable built structures (e.g. dikes or nets) needed to be in place or created and thus at each project site different techniques for fish culture were used. However, in all sites, participants were expected to contribute labour and time for collective activities, including fencing/dike construction, site maintenance, stocking and harvesting, guarding of the culture sites as well as participation in group meetings. Also financial contributions had to be provided by participating farmers to contribute to the purchase of fingerlings and construction materials (e.g. nets or bamboo sticks). Additional financial support as well as advice in regard to many aspects of the project (e.g. water quality, species or technical support) was provided by the local research institutes and government agencies involved in the project. At the end of the season, the aquaculture produce was to be harvested by the group members and shared or sold to local markets with the profit divided among the group members. The implementation of the community-based project faced several challenges and the pilot phase was discontinued by most of the participating villages. The results presented in this paper show that reasons for this cannot be seen in the low willingness for cooperation of participants, but rather in the exogenous factors of the project context.

In order to understand the institutional context in which the project is implemented a throughout analysis of formal laws and regulations as well as of informal rules for managing water resources was conducted for both countries (see for example SRV 1998, RGC 2001b, RGC 2001a, SRV 2003, SRV 2004, RGC 2007). It is important to mention that in the Mekong Delta of Cambodia and Vietnam, property rights on water and land change with the seasonally occurring flood. Land is usually cultivated on an individual basis with people holding at least private use rights to the parcels. In contrast, water is a public good and as soon as water covers the individual plots, the streams, lakes and reservoirs are legally accessed by many households using the water for many different purposes. Actually, during

[2] The Consultative Group on International Agricultural Research (CGIAR) established the Challenge Program on Water and Food (CPWF) in order to create research-based knowledge and methods for growing more food with less water and to develop a transparent framework for setting targets and monitoring progress (CPWF 2005).

[3] This project is a joint effort of The WorldFish Center, the International Food Policy Research Institute (IFPRI), the Fisheries Administration in Cambodia and the Research Institute for Aquaculture No.2 in Vietnam. The research presented here was part of my PhD studies at the Philipps-University Marburg, Institute for Co-operation in Developing countries, Prof. M. Kirk.

wet season, an *open access* to the water resources is found as the water use is not restricted, meaning that de facto there are no rules in place that govern the water use.

The Institutional Analysis and Development Framework (IAD) is used in this research as an analytical tool to understand the structure of the situation the project farmers faced (Ostrom 2005a, 827). As exogenous variables, the rules, the biophysical/material conditions and the attributes of the community influence the action arena and thus the actions individuals can take (Kiser and Ostrom 1982, Ostrom 2005b, 15). Local natural resource users in the research area also themselves in decision situations that were influenced by exogenous variables determining the choices they were able to take. It is assumed, that those variables influence the action arena where the decisions about cooperation vs. free-riding are made. Based on the analysis of the exogenous variables, hypotheses were developed and tested with experimental methods in order to examine how rules affect the action arena and how these would need to be changed in order to increase the common outcomes.

The paper is structured as follows. The next section introduces the different methods used to examine the factors influencing the action arena as well as the action situation itself. In the third section the findings from the field research are presented. In the fourth section the results are discussed and finally conclusions will be drawn.

METHODS

Action Research

Field research was conducted between August 2006 and November 2007 and in September 2009. The Participatory Action Planning Development Methodology (PAPD) (Sultana and Thompson 2003) was used as an action research method and conducted with regard to site-specific conditions. The method facilitates consensus building and the identification of options that take into account the interest of different stakeholders. The preparation of a detailed action plan is another key feature of the method. PAPD involves a scoping phase, a participatory planning phase, as well as an implementation phase (Sultana and Thompson 2003). Depending on the phase of project implementation and research progress, different methods were applied in the field.

The first phase of field research constituted a situational analysis. Here information about communities, the natural resource systems, and the level of interaction between communities and resource systems was acquired to understand the biophysical, economic, social and cultural environment in the research sites. A range of qualitative and quantitative Participatory Rural Appraisal (PRA)[4] techniques has been applied including a HH census, community profiles, participatory resource mapping, field observation and semi-structured key informant and focus group interviews as well as an analysis of institutions in the (collective) management and use of water and land. In the participatory planning and the implementation phase a set of different tools was used to facilitate common planning and implementation of the aquaculture project. In the planning phase, technical and institutional options/problems of a small-scale aquaculture project were discussed and directions for actions defined. The "fish culture groups" were established, who then developed their own detailed action plan (for example physical works, application of rules, monitoring) to implement solutions agreed on. In the implementation phase the process of fish culture was throughout documented in detailed field notes.

[4] PRA is "[…] a family of approaches and methods to enable local people to share, enhance and analyse their knowledge of life and conditions, to plan and to act" (Chambers 1994, 953).

Finally, a discontinuance analysis was conducted as three out of four aquaculture groups decided not to continue the project. The aim was to identify the main reasons for the reluctance to continue. Different views were considered and group interviews as well as individual in-depth interviews with the project participants were conducted. Also non-participants were interviewed.

Socio-economic survey

The survey questionnaire encompasses thirteen sections and was used to obtain information about various aspects of the socio-economic circumstances of the households (HH). The questionnaire covers the following (closed or open format) sections: HH details; HH member details, HH assets and coping strategies; land holdings and farming systems; cropping and inundation characteristics; aquaculture practices; processing and marketing of aquatic products; fish and meat consumption; institutional membership and collective activities; health problems; remittance, savings and credit; shocks and trends; as well as rice-fish preferences. One of the most relevant parts of the survey for the research presented here is the section about land use and tenure. In-depth information on those issues was collected in order to better understand property rights regimes within the communities. Also flooding patterns were considered. The impact of different land tenure forms on the adoptability of the project is thereby examined. Further, the section covering issues about collective action is essential to understand how the attributes of the communities influenced the action arenas.

Field Experiments

Based on the findings from action research and the survey, it was decided to further investigate the cooperation between community members. Three games were chosen, adapted in their designs and implemented in the research villages and four control villages. The first game is a *public good game* as "achievements of shared common goods" was one main motivation for engaging in collective activities mentioned by the farmers. The *common-pool resource game* was developed as all villagers usually share common-pool resources (CPRs) with livelihoods heavily depending on access to those. Additionally, both games can be related to the project implementation itself as farmers contributed to the public good (the project) and then appropriated/harvested fish from the common culture site. Besides these two games, a *trust game* was implemented. One motivation to engage in the collective work was mentioned by farmers to also "strengthening social ties" which is related to trust. Further, the level of trust within a group does influence the levels of cooperation and it is assumed that a trust level correlates with successful collective action.

The public good (PG) and the CPR game were framed according to the local situation with "contribution to a dike construction project" and "fishing in a common pond", respectively. The treatments introduced were "communication" (1), "leadership" (2) and "monitoring" (3).

The PG and CPR game were played with thirty-two participants in each of the eight villages (n=256 players), whereby each sixteen participants were assigned to the PG (128 in total) and sixteen to the CPR 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. Players were allowed to only participate in one of the games. The trust game was played with twenty-six to thirty-four participants in each of the eight villages (n=246 players), whereby half of the participants were assigned to the group A (the sender group) and half to group B (the responder group). The assignment to one of the groups was determined by a lottery at the beginning of the game. The participants were aware of the identity of the other group members and they knew each other as they were

all selected within the same village. In all games, decisions were always made in private, individually and kept confidential even after the games ended.[5] For the specific designs of the three experiments please see the Appendix.

RESULTS

Project implementation and action research results

The fish culture project was implemented in public waterbodies in the Cambodian communities (PE and TK) and in Vietnamese hamlets (E2 and TPB) with the preparation work starting in early 2007 and fish having been stocked in July/August in Vietnam and in November 2007 in Cambodia. The Vietnamese harvested after a grow-out period of four to five months, the Cambodians after only two months. The planning and implementation of the project in these four communities differs substantially, which does justice to the specific local situations in each of the sites. Also the technical approach varies between the countries. In the Cambodian villages, the project must be seen as a small-scale initiative of smaller groups, whereby in Vietnam large areas were enclosed with membership in the groups only being possible for farmers that were able to make an investment of twelve US$ or thirty US$ respectively. Table 1 gives an overview about the amount of members in each group, the size of the sites, the technical approach as well as the financial contributions made by each farmer.

Village	Amount of members in culture group	Size of culture area	Technical approach	Individuals' financial contribution to project
PE	17	2.5 ha	Fencing of land in the public reservoir	2.5 USD
TK	7	0.6 ha	Fencing of land in the public reservoir	3 USD
E2	28	120 ha	Enclosure of "private" rice fields	31.25 USD/ha owned in the respective area
TPB	28	39 ha	Enclosure of "private" rice fields	12.5 USD/ha owned in the respective area

Table 1: Overview about fish culture groups, sites, technical approach and contributions

Overall, the returns of the small-scale fish culture in the four case study sites were disappointing. In both Cambodian sites, it was decided to clear the culture site from water before the official end of the harvest as it was assumed that, due to several reasons, the amount of fish left in the ponds is rather low. This was confirmed and in both sites the harvests was low with twenty-five kg in PE and zero kg in TK, although 178 kg and 105 kg were stocked respectively. The situation was different in Vietnam. In the first village, 155 kg of fish stocked yielded 7,700 kg of fish that was sold to middlemen. The second hamlet, E2 even realised a yield of 11,300 kg (750 kg of fingerlings stocked).

[5] The amount to be earned was aligned to the daily wages and living standards in the two countries. At this time, the daily wage was about one to 1.5 US$ for the Cambodian HHs and three to 3.5 US$ for the Vietnamese HHs. Accordingly, the players in the PG and CPR games were able to earn ten US$ in Cambodia and twenty-four US$ in Vietnam, when playing social optimum all the time. In the much shorter trust game, earnings were lower and players could reach a maximum of two US$ in Cambodia and 4.8 US$ in Vietnam.

Figure 1: Stocking of fish in TPB hamlet in 2007 (pictures by Huynh Huu Ngai)

Villagers in PE and TK did not harvest enough fish for selling and thus there was no income at all for both villages. Also, farmers lost their initial investments of 2.5 and 3 US$ respectively, which correspond to one to two daily incomes. The costs for labour contributions are even not considered in this calculation. Although the two Vietnamese villages were able to harvest and sell several kilos of fish, also here, the profits realised are low or negative when looking at net profits. The farmers in TPB are the only ones who were able to realise a positive return. Compared to the overall costs of 905 US$, the farmers realised a positive income of twenty-five US$ per member, without the financial support from other institutions. In E2, 9,000 US$ of investment costs for fingerlings and dike construction oppose 7,600 US$ of profit. Thus, also here, a negative overall return must be mentioned. Reasons for the differences in the yield and the overall negative return are diverse and will be described in the following.

Natural incidents and technical difficulties

Three groups reported difficulties during project implementation related to natural incidents and technical problems. The most important ones are mentioned in the following: In PE, the farmers lost fish during a natural occurring flood that came unexpected late in the year. Due to heavy rains, the flood level in the reservoir and thus in the culture site raised as high that fish was able to escape over the nets. In January, they decided to pump out the water to check how much fish was left. Only three to four fish per member were harvested and immediately shared. In TK, flood patterns were good. However, when the culture site was prepared prior to stocking, the group emptied the site from all wild fish to prevent predators to be left in the culture site (see also Heng and Pich 2008a). Not all predators were caught and those left ate all fingerlings stocked. Thus, at the end, they harvested four to five large predators, that presumably have eaten all the cultured fish. In E2 in Vietnam, one major incident was that the newly built dike broke during a storm. While trying to fix the broken parts, some of the cultured fish escaped. New heavy investments were required to repair it.

The project implementation and success was thus heavily influenced by natural patterns like flooding and weather conditions as well as on technical difficulties. However, besides these incidents, also conflicts within the groups as well as with the wider community were reported to be at least partly the reason for project failure. The following section explains how project members themselves evaluated the conflicts that occurred in the wider community and within the fish culture groups themselves.

Poaching and other conflicts with non-members

As planned, in all sites the fish was guarded twenty-four hours a day during the whole culture season. Thus, being aware of the possibility that others will try to steal fish from the culture sites, all groups established monitoring systems. However, conflicts were reported to have happened within in the group as well as within the wider community.

Group members in TK report severe conflicts with non-project members:

- High water turbidity around the culture site, which affected the fish, caused by: [6]
    - watering livestock by non-project members close to the site
    - fishing in the CARE Cambodia Sanctuary, where water is deepest and thus wild fish abundant (see also Heng and Pich 2008b).[7]
- Destruction or lifting of the site's net on purpose by non-project members while fishing there. This caused a high frustration as group members.
- The commune council, commune head and the police were addressed to solve the problem, no solution was found.

Following incidents were reported by the Vietnamese farmers:

- Non-project community members did not give up their fishing efforts in the project site. Also farmers that hold land inside the project area, but did not participate in the project, continued to fish or even increased their fishing efforts.
- The commune officer was asked for support in conflict resolution, but a solution was not found.
- Due to the continued fishing in the culture site by non-members, also group members themselves started to fish in the culture site again. Overall, a substantial part was fished away before the official culture seasons ended.
- In TPB, group members agreed that taking own fishing gears to the guarding shift and to harvest some of the cultured fish for their HH consumption is allowed. Thus, most of the fish was presumably taken by group members before the official group harvest.

Collective activities, group conflicts and free-riding

Besides financial means, contributed by all members without exception, there were other duties group members had to fulfil. These included meetings, but also dike or net construction and associated activities, stocking of fingerlings, harvest of fish (including pumping activities in Vietnam) and marketing efforts. In the group discussions, only small conflicts between the members are reported and group members explain that these were usually solved informally through explanations, discussions and encouragement.

However, in individual interviews farmers of all groups reported some difficulties within the group. The main points are summarised as follows:

- In TK, all project farmers explain that due to the disappointment caused by the loss of fish and conflicts with non-group members they "lost their spiritual strength". Due to this, labour contributions to the project decreased.
- In PE, free-riding in regard to guarding was much lower than in TK and only reported to have happened occasionally. However, also here some group members said, that they lost their "motivation and spiritual group strength", when they realised that a large portion of the fish escaped.
- In TPB, free-riding in regard to guarding duties was reported to happen regularly.
- In E2, a high level of frustration is reported, because of heavy free-riding within the group. There was not only a low attendance in the meetings, but also participation in

[6] Some species cannot cope with this high turbidity as their gills get clocked and the amount of oxygen they absorb is thereby critically reduced.

[7] The CARE sanctuary, where the project site is located as well, is the deepest area within the reservoir. Thus, there is still a high abundance of fish even when water in the rest of the reservoir recedes. CARE established this fish sanctuary in 2006 together with the villagers. It was agreed by all community members not to undertake any fishing activities in this area in order to provide the fish with a refuge.

collective work activities was described as very much unsatisfactory. Further, when the dike was damaged by the storm the financial contributions to fix it were low.

To summarise the evaluation has shown that three villages had a negative overall return, whereby the investments made were lost. Natural incidents (unusual high flood and a broken dike) are explained to be the reasons that led to a decrease in the fish yield in two of the sites (PE & E2); remaining predators in the waters, and thus a technical problem, is the reason for no yield in TK. Challenging were also conflicts with non-group members as well as with members that continued fishing in (or close to) the sites. The monitoring of the fishing sites did not prevent a loss of fish. This is due to the size of the culture areas that cannot be easily patrolled, especially at night. Further, concerns were raised by several farmers if persons on duty were actually guarding the fish. Finally, severe conflicts arose within the group in E2 due to work commitments and the dike construction/repair.

Project evaluation by farmers and discontinuance analysis

After the first trial of fish culture, three villages (PE and TK in Cambodia as well as E2 in Vietnam) did not continue with the project and a discontinuance analysis was implemented to identify specific reasons for the discontinuation. The following sections summarises the evaluation by the project farmers.

Several positive associations with the project were mentioned by members in Cambodia. One main belief of the farmers is that profit can and will be generated when the technical problems are overcome. Also, in both villages, farmers explained that they feel that the project is a good capacity building measure and that they have learnt a lot in regard to fish culture. They are satisfied and will share their new knowledge with the rest of the community. Farmers in PE found further positive criteria and mention that they were satisfied with the collective work and the acceptance in the community (e.g. no poaching). They also believe that the "project can increase team spirit through the common work and the sharing of experience". Additionally, the fish abundance in the reservoir increased (especially silver barb), which is due to the fact that the cultured fish escaped during the flooding.

Negative associations with the project mainly concern technical problems with late flooding mentioned in PE and remaining predators in the culture area in TK. Further, in both villages some farmers indicated that the solidarity in the group decreased due to the disappointing developments during the first trial and that individual fish culture might be easier to organise as there would be no coordination efforts with decisions taken on an individual basis. Also, technical problems would be reduced when doing the fish culture on an individual basis. Some farmers expressed the suspicion that other community members did actually fish in the sites and stole fish. They said, this was partly only possible because some members did not fulfil their guarding duties. There is also doubt that the project is technically feasible as "flooding is irregular and very difficult to predict".

Overall it must be mentioned that the groups were motivated to invest money and time in a second trial. They were interested in increasing their knowledge concerning aquaculture and strongly believed the project can be beneficial to the community. However, in both following years, 2008 and 2009, the water levels in the reservoirs did again not permit the fish culture to proceed.

In Vietnam, TPB hamlet, positive associations with the project mentioned were the financial profitability of the project and the high learning effect in regard to fish culture. The training received was considered as very helpful. Adjustments made by farmers in TPB include 1) the

heightening of the dike in order to prevent fish escaping during heavy rains; and 2) the establishment of a better cooperation with middlemen offering higher prices.[8] Also, due to the initiative of the Research Institute for Aquaculture No.2, the rules were adjusted and written down. Following changes of rules were made:

- The management committee must not take guarding duties anymore, only "ordinary members";
- It is now forbidden to carry fishing gears/ fish in the site during guarding duties; and
- Sanctioning for not fulfilling duties is formally institutionalised.

In E2, reasons for discontinuance were elaborated. Farmers mentioned that one of the main reasons for not being interested in starting a second trail is that profits in the first year were so low. Also, the work in the group was not satisfactory, there was mistrust and conflicts in the group, a "bad atmosphere" and "reduced solidarity". Group-members also explain that poaching by and conflicts with other community members were a hindrance. Some members also accused other group members for poaching, explaining that those few spoiled the project for everyone. Members also complained about the high labour input they faced during project implementation. Women explained that they did not like the fact that they were alone during night while their husbands were guarding. Further, most farmers also complained that they were denied access to their "own" rice fields for fishing and other, e.g. agricultural practices (e.g. preparation of fields for next crop). Finally, group members expressed that they lacked support from the authorities. Actually, they felt betrayed as the "authorities pushed them, then when problems arose did not help". Alternatives to the project evaluated by farmers in E2 were to either culture fish individually to avoid conflicts and reduce coordination efforts or to simply rent out the land to duck owners, which promises a fair return with no labour input at all.

Summarising, only one village (TPB) actually did continue with the project in the following year, but decided to discontinue after this second trial, too. This group, however, realised that rules will need to be adjusted to increase profits (e.g. no fishing is allowed for group members anymore and sanctioning was institutionalised).

Results of the socio-economic survey

Land use and tenure

Cambodians mainly rely on rain waters for irrigation and are thus heavily dependent on the annual rainfall. In Vietnam, most farmers profit from well-developed irrigation systems farming on Vietnam flooded/irrigated annual-crop lands (90.3 percent). In Cambodia, 79.6 percent farm on rain-fed annual-crop lands in comparison to only 26.1 percent on flooded/irrigated annual-crop lands.

More than ninety-five percent of the land used is claimed to be "owned by the resident HH". Respondents were also asked to specify the kind of land rights (e.g. official title or use rights) for each plot they live on or cultivate. Overall, 27.6 percent of the Cambodian parcels were claimed to be "legally owned with title based on official survey". In Vietnam, eighty-five percent have a legal title based on an official survey. The following pie graphs show the distribution of land titles in each of the villages for homestead land and annual crop lands (Figure 2).

[8] During the first trail, they tried to sell the fish themselves at the market, but this led to most fish being rotten before it was sold and thus profit further decreased.

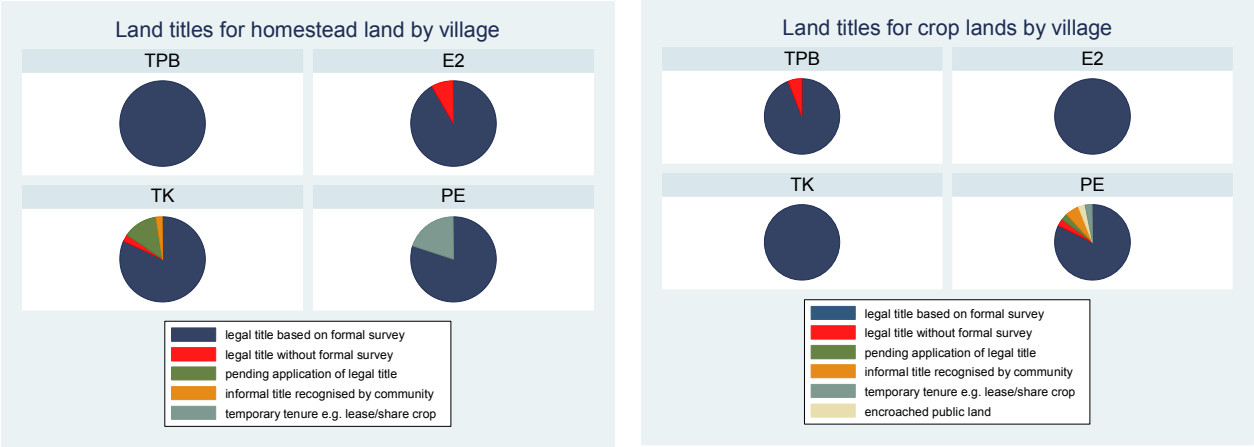

Figure 2: Land titles for homestead and crop lands by village

Data on fishing rights for the different plots is only available for 36.4 percent of all parcels. However, at least eighteen percent of all parcels are legally accessible for fishing by the whole village and/or the neighbouring villages. Less than three percent are fished by the land owning family only (Figure 3).

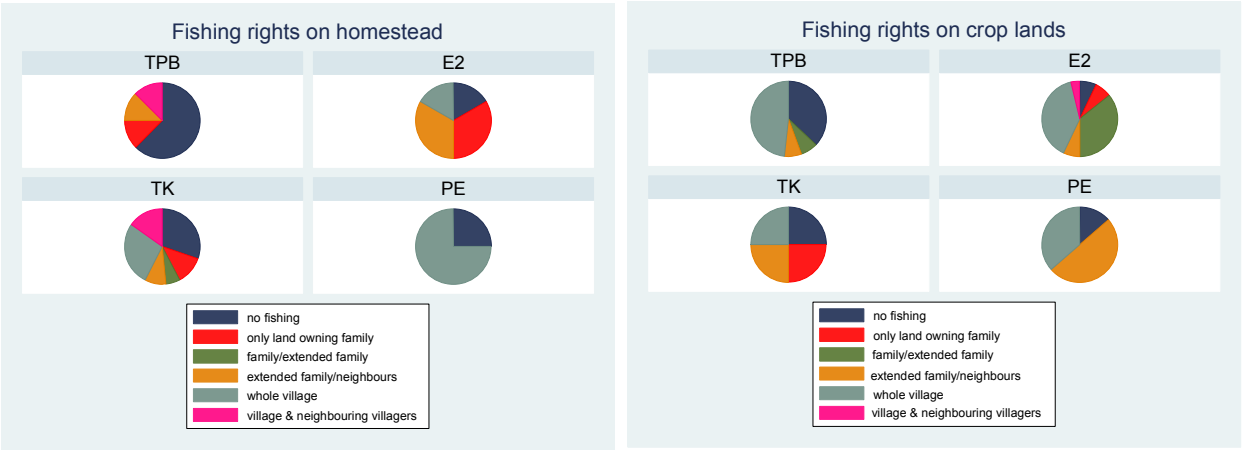

Figure 3: Fishing rights on homestead and crop lands

When looking at the flood levels in regard to rice fields, essential differences become visible. In Vietnam, 49.2 percent of the land is usually flooded between 100 and 150 cm and none of the HHs indicated that its land lies above flood level. In contrast, in Cambodia, 26.9 percent of the HHs have annual crop land that is usually above the flood level. Only 16.3 percent have land that normally floods between 100 and 200 cm (Figure 4).

The Cambodian crop lands are surrounded by dikes with an average height of 25.5 (std. dev. 11.21), while the Vietnamese dikes are higher with a mean of 68.1 cm (std. dev. 52.67). The occurrence of floods in the last five years is a good indicator on the regularity of flooding. The Vietnamese report that their rice fields were flooded on average 4.6 times in the last five years (std. dev. 1.29). In Cambodia, flooding occurred only 1.4 times in the same time frame (std. dev. 1.15), which indicates that it is much more unstable. The flood duration also differs between Cambodia and Vietnam. Rice fields are flooded above thirty cm in Cambodia for a minimum of thirty days per year on average. In Vietnam, it is only half of the days on average for minimum flooding. In contrast, when floods are more severe, maximum flood levels are reached in Cambodia for sixty days, while in Vietnam for only thirty days. The depth of flood waters within the rice fields fluctuates between a minimum of sixty-two cm and a maximum

of 1.4 m on average in Cambodia. The Vietnamese culture under better conditions as the minimum level of water in the fields is ninety-two cm and the maximum 1.47 m on average.

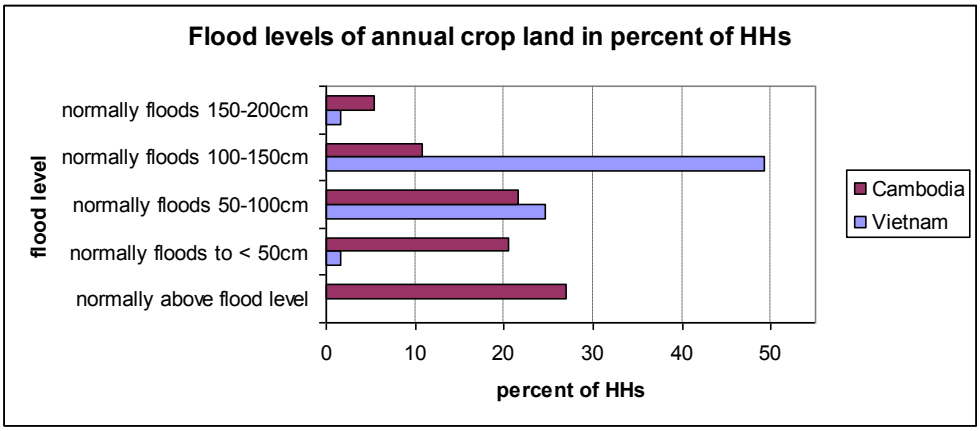

Figure 4: Flood levels of annual crop land in percent of HHs (n=160)

Figure 5 shows the differences in flood, irrigation and drainage control between Cambodia and Vietnam. While 68.3 percent of the Vietnamese rice culture plots are managed with full irrigation, flood and drainage control (using sluices, distribution and drainage canals), the most plots in Cambodia (59.2 percent) have no or only partial flood and irrigation control. Only 2.9 percent have full irrigation and drainage control with access to dikes as well as to distribution and drainage canals. Main irrigation sources for the Vietnamese are gravity (50.8 percent), pumping (24.6 percent) and recession (20 percent). For the Cambodians it is rather recession (13.9), private ponds (13.9) and gravity (11.9 percent).

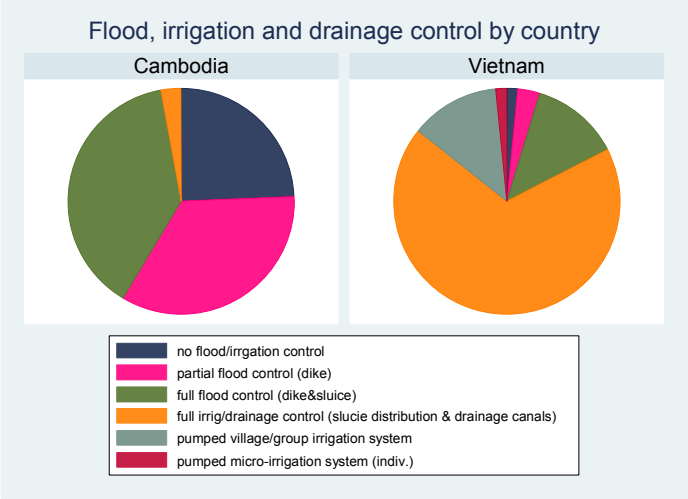

Figure 5: Level of flood control on rice plots by country

Fifty percent of the HHs in the sample report that they face problems related to water availability and/or quality in their rice fields. These include 86.4 percent of the Cambodian HHs, but only 11.1 percent of the Vietnamese HHs. Droughts are the most common problem, however, except of one Vietnamese HHs, only Cambodian HHs suffer from droughts (18.1 percent).

To summarise, while most agricultural land is "legally owned based on a formal survey", on most of the parcels, fishing rights are not limited and allowed to anyone. Vietnamese have much higher flood control in their paddies and flooding is more stable and predictable

compared to Cambodia as infrastructure is much more developed in Vietnam, with higher dikes, more sluices, drainage and distribution canals. Most Vietnamese have full irrigation and draining control on their parcels. Accordingly, problems related to water availability and water quality (e.g. droughts and flooding) are reported mainly by the Cambodians.

Overall, it can be summarised that the conditions for fish culture are much better in Vietnam as a higher flood control is possible, flooding occurs on a regular basis, plots are visible from homesteads and the Vietnamese seem to also have higher control concerning fishing access by other HHs on their plots.

Collective action, formal and informal cooperation

Twenty-five percent of all HH members age eighteen or older (n=634) are a member of a formal organisation in their village. Of those, the Cambodians constitute nearly 69.8 percent. Collective activities the organisational members are involved in include guarding fields, public health activities, procuring agricultural inputs and fish seed supply as well as political meetings, micro savings/credit and other. The activities mentioned most often are "guarding fields" (thirteen percent of all activities), "public health activities" (eleven percent) and "procuring agricultural input" (ten percent).

When asked about informal collective agricultural activities the HHs undertake with other HHs in the village on a collective basis, 107 HHs representing 66.9 percent of the whole sample explain that they are involved in such activities. Fifty-two percent of all HHs in the sample work collectively for field preparation, fifty percent in maintaining public spaces (buildings/roads/temples) and 48.1 percent support each other during transplanting times as well as for crop security/guarding activities. Collective fishing is done by 23.1 percent of all HHs in the sample.

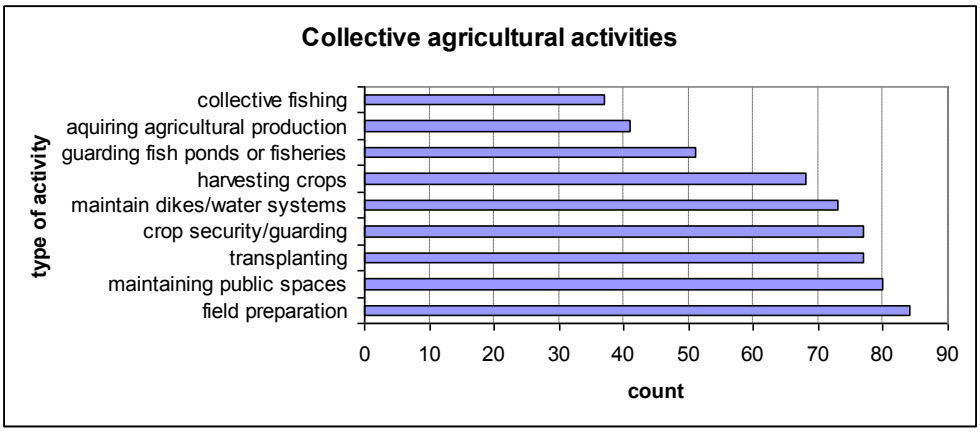

Figure 6: Informal collective activities (n=107)

The motivation for collective activities differs between the villages and is diverse, with "reciprocal labour arrangement" being the reason in more than forty-five percent of the activities. However, also "financial remuneration" plays a role when deciding to engage in collective activities. While in Cambodia the "reciprocal labour arrangement" and "financial remuneration" dominate, in E2 "achievement of a shared common good" is the main reason for engaging in collective activities (more than seventy-five percent). In TPB, also the "reciprocal labour arrangement" is used as motivation for supporting each other (Figure 7).

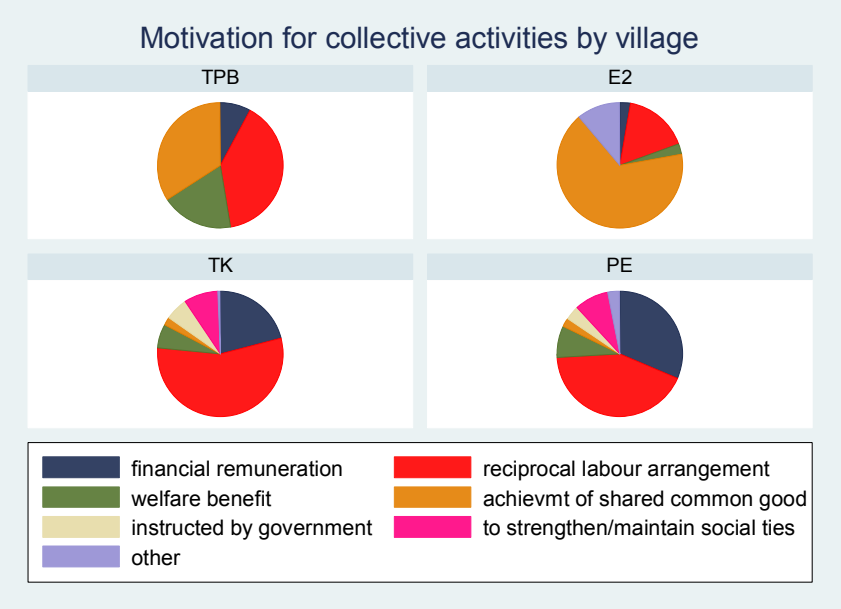

Figure 7: Motivation for engagement in collective activities by village

The data provided in this section further showed how institutional arrangements on local levels influence the livelihoods of people in the research communities. In regard to land and water governance it became obvious that land is considered as private property with most HHs holding an officially granted title to their homestead and cropping lands. However, in regard to fishing the tenure patterns are more diverse and access to water resources is granted to a much larger part of the communities, even on homesteads. Thus, with the seasonal change and flooding of private lands, the access patterns change as well. This, in turn, also shows that exclusion of community members from certain parcels is legally not possible. Thus, these dynamic tenure patterns impact very much on the project implementation as also here, the exclusion of non-members from project sites is difficult to ensure and might be questionable in legal terms.

Results Experiments

Results public good game

The overall cooperation level was high in the PG game with 89.6 percent of the maximum possible income reached over all twenty rounds. Both introduced treatments one and two (communication after ten rounds, leader after fifteen rounds) had a positive effect on the cooperation levels. Cooperation levels significantly increased, when *communication* was introduced from 87.2 percent to 90.9 percent (Wilcoxon signed rank: $z = -5.743$; $p<0.000$). Further, the introduction of a *leader* after round fifteen had a positive significant effect on the cooperation level (Wilcoxon signed rank: $z = -3.854$; $p<0.000$) in comparison to the treatment with communication only (round 10 to 15). However, the effect was not as strong as compared to communication and non-communication. In combination, the treatments one and two led to the players reaching 93.2 percent of the maximum payoff possible. Contrary to literature, an end game effect was not observed and contributions in the last three rounds were higher than in round fifteen to round seventeen (Paired sample test: $t = -0.9229$; $df = 127$; $p>0.1$). "Leaders" themselves contributed 3.8 tokens less on average than the non-leaders. However, this difference is statistically not significant (Mann-Whitney: $z = 1.217$; $p<0.2236$). There is also no significant difference between male and female players (Mann-Whitney: $z = 0.105$; $p<0.9163$).

However, the contributions to the PG were significantly different for project and control villages, but only after the introduction of communication (after round 10). The project villages contributed 0.8 tokens more on average in round eleven to round twenty (Mann-Whitney: $z = -3.242$; $p<0.0012$). Figure 8 presents the mean contributions over twenty rounds for the two categories project and non-project villages. The differences in contributions between the case study villages only are not significant and all project villages perform equally well in cooperation (Kruskal-Wallis: $chi^2 = 2.288$; $df = 3$; $p<0.5147$).

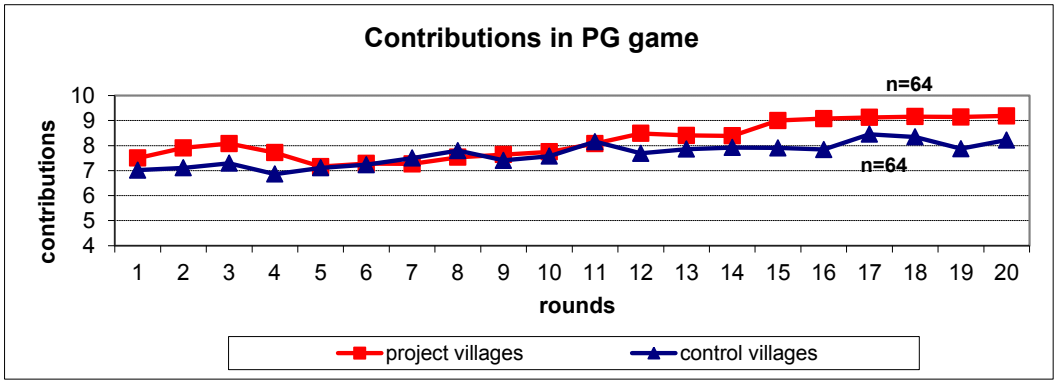

Figure 8: Mean contributions (in tokens) to the PG by village type

Results of the common-pool resource game

In the CPR game, players reached 76.2 percent of the maximum possible profit, thus less than in the PG game. Also in the CPR game the introduced treatment three (*monitoring*) had a significant positive effect on the cooperation level. Players appropriated less from the CPR after *monitoring* was introduced in round eleven (Wilcoxon signed rank: $z = 7.309$; $p <0.0000$). While mean appropriations were 4.8 tokens in the first ten rounds, they decreased to an average of three tokens in round eleven to round twenty. This represents a change in payoff reached from 75.2 percent without treatment to 77.2 percent with treatment. Also here, an end game effect was not observed, when comparing the last three rounds with round fifteen to round seventeen (Paired sample test: $t = 0.4125$; $df = 127$; $p>0.1$). Further, differences in cooperation between males and females are not significant (Mann-Whitney: $z = -1.175$; $p<0.2401$).

The results about the cooperation with the treatments lead to the assumption that the effect of communication (treatment one) and leadership (treatment two) in the PG game are larger than the effect of the monitoring (treatment three) in the CPR game. However, when looking at the cooperation level only, thus ignoring the subtraction caused by monitoring, the monitoring treatment led to a stronger increase in cooperation levels. Here, the cooperation (according to tokens played) rises from 52.4 to 69.5 percent of the maximum cooperation possible, which represents a 32.9 percent increase. With communication the change is smaller and only a ten percent increase in cooperation is reached. Another 4.5 percent increase in cooperation is reached when the leader is introduced. Thus, when looking at cooperation levels only, the effects of the communication and leadership are not as strong as the monitoring effect. In regard to project villages and control villages there is a significant difference in the tokens appropriated from the CPR (Mann-Whitney: $z = 2.686$; $p<0.0072$). In the project villages, player appropriate 1.06 tokens less in each round on average (Figure 9).

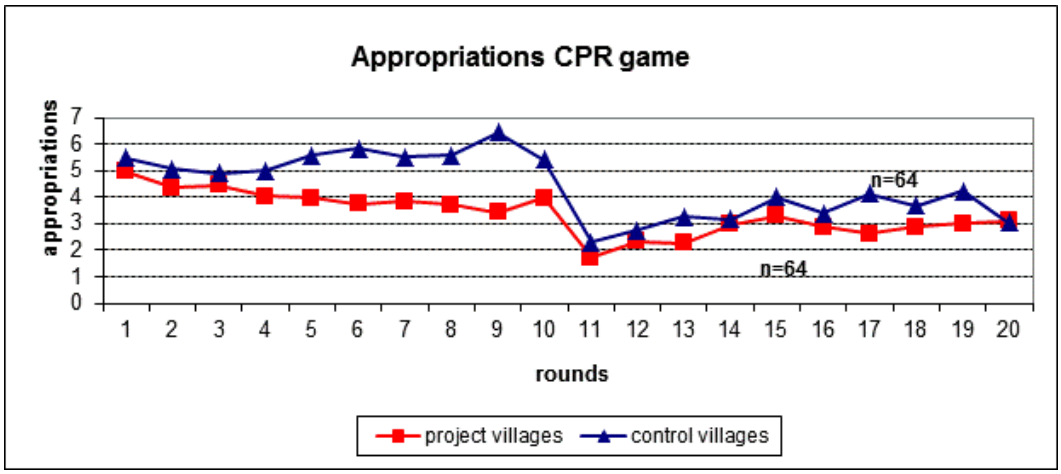

Figure 9: Mean appropriation (amount tokens) from CPR by village type

Results of the trust game

Overall, players in the trust game generated 78.8 percent of the maximum possible income. Senders earned 5.5 tokens (86.75 percent of total maximum) on average and respondents received 7.1 tokens (88.75 percent of total maximum).

The average amount sent by the sender group (group A) was 2.3 tokens, which is 57.7 percent of the initial endowment. Thirty-five percent of the players in group A (n=123 player) decided to send their whole initial endowment. However, also 13.8 percent of the players decided not to send any money to player B. Differences in trust levels between the genders are marginal and not significant (Mann-Whitney: $z = 0.717$; $p<0.4736$). The differences of means between project and control villages are, however, significant at the one percent level (Mann-Whitney: $z = -7.655$; $p<0.0000$) and players in the project villages sent 2.1 token more on average. The mode is also different. The mode in the villages that are not involved in the project is one token. In the project villages, the mode is four, representing 100 percent of the initial endowment and the highest amount of trust. Figure 10 summarises the distributions of amount sent by project and non-project villages.

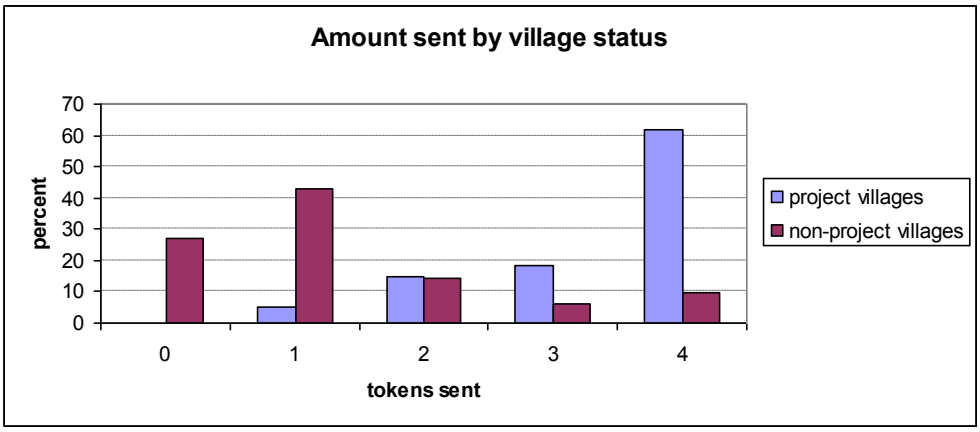

Figure 10: Distribution of amount sent by group A (n=123) by village type

The average proportion returned by the respondent group (group B) is 49.69 percent (std. dev. 0.27) for the whole sample. No differences of reciprocity for male and female players can be observed (Mann-Whitney: $z = -1.558$; $p<0.1193$). Figure 11 shows the box plots of amount returned, dependent on what the player had received from player A. Clearly, those who received more also returned more and thus high investments also yielded a high return. When

players B received four tokens from player A, most players B equally share and sent back eight tokens. However, also hyper-fair return ratios as well as unfair return ratios occurred (see for example all amounts less than eight tokens in the last column of the following box plot).

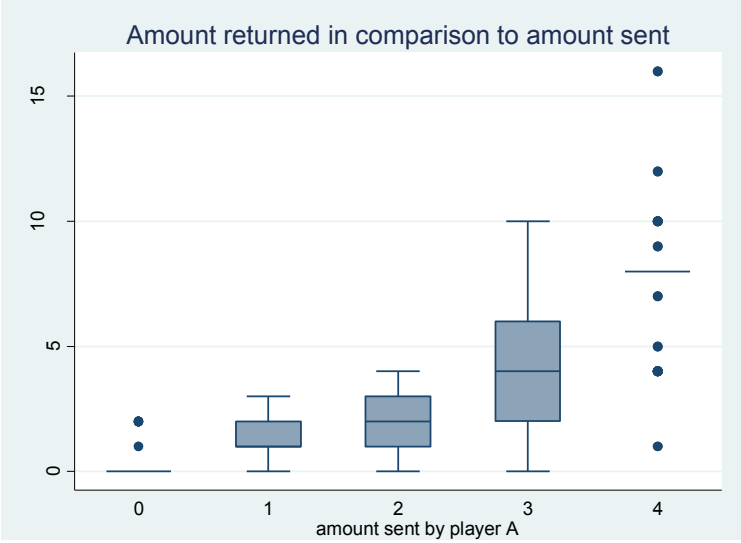

Figure 11: Box plot of amount returned in comparison to amount received (n=123)

There are differences of the return ratio to be measured between the project and non-project villages. The players in project villages returned 57.36 percent (std. dev. 0.25), while the non-project villages only returned a portion of 39.67 percent (std. dev. 0.26).[9] This difference is statistically significant at the one percent level (Mann-Whitney: $z = -3.432$, $p<0.0006$). The mode of the return ratio is also different. The mode in the villages that are not involved in the project is 33.3 percent. In the project villages, the mode is 66.6 percent. Figure 12 summarises the distributions of return ratios by project and control villages.[10]

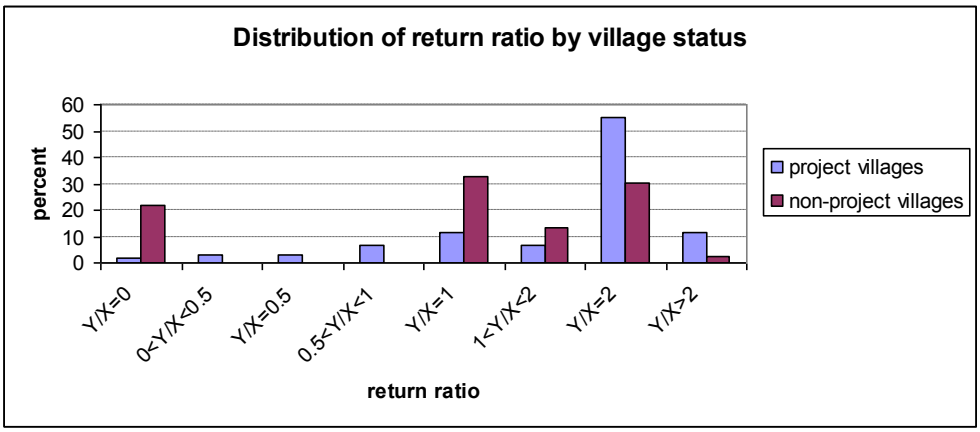

Figure 12: Distribution of return ratio of sender group by village status

A return ratio of two induces equal sharing of the investment gain, a ratio of three indicates, that the second player sent all the profit back to the first player. A return ratio of one indicates "balanced" reciprocity. Here, the first player is not better or worse off than before taking the

[9] Also the differences in means of tokens returned is significant at the one percent level (Mann-Whitney: $z = -7.199$; $p<0.00000$) and players in the project villages returned 4.55 tokens more on average.

[10] Seventeen players in group B did not receive any token from player A. Those are excluded from the analysis as the division by zero is not defined.

sending decision. This was the mode for non-project villages. A return ratio below one indicates that first players were making losses from trusting their community members. A return ratio of zero that indicates "no reciprocity" is found. This was true for 21.7 percent of the players in the non-project villages. In the project villages, a norm of reciprocating behaviour is found as players usually equally shared their gain with the first mover, so that both are better off than before.

All three experiments showed that cooperation levels in the villages that are involved in the community-based aquaculture project are significantly higher than in the control villages. Also trust is significantly higher in the project villages than in the non-project villages. Further, all introduced treatments have a positive effect on cooperation levels. *Communication* and *leadership* increase the cooperation levels in the PG game and contributions to the PG increase with the implemented institutions. Accordingly, *monitoring in combination with sanctioning* decreases free-riding in the CPR game and less fish is appropriated from the common pond in the respective rounds with monitoring.[11]

DISCUSSION

Two factors in regard to property rights are of special importance in the project context: the lack of a legal basis for exclusion of external users and the lack of water flow control. With the implementation of the project a restriction of access to certain parts of the water resources was intended, but turned out not to be enforceable. Although monitoring systems were introduced, the interference by project and non-project members could not be eliminated. Sanctioning systems were not in place, probably due to the fact that a legal basis for excluding potential appropriators was not (yet) given. Respective new, governance systems were not established. The project relied either on a strong informal support from all community members or on support from legal entities that could have formally limit access to certain areas. Both did not materialise. The second factor in regard to property rights that affects the project is the control over the water flow. In the Cambodian research sites, this is also a technical issue as highly developed built structures are not in place. There is no possibility to adjust water levels in a manner that is necessary for the fish culture. Farmers as well as producers of aquaculture are almost exclusively dependent on rain waters.

Further, several difficulties in regard to collective action were detected. The games have shown some of the solutions for the common dilemma in this field context. While during the games, high cooperation levels were reached in the communities, the project implementation was not satisfactory in that sense. Most of the project groups faced free-riding within the group and frustration about the low cooperation which led to discontinuance in three villages. However, although free-riding certainly also occurred in the games, they reveal that the willingness to cooperate is evident. Thus, also in the project framework, cooperation itself cannot be seen as the main factor for project failure. Larger groups, missing sanctioning systems, no secure benefits (as fish could escape, die or be stolen) and ineffective monitoring due to the size of the culture sites as well as a low motivation to guard the fish are the main differences between the reality and the games. In the project it was difficult to estimate and convincingly show future benefits of the project to the participants, while in the games they have been immediate and visible.

[11] For a detailed analysis of the three experiments using regression models to elaborate the factors influencing the cooperation on individual levels see Werthmann (2011).

The combined evaluation of the monitoring measures implemented by the farmers in the project context and the monitoring system in the games leads to another important finding. While there was a significant increase in cooperation reached through the implementation of the monitoring rule in the game, the monitoring in the project context was ineffective. In at least three of the four sites, fish was stolen by project members and other community members during the culture period, which reduced the profits substantially. Noteworthy, in the game situation the monitoring was associated with a sanction. Still, monitoring was imperfect in the game situation (probability of 1/6), but the fear of being sanctioned reduced appropriation levels. Players lost part of their income, when being "caught while poaching". Thus, the ineffectiveness of the monitoring in the project context is probably linked to the fact that both project members and non-members did not need to fear any consequences for poaching (and other offences like destroying nets). Additionally, social sanctions (e.g. exclusion from the group) do not seem to have been imposed during project implementation.

The ineffectiveness of the guarding, which was felt to be a high labour input, led to more free-riding and farmers reduced their individual efforts of monitoring. Consequently, this free-riding led to further frustrations in the group and project farmers themselves also started to increase their fishing efforts in the culture site again. Thus, cooperation can be described high in general terms and at the beginning of the project. But, as stated in theory, one person can spoil the game for everyone - when he free-rides, the others are also more likely to start free-riding. A missing functioning system that included monitoring and sanctioning is thus identified as the main factor for conflicts that arose.

CONCLUSIONS

Aquaculture activities always rely on the public water and as long it is not implemented in an area, where fishing by others can be prohibited (e.g. on homestead areas) the aquaculture producers face a situation where competing claims on the resource might occur. This is especially the case, when aquaculture is introduced in larger waterbodies that are usually accessed by many users. Thus, community-based (aquaculture) projects that introduce new governance systems on local levels are always confronted with already existing formal and informal (traditional) local institutions. Additionally, rules are not self-enforcing and depend on enforcement. This research has shown that the enforcement mechanisms have not worked well, challenged by the size of the waterbody and the amount of users that were needed to be monitored (and sanctioned).

It can be stated that the project was not very much efficient with natural, technical but also important institutional challenges described to be responsible for the low efficiency. The analysis has shown that the project interventions faced severe challenges due to external factors and that those in turn influenced the stability of cooperation among project members.

Collective action was required during the project implementation and project members as well as local resource users were found to face several challenges in regard to cooperation. Cooperation is high when benefits are obvious and immediate and farmers also cooperate in real life when incentives for cooperation are given. However, with this research it was shown that cooperation is often not perfect and can easily break down, when external factors influence the collective activities. It was also shown that instability of collective action can further deteriorate it. The frustration of being a victim of other's opportunism led to opportunistic behaviour of former co-operators as well.

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APPENDIX

Experimental designs

Experiment instructions were presented orally in neutral terms in Khmer or in Vietnamese respectively. 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. All games were arranged in a manner that reading and writing was not necessary for participation. The instructions included examples of possible actions and outcomes. However, participants were not instructed to maximise their earnings and no references to any specific strategy were made. For the PG and CPR games only post-experiment questionnaires were used to collect basic demographic information as well as to assess the understanding of the experimental design and decision tasks. A pre-experiment questionnaire was taken to collect basic demographic information. Here, in a post-experiment survey the understanding of the experimental design and decision tasks were assessed as well as information about action motives and expectations was collected. The trust game was not framed and did not receive any additional treatment.

Design public good game

For the PG game, a typical linear "Voluntary Contribution Mechanism" experiment (see Isaac and Walker 1988) was used, whereby players were asked to contribute to a PG – a dike construction. It was played for 20 rounds. Contributions were only announced after every round and only as group totals. After round ten as well as after round fifteen a different treatment was introduced, 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. For each round, players were given an endowment of ten tokens (1,000 Riel/10,000 VND) that could be kept in a private or invested in a public account (Isaac et al. 1984).[12] Tokens kept in the private account were immediately "private property", whereby contributions to the public account yielded a return to each group member - regardless of individual contribution. This marginal per capita return was 0.5 tokens. The following Figure 13 illustrates the game as played in the villages graphically.

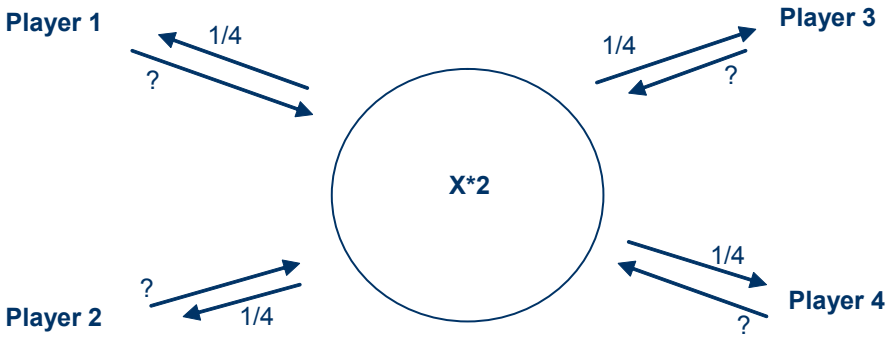

Figure 13: The PG game design

[12] The players thus received each ten notes (10x100 Riel notes or 10x1,000 VND notes) with 1,000 Riel = 0.25 US$ and 10,000 VND = 0.66 US$.

Summarising, the individual payoff function is:

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

with player i = {1, 2, 3, 4} and players j = {1, 2, 3, 4}; x = amount of tokens; amount of players n = 4; a = initial endowment

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-maximising outcome, however, is realised 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 (treatment 1). 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. After another five rounds, a *leader* was chosen from the group (treatment 2). 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, after the four minutes of communication and before the decision, the leader will have the opportunity to set a rule about how much to contribute. However, like in all rounds, players were told again, that individual decisions will be made independently, in private and kept confidential. The results of the PG game are presented in the next section.

Design common-pool resource game

For the second experiment a CPR game (Ostrom, Walker et al. 1992, Walker and Gardner 1992) was used. It was framed as well and players were asked to appropriate fish from a common pond. After having conducted a pre-test, it became obvious, that the implementation of a CPR game representing the concave function of the payoffs for each of the player is too difficult to understand for the participants. Thus, there was a necessity to simplify the game so that also less educated players can participate. The game was therefore created in a manner disregarding the decreasing marginal return of each player, but including a dominant strategy. The CPR game was composed as follows: A pond was endowed with 40 units of fish in each round and players decided to extract units of fish to the private account or leave it to the public account. Tokens appropriated were immediately private gains, whereby fish units left in the common pond yielded a return to each group member. The following Figure 14 illustrates the game with four players graphically.

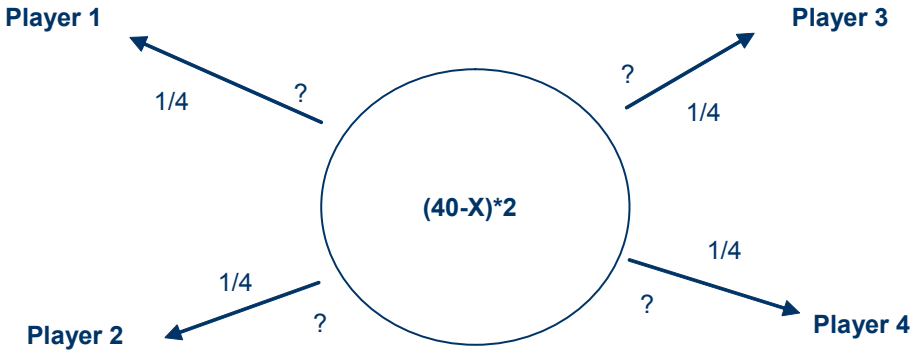

Figure 14: The CPR game design

Thus, also here, regardless of appropriation levels of individual players, each fish unit left in the pond is rewarded by the amount of 0.5 tokens. Thus the marginal per capita return is 0.5 tokens. If the total appropriation by the group is more than 40 units of fish, no player received any reward. Accordingly, the individual payoff function in the CPR game is:

$$g(x_i) = \begin{cases} \dfrac{2(40 - \sum_{j \neq i}^{n-1} x_j - x_i)}{n} + x_i, if \sum_{i=1}^{n} x_i < 40 \\ 0, if \sum_{i=1}^{n} x_i > 40 \end{cases}$$

with player i = {1, 2, 3, 4} and players j = {1, 2, 3, 4};
x = amount of tokens; amount of players n = 4

Thus, also here in the (simplified) CPR game, free-riding is the dominant strategy. Because the private reward of appropriating from the CPR is higher than reward when not appropriating, every individual has a dominant incentive to appropriate from the resource. This results, however, in the Nash-equilibrium and the inefficient use of the resource. At the social optimum, all players would not appropriate any unit and would thus all be better off.[13]

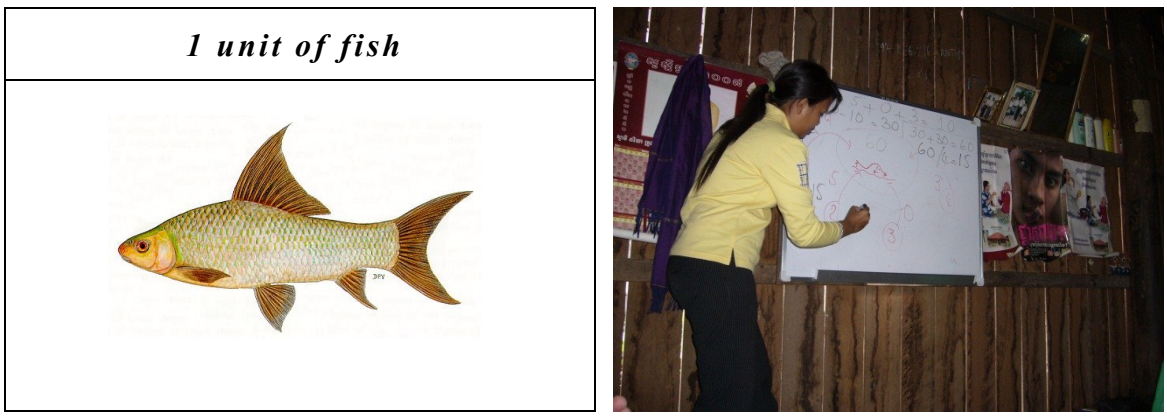

Figure 15: Game cards and facilitator explaining CPR game in Cambodia

[13] In reality, zero appropriations as a social optimum are not often found. However, this point as optimal appropriation rate was used in order to again simplify the game for the participants. Further, the argument was used in regard to the project. When every group member in the group waits until the fish is harvested all together (thus appropriates zero until the harvest season), fish will be larger and thus yields the best market price.

After ten rounds, a monitoring system was introduced (treatment 3). 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. With a probability of one to six an external monitoring of all players occurred. Every player who appropriated more than zero units from the common pond received a fine of four times the units the player appropriated.[14] These units were then subtracted from the players' total payoffs. Sanctioned players also did not receive shares from the common pond in the respective round. After 20 rounds, the end of the game was announced and players received money for each token they gained during the game.[15] The next section presents the results of the CPR game.

Design trust game

The trust game was designed according to BERG ET AL. (1995). In each village, the players were divided into two groups of equal size: the sender group (group A) and the responder group (group B). The sender as well as the responder each received an initial endowment (x) of four tokens.[16] Players in the sender (investor) group A could decide to keep the initial endowment or to send an amount of tokens y ($y = \{0,1,2,3,4\}$) to an unknown player in the responder (trustee) group B. The amount kept immediately turned into a private yield of player A. The amount sent was tripled by the experimenter and then given to the trustee. Player B thus had his initial endowment (x) of four tokens plus the tripled amount of tokens sent by the unknown player A (3y). Player B then decided how many tokens she or he wants to keep and if and what amount $z = \{0,1,...,16\}$ she or he wants to send back to the respective player in group A. All tokens kept, turned into private property of player B, all tokens sent immediately became private property of the respective player A. The games thus consisted of only two rounds in total with each player making one decision. The following Figure 16 illustrates the trust game procedure graphically.

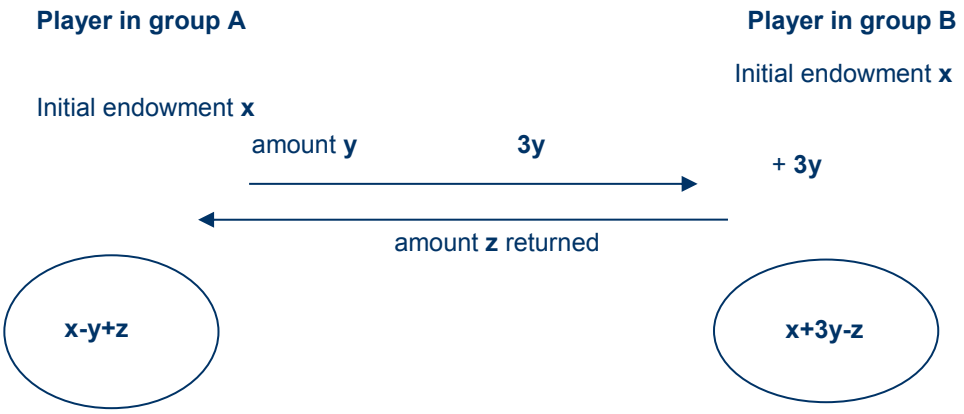

Figure 16: Trust game design

[14] One unit extracted was punished by four units, two units by eights units of fish and so on.
[15] One unit of fish was equal to 100 Riel (0.25 US$) or 10,000 VND (0.63 US$).
[16] This does not correspond directly to the design of BERG ET AL. (1995) as in the games presented here players in group B also received an initial endowment of four tokens. One token accounts for 100 Riel (0.25 US$) in Cambodia and 10,000 VND (0.63 US$) in Vietnam.

Summarising, the individual payoff function for player A and player B respectively are:

$g_a(y,z) = x - y + z$

$g_b(y,z) = x + 3y - z$ with amount sent $y = \{0, 1, 2, 3, 4\}$ and the amount returned $z = \{0, 1, 2,\ldots,16\}$; the initial endowment of $x = 4$

Players were not allowed to communicate before their decision within neither the groups nor between groups. Groups were placed into different rooms or houses during the game. A third room was reserved for the individual decision situation where each player entered, one by one, to hand over the sealed envelopes with the amount they wanted to send to player B. These envelopes were kept by the facilitators and transferred to the responders in group B in a predetermined manner that was unknown to the players themselves. The players in group B then took their decision, also in private and with sealed envelopes. All players received their money privately and in cash.