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The effect of information in a behavioral irrigation experiment

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ABSTRACT

When governing shared resources, the level and quality of information available to resource users on the actions of others and the state of the environment may have a critical effect on the performance of groups. In the work presented here, we find that lower availability of information does not affect the average performance of the group in terms of their capacity to provide public infrastructure and govern resource use, but it affects the distribution of earnings and the ability to cope with disturbances. We performed behavioral experiments that mimic irrigation dilemmas in which participants need to maintain infrastructure function in order to generate revenue from the use of water. In the experimental design, there is an upstream–downstream asymmetry of access to water that may lead to unequal access to water. We find that inequality of investment in irrigation infrastructure and water appropriation across players is more pronounced in experiments where resource users have limited information about the actions of others. We also find that inequality is linked to the ability of groups to cope with disturbances. Hence a reduced level of information indirectly reduces the adaptive capacity of groups.

1. Introduction

It is well known that groups can overcome collective action problems in sharing common pool resources when they can engage in self-governance [1]. This has not only been observed in real-world case studies, but also replicated in controlled behavioral experiments [2]. Communication and the ability to enforce rules have been found to be critical factors that enhance the ability of groups to self-govern shared resources [3,4].

In this paper we focus on the ability of groups to self-govern their resources in the face of disturbances. Previous experimental studies that combine common pool resources and disturbances assumed symmetric access to the resource and no communication [5,6]. We are interested how capacity for self-governance is affected by constraints on information and communication in a system with asymmetric access. The question of the ability of groups to self-organize in the face of disturbances is a critical one because climate change and globalization are increasingly challenging the capacity of small-scale social-ecological systems (SESs) to function [7]. A particularly critical group of such challenged SESs is irrigated agriculture that covers 40% of the world's agricultural land which are the focus of this paper [8].

The work presented here represents the latest stage in a sequence of controlled experiments with farmer and student participants that systematically add biophysical complexity to better understand governance of social dilemmas in irrigation systems – what we will hereafter refer to as "irrigation dilemmas" [9–12]. The irrigation

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dilemma captures situations in which farmers at the tail-end or head-end can experience differences in their influence on the collective action problems related to the maintenance of the irrigation system and allocation of water [9]. The fundamental problem facing irrigation systems is how to solve two related collective action problems: (1) provisioning for the resource, such as in building and maintaining physical infrastructure, and (2) the asymmetric common-pool resource dilemma, where the relative positions of resource users at the head and tail of the system generate asymmetric access to the resource [9]. If actors act as selfish, rational economic agents, we cannot expect irrigation infrastructure to ever be created. Even if the initial problem of providing the infrastructure were solved and water is made available, the head-end user may not necessarily share water with the tail-ender.

In earlier experiments we have shown that participants, farmers and student participants, are able to overcome the irrigation dilemma in experimental settings [10,11]. A key explanatory factor for these findings is the trust that participants have in other community members. Furthermore, the ability of tail-enders to sanction overuse of water by upstream participants by reducing their investments in public infrastructure is consistent with Ostrom's second institutional design principle that requires a good fit between appropriation and provision rules and the local context. These same mechanisms have been found in experimental treatments involving farmers as well as university student participants. Anderies et al. [12] introduced shocks to the infrastructure and variability in water availability. The groups consisting of 5 players who could communicate, were still effective in solving the collective action problems. However, we did find some subtle and interesting differences between the treatments with and without variability (uncertainty). First, the understanding of the experimental environment, measured through answers to quiz questions, made no difference in group performance without disturbances but it did after we introduced the disturbances. Second, more inequality in earnings during the first 10 rounds without disturbances was a highly significant predictor for less cooperation by the group when exposed to disturbances in water availability or infrastructure levels in the second 10 rounds.

In this paper we extend the experimental setting once again and constrain information availability and communication. The original irrigation dilemma experiments were inspired by small-scale irrigation systems where all the individuals could communicate with one another (e.g. a steep, small systems with 100–200 households in mountainous terrain). In such circumstances, the biophysical context has a strong influence on information availability because individuals work in close proximity (e.g. 100 households on 100 ha) and can observe each others' actions [13]. Some irrigation systems, on the other hand, are extremely large, e.g. the Kurnool–Cuddapah (KC) canal in state of Andhra Pradesh in India irrigates about 120,000 ha and is about 300 km long [14]. In this case, not all users can communicate with, and see the action of others. As such, the biophysical context strongly influences the information availability. Besides the biophysical context, information availability is also affected through an increased integration of irrigation communities with the globalizing economy. On the one hand, farmers have less information due to the increasing number of absent farmers who work in wage labor jobs in urban centers, or spend time on the pleasures of modern entertainment (TV). On the other hand, mobile phone and other telecommunication technologies enable people to communicate at low cost between more distance places. In our study presented here, we manipulate the experimental environment to mimic this very issue. What if participants are not able to see the actions of all other participants and cannot communicate with all of them? Will groups still be able to self-organize?

It is important to realize that we use experiments to test hypotheses using social dilemmas inspired by problems observed in irrigation systems. We do not perform experiments intending to mimic "real" irrigation systems. But although experimental designs look at very simplified situations, we are able to zoom in particular attributes of the problem and test causal relationships. This help to advance theory, especially when it is replicated in subsequent studies.

We use behavioral experiments to address the question of the effect of information. This enables us to look at fundamental drivers of decision making in typical conditions that many small scale irrigation communities face. Results from earlier social dilemma – not irrigation dilemma – experiments suggest that limiting the information will affect the experimental outcomes [15,16,17]. Since the majority of participants act in experiments as if they are conditional cooperators, information availability affects the expectations participants have and therefore their tendency to cooperate [18]. We also know that communication is increasing cooperation in social dilemma experiments. Hence we expect that limiting the information of what others do, and limiting the abilities to communicate directly with every other participant, will lead to a reduction of cooperation. Hence our first hypothesis we will test in this study is

H1. Limited information lead to less cooperation and lower earnings per person compared to the full information treatment.

A second hypothesis builds on the first hypothesis and evaluates the consequences of constraining communication in rounds with environmental variability:

H2. Limited information leads to less cooperation and lower earnings when groups cope with environmental variability compared with groups who have full information.

2. Experimental design

Five participants are randomly allocated to different positions, A, B, C, D and E, related to the position along an irrigation canal (A= upstream, E= downstream). Participants play 20 rounds (i.e. growing seasons) where each round consists of three stages. In the first stage, participants are allowed to communicate via text messages in a chat room for 40 s. In stage 2, participants must make a