Documentos CEDE

ISSN 1657-7191 Edición electrónica.

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07

FEBRERO DE 2015

Universidad de los Andes
Facultad de Economía

CEDE
Centro de Estudios sobre Desarrollo Económico

Serie Documentos Cede, 2015-07
ISSN 1657-7191 Edición electrónica.

Febrero de 2015

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Edición y prensa digital:
Cadena S.A. • Bogotá
Calle 17 A Nº 68 - 92
Tel: 57(4) 405 02 00 Ext. 307
Bogotá, D. C., Colombia
www.cadena.com.co

Impreso en Colombia – *Printed in Colombia*

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Vertical Collective Action: Addressing Vertical Asymmetries in Watershed Management[1]

Juan-Camilo Cardenas[a], Luz Angela Rodríguez[b], Nancy Johnson[c]

Abstract

Watersheds and irrigation systems have the characteristic of connecting people vertically by water flows. The location of users along these systems defines their role in the provision and appropriation of water which adds complexity to the potential for cooperation. Verticality thus imposes a challenge to collective action. This paper presents the results of field experiments conducted in four watersheds of Colombia (South America) and Kenya (East Africa) to study the role that location plays in affecting trust and cooperation in decisions regarding to provision and appropriation of water. We recruited 639 watersheds inhabitants from upstream, midstream and downstream locations in these basins and conducted two field experiments: the *Irrigation Game* and the *Water Trust Game*. The *Irrigation Game* (Cardenas et al, 2013; Janssen et al, 2011) involves decisions regarding to the provision and appropriation of water where the location in the system is randomly assigned. The *Water Trust Game* is an adaptation of the trust game (Berg et al 1995) framed around water and economic compensation flows where we explicitly reveal the actual upstream or downstream location of the two players. The results of the two games show that location affect water provision and distribution and that reciprocity and trust are key motivations for upstream-downstream cooperation. Yet, both experiments also suggest that the lack of trust from downstream players towards upstream players may restrict the possibilities of cooperation among watershed users.

Keywords: Collective Action, Verticality, Watersheds, Field Experiments, Irrigation Game, Trust Game, Water Trust Game, Payments for Environmental Services, Colombia, Kenya.
JEL Classification: Q0, Q2, C9

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[1] We wish to thank seminar participants at CREED-Columbia University, ICARUS- Michigan University, ASFEE-Martinique, Universidad de los Andes-Bogotá, CBEES-East Anglia and to the field team and participants in the data collection. The work presented in the paper was conducted as part of the project "Sustaining Collective Action that Links Economical and Ecological Scales" (SCALES-PN20) of the CGIAR Challenge Program on Water and Food, led by the Centro Internacional de Agricultura Tropical (CIAT) and partners such as Universidad de Los Andes, World Wild Fund (WWF) Colombia, Corporación Semillas de Agua, Fundación Humedales and the World Agroforestry Centre (ICRAF).

Acción Colectiva Vertical: Enfrentando las asimetrías verticales en el manejo de cuencas

Juan-Camilo Cardenas[a], Luz Angela Rodríguez[b], Nancy Johnson[c]

Resumen

Las cuencas hidrográficas y sistemas de riego tienen la característica de conectar a las personas verticalmente por las corrientes de agua. La ubicación de los usuarios a lo largo de estos sistemas define su papel en la provisión y apropiación del agua lo que añade complejidad a las posibilidades de cooperación. Así, la verticalidad impone un desafío adicional a la acción colectiva. Este trabajo presenta los resultados de experimentos de campo realizados en cuatro cuencas de Colombia (América del Sur) y Kenia (África Oriental) para estudiar el papel que desempeña la ubicación en afectar la confianza y la cooperación en las decisiones relativas a la provisión y apropiación del agua. Participaron 639 habitantes de partes altas, medias y bajas en cuencas en dos experimentos de campo: el Juego de Riego y un Juego de Confianza y Agua. El Juego de Riego (Cárdenas et al, 2013; Janssen et al, 2011) implica decisiones con respecto a la provisión y apropiación del agua en la que se asignó al azar la ubicación en el sistema. El Juego de Confianza y Agua es una adaptación del juego de confianza (Berg et al 1995) enmarcado en torno al agua y la compensación económica como flujo económico donde revelamos explícitamente la ubicación real aguas arriba o aguas abajo de los dos jugadores. Los resultados de los dos juegos muestran que la ubicación afecta a la provisión y distribución de agua y que la reciprocidad y la confianza son las motivaciones principales para la cooperación entre los de abajo y los de arriba en la cuenca. Sin embargo, ambos experimentos también sugieren que la falta de confianza de los jugadores aguas abajo hacia aquellos jugadores aguas arriba puede limitar las posibilidades de cooperación entre los usuarios de las cuencas hidrográficas.

JEL Classification: Q0, Q2, C9

Palabras claves: Acción Colectiva, Verticalidad, Cuencas, Experimentos en campo, juego del riego, juego de la confianza, Pagos por Servicios Ambientales, Colombia, Kenya.

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Introduction

Watersheds are systems that link people vertically through water flows. Water, and the externalities associated with its exploitation and pollution, flows unidirectionally from upstream to downstream areas. Watersheds hence involve asymmetric relationships among participants as access to clean water is determined by their physical location. Similar to irrigation systems, those who are physically near the head of the system (headenders) have first access to water while those physically distant (tailenders) suffer the consequences of the decisions made in upper locations. This situation leads to a suboptimal equilibrium in which the headenders contribute more to the provision and get most of the clean water, generating underprovision of the resource downstream and under-maintenance of the system (Ostrom and Gardner, 1993). Verticality hinders collective action because location determines key differential behavioral elements for decision making regarding intentions, beliefs and outcomes.

Trust, reciprocity and reputation – the core relationships of collective action (Ostrom, 1998) - are key mechanisms in situations that involve externalities and coordination failures and these mechanisms are enhanced by the awareness about the mutual dependence among participants (Ostrom and Gardner, 1993). Nevertheless, watersheds are complex systems characterized by heterogeneous actors, with different interests, political power and economic resources (e.g. farmers, livestock keepers, mining companies, municipal land use planners, and urban water suppliers) who as a result of their social and physical distance have limited or sometimes no interactions that would enable them to build trust and resolve conflicts (Swallow et al 2006). Therefore, although watershed users are interdependent across social and biophysical scales, the asymmetries in access to clean water and the diversity of interests involved in decision-making makes watersheds management very challenging.

In this study we conducted new experimental games in the field with the participation of rural inhabitants of four watersheds in Colombia (South America) and Kenya (East Africa). Through these experiments, we explore how location affects cooperation, trust and reciprocity in decisions regarding water provision and appropriation. We recruited 639 watersheds inhabitants from upstream, midstream and downstream sites and conducted two field experiments: the *Irrigation Game* (Cardenas et al, 2013; and Janssen et al, 2011) and the *Water Trust Game.* The *Irrigation Game* includes decisions regarding provision and appropriation of water and random assignment of the location in the system. The *Water Trust Game,* on the other hand, is an adaptation of the investment game (Berg et al, 1995) framed around water and monetary compensation flows where we explicitly reveal the actual upstream or downstream location of the two participants. The results of the two games show that location affects water provision and distribution and that reciprocity and trust are key motivations for upstream-downstream cooperation. Yet, both experiments also suggest that the lack of trust from downstream players towards upstream players may restrict the possibilities of cooperation among watershed users.

The next section of the paper summarizes the literature related to the effect of verticality in collective action. Section 3 describes the experimental setting, design and implementation. Data analysis and results are presented in Sections 4. Section 5 concludes the paper with an analysis of the results and a discussion of future research.

1. Verticality in Collective Action

The actions of people living in the upstream areas of watersheds affect those downstream far more than people downstream can directly affect those upstream. Upstream people have the possibility to take water of better quality than people downstream and they generate flows of soil and pollutants that affect downstream populations. Since the vertical location of the individuals along the water system determines their access to the resource – appropriation –, their willingness to cooperate to the system maintenance – provision – is also affected by location. Such a vertical relationship among actors also characterizes irrigation systems: *"In large-scales, centrally constructed irrigation systems, the headenders and the tailenders are in very different positions. Narrowly selfish headenders would ignore the scarcity that they generate for those lower in the system. But if the headenders get most of the water, those at the tail-end have even less reason to want to contribute to the continual maintenance of their system. All common-pool resources generate both appropriation and provision problems. In an irrigation common-pool resource, the appropriation* *problem concerns the allocation of water to agricultural production; the provision problem concerns the maintenance of the irrigation system. In addition, irrigation common-pool resources also have an asymmetry between headenders and tailenders, which increases the difficulty of providing irrigation systems over time"* (Ostrom and Gardner, 1993, p. 96).

Thus, the incentives faced by the people along the water system are different. The higher the position, the bigger the incentives to contribute to the water system maintenance. The behavioral pattern over time is such that the headenders contribute more labor and get more water than the tailenders (Ostrom and Gardner, 1993). Hence, water access asymmetries in irrigation systems can obstruct the possibility to cope with the common-pool resource dilemma but these asymmetries can be overcome if participants are aware of their mutual dependencies. For example, headenders may need the labor provided by tailenders to keep the system operating (Ostrom and Gardner, 1993) and therefore it will be more likely that they correspond to tailenders needs when their contributions are essential to the maintenance of the water system (Lam, 1998). Headenders behave as stationary bandits[2] if they make unfair appropriation of water, tailenders can reciprocate by reducing their contributions. Inequality in resource appropriation is thus bounded by the amount of inequality tailenders will tolerate (Janssen et al, 2011).

Such interdependences between the head and the tail of the system may be less obvious to watersheds actors given the unidirectional flow of externalities. Upstream people have a prime role in clean water allocation since they have first access to water supply. However, they receive no benefits from adopting water and land use practices that enhance downstream clean water availability. Downstream people, on the other hand, benefit from upstream people's cooperative behavior but they may not be in a position to reciprocate such behavior. Nevertheless, upstream-downstream interdependences explain, for example, the cooperative behavior that characterized the historical evolution of irrigation systems, rice terraces and water temples in Bali which was related to water sharing and pests' control. While upstream communities were more concerned about pests' outbreaks, downstream

[2] The metaphor of stationary bandits was developed by Olson, M (1993) and used by Janssen et al (2011) to explain the behavior of headenders in irrigation systems.

communities were more concerned about water shortages so coordination through cropping patterns was the response to this interdependence (Landsing and Kremer, 1993).

Anthropologists studying the pre-Columbian Andean cultures have identified the important role that vertical relations played, through myths, in the understanding of the relationships between high mountains and the regions downstream (Murra, 1972, 1985; Osborne, 1985, 1990). The combination of a tropical location along with the Andean geography created certain conditions where the interdependence between actions upstream and well-being downstream for social groups became a major concern in the management of land, agriculture and trade. Murra (1972) developed a model of verticality or ecological complementarity to explain the complexity with which the Andean cultures developed a system of natural resource management based on the complementarities of the high lands and the low lands. For such system to work, it was important to coordinate the actions upstream and downstream with the basin as a whole management unit. However, much of the agricultural land in mountainous regions around the world today is managed through systems of private property rights and eventually some higher level management based on institutional arrangements by regional or local governments attempting, rather weakly, to regulate land uses along the watershed.

In these contexts of individual land use decisions, institutional arrangements that build on the upstream-downstream interdependences could happen as water-for-money exchanges – e.g. payments for environmental services (PES) - or other mechanisms that work as reverse flows (Swallow et al, 2006). Nonetheless, unless such exchanges or other agreements among users at different locations were perfectly enforceable – which in general is not the case –, their realization would depend on their ability to build the core relationships of trust, reciprocity and reputation (Ostrom, 1998). Empirical evidence has demonstrated the importance of institutional arrangement that preserve the mutual dependencies and reciprocal relationships among participants as in self-governed irrigation systems as opposed to government managed systems (Ostrom and Gardner, 1993; Lam, 1998; Araral, 2009). Factors such as social heterogeneity and landholding inequality are negatively associated with collective action in irrigation systems (Fujie et al, 2005; Araral, 2009, Dayton-Johnson, 2000) whereas the density of social interactions (Fujie et al, 2005; Araral, 2009) and social capital

(Knox et al, 2001; Meinzen-Dick, 2007) are positively related with cooperation. Distributive rules that lead to an equal division of water are associated with higher levels of cooperation (Dayton-Johnson, 2000) which demonstrates that the solution of the provision problems in asymmetric commons depends on how well appropriation problems are solved (Ostrom, 1990).

Verticality – and more generally asymmetry in appropriation - hence adds complexity to the collective action dilemmas related to common-pool resource management. This paper is an attempt to build on the discussion of the factors that affect cooperation in asymmetric common-pool resources using field experiments. In particular, it is aimed at exploring the effect that vertical asymmetries on water access have on trust and cooperation for water provision and distribution in watersheds.

2. Experimental design and implementation

Economic experiments have been increasingly applied to study the factors that enhance or hinder collective action in common-pool resources dilemmas and public goods. Social distance, inequality and heterogeneity affect cooperation (Cardenas et al, 2002, Cardenas 2003, Hackett et al, 1994) whereas face-to-face communication has been proved as a powerful tool to reach and sustain cooperation in these situations (Ostrom, 2006; Cardenas et al, 2004). As discussed before, in asymmetric commons dilemmas, inequality in resource access affect the incentives of participants to cooperate in the provision of the resource. Therefore, in this paper we explore the effect of location in situations that involve vertical interactions in water systems. We develop a framed field experiments strategy[3] conducted in real settings of water users in Colombia and Kenya. The provision and appropriation nature of water and the asymmetries in access due to location are tackled using the *Irrigation Game,* while trust between actual upstream and downstream players is explored in the *Water Trust Game,* an adaptation of the trust game framed around water and reverse

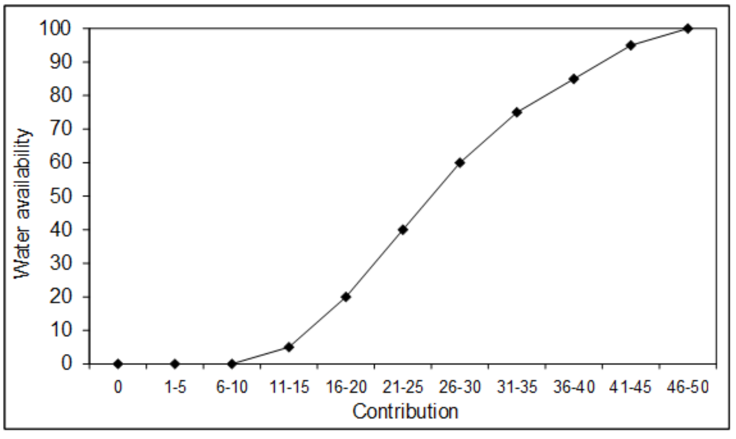
[3] See Harrison G. and L. List (2004) for a taxonomy of field experiments. According to their classification framed field experiments are those developed with nonstandard subjects pool (no students), and that have a field context in either the commodity task, or information sets that the subjects can use.

monetary compensations similar to a Payments for Environmental Services PES-scheme interaction.

3.1. The Irrigation Game

Common-pool resource systems face both provision and appropriation dilemmas. Provision refers to the actions done to create, maintain and improve the resource system and avoid its destruction while appropriation has to do with the allocation of the resource units among users (Ostrom, Gardner and Walker, 1994). In asymmetric commons like irrigation systems, inequalities in the appropriation of the resource affect the incentives to cooperate on its provision (Ostrom and Gardner, 1993) and therefore the setup of the irrigation game involve both provision and appropriation decisions (see Cardenas et al, 2013; Janssen et al 2011). In each round of the game, participants first decide how many tokens of their endowment of ten contribute to the maintenance of water canals (public fund). The amount of available water for the group depends on the total contributions according to a monotonic function of water production (Figure 1).

Figure 1 – Water production as function of units invested in the *Irrigation Game*



Non contributed tokens are kept in a private account which yields private returns. The second decision of the players is the individual water extraction from the total water produced. This decision is taken according to the location of the players along the water canal, and in a sequential manner. The sequence is determined randomly and is represented by a letter: A for the player in the first position and E for the player in the last position. Each group has therefore five participants experimentally assigned to positions in the water systems that go from upstream to downstream according to the letters A, B, C, D and E. Participants hold their experimental positions throughout the game. Water available for players downstream in the canal depends on the water left by players upstream. Given the structure of the incentives and the sequence of the game, backward induction would predict that players should not invest any token into the public fund, which in turn would yield no water for the group. On the other hand, social output could be maximized by every player contributing the entire endowment, yielding a total amount of 100 units of water. In the selfish strategy of zero contributions the social efficiency would be of 50% compared to the maximum 100% efficiency achieved by full cooperation. Notice, even if player A is strategically interested in maximizing her own payoffs, she would be worse off by investing all her tokens because a total contribution of 10 tokens would not suffice to produce enough water unless others were able to contribute.

Ten rounds of baseline treatment are played after which a new set of rules is established for ten additional rounds. Some groups were permitted to communicate – to resemble self-governed solutions- while other face external regulations and other groups continued playing with the baseline conditions. In the **face-to-face communication** treatment, players were allowed to talk with the other players in the group before returning to their places to make their own private decisions. In the **external regulation treatments,** a regulation on the limit of water to extract is imposed – 20 percent of total water produced – and such regulation is imperfectly monitored and enforced. The experimenter rolls a dice in front of the participants each round and if the number obtained is 6, all the participants are inspected, so the probability of being inspected is 1/6. In this case, the monitor checked the decision of all the players and the players that had taken more water than the permit level pay a fine. In the high penalty treatment, the fine is the extra amount taken plus six units of the cumulate earnings; in the low penalty treatment the fine is just the extra amount taken. As in the baseline, in the treatments participants know the aggregate contribution and water availability but not the individual decisions.

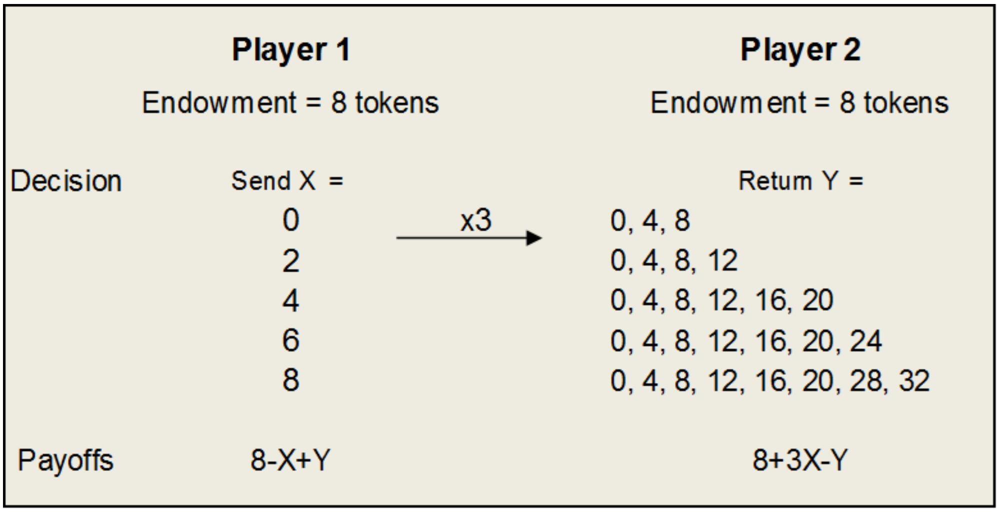
3.2. The Water Trust Game

Unlike irrigation systems where headenders need the cooperation of tailenders to keep the system working, the unidirectional flow of externalities in watersheds entails that reciprocation or signaling from downstream to upstream may not evolve spontaneously and therefore needs to be facilitated through 'reverse flows' such as economic compensations (Swallow et al, 2006). Based on the standard trust game (Berg et al 1995), we construct our *Water Trust Game (WTG)* in such a way that the experimental transaction between upstream and downstream player resembles a payment for environmental services interaction. In this game, player 1 (trustor) and player 2 (trustee) are endowed with *X* tokens. Player 1 chooses how many tokens to transfer to player 2 who receives this amount tripled. Then, player 2 decides how many tokens of its endowment plus the tripled transfer return to player 1.

Since we are interested in exploring the effect of location in trust and reciprocity, the only piece of information we reveal to each player is the location of his partner in the watershed (upstream or downstream). Therefore location of participants is common knowledge in this experiment. Additionally, we explicitly framed the decisions of players upstream as the quantity of clean water sent to player downstream and the decisions of players downstream as an economic compensation for the water received. We implemented the four possible permutations of pairs to control for location of both sender and responder: player 1 upstream and player 2 downstream, player 1 downstream and player 2 upstream, both players upstream and both players downstream.

We implemented the strategy method by asking conditional return decision of player 2 to each possible offer made by player 1 since strategy method provides a full description of the responder's return function. Initial endowments were set at 8 tokens and to ease the task, player 1's offer was constrained to multiples of two and player 2's response to multiples of four (figure 2).

Figure 2 – Description of the *Water Trust Game*



3.3. Recruitment and implementation

We recruited 639 watersheds inhabitants from upstream, midstream and downstream locations of Coello River and Fuquene Lake watersheds in Colombia and Awach and Kapchorean Rivers in Kenya[4]. Those basins are of policy importance in their respective countries in terms of their ecological and socioeconomic relevance[5]. The *Irrigation Game* was conducted with a sample of 355 participants and the *Water Trust Game* with a sample of 284 participants in 142 pairs. The field work was developed during January 2006 and July 2007.

The experimental session for the irrigation game was implemented in groups of five people, usually living in the same village. The recruitment was made as wide as possible in the villages and we recruited people by written or verbal invitation through community leaders some days before the experiment. All adults who showed up were accepted for participating and we distributed them randomly into sessions. Only one member of the same family was allowed to participate in a session. After the instructions were presented and three practice rounds were completed, each group played during ten rounds under the baseline

4 These basins were part of the project titled "Sustaining Collective Action that Links across Economic and Ecological Scales" of the CGIAR Challenge Program on Water and Food.

5 For a description of the context of the watersheds in the study see Cardenas et al (2011). Appendix 1 presents socio-demographic characteristics and perceptions based on a surveyed administered to participants after experiments.

conditions. Ten additional rounds were played under a different set of rules as explained in the previous section. Assistants helped those participants who had difficulty with reading, writing or arithmetic.

The recruitment strategy for the water trust game was different since we wanted to test the effect of real location of people. Therefore, we simultaneously recruited a pair of upstream and downstream participants of the same watershed. One facilitator was located with the participant upstream and the other facilitator with the participant downstream. Upstream and downstream sites are located far apart, in distances that cannot be covered in less than 45 minutes by car. Facilitators were connected through cellular phones and once participants agreed to participate they communicate to each other to start reading the instruction. Supporting material with all possible outcomes under each potential decision scenario was presented to participants (see appendix 2 for a sample of the supporting material). Following reading the instructions, explanation of supporting material, and several examples, participants were asked control questions about the distribution of payments under different hypothetical amounts sent by player 1 and returned by player 2 to make sure they understood the task and potential results of their decisions. Only after all experimental decisions were made and written down in the decision form, facilitators communicated by cell phones to determine outcomes. Since we applied the strategy method, the respective facilitator collected one decision in the decision form in the case of player 1 and five decisions for player 2 – amount sent back under each conditional offer – before they communicated results to each other. During the session we also collected information about expectations of transfers and other survey data.

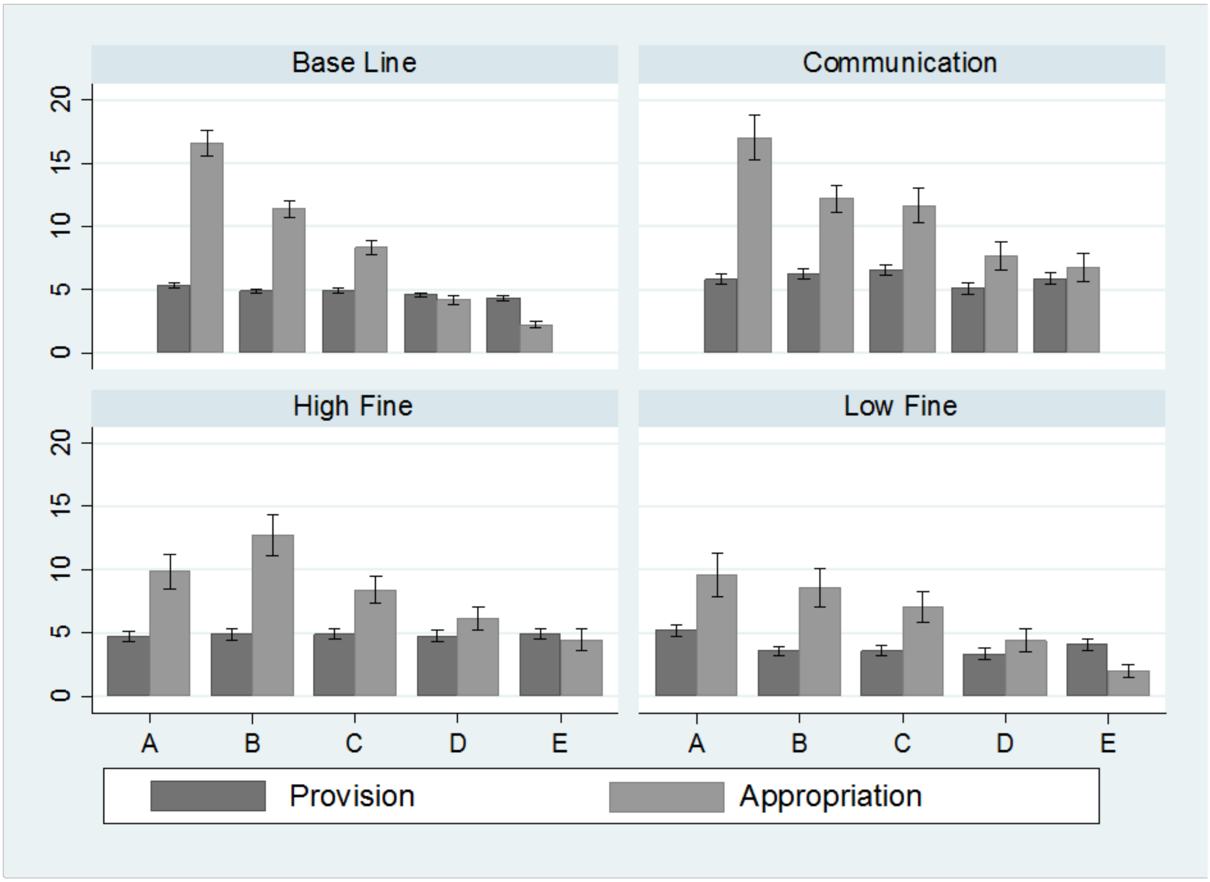
3. Empirical results

4.1 Irrigation Game

The analysis shows that the average contribution in the irrigation game was 4.82 tokens (48.2% of players' endowment) for the ten initial rounds. Groups that were allowed to communicate increased their average contribution to 5.9 while groups in the penalty treatments obtained an average contribution of 4.83 for high penalty and 3.96 for low penalty (see more in Cardenas et al, 2011). However, the average contribution hides an important piece of information of our analysis. These are the averages of five players who are located asymmetrically along the watershed, with contributions being monotonically greater the higher is the location of the player in the irrigation system. As we go downstream, the average contribution of players reduces substantially. While average contribution of player A – the player located in the head of the system - was 5.31 tokens under the baseline conditions, average contribution of player E – the player in the tail - was 4.33. Extraction patterns reveal considerable inequality in water access with people located upstream getting most of the water and player E even obtaining fewer points than contributed. Average appropriation of player A in the baseline was 16.57 units whereas for player E it was 2.22 units.

Recall that these locations are assigned randomly at the start of each session and remain constant throughout the game. The results suggest that as one individual is assigned a unit further down in the irrigation system, her willingness to contribute to the public fund that provides water for all players decreases, affecting the possibilities of building collective action along the watershed. However, the type of institution applied defines the persistence of the situation of remarked differences or more homogeneity in contribution and distribution. The comparison of the behavior of the players regarding contribution and extraction by institution is in Figure 3.

Figure 3 –Provision and appropriation decisions, by player location and treatment



Communication increased contribution as in public goods and common-pool resources experiments (see Ostrom, 2006 and Cardenas et al, 2008). Although external regulations had a positive effect on water distribution, they crowded-out cooperative behavior in provision decisions. Similar results have been found in common pool resources games, where external regulations crowded-out group-oriented behavior in favor of self-interest (see Cardenas et al, 2000). In particular, the high-penalty did not have a significant effect in contribution while the low-penalty had a negative effect which is a little surprising since the penalty was aimed at extraction decisions and not at contribution decisions.

We also explore the effect of experimental location in provision and appropriation decisions in this asymmetric common-pool resource conducting a regression analysis to control for experimental conditions, contextual and individual characteristics. Provision is measured as the percentage of individual endowment of 10 tokens contributed to the production of water while for appropriation we constructed a measure to account for the fact that water available for each player depends on the water that he or she receives. Then, the dependent variable that we use to explore extraction decisions is the percentage of water extracted from what would be the equal share of the remaining water. If for example, player C receives 30 units of water, the equal share would be 10 units for each of the remaining players (C, D, E). If player C extracts 15 units, then the fraction of the equal share that he would be extracting is 1.5. We run robust standard errors fixed effects models where the fixed effects captured each of the particular 71 groups of five participants. Table 1 presents the regression results for both provision and appropriation decisions.

Table 1 – *Irrigation Game,* Fixed-effects OLS model contribution and extraction decisions

	Provision			Appropriation		
	(1)	(2)	(3)	(1)	(2)	(3)
Share of water received (t-1)	0.025**			0.227***		
	(0.009)			(0.036)		
1 if experimental location = A		0.076***	0.131***		0.813***	0.564***
		(0.01)	(0.015)		(0.035)	(0.05)
1 if experimental location = B		0.042***	0.102***		0.79***	0.616***
		(0.01)	(0.016)		(0.03)	(0.044)
1 if experimental location = C		0.031***	0.063***		0.818***	0.8***
		(0.01)	(0.015)		(0.028)	(0.043)
1 if experimental location = D		0.007	0.07		0.391***	0.269***
		(0.01)	(0.015)		(0.025)	(0.04)
1 if treatment = communication	0.152***	0.153***	0.154***	-0.256***	-0.254***	-0.258***
	(0.015)	(0.015)	(0.015)	(0.036)	(0.05)	(0.05)
1 if treatment = high fine	0.017	0.021	0.021	-0.372***	-0.318***	-0.318***
	(0.016)	(0.016)	(0.016)	(0.059)	(0.055)	(0.055)
1 if treatment = low fine	-0.035**	-0.036**	-0.036**	-0.207***	-0.205***	-0.206***
	(0.016)	(0.016)	(0.016)	(0.068)	(0.063)	(0.062)
Others' contribution (t-1)	-0.005***	-0.005***	-0.005***	-0.011***	-0.007***	-0.008***
	(0.0007)	(0.0007)	(0.0007)	(0.002)	(0.003)	(0.002)
Round	-0.0036***	-0.0036***	-0.0036***	0.008**	0.007**	0.007**
	(0.0008)	(0.0008)	(0.0008)	(0.003)	(0.003)	(0.003)
1 if real location of people = up-midstream	0.121**	0.113**		0.966***	0.681***	
	(0.044)	(0.044)		(0.018)	(0.175)	
A * up-midstream			0.046			0.846***
			(0.049)			(0.187)
B * up-midstream			0.036			0.632***
			(0.049)			(0.185)
C* up-midstream			0.083*			0.48***
			(0.05)			(0.181)
D* up-midstream			0.034			0.643***
			(0.05)			(0.179)
E* up-midstream			0.134**			0.445**
			(0.049)			(0.183)
Constant	0.226***	0.206***	0.212***	3.744***	3.286***	3.377***
	(0.06)	(0.06)	(0.062)	(0.259)	(0.228)	(0.229)
Observations	6099	6099	6099	4902	4902	4902
R-squared	0.25	0.25	0.25	0.31	0.4	0.4

Robust standard errors in parenthesis, *** significant at $p<0.01$, ** significant at $p<0.05$, * significant at $p<0.1$

Note: lower number of observations in appropriation decision because extraction measure cannot be calculated if water received by the player is zero

Regarding our experimental design, the share of the total available water received in the previous round plays a significant role in the level of contribution and extraction (model 1). We confirm in particular that the location in the irrigation system (A, B, C, D, E) plays an important role with players A, B and C contributing significantly more than players D and E (model 2 and 3)[6]. We observe the powerful effect of the communication treatment in both provision and appropriation. Communication increases contribution in the provision stage and reduces extraction in the appropriation stage. Although the introduction of regulation to the extraction decision has a positive effect on water distribution, it has a poor effect on contribution (see Cardenas, 2004; 2005 for similar results). Interestingly, the actual location of people along the watershed also confirms our hypothesis that people upstream tend to contribute more and extract more than people downstream. Moreover, the interaction between the experimental location and the real location has also a significant effect in appropriation. Upstream or midstream people extract more compared to downstream people for all experimental locations and this effect is particularly strong for player A, the player with first access to the resource in the experiment. In the case of contribution, only upstream participants located experimentally in C and E tend to contribute significantly more than downstream participants located in the same positions.

Additionally, we found negative and significant but small effect of round on the provision of the resource and a positive effect on appropriation. Contribution of other players in the previous round has a negative effect on contribution while in a symmetric public goods game this effect is positive (see Cardenas et al, 2011) and also on appropriation. We included other controls (see appendix 3) such as gender, age, education level, household size and dummies for watersheds to account for the socio-demographic heterogeneity of the participants. We also run specific regressions by watersheds. We found that older people tend to contribute more and extract less whereas more educated people tend to extract more. Contribution is higher on average in Coello and Awach watersheds and extraction is higher in Kapchorean compared to the other three watersheds. Communication is more effective to increase contribution in the Colombian than in the Kenyan watersheds (see Cardenas et

[6] Since the experimental location is assigned randomly and holds for 10 rounds, water received in the previous round is correlated with the experimental location. For that reason, we included those two variables in different models.

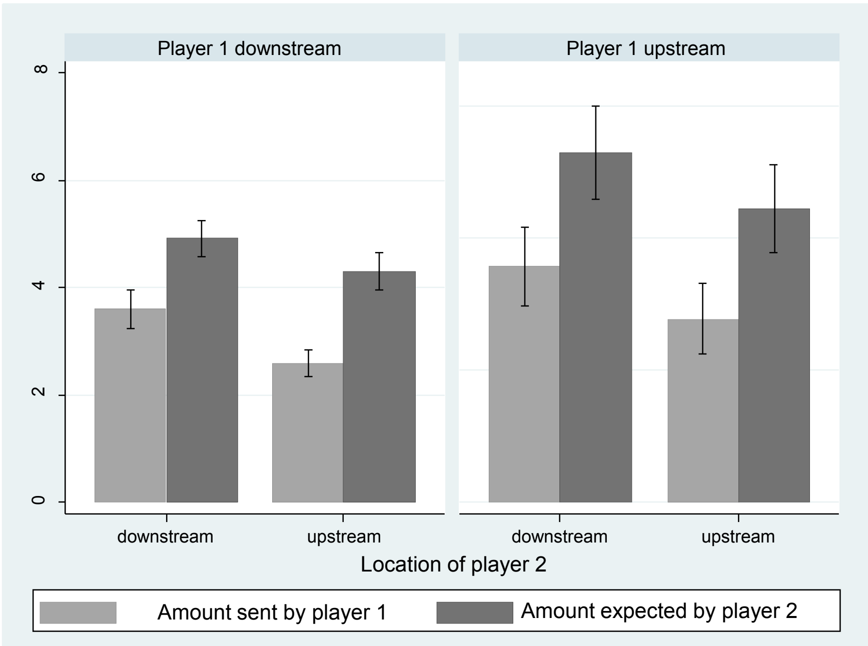
al, 2011 for a discussion about this result) but seems to have a strong effect in extraction as well in the case of Kapchorean.

In short, the results of the irrigation game show not only that the experimental position affects the incentives to cooperate in a situation of asymmetric access to common pool resources but also that that people bring into the game their real experiences which affect their experimental decisions (Cardenas and Ostrom, 2004). Upstream people tend to contribute more especially if they are experimentally located in the last position of the system. Downstream people, who face the effects of water scarcity and pollution in their daily life, extract less compared to upstream people. Our next experiment, the *Water Trust Game*, explores the effect of real upstream-downstream location on trust, an aspect needed to build reciprocity and solve collective action dilemmas.

4.2 Water Trust Game

In the water trust game, player 1 sent on average 41.8% of her endowment to player 2 which is consistent with the range observed for non-students data in developing countries (Cardenas and Carpenter, 2008). Yet in our experiment this average varies according to the treatment with a 47.5% of endowment sent if player 1 was located upstream and player 2 downstream and 32.5% if player 2 was downstream and player 1 upstream. Figure 4 shows that the offer made by the trustor (player 1) is considerable lower when he is located downstream and the trustee is located upstream. This result is confirmed using a t-test to the average of units sent by player 1; only when player 1 is downstream and player 2 upstream the level of offers that is statistically lower compared to the other three permutations. Since our experiment was framed around interactions regarding water and money exchanges and the location of people was the only thing reveled about partners, downstream lower levels of trust on upstream people may be affected by their experience regarding the unidirectional water externalities that flow from upstream locations.

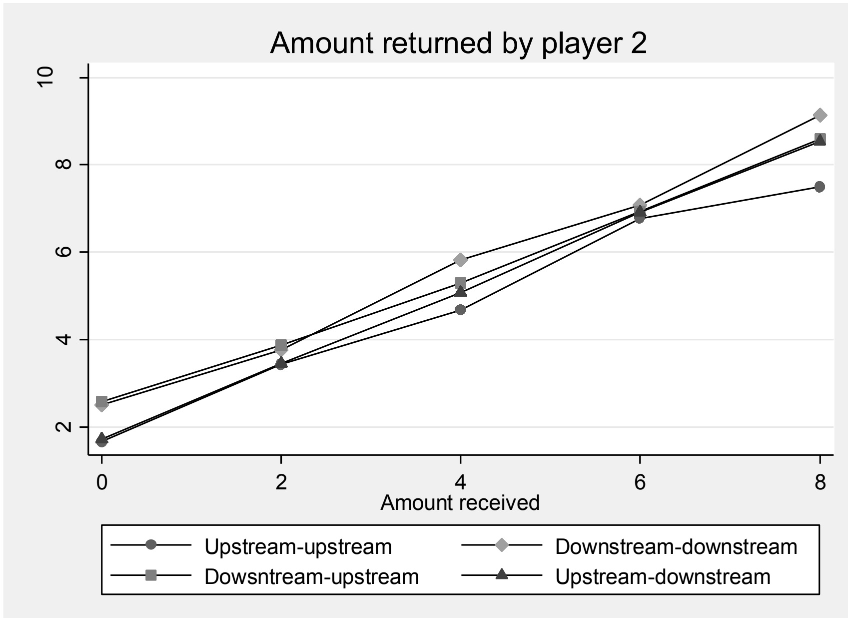
Figure 4 – Decisions of units sent and expectations, by treatment



The largest amount is sent when player 1 is located upstream and player 2 downstream. Although this amount is not statistically different from the symmetric cases – when both players are located either downstream or upstream, it could be an implicit attempt to signaling positive behavior from upstream to downstream. Interestingly, players upstream expect to receive a lower amount of tokens than players downstream and this difference is significant (confidence=95%).

As for the amount returned, figure 5 reveals similar patters than in other studies regarding the trust game: a positive relationship between amount received and amount sent back that can be motivated by reciprocity and/or unconditional kindness (Ashraf et al, 2006). We did not find significant differences according to players' location for the amount returned to player 1 except for the case in which the player 1's offer was zero. In average, 2.11 units were transferred from player 2 to player 1 if player 1's offer was zero but a significant lower amount was transferred if player 1 was located upstream (1.7 units) than if she was located downstream (2.55 units). The average return ratio was 1.33 and we did not find significant differences according to treatment.

Figure 5 – Decisions of units returned second mover, by treatment



In table 2 we present the OLS model of the amount offered from player 1 to player 2. Some robust results are worth mentioning. Reciprocal behavior drives trust by players 1 so those expecting more sent more to player 2. Regarding the verticality effect, we confirm that the location of players matter. In model (1) we see that if the trustee is located upstream, the amount sent by player 1 is significantly lower whereas in model (2) we confirm the results of our graphic analysis: if the trustor is downstream and trustee upstream, the offers are significantly lower. The magnitude of this effect is important since the offer in the downstream-upstream treatment is one unit lower (15 percentage points of the average sent) than the offers under the upstream-downstream treatment. Therefore, lower levels of trust from downstream to upstream participants had a significant and important effect on the social efficiency in the experiment. Furthermore, we found a positive relationship between offers and beliefs about trustworthiness of players located on different places of the watershed. If people believe that most trustworthy people is located upstream the offer is higher, which shows the importance of the perception about upland players to build stable solutions to watersheds problems.

Table 2 – *Water Trust Game,* player 1 and player 2 transfer decisions

	Units sent by player 1		Units returned by player 2	
	(1)	(2)	(3)	(4)
Player 1 upstream	0.276		-0.32	
	(0.297)		(0.465)	
Player 2 upstream	-0.737**		0.318	
	(0.319)		(0.452)	
Downstream-upstream		-1.018***		0.004
		(0.35)		(0.564)
Upstream-upstream		-0.644		-0.356
		(0.475)		(0.624)
Downstream-downstream		-0.181		0.279
		(0.464)		(0.636)
Expectations	0.17***	0.17***	0.132	0.132
	(0.036)	(0.036)	(0.109)	(0.109)
Hypothetical amount sent by player 1			0.814***	0.814***
			(0.062)	(0.062)
Age	0.003	0.003	0.011	0.011
	(0.013)	(0.013)	(0.018)	(0.018)
Gender	-0.453	-0.437	-0.816*	-0.816*
	(0.288)	(0.30)	(0.489)	(0.489)
Education	-0.024	-0.023	0.165**	0.165**
	(0.051)	(0.051)	(0.072)	(0.072)
People upstream more trustfully	0.413**	0.411**	0.357	0.357
	(0.187)	(0.188)	(0.302)	(0.302)
Fuquene	0.804***	0.796**	-0.27	-0.27
	(0.31)	(0.311)	(0.514)	(0.515)
Constant	1.355	1.577*	-0.1	-0.4
	(0.842)	(0.924)	(1.475)	(1.39)
Observations	139	139	690	690
R-squared	0.32	0.32	0.28	0.28

Robust standard errors in parenthesis, *** significant at p<0.01, ** significant at p<0.05, * significant at p<0.1

As we used the strategy method, we have five times as many data points of player 2 than for player 1, therefore in the models (3) and (4) we cluster the data by individuals. We confirmed the graphic results: that reciprocity is the key motivator of amount return whereas location did not play a significant role in trustee's decision. Additionally, we found that women return fewer tokens than men and also that education has a significant effect in the amount returned.

The results of the water trust game are therefore consistent with the results of the irrigation game regarding the effect of verticality on collective action. Upstream people have first access to clean water and since their decisions affect downstream people, trust from downstream to upstream has been negatively affected. The lack of trust from downstream to upstream creates barriers to build cooperation and more efficient relationships around water availability and quality.

4. Conclusions

The challenge of vertical collective action emerges from the asymmetry in the location of players along the water system. Headenders or upstream players have better opportunities to capture the benefits of a common project that maintains or produces water because they have first access to the resource. On the other hand, their actions cause direct externalities to those downstream. Tailenders or downstream players hence notice two effects on their well-being: those upstream have better chances to benefit from the resource, and their appropriation actions affect them directly. Further, the appropriation by those downstream has no direct effect on players upstream and therefore the possibility of signaling through reciprocal responses is less available for downstream players. In our irrigation game, this mechanism seems to operate through the contribution stage. Players downstream are willing to contribute less than upstream players to the public project and their contributions are going to depend on the level of inequality they will tolerate (Jansen et al 2011). In our water trust game, reciprocity was a major motivation for both participants and the framework is such that the first mover has the opportunity to signal behavior and the second mover to reciprocate. The results confirm, within these watersheds, that the virtuous cycle of trust and trustworthiness can increase social efficiency without the need for binding contracts or external intervention.

Nevertheless, in most watershed settings there are not spontaneous mechanisms that create the trust, reciprocity and reputation cycle (Ostrom, 1998). Moreover, the results of the water trust game indicate a lower level of trust of people downstream on people upstream compared to the other treatments. This lower level of trust affected the level of social efficiency reached by upstream and downstream players in the experiments. The challenge is therefore to bring upstream and downstream players to the group oriented outcome by building trust and creating a better allocation of the resource along the watershed. This is what the face-to-face communication treatment achieved in our results. It balanced the effort between upstream and downstream contributions and therefore increased substantially the water produced by the irrigation system, providing better chances for the downstream players (D and E) to obtain water in each round. Given the complexity of watersheds, creating arenas for communication is much more complicated than our cheap talk but mechanisms that allow people upstream and people downstream to come together, exchange their experiences and be aware of their mutual dependencies would be beneficial for social outcomes.

As other experimental evidence has revealed, the imposition of penalties may erode social preferences, resulting in no effect or in a detrimental effect for cooperation. Jack (2009) found that the removal of a weak enforcement to upstream behavior in a trust game like the one implemented in this study had a negative effect on transfers from upstream to downstream participants in Kenya. Furthermore, experimental evidence in payments for environmental services shows that economic incentives may not only erode the prosocial behavior of those targeted for the intervention but also can have behavioral spillovers, reducing the intrinsic motivations of those excluded (Alpizar et al, 2013).

The lack of trust among the two ends of the watershed, and in particular from players downstream to players upstream is a major challenge here. Further research is needed to explore the impacts of simply informing better about the expectations and intentions of both players upstream and downstream and how different government and non-government actors can play in decreasing this lack of trust and information that we observe both because of the experimental location or the actual locations of our hundreds of participants in Colombia and Kenya.

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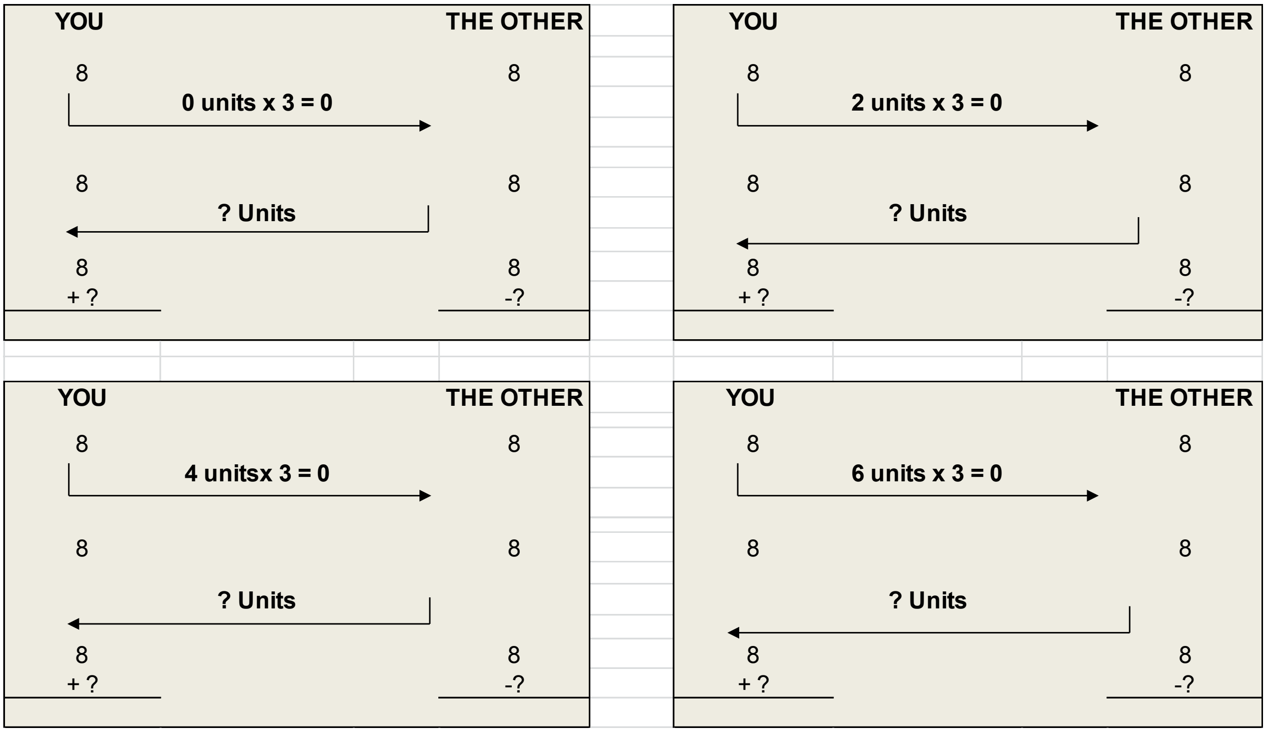
PPENDIX 1 – Socio-demographic characteristics of participants

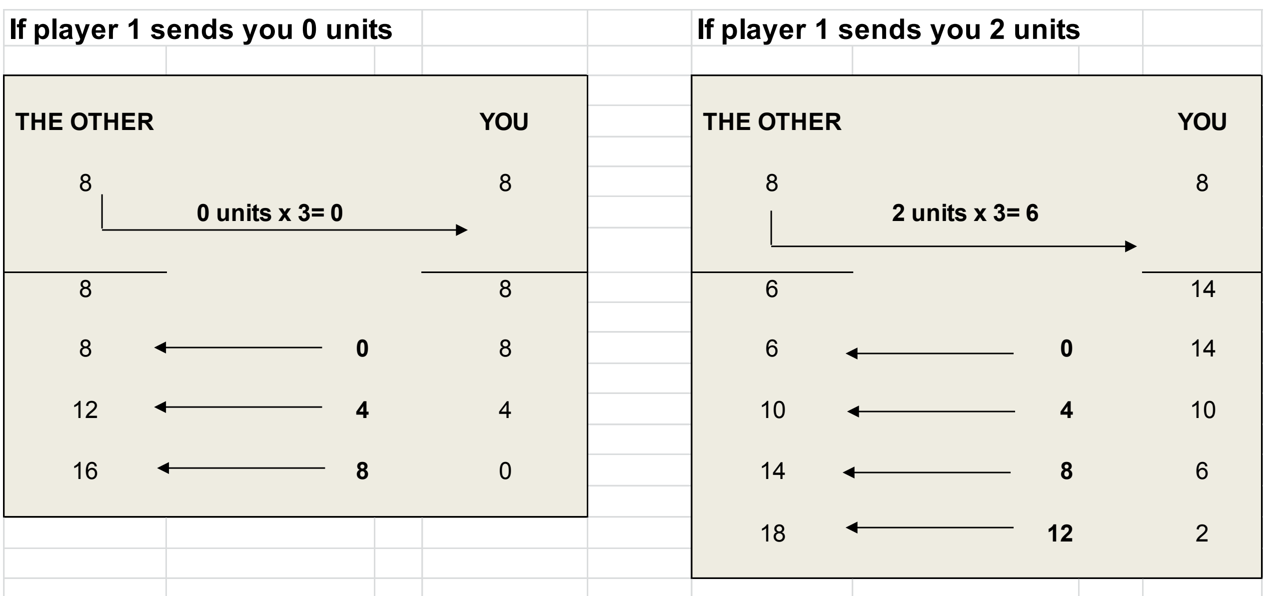
	WATER TRUST GAME		IRRIGATION GAME			
	Kenya	**Colombia**	**Kenya**		**Colombia**	
	Kapchorean River	Fuquene Lake	Awach River	Kapchorean River	Fuquene Lake	Coello River
Sociodemographic characteristics						
Education (years)	6.8	7.5	5.2	4.2	6.8	6.4
Female (%)	42.7%	65.6%	38.3%	23.3%	53.7%	63.3%
Age (years)	39.1	33.8	45.9	38.1	34.8	42.1
Time living in that place (years)	32.3	25.3	38.2	25.5	26.1	29.2
Household size (people)	6.5	5.1	6.2	6.2	5.2	5.1
Main water source (%)						
Piped water	5.7%	81.2%	3.3%	0%	61.5%	41.8%
Natural source (spring, river)	92.6%	23.2%	91.7%	91.7%	20.7%	56.1%
Other	1.7%	4.4%	5%	8.3%	17.8%	2.1%
Utilities access (%)						
Piped water	4.8%	86.9%	5.0%	0.0%	69.7%	61%
Electricity	0.8%	93.7%	0.0%	0.0%	94.7%	83%
Main farm use (%)						
Agriculture	97.3%	63.9%	85.0%	98.3%	26.3%	36.1%
Livestock	2.7%	17.1%	5.0%	0.0%	32.3%	7.2%
Housing	0%	18.3%	6.7%	1.7%	40.6%	50.5%
Perceptions about cooperation and water management						
Participation in community groups (%)			71.7%	58.3%	51.2%	75.0%
Your water use reduces availability downstream	38.7%	41.9%	29.9%	40.1%	37.3%	54.1%
Have participated in activities for water protection	62.6%	46.8%	63.3%	66.7%	54.9%	69.0%
Think people upstream is more trustworthy than people downstream	62.9%	50.6%	50.1%	67.4%	48.2%	52.1%
Neighbors who cooperate in community projects, out of 10	7.2	4.8	6.8	6.6	4.6	4.9
N	62	80	60	60	135	100

APPENDIX 2 – *Water Trust Game* sample of supporting material

Player 1



Player 2 – strategy method



APPENDIX 3 – Irrigation game results disaggregated by watershed

APPENDIX 3.A – Fixed-effects OLS estimation of contribution decisions Irrigation game, by watershed

Provision decisions	Pooled	Coello	Fuquene	Awach	Kapchorean
1 if experimental location = A	0.131***	0.209***	0.156***	0.051	0.047
	(0.015)	(0.033)	(0.026)	(0.036)	(0.03)
1 if experimental location = B	0.102***	0.072**	0.067**	0.079**	0.105***
	(0.016)	(0.032)	(0.028)	(0.036)	(0.033)
1 if experimental location = C	0.063***	0.062**	-0.004	0.089**	0.083***
	(0.015)	(0.032)	(0.026)	(0.035)	(0.031)
1 if experimental location = D	0.07	0.148***	0.015	0.031	0.133***
	(0.015)	(0.031)	(0.028)	(0.037)	(0.031)
1 if treatment = communication	0.154***	0.238***	0.147***	0.066*	0.094***
	(0.015)	(0.029)	(0.025)	(0.034)	(0.034)
1 if treatment = high fine	0.021	0.067*	0.022	-0.055*	
	(0.016)	(0.035)	(0.022)	(0.032)	
1 if treatment = low fine	-0.036**	-0.056**	0.006		-0.035
	(0.016)	(0.027)	(0.025)		(0.032)
Others' contribution lagged	-0.005***	-0.001	-0.0008	-0.008***	-0.018***
	(0.0007)	(0.001)	(0.001)	(0.001)	(0.002)
Round	-0.0036***	-0.001	-0.005***	0.002	-0.007***
	(0.0008)	(0.002)	(0.001)	(0.002)	(0.002)
A * up-midstream	0.046	-0.016	-0.194***	0.039	0.072
	(0.049)	(0.06)	(0.049)	(0.051)	(0.055)
B * up-midstream	0.036	-0.036	-0.106**	0.013	-0.036
	(0.049)	(0.059)	(0.052)	(0.057)	(0.055)
C* up-midstream	0.083*	-0.0107*	-0.083*		
	(0.05)	(0.051)	(0.049)		
D* up-midstream	0.034	-0.039	-0.128**	0.05	-0.119**
	(0.05)	(0.051)	(0.051)	(0.049)	(0.052)
E* up-midstream	0.134**	0.132**	-0.08	0.139**	0.015
	(0.049)	(0.056)	(0.05)	(0.049)	(0.52)
Age	0.003***	0.001	0.004***	-0.002	0.008***
	(0.0003)	(0.0007)	(0.0005)	(0.001)	(0.001)
Gender	-0.014	0.011	0.022	0.027	-0.12***
	(0.008)	(0.016)	(0.014)	(0.022)	(0.023)
Education level	0.002	0.003	0.004**	-0.006	0.013***
	(0.001)	(0.002)	(0.002)	(0.004)	(0.001)
Household size	0.007	-0.0003	0.017***	0.011**	-0.014***
	(0.001)	(0.003)	(0.002)	(0.004)	(0.004)
Coello	0.153***				
	(0.063)				
Fuquene	0.085**				
	(0.044)				
Awach	0.14***				
	(0.06)				
Constant	0.226***	0.318***	0.166***	0.628***	-0.056
	(0.06)	(0.071)	(0.049)	(0.077)	(0.052)
Observations	6099	1653	2337	1045	1064
R-squared	0.25	0.25	0.24	0.25	0.25

Robust standard errors in parenthesis

*** significant at p<0.01, ** significant at p<0.05, * significant at p<0.1

APPENDIX 3.B – Fixed-effects OLS estimation of extraction decisions Irrigation game, by watershed

Appropriation decisions	Pooled	Coello	Fuquene	Awach	Kapchorean
1 if experimental location = A	0.564***	0.13	0.721***	0.82***	0.3**
	(0.05)	(0.085)	(0.085)	(0.098)	(0.151)
1 if experimental location = B	0.616***	0.337***	0.834***	0.815***	0.22*
	(0.044)	(0.077)	(0.085)	(0.092)	(0.127)
1 if experimental location = C	0.8***	0.444***	0.882***	0.944***	1.069***
	(0.043)	(0.081)	(0.07)	(0.095)	(0.107)
1 if experimental location = D	0.269***	0.014	0.35***	0.451***	0.017
	(0.04)	(0.069)	(0.063)	(0.084)	(0.102)
1 if treatment = communication	-0.258***	-0.155*	-0.209***	-0.179	-0.394***
	(0.05)	(0.09)	(0.08)	(0.11)	(0.117)
1 if treatment = high fine	-0.318***	-0.316***	-0.279***	-0.22**	
	(0.055)	(0.103)	(0.088)	(0.098)	
1 if treatment = low fine	-0.206***	0.092	-0.389***		-0.6***
	(0.062)	(0.121)	(0.075)		(0.149)
Others' contribution lagged	-0.008***	-0.015***	-0.013***	0.006	0.015**
	(0.002)	(0.004)	(0.003)	(0.006)	(0.007)
Round	0.007**	0.004	0.009*	-0.009	0.02**
	(0.003)	(0.007)	(0.005)	(0.006)	(0.008)
A * up-midstream	0.846***	1.297***	-0.044	0.023	1.06***
	(0.187)	(0.122)	(0.112)	(0.156)	(0.2)
B * up-midstream	0.632***	0.641***	-0.105	0.05	1.305***
	(0.185)	(0.103)	(0.106)	(0.155)	(0.17)
C* up-midstream	0.48***	0.449***	-0.154*	-0.235*	0.369**
	(0.181)	(0.107)	(0.089)	(0.132)	(0.163)
D* up-midstream	0.643***	0.493***	0.034	0.187	0.572***
	(0.179)	(0.088)	(0.078)	(0.117)	(0.139)
E* up-midstream	0.445**				
	(0.183)				
Age	-0.006***	-0.002	-0.005**	-0.007*	-0.031***
	(0.001)	(0.002)	(0.002)	(0.004)	(0.005)
Gender	0.036	0.07	-0.021	-0.022	0.068
	(0.026)	(0.05)	(0.05)	(0.063)	(0.078)
Education level	0.017***	0.015*	0.019***	0.009	0.022
	(0.004)	(0.007)	(0.007)	(0.012)	(0.017)
Household size	0.001	0.032***	-0.021**	-0.017	0.131***
	(0.004)	(0.009)	(0.008)	(0.012)	(0.019)
Coello	-1.672***				
	(0.185)				
Fuquene	-1.739***				
	(0.246)				
Awach	-2.024***				
	(0.226)				
Constant	3.377***	2.04***	2.448***	1.258***	4.515***
	(0.229)	(0.231)	(0.247)	(0.249)	(0.194)
Observations	4902	1400	1978	912	612
R-squared	0.4	0.46	0.32	0.44	0.56

Robust standard errors in parenthesis
*** significant at p<0.01, ** significant at p<0.05, * significant at p<0.1

APPENDIX 4 – Experimental protocols

APPENDIX 4.A – Instructions for the Irrigation Game

FIRST STAGE INSTRUCTIONS

<< *When all participants have arrived, the monitor must begin to read the instructions*>>

Good morning / evening, we would like to thank you for accepting this invitation. We will spend about three hours, which will include explaining the activity, playing the game and answering a short survey at the end. Let's get started.

The follow exercise is a different and entertaining way to actively participate in a project about individual decisions. Depending on the decisions that you make today, you can win some money. That's why it is important to pay attention to these instructions. The funds to cover these expenses are donated by a scientific organization.

If you have any question, any of us can answer and help you.

<<*Here is important to introduce all the team members*>>

<<*It is necessary to ask if there are people who live in the same house, and organize them in groups of 5 people in such a way no people who live together be in the same group*>>

<< *It is important to be clear that the game is independent for each group. What happens in one group doesn't affect the other groups*>>

Each of you could be asking why we are going to give you money. We use money because it is necessary for this exercise to have you make economic decisions, decisions with consequences for your own pocket, like in real life. The money isn't a payment to your participation and we hope it won't be your only motivation.

It is very important that each person makes his/her decision individually, with no help from the other group members. During the game, the players cannot communicate with their group partners. If you need help, you can ask one of us. We will not reveal your decisions or your earnings to anybody.

In this exercise it is intended to recreate a situation in which a group or family must make decisions about the use of water to irrigate their plots. You have been selected to participate in a five-person group with other people who have agreed to participate. This exercise is different from other exercises in which other persons have participated already in this community. Therefore, comments that you have heard from other people don't necessarily apply to this exercise.

You will play several rounds equivalent, for example, to years or watershed seasons. Each round consists of two decisions. First, each of you decides how much to contribute to a public fund in order to maintain the watershed. The quantity of water units available for the five players depends on the contribution of the five players. The next decision is for each player to take some quantity of the water units available. Each unit that you obtain in this game is equivalent to 1,5 shillings. For example, if you get 200 units over 20 rounds of the game, you will win 300 shillings.

TABLE OF AVAILABLE WATER QUANTITY	
TOTAL UNITS INVESTED IN THE PUBLIC FUND BY ALL 5 PLAYERS	WATER QUANTITY AVAILABLE
0-10	0
11- 15	5
16-20	20
21-25	40
26-30	60
31-35	75
36-40	85
41-45	95
46-50	100

In each round, you have 10 units to spend, and you decide how many of these units to spend in the public water fund, and how many you keep for yourself. It is important to understand that these units are not real, they are imaginary units, so you won´t have they in your hand, but in your mind. You can think of this as the amount of effort you invest in the maintenance of the watershed. The level of this effort is between 0 and 10.

In order to know how much water will be available for the group of the five players, depending on the total contributions, you can see the TABLE OF AVAILABLE WATER

QUANTITY <<*The monitor shows TABLE OF AVAILABLE WATER QUANTITY poster*>>

This table contains the information that you need to calculate the resulting quantity of the available water, depending on your contribution and those of the other 4 players. On this table you can see the sum of units invested in the public fund and the water available, resulting from your decision and the decision of the other 4 players. Your decision and the decisions of the other 4 members of your group will be added, and this sum will determine how much water will be available.

For example, say everybody invested 2 units in the maintenance of the watershed, and kept the other 8 units for themselves. The sum of the units contributed to the fund is 10 (2*5=10), which means 0 units of water. As a result everybody ends up with 8 units at the end of that round.

Another example is that everybody invests 5 units in the public fund, the sum of units will be 25 (5*5=25), which means 40 units of available water to allocate among the 5 players. <<*We can use coins or something like that to explain the allocation of the 10 units*>>

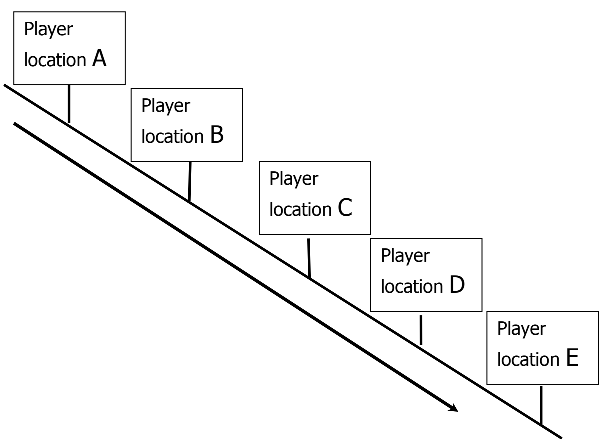
The contribution decision is written down on an **ORANGE DECISION CARD** like this <<*The monitor shows and gives the orange decision cards to the players*>>. These cards have a number, please check that all the cards have the same number, from now on this will be your player number.

These cards have a blank space for the round number, which the monitor will be announcing, and a blank space to write down your contribution decision, which range from 0 to 10. The monitor will collect the ORANGE DECISION CARDS during each round. Then the monitor will sum the total units that the group decides to contribute to the public fund and she or he will write on the board the current size of the public fund, according to the table of available water.

Remember decisions are made privately and everybody can decide on how much they invest in maintenance of the water canals.

After the first decision is made, the monitor collects the orange cards and announces the amount of water available. The next decision is to take a **quantity of water** from the available water. Everybody has the same amount of land for water their crops. Each of you receives, FOR ALL THE ROUNDS, randomly a card marked with the following characters: A, B, C, D, E. The player who obtains character A will be the first to decide how much water takes to irrigate his or her plot. Next, the player with the character B decides, then the player with the character C, then the player with the character D, and finally the player who has the character E.

WATER FLOW DIRECTION – WATERSHED



This means that characters on the cards define the order in which the plots of each player are situated through the watershed <<*The monitor shows a draw in a poster that represents this situation*>>.

On this graph, the water flows from up to down. The player who has the letter A will be the first person who decides how much water to take and writes down his/her decision on a **YELLOW DECISION CARD** like this << *the monitor shows and gives the yellow decision cards to the players*>>. The monitor will receive the YELLOW DECISION CARD from the first participant and will subtract the collected water from the total available water and write the remaining amount of water on a BLUE piece of paper to show to player B, who has the second option to make a decision. This process continues until player E has made a decision.

The next round starts again with first deciding on the contribution to the public good, in order to maintain the watershed.

<<*Now, the monitor should give the player calculation sheet to the players*>>

Each of you has on your desk a **PLAYER CALCULATION SHEET**, which will be used to save the information about your decisions on each round that can be helpful to make your future decisions. On the fist column (column A), you should write down your contribution decision, the same number that you have written down on the ORANGE DECISION CARD. Remember that you have 10 units of effort that you can send to the public fund or keep for yourself. On the second column (B), you should write down the units that you kept. On the third column (C), you should write down your extraction decision, the same that you have written on the YELLOW DECISION CARD. This amount can't be larger than the available water, which will be shown to you on the BLUE PAPER by the monitor. Column D is the amount of water available after your decision. On the last column (E), you should write down your profits, which are the sum of the units you kept (column B) plus the units of water you extracted (column C). Remember that your profits will be changed to shillings: each unit that you win will be equivalent to 1,5 shillings and we will give it to you at the end of the game.

Please, write down your player number on the upper part of the paper.

<< *In order to explain the next example, could be useful to use the poster or players location on the watershed*>>

Let's look at an example. Imagine that each of you decides to contribute 7 units to the public fund, and write this number down on the ORANGE CONTRIBUTION CARD. If each member of the group contributes 7 units, the sum of the contribution of the 5 members will be 35 (7*5=35). Now the monitor announced the amount of available water according to the TABLE OF WATER AVAILABILITY QUANTITY, which corresponds to 75 units of water. Then, the player A will make his/her water extraction decision. Imagine he/she decides to extract 15 units of water, he/she must write it down on his/her YELLOW DECISION CARD, and give the paper to the monitor. The monitor will write the remaining quantity of water on the BLUE PAPER (75-15=60), and will give it to the next player, player B.

Then the player B will decide the amount of water to extract. He/she must write this decision on the ORANGE DECISION CARD and give the card to the monitor. Suppose the quantity the player B decides to extract, of the remaining 60 units of water, is 15 units. Then the monitor will write down the remaining water on the BLUE PAPER (60-15=45), and will give it to player C. Player C makes his or her extraction decision, suppose it is 15 units, and writes it down on the YELLOW CARD. Then he/she must give this paper to the monitor, who will calculate and write down the remaining amount of water on the BLUE PAPER (45-15=30) and will give it to player D. Then player D makes its extraction decision, suppose it will be 15 too, and write it down on the YELLOW PAPER. Then he/she gives this paper to the monitor, who will calculate and write down the remaining amount of water on the BLUE PAPER (30-15=15) and will give it to player E. Finally, player E makes his/her extraction decision, suppose it will be 15, so the final remaining water will be zero (0).

The next round starts again with first deciding on the contribution to the public good.

It is very important to remember always that the decisions are absolutely individual, which means that the numbers you write down on the game cards are private and you must not show them to the other members of your group.

Are there any questions about this? <<*Monitor pauses to answer questions*>>

Remember that the points you earn depend on your own decisions and will become money at the end of the exercise.

Consent form: This paper is a requirement for universities which conduct activities with participation of people. On this format, we give you information about the confidential management of the information that we collect by these activities. If you accept to participate, you should read and sign this consent form, certifying that you were informed about the study and the management of the information. The information you write down on the format is confidential and only the researchers of the study will see it. This form is very important because it is not only a guarantee of confidentiality about the information management, but it is also necessary to be able to give you the money at the end of the game.

<<The instructor reads the consent form out loud. Then the instructor asks the players to write down their player number at the top of the form, and write their name and identification number, and sign the form >>

To start the first round of the game we will organize the seats and desks in a circle where each of you face outwards. 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 to assist you with these. And keep in mind that from now on, no conversation or statements should be made during the game unless you are instructed to.

We will have first a few rounds of practice that will NOT count for the real earnings, just to practice of the game. For these rounds, the monitor will distribute the letters by his/her own criterion. When we begin the real rounds that are going to count toward your earnings, the letters are going to be distributed randomly.

<<Distribute the letters for the practice rounds>>

Now, we are going to distribute randomly the letters, A to E, for the next rounds. Remember that the letter you get will be your position on the watershed, and will be the same for all the rounds.

<< The instructor could put all the letters inside a dark bag and let players to take letters out>>

Note: *It could be useful remembering the players which card they have to use (orange or yellow) every time. Maybe telling them something like: "Round number 1, please write it down in an orange card. Now please make your contribution decision and write it down too"*

SECOND STAGE INSTRUCTIONS

Communication:

<< When the first 10 real rounds finish, the instructor will let participants communicate before each round>>

From now on, we are going to start a new game very similar to the last game. The only difference is that you can, if you want, talk for two minutes with your team partners before you make your decisions. You will have the possibility to talk to the other group members before playing, and this communication is completely voluntary. For the first two minutes of each round, you can talk about whatever you want. When the allowed time to speak has finished, you should return to your seat and make your decisions in the same way that you have been doing.

<< *The instructor let the players talk for two minutes. The instructor and the other team members must be careful about not to influence the conversation*>>

Now, we are going to distribute the cards with the letters A, B, C, D and E for the next rounds.

High penalty:

Each of you has a right to one-fifth part of the water of the watershed. This amount is calculated after the available water is announced. The order to extract the water remains the same for all rounds: ABCDE. A dice is thrown in each round. When 6 is thrown, an inspector arrives and will check the water extraction. If the subject has taken more than one-fifth of the total, the subject pays back the extra amount taken, and an extra amount of 6 units.

Are there any questions about this? <<*Monitor pauses to answer questions*>>

Now, we are going to distribute the cards with the letters A, B, C, D and E for the next rounds.

Low penalty:

Each of you has a right to one-fifth part of the water of the irrigation system. This amount is calculated after the available water is announced. The order to extract the water remains the same for all rounds: ABCDE. A dice is thrown in each round. When 6 is thrown, an inspector arrives and will check the water extraction. If the subject has taken more than one-fifth of the total, the subject pays back the extra amount taken.

Now, we are going to distribute the cards with the letters A, B, C, D and E for the next rounds.

Are there any questions about this? <<*Monitor pauses to answer questions*>>

APPENDIX 4.B – Instructions for the Water Trust Game

WELCOME (for players 1 and 2)

We would like to thank you for accepting this invitation. The follow exercise is a different and entertaining way to actively participate in a project about individual decisions. We will spend about 30 minutes, which will include explaining the activity, playing the game and answering a short survey at the end.

Depending on the decisions that you make today, you can win some money. That's why it is important to pay attention to these instructions. It is important to know that you can leave the game at any time, but you will only receive any money that you win if you complete the exercise you could receive the money that you win. The funds to cover these expenses are donated by a scientific organization.

You could be asking why we are going to give you money. We use money because it is necessary for this exercise to have you make economic decisions, decisions with consequences for your own pocket, like in real life. The money isn't a payment to your participation and we hope it won't be your only motivation.

This exercise will be done in couples. Each couple is compounded by a **player 1** and a **player 2**, both living in the same watershed, that means both of you obtain water for consumption from the same spring, river or water flow. You and the other person are going to participate in an exercise in which you should make similar decisions to those you make when you decide how use water. Specifically, we are talking about the river _______________, where you and the other person who is going to participate in this exercise are living.

In some cases, both of you could be located in the upstream, where the springs are, or both could be in the downstream where the water arrives, or one of the participants could be upstream and the other downstream.

You are UPSTREAM / DOWNSTREAM of this watershed and the other person is UPSTREAM / DOWNSTREAM of the same watershed. In this moment, that person is with a coworker who is explaining that person the same exercise that I'm explaining to you. Later we are going to get in touch through a mobile phone in order to communicate the players decisions.

However, none of the players will know the exact identity of the person who he or she is playing with. The other person who is going to participate with you in this activity will only know your location in the watershed (upstream or downstream) and the water source where you obtain the water that you use. The other person won´t know your exact identity, and that information never will be revealed.

It is important you know that all the information you give to this exercise is confidential and will be used only for academic purposes. Neither your name, nor your identification will appear in any report of the study.

With that information, we want to ask you if you want to participate <<*it is important to ask them: yes or no?* >>

Now, please look at the sheet that is in front of you. This paper called "consent form" has the information that I have explained to you. This sheet have been signed by a professor, who is the principal researcher of this research, and you should sign it so that you have the certainty that all the information that we are giving to you is true and that the information will be used properly.

<<The instructor reads the consent form out loud. Then the instructor asks the player to write down his/her player number at the top of the form, and write his/her name and identification number, and sign the format >>

GAME EXPLANATION

As I told you, in this game, you and another person are going to make decisions related to water management that links you. For example, if you live in the upstream of the watershed, your decisions affects the quantity and quality of water that downstream people receive. Thus, if you live in the downstream of the watershed, the decisions of upstream people affect the quantity and quality of water that you receive. Downstream people could try to affect upstream people decisions, as I will show you with some examples.

If player 1 is located UPSTREAM and player 2 is located DOWNSTREAM

For player 1

To start, we are going to give 8 units to each player. Each unit corresponds to 30 shilling, which means that at the beginning of the game each player has 240 shillings. Then, you player 1, located in the UPSTREAM of the river ____________ will have the opportunity to send a share of your 8 units to player 2, who lives in the DOWNSTREAM of the same river watershed. You can send him or her 8, 6, 4, 2 or 0 units. The units that you decide to send represent quality and quantity of water that you make available for player 2, for their household and land uses.

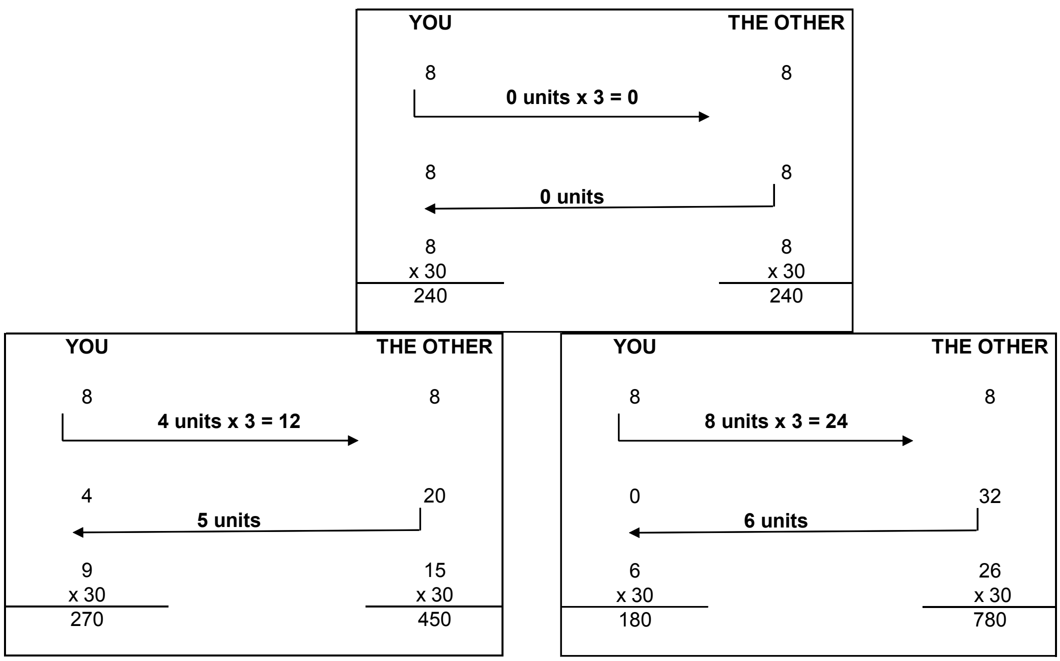
The amount that you send to player 2 will be tripled, or multiplied by 3, before player 2 will receive it. It means that player 2 will receive three times the amount of units that you have sent him or her, units that represent clean and sufficient quantity water.

Then player 2 has to decide how many units he or she will send back to you of the amount he or she has, which is three times the amount that you have sent plus the 8 units that he or she had at the beginning of the game. These units that player 2 sends backs represent a compensation for the water received.

While you decide how many units send, that person must choose how many units he or she will send back to you for each option (three times 8, 6, 4, 2 o 0 units), plus the 8 units he or she has since the beginning of the game. That amount doesn't get tripled, it is just transferred.

Remember that the amount that player 2 receives depends on the quantity of units that you send him/her of your 8 units. Each unit that each player wins during the game will be multiplied by 30, so your final earnings will be the sum of all the units you win during the game, multiplied by 30.

Let`s look at some **examples**:



Notice that if the quantity sent by player 1 is higher, the quantity that player 2 will receive will be higher. However, the decision of how many units send to player 2 and the decision of player 2 about how many units sends back to player 1, are unconstrained and self-determining. You can finish the game with 8 units, more than 8 units or less than 8 units, of earnings.

Are there any questions about this? <<*Monitor pauses to answer questions*>>

Now, I`m going to show you some examples in order to verify that it is clear how the game goes:

Control questions: <<*it could be helpful using paper sheets*>>

1. You send 8 units, then player 2 receives 24 (3 x 8 = 24). Player 2 sends you back 12 units. How many units do you earn? (12=8-8+12), how many units does player 2 earn? (20=24+8-12)

2. You send 6 units, then player 2 receives 18 (3 x 6 = 18). Player 2 sends you back 8 units. How many units do you earn? (10=8-6+8), how many units does player 2 earn? (18=18+8-8)

3. You send 0 units, then player 2 receives 0 (3 x 0 = 0). Player 2 sends you back 0 units. How many units do you earn? (8=8-0+0), how many units does player 2 earn? (0=0+8-0)

Do you have any question about the activity?

Now you can make your decision. <<*Monitor shows the different options on the colour cards and marks with an X the decision of player 1 on the format* >>

Now, could you please answer these questions? <<*Fill out the survey*>>

For player 2

You are player 2. The other player lives in the UPSTREAM of the watershed of river ___________, which is the source of the water that both of you use.

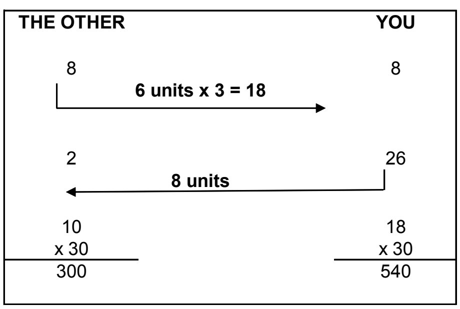
To start, we are going to give 8 units to each player. Each unit corresponds to 30 shilling, which means that at the beginning of the game each player has 240 shillings. Then, player 1 will have the opportunity to send a share of his or her 8 units to you, who lives in the DOWNSTREAM of the same river watershed. Player 1 can send you 8, 6, 4, 2 or 0 units. The units that player 1 sends to you represent the quality and quantity of water that is available for you, for your household and land uses.

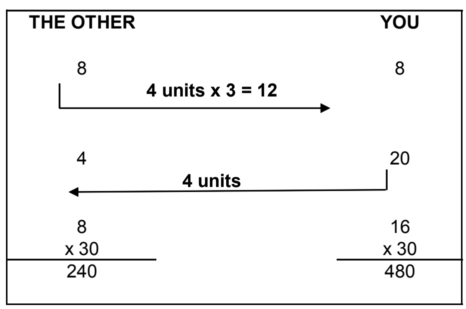
Any amount that player 1 sends to you will be tripled, or multiplied by 3, before you receive it. It means that you will receive three times the amount of units that player 1 has sent to you, units that represent clean and sufficient quantity water.

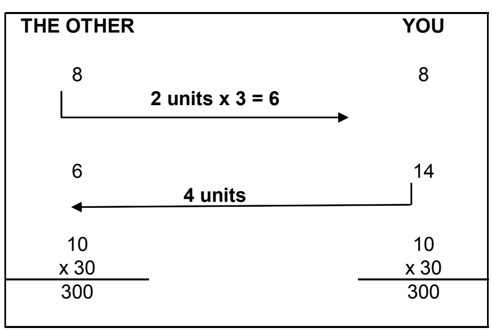
Then you have to decide how many units to send back to player 1 of the amount you have that is three times the amount that player 1 has send to you plus the 8 units that you had at the beginning of the game. These units that you send back represent a compensation for the water received.

Before you know the amount of units that you actually receive, which are three times the amount of units that player 1 sent to you, plus the 8 units that you have received at the beginning of the game, you should decide how many units to send back to player 1, according to each possible amount of units that you could get. The amount that you could get depends on triple the amount of units that player 1 sent to you (24, 18, 12, 6, 0) and the 8 units you received at the beginning of the game. The amount that you send back to player 1 won`t be tripled, just transferred.

Let's look at some **examples**:







Notice that if the quantity sent by player 1 is higher, the quantity that player 2 will receive will be higher. However, the decision of how many units send to player 2 and the decision of player 2 about how many units sends back to player 1, are unconstrained and self-determining. You can finish the game with 8 units, more than 8 units or less than 8 units, of earnings.

Are there any questions about this? <<*Monitor pauses to answer questions*>>

Now, I`m going to show you some examples in order to verify that it is clear how the game go:

Control questions: <<*it could be useful to use paper sheets*>>

1. Player 1 sends to you 6 units; then you receive 18 (3 x 6 = 18). If you send back 8 units to player 1, how many units does player 1 earn? (10=8+2) how many units do you earn? (18=18+8-8).
2. Player 1 sends you 2 units; then you receive 6 (3 x 2 = 6). If you send back 4 units to player 1, how many units does player 1 earn? (10=6+4) how many units do you earn? (10=6+8-4).
3. Player 1 sends you 8 units; then you receive 6 (3 x 8 =24). If you send back 12 units to player 1, how many units does player 1 earn? (12=0+12) how many units do you earn? (20=24+8-12).
4. Player 1 sends you 0 units; then you receive 0. If you send back 0 units to player 1, how many units does player 1 earn? (8) how many units do you earn? (8).

Now, according to each possible quantity that player 1 can send to you, you will decide the quantity of units that you will send back to him or her. When we know the decision of player 1, we are going to see how many units you will receive and how many units you have decided to send back to player 1 of the amount that you received plus your 8 initial units. According to this decision, your payment will be determined.

<<*Monitor shows the different options on the color cards and marks with an X the decision in the player 2 format* >>

Now, could you please answer these questions? <<*Fill out the survey*>>