Long- and short-term determinants of water user cooperation: experimental evidence from Central Asia

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Abstract:

This study contributes to the understanding of long- and short- term determinants of cooperation among water users. We experimentally investigate the potential of water users' self-governance in enhancing their contributions to a common pool as opposed to external regulation. Our focus is on the irrigated areas of Kazakhstan and Uzbekistan. Due to their Soviet past, these countries have a reputation for low bottom-up cooperation potential. Based on the different pre-Soviet irrigation traditions of the two study sites, we assess the effectiveness of short-term incentives compared to long term cultural factors of cooperation. History might matter, but we find it does not predetermine the success of current water decentralization in ancient as compared to relatively recently established irrigation sites. We find that external regulation, in fact, decreases farmers' cooperation, whereas face-to-face communication increases it. This finding calls into question the top-down approach prevalent in current water policies of the region. Moreover, it suggests the viability of endogenous cooperation and hence encourages the implementation of truly self-governed water management policies in Central Asia. However, the substantial heterogeneity in individual contributions apparent at the village level also signals a warning that one-size-fits-all approaches to local cooperation are unlikely to succeed.

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Keywords: Water-management, self-governance, field experiment, cultural determinants, Central Asia.

1 Introduction

At least since Hardin's (1968) publication of the "tragedy of the commons", how to prevent natural resources from over-exploitation has been a long-standing matter of academic and practical debate. Today many scholars argue that resources such as water, pastures or forests should be managed by local communities based on self-management principles rather than subjected to command and control regulation by a central government authority (Dietz et al. 2003; Pretty 2003; Ostrom 2005).

Yet the literature also increasingly acknowledges that arrangements for natural resource management which work in some places cannot be easily transplanted to others, and that some countries or cultures may even be less suitable for local resource management models than others. For example, experimental work in fifteen indigenous societies found enormous variation in the levels of individual selfishness or in willingness to contribute to the public good (Henrich et al. 2004). The prolific literature on social capital recognises that mutual trust among individuals and the inclination to cooperate vary a lot across localities and may obstruct their long-term prosperity (e.g. Putnam et al. 1993; Knack and Keefer 1997; Guiso et al. 2004). Views widely differ, however, to what extent such social capital is pre-determined by cultural endowments and historical antecedents that resist any short-run modification. If this was the case, policymakers can hardly hope to promote local cooperation by institutional reforms or other interventions, a view that runs counter to the very idea of development policy.

In this article, we focus on Central Asia, a world region that has a reputation for low levels of generalised trust among individuals (Rose-Ackermann 2001) and that struggles to establish a vibrant civil society and effective grassroots organisations (Ruffin and Waugh 1999; Omelicheva 2015). Attempts by international donors to promote principles of Integrated Water Resources Management (IWRM) in the region have been decisively mixed (Yakubov 2012; Zinzani 2015). By modifying a field experimental setting due to Cardenas et al. (2011), we investigate the contributions of individual farmers to a public irrigation infrastructure in two agricultural regions of Kazakhstan and Uzbekistan. Our interest focuses on the following questions: How does self-governance of farmers affect their contributions to the public infrastructure compared to exogenous regulation based on penalising defectors? How effective are such short-term alterations of incentives in relation to long-term cultural factors? What can thus be learned for the prospects of self-governed water management in these regions?

Our experiments were conducted in twelve villages located along major irrigation canals in South Kazakhstan (Maktaaral district) and Samarkand provinces, involving 235 farmers in a total of 47 sessions. During the experiments, farmers obtained an endowment to be allocated either for private consumption or to a public irrigation fund. Depending on the size of the irrigation fund, water availability and thus returns from farming for individual farmers increased. Based on experimental protocols developed by Cardenas et al. (2008; 2011) and a regression analysis of the data, we test the effect of two treatments on the share of farmers' budget dedicated to the irrigation fund: group-internal communication as a facilitator of self-governance and penalties for defectors as a form of external regulation.

In addition, we selected the experimental locations in a way that allows comparison of country and possibly cultural influences. Our two study sites have a very different history of irrigation development and, since the collapse of the Soviet Union, belong to two independent states with specific policy contexts. Irrigation in Samarkand had been managed at the community level since ancient times. Local water consumers used to elect and sanction water masters (mirabs) for centuries (O'Hara 2000). To the contrary, a large-scale irrigation infrastructure and bureaucracy was brought to South Kazakhstan only by the Soviets in the early 20th century (Dukhovny and Schutter 2011). Since independence, however, Kazakhstan has moved further towards a decentralised system of water management than Uzbekistan, and agricultural water policy has been more liberal (Wegerich 2008; Zinzani 2015).

Against the stereotype that trust and the self-organising power of citizens in the post-Soviet societies is underdeveloped, we find that the option to communicate within the group of users increased individuals' commitments to the common pool in a statistically significant way. While this is now a standard result in the literature (Cardenas and Ostrom 2004; Cardenas et al. 2011), our study is the first to confirm it for water cooperation in Central Asia and the post-Soviet realm in general. Consistent with research on the crowding out of publicly spirited behaviour by government regulation (Bowles 2008), we also find that strong penalties reduce individual contributions. However, this effect was statistically significant only in our Kazakhstani site. Across our core econometric specifications, water users in Kazakhstan contributed significantly more to the irrigation infrastructure than those in Uzbekistan. Even so, differences between villages irrespective of their location in either one of the countries were even more pronounced than between countries per se.

These results allow us to speculate about the long- and short-term drivers of water cooperation in Central Asia. We don't find evidence that cooperation is more prevalent in societies that have a long standing tradition of labour- and coordination-intensive agriculture (such as in the irrigated areas of Uzbekistan). This result disagrees with studies such as by Talhelm et al. (2011) trying to establish a "rice theory of culture" but supports Carnap (2017) arguing that there were no clear-cut connections between historical agricultural practices and current levels of social capital in India. Our findings suggest that in comparison with paternalistic Uzbekistan, the more liberal style of local governance in post-independence Kazakhstan encouraged individual cooperation.

Our results thus call into question the long-term cultural determination of local cooperation. They rather suggest that short-term policy modifications of water users' interaction may well have relevant effects on cooperation outcomes. In our study sites, other than top-down regulation, autonomous interaction by group members can improve their willingness to contribute to the common good. At the same time, the general inclination to work together was highly location specific. Taken together, these experimental results should encourage policymakers in Central Asia to pursue an agenda of decentralisation and local self-governance for water management.

The next section briefly reviews the literature describing both short-and long-term determinants of cooperation in the commons in an experimental and cultural context. Section three explores historical and current patterns of irrigation management in Central Asia. Section four gives the core hypotheses of the study and provides insights into our experimental design and methodology. Section five presents the results to be discussed in the context of the literature in section six, and section seven concludes.

2 Determinants of cooperation in the commons

The management of common pool resources (CPRs) represents a social dilemma, where human subjects face a situation in which individual interest conflicts with group interests. Consequently, organizing users' groups to achieve a collective solution is prone to free riding (Hardin 1968; Bowles, 2004). To understand how it could be overcome, Cárdenas and Ostrom (2004) ask how individuals make decisions concerning the use of natural resources within a group context and how those individuals come up with self-governed solutions mitigating the unsustainable exploitation of CPRs. They suggest that the participants of the experiment transform the material payoffs into a subjective-internal game in the field, driven by three categories of variables: (i) the material payoff of the game, (ii) the group-context and (iii) identity layer variables.

The information belonging to the *material-payoff* layer is the common knowledge of formally introduced rules of the game. Furthermore, the decisions of the individual might depend on how much that person knows about other participants of the game. The *group* composition knowledge thus refers to processes of reciprocity and retaliation, which might affect the level of trust and, thus, the cooperation decisions. Additionally there are some types of information which are possessed or stored by the individuals themselves. This type of information about their *identity* is not conditional on others' behaviour in the game, but rather reflects the players' own characteristics, cultural and moral values, perceptions and experiences (Cárdenas and Ostrom 2004).

This multi-layer framework helps explain how other factors than short-run material payoffs will affect the cooperation decision of actors. In fact, the layers may make cooperation the best response in the internally re-constructed game. But they also illustrate how some of these factors may be influenced by on-the-spot alterations of material payoffs, whereas others are predetermined by long-term processes of socialisation and cultural identity formation. This distinction has important implications for the extent to which cooperation can be influenced by policy measures, as they typically affect material payoffs only. If, in a given empirical setting, cooperation outcomes are largely driven by material payoffs rather than culture, institutional and policy reforms will have a much bigger leverage to affect these outcomes.

In experimental research, two widely studied options for influencing cooperative outcomes include endogenous cooperation via communication and external regulation via penalties. Laboratory experiments extensively proved the positive effect of *communication* on individuals' decision to cooperate in a repeated common pool resource environment. Ostrom and Walker (1991) found that when the communication was costless, players were able to successfully use this opportunity to efficiently improve their own understanding of the game settings, devise verbal agreements over the implementation of strategies and deal with non-conforming players. Furthermore, sanctioning opportunities, on a volunteer and majority-rule base, enabled the groups to achieve the highest average net yield (Ostrom et al., 1994). Furthermore, Cárdenas et al. (2011) detected similar positive effect of communication on cooperation decisions in a field experimental study with Colombian and Kenyan CPR users under anonymous individual decision making.

On the other hand, when faced with a credible *threat of punishment*, free riders will be induced to cooperate as well (Falk et al. 2002). Tenbrusel and Messick (1999) found that in dilemma situations, cheating was more likely to occur when sanctioning was weak. They also found evidence that sanctions made more people think of the decision as a business decision rather than an ethical one. When sanctions were high, cooperation could only be induced for the individuals who considered the decisions to be a business problem. However, Andreoni and Varian (1999) argue that the implementation of explicit incentive devices in the form of sanctions may also be damaging as they might crowd-out voluntary cooperation. If sanctions signal that selfishness is an appropriate response, if they compromise individuals' sense of selfdetermination, or if they convey an atmosphere of distrust or unfair treatment, they are likely to undermine the inclination to contribute to the common good (Bowles 2008). Cárdenas et al. (2011) found a positive high-penalty effect as opposed to a negative effect of low-penalty treatment, thus supporting Tenbrusel and Messick's findings.

The long-term determinants of cooperation have recently become the focus of empirical work using the concept of social capital, such as norms of reciprocity and networks of civic engagement (Putnam et al. 1993, 167). Carnap (2017) reviews the literature showing how agricultural practices and agro-ecological conditions of the past continue to exert an influence on the current-day organisation of cooperation. This work has become more fine-grained and focusing on specific subgroups of populations or societies. For example, Cohen et al. (1996) analysed behavioural differences between US males grown up in Northern or Southern states of the US to argue that descendants of pastoralists (the Southerners) display more aggressive behaviour than those of crop farmers (the Northerners), as they were used to defend their territory. Northerners, on the other hand, were more inclined to cooperate and coordinate. In their "rice theory of culture", Talhelm et al. (2014) show that Chinese students originating from rice growing regions displayed more interdependent and collectivist behaviour than students from wheat growing regions. They argue that rice growing needs much more coordination and interpersonal exchange in irrigation and labour management.

Cultural predispositions may make short-run policies more or less effective. For example, Cárdenas and Ostrom (2004) provide evidence of stronger externally introduced rule compliance among participants who self-classified as "state-believers", i.e. players who indicated that the state organization should take care of local CPR management. According to Wittfogel's (1957) classic theory of "hydraulic societies", the need to coordinate water management fostered the emergence of strong and hierarchically structured states based on rule compliance. On the other hand, more "individualistic" societies may be more inclined to rely on grassroots organisation and self-governance. In particular, the degree of autonomy that local communities enjoy vis-à-vis a central government has been shown to be a decisive factor in improving local self-management of the commons (Wade 1988; Ostrom 2005, 219-254).

3 The context of irrigation management in post-Soviet Central Asia

Dominated by low-lying deserts and flanked by extensive mountain ranges, the Central Asia region has been dependent on irrigation water conveyed by river streams since the beginning of civilization (O'Hara 2000). Water availability determined the location of early settlements, but ancient agricultural producers learned how to use this scarce resource as effectively as possible by establishing widely branched irrigation networks, water lifts, and accompanying management systems (Abdullaev and Rakhmatullaev 2013; Dukhovny and Schutter 2011). Ancient cities like Bukhara, Samarkand or Merv thrived on their ability to economize on the precious resource. Archaeologists and historical geographers documented how traditional water management relied on a highly hierarchical system of water masters (mirabs) who nevertheless were accountable to the water user communities. Specifically, the water masters were elected by water users and were paid a portion of the grain harvest, thus providing incentives for productive water management (O'Hara 2000, 373). Historic water user associations (ketmans) encompassing several villages were responsible for the local maintenance of the irrigation system and entrusted elders (aksakals) to decide about water distribution. Accountable to their local neighbourhood community (mahalla), elders would conscript the water users for regular construction and maintenance work (Dadabaev 2017). Villagers who refused to take part in labour mobilisation campaigns (hashar) would be fined or denied access to land and water.

The advent of first Russian Tsarist and later Soviet control of Central Asia in the early twentieth century undermined the traditional systems of water management. It replaced them by a state-run water bureaucracy detached from the finely calibrated incentive systems that had ensured productive water use for centuries (O'Hara 2000). Central Asia became a major cotton exporter to the rest of the Soviet Union, as vast areas of former desert and steppe land were turned into irrigated cotton plantations (Dukhovny and Schutter 2011). For example, major land development took place in the Hunger Steppe, including the Maktaaral district of the then Kazakh Soviet Socialist Republic (SSR), and in the Vaksh river valley in the Tajik SSR. Under the order of Moscow, massive canal structures were constructed and local decision making was replaced by scientifically determined irrigation norms administered by agricultural and water ministries and their local agencies. Workers from other parts of the Soviet Union or formerly nomadic Kazakhs were settled in the newly developed territories (Dukhovny and Schutter 2011). In the existing settlements, social institutions such as the neighbourhood community were absorbed by the collective and state farms established by the Soviets (kolkhozes and sovkhozes; Sievers 2002). As in other parts of the Soviet economy, coordination failures, inefficiencies and the squandering of resources loomed large. However, access to water was no longer regarded as a problem: "Diversion schemes brought what seemed to many an infinite supply of free water; the population, who had long viewed water as a scarce commodity, forgot its worth" (O'Hara 2000, 376). Considered nowadays one of the biggest environmental disasters of humankind, extensive irrigation led to the almost complete desiccation of the Aral Sea (Micklin et al. 2014).

The disintegration of the Soviet Union in 1991 left the independent republics of Central Asia with a legacy of dilapidated irrigation networks, an inefficient and underfunded water administration, a cotton monoculture planted on increasingly salinized soils and the challenge to develop a strategy for their agricultural sectors (Saiko and Zonn 2000; Liubimtseva and Henerby 2009). Administrative borders between the former Soviet republics that were almost invisible before suddenly raised the question of who would be entitled to use the water resources of the major transboundary rivers. Each independent republic embarked on a process of national identity formation that also led to different styles of governmentality and economic development strategies. Despite the common Soviet history, notable differences emerged between the two most populated countries of the region, Kazakhstan and Uzbekistan.

Since independence, both Kazakhstan and Uzbekistan have been ruled by long-standing presidents who had been appointed as party leaders already during the late Soviet Union.

However, referring to popular perceptions, Adams and Rustemova (2009, 1272) described state leadership in Kazakhstan as “managerial, flexible and pragmatic”, whereas Uzbekistan’s government was seen as “paternalistic and dogmatic”. The authors’ review of the recent academic literature suggests that these attributes of governmentality in both countries may reflect historic agro-ecological characteristics of the two nations:

“The nomadic Kazakhs had loose governmental structures that required consensus among various leaders, thus permitting them considerable autonomy, whereas sedentary societies such as that of the Tajiks and Uzbeks … required strong central control, rewarding submission to the needs of the group, which leads to monitoring and control over individual behaviour. … State centralisation in Kazakhstan may also be hampered by the vastness of the territory and low density of Kazakhstan’s population, … [which] led to an elite at the time of independence that was divided ethnically and regionally fragmented, pulling the state in various directions and resulting in a greater diversity of policy and greater pragmatism”. On the other hand, “Uzbekistan’s dense rural population and the distribution of water for the irrigation-dependent agriculture that makes up a large part of Uzbekistan’s economy make it a ‘hydraulic economy’” (p. 1274).

We concur with Adams and Rustemova that such historical determinism should be critically scrutinised, yet the agricultural reform paths chosen in both countries after independence and subsequent scholarly analysis lend some support to the general tendency (Table 1). Kazakhstan followed a course of gradual liberalisation of agriculture, dismantled the former collective farms and introduced private land ownership in 2003 (Petrick and Pomfret 2017). In South Kazakhstan province, currently about half of the land is used by individual farms. The remaining land remains in state farms or private agricultural enterprises. On average, individual farms in South Kazakhstan cultivate much less land than similarly organized farms in the rest of the country, about 6 hectares of arable land per farm. A private cotton export sector had emerged in the 1990s that re-attracted government attention only recently (Petrick et al. 2017).

Table 1: The two study sites in comparison

	Maktaaral (South Kazakhstan)	Samarkand (Uzbekistan)
Historical water management practices	Soviet land & irrigation development, water bureaucracy	Ancient irrigation systems based on communally accountable water masters, widely deformed during Soviet rule
Post-independence strategic role of agriculture	Production widely liberalised, emergence of a private cotton chain, recent subsidy increases	Cotton & wheat considered strategic crops, state-mandated delivery quotas, price controls
Land tenure	Private land ownership possible, long-term leases of state land	Long-term leases, state-mandated land allocations to strategic crops
Farm restructuring	Dissolution of state farms in early 1990s, av. cotton farm has 6 ha of land	Land distribution after 1998, reconsolidation after 2008, av. cotton farm has 100 ha of land
Water governance	Formation of water user associations in 1990s, state water agency	Partly dysfunctional water user associations est. after 2003, central planning of water allocation prioritizing irrigation of strategic crops

Source: authors.

To the contrary, Uzbekistan left the existing state administration of cotton production widely intact and sweepingly introduced private farms only in the 2000s (Pomfret 2008). This combination created a very particular Uzbekistani individual farmer who “has to bear the contradictions of being a state-steered, but privately owned, family managed enterprise” and who faces indirect taxation for production of state order crops such as wheat and cotton (Trevisani 2007, 150; Djalalov 2007). On a more general level, in Uzbekistan, “the state is still perceived by the people as the most legitimate organization for meeting their needs. Fundamental respect for the state as a legitimate representative institution is maintained in the minds of the people and is rooted in the Soviet-era political traditions and mindset in which the government was expected to provide an adequate living standard while the people did not challenge its authority” (Dadabaev et al. 2017, 17). The traditional institution of the Uzbekistani neighbourhood community (mahalla) underwent a gradual transformation that turned it into a hybrid organisation increasingly integrated into official legislation and co-opted by the government to exercise control over its citizens. This process started under Soviet rule and was further promoted after political independence (Sievers 2002; Dadabaev 2017).

Under the influence of international donors, both Kazakhstan and Uzbekistan considered the introduction of Integrated Water Resource Management (IWRM) principles to tackle the long-standing challenges in irrigation management, including the establishment of participatory Water User associations (WUAs) (Dukhovny and Schutter 2011; Zinzani 2015). Again, Kazakhstan introduced WUAs earlier than Uzbekistan and went further in granting them autonomy from state administration. However, local implementation proved difficult in either of the countries, as top-down government initiatives often conflicted with donor interests favouring bottom-up mobilisation of water users, and because of the rapid increase in the number of individual farms, changes in cropping patterns, generally poor financial and technical capacity of the new organisations, lacking leadership skills, and the persistence of mandatory state deliveries in Uzbekistan (Abdullaev and Rakhmatullaev 2013; Hamidov et al. 2015; Veldwisch and Mollinga 2013; Wegerich 2008).

4 Empirical approach

Because they allow the isolation of individual factors influencing cooperative outcomes while still providing a contextual frame to real-world decision makers familiar with that context, field experiments have become increasingly popular among scholars of local public good provision (Cardenas and Ostrom 2004). However, we are not aware of any field experiment conducted before on natural resource management in any post-Soviet country. In Central Asia, attempts to analyse local cooperation have either focused on the description of social institutions such as clans or neighbourhood committees or, in rare cases, devised survey instruments (e.g. to measure “social capital” as in Radnitz et al. 2009). At the same time, in addition to inevitable logistical issues, these efforts are regularly hampered by problems of official censorship, hostility of authorities towards independently conducted polls, and social expectations levied on respondents to please the authorities (Dadabaev 2017a). Given these possible constraints, our empirical study described next is a first attempt to utilise the methodological advantages of field experiments in a Central Asian setting.

4.1 Core hypotheses

Our review of the literature on the effects of policy treatments on cooperation levels leads us to the following hypotheses to be tested in a field experimental setting:

H1: Communication increases the cooperation of water users.

H2: Penalties increase the cooperation of water users.

Based on the idea that Uzbekistan has a much longer tradition of local water cooperation than Kazakhstan, we posit:

H3: Water users in Kazakhstan make lower contributions to the common pool than users in Uzbekistan.

However, as the literature considers Kazakhstan to be associated with a more liberal and decentralised regulatory environment, whereas Uzbekistan seems to host more citizens that could be labelled "state-believers", we suggest that:

H4: Communication has a stronger positive cooperation effect in Kazakhstan.

H5: Penalties have a stronger positive cooperation effect in Uzbekistan.

In the following, we subject these hypotheses to empirical scrutiny by using unique experimental data from irrigated areas of Maktaaral (South Kazakhstan) and Samarkand (Uzbekistan).

4.2 Experimental design

We replicated the irrigation game experiments of Cárdenas et al (2011) with a total of 235 farmers from twelve villages in pen and paper conditions (see appendix 1 for details on the field setting). The framing of the experiment was around water management and we assume that it was not difficult for the participants of the experimental sessions to understand the task. The irrigation game captured the characteristic of the sequential access of users to nonstationary and storage-impossible canal irrigation systems. One session with one group consisted of five players and each game continued for 21 rounds in total. The anonymity of all players' decisions was provided with the use of experiment cabins, which isolated the players from each other. The participants noted their decisions on the decision sheet they had in their hands, which was collected after each round.

Before each round we provided each player with ten coupons of endowment. In each round the players had to make two decisions concerning the creation of irrigation infrastructure and water use respectively. Both their investments and their earnings based on their water use decisions were expressed in coupons. They were provided with information tables concerning the collective investment level with its respective earnings and concerning the water use amounts with its respective crop-earnings (appendix 2)

We instructed the participants to make decisions on the endowment allocation. They could allocate the coupons across two options, namely to their private account or to their collective "public fund" which would then be used for the maintenance of the water infrastructure they were using to extract water for their crop production. The returns from these two accounts were constructed in a way to ensure that the situation symbolized a public good dilemma with multiple equilibria. That is, keeping everything in a private account is a best response Nash equilibrium, but if everyone contributes their endowments towards the public fund, then the socially optimum outcome is achieved. If the previous is the risk dominant equilibrium then the latter is the payoff dominant equilibrium.

We announced to the players how much they had collectively invested and how much water was available for their aggregate use. Then the next stage of the game started, the "appropriation" stage, where participants needed to make independent decisions on water extraction. Players were randomly assigned locations, symbolized by the first five letters of the alphabet (A, B, C, D and E). A was the head-end user, E the tail-end water user. These letters represented the order of the players' access to the resource.

We assigned baseline and treatment groups. The baseline groups did not communicate and they did not face penalties (see appendix 2 for more details). Through these experiments we studied the influence of communication and sanctioning on cooperation in public good dilemma. The experimental groups were treated with communication, low and high penalties. In the communication treatment, the groups were allowed three minutes to talk to each other before each round. During the penalty sessions, equal water sharing norms were established and norm-obedience was monitored with a probability of one over six. If norm-violation was detected, then the excess earning was withdrawn from the player in a low-penalty treatment case. In the case of a high-penalty, the violator's excess earnings and an additional six coupons were subtracted from his or her revenue column. By introducing an externally egalitarian sharing rule with imperfect monitoring, in other words a sanctioning mechanism, we created an environment which abstractly resembled the way in which WUAs were introduced to these communities of water users in our study area. Treatments started in the 12th round so that we were able to do both within group and between group comparisons.

4.3 Econometric model

To test our research hypotheses, we estimated the following regression model using ordinary least squares (OLS):

$$y_i = x_i'\beta + \varepsilon_i \quad ,$$

where y_i is the i'th player's cooperation level represented in the experimental observations as the share of his/her coupon endowment contributed to the public irrigation maintenance fund. x_i' includes treatments, country and control variables described in Table 2.

The coefficients of the treatment and country variables allow testing H1 – H3. We included interaction terms involving the treatment and country variables into one regression specification to test H4 and H5. All other variables serve as control variables which were partly taken from a post-experimental survey.

Table 2: Definition of variables and descriptive statistics of the experimental data

Variable name	Maktaaral					Samarkand				
	count	**mean**	**sd**	**min**	**max**	**count**	**mean**	**sd**	**min**	**max**
Individual endowment share contributed to the public fund %	2415	0.59	0.31	0	1	2519	0.51	0.29	0	1
Round	2415	10	6.06	0	20	2520	10	6.06	0	20
Others‘ contribution in preceding round %	2414	23.63	7.33	4	40	2519	20.21	6.15	2	40
Relative share of extraction in preceding round %	2405	0.20	0.17	0	2.17	2485	0.20	0.25	0	1
Experimental location [5=A...1=E]	2415	3	1.41	1	5	2520	3	1.41	1	5
Individual deviation in cotton land share from the group average [0..1][a]	2415	>-0.01	0.30	-0.78	0.54	2520	<0.01	0.09	-0.31	0.32
Individual deviation from group's average land size (ha)[b]	2373	-0.08	11.28	-31.87	63.11	2520	<0.01	23.0	-58.01	131.48
Actual position: Upstream (0/1)	2415	0.27	0.44	0	1	2520	0.33	0.47	0	1
Actual position: Midstream (0/1)	2415	0.43	0.50	0	1	2520	0.28	0.45	0	1
Education (years)	2394	15.05	3.25	9	18	2520	13.35	2.95	11	18
Household size (#people)	2394	6.55	2.86	2	20	2520	6.62	2.50	2	21

Notes: [a] *Individual deviation in cotton land share from the group average*=$c_{ij} - \overline{c_j}$ where $c_i$is i's share of cotton in total land (in real life) and $\overline{c_j}$ is the mean cotton share in group j;[B] *Individual deviation from group's average land size* = $\mathrm{l_{ij}} - \overline{\mathrm{l_j}}$ where $\mathrm{l_{ij}}$ is *i*'s farm land size (in real life) and $\overline{\mathrm{l_j}}$ is mean farm land size in group j .

Source: Authors.

5 Results

5.1 Description of participants and outcomes

We conducted the irrigation game sessions among water users in six villages in Maktaaral and in six villages in Samarkand. Almost all of the participants were involved in crop production with an average farming land size of 10.5 ha in Maktaaral and 37 ha in Samarkand (Table 3). Out of 120 participants in Samarkand only two were women. In Maktaaral, 15 of the 115 farmers that took part in the irrigation game sessions were female. The average ages of the farmers in the Maktaaral and Samarkand sample were 40 and 42 respectively. More than 54% of Maktaaral farmers and 28% of Samarkand farmers possesses University degree in our sample.

Table 3: Description of the participants

Characteristics	Maktaaral			Samarkand		
	count of observations	**count of farmers**	**mean**	**count of observations**	**count of farmers**	**mean**
Land endowment per farm	2373	113	10.52	2520	120	37.13

(mean, ha)						
Specialized in: crop production (% of total number of respondents)	2394	114	100	2520	120	100
Upstream (%)	2415	115	30.43	2520	120	33.29
Midstream (%)	2415	115	34.78	2520	120	33.37
Downstream (%)	2415	115	34.78	2520	120	33.33
Male (%)	2415	115	0.87	2520	120	98.32
Age (years)	2394	114	40.37	2520	120	41.78
Household size (people)	2394	114	6.55	2520	120	6.62
Education level:	2394	114		2520	120	
Incomplete secondary (9 year school- completed, in %)			0.88			0
Secondary general (11 year school, in %)			18.46			35
Secondary professional (vocational school, in %)			26.32			36.67
Higher (University degree, in %)			54.34			28.33

Source: Authors based on post-experimental survey data

The average contribution patterns were different across different treatment sessions and rounds (Table 4). The contributions of the players decreased over time in both study areas when no penalties and no communication were enacted. When the players were allowed to communicate with each other, the average share of endowment contribution to the public fund increased. This was not the case for either of the penalty treatment games, but rather the average share of endowment contribution continued to decrease even after the introduction of equal sharing rules with low and high penalties (appendix 3).

The irrigation game sessions produced a total number of 4846 observations. These observations are nested within one player and players within sessions, sessions within villages and villages within countries. In order to capture these aspects of the data, we included fixed effects for countries and villages in the regression models. The identity and group layer variables-characteristics of players during the 21 rounds of the game do not change and they thus control for fixed session effects.

Table 4: Average individual contributions to the public fund across session phases and treatments

	Maktaaral		Average percentage point change	Samarkand		Average percentage point change
Baseline sessions						
Baseline - rounds 1-11	0.64	**	-9.80%	0.52	***	-15.60%
Baseline-rounds 12-21	0.58			0.45		
Communication sessions						
Baseline-without communication rounds 1-11	0.63		3.60%	0.49	***	20.20%
Communication rounds 12-21	0.66			0.61		
Low-Penalty sessions						
Baseline-without low penalty rounds 1-11	0.59		-6.00%	0.52	**	-10.60%
Low penalty - rounds 12-21	0.56			0.47		
High-Penalty sessions						
Baseline-without high penalty rounds 1-11	0.55		-8.30%	0.52	*	-8.10%
High penalty - rounds 12-21	0.50			0.48		

*Notes: t-test significance level: ***1%, **5% ,*10%: test on the equality of mean values of the 1-11 and 12-21 rounds of respective games*

Table 5 presents the regression results of three OLS models. Model 1 represents the simplest specification including the treatments and a direct country effect. Model 2 adds country and treatment interaction effects to the specification. Model 3 keeps the treatments but replaces the country effects by village level fixed effects. All models generate insights about hypotheses H1 to H3, while model 2 specifically addresses H4 and H5. In the following we discuss, in turn, the results on the core hypotheses, further determinants of cooperation, and village effects.

Table 5: Regression results of the individual endowment share contributed to the public fund

	Model 1: Country effect		Model 2: Country & treatments effects		Model 3: Village effects	
Round	-0.003	***	-0.003	***	-0.004	***
	(-3.93)		(-3.80)		(-5.35)	
Communication treatment	0.100	***	0.118	***	0.134	***
	(6.37)		(5.66)		(8.87)	
Low penalty treatment	0.004		0.005		-0.002	
	(0.24)		(0.26)		(-0.14)	
High penalty treatment	-0.016		0.010		-0.020	
	(-1.11)		(0.56)		(-1.46)	
Others' contribution in preceding round %	0.007	***	0.006	***	>-0.001	
	(10.31)		(10.16)		(-0.41)	
Relative share of extraction in preceding round %	0.116	***	0.115	***	0.108	***
	(5.05)		(5.03)		(4.78)	

Experimental position [5=A...1=E]	0.018	***	0.019	***	0.017	***
	(5.29)		(5.30)		(5.12)	
Individual deviation in cotton land share from the group average	0.096	***	0.095	***	0.092	***
	(4.81)		(4.82)		(4.73)	
Individual deviation from group's average land size	-0.001	***	-0.001	***	-0.001	***
	(-3.36)		(-3.35)		(-3.46)	
Actual position: Upstream	-0.010		-0.010		0.004	
	(-1.00)		(-1.00)		(0.34)	
Actual position: Midstream	0.021	**	0.023	**	0.018	*
	(2.07)		(2.28)		(1.78)	
Education (years)	-0.005	***	-0.005	***	-0.007	***
	(-3.40)		(-3.34)		(-4.88)	
Household size (#people)	-0.002		-0.002		-0.002	
	(-1.45)		(-1.41)		(-1.08)	
Engbekshi Village (0/1)					0.145	***
					(6.50)	
Zhanazhol Village ((0/1)					0.313	***
					(13.64)	
Dostyk Village (0/1)					0.201	***
					(9.94)	
Intymak Village (0/1)					0.391	***
					(18.21)	
Maktaly Village (0/1)					0.145	***
					(7.12)	
Kyzylkum Village (0/1)					0.183	***
					(8.49)	
Eski Jomboy Village (0/1)					0.255	***
					(12.28)	
Juriat Village (0/1)					0.199	***
					(9.99)	
Qochqor-Torayev Village (0/1)					0.069	***
					(3.54)	
Aytamgali Village (0/1)					0.162	***
					(8.45)	
Dehkanabad Village (0/1)					0.136	***
					(7.00)	
Kazakhstan (0/1)	0.067	***	0.08	***		
	(7.62)		(7.55)			
Kazakhstan * Communication treatment			-0.037			
			(-1.37)			
Kazakhstan * Low penalty treatment			-0.004			
			(-0.15)			
Kazakhstan * High penalty treatment			-0.058	**		
			(-2.23)			
Constant	0.393	***	0.386	***	0.427	***
	(13.56)		(13.28)		(13.77)	
Observations	4,846		4,846		4,846	
R-squared	0.092		0.093		0.154	

Robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1

5.2 Communication, sanctioning and country effects

In the context of our study, the communication treatment tests whether self-organized cooperation in irrigation water management evolves if participants are allowed to talk to each other (H1). We found a positive effect of the communication treatment on the individual's decision to cooperate in the form of investing more in the public fund. The significantly positive effect is observable in all three models presented in Table 5, so that H1 is clearly confirmed. The participants were hence able to use the repetitive interactions to enhance their understandings of the game settings, and devise informal and internal agreements on strategies for dealing with norm violations, with a direct effect size of between 10 (Model 1), 11 (Model 2) and 13 (Model 3) percentage points.

H2 entails the hypothesis that penalties induce cooperative behaviour. None of the three regression models allows rejecting the hypotheses that any of the low or high penalty effects were equal to zero, so that the evidence speaks against H2.

Model 1 provides an estimate of the direct country effect undisturbed by interaction terms and village effects. It suggests that users from Kazakhstan were contributing 6.7 percentage points more on average than the Uzbekistani users. This result provides evidence against H3.

To test H4 and H5, we used the coefficients of the interacted variables from models 2 to estimate the treatment effects by country, employing the delta method to calculate the standard errors of the compound effect (Table 6)**.** In contrast to what we hypothesized, the effect of the communication treatment in Maktaaral was positive but smaller in size than in Samarkand (H4). Uzbekistani participants contributed 11.8 percentage points more under communication, whereas Kazakhstani players contributed only 8.1 percentage points more. That is, H4 is not supported by what we see in Table 6.

Table 6: Treatment effects on the individual endowment share contributed to the public fund, by country

	Model 2			
Treatments	*Maktaaral (Kazakhstan)*		*Samarkand (Uzbekistan)*	
Communication	0.081	***	0.118	***
	(3.93)		(5.66)	
Low penalty	0.001		0.005	
	(0.05)		(0.26)	
High penalty	- 0.048	**	-0.010	
	(-2.23)		(-0.56)	

Note: Effects based on coefficients of interacted variables shown in Table 5. Significance level: *** p<0.01, **p<0.05, * p<0.1; t-statistics in parentheses.

We did not find evidence of sanctioning effects, whether positive nor negative, on the decisions by Uzbekistani participants (H5). However, high penalties produced a significantly negative effect in the Kazakhstan sessions. Other than in Tenbrusel and Messick (1999) and Cardenas et al. (2011), high penalties were thus less effective than lower ones.

Our evidence thus calls into question the validity of H5, positing higher contributions under penalties. While we detected no positive penalty effects on cooperation in Uzbekistan, high penalties even crowded out contributions by Kazakhstani users (Table 6). Therefore, the externally introduced equal resource sharing rules with imperfect monitoring and enforcement mechanisms did not improve cooperation among participants in Kazakhstan, but rather deteriorated it.

5.3 Further determinants of cooperation

With more repetition of the interactions, the players learn about the rules and the material consequences of particular actions and, with time, what Cardenas and Ostrom (2004) call internal game payoffs converge with the external game payoffs. The decisions of the individuals might hence move closer towards the self-regarding Nash equilibrium as the rounds continue (Isaac et al., 1985). We found evidence of a small learning effect across all three models in Table 5, around -0.3 and -0.4 percentage points.

According to estimates in models 1 and 2 when the participants experienced a higher contribution from the rest of the group in the previous round, they tended to increase their own contribution in the next one. This effect is very small in size although it is statistically significant. Players hence seem to behave reciprocally according to two models in Table 5, contrary to the results by Cardenas et al. (2011). We tested for interaction with the country dummy, this effect proved to be significantly different from zero, but estimates were small in size ranging from 0.006 and 0.01. According to our data, players in Kazakhstan are more reciprocal than players in Uzbekistan. Moreover, we found that water users contributed more to the public fund when they received a higher share of water available to the group in the preceding round. We attribute this effect to reciprocating behaviour (tit-for-tat) or an increased certainty farmers perceive concerning the return on their own investment.

Furthermore, we hypothesized that individual decisions depend on how much the person knows about the other participants of the game. We expected that an individual farmer whose farm land size is higher (lower) than the group's average would be less (more) cooperative. We found that indeed such mechanism seems to be at play. On the other hand, farmers with an above average share of irrigation-dependent cotton in their crop rotation contributed more.

Players who were randomly assigned higher positions with respect to water tended to contribute more of their endowments to the public fund than players in lower positions, although the effect was quite small (Table 5). The upstream water users had better access to water than the downstream users. Therefore, they were surer that their investment in the infrastructure would pay back, as argued by Cárdenas et al (2011).

The actual position along the canal also influenced the individual decisions to cooperate. Midstream farmers tended to contribute more than both the downstream and upstream water users in all three models. This finding supports Uphoff et al (1990) stating that farmers will be more willing to participate in water self-management where water supply is relatively scarce rather than absolutely scarce or abundant.

Farmers with more years of education and more household members contributed less. But taken together, with the exception of share of extraction in preceding round, these further factors appeared to have little influence on cooperation as compared to the treatment effects.

5.4 Village effects

In addition to the country effects, our data also allows a more fine-grained analysis of village-level variation in farmers' contributions to the public fund. The village fixed effects (model 3 in Table 5) include all village-invariant observable and unobservable factors. There are many possible factors contributing to a village's social capital, which are hard to define and measure. The village fixed effect captures those effects without having to define or measure them explicitly. However, we cannot separately isolate the effects of different such factors (Khwaja, 2009, 905).

We list the average contributions by village relative to the lowest ranking village, Chimboy in Samarkand province, in Table 7. The average contributions are taken from model 3 in Table 5 and are thus purged from individual player characteristics as included in the regression. As Table 5 reports, the differences to the reference village are all significantly different from zero at the 1% level. The difference can be up to 39 percentage points (as for Intymak village). We ranked the villages according to their location along the canal, starting from the head end in both study sites, to qualitatively assess the relation between actual canal location and experimental cooperation levels. In fact, no clear pattern appears, thus calling into question arguments by Wade (1988, 163) that tail-end users are more inclined to cooperate as water is scarcer than at the head end.

Moreover, we added a couple of remarks on village characteristics that we discovered during the field study. Ethnically heterogeneous or distinct villages (Engbekshi, Dostyk, Qochqor-Torayev) tend to display lower cooperation scores, thus giving some support to the view that ethnic fractioning may jeopardize cooperation (Khwaja 2009). Engbekshi was called "Slavyanka"

("Slavic") until 1993. According to local sources, it was founded in 1900 under Tsarist rule, when Slavs, Tatars, Greeks and Koreans were settling in the area. After the collapse of the Soviet Union, the share of the non-Kazakh population declined, although the old name remains in use among local people. We had particular difficulty in engaging players for the sessions in this village and even had to cancel one session (Table 7).

Table 7: Village effects

Villages listed according to their order along the canal, starting with head end	**Average contribution relative to lowest ranking village (from regression table)**	**Remarks on village characteristics**
Maktaaral		
Engbekshi	0.145	Slavic settlement established in 1900; relatively heterogeneous ethnic composition
Zhanazhol	0.313	
Dostyk	0.201	Ethnically homogeneous Tajik village
Intymak	0.391	Village name means "solidarity" in English
Maktaly	0.145	
Kyzylkum	0.183	
Samarkand		
Eski Jomboy	0.255	Free from state cotton order
Juriat	0.199	Free from state cotton order
Qochqor-Torayev	0.069	Ethnically distinct, called "Arab village" by outsiders
Chimboy	0 (=reference village)	Relatively poorest quality of roads among all villages
Aytamgali	0.162	
Dehkanabad	0.136	

Source: authors.

On the other hand, an ethnically homogenous village representing the majority group, Intymak (meaning "solidarity" in English), displays the highest cooperation score. Farmers voluntarily organised themselves into groups in front of the experiment venue, waiting for us to finish the session and asking us if we can run another session with them. In Chimboy, the low cooperation levels demonstrated during the experiments were also reflected in the exceptionally poor shape of the transport infrastructure. However, the absence of the cotton order in Eski Jomboy and

Juriat did not seem to have a noticeable effect on cooperation levels. These observations don't provide conclusive evidence but should rather be taken to stimulate further research.

6 Conclusions

Based on unique field experimental data from agricultural water users in Maktaaral (Kazakhstan) and Samarkand (Uzbekistan) we found no evidence that historic irrigation patterns or ancient management practices constitute long-term determinants of local water cooperation today. While Samarkand has a much longer tradition of decentralised water management, current cooperation levels were actually higher in our Kazakhstani site.

Even so, the comparison of Kazakhstan and Uzbekistan suggests that endogenous cooperation can be stimulated by a regulatory environment that enables more autonomous decision making (as in post-independence Kazakhstan). Moreover, policies that foster within-group interaction promote cooperation both in Kazakhstan and Uzbekistan. Starting from a higher ex-ante cooperation level, the policy effect was lower in Kazakhstan. Under a treatment allowing face-to-face communication in the group, the players consistently contributed more than 60 per cent of their endowment to the public fund. The average contribution level under communication among Kazakhstani water users (66 per cent) was in fact identical to the one found by Cardenas et al. (2011) for Colombia using the same experimental setting. While contribution shares in Uzbekistan were slightly lower (61 per cent), they still exceeded the ones reported by Cardenas et al. for Kenya (47 per cent).

Our results imply that penalties have little effect in an environment described as paternalistic and state-centred (represented here by Uzbekistan). In a more liberal environment (as in Kazakhstan), high penalties for defectors may even crowd out voluntary contributions. In addition, strong village-level effects suggest that idiosyncratic local characteristics such as ethnic composition or norms of cooperation may be more decisive for cooperative outcomes than policy blueprints imposed from outside.

The results presented here thus call into question an emerging literature arguing that historic agricultural practices play a crucial role for understanding current-day cooperation outcomes (Talhelm et al. 2011; Carnap 2017). However, the findings also unequivocally support the idea that policies entrusting local users with a degree of autonomy and scope for local interaction do work in Central Asia. As this effect was stronger in the Uzbekistani site characterised by a more constrained and hierarchical real-world policy environment, the results even suggest that the potential for local cooperation is similar in both places. While this finding is borne out by many empirical studies worldwide (such as quoted in Ostrom et al. 1994 or Cardenas et al. 2011), we are the first to demonstrate it experimentally for post-Soviet Central Asia.

International observers repeatedly recommend that Central Asian water administrators should strive to revive ancient principles of local water cooperation and management in the region (Abdullaev and Rakhmatullaev 2013; O'Hara 2000). In our Maktaaral site, the only notable tradition of water management is due to the Soviet water bureaucracy, but still the cooperation levels are higher today than in ancient Samarkand. This insight suggests two conclusions: First, whatever historically beneficial management practices may have prevailed in Samarkand, they were muted or even revoked by a century of top-down administration and thus assimilated to practice elsewhere in the Soviet Union. Second, history is not predetermining the future; current water management can be policed and there are more or less conducive ways to do so.

In Central Asia, it appears that productive ways of water governance need to be re-invented and turned into going practice once again. As shown above, twenty-five years after national independence, both Kazakhstan and Uzbekistan display a decisively mixed record of experimenting with such new (or renewed) practices and policies. The results of a single experimental study are in no way sufficient to fully identify the behavioural trend of Kazakhstani or Uzbekistani water users as a whole. Our results, however, provide us with a basis for informed speculation. The evidence provided here supports the view also advocated by international donors that decentralised and participatory water management for example in WUAs under a regime of IWRM can be viable. While the complexity of administering such governance systems greatly exceeds the stylised forms of interaction captured in field experiments, our results nevertheless convey the message that greater autonomy for water users enabling their truly endogenous organisation will evoke higher individual contributions to the local common good. However, the substantial heterogeneity in individual contributions apparent at the village level also signals a warning that one-size-fits-all approaches to local cooperation are unlikely to succeed.

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Appendix 1: Field and project setting, selection of regions, villages, participants

We selected twelve villages in total for the experimental sessions. The selection of the villages in both Maktaaral and Samarkand was based on one common criterion: the relative location of the village with respect to the main surface irrigation source. We conducted the experiments in Kazakhstan during October and November of 2016 and in Uzbekistan during November and December of 2016. The team of experimenters consisted of the first author and a local moderator who explained the rules and regulations of the game to the participants and assistants.

Table 8 - Study sites and session schedule

Province	District	Relative location within the study area	Village	Average contributed share of endowment	Number of sessions per village	Number of participants per village	B	Sessions per treatment		
								C	L	H
South Kazakhstan	Maktaaral	Head	Engbekshi	0.506	3	15	1	1	*0	1
		Head	Zhanazhol	0.674	4	20	1	1	1	1
		Mid	Dostyk	0.546	4	20	1	1	1	1
		Mid	Intymak	0.739	4	20	1	1	1	1
		Tail	Maktaly	0.507	4	20	1	1	1	1
		Tail	Kyzylkum	0.548	4	20	1	1	1	1
Samarkand	Jomboy	Head	Eski Jomboy	0.627	4	20	1	1	1	1
		Head	Juriat	0.562	4	20	1	1	1	1
	Pastdargom	Mid	Q. Torayev	0.441	4	20	1	1	1	1
		Mid	Chimboy	0.371	4	20	1	1	1	1
	Payarik	Tail	Aytamgali	0.527	4	20	1	1	1	1
		Tail	Dehkanabad	0.503	4	20	1	1	1	1
			TOTAL		**47**	**235**	**12**	**12**	**11**	**12**

Notes: B: Baseline; C: Communication; L: Low- penalty and H: High-penalty.
* One low-penalty session was cancelled in Engbekshi. We scheduled 3 times, but we could not attract enough farmers every time.

After deciding on the particular village set in each country, we met with district level authority representatives to introduce ourselves and explain our objectives and request official permission for our activity in their territory. Once the formal matters were resolved, we paid a visit to all the villages on our list. During these initial introductory visits, we contacted local village leaders and explained them the context of our study and requested their support in communicating this message to local farmers. In this way, we created a preliminary schedule of our field trip, during which the experimental sessions needed to be accomplished in each village. Essentially, recruitment took place through word of mouth, but it was always sourced from the local leader. That is, we requested the village leader to announce our experiments to the farmers in his village on a particular date. This was especially useful to organize initial sessions in a new village. Then most of the times farmers, who participated in the experiments, supported us by engaging fellow farmers to take part in the next sessions in the villages.

The experiments were conducted in various locations in the villages. Sometimes it was classrooms of the village schools and technical colleges. Occasionally local village authority representatives provided us with a space from their own buildings. All sessions were conducted with the permission of the respective local-district authorities.

Locations where experiments were conducted

Engbekshi – village school assigned a classroom for the experiments. It was equipped with a sufficient number of tables and chairs and a whiteboard.

Zhanazhol – village authority allocated a room from the aul-akimat (village authority) building.

Dostyk – half of the sessions were conducted in a room located in a local WUA office. The other half of the sessions were run in a local village school classroom.

Intymak – the village authority allocated a room for us in its building for all sessions.

Maktaly – we conducted the sessions in a village authority building. The sessions which were run during the weekend were held in the private house of a local farmer.

Kyzylkum – we received a hall in the building of the village authority (aul-akimat).

Aytamgali – a classroom in a village school was assigned by the district authority (Payariq hokimiyat)

Dehkanadbad – a classroom in the local agricultural technical college was assigned by the district authority (Payariq hokimiyat).

Qochqor Torayev – a meeting room of a local machine tractor park (MTP) building was assigned by the director of the MTP.

Chimboy – a classroom from a service college was assigned by the local MTP director of the village.

Juriat – a classroom from a village school was assigned by the district authority (Jomboy hokimiyat)

Eski Jomboy – a classroom from a village technical college was assigned by the district authority (Jomboy hokimiyat)

Appendix 2: Experimental Protocol

Irrigation Game

BASELINE

1. Dear farmers, thank you very much for accepting our invitation and coming to this place.

2. This is XXX from YYY. And this is the group which has gathered to assist XXX in conducting the experiment. I am _______, and I will be explaining all the instructions to you today. And these are __________ (names of other assistants) who will be assisting in the experiment.

3. This is a voluntary session. If you do not want to participate you can leave our session, but our request is to do so before we start the process.

4. We have gathered you here with the aim of conducting a research experiment. This is an exercise to understand the potential of farmers to manage irrigation systems in your area. Since Kazakhstan/Uzbekistan became independent, things have been gradually changing. Different reforms are being implemented. Such reforms are implemented in the irrigation water management sector of the country. The country is moving towards passing water management into the hands of water users like you. Because of these ongoing changes and processes in Kazakhstan/Uzbekistan, we are interested in studying the potential of water users.

5. Each person who takes part in the experiment will receive 2 euros (equivalent in local currency: KZT/UZS) for his/her participation. It is a payment for showing up here to the experiment.

6. You can earn more during the course of the experiment; the money you earn today comes from the research institute.

7. Why have we introduced a payment mechanism to this experiment? We wanted to have a realistic environment. We want to know what irrigation water means for crop production in Maktaaral/Samarkand. It means: if irrigation is applied appropriately, the farmer/peasant obtains a better harvest, and this means that he/she obtains better earnings. Am I right?

8. So our experiment wants to capture this real-life-aspect, though in a very simplified way. All details we receive today in this session will only be used for research purposes. No part of them will be available to any government agencies either in here or in ZZZ (country).

9. We request you to listen to the instructions very carefully. Whenever you do not understand, please just ask your question immediately, by raising your hand. Also, if you do not hear the instructions very well, let us know.

10. Each round of the experiment is expected to last 3-4 minutes. We are expecting to take 2 to 2.5 hours of your time today.

11. Imagine all of you are farmers with the same sized land. And you cultivate the same crop.

12. In real life we know that in order to be able to irrigate our fields we need to have an appropriate irrigation system. In order to have an appropriate irrigation system we need to invest either in the form of money or labour. So this experiment is based on such real-life scenarios which are usually faced in making decisions about irrigation.

13. You – all five – are one group of water users, who use the same watercourse. You will play several rounds. Each round is equivalent to one irrigation season (figuratively).

14. Within this group of five, each player is randomly assigned a unique position identified in alphabetical order (Cyrillic): А, Б, В, Г, Д. (then converted in - A, B, C, D, E equivalent in Latin)

15. By drawing concealed envelopes [an assistant distributes five envelopes to the participants in this moment] you will receive those letters. Please, without showing to others, open your envelope and see what letter of the alphabet you have received. See it and remember it please.

16. Now, as you may have noticed, there are folders in front of each player (on your tables). Please open that folder and you will see a first page which is a **yellow** colored piece of paper with the title “Player’s decision and earnings in coupons”. On the top of this yellow sheet you will see a line where it says: “player’s position”. If you remember what letter you received in the envelope (if not, then please look back and see again) please write that letter there (on the yellow page).

17. In the folder, you will see a name-badge with some numbers, could you please attach it so that we can see them clearly.

18. Before starting each round, we will distribute 10 coupons to each player. To save time, we will not distribute them physically, but they are inserted in your yellow paper. Look at that yellow paper and see the second column, there is “10” in every row. So this means that we are distributing them to you each round.

19. What do those coupons mean? They are our currency in the experiment. One coupon means 0.02 euro (local currency equivalent). Each round we are actually distributing to each player (0.02*10) 0.2 euro. What to do with those coupons (with such monetary value)?

20. Each round you are asked to make two decisions: The **first decision** is about **investment.** That is investment of the coupons we distribute to you each round. You should decide where to invest.

21. There are two options of investment for every player. **One** is to keep in your private account. Another is to invest in the Public Fund, which will be used for the maintenance of irrigation infrastructure. Basically, whatever (amount of coupons) is not invested in the public fund it is kept in your private account.

22. Why do you need to invest in irrigation infrastructure? The amount of water available for you to irrigate depends on your collective level of investment. Investment in the maintenance of irrigation infrastructure means that less water is wasted. More water is available to you.

23. Collective investment for a group is calculated by adding the individual investment of each of you. The sum of the contribution will affect the amount of water available to the five players. Now I want to show you how it happens.

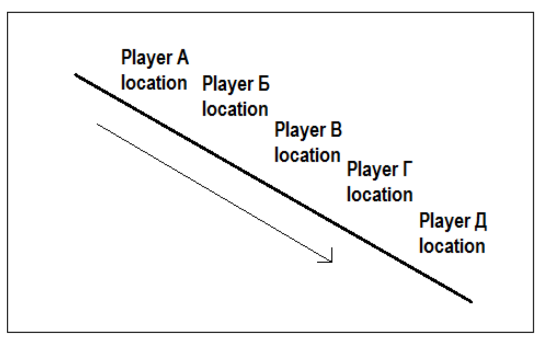
24. Again, look back to your folder. There you find a **blue** paper. In that paper you will see a table and graph. They both have the same information. Let’s, for convenience, choose one of them, let’s go to the table. There you will see two columns. One is the collective amount of investments made by your group. The second column illustrates the total water available to your group (in minutes). Let’s say: if you altogether invest 41 coupons (all five of you) then you will

have 96 minutes of water [SHOW IT VERY CAREFULLY, MAKE SURE EVERYONE IS UNDERSTANDING]. For simplicity sake we are using minutes instead of volumetric units of water use measures. [ASK FURTHER QUESTIONS ABOUT THE TABLE on blue sheet] We will announce your collective investment. But we will not say anything about your individual investments.

25. If you remember, we said each round each player makes two decisions. The investment decision was your first decision in the round. Your second decision is about your water extraction. That is your water use.

26. As in real life farming, here your earnings are dependent on your water use. Lets' go back to your folder. There you will see a **pink paper**, which has the title "Second decision". Again, there you see both a table and a graph. As it was on the blue paper, here as well both (table and graph) carry the same information. Let's go with the table as we did before [SHOW WHICH on the paper]. The first column of the table shows you how many minutes of water you used and the second column shows how many coupons you earn from your used water minutes. For example, one player uses 18 minutes of water, how many coupons do you earn? You earn 19 coupons. [ASK QUESTIONS TO MAKE SURE THEY – EACH UNDERSTOOD the table]. This was briefly about your second decision.

27. Now we return to the yellow paper [SHOW IT], the paper where you wrote the letter of the alphabet. You might ask: why we need to give such a position to you? Well, you all are farmers in irrigated areas, who have a lot of experience in water use. That is, you know very well that there are always people who get access to water before others because of their position. In other words, there is always someone who is an upstream water user and someone who is a downstream water user. [DRAW THE FOLLOWING AND EXPLAIN]



28. So in our case, as you might have understood that player A is an upstream water user. Only after A finishes using water, can player Б withdraw water to his field. Then comes B, then Г and Д. Remember, do not tell anyone your position, I mean the other players.

29. Now that I have somewhat introduced the main conditions of our experiment, I will provide you with an example for better understanding. For example, I am one of five players. In the envelope I received the "A" position. That is, I am the upstream water user. And [indicate another assistant] she/he received "Б" . But we both don't know each other's letters. I just know my own. That is it. The round starts. The experimenter asked us to make our first decision of the first round. I need to decide where to invest my 10 coupons. [REMIND about initial endowment of each round, about 10 coupons]. I need to decide how many of the 10 coupons to invest in the public fund which then goes to the maintenance of the irrigation system we use. I will write down my decision on the yellow paper in the third column [SHOW IT]. Then all the yellow papers are collected. Here on this table [SHOW the table] everyone's investment is summed up and the group investment is written on the board. The point is that everyone knows the aggregate investment, but nobody will know what (for example) my particular-individual investment was. On the board we will write the group investment. And looking back to the blue paper we will see how much water that investment creates for our collective use.

30. Then the time for the second decision comes. NOW please pay attention! After the first decision, the experimenters collected the yellow paper (do you remember?), so in order for us to make our second decisions we need the yellow papers back. Those papers are returned back, BUT only one player receives his paper with such a sticker [SHOW the sticker] with water minutes available to him. For example, let's say the group investment was 42 coupons, please look to your blue paper, how many water minutes does it give? 95 right? So player A (upstream one) receives his paper with a sticker attached, where 95 is written. This means that first it is only this player's turn to withdraw water and the rest of the participants will just sit without doing anything. We have these wooden barriers in between you because of this reason, to make sure that you cannot see each other writing or not writing. So, coming back to this sticker. We said 95

minutes was the group's water level, player A 's paper is attached with this "95" sticker. Then we will distribute the papers to the owners. So player A (who received his paper with the sticker) makes his first decision. Then we collect everyone's yellow paper. We take records for ourselves. We update the sticker. For example if Player A used 15 minutes of water (95-15=80). We take a new sticker and write 80 minutes on it and attach it to player Б's yellow paper. (Why Б?, because it is the second person who can get access to the water – [show the graph]). Б makes a decision then the yellow papers are collected, an updated sticker is attached to player В's paper (Cyrillic), and so on so forth, and this procedure continues until the last player Д makes his water use decision. Then the next round starts.

31. To train ourselves, we can start with a "practice" round. You can see a row where it is written "Practice round". So we can play this round, and see if everyone has understood things correctly or not.

32. If you have any questions, you can also ask now. If not, we will start the round.

[PLEASE BEFORE STARTING SHOW HOW TO CALCULATE THEIR EARNINGS]

Communication treatment (explained after round 11)

33. Now we would like to introduce something else to the experiment.

34. Before starting every round, that is, before making your first decision, we will invite you talk to each other. We will give you three minutes before each round to communicate. We will not intervene in your conversations. It is totally up to you how you lead the communication. After three minutes of communication, the same steps will follow. That is, you make your simultaneous first decision. Then the papers are collected. Then you will make your second decisions sequentially in alphabetical order.

Penalty treatment (explained after round 11)

[Either communication or Penalty treatment is played, but not both]

35. Now we would like to introduce something else. We will introduce a regulation.

36. The regulation is about the amount of water you use/extract. We say: whatever amount of water you have after your investment decision, we will divide the total water minutes by five

(Total Water Minutes/5) and the result will be the norm (of equal sharing). [On the board we will write down new line "RULE____minutes per person"] After the second decision is made, an inspector is sent to investigate your second (water use) decision. Our inspector will inspect you only when [SHOW THE DICE] "six" is rolled. One of our assistants [TEL THE NAMEs] will roll the dice in front of you. And if the dice shows 6 you will be checked. If you violate the norm-rule (which was written on the board), our assistant will tell us how much you extracted,

36.1**. [Low-penalty-treatment**] and we will subtract the extra coupons you made from the violation of the rule. We will take them back. If the dice does not roll 6, you will not be inspected.

36.1. [**High-penalty-treatment**] we will subtract the extra coupons you made from the norm violation, and in addition you will be forced to pay a fine in the form of 6 coupons.

Player's decision sheet (yellow paper)

Player's position (alphabetical letter from your envelope) ___________

Player's decisions and respective earnings					
	X	**Y**		**Z**	**X-Y+Z**
Round	**Number of tokens we give each round**	**1st DECISION: Your contribution for irrigation infrastructure maintenance**	**2nd DECISION: Your water use** (how many minutes you use water)	**Your earning from water use** (see how much water you used then look to the "water use" table)	**Your total earning (in coupons)**
Practice	10				
1	10				
…	…	…	…	…	…

Player ID____________________

Water amount resulted from collective investment – table

First decision (blue sheet of paper)

Group investment (in coupons)	**Water available (in minutes)**
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

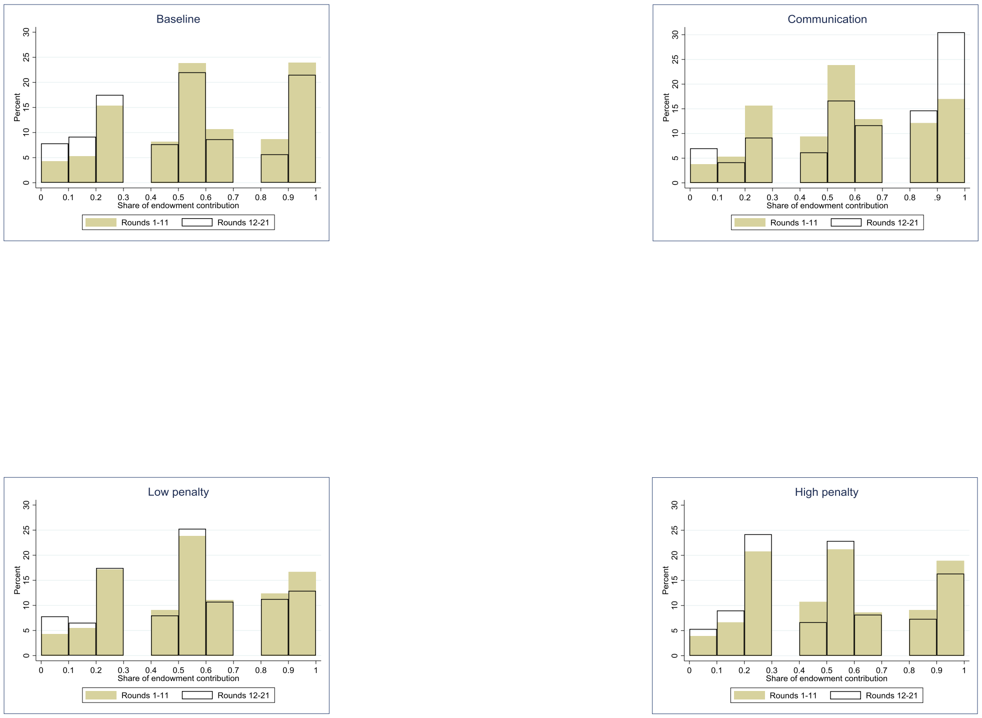
Amount of earnings (coupons) from irrigation decisions – table

Second decision (pink sheet of paper)

Your water extraction in minutes	**Coupons earned**
0-5	0
6-7	2
8-10	5
11-12	10
13-15	15
16-17	18
18-20	19
21 -22	20
23-25	20
26-28	18

Appendix 3: Distribution of contribution decisions across baseline and treatment games

Figure 1: Distribution of contribution decisions across baseline and treatment games



Source: Irrigation game experiments in Kazakhstan and Uzbekistan