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Community, state and market: Understanding historical water governance evolution in Central Asia

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Community, state and market: Understanding historical water governance evolution in Central Asia

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Leibniz Association

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ABSTRACT

In Central Asia, community water governance institutions emerged and prevailed for a long time. By employing an analytical modelling approach using variants of the evolutionary Hawk-Dove game, we scrutinise three epochs' (pre-Tsarist, Tsarist and Soviet) coordination mechanisms and qualitatively compare them in the efficiency spectrum. We find that the pre-Tsarist community water governance setting, due to its synergetic and pluralistic aspects, was associated with higher efficiency than the Tsarist and Soviet periods' settings. The pre-Tsarist community arrangement linked irrigation duties with benefits. Our analytical model reveals how the Tsarist Russian regulation that replaced the election-sanctioning element with a de-facto system appointing the irrigation staff and paying them fixed wages corrupted the well-established pre-Tsarist decentralised water governance. We term this move the "Kaufman drift". Resulting inadequacies in the water governance could have been averted either by restoring the community mechanism's election-sanctioning attribute or else with an alternative approach such as privatising water resources. With the use of the "Krivoshein game," we produce an alternative scenario for the region where we envisage the potential consequences of the water privatisation. Modelling history might not disentangle the complex nature of water governance evolution fully, however, the heuristics we use in the analysis assist in guiding the diagnosis of the matter and its solution. This makes our study well-timed for contemporary Central Asia. The analyses assess current water management's chances to return to ancient principles of election-sanctioning and perspectives of private irrigation water rights.

KEYWORDS

Central-Asian water, self-governance, hierarchy, markets, evolution

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1 Introduction[1]

Water is an economic resource for agricultural development, which is contested, controlled and sometimes fought about (Bichsel, 2016: 359). In Central Asia, water governance has entailed all those activities for many centuries (Lewis, 1966). It is a region where the community institutions of residence self-governance (mahalla) and Islamic endowments (waqf) with the capacity to produce many forms of public goods in water management emerged and prevailed for a long time (McChesney, 1991; Sievers, 2002). The region's water users, indeed, reaped the combined benefits of such community institutions, which were enriched with an election-sanctioning mechanism in the coordination of both water users' participation and irrigation officers' continuous decent service (Thurman, 1999; O'Hara, 2000; Abdullaev and Rakhmatullaev, 2013).

However, Central Asia's landscape considerably changed between the 1860s and the 1990s when the region was under the rule of Tsarist Russia and then the Soviet government. As a rule, the invading nation perceived the new colony as backward. It introduced its development program, which mainly aimed to solidify the regional specialisation via extending irrigated land area and cotton production (Obertreis, 2017). When the Soviet empire collapsed, it left its Central Asian successor countries with a legacy of a centrally controlled irrigation network geared to collective and state cotton farms' needs. As exemplified by the "great cotton scandal" caused by largely inflated cotton yield reporting under the Communist Party leader Sharof Rashidov, it also left a corrupted and discredited public administration of agriculture (Gleason, 1990; Obertreis, 2017: 410-417).

After national independence, international donors recommended or demanded the restructuring of farming and irrigation facilities, generally emphasising a more decentralised and democratically legitimised administration and private property in productive assets (Lerman et al., 1996; Spoor, 1998). Especially in the irrigation sector, governments and donors placed hopes on the introduction of "Integrated Water Resource Management (IWRM)", stipulating the participation of water users in irrigation governance and the relevance of economic principles for effective water management (Zinzani, 2015; Amirova et al., 2019). Yet the effectiveness of these strategies has been quite mixed, considered by some as an outright

[1] The study is based on parts of the first author's dissertation thesis (Amirova, 2019). It was conducted in the framework of a research project, "Institutional change in land and labour relations of Central Asia's irrigated agriculture (AGRICHANGE)" funded by the VolkswagenStiftung within the funding initiative "Between Europe and the Orient – A Focus on Research and Higher Education in/on Central Asia and the Caucasus". We gratefully acknowledge this financial support. Martin Petrick's work on the manuscript was supported by the German Academic Exchange Service (DAAD) from funds of the Federal Ministry for Economic Cooperation (BMZ), SDGnexus Network (grant number 57526248), program "exceed - Hochschulexzellenz in der Entwicklungszusammenarbeit". A post-doctoral fellowship project, "Institutions, change mechanisms and impacts in natural resource management of Central Asia" (INRESCA), funded by VolkswagenStiftung, supported Iroda Amirova's follow-up work on this paper.

failure (Veldwisch and Mollinga (2013) on water management; Omelicheva (2015) on democratisation more generally).

Departing from the present challenges in water management in Central Asia, this article proposes an innovative explanation of water management institutions' emergence and persistence. Drawing on the existing historical evidence, we develop a theoretical model of water user interaction that captures the epochs of water management in Central Asia in terms of evolutionary game theory. In addition to providing a new explanation for the evolution of water governance, our model allows us to explore two questions of particular relevance from today's perspective. First, how likely it is that current water management could return to ancient principles of election-sanctioning? Second, whether introducing private property in water management could improve irrigation management efficiency.

Based on explicit game-theoretic modelling informed by historical evidence, we show how social institutions such as the neighbourhood community mahalla enabled successful decentralised water user cooperation in the pre-Tsarist period. However, following the Russian and Soviet conquest, historically identifiable top-down administration and bureaucratisation processes ultimately corrupted the irrigation sector and led to its decline. Going beyond these established historical insights, our model suggests how regulation by the invaders triggered a highly path-dependent institutional evolution that today's reformers are unlikely to undo easily. Given the difficulties in Central Asian water governance nowadays, one possible solution is returning to the community mechanisms of water governance as it was practised before the Russian invasion. The pre-Tsarist mode of water governance in Central Asia linked the irrigation duties to their benefits. It rewarded civic-minded water users while punishing civic apathy on platforms such as the mahalla. Another possible pathway out for the decaying efficiency of Central Asian irrigation water governance can come through the introduction of private property rights in water resources. Again, drawing on historical proposals of irrigation privatisation, we use a modified version of our model to show that private regulation has the potential to achieve efficiency levels similar to an (ancient) water user community characterised by election-sanctioning mechanisms.

To model institutional evolution, we depict institutions not as a set of exogenous constraints but as the outcome of water users' interactions. According to evolutionary game theory, the outcomes that emerge from the best-response play (interactions) are called conventions or equilibria (Bowles, 2004). As these conventions are institutions, we explain Central Asia's water governance's institutional change as a problem of convention selection. By doing so, we explain why one equilibrium emerged and persisted for long when other alternative equilibria were possible in water users' best response play and why those long-time persistent conventions eclipsed. We refer to an extension of the evolutionary "Hawk-Dove game" with individual water users' preferences in water appropriation, sharing and civic engagement (participatory and sanctioning) (Bowles, 2004: 382-386). We refer to the game strategies as

the cultural traits which can be learned and/or updated following certain copying behaviour (replication dynamic).

Our theoretical approach contrasts with the historiographic literature on the subject, which provides the major inspiration for our work, but rarely engages in formal theorising or even any theorising at all. Among our main historiographic sources, Thurman (1999) comes closest by providing a theoretical reflection on two central "modes of organising a management 'charter'" for public irrigation, namely "State Government" and "Irrigation Community" (p. 4, following Robert C. Hunt). Thurman suggests that bureaucratic management and ensuing corrupt practices may induce "free riding" and "rent-seeking" among the water users. On the other hand, community governance may reduce the costs of monitoring and maintenance, the "transaction costs" of the irrigation system (pp. 6-8). Building on a wealth of historical evidence, he (in our sense convincingly) argues that water governance in the Fergana valley moved from the latter to the former under Russian and Soviet rule.

By drawing on evidence from the Zarafshan valley and historical Samarkand, Morrison (2008) similarly describes the problematic implications of the Russian colonial administration but widely abstains from any reference to theoretical concepts. Following James C. Scott, Obertreis' (2017) theoretical interest in "high modernist" ideology throughout the history of Central Asian colonisation addresses a higher level of abstraction. It is thus largely complementary to our approach. This research article was part of a PhD dissertation which focused on the institutional analysis of irrigation water governance in Central Asia (2019).

By applying evolutionary game theory, we generate insights into the stylised interactions of water users. We thus ease the understating of, possibly, a reciprocal cause and effect relationship between the water users' endogenously chosen strategies and the emerging water management institutions (conventions) along with the role of chance events (exogenous political shocks). We evaluate historical water coordination mechanisms such as community and bureaucratic arrangements. Section 2 provides the analytical framework, that is, the evolutionary game model, the lens through which the paper, in section 3, reiterates the historical events documented in the literature and explains the evolution of water governance from the perspective of behavioural preferences, replication dynamics, conventions, and drifts. Section 4 examines what we call the "Kaufman drift," i.e. the corruption of decentralised water governance and its repercussions in the long term. Section 5 elaborates on what could have happened if the water resource was privatised, drawing on historical plans to do so under Tsarist agricultural minister Krivoshein. Section 6 provides a final discussion of the implications for current-day policy challenges.

2 Evolutionary game theory as an analytic narrative

In this section, we introduce the tools through which we reiterate the historical events known from the literature and derive insights regarding the mechanisms at play, game changers and drifts from one convention into another. We model water users' interaction in an evolutionary Hawk-Dove game with three alternative strategies to share a common good. In our particular case, the common good is the water available to one village (a symbolic group) as a whole.

According to evolutionary game theory, interacting parties are a priori programmed to play one or another strategy, while some strategies earn more than others (Dixit et al., 2015: 465-504). Successful strategies with higher payoffs are replicated more than unsuccessful ones. As a result, successful strategies proliferate in the population (Weibull, 1995; Petrick, 2013).

2.1 Using game theory for understanding challenges in irrigation governance

Game theory allows the analysis of strategic social interaction and thus generates insights on the role of institutional details reflected in any game-theoretic model (Bowles, 2004: 32). One of the most prominent game-theoretic models, the "prisoners' dilemma", addresses the conflicting interests of two parties in providing a common good, such as an irrigation infrastructure, and predicts that coordination will fail due to overwhelming free-riding incentives for both parties (Dixit et al., 2015: 417-459). Models or "analytic narratives" of this sort motivate the search for institutional arrangements that can overcome such socially harmful incentives. Bureaucratic and community governance represent two prominent solutions, as Thurman (1999: 4) noted and his references. Whereas Thurman's theoretical reflections stop here, we take them as a starting point to provide a more comprehensive framework in which institutions can evolve endogenously or react to exogenous political shocks. Towards this end, we employ a slightly different model, the Hawk-Dove game.

2.2 Hawks and doves as an elementary model of resource governance

The originally static Hawk-Dove game entails two strategies: Hawk and Dove. The underlying context of such interaction is the competition for a resource. The hawk-strategy is aggressive and fights to get the whole resource, while the dove-strategy is peaceful (does not fight) and offers the whole resource to the hawk-strategy player. When only dove-strategy players interact, they equally share the resource. When only hawk-strategy players meet, they both fight. In this classic game, the best-response play resulting equilibrium is the Hawk-Dove (Dove-Hawk) strategy combination. The Hawk-Dove game is characterised by a waste of resources. This characteristic stems from Hawks' fighting, not from their exploitation of Doves. In this kind of setting, the solution is to find a way that would diminish the number of disputed interactions (Bowles, 2004:78-87). We adopt this game with its hawk and dove

strategies but alter the strategies' names into grabbing (or obtaining resources by violating either formal or informal rules) and sharing, respectively. Besides, following Bowles (2004) and Bowles and Choi (2019), we introduce a third punishing (civic) strategy to this classic game as an option to solve it.

Let us suppose that n farmers (peasants) of a village, who are engaged in irrigated crop production, are randomly paired to share a common water resource. The value of the water is denoted with v. The water users can adopt three strategies: (unconditionally) grabbing, (unconditionally) sharing, and punishing (or conditionally sharing). It is impossible to detect an individual's behaviour (type) before interaction.

When sharing water, users interact, and then they will share the available water among them equally ($v/2$). However, when a grabbing type farmer interacts with a sharing type, then the grabber gets all water (v) and leaves no water (0) to the interaction partner; when grabbers meet each other they fight where the winning party gains the water (v), and the losing side faces the cost of the fight (*c*).

As a modelling default and without further knowledge or assumptions about any asymmetry between the parties, both sides of the interaction assumedly have an equal probability of defeat and victory.

A fight is a within-group conflict among water users over water use or over a common investment project. Consequently, our interpretation of the cost of the fight among peasants is their effort invested in stealing water by various means (including bribing the irrigation staff or subjective costs of damaged reputation). If the grabber is successful and obtains that extra portion of water (or free rides the common maintenance activities), the counterparty carries the whole burden (cost). For the counterparty, that cost of a defeated fight is the effort it invested in guarding its water turn (or the investment contribution which did not generate a return as the grabber reaped that potential benefit). Hence its effort was useless as the water was stolen (or the share was not contributed) by the successful grabbing type peasant.

When punishing types are paired with either a sharing type or a punishing type, they share water equally ($v/2$). When a punishing strategy-playing individual interacts with a grabber, then all of the punishing type water users (of the village) join forces and punish that grabber. In case of victory, punishing water users share the water among themselves (all punishers). However, in case of the defeat of punishing farmers, the punishing farmer bears the cost the fight (*c*). The probability of successful punishing the grabbers is simply assumed to be the Punishers' (β) population frequency.

In order to make it simpler to analyse, we normalise the size of village farmers' population to unity, that is, n=1, and denote the fraction of punishing-type of farmers as β. Furthermore,

we denote the fraction of sharing water users in the village with α, and the fraction of grabbing water users of the village with $(1-\alpha-\beta)$ or γ.

The punishing strategy is a collective strategy because punishing-type individuals support other punishing-types who are interacting with grabbers. Consequently, the success of a grabber in an interaction with a punisher depends on the (β) fraction of punishers in the village population (n). We can also term the punishing type "civic", as in Bowles and Choi (2019). This type highly values social norms (e.g. water sharing) and opts for punishing when that norm is violated. In case Punishers are successful randomly paired with a grabber - Punisher retains $v/\beta n$ with the probability of β, but with the normalised population, Punisher retains v/β.

We illustrate the payoffs of the interaction of water users in Table 1.

Table 1: Payoffs in the Water Users' Civic Game

	Grab	**Share**	**Punish**
Grab	$(v-c)/2;$ $(v-c)/2$	$v;\ 0$	$(1-\beta)v-\ \beta c;$ $v/n-(1-\beta)c$
Share	$0;\ v$	$v/2;\ v/2$	$v/2;\ v/2$
Punish	$v/n-(1-\beta)c;$ $(1-\beta)v-\ \beta c$	$v/2;\ v/2$	$v/2;\ v/2$

Source: Adopted from Bowles (2004: 383).

We calculate the expected payoffs for the three strategies as below:

$$\pi^{share} = (\alpha+\beta)\frac{v}{2} \qquad [1]$$

$$\pi^{grab} = \alpha v + \beta\{(1-\beta)v - \beta v\} + (1-\alpha-\beta)\left(\frac{v-c}{2}\right) \qquad [2]$$

$$\pi^{punish} = (\alpha+\beta)\frac{v}{2} + (1-\alpha-\beta)(\beta v - (1-\beta)c) \qquad [3]$$

We use a simplified theoretical model of water users' interaction, which does not take into consideration the asymmetric access to the water. We, however, acknowledge that it is an essential characteristic of identifying the level of cooperation. For example, experimental studies from various world localities, including Colombia, Kenya, Kazakhstan, and Uzbekistan, revealed that upstream water users were more cooperative than downstream users (Cárdenas et al., 2011; Amirova et al., 2019).

2.3 The evolution of group interaction in the triangular state space

Figure 1 presents the graphical illustration of the state space for this system of interactions (ignore vectors and all other details inside the figure for the moment). Figure 1 depicts the distribution of strategies in the village. Any combination of preferences (types) is possible, and the range can vary from extreme (all sharers or all grabbers or all punishers) to anything in between. Figure 1 was generated by assuming the values of v and c of Table 1 to be 2 and 3, respectively.

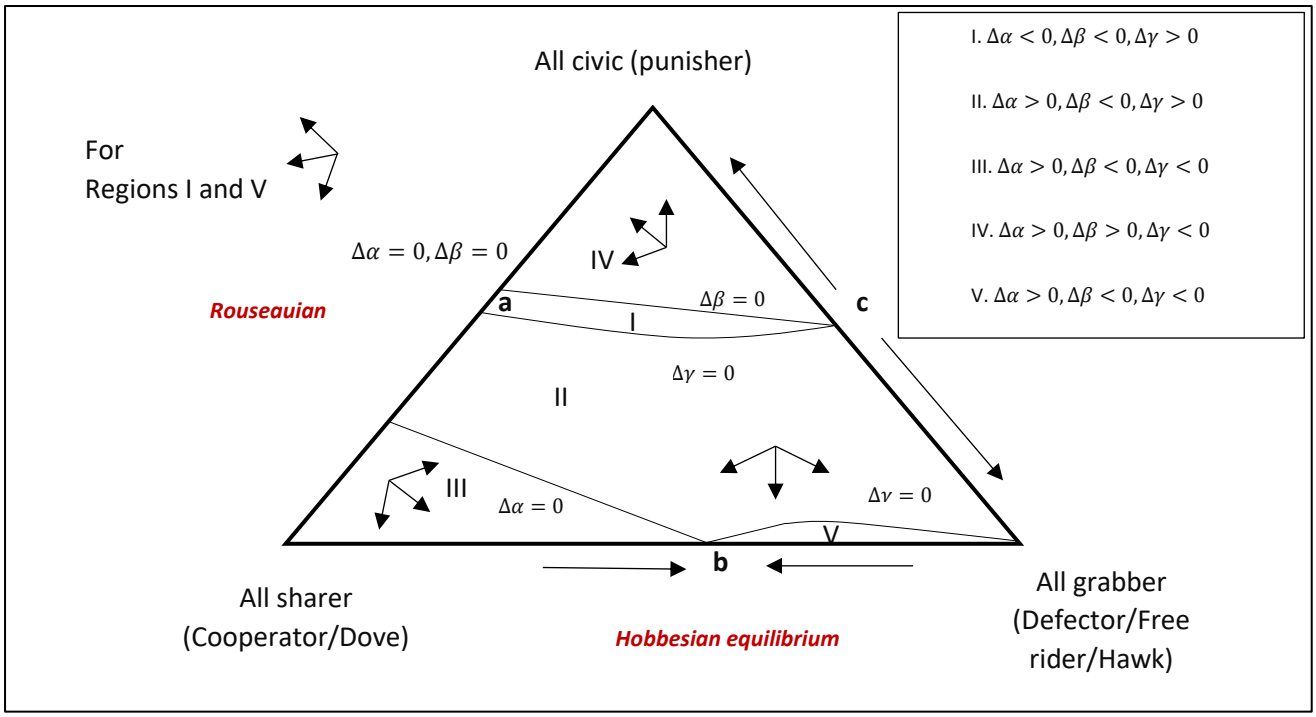

Figure 1: State-space: within-group dynamics
Source: Adopted from Bowles (2004: 385).

The vectors in Figure 1 indicate the direction of movement in the region defined by the loci along which α, β and γ are stationary (note that: $\gamma = 1 - \alpha - \beta$). These movements (to either

side) occur as a result of an updating of preferences (i.e. the choice of strategies). The choice-updating process is payoff-monotonic and follows a replicator dynamic as in (4), and (5):

$$\frac{d\alpha}{dt} = \alpha\left(\pi^{share} - \underline{\pi}\right) \qquad [4]$$

$$\frac{d\beta}{dt} = \beta\left(\pi^{punish} - \underline{\pi}\right) \qquad [5]$$

where $\frac{d\alpha}{dt}$ and $\frac{d\beta}{dt}$ are the changes of the respective population shares over time, and $\underline{\pi}$ is the average payoff to all three strategies, with $\underline{\pi} \equiv \alpha\pi^{share} + \beta\pi^{punish} + (1 - \alpha - \beta)\pi^{grab}$.

Figure 1 is divided into five (I, II, III, IV, and V) regions. Vectors in each region indicate the forthcoming proliferation of strategies. For instance, in region IV both α and β are increasing but γ is decreasing. This means that if water users' interaction occurs with any combination of preferences falling in this region (IV), eventually grabbing-type individuals will disappear, as a result of the updating process initially grabbing players opt for sharing or punishing strategies instead. In this particular region the payoff to a punishing or sharing strategy is higher than to the grabbing strategy.

Bowles (2004) calls this equilibrium the Hobbesian equilibrium. The aggregate payoff of such equilibrium is low due to frequent fights over water (among grabbing types of farmers) and hence costs (also called a deadweight loss). This then decreases the aggregate benefit of water use in such a setting. The Hobbesian equilibrium is an evolutionarily stable strategy (ESS). That is, the population all playing ESS will resist an invasion of individuals playing some other strategy. Small perturbations around ESS are self-correcting. On the other hand, the point a, another stable stationary outcome (but not ESS), is a combination of sharing and punishing strategies. Following Bowles (2004), we call this the Rousseauian equilibrium[2].

2.4 Theoretical equilibrium solutions vs historical reality

The theoretical prediction dictates that water users' society should have spent most of their time in a Hobbesian convention, not in a Rousseauian because the former is ESS and the latter is not. However, Central Asian water management history, along with other societies of the world (as in Sri Lanka, Pakistan, India, Nepal, etc.), provides us with evidence that, in fact, most of the epochs of water users' interactions could be characterised by conventions resembling a Rousseauian equilibrium.

[2] While Thomas Hobbes is known for his illustration of the “war of all against all” in the “state of nature”, Jean Jacque Rousseau admired the collective upholding of social norms (Bowles, 2004: 385).

There are several documented instances of successful water self-governance history with long-term persistence records in other parts of the world, although the evidence might sometimes be mixed (Bardhan, 2000: 847)[3]. However, all those cases from different parts of the world show that water (local) self-governance arrangements were possible and persistent for a long. Those self-governance arrangements, which were ubiquitous over a long time, emerged independently, persisted in varied locations and cultures, indeed suggest that most water users' groups spent most of the times in an interaction approximating a Rousseauian equilibrium which combines the unconditional co-operators and collective upholding of social norms (civic-minded water users).

In the next sections of our analytical narrative, we first assume that community (pre-Tsarist) water governance in Central Asia induced a prevalence of unconditional cooperation and a civic pairing of strategies. After that, we show why and how the Central Asian version of the Rousseauian equilibrium in water governance became subject to drift and eventually converged toward a Hobbesian equilibrium.

3 Evolutionary game theory at work

This section analyses the Central Asian epochs of water governance through the prism of the evolutionary Hawk-Dove-Civic game-theoretic model.

3.1 A Rousseauian equilibrium in the pre-Tsarist period

Following Thurman (1999) and O'Hara (2000), we claim that pre-Tsarist water governance in many ways reflected an inclusive setting in the sense of Acemoglu and Robinson (2012). Usually, networks of aryks, which fed farms, villages, and towns, were constructed and managed locally by communities of peasant farmers (dehqans). However, greater feeder canals (nahars) required greater resources and hence were subject to more complex coordination (Morrison, 2008: 202). This role of a coordinator for the construction and maintenance of a large net of nahars and installations alike, the country-wide water allocation and distribution, was taken by the central water authority, which was led by a Mirab-bashi, the chief water master. Water users' communities which consisted of dehqans elected the Mirab-bashi and paid his remuneration, known as Kipsen. Kipsen was never some constant percentage from the grain harvest, but rather it depended on the satisfaction level of dehqans concerning the irrigation service quality they received. Furthermore, there were mirabs, and

[3] Sri Lanka, for example, had a very productive system of irrigated agriculture, which supported impressive ancient cities and large kingdoms. The island's traditional irrigation system, which relied on self-governance (collective action) via village councils and irrigation headmen (vidanes) mechanisms, emerged and persisted for thousands of years until the island's colonization by Western nations (Uphoff et al., 1990: 28). Panchayats, which played significant role of coordinator in self-water management at community level in India and (today's) Pakistan, prevailed for many centuries until Western colonization, as well (Wade, 1988; Javaid and Falk, 2015).

their assistants called as aryk-amins, who supervised the secondary canals' maintenance, water allocation and distribution. They were also, like Mirab-bashi, elected and paid by the dehqans based on the same principle. There were ketmans (water users' associations) comprised of three to four villages. The ketman was responsible for the village-level constructions and maintenance of irrigation systems. One ketman would have three to four elected elders (aryk-aksakals) representing their respective villages' interests. There were even further smaller management components (tops) that consisted of either a few streets or family units (O'Hara, 2000: 373). The setting thus had certain pluralistic attributes.[4]

The election-sanctioning mechanism of pre-Tsarist community water governance enhanced the civic-mindedness of the dehqans (increased number of punishing type peasants). The state was held accountable due to competition among khanates for more dehqans.

3.2 The role of mahalla and waqf in sustaining the Rousseauian equilibrium

Mahalla is an indigenous institution of Central Asia's neighbourhood community, managed by a group of elders chosen by the community (mahalla-aksakals). In pre-Soviet Central Asia, the role of elders and hence mahallas included a range of functions, such as the collection of taxes, delivery of orders, provision of security, residents' dispute arbitration and the guardianship of orphans and widows (Dadabaev, 2017). In mahallas, social norms were and are still applied to a broad range of social interactions, which are often interlocked. For example, suppose an individual failed to cooperate (contribution in either monetary or labour form) in the maintenance of the road. In that case, he might face ostracism in a particular form such that he might not be invited to morning ritual feasting next time or "toi" (social gathering to celebrate positive events such as wedding and etc.) or other events (Sievers, 2002).

There were several villages or mahallas (latent or subgroup) in each water users' community (ketmans) with their elected leaders to represent their interest in water division and cost sharing. Mahalla was an institution that could stigmatise its own residents when they did not obey the moral norms of water and cost-sharing behavior (e.g. participation in khashar) (Sievers, 2002). The mahalla institution had mutual monitoring and peer-based enforcement mechanisms. Because it had such monitoring and sanctioning elements, the mahalla nurtured the civic-mindedness (rewarded punishing type players) among its inhabitants. By doing so, it played a crucial role in the proliferation of punishing (civic) strategy in the population of water users and hence continuous sustainment of Rousseauian equilibrium.

[4] Of course, pre-Tsarist Central Asian irrigation governance arrangements was not free from deficiencies. For example, the infrastructure required grandiose resources (mostly labor) for maintenance and possible reconstruction each season and also after every flood.

The charitable endowment (waqf) "is an unincorporated trust established under Islamic law by a living man or woman for the provision of a designated social service in perpetuity. Its activities are financed by revenue-bearing assets that have been rendered forever inalienable" (Kuran, 2001: 842). Historically, it was a private institution for providing public goods. It provided community social services in Islamdom and it was woven into the fabric of daily life of Muslim Central Asian societies. Financing public buildings and facilities like irrigation infrastructures, supporting education, providing welfare for the poor and the like were the variations of waqf actions of community members which undeniably was one of the major producers of the public good of its time (McChesney, 1991: 3).

We consider the waqf institution of comprehensive charity and the mahalla neighborhood community as institutions of collective enforcement as represented by the punishers in the Rousseauian equilibrium of our model. They made second-order punishment possible in everyday life against deviating and in favor of cooperating members of the community.

The pluralism of federal water governance, waqf and mahalla were the bundle of arrangements in irrigation water governance, which synergistically prevailed and provided the asymptotically stable equilibrium, which was composed of mostly punishing (civic) type of water users, before the arrival of the Russian Empire. However, ultimately it was meant to eclipse in the coming century from the region's practice altogether.

3.3 The slide towards a Hobbesian equilibrium during Tsarist and Soviet water governance

The eclipse of pre-Tsarist community water governance is linked to the epoch of the Russian colonisation of Central Asia. The period between 1860 and 1917 was associated with the expansion of cotton production via the extension of irrigated land areas at the expense of converted deserts (Obertreis, 2017). In this period, Konstantin Petrovich von Kaufman, Governor-General of Russian Turkestan, disposed most powerful irrigation officials and replaced them with Russian irrigators. In cases where he retained traditional water officers (such as mirabs, aryk-aksakals) he imposed tight Russian supervision. The central department in Tashkent appointed an irrigator, an assistant and a group of conductors to each province (Morrison, 2008: 210). There existed a de jure election system, but such system de facto turned into a state appointment system. Moreover, the very election mechanism degenerated into sales of positions to the highest bidders (Thurman, 1999: 249). In other words, the synergy of water governance arrangements faced a metamorphosis, and it was losing its pluralistic attribute. This, in turn, made the community water governance slide toward the alternative Hobbesian evolutionary stable state's basin of attraction, entailing a grabbing majority of dehqan types. This drift decreased the efficiency of the irrigation system, and it was reflected in physically deteriorated irrigation infrastructure and a waste of resources on many failed irrigation infrastructure projects.

In terms of our model, we suggest that this policy was a perturbation with the capacity to break the ESS of pre-Tsarist community water management (Rousseauian equilibrium), which had linked irrigation duties to irrigation benefits due to its election-sanctioning mechanism. Hence, there is a rationale behind our claim about Kaufman's regulation (a chance event) serving as a trigger of the significant perturbation in the system. Because of such drift, corruption accumulated (proliferated) to such a level that it became ubiquitous (pervasive) at the beginning of the 20th century[5].

4 The "Kaufman drift" corrupts decentralised governance as an unintended consequence of Russian regulation

As a modification of Figure 1, the solid contours of Figure 2 show iso-average-payoff loci, every single of which is associated with a particular average payoff (π) ranging from -0.3 to 1. The higher the fraction of civic individuals in the water users' population, the higher is the average payoff level. The average payoff level reaches its maximum when all members of the population are either punishing or unconditional cooperating types, with no grabbing peasants at all.

Figure 2 abstractly illustrates the dynamic of water users' preferences and the interactions' payoffs attributable to the historical epochs briefly covered in previous sections. They are illustrated with five points denoted with x and subscripts ranging from 0 to 4 in Figure 2. Pre-Tsarist community water governance induced the dehqans' interaction to locate close to Rousseauian equilibrium, which Figure 2 roughly depicts with x_0.

Then Tsarist water governance intervened into the election-sanctioning mechanism of the community water governance. This intervention was revealed in von Kaufman's policy in 1877 which implied massive disposal of customary water management officers, who were elected, and their replacement with the irrigators of state choice. This changed the setting of the interactions (Morrison, 2008; Rysbekov and Rysbekova, 2016). In the previous scenario, the possibility of electing the aksakals, aryk-amins, and mirabs served as leverage, in the hands of dehqans, which, then, induced accountable water administration. Because the punishing trait (through not electing and, or paying low amounts of remuneration) had its consequences, the payoff to the respective strategy could be assumed to be higher than sharers and grabbers, therefore it was ESS. The payoff level to the punishing strategy (in our model), after the Tsarist-Russia's de-facto appointing attitude, was reduced and more peasants although could be still sharing water, less and less of them were punishing. This, in Figure 2, is reflected in the movement of the convention from x_0 to x_1. This movement, from x_0 to x_1, we call the "Kaufman drift". After this movement, the state at x_1 was prone to further invasion of

[5] We acknowledge that corruption (perturbation) existed before the Tsarist conquest. For example, the emir (monarch) of Bukhara initiated several reforms to eliminate corruption in the government (Saifi, 2002: 75). However, due to the existing election-sanctioning mechanism, we assume that the strength of that perturbation was not large enough to cause a drift from the Rousseauian equilibrium.

grabbing dehqans who would steal the water or bribe the mirabs. Due to the invasion of grabbers, x_1 shifts toward x_2, a (nonstationary) population state where grabbers along with punishers and sharers coexist. Due to the path dependency among the dehqans and mirabs, aryk-amins and aksakals there could still be punishing type strategies ($\beta > 0$) in this unstable equilibrium.

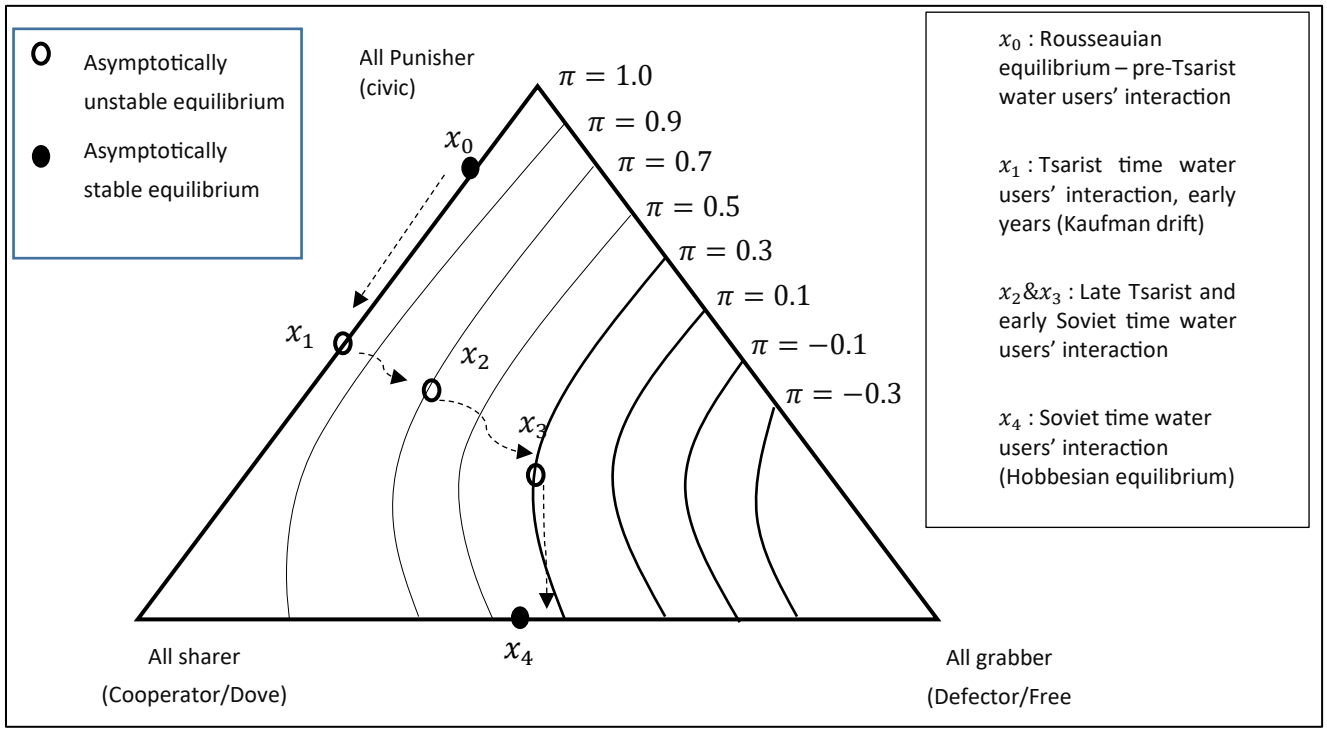

Figure 2: Average payoffs through epochs of water governance of Central Asia between 1860 and 1990 [Kaufman drift]

Source: Adopted from Bowles (2004: 388).

The drift took place until the interaction of water users attained an evolutionarily stable state at x_4: with only grabbers and co-operators and no civic fraction in water users' population, that is a Hobbesian equilibrium.

Let us derive parallels from Soviet epoch, which then could serve to support our idea about the prevalence of a Hobbesian-like interaction among Central Asian water users which carried destructive socio-economic consequences into the 20th century. During the 1970s, over-appropriation of irrigation water at the state and collective farms turned into a typical and widely recognised practice, and hence was usually harshly criticised by scientists, politicians, and engineers in the country (Obertreis, 2017). Throughout the region, it was documented that many irrigation canals lacked concrete lining, hence significant amounts of water was also lost in the transportation process (Dolgopolov and Fedorova, 1973). Widespread secondary soil salinisation, organisational inadequacies, and inefficient technologies were a commonly accepted plague of the Soviet irrigated agricultural sector as a whole (Micklin, 1978). There were no effective means of fighting water wasting both at the farm and higher

levels. Though several services were organised to control the water use in the 1960s, they could not change the ever deteriorating unsustainability in water usage patterns. Instead, irrigators were constantly losing their reputation and hence were not able to penalise the illegal water users (Obertreis, 2017: 369). We interpret these qualities (plagues) as symptoms of the convention where the grabbers prevail, as farms constantly over-appropriate water resources and irrigation systems remain unmaintained. Grabbing occurs at such frequencies that civic (punishing) behaviour cannot proliferate. In other words, the x_4 (Hobbesian equilibrium) point in our Figure 2 could have been firmly established by the 1960-1970s.

The Tsarist intervention, later completed by the Soviet regime, changed the payoffs of the game by altering the gains of strategies. It, then, led to a complete disappearance of civic (punishing) preferences, and by doing so led to a fundamental decay of the system, by reducing the average payoffs (Figure 2). In our model context, this outcome is perfectly consistent with the view that Russian regulation had only the best intentions of fixing the water use efficiency. In fact, the model suggests that the deterioration of civic-mindedness was an *unintended* side effect of the centralisation of water governance.

5 The "Krivoshein game": potential effects and limitations of a water privatisation scenario

The coordination of natural resource governance can be implemented via the market, bureaucratic or users' self-organisation (community management) mechanisms (Ouchi, 1980). If the water governance arrangement that prevailed in the pre-Tsarist epoch closely resembled a synergy of community and hierarchical mechanisms, then the Soviet epoch introduced solely bureaucratic arrangements into water governance of Central Asia. If to simplify, in water governance of Central Asia, we now have historical evidence concerning two out of the three coordination mechanisms mentioned by Ouchi (1980). These are also the "organisational modes" identified by Thurman (1999: 4). Our analytical survey so far allowed us to compare them along the efficiency spectrum. The third arrangement, the market mechanism, however, is missing in the catalogue of observed water coordination institutions of the region

5.1 Merits of treating water as a private good

Water markets could stimulate flexibility in water use and establish a widely acknowledged value of water, which then provides incentives for more efficiency in resource use (Saliba and Bush 1987). This then would incentivise the farmer to invest in improved irrigation systems, including infrastructure and technology. Moreover, such markets encourage farmers to pay for the safe disposal of drainage produced in their fields. We could also consider other societal benefits such as a reduction in environmental pollution and benefits to the urban sector from additional water for its consumption (Dinar and Latey, 1991). With such increased efficiency

and sustainability, the privatisation of irrigation water resource can mitigate many pitfalls like water stealing or corruption in water governance, the very problems the Central Asian water users' society has been facing for a long time now (Morrison, 2008; Obertreis, 2017; Wegerich, 2008).

At the same time, such an arrangement is not free from downsides due to incomplete information, which is private and unobservable. The incomplete information on the marginal value and use of the irrigation water, as the farmers might have an incentive to underreport actual usage of water (in the case of volumetric pricing). These are distinctive issues of irrigation water resource pricing that stem from socio-economic and biophysical attributes of the water (Johansson et al., 2002). For that reason, the complexity of water privatisation exceeds the complexity level of land privatisation.

Launching functioning tradable water rights could be one solution to enhancing the efficiency and sustainability in water use in developing countries at large (Rosegrant and Binswanger, 1994). There is broad interest in the idea of treating water as an economic good which is one of the prerequisites of water markets. This very attribute is the primary principle of Integrated Water Resource Management (Woodhouse and Muller, 2017), a policy framework current Central Asian countries are attempting to apply in their water governance (Zinzani, 2015). In other words, although the market mechanism in its pure format is not introduced into the setting, its elements are already taken up, and implementation trials in the region are in progress since 2003, with unclear consequences though.

A private property regime is not free from the danger of corruption. In particular, if a water user X is the owner of the resource, then X's ownership is only enforceable by the state with the involvement of the bureaucrats. After receiving a bribe in cash or in-kind, however, the bureaucrats might abuse their power and side Y unfairly instead of enforcing property rights of X. It is a classic case of a corrupted market mechanism (Rose-Ackerman, 1975). Moreover, access to water is often considered a basic need. Besides, the flow of water through a basin is complex, and it provides a range of externalities, market failures, and high transaction costs. All of these characteristics, coupled with a weak institutional setting prone to corruption, make the selection of an appropriate set of prices for water exceptionally difficult (Rosegrant and Binswanger, 1994; Perry et al., 1997).

5.2 Krivoshein and the Bourgeois strategy of water privatisation

Recalling history allows us to discover that there were earlier attempts to introduce market mechanisms into the water governance in Central Asia, although under a wider goal of strengthening the imperial influence on the Central Asian khanates.

Thurman (1999: 69) quotes historical sources referring to the khanate period before Russian conquest, indicating that local customs in many areas of the Fergana valley permitted sale

and ownership of water, but doubts that it had much practical significance. After Tsarist Russia's invasion, the Central Asian water users' society responded to community water management's mutation by practising irrigation water trade in the informal frameworks. By following Sugden (2005: 56) and North (1990: 41), we perceive the water trade, and associated actions by majority peasants and irrigations officers as the emergence of informal rules, which have not been consciously designed, and it is in the majority's interest to keep. Joffe (1995) and Pochekaev (2017) suggest that later on, at the turn of the 19th century, the Ministry of Agriculture of Tsarist Russia was aware of the breakdown of well-established non-state water governance structures in its Central Asian colonies. The community mechanism was the formal arrangement over irrigation water governance matters backed up by the state. The trade of water and associated actions of irrigation specialists (mirabs, aryk-amins etc.) was referred to as corruption and rent-seeking (Obertreis, 2017). In this paper, we interpret this observation as one where there is a conflict between formal and informal rules of water governance. Moreover, there were financial difficulties in the implementation of irrigation projects in the Hungry Steppe. For example, the Romanov Canal's final cost, which was originally projected at 2.5 million rubles, amounted to about 8 million rubles. This difficulty induced the central government to turn to the private sector for assistance. The Tsarist government approached textile industries and requested them to invest in irrigation (Joffe, 1995: 372). So the breakdowns in customary water governance and the financial issues with the grandiose irrigation projects were accordingly reflected in the new water legislation proposal of the Minister of Agriculture Alexander Vasilyevich Krivoshein. According to that newly suggested water legislation, the state was still supposed to dominate the management. However, Krivoshein proposed to establish a priority ranking of access to free water in the region. The first priority would belong to the state and public needs and the second priority to drink and domestic usage. The third priority would go to irrigation works and industrial-technical enterprises (Pierce, 1960: 151-152). According to the newly proposed water legislation, private capital was to be engaged in the irrigated water sector only, and the state-dominated the management.

The proposed water law, along with other propositions, "would make it legally possible to buy and sell water, and supersede the mixture of Sharia [Islam] and custom which had hitherto prevailed" (Morrison, 2008: 235). At the same time, such as "water trade" might not mean trade as in a market economy. However, the involvement of the private capital to irrigation projects would let the private ownership regime prevail even in society where the state is predominant over many economic issues such as in Tsarist Russia. The water law, which would legalise the water trade in the irrigation sector, would cancel the gap between formal and informal arrangements of water users in the region.

What if Tsarist Russia was not dismantled and the government implemented the Krivoshein's water law? In this section, we explore an alternative scenario for Central Asia's water governance with the help of yet another extension of the evolutionary Hawk-Dove game.

The Hawk-Dove like interactions, with the hawk-dove (share-grab) strategy combination being an ESS, are destined to result in resource wastage due to the contestations. The fights in the water management context could imply water stealing. The costs associated with guarding the water turns would then be the cost of the fight. One of the solutions to this waste not explored theoretically yet in our model is a private ownership mechanism (Bowles, 2004: 389-390). In order to accomplish this goal, we follow Maynard Smith (1982: 22) and introduce a new strategy called a "bourgeois" into the game setting (Bowles, 2004: 85).

This new strategy implies that if the peasant owns the (water) resource, then he/she will behave like a Hawk (unconditional grabber). If, however, the (bourgeois) peasant is not the owner of the resource, he would share the water resource with the interacting party (behave like Dove). By default, we assume that half of the time the bourgeois player is the resource possessor and hence claims for it, and the other half of the time he is a non-possessing bourgeois, hence does not claim the water. The assumption is that the ownership is never questioned among bourgeois and sharers[6].

Table 2: Payoffs in the Water Users' Bourgeois Game – the "Krivoshein Game"

	Bourgeois	**Share**	**Punish (Civic)**
Bourgeois	$v/2;$ $v/2$	$3v/4;\ v/4$	$\frac{1}{2}[(1-\beta)v-\ \beta c];$ $\frac{1}{2}[v/n-(1-\beta)c]$
Share	$v/4\ ;3v/4$	$v/2;v/2$	$v/2;v/2$
Punish (Civic)	$\frac{1}{2}[v/n-(1-\beta)c];$ $\frac{1}{2}[(1-\beta)v-\ \beta c]$	$v/2;v/2$	$v/2;v/2$

Source: Adopted and adjusted from Bowles (2004) and Bowles and Choi (2019).

A sharing farmer submits half of the resource available to him/her to the fellow interacting party or even the whole resource in case that the fellow peasant claims ownership, that is, if the interacting side is the resource possessing bourgeois.

The punishing (civic) type peasant shares the resource when he/she is interacting with a self-like or sharing type peasant. However, when a civic farmer is paired with a peasant who does not share (resource possessing bourgeois), the civic peasant joins with other civic type water users in the group to contest the claim of the resource owning bourgeois. In the case of the

[6] Maynard Smith (1982) does not provide a deeper explanation for choosing the label "bourgeois". We thus assume that he refers to stereotype Marxist notions of a social group (class) that owns the means of production and is concerned with preserving their economic supremacy due to such private property. Whereas Maynard Smith uses the term as an analogy in the context of evolutionary biology, we reintroduce it here to its original setting.

civic peasants' success (with a probability that increases with the increasing fraction of civic users), the civic type users allocate the resource among themselves and leave the losing bourgeois to carry the fight's cost (contest) all alone. Alternatively, if the civic peasants lose the contest, they bear the cost of fight themselves.

Here, we assume that payoff monotonic updating (higher payoff earning strategies are replicated) and conformist cultural transformation are at play. This would imply that peasants are more likely to replicate the more numerous peasant types' revealed behaviour.

For the setting where the population is consisting of three types, sharers, punishers and bourgeois as in Table 2, we can reproduce the state space similar to the one in Figure 1, where we replace all-grabbers with all-bourgeois. This is logical because, as with Krivoshein's suggestion, the water privatisation carries the potential (or at least aims) to mitigate the water user groups' issues associated with water stealing (grabbing). In this dynamic, the stationary and stable states are the all-civic group of water users and combinations of the bourgeois with sharers (Bowles and Choi, 2019). Like in Figure 1, the all-civic state represents a relatively conflict-free social system, but it is not ESS, that is, it is subject to drift. The group representing pairs of bourgeois and sharers, on the other hand, is self-correcting (i.e. it is an ESS). It is an interesting implication of such a set of interaction possibilities that in any stationary state (all civic or combination of the bourgeois with sharers) the *social surplus is the same* (sum of payoffs is equal to v). That is, both stationary states are equally (comparably) efficient. However, the surplus distribution of the mixed state with bourgeois and sharers does not represent egalitarian principles, as it is the case in the all-civic state, where each member of the group gets an equal share of the resource.

The mixed state of bourgeois and sharers is ESS because when few punishing types are introduced to the mix, they have to bear the cost of the many fights with the water possessing bourgeois peasants. As a result, these punishers' net payoff is diminished, and hence in the updating process, they are not replicated but fade out.

If water resource ownership was legalised, as it was promoted by Krivoshein after the demise of community water governance, the water users of the region could indeed have a utilitarian (because of the total surplus size) and a viable (as it is a Nash equilibrium) solution for the emerging problem in the irrigation water sector. At the same time, we acknowledge that the principal problems with water privatisation could probably also withhold the successful implementation of Krivoshein's privatisation law. Indeed, the pursuit of such approaches in the absence of the required preconditions may possibly have even negative effects (Perry et al., 1997).

6 Discussion and implications

6.1 Institutional persistence and external drivers of change

Irrigation systems diverged regionally, locally, over time, and were interwoven with the societies' social and political organisation in Central Asia across different epochs (Obertreis, 2017). This paper explained the evolution of irrigation water governance of the region and investigated two major inquiries. Firstly, our analysis elicited what happens if today's Central Asian water governance returns to the ancient election – sanctioning principle. Secondly, we investigated the prospects of private property in the irrigation water sector in the efficiency spectrum.

The persistence of a Rousseauian equilibrium in pre-Tsarist Central Asian irrigation water governance, where sharers and punishers coexisted, can be explained by the reasons from Bowles (2004: 388). Firstly, because of a cultural trait of second order punishment, which induced individuals to punish sharers for not punishing grabbers. The parallel institutions as mahalla and waqf served to nurture the strategies as punishing and sharing respectively. Secondly, group selection took place among user communities who had shared their fate in times of adversity. Thirdly, because the conformist cultural transmission operated as a behavioural update mechanism.

The Tsarist rule – the second period in the region is associated with the deterioration of community water governance. The second period's water governance relied on both centralised and decentralised governance principles. The state intervention to foster cooperation entirely centralised water management bodies eventually reduced the role of mutual monitoring and peer-based enforcement mechanisms attributable to the pre-Tsarist community water management of the region (O'Hara, 2000; Abdullaev and Rakhmatullaev, 2014). Furthermore, coercive collectivisation of agriculture was the manifestation of the new communist ideology and related institutional arrangement in the Central Asian Soviet republics.

The theoretical modelling approach presented in the paper suggests the coevolution of behavioural strategies and institutional conventions. That is, strategies influence institutions' development and vice versa (Bowles, 2004: 401). Consequently, individual behaviour regarding water sharing is subject to updating via copying behaviours that are widespread and successful. Conquering, arresting, executing, massively evacuating, resettling and forcefully deporting were distinctive behaviours of the ruling regimes in Tsarist and Soviet Central Asia (Morrison, 2008; Obertreis, 2017). These manners could also be interpreted as being one possible option of the Hawk or grabbing strategy in Hawk-Dove-Civic game-like interactions. Consequently, the continuous rule of the Russian Empire and then of the Bolsheviks could serve as a role model (widespread and/or with higher payoffs) for the water

users of the region. Conformist updating could have induced the Central Asian water users to opt for "grabbing" in interactions over water as part of the best-response play. This behavioural update happened amidst the community water governance losing its levers and being corrupted. Changes resulting from interventions in the prevailing arrangements led to efficiency losses. These losses, coupled with the role model (Hawks being more successful and numerous) could explain the rationale behind water users' apathy, irrigation officers, and engineers in the 20th century. These attitudes accumulated and eventually resulted in one of our civilisation's greatest anthropogenic catastrophe, namely Aral Sea's (Lake's) transformation into Aralkum Desert.

If the water resource was privatised as a result of legalising (formalising) the internally (informally) evolved bourgeois trait, Central Asian water users could have enjoyed higher levels of social surplus instead of regressing into conventions characterised by lower levels of aggregate payoffs (e.g., as in the Hobbesian equilibrium). However, principal problems associated with water privatisation due to water's biophysical attributes and the absence of required preconditions could have hindered privatisation reforms.

Two major external shocks, with lasting spillovers, took place in Central Asia between the 1860s and the 1930s: the colonisation by Tsarist Russia and the regime shift towards the Bolsheviks. The Tsarist rule in the region is associated with the deterioration of community water governance, which relied on both centralised and decentralised governance principles. Meanwhile, Soviet rule is associated with the full abolishment of self-governance in the irrigation water management and its replacement with a water bureaucracy. Entirely centralised water management bodies eventually reduced the role of mutual monitoring and peer-based enforcement mechanisms attributable to the region's pre-Tsarist community water management. Furthermore, coercive collectivisation of agriculture manifested the new communist ideology and related institutional arrangement in the Central Asian Soviet republics.

6.2 A new reform agenda?

The international community of researchers continuously recommended that the Central Asian water administration should relaunch pre-Tsarist community principles of water governance. In these dialogues, the decentralised nature of self-governance was instrumental in facilitating local cooperation (Abdullaev and Rakhmatullaev, 2013; O'Hara, 2000). Despite these discussions culminating in irrigation management transfer and establishment of WUAs, there have been few real changes in Central Asian irrigation water governance almost thirty years since the collapse of the Soviet Union.

Today's water administration is still hierarchical and lacks democratic governance. The Hobbesian-like arrangements prevail in the newly established water management organisations, such as WUAs' lost in transition' (Veldwisch and Mollinga, 2013). Since the start

of the decentralisation process, the region's irrigation infrastructure has eroded further (Djanibekov et al., 2012).

Yet, the recent processes in Uzbekistan offer an example of radical change which is supposed to challenge the current water governance arrangements. The new president Shavkat Mirziyoyev, after taking office in late 2016, launched a wave of unprecedented reforms guided by the Western discourses on good governance. The country is said to begin its new vitality with the start of real reforms (The Economist, 2019). In agriculture, the major water-consuming sector in Central Asia, the reforms were outlined in the Agri- and Food Development Strategy for 2020–2030 (adopted in 2019). The shift towards a more liberal regime in Central Asia's most populous country and its consequences on water resource governance is pivotal to the whole region's water policy dynamics, in particular.

The new government sees the minimisation of state intervention in the agricultural sector as a central pillar of ongoing reforms. In early 2020, it abolished the state procurement system in wheat and cotton, the backbone commodities of Uzbek agriculture (Petrick and Djanibekov, 2019; Lombardozzi and Djanibekov, 2020). Another pillar is the organisation of agriculture within the production 'clusters' by inviting private investors to develop vertically-integrated supply chains (ILO, 2019). The new private players in agriculture will result in new arrangements in local water management and infrastructure maintenance. For instance, the shift to investor-owned agricultural organisations will alter the existing social order and the structure of power relations in water governance. The 'cluster' reform already now legitimised the monopsony of investor-owned organisations (RFE-RL, 2019), which can complicate further the applicability of IWRM principles and the power of water users in water governance.

In the area of water governance, the Agricultural Strategy does not provide a comprehensive vision. It outlines efficient water resource management among its prioritised tasks by emphasising the importance of sustainable water management and resource-saving technologies to address improved water efficiency and decreasing water supplies. Similar to previous efforts, the Strategy offers technological (or technocratic) solutions and thus misses the issues of local water governance and institutional changes. To support the reforms outlined in the Agricultural Strategy, institutional changes in water management are indispensable. Therefore, proposals for more radical changes were gathered into another policy document. In February 2020, the Uzbek ministry of water resources made public a draft of a presidential decree on the adoption of a Concept for Water Sector Development for 2020-2030[7]. Among major changes, the document refers to decentralised water governance and water tradability, which relate to the proposals of Krivoshein. It highlights the introduction of market principles of water pricing and allocation of public funds and decentralisation of water

[7] Draft of presidential decree on the adoption of Water sector development concept (in English) https://aral.uz/en/blog/2020/07/23/decree-of-the-president-no-up-6024-on-approval-the-water-sector-development-concept-of-uzbekistan-for-2020-2030/

management by transferring state-owned inter-farm infrastructure to private organisations, voluntary unions of water users and clusters, and inviting private and foreign investors into the water sector. The document emphasises that guiding principles of these changes should be transparency, economic efficiency, social justice and environmental sustainability. The shift to private recovery of water infrastructure costs, especially those serving agriculture, will imply the introduction of volumetric pricing of delivered water. Furthermore, the introduction of water market will cover new regulation permitting transferability of water rights among agricultural producers based on monetary compensation. The nature of these changes also implies the redesign of decision-making and bureaucratic organisation of the water sector. However, the Concept mentions the experimental approach for such changes based on intermediate evaluations. It is not fully clear whether a different form of reforms will be opted for when the proposed changes fail to produce expected outcomes. The finally approved version will show whether the document implies major changes in water governance. If the reforms do not lead to the expected outcomes, then current water management arrangements would probably persist.

A bit earlier than Uzbekistan, Tajikistan developed its National Development Strategy for the period up to 2030 (NDS-2030) by taking into account Tajikistan's commitments on the Agenda of the XXI century and Sustainable Development Goals (SDGs). Sustainable environmental management, along with good governance, are among the priorities of the NDS-2030. To achieve the ultimate goal, which is to improve the living standards based on sustainable economic development, the NDS-2030 sets the list of main actions to conduct. Implementation of IWRM is among those prioritised strategic goals in the NDS-2030. Until 2030 Tajikistan aims to finalise the initial phase of transition to the IWRM. With the Government Resolution of the Republic of Tajikistan dated December 30, 2015, No. 791 "On the Program of Reform of the Water Sector of the Republic of Tajikistan for 2016-2025", the Tajik government made a significant shift towards the water decentralisation via faster adoption of the IWRM framework[8]. Among essential implementation means of the water sector reforms, Tajikistan aims to improve the water users' and civil society's participation in the water decentralisation process.

Although Tajikistan seems more clearly determined in its legislation about IWRM principles adoption, reforming the water governance reforms than it is the case for Uzbekistan, still as Sehring (2020) correctly mentions, the discourse on the water in Central Asia is still mainly a discourse on water management and not on governance[9]. Consequently, the uncertainties associated with the Central Asian counties' reforms of water governance still exist.

[8] Government Resolution of the Republic of Tajikistan dated December 30, 2015 No. 791 "On the Program of Reform of the Water Sector of the Republic of Tajikistan for 2016-2025", Available at http://extwprlegs1.fao.org/docs/pdf/taj189751.pdf

[9] Water governance refers to the range of political, social, economic and administrative systems that are in place to develop and manage water resources, and the delivery of water services, at different levels of society. Governance covers the manner in which allocative and regulatory politics are exercised in the management of

In other words, the Hobbesian equilibrium is prevailing. Reformers do not displace it easily, due to its positive feedback mechanism. Such path dependency is one of the major reasons limiting current IWRM water reform effectiveness in the region (Sehring, 2009). There are at least two ways out of this Hobbesian equilibrium. One conceivable way out of such ESS may be via the introduction of private property regime in irrigation water, as proposed in the draft concept of water sector reforms in Uzbekistan. Along with increased efficiency and sustainability, tradable water rights can soothe water stealing and corruption issues in Central Asian irrigation water governance. However, private and hence unobservable incomplete information coupled with a weak institutional setting, prone to corruption, complicate private property regime enforcement over water.

Another feasible solution is restoring the election-sanctioning element to the WUAs. Doing so will nourish civic-mindedness among the Central Asian water users and brings the benefits of genuine community water governance mechanisms. The community arrangement can handle the market failures associated with incomplete contracting and high transaction costs.

Indeed, the water decentralisation, which the IWRM promotes, relies on a community mechanism involving peer-monitoring-sanctioning attributes. The framework also exhibits market elements in terms of water service pricing, for instance. It attempts to implement institutional complementarity: the synergy of the community and market mechanisms. Complementarity is called successful when one institution's effectiveness (the community mechanism in our case) is enhanced by additional elements of another institution (the pricing element of the market mechanism). However, existing empirical studies evidence that Central Asian states disturb community-based election-sanctioning through top-down appointing or "strongly recommending" the WUA leaders. WUA leaders are then accountable to state bureaucrats rather than to WUA members (Wegerich, 2008; Veldwisch and Molinga, 2013; Zinzani, 2015). "Kaufman" or Soviet style government's interventions, as such, destroys the community's capacity to govern the water resources. This is known as institutional crowding out, in fact the opposite of institutional complementarity (Ostrom, 2000; Bowles, 2004).

The models we used in the analyses are constructed in the simplest possible way, however, they are instructive to capture the key idea of the analysis. Consequenlty, we are far from the idea that the extensions of Hawk-Dove models presented in this study fully explain Central Asian water governance history. As Bowles (2004) rightfully acknowledges, simple models such as Hawk-Dove-Civic or Civic-Dove-Bourgeois games cannot provide a sufficient framework for understanding the complex history of water governance.

Instead, we referred to these extensions of evolutionary games as heuristics. The heuristics do not necessarily need to mirror the reality but rather be instructive enough to identify the causal mechanism that then forms a more complex and open system. Therefore, our analysis provides us, both researchers and policymakers, with more insights and tell us where to look

resources (natural, economic, and social) and broadly embraces the formal and informal institutions by which authority is exercised (Rogers and Hall, 2003).

if we are interested in understanding the matter's cause. Moreover, they raise awareness that seemingly minor and temporary chance events, initiated from outside such as Kaufman's administrative intervention in 1877 or evolving from inside, could have historically fatal consequences.

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