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Authors: Dörre, Andrei, and Goibnazarov, Chorshanbe

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Small-Scale Irrigation Self-Governance in a Mountain Region of Tajikistan

Andrei Dörre[1]* and Chorshanbe Goibnazarov[2]

** Corresponding author: adoerre@zedat.fu-berlin.de*

[1] Freie Universität Berlin, Institute of Geographical Sciences, Centre for Development Studies, Malteserstrasse 74-100, House K, 12249 Berlin, Germany

[2] University of Central Asia, 47A Druzhba Narodov Avenue, 734013 Dushanbe, Tajikistan

In the Pamirs of Tajikistan, meeting food needs is an ongoing struggle. One of the challenges to local agricultural production is water scarcity. This paper presents a case study of a small-scale, self-organized irrigation governance system in a village in the western Pamirs, applying the concept of "hydrosocial arrangements" to explore its physical and social components and the interactions between them. It concludes that the system has proven sustainable and resilient, largely because of its strong sense of community ownership and its flexibility. Political actors and development practitioners often lack detailed knowledge about such well-functioning local solutions, but external interventions applied without that knowledge risk destroying effective systems that are already in place. It is important to design interventions that are tailored to local needs and based on a comprehensive and well-contextualized understanding of local structures, relations, and values.

Keywords: *Irrigation agriculture; food supply; hydrosocial arrangements; community-based natural resource management; collaborative action; post-socialist transformation; Central Asia; High Asia.*

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Self-organized irrigation regimes in High Asia

This paper describes a small-scale, self-organized irrigation system in a mountainous region of Tajikistan, to illustrate the ability of people in remote mountain communities to work together to manage water resources in a challenging environment with limited and fragile infrastructure. It applies the concept of "hydrosocial arrangements" to explore the interrelations between the physical and human elements of the system.

Theoretical focus

Recent studies of water resources issues have highlighted the importance of adopting an integrated perspective that considers both hydrological and social factors. In exploring self-organization to manage water resources, Sivapalan et al (2012: 1271) coined the concept "socio-hydrology" and defined it as an approach whereby "humans and their actions are considered part and parcel of water cycle dynamics." Nüsser et al (2012: 51) referred to the complex water-related human–environment relations in High Asia as "socio-hydrological systems," formed by "sociohydrological interactions" (Nüsser and Schmidt 2017: 404). The physical components of such regimes consist of nonhuman ecosystem and infrastructure elements. The social components include actors and organizations, human relations and interactions, and regulatory institutions. Irrigation regimes are custom-tailored, contingent configurations that are purposefully negotiated, developed, constructed, maintained, and reproduced by self-organized actors. They can be adapted to shifting social and ecological conditions. We call such regimes "hydrosocial arrangements."

Other researchers, while not all using sociohydrological terminology, have applied similar perspectives to meltwater-based irrigation agriculture in High Asia, including Israr-ud-din (2000) on the eastern Hindu Kush; Schmidt (2004), Kreutzmann (2011), and Parveen et al (2015) on the Karakoram; Nüsser et al (2012) on the Himalayas; and Hill (2013) on the Alai Mountains. These studies produced detailed pictures of time-bound and place-specific local irrigation assemblages consisting of entwined physical and social elements, and their interactions in the course of environmental and social change.

Geographic context

In Central Asia, the postsocialist transformation created many uncertainties, especially in Tajikistan, which used to be the poorest Soviet republic. The breakup of the socialist system was followed by a breakdown of the national economy, a radical thinning of social services provided by the state, weakened exchange relations with neighboring states, and a civil war (1992–1997). People had to create new survival strategies using all available assets. For rural populations, locally accessible resources became essential, especially in terms of food supply (Bliss 2006; Herbers 2006).

This study focuses on the Gorno-Badakhshan Autonomous Oblast in the remote western Pamirs in Tajikistan, a semiarid region where dependence on local resources is heavy but some food is imported. The region faces food supply challenges ranging from water scarcity to inadequate roads, which have prevented the realization of Sustainable Development Goal 2, ending hunger (Kassam 2009). Local agriculture is highly fragmented and consists mainly of household farms that practice a mix of cultivation and animal husbandry (Kreutzmann 2012). Due to the semiarid conditions, cultivation depends on irrigation. Land suitable for cultivation is scarce due to the high relief intensity, rocky soils, slow pedogenesis, and water scarcity (Mukhiddinov 1975; Sosin et al 2012; Golosov et al 2015). Less than 13,000 ha of arable land, located mainly on the flat sections of the lower parts of debris cones and alluvial fans, was used in 2013 for agriculture for a growing population of about 212,000 (AOPJT 2014: 17–18, 91).

Natural hazards pose frequent threats to agriculture. Low levels of snowfall and long winters, as well as low temperatures, cold spells, and overcast skies in spring and summer, repeatedly lead to water shortages, shorter growing periods, and small yields. Local food production is, and has historically been, insufficient to meet local food needs (eg Eggert 1897; Badrickii 1901; Bobrinskii 1908; Baranov 1936; Khonaliev 2005; Kassam 2009), and the region has had to rely on food imports.

However, food imports, too, have faced impediments. Much international trade flows through Gorno-Badakhshan to the country's economic centers, leaving it only weakly integrated into the regional food market. Landslides frequently destroy irrigation infrastructure and arable land and endanger the already limited road system (Zimmermann et al 2016; ASIA-Plus 2017a). Border markets, locally called *Afganbazary*, are small and frequently closed due to the unstable security situation in Afghanistan (Bahrom 2016; Kreutzmann 2017; Levi-Sanchez 2017). The region's insecurity and isolation drive up food prices to above the national average. At the end of 2013, for instance, the average national wholesale price per kilogram for wheat and potato was 1.33 (US$ 0.28) and 1.60 (US$ 0.34) Tajikistan Somoni (TJS), respectively, while the average prices in Gorno-Badakhshan were TJS 2.27 (US$ 0.48) and 2.50 (US$ 0.52), respectively (ASPRT 2014: 110). Not only are prices high in the region but purchasing power is relatively low, with limited work opportunities and low wages. The average monthly salary in 2013 was about TJS 695 (US$ 146) in Tajikistan as a whole, compared to about TJS 587 (US$ 123) in Gorno-Badakhshan (AOPJT 2014: 55–56).

To cope with these challenges, local communities have developed effective common-resource governance approaches—good examples of the ways that sociocultural assets and practices can be successfully employed to make natural resources and ecosystem services sustainable and equitably accessible.

This paper describes such practices in the village of Shirgin, located on the upper Panj River within the Vrang *jamoat* (municipality) of the Ishkashim *nokhiya* (district) (Figure 1). It describes the physical and social components of Shirgin's hydrosocial arrangement, how the arrangement has worked in practice, and the system's guiding principles. It concludes with a discussion of the characteristics that help make the system sustainable and resilient under shifting social and ecological conditions.

Methods

Informed by the considerations described above, our case study focused on the factors that made the irrigation system sustainable and resilient. The study was carried out between 2015 and 2018. We conducted 35 interviews with 21 people in Shirgin, including the *rais-i kishloq* (head of the village), *muisafedon* (village elders), and knowledgeable people such as farmers (*dekhqonon*) and teachers (*omyzgoron*). The interviews focused on current demographic, socioeconomic, and environmental conditions, as well as irrigation governance and management approaches. They included questions about environmental features and the water supply, as well as the local actors, institutions, decision-making processes, and practices. We also asked for historical information on daily life in Shirgin and on irrigation-related issues. Elderly people shared their memories and local oral traditions. We also did historical research in the archive of the Institute of Oriental Manuscripts of the Russian Academy of Sciences in St. Petersburg, the former capital of the Russian Empire; the Russian State Military History Archive in Moscow; and the Central State Archive of the Republic of Uzbekistan in Tashkent. Data related to the physical components of the irrigation arrangements in Shirgin were obtained through 7 transit walks, combined with infrastructure mapping and observation of monitoring and irrigation practices. Local key respondents, who contributed their own insider knowledge to the study, validated the findings presented in this paper. It is therefore knowledge about how to deal with environmental change and social transformations.

Shirgin's hydrosocial arrangement

Shirgin (37°0′30″N, 72°31′30″E) is located on a rocky hillside at an altitude of 2800–3000 m (Figure 2). Two conditions make it an interesting case of self-organized

FIGURE 1 Map of the study area. (Map by A. Dörre, based on GUGK 1987; Jarvis et al 2008; OSM 2017)

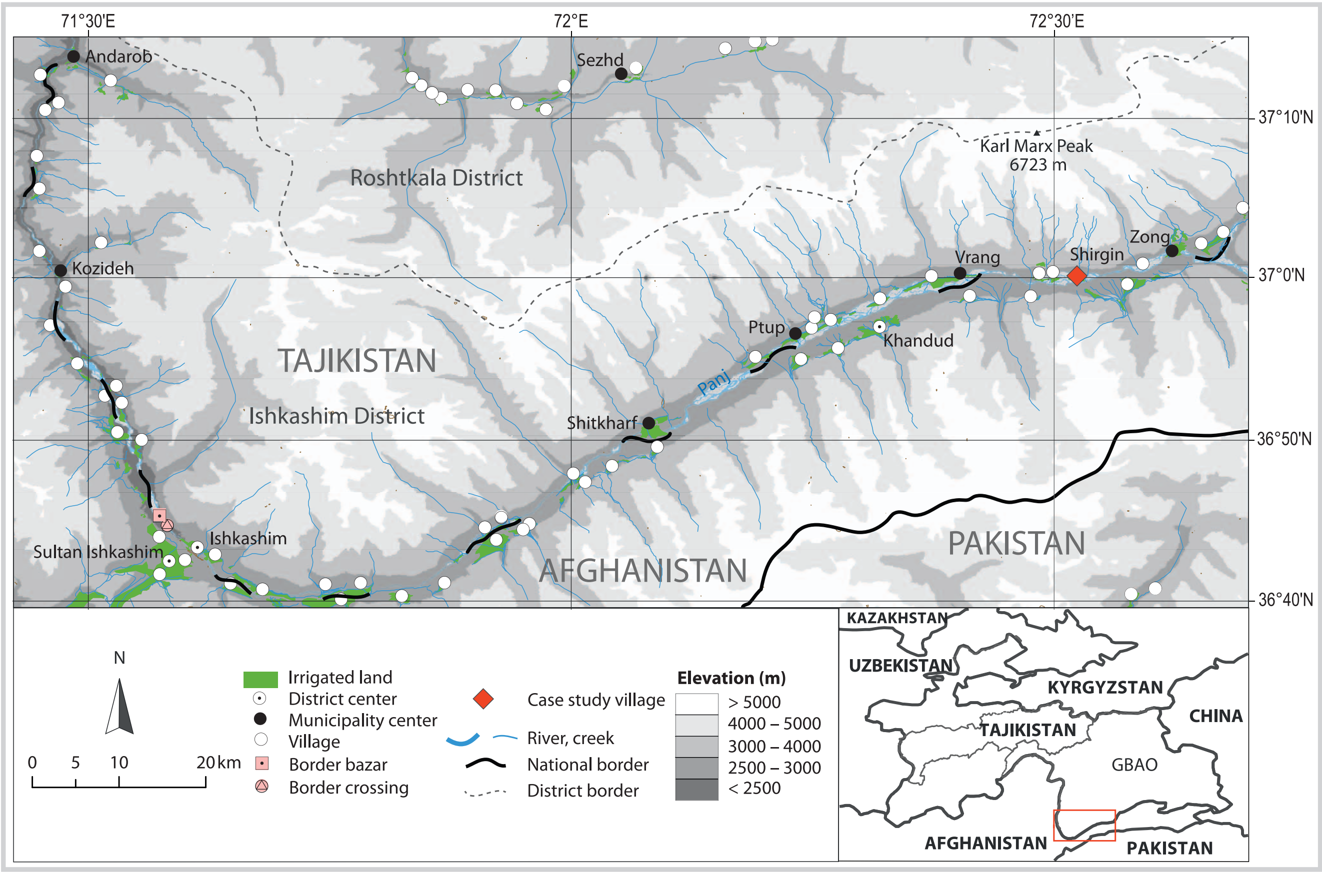

FIGURE 2 Shirgin village. (Photo by A. Dörre)

TABLE 1 Shirgin's past and present population, crops, and irrigated area.[a)]

	1902	1931	Early 1980s	2008	2013
Inhabitants	110	242	No data	895	1232
Households	11	19	About 38	94	101
Irrigated land (ha)	8	No data	About 80	No data	111
Irrigated land per capita (m^2)	727	No data	No data	No data	901
Main crops	Grain, legumes	Grain, legumes	Forage crops	Grain, legumes, potatoes	Grain, legumes, potatoes

[a)] Sources: Snesarev 1902; UNKhU 1932; Nazarov 2011; ADC 2013.

irrigation governance: the impediments to the community food supply and the presence of a locally organized irrigation system. The road to Gorno-Badakhshan's administrative center, Khorog, is highly prone to avalanches and landslides (ASIA-Plus 2017b). This poses a threat to the secure provision of goods from abroad. The few existing wage work opportunities in public services are underpaid. Desirable jobs in economic enterprises, scientific institutions, or conservation projects such as the Tajik National Park (Cunha 2016) do not exist. Therefore, subsistence-oriented local food production remains crucial. Aside from animal husbandry, local production is characterized by horticulture and irrigation cultivation, which both have a long history in the Western Pamirs (Olufsen 1904; Bobrinskii 1908; Andreev and Polovcev 1911; Mukhiddinov 1975). However, due to environmental conditions, only one harvest is possible per year.

Agriculture has gone through several major changes since the beginning of the 20th century. A 1902 survey by the Russian Pamir Detachment reported that the village had 11 households with 110 inhabitants and 8 hectares of irrigated farmland, used mainly to cultivate wheat, legumes, and millet (Snesarev 1902: 5v–6). After the end of the Soviet collectivization campaign in the western Pamirs in 1939, the agricultural sector of this continuously growing settlement experienced extensive changes. Shirgin was part of a number of repeatedly restructured *kolkhozy* (collective farms) and a *sovkhoz* (state farm) after 1977; at that time, agricultural production shifted from cultivation toward animal husbandry under the national planned production system. Agriculture mainly produced fodder, and food was imported. This restructuring was accompanied by land reclamation and extension of the irrigation infrastructure. Similar changes occurred throughout Gorno-Badakhshan during the Soviet regime (Luknickii 1955; GKTS 1988; Kreutzmann 1996; Herbers 2006). However, due to the steep and rocky surface and lack of water in Shirgin, the scope of both land reclamation and irrigation infrastructure extension remained comparatively small.

To make the best use of the available water, Soviet irrigation schemes were informed by local knowledge, practices, and experiences and adjusted to meet the demands of the new enterprises and crops. The state farm was transformed in the 1990s into 2 *khojagi-i dekhqoni* (farmer associations), and land was privatized. Food crop cultivation gained in importance again because external supplies were insufficient. Similar developments took place throughout western Gorno-Badakhshan during Tajikistan's civil war of 1992–1997 (Bliss 2006; Herbers 2006).

Today, Shirgin has more than 1000 inhabitants. Irrigated land covers 111 ha and is used mainly for wheat, legumes, and potato cultivation (see Table 1). Farmers draw on knowledge gained from extensive experience in irrigation agriculture based on established resource use and management skills, as well as technical infrastructure from different historical times. Assets like local-specific environmental knowledge, long-term agricultural experience, and finely tuned management solutions have helped them to create a hydrosocial arrangement that has proven to be a sustainable and resilient adaption both to local water scarcity and to the social upheaval that occurred after Tajikistan's independence.

Physical components: irrigation infrastructure

There are no irrigation water sources within the village; this has made it necessary to transport water from distant sources. The south-facing glacier system of the Karl Marx Peak (6723 m) provides Shirgin's main water storage, with seasonal snowfields at lower elevations providing secondary storage. Seasonal meltwater feeds several creeks. These are tapped by several canal heads (*sargah*), which direct the water (*yupk*) through canals (*vod*) to the village, using the natural gradient of the rocky slopes. Large canal sections are made out of natural materials, such as soil, concrete-fixed blocks that have been stabilized with cement, and boulders for the walls and slate flagstones for the beds. Shirgin has 4 primary canals (Figure 3).

According to oral tradition, a local *pir* (Isma'ili clergy) instigated the building of the nearly 6-kilometer-long *Pirvod* (Canal of the Pir) in the 19th century. The water comes from a glacier-fed creek, which is tapped at an elevation of about 4000 m and channeled to a steep bluff north of the village. An artificial waterfall bridges an

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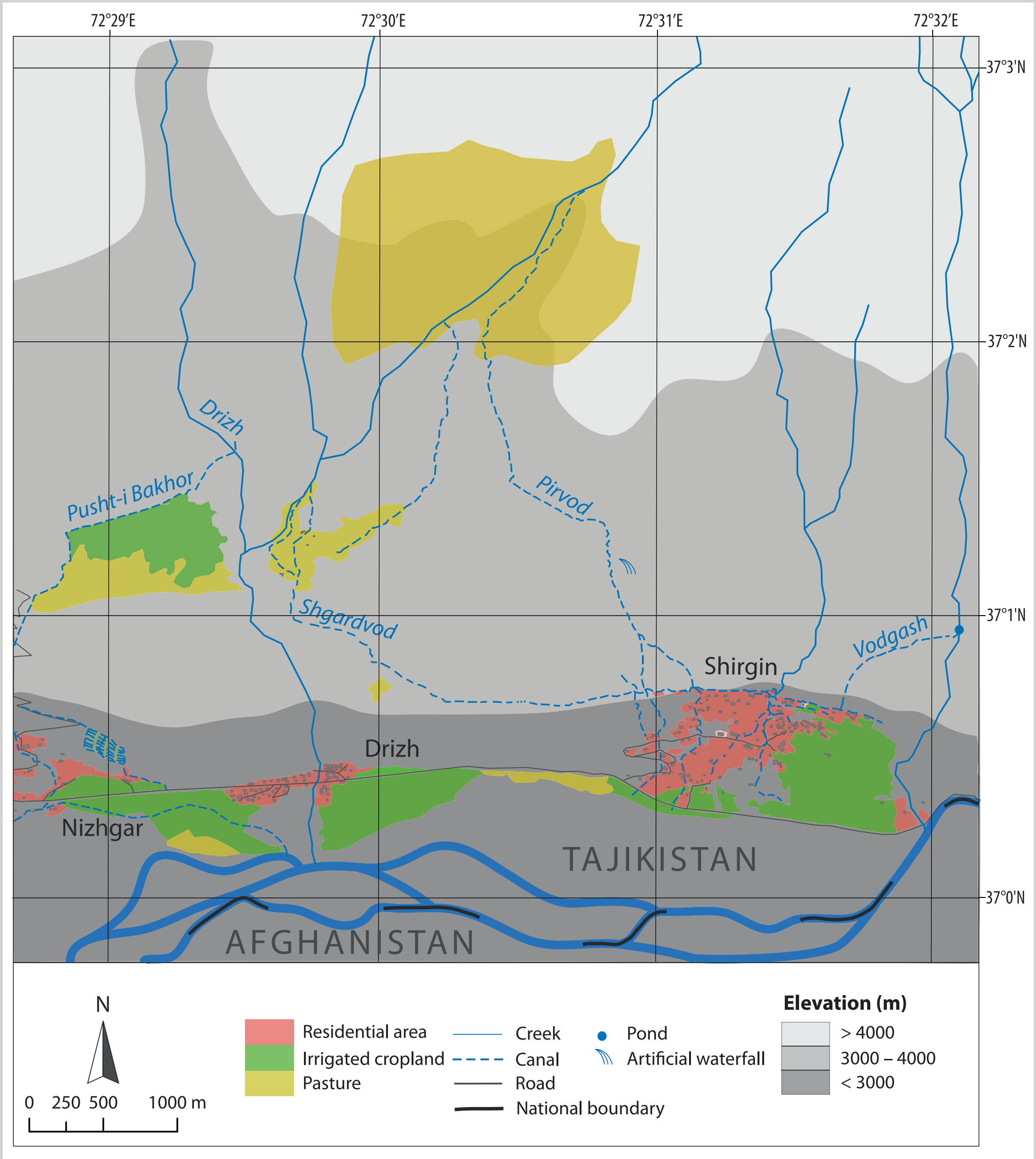
FIGURE 3 Map of Shirgin's main canals. (Map by A. Dörre 2018 based on GUGK 1987; USGS, EROS 1995)



elevation difference of about 300 m. According to Baranov et al (1964), similar structures can be found in several other places in the western Pamirs. They enable less steep canals to be used and prevent erosion from the rapid inflow of irrigation water. The lower canals direct the water into the distribution system in the village. Generally, *Pirvod* is blocked by ice from September until June. The smaller *Vodgash* taps a natural pool at an elevation of 3350 m, which is fed by seasonal snowmelt. Just a few homesteads and land plots receive water from this canal from late April to June.

To address the needs of the growing population and the continual risk of crop shortfalls, land reclamation and canal extension measures were carried out in the early 20th century. A tributary of Drizh Creek, roughly 4 kilometers west of the village, was tapped and the *Shgardvod* (Straight Canal) was dug to deliver its water to the village, a challenging task because of the rocky terrain. Technical support was provided by the Russian Pamir Detachment, which promoted the improvement of local agriculture by supporting canal construction and land reclamation, intensified cultivation, and the introduction

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of new crops in the western Pamirs (Kivekes 1902; Cherkasov 1905; Yagello 1916). Shgardvod provides water from April until October. In the course of the *Pusht-i Bakhor* (Delayed Spring) land reclamation project for the cultivation of fodder crops, a fourth canal (which has the same name as the project) was built 5 kilometers west of the village (Mirzo 2010; Dörre 2018).

While the *Pusht-i Bakhor* canal does not connect to any secondary canals, the 3 primary canals named *Shgardvod*, *Pirvod*, and *Vodgash* feed 6 secondary canals, which transect the neighborhoods *Mullovod*, *Gymbazsar*, *Darikhona*, *Jravyk*, *Myktabbar*, and *Sildavdur* (Figure 3). While *Sildavdur* and *Jravyk* in all likelihood stem from presocialist times, the canal currently named *Mullovod* was likely constructed in the course of the Soviet land reclamation (Gryunberg and Steblin-Kamenskii 1976). Locked by sluices (*ishyn*), dozens of tertiary canals branch off toward clusters of cultivated fields, gardens, and orchards. The fourth and final infrastructure level consists of hundreds of small channels carrying the water into individual farm plots (Dörre 2018).

Social components: water governance

The social aspect of the hydrosocial arrangement includes individuals, organizations, water management rules, irrigation schedules, and the work done to maintain the system.

Shirgin's hydrosocial arrangement is clearly a local affair, with only marginal involvement of external players. Development organizations provide assistance and expertise only at the community's request. An officially registered water user association (LoW 2006) does not exist. Instead, like in the pre-Soviet past, a *madjlis* (village assembly) gathers annually around Shogun, the vernal equinox on 21 March, to elect a *mir-i āb* (water master) by open ballot. This practice, and the fact that Soviet irrigation schemes in Shirgin were informed by pre-Soviet irrigation practices, suggest that for irrigation, the "breach of traditions" (Theesfeld and Boevsky 2005) experienced in many lowland regions in Central Asia and other socialist countries did not occur in Shirgin. Today, the village assembly represents the community of the village. It is made up of community leaders, representatives of village women and youth, and heads of households.

The *mir-i āb* regularly inspects the canal heads and primary canals. When damage is found, which often occurs in the spring, collective work parties (*kiryar*) repair it. The Shgardvod canal has a somewhat different maintenance system, with each household responsible for a specific canal section. The *mir-i āb* also develops irrigation schedules. Each household pays the *mir-i āb* TJS 10 (US$ 2.10 in 2013) per season.

Below the *mir-i āb* are the *sardorkho-i dekhqonon* (head farmers), who supervise the secondary canals and ensure that the irrigation schedule is observed. Up to 4 *sardorkho-i dekhqonon* take turns overseeing each secondary canal. These head farmers are elected on an annual basis by household subgroups.

These subgroups consist of up to 10 households that use adjacent land plots receiving irrigation water from the same secondary canal. Most households have several plots in different locations of the village. Usually, these plots are fed by different secondary canals, and thus, many households may belong to multiple subgroups. While the *sardorkho-i dekhqonon* also oversee the sluices sending water into the tertiary canals assigned to the different subgroups, members organize water allocation within their subgroup by consensus. Members are responsible for allocating irrigation water through the tertiary canals in a way that satisfies all group members' needs, swiftly adjusting arrangements when conditions change. Cooperation and mutual support for opening, closing, and repairing the sluices, supervision of the water flow, and mutual irrigation of the individual fields is common between group members.

This kind of organization in subgroups is especially important for the early irrigation period from the middle of April until mid-May when all households of the village are divided into 2 main groups, each with 6 subgroups. Each main group is entitled to 24 hours of irrigation every other day. Within that period, each subgroup gets 2 daylight hours and 2 night hours. A typical schedule for the early irrigation period is shown in Table 2. The schedule is usually displayed on the door of the cultural center; this creates transparency and possibility of control.

Individual households, who represent the final tier of Shirgin's irrigation governance system, handle the water distribution on their land plots (*wundr*) independently. The parallels between the physical and social components of the arrangement are summarized in Figure 4.

The second irrigation schedule works from mid-May until the harvest. If there is no extreme water shortage, neighborhoods and clusters of irrigated land plots are assigned irrigation rights on a specific day of the week. Farmers organize the water allocation within their neighborhoods and clusters of irrigation land autonomously. In the rare occasions when water is abundant (this occurred for a while in 2017), all schemes are suspended in favor of open access. However, water shortages are more common during this season. In 2018, after a snowless winter, a drought is feared. In such situations, the canal-specific subgroups mentioned above receive 24-hour-long irrigation rights. In cases of even greater scarcity, the slots are reduced to only a few hours. After the legume harvest in August, the demand for irrigation water lowers markedly, and use restrictions are abandoned. If water is still available, everybody can use it as needed.

Close monitoring of shifting environmental conditions and clearly defined responsibilities enable the farmers to

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TABLE 2 Irrigation schedule for the early growing season.

Group	Subgroup	Time slots, day irrigation	Time slots, night irrigation	Start of irrigation rounds
A	1	7–9 AM	7–9 PM	April 17, 19, 21, 23, 25, 27, 29 May 1, 3, 5, 7, 9, 11, 15, 17, 19
	2	9–11 AM	9–11 PM	
	3	11 AM–1 PM	11 PM–1 AM	
	4	1–3 PM	1–3 AM	
	5	3–5 PM	3–5 AM	
	6	5–7 PM	5–7 AM	
B	1	7–9 AM	7–9 PM	April 18, 20, 22, 24, 26, 28, 30 May 2, 4, 6, 8, 10, 12, 14, 16, 18, 20
	2	9–11 AM	9–11 PM	
	3	11 AM–1 PM	11 PM–1 AM	
	4	1–3 PM	1–3 AM	
	5	3–5 PM	3–5 AM	
	6	5–7 PM	5–7 AM	

identify and mitigate hazards and damage to the irrigation infrastructure. Canal heads and sluices, for instance, can be adjusted to remove water from the primary canals to reduce the risk of flooding during times of high runoff. Quick repairs of channel leaks prevent mudflows and the destruction of infrastructure, fields, and crops and help to conserve water.

The arrangement in Shirgin is notable for its longevity: the water master has been reelected annually for several years, and the schedules he developed have been in effect for more than 10 years. He noted that the current arrangement was derived from the arrangement used by the state and collective farms during the Soviet period. Since the Soviet irrigation schemes were informed by historical local knowledge, practices, and experiences, there are very likely continuities between pre-Soviet irrigation regimes and the current arrangement. More qualitative research would be necessary to determine this in detail, and to decide whether it constitutes a "transfer of tradition" (Theesfeld and Boevsky 2005). In any case, the community appears to be satisfied with the *mir-i āb*'s performance and to believe in his accumulated knowledge and experience. The schedules also seem to be flexible enough to adapt to changing conditions.

Discussion and conclusion

The perpetuation of place-specific regimes requires a high degree of acceptance by the users. In our opinion, Shirgin's bottom-up irrigation governance and management regime represents such an example. In a region with numerous food-supply challenges and no externally imposed governance institutions such as water user associations, the community organized its own system for handling this scarce and vital resource. The system's relative longevity suggests that it is well adapted to local conditions; the sense of community ownership and flexibility seem to be key factors in its success.

Shirgin's irrigation system exemplifies crucial aspects of community-based resource governance and management—including communal decision-making (transparent election of the water master through representatives of the whole community, and commonly acknowledged rules and irrigation schedules), collaborative action and burden sharing (collective repair and maintenance work), sharing of management responsibilities among many farmers, and prevention of free riding through social control. The regime is also flexible and differentiated enough to successfully balance different cultivation-related interests within the user community and to adapt quickly to shifting environmental conditions.

Many interviewees said they considered the distribution of irrigation water equitable. In this regard, the irrigation regime promotes community cohesion and supports the survival of individual households under challenging social and ecological conditions. Shirgin's arrangement can be seen as an example that stands in contrast to cases presented by Stucker et al (2012) and Theesfeld and Klümper (2016) from the Fergana Basin and western Tajikistan, respectively, where cooperation between and within communities was shown to be rather

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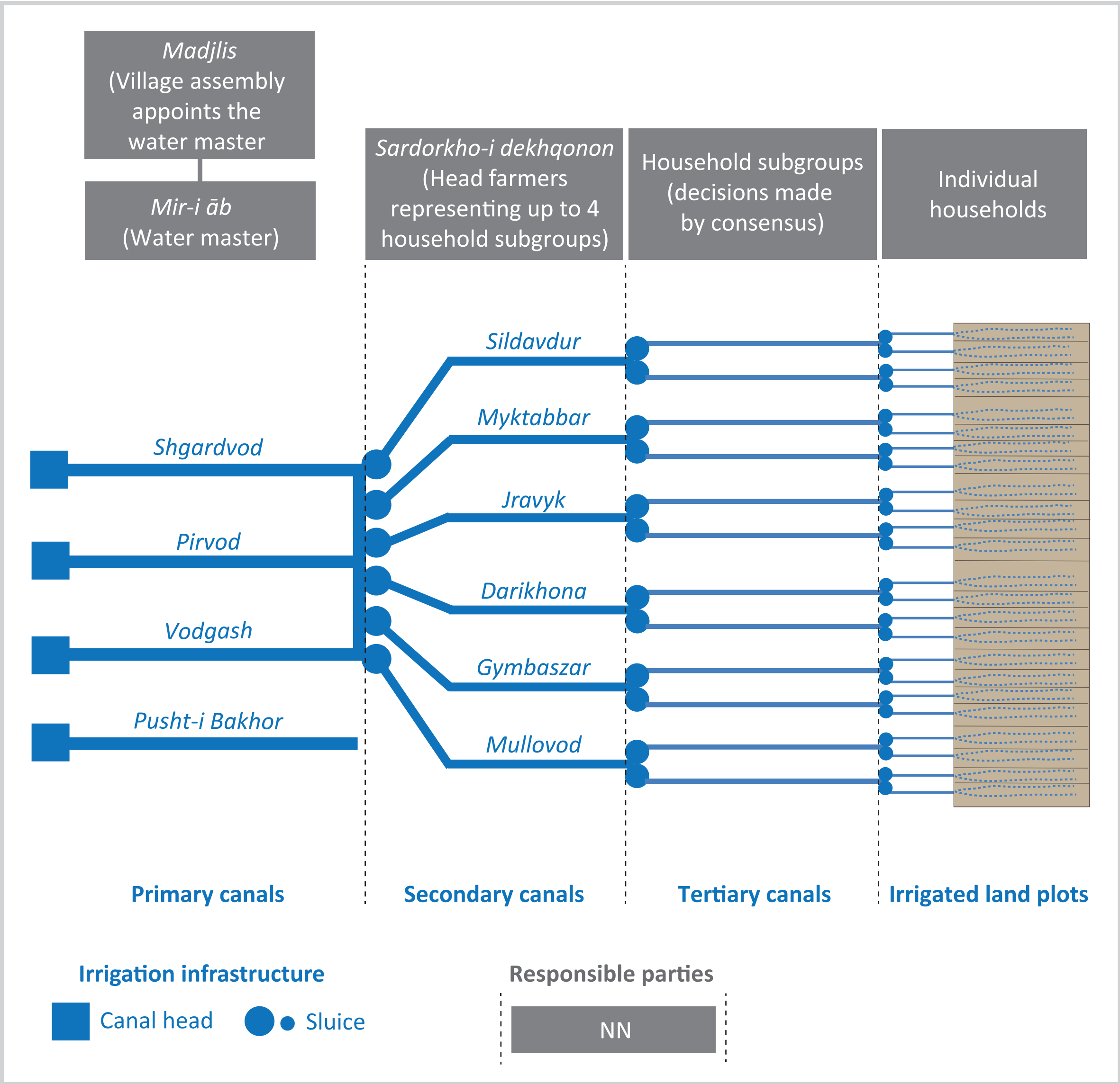
FIGURE 4 Organization of Shirgin's irrigation system. (Design by A. Dörre).



ambivalent and difficult. One reason for Shirgin's success is that water access rights are not contested there. Another reason is that Shirgin's water resources are not shared with other settlements and thus can be autonomously deployed.

We conclude that the beneficiaries of Shirgin's irrigation system strongly identify themselves with it and have a strong sense of community ownership. This sense of ownership and the system's flexibility appear to be the main factors in its sustainability and resilience to the shifting social and ecological conditions of post-Soviet Tajikistan.

This study also shows that the hydrosocial perspective makes it possible to comprehend environmental conditions affecting irrigation agriculture, the encounters between the people who pursue it, and the interrelations between the environmental and social realms. Applying this perspective can provide contextualized insights about the potentials, performance, guiding principles, and limitations of other irrigation regimes in Tajikistan's mountain regions and beyond.

In our opinion, political actors and development practitioners often lack detailed knowledge about bottom-up, contextualized, and well-functioning local resource governance and management arrangements. External interventions applying one-size-fits-all approaches can destroy established and widely accepted local governance solutions. Thus, it is essential to look at each case individually, and try to gain a comprehensive

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understanding of its structures, relations, and core principles of operation. This case study can serve as an example of a detailed and contextualized body of knowledge about the versatile capabilities of rural communities to meet the existential challenge of water scarcity within a challenging social context, which should be consulted before implementing political and development measures.

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