LOCAL KNOWLEDGE-BASED WATER MANAGEMENT AND IRRIGATION IN THE WESTERN PAMIRS

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ABSTRACT

For many people living in Central Asia, the economic decline and societal disintegration of the post-Soviet space meant a dramatic socio-economic marginalization and pauperization. Against this background and accompanied by the liquidation of numerous state enterprises, many citizens lost their jobs and secure wages. Simultaneously, the state radically cut the provision of social services. The increased uncertainty led to a rising dependency on access to, as well as utilization and the decentralized management of, locally available resources and assets for one's own survival, especially in the countryside. Because of the immediate relationship between these challenges and the comparatively scarce availability of affordable food products, the collaborative management of scarce water sources and common operation of labour-intensive irrigation infrastructure for local agricultural food production are especially significant in arid high mountain regions such as the remote Western Pamirs in Tajikistan. By means of a micro-level study conducted in the Wakhan Valley, it will be shown how self-organized management practices and pragmatic technical solutions fed by local knowledge contribute to addressing the uneven and irregular spatiotemporal water supply for irrigation. The findings reveal that local-specific water management and irrigation arrangements prove to be not only an essential basis for local food production but also a central instrument for balancing interests within a community and a means of social organization. The study provides an example of where human and social assets such as local environmental, cultural and social knowledge; common decision-making; and coordinated action become key factors for equitable utilization of locally available natural resources on the one hand. On the other hand, the study shows how local knowledge-informed collaborative resource management contributes to community cohesion and individual survival in a society which is struggling with manifold societal challenges.

Keywords: Agriculture, Community-based natural resource management, Food supply, High Asia, Irrigation, Local knowledge, Pamirs, Tajikistan, Water.

1 MOBILIZING HUMAN AND SOCIAL ASSETS TO FACE SOCIAL CHALLENGES

In the course of the dissolution of the Soviet Union in 1991, societal disruptions accompanied by socio-economic upheavals, such as the liquidation of numerous state enterprises, have caused aggravated living conditions in the agrarian countries of Central Asia, which were formerly among the poorest of the Soviet Republics receiving substantial economic support from the political centre. Many people lost their jobs and secure incomes in the course of the restructuring of the command economy, including the agricultural farm sector consisting of state (*sovkhozy*) and collective (*kolkhozy*) enterprises. Simultaneously, the new states radically cut the provision of social services [1, 2]. In the countryside, manifold additional challenges, such as limited market integration, and monetary incomes lower than the national average exacerbated the already existing difficulties to make a living. The newly gained sovereignty was, therefore, perceived by many people as a 'burden of imposed independence' [3].

Against the background of the abolition of the Soviet economic system and the end of command structures strongly intervening in local affairs, on the one hand, and new state institutions often incapable and unaccountable in terms of providing effective administrative services, reliable social support and efficient resource management performances, on

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the other hand, the increased uncertainty raised the people's need to mobilize all resources and assets at hand to ensure their own survival. Informed by DFID's sustainable livelihoods approach [4] and Bourdieu [5], such assets can be categorized into human (e.g. knowledge, skills and physical capability), social (e.g. social networks, relationships of trust, memberships and affiliations) and material (e.g. natural resources such as land, water and forests, and infrastructure like irrigation canals and agricultural equipment), as well as financial (e.g. savings, income, and access to loans) forms of capital.

This article argues that both human and social assets purposefully mobilized and deployed at the local level are fundamental prerequisites for access to common natural resources, as well as their management and utilization. Popularized by the anthropologist C. Geertz [6], the concept of local knowledge (LK) being a specific kind of human capital can be seen as an inventory of spatial-historically bounded knowledge whose features are shaped by the socio-ecological conditions of the respective locality and the daily practices of its inhabitants. According to Mistry [7], LK is characterized, among other things, as follows: (i) LK cannot be transferred easily to another location because it is context specific; (ii) LK is generally transferred orally, as well as through demonstration, observation and imitation; (iii) Instead of being static, LK changes over time through adoption to novel situations, experimentation and learning; (iv) LK is widely shared, and this enables long-term application, and intergenerational transfer of LK; and finally, (v) LK emerges from people's daily performances and interactions within different life spheres that intersect one other, and, therefore, has to be seen as a holistic body of knowledge.

While environmental, cultural and social LK represents the most substantial part of customized approaches for the management and utilization of natural resources, as well as the operation of the related infrastructure, common decision-making is the process of the creation of the institutional framework for such assemblages of collaborative action. Accordingly, these local-specific arrangements go beyond immediate resource-related issues; they also have the potential of being effective means of social organization, and equitable instruments of balancing interests within the respective community. Against this background, LK became increasingly popular in the development discourse in recent years after frequent failures of blueprint top-down development measures. LK-informed development strategies that take into consideration local interests, experiences and practices were expected to produce more efficient and locality-specific responses to environmental and societal challenges on the ground and simultaneously empower the respective community [8, 9].

In the following paragraphs, the article centres its attention on the issue of LK-based collaborative water management and irrigation approaches in rural Central Asia using an example from the arid Western Pamirs in Tajikistan. LK-based management and operation of scarce water resources and irrigation infrastructure for agricultural food production are especially significant in this high mountain region due to the tense food supply situation caused by multiple societal and environmental factors. After outlining the food supply–related context of the research area, the paper introduces the case study of Shirgin Village, located in the Wakhan Valley at the upper Panj River right at the border with Afghanistan. It will be shown how, against the background of the absence of a superior body governing local water issues, sophisticated LK-informed practices and pragmatic organizational solutions contribute to addressing the problem of uneven and irregular spatiotemporal water supply for irrigation purposes. After presenting the natural and infrastructural components of the water supply and irrigation system of Shirgin, water management and irrigation-related LK, as well as decision-making bodies and processes, will be introduced.

The study has two goals. First, it tests the pragmatic subject-centred analytical perspective on LK for its explanatory power about local-specific resource management and utilization approaches. The second goal is to deliver an example where locally mobilized and deployed human and social assets become key factors for equitable utilization of locally available natural resources and related technical infrastructure; for community cohesion and individual survival in a society which is struggling with manifold societal challenges.

2 FOOD SUPPLY–RELATED CONTEXT OF THE WESTERN PAMIRS

The post-Soviet economic decline and societal disintegration described above were particularly prevalent in Tajikistan, where, in the course of a cruel civil war (1992–1997) accompanied by tremendous human and material losses, the socio-economic vulnerability of many people increased remarkably [10, 11]. In the course of the war, reliable food supply, as one of the essential preconditions for bare survival, came under threat in remote rural areas such as the arid high mountains of the Western Pamirs located in Tajikistan's Gorno-Badakhshan Autonomous Province (GBAP). The collapse of the national supply network, bad harvests and a blockade by government forces in 1992–1993 led to a severe famine that struck the whole population. For years, nearly all inhabitants relied on humanitarian assistance offered by the Aga Khan Foundation's 'Pamir Relief and Development Programme', which delivered staple food products like flour, oil and sugar from the organization's supply centre located in Osh, Kyrgyzstan [12–14, 19].

GBAP's food supply system structurally rests on two pillars. Local agricultural production, as the first pillar, is limited by the terrain and altitude of the mountainous environment. This economic activity is predominantly pursued at the household level by local farmers. Because of the environmental constraints of the cold and arid high mountain desert, the mainly Kyrgyz population of the eastern plateaux-like part of GBAP corresponding to the *nokhiya* (district) of Murghab is mainly practicing pasture-based animal husbandry. The Western Pamirs administratively including the *nokhiya* of Darvoz, Vanj, Rushon, Shugnon, Roshtqal'a and Ishkoshim are predominantly inhabited by Pamiri farmers belonging to the Isma'ili branch of Shi'a Islam (Fig. 1). They are pursuing an approach called mixed or combined mountain agriculture. This strategy combines the use of small land plots for food and fodder cultivation located mostly on plain debris cones and alluvial fans at the bottom of deep narrow valleys close to the farmers' residential centres, with animal husbandry seasonally utilising more or less distant mountain pastures. Due to annual precipitation lower than the agro-ecological threshold of 250 mm, this kind of land cultivation depends highly on irrigation [15–19]. Land plots suitable for cultivation in terms of flatness, soil properties, water availability and other characteristics are scarce due to the challenging conditions of the arid and steep mountainous environment. According to the Statistical Agency of Tajikistan [20], only 12,219 ha arable land existed in GBAP in 2013 for approximately 212,000 inhabitants. This corresponds to less than 0.06 ha per capita or just half of the national average. Local agricultural production covers GBAP's food demand only partially. Until today, the provision of externally produced staple foods and groceries is essential [12, 13, 21–23]. These imports represent the second pillar of GBAP's food supply system.

The challenging food supply situation in GBAP can be seen as the product of different factors. Natural hazards like rockfalls and other gravitational mass movements pose a continuous threat to the few existing roads connecting the region with the agricultural centres and economic growth poles of the country. Clouds and quickly shifting weather conditions impede the maintenance of regular flight operations between the country's capital Dushanbe and GBAP's main airstrip in Khorog. These conditions lead to a fragile and cost-intensive accessibility to the region and its comparatively weak integration into the national market.

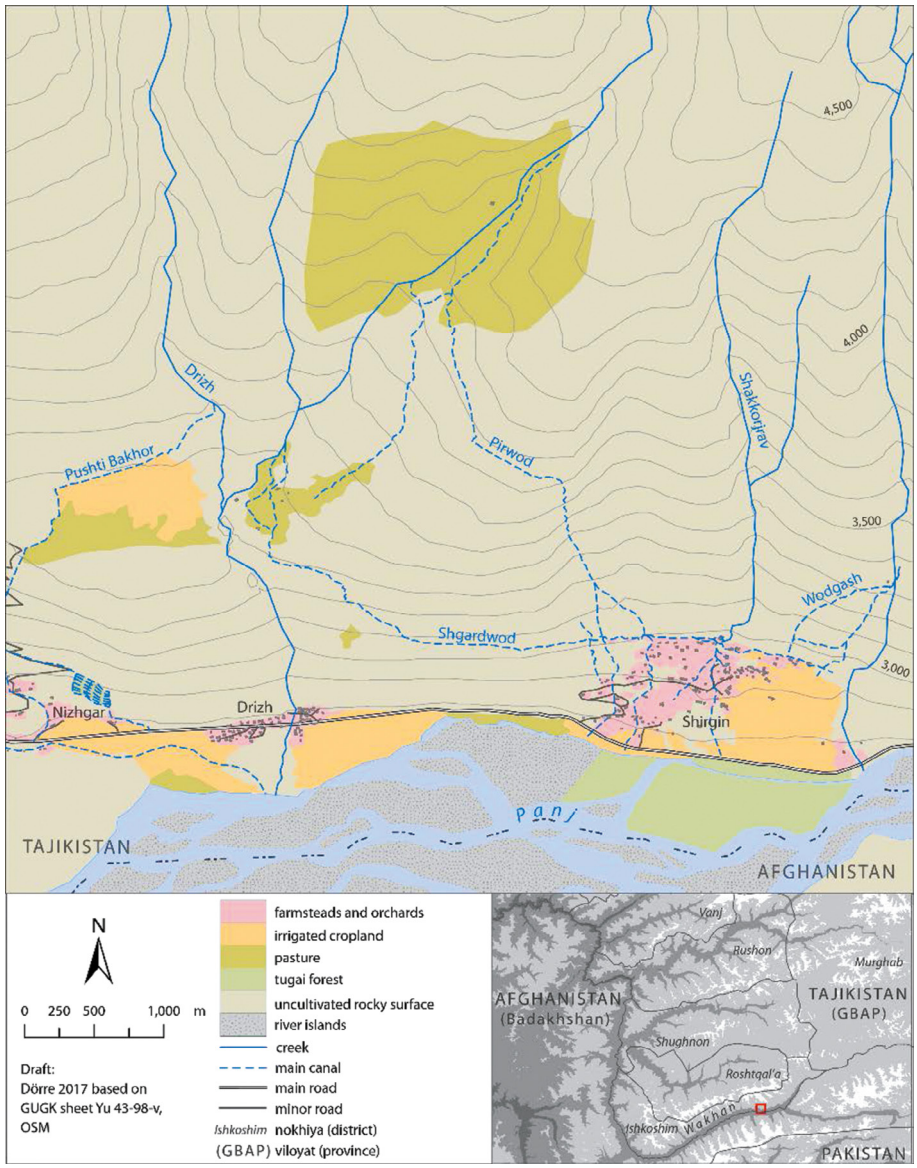

Figure 1: Spatial extension of the water supply system of Shirgin, and location of the research area in GBAP.

The high transportation costs contribute to prices for food, fertilizer, fuel and agricultural equipment, which are higher than in other regions of the country. For more than 51% of GBAP's population (which is the highest regional poverty rate in Tajikistan) monetary incomes lower than the national poverty line for monthly consumption (162 Tajik somoni (TS) per capita; ca. 20 US$) hamper access to these imported products [24]. Even basic products like flour are hard to afford when the price per kilogram is 3 TS or higher [25]. Finally, the de facto closed border with Afghanistan, international trade directed mainly to the capital and limited capacities of Tem reloading facility near Khorog for Chinese products imported

from the Xinjiang Uyghur Autonomous Region of China represent serious obstacles for GBAP's exchange relations with, and its integration into, international food markets. Against this background, local agricultural food production gained importance after the dissolution of the Soviet Union and the following civil war.

3 WATER MANAGEMENT AND IRRIGATION IN SHIRGIN

The inhabitants of the arid valleys of the Western Pamirs have long-lasting experiences in cultivation based on proven water management skills and irrigation practices. Historically, thanks to local-specific resource-related knowledge, rules and practices, a remarkable share of the food products consumed was produced locally. However, the majority of the people lived on the breadline, and were highly vulnerable to crop shortfalls and other shocks [26]. The valley of the upper Panj River is a demonstrative example. While the land parcels were irrigated by water coming from the main river and its tributaries, the related infrastructure, such as channels and locks, was constructed and maintained by the communities [15, 17, 19, 27, 28]. After 1991, the knowledge and experiences accumulated over time proved to be highly valuable for adaptation to the new era with all its challenges.

The village of Shirgin (37°00'31"N 72°31'19"E) has an altitude of 2,800 m up to 3,000 m and is located in the Wakhan Valley on the right bank of the upper Panj River (Fig. 2). In administrative terms, Shirgin belongs to the *jamoat* (municipality) of Vrang, being part of Ishkoshim *Nokhiya*. With approximately 850 inhabitants living in 100-something households, Shirgin is considered to be of medium size compared to other settlements in the district [29].

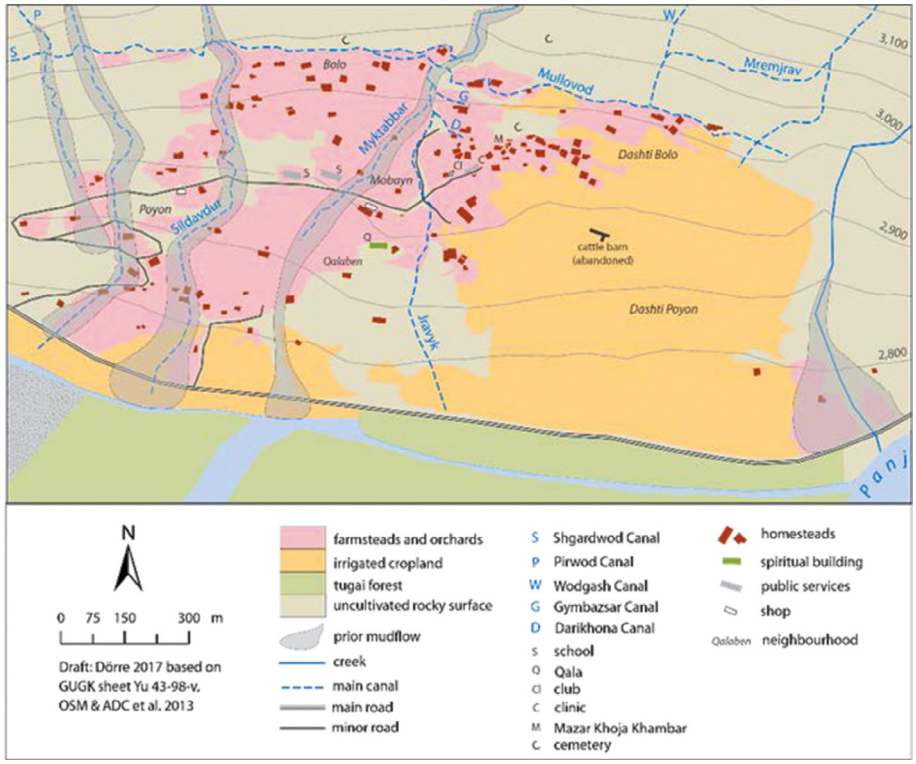

Figure 2: Canals and land use within the village limits of Shirgin.

Several reasons make Shirgin an appropriate case for the study of local-specific water management and irrigation arrangements.

The village is exposed to a couple of economic challenges concerning the food supply. The prices of staple foods offered in the few shops of the village are higher than in Khorog or Ishkashim. In August 2016 for instance, a 50 kg sack of flour was 170 TS, and pulses, an important protein source in the local cuisine, cost 8–10 TS/kg. At the same time, the few existing jobs, limited to the school, a kindergarten and a tiny clinic, are structurally underpaid. A teacher's monthly salary, for instance, is around only 450 TS. Additionally, the risk of mudflows poses a threat to the reliable provision of food products from Khorog, Ishkoshim and Vrang. Therefore, subsistence-oriented cultivation supplemented by animal husbandry is crucial for Shirgin's population.

Animal husbandry relies on seasonal pastures adjacent to the village, as well as beyond the Khargush Pass located 90 km to the East. Cultivation instead depends on irrigation due to the arid conditions, which are similar to the climate of the district centre Ishkoshim (approximate precipitation per year 100 mm with a peak in spring). At the same time, cultivation is restricted by the small area of suitable land plots (Fig. 2). With 111 ha of irrigated cropland and orchards covering 25 ha in total, only a bit more than one ha of arable land and a less than 0.25 ha of orchards are at each household's disposal on average [30].

The data for this analysis were gathered by the author during field stays in the spring of 2015 and the summer of 2016, as well as by a research assistant in the summer of 2015. Information on current environmental conditions, water management and irrigation arrangements was collected from knowledgeable persons involved in these issues and representatives of the local administration. Representatives of local households explained their daily activities around the issue of securing their food supply. Site inspections accompanied by local guides were combined with a mapping of the water supply and irrigation infrastructure, as well as observations of irrigation practices. Finally, following an oral history approach, elderly people were interviewed about their experiences and memories regarding water supply and irrigation in the past and how this knowledge is currently applied.

3.1 Shirgin's water supply and irrigation system

The lack of suitable water sources within the village limits, water scarcity during the vegetation period, the hillside situation of Shirgin, as well as its spatial extent, require an artificial water delivery and spatial distribution system consisting of canal heads tapping natural water sources, canals leading the water to the village, as well as channels and locks to distribute the water as needed. Over time, Shirgin's population developed proven LK-informed technical solutions and sophisticated management practices to address the problem of an uneven and irregular spatiotemporal water supply for irrigation purposes.

According to local respondents, the present irrigation infrastructure is based on historical constructions executed by the local population in the 19th century under the guidance of an Isma'ili religious leader, with support from Russian border guards in the early 20th century, and, finally, under Soviet rule. In socialist times, the canal system was used mainly for the irrigation of lands belonging to the collective farm 'Lenin', as well as for privately used plots near to the farmsteads [12, 31]. In that time, the infrastructure was maintained at the expense of the *kolkhoz*, which was shifted into a *sovkhoz* in 1977. The state farm was transferred in 1996 back into a *kolkhoz*, and, finally, to a so-called *khojagii dekhqoni* (farmers' association) named 'Mullo-i Bek', assembling most of the farmsteads of the three villages of Shirgin,

Nizhgar and Drizh (Fig. 1). Since then, the farmers have had to organize the supply and distribution of irrigation water by themselves, as well as the maintenance of the irrigation infrastructure.

3.1.1 Water tapping and supply-related infrastructure

Four main canals with different characteristics pipeline irrigation water from diverse natural sources to the agricultural lands used by Shirgin's inhabitants. These are from West to East: *Pushti Bakhor*, *Shgardwod*, *Pirwod*, and *Wodgash* (Figs. 1 and 2).

The *Pirwod* ('canal of the Pir') is regarded to be the oldest canal of Shirgin, stemming from the 19th century. According to local legend, the Isma'li religious leader *Pir Saidmamadsho* living in the *Qala* (castle) of Shirgin initiated and guided the construction of the approximately 6 km long structure. The canal head taps a snow- and glacier-fed creek at an elevation of approximately 4,050 m, and channels the water via a flagstone-lined, approximately 40 cm wide and deep construction using the natural gradient to a steep bluff located just north of the village. Here, the canal water creates an artificial waterfall. After the waterfall, another canal structure pipelines the water into Shirgin's distribution system (Fig. 3). Because of the altitude of the source, *Pirwod* works only temporarily from June to September. The rest of the year the canal head is blocked by ice. If the weather turns cold, windy and cloudy, the canal head can even freeze in summer. Such situations quickly lead to less irrigation water in the canal [32, 33].

Another canal initiated by a *Pir* is the shorter *Wodgash* ('canal's mouth'). This canal stems from a snow-fed natural pool located approximately 2 km to the Northeast of the village centre at an altitude of 3,350 m. From late April to June, the *Wodgash*, which was dug into the rocky surface, provides water to a couple of homesteads and land plots located in the Eastern

Figure 3: The *Pirwod* Waterfall (upper right) and *Shgardwod* canal (coming from the West, here from the left side) (Photograph: Dörre, August 2016).

Figure 4: Downslope vegetation lines mark the course of the *Wodgash* (*left*) and *Mremjrav* (*right*) canals (Photograph: Dörre, September 2016).

part of the village. In times of high discharge, the nearby subordinate *Mremjrav* takes over the water surplus and pipelines it to the consumers (Fig. 4). This solution is important for two reasons. First, the farmers can receive more water at the beginning of the cultivation period. Second, it reduces the risk of mudflows initiated by the steep *Wodgash*, by taking water out of this channel. When all of the snow feeding the pool is melted, the water level of the pool sinks and it cannot be tapped any more. In June, the *Wodgash* dries out. If the snow feeding the pool does not melt due to cold, cloudy or windy weather, the *Wodgash* can fell dry even in April or May [34–36].

At the time when the Russian Empire occupied the Pamirs at the end of the 19th century, the *Pirwod* and *Wodgash* canals could not provide enough water for Shirgin's growing population. In the course of the following search for new water sources, a tributary of the Drizh Creek located approximately 5 kilometres to the West was identified at an elevation of 3,400 m. The challenging task of digging the canal into the rocky surface was completed with support from the Russian border guards stationed at the nearby Langar Kikhn Post. In the early 20th century, the *Shgardwod* ('straight canal') project characterized by several masoned and long concreted sections was finished (Fig. 3). The canal works from April until October. The *Shgardwod* and *Pirwod* canals are regarded as Shirgin's main water lines [32, 33, 36, 37].

Finally, the fields of *Pushti Bakhor* ('delayed spring') located five kilometres outside of Shirgin to the West at 3,300 m were also developed in pre-Soviet times for the cultivation of fodder crops. In the course of this land acquisition project, a canal with the same name fed from the Drizh Creek was built, as well as a couple of sheep stables [32, 38, 39]. Today, local herders use the area as a summer pasture for sheep and goats, as well as for cattle [40].

3.1.2 Water distribution infrastructure

Within the limits of Shirgin, six main canals run through the neighbourhoods to distribute the irrigation water. They are locked, and can be opened only according to commonly defined schedules. These canals are, from West to East, *Sildavdur*, *Myktabbar*, *Jravyk*, *Darikhona*, *Gymbazsar* and *Mullovod* (Fig. 2). Hundreds of blocked side canals branch off towards clusters of cultivated fields, garden plots and orchards. The final stage of the irrigation system is tiny channels in the fields, gardens and orchards. These runnel- and furrow-shaped water lines are locked with small barrages made out of stones, iron sheets, branches, wool, textiles or animal hides, which can be removed quickly and easily on demand.

3.2 Water management and irrigation practices

To gain a better understanding, the study of local-specific water management and irrigation arrangements can be differentiated by looking specifically at the three subjects of decision making, the involved actors and the practices executed by them.

Against the background that a superior institution governing local water issues does not exist, Shirgin's central decision-making body is the village assembly that gathers every year during the celebration of *Shogun* (also known as the Persian New Year, *Nawruz*), the vernal equinox on March 21. At this occasion, the assembly elects the *Mirāb* ('water master'). He is responsible for securing the water supply through supervising the three main canals: *Pirwod*, *Shgardwod*, and *Wodgash*. In case he identifies damages or other problems with the infrastructure during his daily inspections, he announces an *Ashar* ('collective work'). As a century-long experience has shown, most damages occur in the winter, and have to be repaired before the start of the irrigation period. The maintenance regime for the *Shgardwod* canal is organized very pragmatically. The community agrees that each household is responsible for a specific section of the canal, and has to conduct small cleaning, maintenance and repair jobs to secure the functionality of the canal. Bigger damages require calling an *Ashar* [34, 36], 41]. Another duty of the *Mirāb* is the creation of irrigation schedules adapted to different stages of the cultivation period and the amount of available water. These schedules also have to be accepted by the leaders of the community and the village assembly. They will be briefly delineated below.

For several years, the same experienced man has occupied the position of the water master [33, 36]. This circumstance shows that the community is satisfied with his work and trusts his assessments. It also underlines the importance of accumulated knowledge, experience and mutual trust for the successful management and usage of common pool resources.

According to the flow of the water, so-called *Sardori-Deqkhonon* ('heads of farmers') are one management level below the *Mirāb*. They are responsible for the supervision and the proper handling of the locks blocking the main canals, as well as for the condition of the canals themselves. Each canal has four heads, which take turns and represent a different subgroup of up to ten farmers using the same canal. They are elected by their group and are responsible for irrigation practices according to the agreed schedules [33, 36]. Within these subgroups, the water division is organized by the members themselves. They continuously negotiate the time and the duration of their irrigation slot, and open and close the locks in accordance to the agreements. These arrangements are highly flexible, to quickly encounter shifting conditions. After the village assembly, the water master, the *Sardori-Deqkhonon* and the canal subgroups, individual farmers can be seen as the fifth and final tier of Shirgin's water management and irrigation arrangement.

Finally, the irrigation schedules adapted to different scenarios, in terms of two different stages of the cultivation period, and the amount of available water shall be outlined [33, 36].

One schedule is used during the beginning of the cultivation period from the middle of April until mid-May in years with normal water supply. All farmers are allocated to two main groups, each consisting of six subgroups of up to ten households. The six subgroups belonging to the first main group are entitled to irrigate their fields on even dates, the second main group on odd dates. The irrigation entitlement of a group comprises a day irrigation round lasting from 7 am to 7 pm, and a night irrigation round lasting from 7 pm until 7 am next morning. Accordingly, every subgroup has the right to irrigate their fields for two hours during the day, and two hours during the night. The water distribution within the subgroup is negotiated by its members.

In years without water scarcity, a second schedule is used from the middle of May until the harvest of legumes in August. Every neighbourhood receives irrigation rights valid for one specific day of the week. The neighbours organize the water distribution by themselves.

In years with water scarcity, a third schedule is used for the same cultivation period, as in schedule 2. Instead of whole neighbourhoods, canal-specific subgroups mentioned before receive 24-hour-long irrigation rights, and have to negotiate the water distribution within their groups. In case the water shortage is severe, the time slot for irrigation can be shortened. The responsible *Sardor* ('head') opens and closes the locks of the respective distribution channel his group is allocated to.

After the last field harvest has taken place in the middle or the end of August, a fourth irrigation approach is applied to irrigate remnant potato and vegetable beds and small legume sowings adjacent to farmsteads. At this time, the water demand is low and a regulation restricting the use of irrigation water is not necessary anymore. Every farmer can use as much water as needed and available.

4 CONCLUSION

The strength of Shirgin's community lies, on the one hand, in the outstanding water management and irrigation-related inventory of local knowledge comprising rich expertise about the environmental conditions of the surroundings of the village, its historical heritage, the detailed characteristics of the community and the place going beyond the immediately visible, as well as long-term personal experiences of the responsible managers, and the individual farmers. On the other hand, social assets such as mutual respect and support, trust and collaborative teamwork are characteristic of the relations between the different tiers of Shirgin's water management and irrigation approach. Therefore, it can be seen as a local-specific 'hydrosocial arrangement'.

This study provides an example of human and social assets becoming key factors for equitable utilization of locally available natural resources, as well as community cohesion and individual survival in a society which is struggling with manifold societal challenges. The findings support the argument that local knowledge-based approaches for the management of common pool resources have the potential to be not only a basis for resource utilization but also a central instrument of balancing interests within a community and a means of social organization.

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