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5 Sustainability of Post-Soviet Water Management in Jan-Bulak Village

Introduction

Irrigation and freshwater supply in the area of the so called "water tower of Central Asia" (Sorg et al. 2012: 725) - the Tian Shan Mountains - is shifting because climate change is adversely affecting the cryosphere in high mountain regions in the Central Asian newly independent states. However, not only physical geoscientific phenomena are changing the relation between humans and nature. Since the demise of the USSR in 1991, the water allocation itself has undergone dramatic transformation from governmental to private use and administration (Abdullaev & Rakhmatullaev 2015: 857-858; Rost et al. 2015: 863).

For human and physical geoscientists all over the world adaption to the consequences of global change for humanity and nature will be one of the greatest challenges of the 21st century. Exploring, analyzing, understanding, and organizing this issue is already one of the main topics of many academics worldwide, in order to preserve natural as well as anthropogenic cultural spaces. Water scarcity therefore is one of many aspects that have been explored and analyzed by scientists in order to understand how social and ecological systems are working reciprocally in countries in the Global South and North.

Hence, it was possible to deduce how scarcities of resources arise and how resource users, governments and further stakeholders are dealing with these phenomena in order to achieve, implement, and enhance sustainability (Basurto et al. 2013: 1366-1378). Nevertheless, in order to realize this deduction it is necessary to know what so-called 'sustainabilities' are, according to science (Ostrom 2009: 420-421).

For this purpose, a general definition of this concept shall be worked out in the following: In mainstream geoscientific literature the term sustainability in the field of ecology is defined as the

> "preservation and at the same time continuous and optimal use of a resource in the environment of humans for the benefit of current and future generations" (Leser et al. 2011: 593).

In this paper, we want to extend the understanding of sustainability in order to realize and achieve a more holistic scientific approach. Proponents of the field of critical resource geography say that the common definition of sustainability might be interpreted as a reason for Northern economic hegemony facilitated by neoliberal practices, e.g. 'rolled out' by global institutions (such as the World Bank) with the (apparent) power to impose their will on whole countries (Castree 2006: 4). Therefore, the role of power, knowledge, ethnicity, class, and gender as concepts have to be considered in the concept of sustainability in order to achieve a more holistic approach (Castree 2006: 3-4; Lawhon & Murphy 2011: 364).

In the context of resource scarcity related to sustainability, self-organisation is also playing a key role especially when the users are highly dependent on resources becoming scarcer. In addition, if the resource use is not the subject of the government or any other superior administrative unit, self-organisation becomes even more necessary to assure an adopted, fair and sustainable use of scant resources.

In light of this assessment, the present paper focuses on answering the following research question: "How far is self-organisation and sustainability regarding the water management and irrigation patterns in the former soviet *kolkhoz* of Jan-Bulak, Naryn Oblast', already implemented and where is some future potential?"

The general framework of Social Ecological Systems (SES) by Elinor Ostrom will be applied to analyze field research data that was gathered in July 2016.

The general framework of social ecological systems for analyzing sustainability

> "The world is currently threatened by considerable damage to or losses of many natural resources, including fisheries, lakes, and forests, as well as experiencing major reductions in biodiversity and the threat of massive climatic change" (Ostrom 2009: 419).

This overuse of natural resources has always been a challenge for different stakeholders who directly or indirectly depend on the respective resource. For this reason, sustainable management of water, soil, forests or livestock is extremely important to realize natural resource justice and to diminish and prevent (neo-) extractivism and exploitation.

Due to Elinor Ostroms framework of coupled SES, it is possible to depict, elucidate and evaluate complex short- and long -term interactions of energy, material and information flow between the anthroposphere and the geosphere. Hence, SES is a scientific approach that tries to promote and contribute new strategies for transformation in order to implement a more sustainable management of natural resources (Ostrom 2009: 419). Moreover, this concept is based on many empirical case studies within which the idea of SES was developed (Basruto et al. 2013: 1366-1378; Scholz & Brand 2011: 509).

The framework of SES contains four core subsystems. Resource Systems (RS) (e.g. water systems); Resource Units (RU) (e.g. the amount and flow of water or crops); Governance System (GS) (e.g. the set of rules, monitoring and administration created by governments and/or non-governmental organisations (NGO) for implementation); and Users (U) (e.g. inhabitants who are using a resource for sustenance or for commercial purpose).

These four core subsystems are connected by Interactions (I) between each other and also affected by Outcomes (O), which are influenced by I. Among RS and RU as well as GS and U mutual interactions exist. However, the subsystems of RS, RU, GS and U with its I and O as a whole system is nevertheless further affected by social, economic and political settings (S) and related ecosystems (ECO). These interactions are also reciprocal. A more detailed view of the respective subsystems of the framework reveals many different second-level variables (Fig. 1).

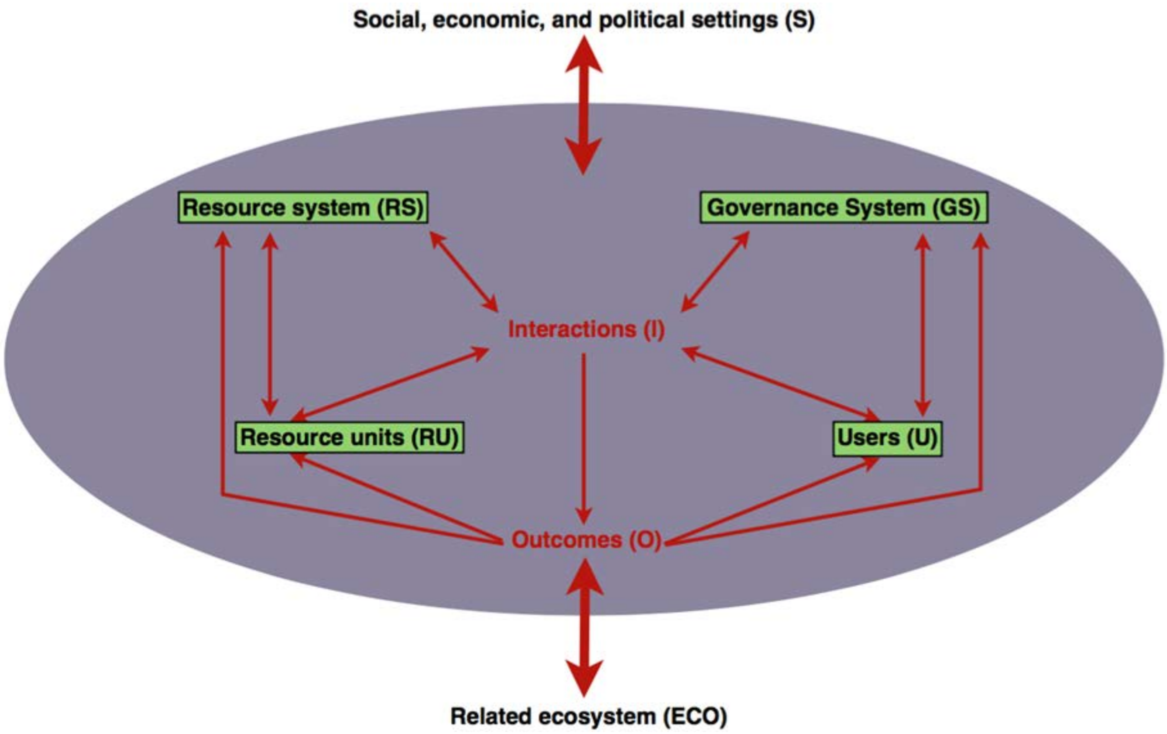

Fig. 1: The framework of Social Ecological Systems for analysing sustainability. Design: Marx 2017 based on Ostrom 2009

According to Ostrom (2009), ten second-level variables derived from many years of empirical research on SES from field researchers are critical for analysis (cf. Baland & Platteau 2007: 276; Basurto et al. 2013). These key variables act as a positive or negative factor on the behaviour of the self-organized management of U. According to this long-term empirical knowledge, the size of a resource system (RS3) is an important indication. This means that self-organisation depends on the definition of boundaries.

For example, costs of administration and organisation are rising if the size of a RS is very extensive, because monitoring and continuation of regulations become more difficult (Baland & Platteau 2007: 321-324). Likewise, small RS do not generate adequate amounts of good. As a consequence, RS have to be moderate in their territorial size to obtain a manageable self-organisation. Nevertheless, an RS also has to have attributes of scarcity, which concerns the productivity of an RS (RS5). Therefore, U will only start to self-organize if a resource such as water in a canal- or river-system should neither be exhausted nor be existent in large quantities. Scarcity and the danger of a less productive RS are, in this context, a corresponding variable of why U realize self-organisation (Wade 1994: 1, 12-13). Another important aspect is the predictability of the dynamics of an RS (RS7): The adjustments of guidelines may influence a SES, whereby water systems, due to their dependency of several factors, are more difficult to predict. One of these factors is resource unit mobility (RU1), because expenses of a moveable resource, e.g. water, are more difficult to administrate than fixed objects like water in a lake. Focused on the subsystem of U, five variables are pointed out: The number of users (U1) as well as the respective leadership (U3), norms/social capital (U4), knowledge of the SES (U5) and the importance and dependency of a resource to users (U6). U1 means that costs of administration are higher if the quantity of organisation-members who are using a resource is high because consensusbased adjustments and changes are more challenging to realize in larger groups (Baland & Platteau 2007: 298-299; Wade 1994: 15). Nevertheless, Ostrom says that even if the group size is important, self-organisation still "depends on other SES variables and the types of management tasks envisioned" (2009: 421). As a result, U3 might influence U1. A good leadership, for example, can enable self-organisation without the higher number of users will have negative effects on it. U3 might be also influenced if some people of an organisation have entrepreneurial abilities or if graduates from university and/or a parliamentary advisory committee are involved in decision-making processes (Baland & Platteau 2007: 339-340, 342). Accordingly, the variables of U4 are also not to be scoffed for a well-functioning self-organisation. Ethical standards, moral and social competence as well as trust in each other are still extremely important to reduce expenses of self-organisation, which also means that rules have to be respected by every single person. As a result, it is logical that rules and agreements can only be kept if resource users create their own regulations due to collective choice-rules (GS4) (Berkes et al. 2006: 1557). In such a case following the rules is more likely. U5, which means that users understand, comprehend and are aware of the four subsystems RS, RU, U and GS, is another decisive factor (Gadgil, Hemam & Reddy 1998: 44-45). This also means users should know particular variables and characteristics of the subsystems and their interactions and implications such as the regeneration capacity of a resource or general information about their own population as well as ecological and physical knowledge. Subsequently U6 is a further key variable. This variable is defined due to dependency especially if resources, such as water, soil or crop plants are eminent to users' livelihoods. In long-term development this in turn implies that efforts of self-organisation rise if users do not deal sustainably with the RS, as the scarcity of common resources will probably increase. Even if these ten key variables are meant to be the most important factors for analyzing self-organisation, other aspects such as storage characteristics (RS8), NGOs (GS2), history of use (U2) or conflicts among users (I2) as well as the ECO, S and O with its single variables might be, depending on the respective SES, further eminent (Ostrom 2007: 15181-15182; Ostrom 2009: 420-421) (Tab. 1).

Table 1: Settings, systems and variables associated with self-organisation (based on Ostrom 2009) (key variables are in boldface type)

Setting/ First-level subsystems	Second-level variables associated with self-organisation	Third-tier variables
Economic development (S1)	GDP (1994-2016): 3.58 % (S1.1)	
	GDP per capita 1,017.15 USD (S1.2)	
Demographic trends (S2)	Population growth (2005-2015): 1.52 %	
Related ecosystems (ECO)	Climate patterns of Jan-Bulak – steppe climate (ECO1)	
	Pollution patterns from goldmine and industry (ECO2)	
Governance system (GS)	Government organisation Naryn Basin Water Management (GS1)	
	nongovernment organisation Kyzyl-Zoo-Dostuk Water User Association (GS2)	
	Operational rules (GS3)	Farmers have to clean canals to get permission to irrigate fields (GS3.1)
		Irrigation of fields only 3-4 times each season (GS3.2)
		Amount of irrigation water of AKC decided by engineer and director of GS2 (GS3.3)
	Collective choice rules (GS4)	Turning system (GS4.1)
		Lottery system (GS4.2)
	Constitutional rules (GS5)	Irrigation cycle of twelve hours costs 42.20 Som (water from Big Naryn Canal) (GS5.1)
		Irrigation cycle for one season costs 500 Som (water from Ak-Kiya Canal) (GS5.2)
	Monitoring and sanctioning processes (GS6)	
Resource system (RS)	**Sector of water and the related canal system (RS1)**	
	Clarity of system boundaries defined by fields belonging to Jan-Bulak (RS2)	
	Size of the resource system (1,911 ha) (RS3)	
	Human constructed facilities (RS4)	Big Naryn Canal (RS4.1)
		Ak-Kiya Canal (RS4.2)
		Small canal built by spades (RS4.3)
	Productivity of RS (RS5)	
	Equilibrium properties (RS6)	
	Predictability of the system dynamics (RS7)	
	Storage characteristics (RS8)	
Resource units (RU)	Resource mobility (RU1)	
Users (U)	**All users (2,393 inhabitants) (U1)**	
	History of use/construction (U2)	
	Leadership (U3)	Members of the Kyzyl-Zoo-Dostuk Water User Association (U3.1)
		Members of the Naryn Basin Water Management (U3.2)
		World Bank (U3.3)
	Social capital (U4)	Regulator and engineer of Naryn Basin Water Management as well as Kyzyl-Zoo-Dostuk Water User Association (U4.1)
		Smallholders of Jan-Bulak (U4.2)
		Members of Kyzyl-Zoo-Dostuk Water User Association (U4.3)

Users (U)	**Knowledge of Social Ecological Systems (and mental models) (U5)** **Importance and dependency of the resource (U6)** Technology used (U7) Additional profession (livelihood-strategy) (U8)	
Interactions (I)	Harvesting levels of diverse users (I1)	Increase of crop yield in the western part (I1.1) Decrease of crop yield in the eastern part (I1.2)
	Conflicts among users (I2)	Conflict between two smallholders (e.g. about water) (I2.1) Conflicts between smallholders and Murabs (I2.2)
	Investment activities (I3)	Kyzyl-Zoo-Dostuk Water User Association gets financial support from the World Bank (I3.1) Payment of contribution (I3.2)
	Self-organizing activities (I4) Network activities (I5)	
Outcomes (O)	Low wage for Murabs (O1) Ecological performance measures of sustainability (O2)	

Water management and irrigation in Jan-Bulak

The objective of the following chapter is to analyze, evaluate and discuss the key variables. Further variables that are important for answering the research question are included as well. As a result, reciprocal interactions of variables are deduced, analyzed and discussed.

The research data has been obtained during a two weeks on-site visit in July 2016. The team was completed by a local research partner, who was acting as a translator and contact arranger. The inspection of the canal system was implemented by several transect walks with local farmers and employees of the Naryn Basin Water Management (NBWM) and the Kyzyl-Zoo-Dostuk Water User Association (KZD-WUA). At the same time, questions regarding operating principles of the canals and gates, opening and closing times as well as responsibilities were answered. In a further step semi-structured interviews with three local farmers were conducted to gain detailed information about the irrigation system and its execution. Deeper insights into the functioning were gained through participatory observations of a field irrigation and the opening of the main gate. During an interview with three active *Murab* (water managers), a participative map was designed to illustrate the current canal system and the different areas of responsibilities (Fig. 2).

In addition, semi-structured interviews with the head of the Aiyl Okmotu and an employee of the NBWM in the office in Naryn have been conducted. A comprehensive knowledge was also obtained through an extensive talk with the director of the KZD-WUA in his office in Jan-Bulak.

Even without focusing on the local level, the importance of a sustainable use of water in Kyrgyzstan can already be derived from some general indicators like demographics (S2) and the economic development of the country (S1). Kyrgyzstan's total population amounts to 5,965,000 inhabitants with an annual population growth of 1.52 % between 2005 and 2015

(UNSD 2017). It is important to notice that the proportion of the rural population amounts to 64.3 % in 2015 with an annual growth rate of 1.17 % between 1992 and 2015 (FAO 2017a). Due to the fact that especially this portion of the population is highly dependent on agriculture and therefore on irrigation water, the enormous importance of the sustainable use of this resource becomes obvious and is underlined by a relatively high portion of the agricultural sector accounting for 17.9 % (2016) (CIA 2017) of the country's Gross Domestic Product (GDP). The knowledge about S is especially important to estimate development trends of the future and their level of influence. Nevertheless, these data (for example data on population growth) are more important on the national level to gain a holistic view. But to derive concrete impacts on the region by this variable, some more detailed statistics, which were not available, about local population growth would be necessary.

A closer look into the proportion of land used for agriculture (55 %) compared to the available arable land (12 %) highlights that an efficient resource use is crucial to maintain the already restricted cultivation area in order to supply the increasing population with food (FAO 2017b). For this, irrigation water is needed and because of that it must be ensured that the resource is not overused as a result of high demand.

Furthermore, some governmental water policies have taken place in recent years. In addition to a modern Water Code, which was signed into legislation in 2005, a Water Management Improvement Project was implemented in 2006 lasting until 2013. One goal of that project was the support and rehabilitation of WUAs in Kyrgyzstan (WB 2017: 2-3). The establishment of WUAs was intended to decentralize the task of the regulation and management of water resources and was already accepted in 1997 when the government agreed on the associated bill. The Law "On Water User Associations and Unions of Water User Associations" was thus adopted in March 2002. Two years later, twelve WUAs were established in the Naryn Region as a result of it (Degembaeva et al. 2016: 97), aiming at a better water supply of the users on the national and local level. The World Bank (WB) has a long tradition as supporter and provider of financial aid related to the water sector in post-Soviet countries (WB 2013: 4).

Nevertheless, it has to be questioned how those governmental and international efforts are influencing the local situation. The effectiveness of the governmental actions regarding the establishment of WUAs can be further questioned, considering that out of twelve legally registered WUAs in 2004 in the Naryn Region, after eleven years only four were still operating (Degembaeva et al. 2016: 97).

Geographical conditions

During the Soviet era, Jan-Bulak was established as the *kolkhoz* named after Karl Marx in 1931. Today, it belongs to the Naryn Oblast' with a total population of 2,393 (determined on 01.01.2016) (Aiyl Okmotu of Jan-Bulak 2016: 1). As the majority of the people living in this village are both smallholders and medium farmers or they practice subsistence farming in addition to their actual profession (U8) as a livelihood-strategy. The number of inhabitants can also be seen as U1. The RS is represented by the sector of water and the relating canal system (RS1), which is mainly used for agricultural irrigation. The canal system relies on the characteristics of the ECO with the corresponding river and is therefore sensitive to possible disruptions like changes in the climate pattern. This issue is enhanced by the steppe climate (ECO1) of the area. With 280 mm per year, there is only little precipitation. The precipitation maximum occurs in May (47 mm) and June (52 mm). In view of these low values it is snow and glacial melting from the mountains, which ensure irrigation. The main source for irrigation water therefore is the Naryn River, which gets water from the Yssyk Köl Oblast' located in the north-eastern part of Kyrgyzstan, as well as from tributaries from the Naryn Oblast'. However, on the upper course pollutant entry is coming from the Kumtor goldmine and other industrial activities (ECO2) (Climate-Data 2017; Kronenberg 2013: 81; Sorg et al. 2012: 725). As this section indicates, the ECO can be interpreted as vulnerable. With regard to global climate change in terms of a complete melting of glacial ice in high mountain areas the situation is getting worse because flows into and out of the focal SES are decreasing. Consequently, ECO2 endangers the RS as the concentration of chemical pollutants and contamination of water increases.

The canal system and organisational structure

At the moment, two existing canals are leading to Jan-Bulak. These are called: Big Naryn Canal (BNC) (RS4.1) and Ak-Kiya Canal (AKC) (RS4.2). The boundaries (RS2) of the RS are defined by the fields, which belong to Jan-Bulak and also the canal system itself can be seen as a spatial boundary as it regulates and determines the water flow (Fig. 2). The total range of agriculturally used fields belonging to Jan-Bulak and used by the inhabitants (U1) has an area of 1,911 ha, which is also the total size of the resource system (RS3). Due to the inhabitants, the size of the resource system – marked out by the fields- as well as both the canals with their purpose of supplying the agricultural fields of the users with irrigation water, it can be said that the RS is well defined, basically equipped and has a manageable territorial size.

The Soviets built the BNC (RS4.1) in 1941 (U2), which gets water from the Naryn River. Its starting point is located on the eastern end of Naryn city. At its ending point the canal merges into the other important canal, the AKC (RS4.2). For the irrigation of the fields belonging to the community of Jan-Bulak the BNC only provides 0.6 m3/s of water, which is caused by a decreasing water flow rate due to further irrigated areas of the (peri-)urban districts of Naryn as well as evaporation and infiltration at the canal itself.

The majority of the fields are irrigated by the AKC, beginning at the eastern boundary of the village, which was also built by the Soviets from 1981 to 1985 (U2). Due to its history the canal system as it currently exists can be seen as the heritage of the Soviet era. Therefore, the tradition and infrastructure of irrigation was established by the Soviets and thus still influences the present usage of the water resource. The AKC irrigates an agricultural area of 13.61 km^2 and has a water flow rate of 0.8 m^3/s at its beginning. Due to changes in the water flow rate during the year, depending on factors like melt water, precipitation and water withdrawal on the upper course of the river, a definition of a specific value of the unit water flow is difficult. The available amount of water for irrigation or the number of hectares which can be irrigated in a specific time period may be the best approximation of the number of RUs as well as an indicator for RS5. Furthermore, these indicators are also interrelated to the variable RS7. To set this variable, combined U5 like the water flow rate today and in the past is crucial. Therefore, users have to be aware of the amount of water which can be used for irrigation as well as of the approximate amount of water loss due to inefficient water management, poor conditions of the canals, evaporation, leaching and climate changes as described above.

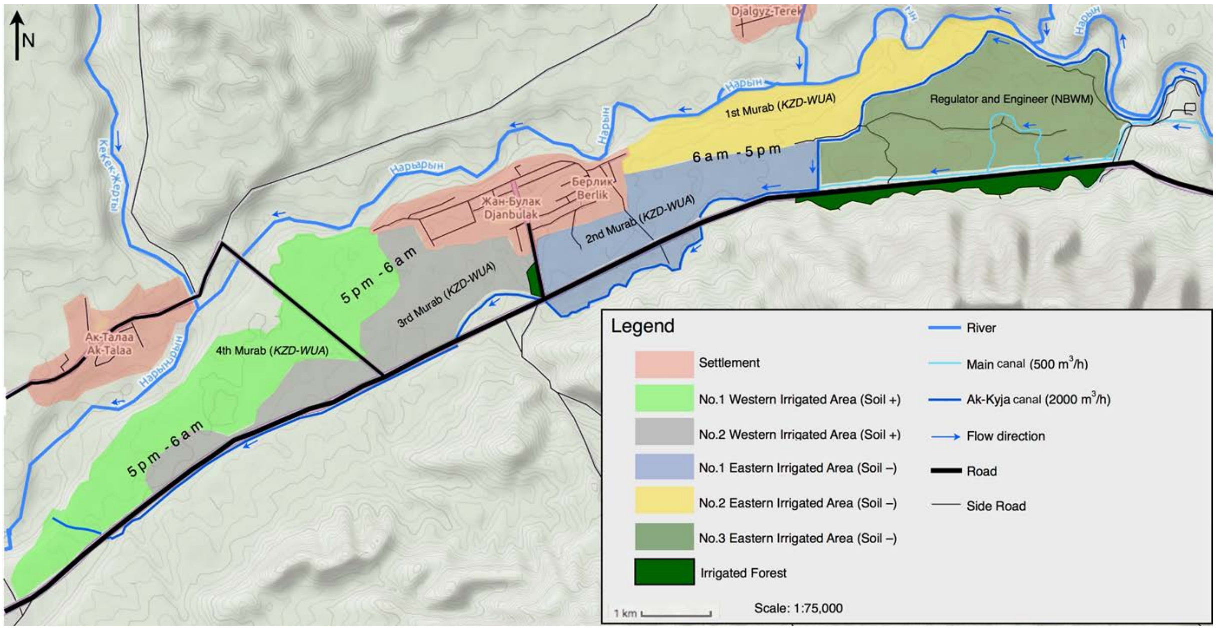

Fig. 2: Participatory map: Irrigation system in Jan-Bulak and its schedule of the turning system. Design: Marx, Müller & Zhumagulova 2016

RU1 is high due to the physical features of water, but very limited in steering possibilities. Nevertheless, the usage of a canal system is one adaption to this limiting factor. The water availability is also highly dependent on natural conditions, like precipitation, droughts and heat waves, along with the existent river regime (cf. geographical conditions). In the face of climate change, these influencing factors will change and become even less predictable. In order to counter these insecurities of future water availability we have to mention that RS8 is currently non-existent. Hence the availability of water in the future is a key characteristic of reasonable self-organisation (I4) and sustainability (O2) of the SES in Jan-Bulak. During the field research, these problems have been discussed with smallholders. On this occasion it turned out that peasants in the research area have a very high U5 because they were aware of evaporation, infiltration and leaching caused by inefficiency. But solution strategies such as fundamental repair measures of the canals to stop water infiltration or irrigation practices towards less evaporation are not focussed on at the moment. Also possibilities for an efficient RS8 in case of a dramatic shift of the flow regime caused by climate change respectively the complete melting of glaciers are not being planned. According to smallholders, this problem will only be resolved when there is no more water in the river. The interaction among RUs is very high, as water is directly influencing the growth rate of crops and therefore the crop yield. The importance of irrigation also emphasizes the high economic value and a high U6. Especially the last two variables associated with the unpredictability of the RS in the future (see above), underlines the requirement of an adequate management of the RS, undertaken by I4.

The GS of the canal system in Jan-Bulak can be divided into two sections. There are the NBWM as a governmental organisation (GS1) and the KZD-WUA as an NGO (GS2). The NBWM administrates the BNC. Its range of responsibilities regarding the BNC includes maintenance, repair measures and cleaning of the canal. These tasks are undertaken by an employee of the NBWM (U4.1) (Fig. 3).

One irrigation cycle takes twelve hours and costs 43.20 Som per ha (GS5.1), for the fields that are supplied by the BNC. Farmers whose fields are irrigated by the AKC have to pay 500 Som per ha (GS5.2) for each season. This indicates that the irrigation fee of the KZD-WUA is almost 1.5 times higher than the fee of the NBWM. As farmers are responsible themselves for taking care of irrigating their fields, they can also be seen as a social capital (U4.2) in the context of the irrigation system. Some operational rules (GS3) regarding the usage of the canal have been set. Farmers have to clean their small canals to get the permission to irrigate (GS3.1). Furthermore, each field is irrigated three to four times between April and October (GS3.2), depending on the rain, which enables two harvests per season. If we consider these operational rules set by the smallholders themselves, it is possible to say that this organisation structure is an indicator for self-organisation.

Fig. 3: Flow rate regulation at the gate of the Big Naryn Canal. Photography: Marx, 2016

The order of irrigation is based on a turning system (GS4.1). According to farmers, first irrigated fields lead to a better harvest rate. In this regard, equilibrium properties (RS6) are not given as the farmer who can irrigate first has an advantage over the others. In case of I2 between two farmers about the amount of water (I2.1), a Universal Current Meter from the NBWM, a tool to demonstrate whether the water distribution is equal or not, can be used as a conflict-solving method. Nevertheless, monitoring and sanctioning processes are missing within the GS, and the risk of free rider problems is increasing in the SES.

GS2, which is partly financed by the WB (I4.1), administrates the AKC. GS2 was founded in 2003 and provides together with the employee of the NBWM a number of the social capital (U4) of the system. To get a better understanding of U4 it was further subdivided into four third tier variables. According to GS2 the board of directors, consisting of seven members, is elected every three years as well as one director is recommended by local citizens. The proposed director has to be confirmed by the seven members of the board of directors. The director determines people to hold the positions of one engineer, regulator, accountant and four *Murab*. Depending on the water flow rate of the Naryn River and the harvest period of grass the engineer and the director decide about the amount of water which will enter the AKC at the main gate during the irrigation period and can thus be seen as another operational rule (GS3.3). All members of the KZD-WUA are executing their position in addition to their actual profession. Therefore, sometimes they have a very high workload and their tasks within the KZD-WUA cannot be executed properly because of their obligations from their actual profession (U8).

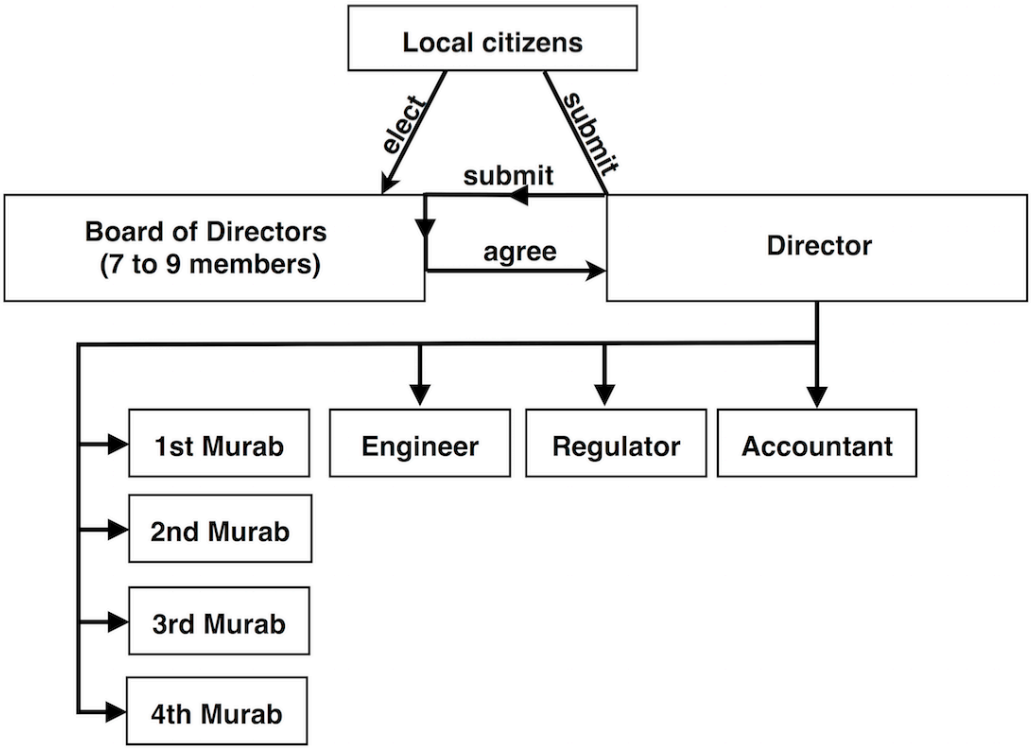

Fig. 4: Organigramme of the Kyzyl-Zoo-Dostuk Water User Association.
Design: Marx, Müller & Zhumagulova 2016

According to GS2 this regulation should be realized by the regulator of the association but is temporarily held by an employee of the NBWM (U4.1). Regarding the hierarchical structure of GS2 with its various responsibilities distributed among its members (U3.1/4.3) and the employees of the NBWM (U3.2/4.1), it is very difficult to identify a clear leadership (U3). Additionally, for some major investments GS2 depends on the willingness of the WB (U3.3) In case of the requirement of large repairs, a letter of inquiry has to be submitted to the main office of the WUAs in Naryn. From there the request will be forwarded to the responsible authority of U3.3. This means that I4 of GS2 is depending on U3.3. In the past, the KZD-WUA already got financial support by U3.3. 3,600,000 KS were given to GS2 as a starting capital for repairing and maintaining the AKC. 25 % of this amount had to be paid back. Further 28,000 USD were subsidised in 2014 for a new excavator (U7) for consolidation and improvement works. Most of these investment activities (I3.1) have been conducted by U3.3. Some smaller investments in repair measures can also be conducted by GS2, financed by the payment of contribution (I3.2). However, according to peasants these attempts to improve have not led to less infiltration or evaporation of water in the canal system. Consequently, I3.1, given by WB, are not leading to an improvement of the situation.

Table 2 shows the current salaries and the duration of employment of the present employees of GS2. According to them, the wages cannot cover living expenses. Combined with a high workload the motivation remains sometimes poor also because employees have to secure their long-term livelihood (U8). Even though the differences between the wages seem not to be that big, it has to be considered that a *Murab* has quite more working days than the accountant or the engineer. For that reason, it is understandable that especially this position is rather unpopular and the people are complaining about bad salaries.

Table 2: KZD-WUA positions and their corresponding salary and duration of employment in years (Data base: Interview with the Director of the KZD-WUA, July 2016)

Position	Salary	Duration of employment (years)
Director	4,000 Som	8
Accountant	2,500 Som	1
Engineer	2,000 Som	2
Murab	2,000 SomS	1 (only 1 Murab is working since 4 years)

The last section also demonstrated that the whole system only works due to a high level of information sharing among U1, the esponsible persons (U3.1; U3.2) and GS2 with its contact to U3.3 as financier. This also includes many network activities (I5), which have to be undertaken to ensure the functioning of the SES.

Irrigation system of Jan-Bulak

The supply of irrigation water for the fields which belong to the BNC is the responsibility of the regulator and the engineer of the NBWM (U4.1). The irrigation system of the area of the AKC however is more complex. It is divided into a western and an eastern part due to variations in the topography, the relief and the geographical location of the fields. It is further subdivided into four sectors of responsibility (Fig. 1), controlled by four water managers (Sehring 2005: 9-12). The irrigation itself is realized through small canals, which have been built by the farmers themselves (RS4.3) using spades (U7) (Fig. 5). These canals get water from the BNC or AKC to enable irrigation. Therefore, farmers have to manage and control the appropriate water supply for their own fields.

The provision of irrigation water however is the responsibility of the *Murab* (Fig. 6). As Figure 1 shows, the irrigation in the eastern part takes place from 6 am to 5 pm and the western part is irrigated after 5 pm until 6 am. The *Murab* of the eastern part have to close the water gates to ensure the water availability for the irrigation of the fields in the West. The eastern part is characterised by a hilly terrain, which is why irrigation at night with headlights would be more complicated than in the shallower part of the West. Due to these conditions and the fact that the water is entering the area from the East, the fields of the eastern part are irrigated during the day until 5 pm. Nevertheless, according to peasants a better harvest rate can be observed in the western part because of more fertile soils and a less sandy character. Irrigation at night also leads to less evapotranspiration and evaporation, resulting in differences of the (I1) yield between the western (increase) (I1.1) and the eastern (decrease) part (I1.2).

This indicates that due to different conditions, variations in the harvest rates occur and lead to a further disequilibrium between different farmers. This is partly caused by the turning system but also reliant on the existing natural conditions (RS6). On the contrary, the order of irrigation in the West is based on a lottery system (GS4.2), changing every season to guarantee greater fairness among agriculturists. Because of less water availability in the West, the last irrigated field may have the greatest disadvantage (see RS6). However, this type of water management is not always working without conflicts (I2). Farmers of the western part complained about occasional suffering from water scarcity due to poor working morals of individual *Murab* (I2.2). This issue was mentioned at assemblies several times, but no improvement has been realized. The collection of irrigation fees from the farmers is another task of the *Murab*. This approach turned out to be problematic because local farmers are not always willing to pay this fee if their *Murab* is not working conscientiously. Due to a missing GS6, both of these problems have remained without consequences and thus aggravate the situation. This means that the organisational structure between GS1, GS2, GS3 and U1 is principally working, but nevertheless there are eminent problems.

Fig. 5: Regulation of the water flow for the irrigation of a grass field.
Photography: Marx, 2016

The mentioned conflicts between the water managers and the farmers (I2.2), the low wage and sometimes unpleasant working conditions can be seen as a reason for the inefficient and insufficient work (O1) of the *Murab*. It also has to be considered, that the *Murab* need to fulfil their obligations from their actual profession (U8) as well and are therefore prone to a high workload. Better salary and GS6 could be helpful to solve this problem. The question of salary again is related to the financial situation of the KZD-WUA and once again highlights the scope of this problem and the importance of a financial invulnerability.

Summary and conclusion

The following conclusion will summarize in how far self-organisation is already implemented in Jan-Bulak. Subsequently the question if a sustainable water management and irrigation system is already achieved or if there is a high potential to achieve it will be answered. This shall be implemented using a flowchart (Fig. 7) that has been created on the basis of the presented analysis and discussion of the research data.

The paper shows that self-organisation is partly given in Jan-Bulak as the users are provided with a more or less satisfying amount of irrigation water at the moment. A manageable size of the RS combined with a high economic value of water and the users' dependency on it as well as the users' knowledge of the SES, demonstrates the need and also the opportunity for self-organisation. Further positively influencing components are the existent canal infrastructure, the adjusted water management and the complex irrigation system, which have been jointly developed by the users, and include controlled procedures and rules.

Furthermore, the KZD-WUA and the NBWM, on a subordinate level, represent mediatory authorities as well as an implementing instrument.

But the actual existence of self-organisation (I4) and sustainability (O2) needs to be questioned. For although the analysis showed some important components for self-organisation and a responsible resource use are given, negatively influencing aspects became apparent as well. The main issue is the lack of financial resources. As the flowchart shows, this problem can be attributed to several factors such as non-adopted and non-context related support of the WB. It also demonstrates that the payment of contribution is not working properly whereby the KZD-WUA is limited in its opportunities to build up some savings (Fig. 7). Even more numerous are the impacts resulting from this financial problem. Low wages are negatively influencing the working morals of the *Murab*, resulting in conflicts between them and the users. As a consequence, the latter do not receive enough water or not at the right time. As the flowchart shows this issue is worsened by an unfair turning system that leads to different harvest rates among the users and aggravates the conflict potential which is counterproductive to achieving I4 (Fig. 7). Therefore, ethical standards, moral and social competence and trust in each other, which are important aspects to reduce expenses of self-organisation, are not given. In addition, the impact of the people's obligations to fulfil their liabilities regarding their actual profession as it is part of their livelihood-strategy also needs to be considered as this aspect can also have negative impacts on self-organisation when they cannot handle the high workload of both, their actual profession and their liabilities to the community regarding water issues or to the KZD-WUA.

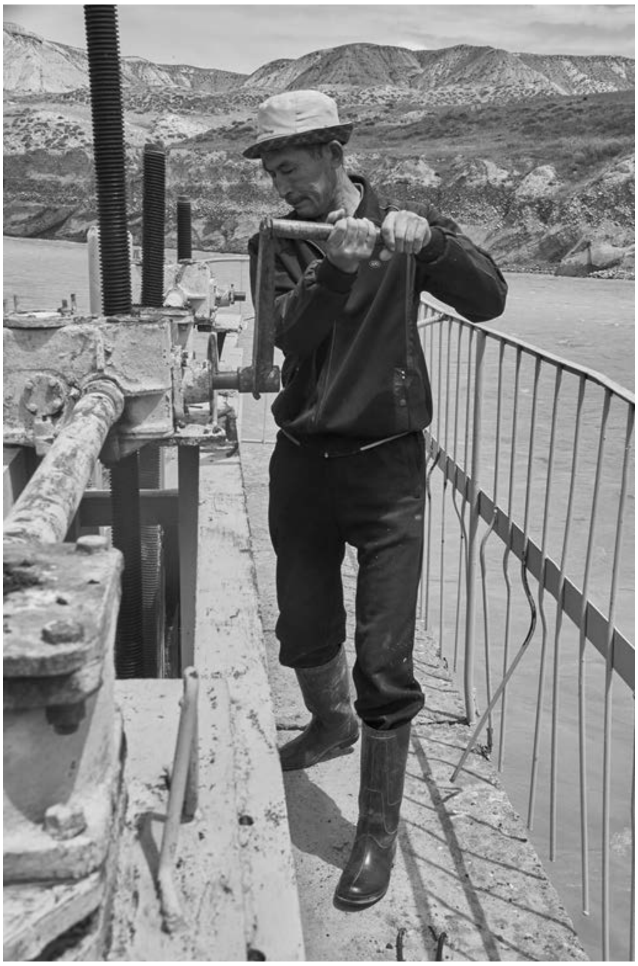

Fig. 6: Murab, opening the main gate at the Naryn River. Photography: Marx, 2016

Poor canal conditions and missing future plans to preserve the prospective water availability in the face of climate change are further components which demonstrate that, according to the SES approach, a sustainable resource use now and in the future cannot be guaranteed.

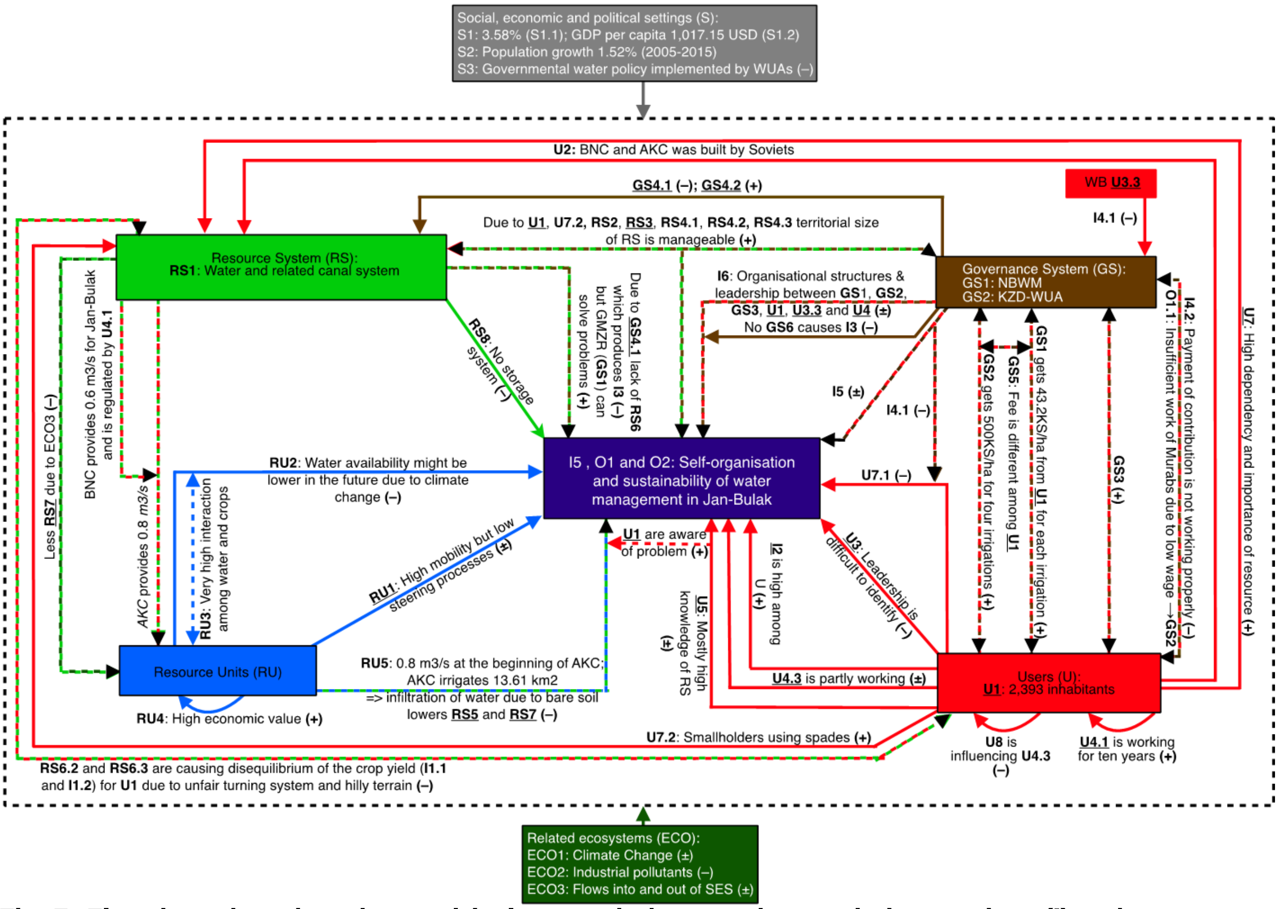

Fig. 7: Flowchart, based on the empirical research data, to show main interactions (I) and outcomes (O) of reciprocity among the components U, GS, RS and RU. Design Marx, 2017

According to the research question (+) refers to positive influences on self-organisation (I4) and sustainability (O2), whereas (–) refers to negative influences.

Arrows of one colour: influences of U, GS, RS, RU, S or ECO

Varicoloured arrows: reciprocal influences

Key variables of self-organisation: underlined

In attempting to answer the research question it became apparent that the reason why self-organisation and sustainability are not totally fulfilled needs to be considered on a broader level and cannot only be attributed to the users of the RS. Data about the economic, social and political settings are available on the national level and provide important information, but they are not enough to deduce their impact on the local level. In addition, we need to take a closer look at the role of the WB, operating as a financier. As financial resources are the main problem, it seems that the top-down approach with its 'rolled-out' practices, neglecting traditional and cultural aspects as well as local conditions are not target-oriented towards improving the local situation. Especially the WB could compensate the costs that will result from a higher number of users in the future due to population growth and the strong use of the canals if their support was solution-oriented. But to manage this high number of users a clear leadership is also indispensable. The analysis and the flowchart thus demonstrate that, in our case, the responsibilities are highly distributed among different positions and the actors cannot act independently as they are restricted in their possibilities (e.g. KZD-WUA from WB). A clear leadership with related competences is therefore not given. But it also has to be considered that the traditional leadership such as the council of elders is not even integrated in the Governance System. This again proves a missing context-related approach in the system.

In accordance with these deductions it becomes obvious that power as well as knowledge and sovereignty of information and interpretation, have been mainly implemented by the WB. This can be seen as a reason why self-organisation – if at all – is only partly given and implemented by Kyrgyz national institutions and by users on a local level.

Logically this strategy produces a gap of power within the SES, whereby sustainability, as defined in the first chapter with a balance of power and knowledge, is not given. On this basis we can deduce that the WB is not concerning complex post-colonial and especially in Kyrgyzstan post-socialistic issues that would be of vital importance.

As a result, the paper makes clear that influences as per description of institutions from countries in the Global North such as the WB have to be built on respect and critical self-reflection to fulfil concepts like self-organisation and sustainability. Only in this way and without a 'roll out' of neoliberal practices, development cooperations from the Global North will obtain holistic sustainability based on ethical standards, moral and social competence in order to implement commons and minimize water scarcity and consequences caused by climate change. Therefore, the approach of the SES needs to be adopted in a way that also allows further considerations of socio-cultural aspects to be included instead of mainly focusing on environmental aspects. In this regard the question considering sustainability cannot be completely answered in this paper. On the one hand it becomes apparent that the used approach of the SES in our case was suitable to obtain an overview of the current situation, the interaction and influences between the different actors and variables. On the other hand, more variables and their complex interactions are needed and have to be taken into account to make a more holistic statement regarding the research question. This was in turn not possible in this case due to the limited stay and research scope. Nevertheless, this paper provides another example of how water allocation has undergone a dramatic transformation from governmental to private use and administration in a post-Soviet country. It is also a good base for further research regarding sustainability in the sector of water management and the further integration and implementation of context-related solutions based on prospective research results to explore and analyze global issues concerning water scarcity.

List of Abbreviations

AKC	Ak-Kiya Canal
BNC	Big Naryn Canal
KZD-WUA	Kyzyl-Zoo-Dostuk Water User Association
NBWM	Naryn Basin Water Management
SES	Social Ecological System
WB	World Bank
WUA	Water User Association

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