The Land and Water Nexus in a transition context: The case of Tajikistan

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Summary

Natural resources are under pressure, especially due to climate change and global population growth. For the agricultural sector, in particular the competition for accessible land and water resources rises due to an increasing demand for food. From 2007 onwards, the competition for both resources has become even more pronounced with the global land and water rush. The economic value of agricultural land depends on adequate water availability. Although the joint use of land and water resources are indispensable for agriculture, the two resources are mostly not jointly governed at the national level, where land and water policies are negotiated, introduced and enforced. Farmers´ natural resource use practices do not necessarily reflect the rights on paper, as on farm level the two resources are in fact jointly used. Production practices are also a result of farmers´ customary claims, which are informal but generally recognized as a reference system. The land and water claims can deviate from property rights defined by law and result in joint resource management. This difference between formal rights and informal claims leads to insecurity of the joint resource use. On the other hand, formal rights do not lead to the intended exploitation of the production potential as they fail to jointly consider land and water resources.

The integration of land and water governance is not only neglected on the policy level, but it is mostly disregarded by empirical analysis. Previous studies are inconclusive regarding the analysis of joint land and water governance. Only a few empirical case studies investigated the impact of large-scale land acquisition on water governance. A more general perspective of the relationship between ad-hoc and small-scale land governance change on irrigation water governance is incomplete. So far, theories such as the property rights theories, usually consider one resource sector, neglecting the nexus of two resources. On the conceptual level, only a few studies have addressed this problem. Prior studies on land or water governance often use one proxy to analyse e.g. land or water rights. Based on this, conclusions on the success or the failure of reforms in question are assessed. But, to address this nexus, new operationalisations of local governance concepts have to be addressed to compare between the resource sectors and between research areas.

The aim of the thesis is to analyse the complexity of land and water governance jointly under a property rights perspective. New tools to measure governance as well as a more general framework to integrate a nexus perspective are developed. Three specific topics are chosen that address the outlined problem situation in different chapters. In these chapters, this research more specifically aims to:

1) contribute to the water security debate and develop a multi-dimensional irrigation water security index for farm households (Chapter 2),
2) conceptualize and map property rights and customary claims from the perspective of various farm types (Chapter 3),
3) determine specific land governance characteristics affecting new modes of irrigation governance at local scale (Chapter 4).

To investigate the three main topics, the case of Tajikistan is chosen. So far, empirical evidence in this context is limited, which especially holds true for the rural lowland areas of Tajikistan. Within Central Asia, Tajikistan still remains one of the poorest states. About 73 % of the Tajik population live in the rural areas and depend on agriculture while arable land is very scarce and only accounts for 7 % of the total area. The agricultural sector, especially the land and water sectors, is affected by the transition process since independence, which has triggered different structural changes. The empirical analysis relies on primary quantitative and qualitative data collected in 2013. Two research locations were selected: Bokhtar in the Khatlon province and Bobojon Gafurov in Soghd province. Both regions share similarities in their agricultural production patterns and are located in the semi-arid lowlands, which means that farmers depend on surface irrigation.

In Chapter 2 land uses and users with varying water security levels are identified. To measure water security, this chapter develops a new irrigation water security index specifically investigating water security at farm household level. This multi-dimensional index considers three critical dimensions: 1) hydrology, 2) governance, and 3) a hybrid dimension, influenced by hydrology and governance. The index provides valuable insights for the case of Tajikistan. It can be seen, for instance, that water governance is a very critical dimension that becomes even more central once worsening hydrological conditions are considered. For farmers, it would be desirable to improve the correspondence between the governance and hydrological dimensions. Hydrological water security can trigger better water governance security as farmers directly appreciate improved hydrological water security. Results indicate that if a certain threshold of hydrological security is exceeded, governance security improvements do not occur.

In the Chapter 3, perceived land and water property rights of individual farmers are investigated. This chapter suggests that agricultural productivity gaps can be due to the existing discrepancy between formal property rights and perceived property claims, because customary claims are either not backed up by legislation or farmers' customary claims are less pronounced. This chapter is not only of empirical importance. Also, a systematic operationalization of the bundle of rights approach and, thus, a new method of quantifying the customary claims is developed in order to contrast these to property rights. Additionally, since many researchers in the field of property rights have relied mainly on single case study approaches, this systematic analysis is not only of importance for the methodology of single case studies. It can furthermore help to improve comparisons between cases from various contexts.

The aim of Chapter 4 is to determine the nexus of land and water governance. For the latter one specifically cooperative water management at a local scale is looked at. Starting from the common pool resource and social-ecological system literature, this chapter outlines two ways of extending the Social-Ecological framework. First, by integrating a land resource unit and system to the existing irrigation SES and second, by considering land governance as an external influence on the irrigation SES. The empirical results emphasize the need for a land-water nexus perspective. The results suggest that in Tajikistan's lowlands especially formal land tenure security, as well as perceived land management claims positively impact cooperation behaviour.

The findings of all chapters show the land and water nexus from different perspectives. The results suggest that governance linkages exist and should be more recognized. Policy changes made on the national level, such as land certification, have an impact on water governance at local level. Findings confirm that the perceptions and decisions of resource users diverge from formal law in both resource sectors which is increasing tenure insecurity on the long run.

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Abbreviations

CPR	Common Pool Resources
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
GWP	Global Water Partnership
G_{WSI}	Governance Water Security Index
H_{WSI}	Hydrological Water Security Index
Hy_{WSI}	Hybrid Water Security Index
IFAD	International Fund for Agricultural Development
IWRM	Integrated Water Resource Management
NIE	New Institutional Economics
SES	Social-Ecological-System
USSR	Union of Soviet Socialist Republics
WSI	Water Security Index
WUA	Water User Association

1 General Introduction

The term land has multiple meanings and is included in various concepts. Land can have the connotation of a territory when it is a legally separated area. Furthermore, land can have physical attributes when specifying e.g. the soil or the geomorphological conditions. The topsoil (or mother soil) is the most fertile soil and livelihood for plants, animals and crucial for agricultural production. Thus, depending on the subject of interest or the research unit, land as a resource can have ecological, social, cultural or economic values. On the earth, one can clearly distinguish between the solid surface land and the fluid surface water. The latter one covers 71 % of the global surface, whereof only 2.5 % is freshwater (Gleick 1993). Freshwater resources have multiple properties for human life: for agriculture and food production, for domestic purposes, drinking water, for industrial use etc. The nature and meaning of land and water resources can have very different forms and often makes it challenging to compare the two sectors. But, especially in the agricultural sector the interdependency of both resources is remarkable. Here, land and freshwater jointly are two vital resources for agricultural productivity. This in turn remains an important driving force for income growth, food security and rural development in many countries (FAO et al. 2011). Especially in developing countries, productivity growth can contribute to improved livelihoods in rural areas as agriculture still remains the main income source (Thirtle et al. 2003).

Both resources are challenged in manifold ways, whereof especially water is considered to be very much threatened in the future. Vorosmarty et al. (2010) estimated that already 80 % of the population faces severe water security risks. Resource scarcity on the long run further increases rivalry in consumption, competition and raises excludability issues between resources users. To address the resource use problems, tenure security became a demanding challenge of the land and water sector. Around the world, tenure rights are very heterogeneously established and enforced (see e.g. Dekker 2005; Cotula et al. 2006). Tenure security is said to include "objective elements (clarity, duration and enforceability of the rights) and subjective elements (landholders´ perception of the security of their rights)" (Cotula et al. 2006, p. 19). How resource users actually perceive their rights can often differ, depending on different implementation strategies of reforms, information transfer and other external factors (Deininger 2003; Wilusz 2010). So it is of importance to understand peoples´ preferences, decisions-makings and action towards land and water use within a specific context (Alston et al. 2009; Ellickson 1991), as tenure security can significantly contribute to agricultural growth and rural income and increases the users' incentive to invest in the resource (Deininger 2003; Besley 1995; Arnot et al. 2011).

In most of the transition countries, agriculture still remains an important income source for the rural population. The transition process correspondingly affected a major shift of governance structures, especially the introduction of new formal tenure rights in the land sector. Farmers were confronted with individual management and decision-making challenges. Tajikistan, one of the least developed countries among the transition countries, also experienced tremendous shifts in the agricultural sector. Agricultural production relies almost exclusively on irrigation. The dynamics in the land and water sector are manifold and challenges the two interlinked resource systems. The aim is to address the previously outlined topics of water governance security, tenure rights and the land and water nexus within this thesis – always under a joint consideration of land and water resources.

1.1 A review on land and water governance

Reviewing the literature on land and water rights as well as governance, one can determine different property rights developments and conceptual meanings between the resources. The resource land can be formally organized in different property regimes. In many countries, agricultural land is often private, state property or community owned property[1]. For the latter one, users can get use rights (either limited or unlimited). Land governance can be defined as "the most efficient way of administration of land issues, such as cadastres, land titling and so on" (Borras and Franco 2010, p. 2). They further emphasize it is "a matter of technical and administrative governance, rather than a matter of democratizing access to and control over wealth and power" (Borras and Franco 2010, p. 2). It is in fact often the privatization of land, with the aim to use land financially efficient, one is implicitly referring to when aiming at improved land governance (Borras and Franco 2010). Land policies are a common instrument to deal with the increasing pressure on the resource or to formalize land property. Holding a formalized land title can potentially provide security to the user and additionally be used as collateral (Deininger 2003). This formalization is easy to measure and to indicate whether land governance is successful or not. However, it merely indicates an economic component of the value of land and neglects for instance individual perception on land claims, traditionally evolved land norms and values. Thus, a more diversified view on land property rights, such as proposed by Schlager and Ostrom (1992) or Meinzen-Dick (2014) as bundle of rights, can be helpful to further evaluate land governance and farmers' rights.

[1] Here, I only refer to agricultural land used for farming, not pasture land.

In contrast to the static resource land, water is a fluid resource and it is more difficult to assign specific water rights in form of a specific water title (Hodgson 2004). But, it is not only the different physical nature of the land and water resources (fluid vs static resource), which makes water rights more complicated to define than land rights. It is also the related systems´ characteristics, organization and farmers´ perception on rights which lead to different management needs of water resources. Here, water access and use rights can be assigned and volumes to be used could be negotiated. Water governance is often defined as "political, social, economic and administrative systems that are in place to develop and manage water resources and the delivery of water services at different levels" (Rogers and Hall 2003, p. 7). Accordingly, it is not only the resource itself which is governed, also water related services. Decision-making regulations on water access, management and distribution are central to this concept (Groenfeldt and Schmidt 2013; Schneier-Madanes 2014). These decision-making schemes are often changed over time and adapted to specific resource developments or inter-sectoral competition. Control mechanisms exist, especially where water resources are scarce and competition increases (Meinzen-Dick and Nkonya 2005). In addition, due to the fluid nature and broader scale of some watersheds, water governance can become more complex when it comes to transboundary rivers (Scheuman et al. 2009; McKinney 2004). Especially the water sector is often affected by decisions taken outside of the own sector, such as decisions made by land reforms (Sjöstedt 2011).

Both definitions of land and water governance have in common, that they include an administrative component, where access and use are defined. But although land and water rights are usually separately defined at the national level, it is often the case that water access rights are (implicitly) embedded in land rights (Hodgson 2004; Cotula 2006). International organizations or networks such as IFAD (International Fund for Agricultural Development) or GWP (Global Water Partnership) have published case studies and policy recommendations about the importance of an integrated land and water governance approach, specifically to enhance food security (IFAD 2004; GWP 2014). They listed the following potential linkages between land and water governance: 1) land acquisition can cause water acquisition; 2) secure land titles can increase water investments; 3) land tenure security is able to enhance water access; 4) securing land rights can secure women's´ access to water (Global Water Partnership (GWP) 2014).

In this thesis, the term nexus is used to describe the interconnection and potential feedback loops of land and water resources. The nexus approach stems from the current discussion about the water-land-energy nexus (SEI 01.03.2016; Hoff 2011). During the past years, the term water-land-energy nexus was recognized as a joint critical factor to food security (Hoff 2011). In this regard SEI (01.03.2016) defines the nexus approach as "systemic thinking and a quest for integrated solutions to guide decision-making about resource use and development, to minimize externalities". Here, the nexus is limited to land and water resources. The nexus of land and water can exist as depicted in Figure 1-1. The literature has already investigated that land or water rights can have an impact on e.g. sustainable land or water use practices (Deininger 2003; Rosegrant and Binswanger 1994). This figure shows further possible linkages between the resources. First, water rights (formal and informal) can determine water use and thus have an impact on land use options or cropping decisions. This can vary over time and land use practices can be adapted according to changing water availability levels. Further, the right to access water determines the land use possibilities and the value of land. Second, land rights can have an effect either on water rights or water use practices. Land rights can include the way of accessing water and determines the source of using water (groundwater, surface water). In addition, some land rights can regulate the particular water governance between farmers. Especially the link between land and water rights (grey boxes) has not been sufficiently addressed so far in the literature. But, as the following problem statement describes, it is important to look at the interface between the two resources from an institutional perspective.

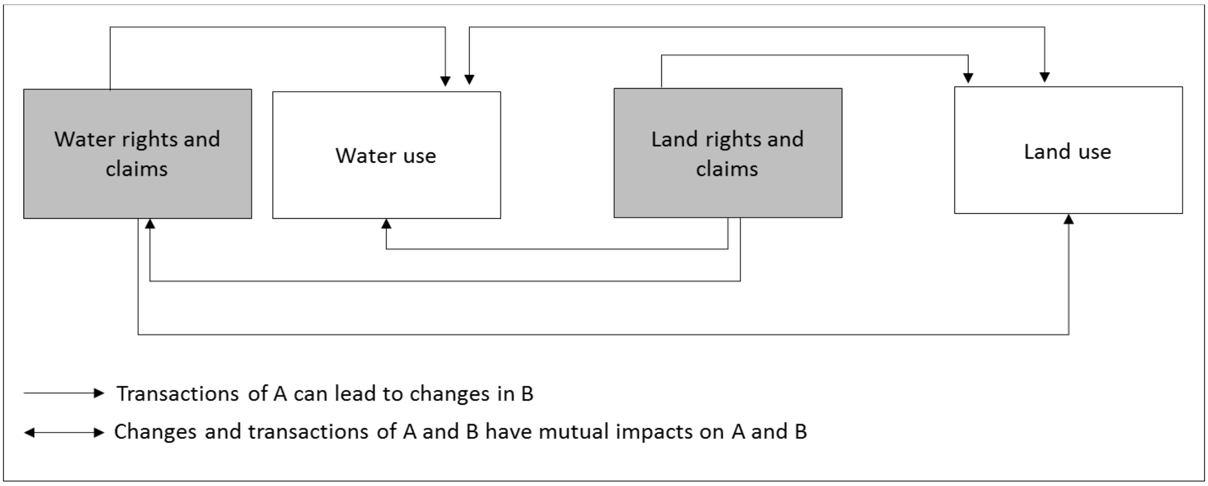

Figure 1-1 Land and water governance linkages
Source: Adapted from Gehrigk and Aarnoudse 2013

1.2 Problem statement

This chapter consists of two parts. First, factual problems arising from land and water policies on the background of the nature of these resources and the overall economic environment are outlined. Following this, the research problems and gaps are outlined.

Problems in land and water policies

Climate change, population growth and demographic increases the competition for land and water resources. With an expected population of 9.7 billion people in 2050 (United Nations 2015) an increasing food demand is putting pressure on the finite resources. One can observe, that over the past 50 years, cultivated areas worldwide have increased by about 12 % (FAO 2011). However, land resources are limited and agricultural production mainly has to be intensified on current agricultural land. Global demand for land and water is not only increasing but interlinked. The economic value of agricultural land directly depends on adequate water availability, including rainfall, surface and groundwater irrigation. Irrigated agriculture has been one technology to boost agricultural production and contributes to food security. Globally, irrigated areas significantly increased from 184 million ha in 1990 to 324 million ha in 2012 (FAO 2014). But in the same way as land resources, water resources are under pressure and water insecurity is increasing. The competition for both resources has become even more pronounced with the global land rush.

Land and water resources and their governance are mostly subject to policies, many of which are, negotiated, introduced and enforced at national level. In the context of these national policies, a problem of disconnection can be identified. Most land or water policies do not address the linkages between the resources nor potential impacts on each other that can occur at local scale. The GWP (2014) for instance calls the current approach of separated land and water policies a "silo approach". A silo approach is particularly risky when one resource is degrading. So far, tools, mechanisms and rules for joint water and land management are mostly missing. In addition, the regulatory regimes are sometimes non-conform and often do not meet the increasing demand of both resources. The management of one resource system is not always able to respond to the dynamics on the demand side, especially not if dynamics are induced in other resource sectors (Hodgson 2004, 2009).

The question is, what are the effects from the missing integration on the farm level. The problem at the national level triggers down to the farm level, where in fact joint resource use practices exist. Farmers depend on access to land and water equally to meet their food security concerns and generate income. Land laws often do not consider customary land rights and, thus, also often neglect established attached customary water rights. In many developing countries, the lack of transparent and long-term land tenure as well as weak governance systems in place have increased conflicts over arable land between farmers (Deininger 2003; Deininger et al. 2012). Likewise, competition over irrigation water has increased. Although water might be hydrologically available, a weak water governance system in place can threaten farmers´ water security. This is "particularly harmful for the poor in developing countries" (Deininger et al. 2012, p. 15) as resource access significantly generates their livelihood. If access to one resource is vulnerable, it can likewise have impacts on access to other resources as well or tremendously lower their value. Water security risks can also be observed for farmers in case they face heterogeneity in accessing water and power asymmetries in negotiating about water (see e.g.

(Theesfeld 2004). These water security risks can have tremendous effects on land use and land governance – and vice versa.

Research problems and research gaps

The need for tenure security and stronger land governance caught more attention in research in the course of the so called "global land rush" (Deininger and Byerlee 2011). Questions in how far a change of formal land titles or land acquisition has an impact on existing and traditional water use practices and the rights towards water access emerged (Bues and Theesfeld 2012). Only a few empirical case studies investigated the impact of large-scale land acquisition on water governance and water security (Rulli et al. 2013). A more general perspective of ad-hoc land governance change, as it happened in many transition countries, on irrigation water governance is incomplete.

On the conceptual level, only a few studies have addressed this problem (see e.g. Theesfeld 2015, 2016). Although concepts and theories of New Institutional Economics (NIE) have largely studied the complexity of resource management and governance (North 1990; Alchian and Demsetz 1973; Ménard and Shirley 2008; Williamson 2000), the nexus of two resources has not been dealt with in detail. A paramount part of NIE is to analyse the role, implications, and evolution of institutions – the rules of the game (North 1990). In different settings "resource users often create institutional arrangements and management regimes that help them allocate benefits equitably" (Agrawal 2001, p. 1649). These institutional arrangements are not created in isolation for one resource. One form of institutions (formal and informal) are property rights. With a well-defined property rights system in place, obligations and responsibilities towards a resource emerge and overall tenure security can be achieved (Bromley 1992, 2006). In research, usually property rights of one resource are analysed. But considering for instance water rights as a discrete unit of property is misleading, as changes in the water regime can be caused by i) changes in water rights, ii) changes in land use as well as land users, and iii) changes in land use rights. So far, research is rather incomplete investigating an encompassing theoretical framework for land and water property rights. Understanding how farmers, especially small-scale farmers, perceive their land and water access rights jointly can be key to address food security in many countries.

It is not only the theoretical framework which is missing in the nexus debate, it is also the missing operationalisation of farm level governance concepts. For land and water resources, it is difficult to code and measure governance and institutions. Prior studies on land or water governance often use one proxy to analyse, for instance, land or water rights. Following this approach, conclusion on success or failure of land reforms are typically measured using a proxy whether or not farmers hold a land title. Also the existing water security measurements reveal an operationalization problem at farm level. So far, researchers have mainly investigated water security at the national level, neglecting variance of individual governance and hydrological concerns resource users are facing. Research with a too simple operationalization can result in a black box and policy recommendations drawn from such studies may be inconclusive or misleading for policy makers.

To sum up, three main research needs are identified. First, in-depth empirical analysis of the land and water nexus, which does not only focus on international large-scale land acquisition but on domestic land governance changes, is needed. The nexus has to be identified, resource sectors have to be compared and interlinkages between the resources have to be analysed. Second, theoretical frameworks that address the land and water nexus, especially considering the property rights theory, have to be discussed. Third, to address this nexus, new operationalisations of local governance concepts have to be developed and validated in order to compare the governance of the resource sectors and across research areas.

1.3 The case of Tajikistan

In countries where a sudden and quick change of land governance are implemented, effects on irrigation governance can be expected. The transition economies are a very good example of broad institutional changes over the past years. Here, many countries were pushed to and aimed quickly to establish a land reform. Often, changes in land reform happened without specifically considering the irrigation sector.

Within Central Asia, the case of Tajikistan has been selected as empirical case study due to the following reasons. First of all, it is a very good example for ad-hoc, but ongoing domestic land governance changes. Land reform, especially after 2007, pushed land reallocation and smaller-scale farms developed. Compared to e.g. Kyrgyzstan, land has not been equally distributed among farmers, nor have land consolidations such as in Uzbekistan taken place. In contrast, many different farm types with different farm sizes developed. However, the number of very large-scale farmers or even agroholdings, such as in Kazakhstan is very low. Now, the agricultural sector in Tajikistan is dominated by small-scale farming units. Each individual farmer has own perceptions towards his property claims. As Pomfret (2008, p. 303) mentions: “true land reform in southern Central Asia is intimately linked to water”, which is especially the case for Tajikistan. Therefore, the second selection criteria is the high dependency on (surface) irrigation. About 70 % of the agricultural production depends on irrigation. Due to its high mountain ranges, agricultural production is limited to a very limited area (see also irrigated areas in Figure 1-2). But these areas constitute a very important income source and contributes significantly to food security in the country. The agriculture sector, and thus also the irrigation sector is already challenged by a very harsh climate and Tajikistan is considered as very vulnerable to climate change in the future. The third reason that gave evidence for this research, is inadequate water access and allocation of water resources in the irrigated regions of Tajikistan, although water is abundant from a hydrological perspective (Sehring 2009). Some instances for a weak water governance regime are for instance indistinct defined roles and responsibilities for monitoring, maintenance and operation of irrigation canals, knowledge gap and information asymmetries of implementing the formal principles of water use rights, in this case the water codes (Sehring 2006; Pahl-Wostl et al. 2012). This implies problems in the provision of water. Thus, considering the land and water nexus, especially the irrigated areas of Tajikistan resemble an interesting case to be investigated that future food security challenges can be met.

In general, empirical research in Central Asia is still very limited. Pomfret (1995, p. 7) emphasizes that "a major difficulty in evaluation the transition debate is the paucity of empirical evidence" which especially holds true for the rural areas of Tajikistan. So far, limited empirical evidence is restricting a better understanding of the agricultural areas in Tajikistan.

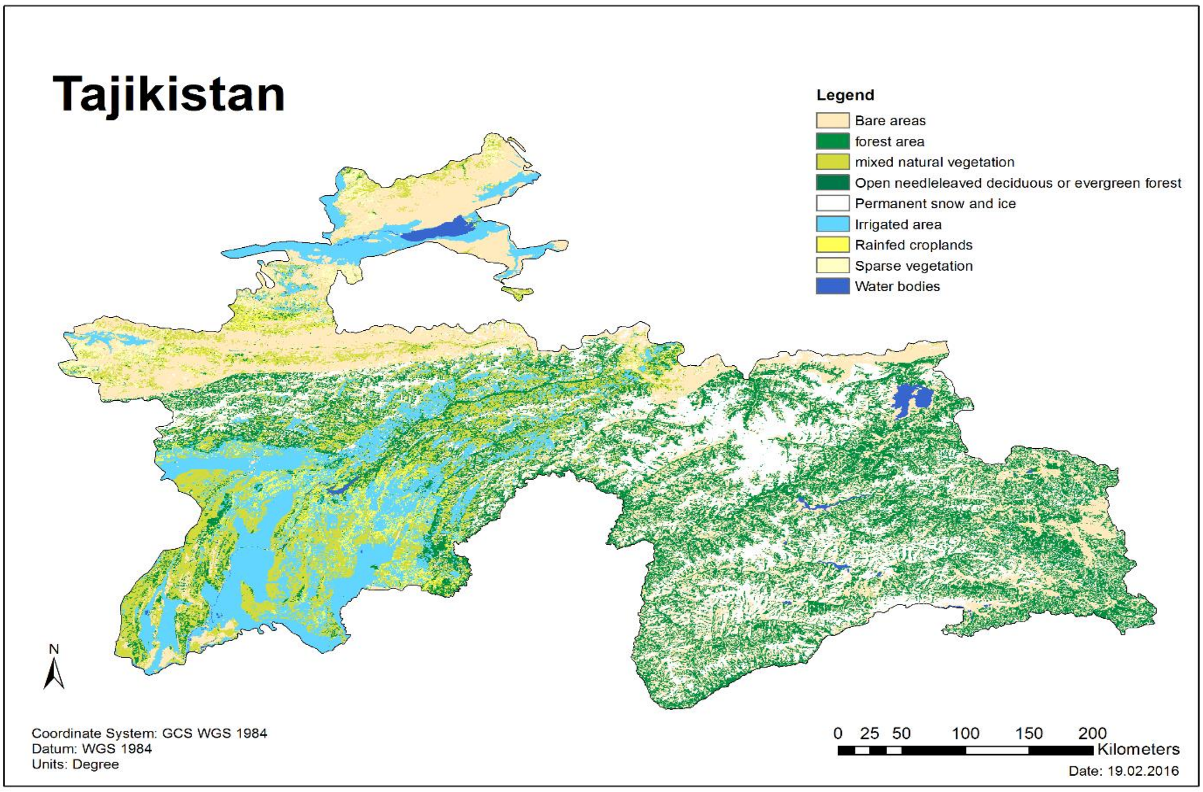

Figure 1-2 Land cover map tajikistan
Source: Figure prepared by Neumann and Klümper based on Global Land Cover Dataset (GLC2000); http://tiles.arcgis.com/tiles/fnDPFZb3ChDyhw97/arcgis/rest/services/biopama_RIS_services/MapServer

1.3.1 Regional historical background

The Central Asian region has a long history and gained economic but also cultural importance as part of the historical trading route the "Silk Road". Not only products such as silk, spices, porcelain and other high value goods were traded, also cultural, religious and technical thoughts were exchanged. Pomfret (1995) describes the Central Asian states (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) as a "a natural unit because of their common history and geography" p. 3. However, the landscape between and within the countries is very diverse with high mountain ranges e.g. in Tajikistan, and vast plains (steppe lands) e.g. in Kazakhstan.

In Central Asia, the climatic conditions vary and result in different agricultural areas, from highly intensive agriculture along the rivers to nomadic pastoralism in the more mountainous areas (Pomfret 1995). The rural areas, especially in the lowlands along the rivers, have always been important agricultural regions for Central Asia. The prevalent intensification and development in agriculture came along with the introduction of irrigation systems, especially along the two major rivers. Irrigation systems were mainly constructed during the Soviet Union time with large-scale investments financed by the state. Upstream, dams such as the Nurek in Tajikistan or Taktogul in Kyrgyzstan were constructed. Still today, these dams control whether agricultural areas in Uzbekistan and parts of Kazakhstan can be irrigated or not (O'Hara 2000). Farming and irrigation systems were organized and financed by the state and let the agricultural sector flourish for several years.

Since independence, the Central Asian states are described as sovereign states, however with competing power issues and various developments over the past years. As Promfret (1995) says during Soviet time "images of Central Asia are anecdotal and disconnected" (p. Preface). For some parts of Central Asia, this statement still holds true after 14 years since the breakdown of the USSR, either due to geographically remote areas or state protection. Some historical trajectories of the Soviet time remain, also in the agricultural sector, which still affects the current agricultural production of Central Asian countries and their rural areas.

1.3.2 The agricultural sector in Tajikistan

Within Central Asia, Tajikistan still remains one of the poorest states with about 42 % of the total population[2] living below the poverty line (World Bank 2015). About 73 % of the Tajik population lives in the rural areas and depends on agriculture (FAOSTAT) and 897 000 people work in the agricultural sector, but arable land is scarce and only accounts for 7 % of the total area. The lowest wages and salaries in real sector are in agriculture, hunting, and forestry (290.12 somoni) (Statistical Agency under President of the Republic of Tajikistan (TAJSTAT) 2014). Besides agriculture, remittances are an important income flow in the rural areas (42 % of the GDP generated by remittances). The agricultural sector, especially the land and water sectors[3], are affected by the transition process since independence and triggering different structural changes.

[2] Total population in 2014: 8.41 Mio; 1999: 6.09 Mio FAOSTAT
[3] A more detailed description of the land and water sector as well as their reform developments after 1992 is further described in chapter 3.

For the land sector, structural change can be mainly observed with regard to 1) farm types as well as sizes and 2) agricultural land use (Theesfeld and Kluemper forthcoming; Rozelle and Swinnen 2004; Verdery 2003). Since the breakdown of the Soviet Union, farmers can be granted with individual land certificates, which is either a share of land from unused land or from former collective and state farms (Robinson et al. 2008; Robinson et al. 2010). Over the years, land reform efforts resulted in an increase of the number of private farms and a decrease in farm sizes. Now, three main types of agricultural farm types exist; 1) collective farms (19,9 % of arable land), 2) individual farms (59,3 % of arable land), 3) household plots (22,7 % of arable land) (TajStat 2012). The latter one has always contributed to food security and has an increasing share of gross agricultural output. The most considerable transformation took place from large-scale collective farms, which still produced on 95 % arable land in 1992, to individual farms which were only introduced after 1992 (Hofman and Visser 2014). However, the implementation of land reform differs a lot between the regions in Tajikistan, also between the up- and lowlands (Hofman and Visser 2014; Robinson et al. 2008).

Another change can be observed in terms of agricultural land use. Until 1990 Tajikistan was one of the main Soviet cotton producing regions, especially in the lowlands of the southern regions (Hofman and Visser 2014). Cotton production was supported by the state, but after the collapse financial and technological support were diminished. Although, cotton production in the lowlands is still dominating and remains the main export crop, the wheat, potato, rice and fresh vegetable area harvested increased over the past years (Theesfeld and Kluemper forthcoming). Whereas in the uplands mainly rainfed (cereal) production is dominating, the lowlands are dominated by more irrigation intense cotton, rice and vegetable production.

In the lowlands, precipitation rates are especially low in the cropping season. Overall 70 % of the arable land is irrigated and the areas have increased from 450 000 ha in 1960 to 724 000 ha in 2006 (Lerman and Sedik 2008). Most of the water (93 %) used for irrigation is surface water. The three river basins allowing for irrigation are: 1) Syr Darya basin: in the north; 2) Amu Darya basin: in the south, main rivers are Vakhsh, Pyandh and Kafirigan; 3) Zeravshan basin: central part.

Water policies are likewise part of the agricultural transition period. Since the collapse of the Soviet Union, the water sector follows a more hierarchical approach with decentralized management units. Water management is organized at the state, province, district and Water User Association (WUA) level. The state, province and districts are responsible for planning, management, large-scale distribution, and control of use and quality. On the district level, water should be supplied to WUAs, who are responsible for inter-farm canal management and maintenance. Especially the latter form of organization has been newly introduced, where individual farmers are members and collectively contribute to irrigation management (Sehring 2009, Theesfeld and Kluemper forthcoming).

1.4 Research objectives and contribution

The overall objective of this dissertation is to explore the land and water sector jointly and to identify the interface of land and water governance in a changing institutional environment for the case of two selected agricultural regions in Tajikistan. The nexus approach in this dissertation consists of an: a) *identification*, b) *comparison* and c) *determination of* possible interfaces between land and water governance. Three specific topics are chosen to address the outlined problem situation and to fill the identified research gaps in different chapters. In these chapters, this research more specifically aims to:

1) contribute to the water security debate and develop a multi-dimensional irrigation water security index for farm households (Chapter 2),
2) conceptualize and map property rights and customary claims from the perspective of various farm types (Chapter 3),
3) determine specific land governance characteristics affecting new modes of irrigation governance at local scale (Chapter 4).

These chapters are all distinct and non-consecutive. First, different water security levels are *identified* for different land uses and land users (Chapter 2). Second, both resource sectors, the rights on paper and in practice for land and water are *compared* (Chapter 3). Third, specific links between land reform outcomes and irrigation governance are *determined* (Chapter 4).

The first contribution aims to contribute to an in-depth empirical analysis of domestic land governance changes and linkages to the irrigation sector. In addition, compared to Sub-Saharan Africa or South-East Asia, still little is known especially about property rights and farmers' perception in the agricultural sector in Central Asia, and specifically in Tajikistan. Official data availability as well as individual surveys conducted by researchers are scarce in the agricultural sector. Some qualitative case studies exist: e.g. by Sehring (2009) on water issues or by Hofman (2013); Hofman and Visser (2014); Mukhamedova and Wegerich (2014) on land reforms. In Tajikistan, most of the studies are conducted in the mountainous regions of the Pamir e.g. Hill (2013), which however did not undergo this tremendous development of irrigated agriculture during the Soviet past. In contrast, this dissertation uses both: quantitative and qualitative data on land *and* water governance. In addition, the survey was conducted in two geographically separated regions and further included various farm households. On purpose, household plots were included as they produce a considerable share of gross agricultural output and likewise use irrigation water. So far, no survey includes this variety of different farm sizes. The second contribution should fill the research gap of the land and water governance nexus discussion where two discrete units of property are linked. By considering the nexus of resources, we can specifically determine: 1) if land and water rights are equally perceived by the farmers; 2) if one reform is more transparent than the other; 3) if differences among farm types are the same for both resources. The third contribution is on the methodological level. Most of the studies, which are conducted in the research field of land and water property rights and are concerned specifically with land and water reallocation, use case study approaches (qualitative research approaches). This study combines multiple methods of data collection (see chapter 1.5). In addition, existing concepts, such as the bundle of rights approach (Schlager and Ostrom 1992) are often used in a qualitative, descriptive way. In this dissertation these concepts are quantified to allow for comparison between the sectors. Thus, it is aimed to contribute to the growing literature on property rights by operationalizing existing concepts. Especially in the first two chapters, the core of the analysis builds an operationalizing and quantifying procedure. In addition, a more specified term of customary claims that include perceptions, practices and expectations is introduced. This term of customary claims to land and water come up in all the three main chapters and are analysed in different ways, but always constitute a major part of the analysis.

1.5 Research Design

The study follows the idea of an explanatory research design. As Neuman (2011) explained, the purpose of a research is defined as explanatory, if the study seeks to determine and find out competing explanation of already existing theories.

To answer the research question, the dissertation is divided in six main research stages. One method is established by building upon findings of the other method. By using this approach, it is aimed to increase validity by applying a sequential mixed methods approach (Ivankova et al. 2006). Each step is briefly described in the following.

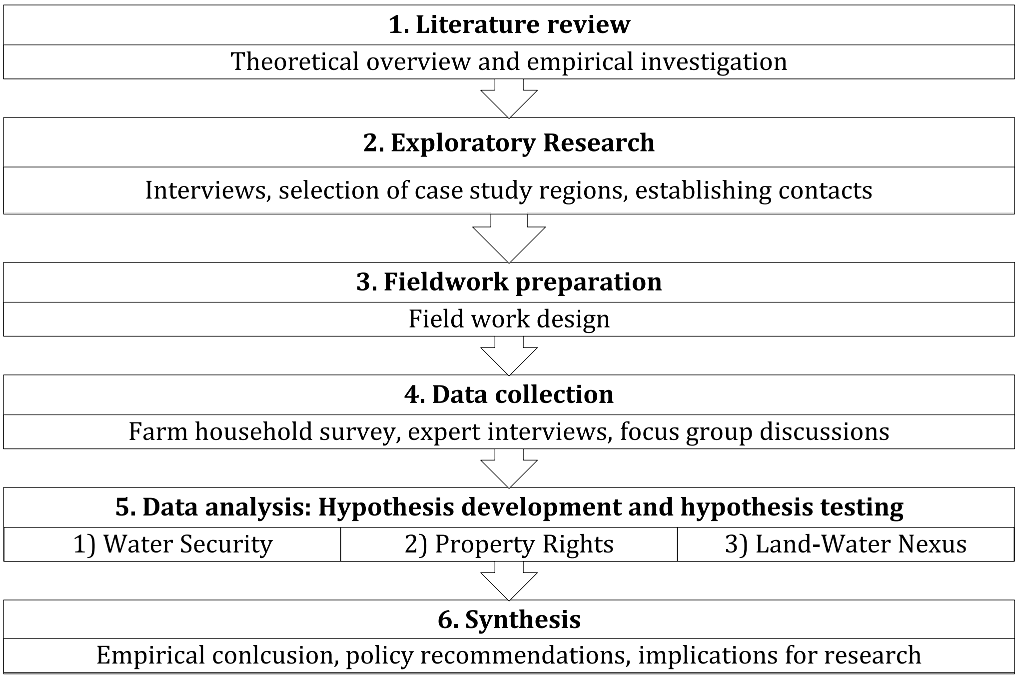

Figure 1-3 **Methodological design**

Source: Own Figure

The **first step** included an in-depth literature review on current research about the land and water nexus, which was very much motivated by the ongoing land and water grabbing discussion. In addition, property rights literature was studied. To get introduced to and to grasp first regional variations between the Central Asian countries and later specifically for Tajikistan, several consultations with researchers working on Central Asia were held.

The **second step** included an exploratory field study for 3 weeks in May 2012 in Tajikistan. With the help of the Tajik Academy of Science first interviews and consultations with experts were undertaken with representatives of the Land Committee, Agricultural Ministry, World Bank project on land reforms, USAID project on WUAs and family farming project, GIZ, Caritas Switzerland and agricultural researchers. In addition, two field trips were undertaken to the Khatlon province: 1) district Yavan: visiting farms, and water distributary system; 2) district Rumi: participation/observation in a WUA establishment in one community, informal interviews with farmers[4].

In the **third step**, the main field work was prepared and a preliminary farm household survey was set up. This survey was divided in five parts: a) general information (farm type, size of land types, people engaged in farming); b) land and water use and attributes (crops produced, sold and prices received, irrigation water source, irrigation infrastructure used); c) land and water tenure and

[4] Some of the first findings were summarized in an article and compared with the case of China in: Gehrigk, Frederike; Aarnoudse, Eefje (2013) Konflikte um Wasser und Land: Tadschikistan und China im Vergleich. IAMO Jahreszahl 15: 73-83.

regulations (responsibilities in the land and water sector, formal land and water rights, land reform); d) bundle of land and water rights (farmers´ perception on land and water claims); e) outlook of land and water access (open questions); d) farm household details (gender, age etc.). The bundle of rights were asked according to the criteria developed by Schlager and Ostrom (1992) which were specified for the Tajik land and water sector. The theory of bundle of rights can be operationalized for the field work as guiding tool for the case study approach to ask for the resource regime characteristics. Therefore, the theory helps to identify cases and variables. In this case, the bundle of rights indicators were asked on a 5-point-likert scale. The reason for this was to receive standardized data which ensure comparability between the cases and between land and water. Other parts of the survey were included based on relevant criteria (first and second tiers) from the Social-Ecological-System framework (Ostrom 2007; McGinnis and Ostrom 2014).

In the **fourth step**, the field work was conducted with academic assistance by the Tajik Academy of Science and logistical assistance by Caritas Switzerland from March – May 2013. One Tajik assistant continuously accompanied the field work process. Two research locations, where research permissions were organized, were selected: Bokhtar in the Khatlon province and Bobojon Gafurov in Soghd province (see Figure 1-4). Both regions were selected according to the following criteria: first of all, they are dominated by an agroecosystem and share similarities in their agricultural production patterns, located in the semi-arid lowlands, their high dependence on surface irrigation, agro-ecological conditions (gray soils). In addition, both districts are located next to the second (Khujand) and third largest city (Qhurganteppa) of the country, which are important economic hubs besides Dushanbe. However, both regions are geographically completely separated from each other through the mountain ranges of Zarafshan. Bokhtar is closer to the capital Dushanbe and during the civil war in 1994 it was very much affected. Overall, Khatlon province is considered slightly poorer than Soghd province. Southern Tajikistan is more fragmented, also in terms of ethnic and religious groups. This fragmentation especially arose from the Soviet resettlement policy starting in the 1920s. Especially people from Gharm and Kulob were resettled to Khatlon to contribute to agricultural development. Now, the fragmentation can be mainly observed by village, where regional ties and localism can contribute to segregation between villages. Those who were resettled are now often struggling in the rural areas[5]. In contrast, the Soghd oblast has always been more developed. Nourzhanov and Bleuer (2013) also describe this region having "the spirit of entrepreneurship" p.94, which could be observed in the beginning of the land reform, which passed much quicker than in other regions (Nourzhanov and Bleuer 2013).

[5] In one of the surveyed villages in Bokhtar, I was told that this is a "Gharm-village", where people were resettled: "here, people are poorer, they don´t even have a mobile", "look at their canals, they do not get any financial support from the authorities".

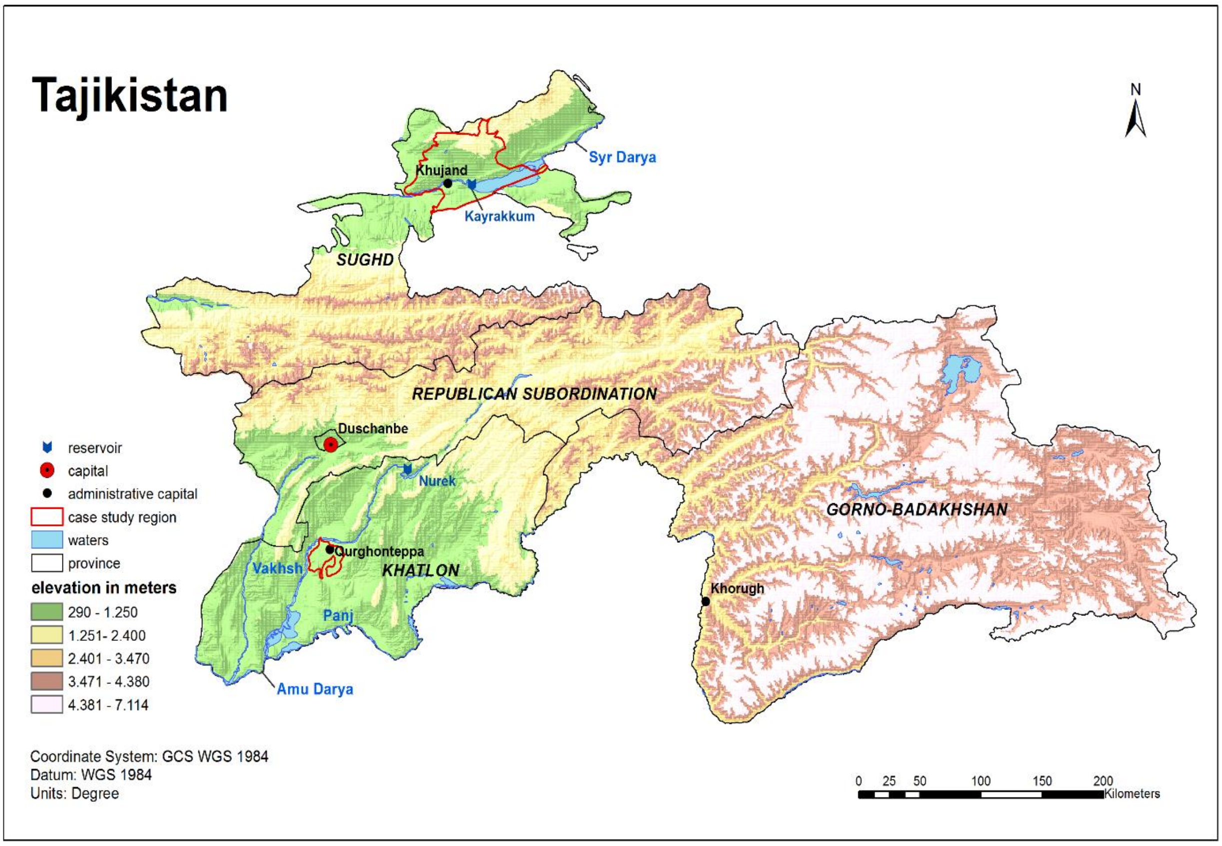

Figure 1-4 Topographic map of Tajikistan indicating the case study regions

Source: Figure prepared by Neumann and Klümper based on GADM, version 1 and CGIAR SRTM Data; http://srtm.csi.cgiar.org/

In both provinces as well as in the capital, the data presented in Table 1-1 were collected[6]. The selection of the farm households took place based on a stratified random selection process. After non-randomly selecting the districts, all communes (jamoats) were selected. Within the communes 1-2 villages were randomly selected. However, due to missing farm household lists, a quasi-random selection process was chosen (Bennett et al. 1994), which is commonly applied in developing countries. All enumerators start in the centre, choose a random direction and selects the first farm household in this direction. The following houses are randomly selected along that route.

Table 1-1 Quantitative and qualitative data

	Farm household survey	In-depth interviews	Focus group discussions (participatory mapping)	Expert Interviews
Bokhtar (Khatlon province)	177	20	2	6
Bobojon Gafurov (Soghd province)	222	20	2	5
Dushanbe (capital)	0	0	0	7
Total	399	40	4	18

[6] The survey and the interview guidelines are provided in the Appendix.

The survey was tested for two days (in Bokhtar) prior to the actual survey. The farm household survey was conducted in both districts (first in Bokhtar, then in Bobojon Gafurov). In each district, three enumerators conducted the survey. On purpose, only women were selected to conduct the survey, because access to farm households, where the man was absent, is easier as woman. In addition, all enumerators came from one of the surrounding villages to know the local context as well as the specific context of rural life (e.g. when to dress with traditional clothes etc.). All of them spoke Tajik, Uzbek and Russian. Before conducting the survey, a two-day training workshop and a trial run of conducting the survey took place. The survey was available in Russian and Tajik language, depending on the preference of the surveyed farm household. Open questions were always filled in in Russian to facilitate data entry later on. Together with the assistant, we always joined one of the enumerators randomly and depending on the situation, further in-depths informal qualitative interviews were held and simultaneously translated into English. In each district, we further organized two focus group discussions (mostly with WUAs). Here, a participatory mapping together with a discussion round was organized. Participatory mapping is a problem-oriented research method (Martin and Sherington 1997; Chambers 1994). This helped to understand and grasp regional differences and the organization of irrigation management. Not all of the discussions were recorded, thus complete transcription was not possible. In each district as well as in Dushanbe further expert interviews were conducted with the Land Committee, Water Ministry, Agricultural Ministry, Statistical offices and local NGOs.

The **fifth step** then included first the development of hypothesis, based on literature review and field work experiences. All hypotheses were established for each chapter specifically. Followed by this, the hypothesis testing phase was undertaken which was divided in three parts, represented by each chapter as described below. Finally, in the **sixth step**, the results were synthesized, discussed and policy recommendations were give.

1.6 Outline

The following study is organized in three distinct and non-consecutive chapters. Each chapter includes an empirical analysis where specifically the case of Tajikistan is analysed. Chapter 2 develops a new index of irrigation water security and analysis each dimension of irrigation water security for different farm types in Tajikistan. The following Chapter 3 presents an operationalisation approach of land and water property rights. Here, discrepancies between rights on paper and claims in practice are compared between the land and water sector. Subsequently, Chapter 4 analysis determinants of the land sector contributing to the willingness to cooperate in irrigation management. Finally, with the help of the results of each chapter, the final Chapter 5 draws conclusions for research, but points to some limitations faced during the analysis. Further, policy recommendations based on the findings are presented.

2 Can water abundance compensate for weak water governance? Determining and comparing dimensions of irrigation water security in Tajikistan[7]

Abstract

In this paper we consider both, hydrology and governance as critical dimensions for irrigation water security. We scale down the overall water security concept to the agricultural sector and discuss irrigation water security faced by farmers in Tajikistan. Irrigation water security is investigated by three different dimensions: a) a hydrology dimension, expressing a lack of water availability, b) a governance dimension, i.e. the perceived difficulty to access water and c) a hybrid dimension of governance and hydrology. Considering these dimensions, we develop an irrigation water security index, which will be empirically tested using farm household survey data (N = 399). This index gives evidence that different farm types, e.g. small versus large, face different water security threats. Further, if one dimension is less distinctive, the complementary dimension can occur as coping mechanism. Thus, we conclude that different coping mechanisms and incentives for more sustainable water use are needed.

Keywords: irrigation water security, governance dimension, hydrology dimension, Tajikistan

2.1 Introduction

According to the World Bank (2007) 1.2 billion people already suffer from absolute water scarcity. Grey et al. (2013) and Zeitoun (2011) emphasize that particularly the world´s poor currently face severe water insecurity.

Water security can be evaluated on different scales, from the global to the household level. One has to differentiate between different security threats such as to drinking water supply, to economic growth, to water related ecosystem services (Bakker 2012), but also to agricultural production (Rosegrant et al. 2009). Globally, 20 % of cropland is irrigated and in some countries,

[7] This chapter has been published in a revised version as the following open-access article: Klümper, F., Herzfeld, T. and I. Theesfeld (2017). Can water abundance compensate for weak water governance? Determining and comparing dimensions of irrigation water security in Tajikistan. Water 9(4): 286, doi.

such as Tajikistan, the share amounts even to 65 %. This makes agriculture the largest water user worldwide with 70 % of water withdrawals (Rosegrant et al. 2009). "The development of irrigated agriculture has boosted agricultural yields and contributed to price stability, making it possible to feed the world's growing population" (Rosegrant et al. 2009:205). Water for irrigation is strongly linked to food security, but farm households and consumers depend on it differently. Whereas commercial farms and rich consumers might have capacities to deal with variability in water availability, poor consumers and subsistence farmers face direct and immediate consequences. Thus, it is relevant to look at the disaggregated level in terms of irrigation water security to specifically understand water security threats by different farm households. Especially in rural areas, where agriculture is the main income source and is, thus, the most effective way to reduce poverty, water security for all households is of importance (World Bank 2007). Furthermore, even water abundant countries can be hampered by water insecurity, which is the critical issue in this paper. Threats to irrigation water security can be of institutional or biophysical nature and result in different dimensions to be considered. Thus, 1) governance systems, governing farmers' decisions and actions, and 2) hydrological conditions, indicating the de facto water availability are critical to enhance irrigation water security.

In Central Asia, one of the most arid areas worldwide, the agricultural sector is to a large extent depending on irrigation systems (Aleksandrova et al. 2014). Both, the agricultural and water sector have changed tremendously since 1990. Some of the countries aimed quickly to dissolve the Soviet state and collective farms. The resulting farm structure is dominated by family farms which, consequently, challenge irrigation infrastructure as new individual consumers. However, the large-scale irrigation systems established during Soviet time cannot entirely ensure the increasing number of small-scale family farms (Sehring 2009; Abdullaev and Atabaeva 2012). Water negotiations and conflicts between and within the countries are limiting agricultural growth. Zakhirova (2013) emphasizes that "disputes over water are largely the result of an allocation policy rather than scarcity of water supplies in the region" (Zakhirova 2003; p. 1997).

Tajikistan, the poorest of the Central Asian countries, shows a medium to low national water security indicator across different sectors (Asian Development Bank 2013). The national estimate however, does not include the countrywide variations. Although fresh water resources are abundant (annual water availability: 17 000 m3/cap/year), it is interesting why Tajikistan is considered as water insecure, also in the agricultural sector (Zakhirova 2013). Here, one single national hydrological figure is limited in its validity for farmers´ irrigation water security. As Cook and Bakker (2012) underline, only a few studies address and measure water security on the community and farm or household level, nor do these studies link water security to the agricultural sector (Sinyolo et al. 2014; Sangkapitux and Neef 2006; Jepson 2014).

The objective of this paper is to go beyond one national-level indicator and develop an irrigation water security index at household level considering specifically a hydrology as well as a governance dimension. Our contribution to the literature is twofold. First, we suggest an index of irrigation water security focusing on the farm household level, mainly smallholders. Irrigation water security in our study concerns three main dimensions. The dimensions of irrigation water security that depends on 1) hydrology, 2) governance and 3) on governance and hydrology, the so-called hybrid dimension of water security. With these dimensions, we are able to answer the question whether different dimensions of water security are always necessarily complementary. So far, a water security index focusing on smaller-scale farm households often does not include specifically hydrology and governance as two different dimensions, neither compares the dimensions. A second contribution of the paper is the application to the case of Tajikistan, a seemingly water abundant country. Based on a cluster analysis, we are able to differentiate farm typologies with varying irrigation water security dimensions. Subsequently, we test whether the hydrology and governance dimension of water security in the irrigation sector is distributed equally and if they always appear complementarily across the groups. For decision-makers this contribution can be especially interesting as it indicates and identifies specific system characteristics that might increase water security. For the empirical part, we use data from a farm household survey collected in 2013.

The paper is structured as follows: First, we define the concept of water security with a focus on irrigation water security. Here, we explain in detail the different dimensions. Subsequently, we describe our methodology introducing the study area and data. The main part presents our definition of the irrigation water security index, where we also operationalize the three different dimensions of irrigation water security: 1) hydrology, 2) governance and the 3) hybrid between governance and hydrology. The presentation of the results in Section 4 consists of a brief description of the overall index and the results of the comparison across farm types. While concluding, we discuss strengths and limitations of a household level water security index.

2.1 Water Security: from the national to the local scale

The most common concept of water security defines it as “the availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies, for agriculture and rural livelihoods” (Grey and Sadoff 2007: 547–548).

This definition is mainly applied by studies analyzing national and global water security (see e.g. Asian Development Bank 2013). It encompasses different sectors and addresses different disciplines (social, environmental sciences etc.). However, Cook and Bakker (2012) or Grey and

Sadoff (2007) stress that the water security definition is often too broad to be operationalized as such. Therefore, we suggest re-defining this definition for irrigation water security of farmers. This is especially important in countries, where agriculture is the main income source in the rural areas such as in Tajikistan.

Having the agricultural focus in mind we narrow down the previous definition. In our paper, irrigation water security relates to the objective hydrology and subjective governance options by each farm household to sustain their agricultural needs either for subsistence or for commercial farming. If farmers face a lack of water availability, it is the dimension of irrigation water supply security that depends on hydrology alone. Here, we refer to it as the "hydrology dimension". In contrast, if farmers perceive any difficulty to access, it is the dimension of irrigation water supply security that depends on governance, referred to as the "governance dimension". Farmers are assumed to be water insecure if outcomes of one or both dimensions are challenged. However, we think that water security is not a binary concern. There might be situations where small changes of policies or informal institutions and/or hydrological conditions lead to either no changes at all or drastic shocks.

It is important to look at the disaggregated level as for instance water scarcity can affect farmers´ individual decision-making regarding irrigation technologies or other water applications (Beau et al. 2015). Jepson (2014) stresses that a household is "the key unit of water delivery and the place where most water services are accessed. […] Farm households shape behaviors and decisions relating water use" (Jepson 2014: 109). For instance, if a household feels insecure in accessing water, they might respond in different ways, e.g. they find a coping strategy or they try to avoid certain practices. Furthermore, a farmer's perception of the security of access to irrigation water will determine the willingness to invest in water saving technologies and adopt water saving practices (Jacoby et al. 2002; Carey and Zilberman 2002). As Alam (2015) states, it is expensive and time consuming to mitigate water scarcity. Thus, it is not possible for all farmers to invest in mitigating strategies and the status quo of different water security levels differs among farm households.

2.1.1 Linking the hydrology, governance and a hybrid dimensions

Lorey (2003) and Biggs et al. (2013) stress the distinction of water security between 1) governance and 2) hydrology. The connective capacity between them has been recognized, but a systematic translation is missing in the water security debate (Norman et al. 2013; Bakker and Morinville 2013). There are of course many variables that seem to be related to hydrology, but are also influenced by governance. Thus we add a so called "hybrid dimension".

Each dimension can be either measured objectively or subjectively. Hydrological variables are usually expressed with objective data. However, with regard to the governance as well as the hybrid dimension, objective as well as subjective measures can be adduced, depending on the aim of the concept. As we want to express the variance of the governance dimension between households, only subjective measures are considered. Often, objective governance criteria that describe the variance among households are difficult and expensive to collect. In addition, if they exist, they can be misleading especially in terms of corruption or black market measures. Therefore, subjective data in terms of perception-based indicators are very commonly used for such a governance dimensions (Besley 1995).

The hydrology dimension of water security is an important objective measurement to determine water security. Hydrology can result in water abundance and can provide significant security of supply for irrigators, even if water governance is weak. The total actual renewable water resource indicator is a key hydrological water resource measure (Grey and Sadoff 2007), also at the farm level. The hydrology dimension of irrigation water security can also vary according to the distance to water infrastructure, available water sources used such as ground- or surface water, rainwater as well as the quality of water. Using e.g. multiple sources can be more reliable when it comes e.g. to environmental disturbances such as a drought.

The governance dimension describes the decision-making process of resource supply where various interests, responsibilities, policies and means of supply and services are considered for a certain time (Rogers and Hall 2003). Transparency, accountability and participation are main principles of water governance assessments (Jacobson et al. 2013). The three principles include socio-political dynamics and aspects like power relations (Bakker and Morinville 2013). In some irrigation systems daily negotiations take place, which demands for farmers' participation and a transparent process. Of course, participation can be time demanding and only be affordable for large farmers with abundant labor. However, the level of participation and transparency, e.g. by farmers being engaged in local water networks, can vary considerably among the farmers. Therefore, local governance can differ considerably between households. Especially at the farm household level, the subjective investigation of local governance, measured by perceptions, is very common. Sinyolo et al. (2014) and Besley (1995) mention, that perception assessments indicate the de facto actions and decisions being made by the farmers.

The hybrid dimension forms a linking element between the governance and the hydrology dimension. It is influenced by hydrological and governance environment faced by a farmer. An indicator of the hybrid dimension can be of hydrological nature, but is likewise strongly influenced by governance. For instance, water variability can be a hydrological risk. However, in most cases, this variability cannot only be attributed to a hydrological problem. Water variability in the canal depends e.g. on the water flow/input (hydrology) but also on access, control and management regulations (governance). Subjective assessments of hydrological variables can also be important and determine the current and future water use (Jepson 2014).

All of the indicators of the different dimensions are considered to vary over households, however to a variable extent. Considering a scenario, where all farmers have their own well with continuous water flow during the year, hydrology dimension of water security should be close to equal among all farmers. If this scenario is supported by a situation where all farmers enjoy the same bundle of clearly defined water rights, conflict resolution mechanisms, and stability of the institutions over time less variance is expected within the indicators of the governance dimension, leading to low variance of overall water security between household. However, the latter indicators of the governance dimensions are (theoretically) assumed to vary across households, especially in many developing contexts. These might especially be significant in a context with low rule of law, relatively in-transparent regulation, and power imbalances between decision-makers or regulations under transition. Ideally, institution building will shift a country from the latter scenario of weak governance towards the first scenario of stronger governance. Thus, the household perspective offers more insights than a national perspective.

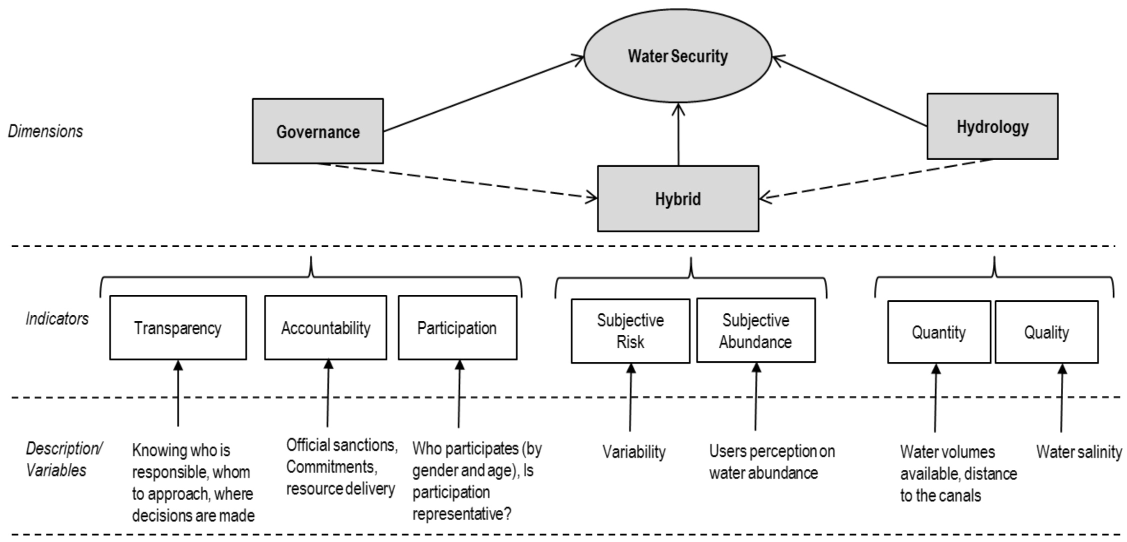

Figure 2-1 Three dimensions to design the irrigation water security index

Source: Own Figure

2.1.2 Current water security measurements

In the literature, different water security measurements for the different sectors were developed. However, as far as we know, no specific index exists which particularly focuses on the agricultural sector at global or national scale. Several national indicators integrate agriculture as one component of overall water security. For instance, the index by Lautze and Manthrithilake (2012) incorporates agricultural water security as one component to consider the hydrology dimension. Another national index was developed by the Asian Development Bank (2013), who includes agriculture into the economic water security component. To date, an integration of governance variables is often missing, which was also stressed by Dunn and Bakker (2011), who conducted an inventory of freshwater indices. Also Norman et al. (2013) emphasize that the current assessment tools are not meaningful to indicate water security at community level. Norman et al. (2013) developed a water security assessment, the Water Security Status Indicator (WSSI), which addresses drinking/freshwater at the local scale and integrates multivariate indicators. Another community level water security index, for domestic water security, was developed by Jepson (2014). She considers three dimensions: 1) access (capacity, physical access, and affordability), 2) water quality (biophysical characteristics affecting health, 3) water affects (emotional and cultural experiences of water). Two measures of irrigation water security were identified in the literature. Sangkapitux and Neef (2006) define the concept of water security on the farm household level and developed the following index: 1) diversity of water sources, 2) access to sources (using share of irrigated land), 3) risk of water scarcity and conflict. Yet, each dimension is represented by one single proxy. Sinyolo et al. (2014) developed another farm household water security index based on perceptions of irrigators using 12 variables. Here, the focus lies on subjective assessments on reliability and consistency as well as water payment schemes.

2.2 Methodology

In this chapter we briefly describe the study area of Tajikistan with a focus on the water sector. Then, we describe the data collection and data available for this paper.

2.2.1 Study area description

Tajikistan is a mountainous and land-locked country in Central Asia. Agricultural production is restricted to an area of only 7 % of the total area. The high mountain ranges limit intensive agricultural production to the lowlands of Vakhsh and Syr Darya river basin (McKinney 2004). The mean precipitation level is 651 mm/year. However, this estimate varies a lot between the lowlands and uplands. Especially in the lowlands, precipitation is very low during the summer months. In contrast, during spring time many floods occur due to melting water from the mountains. The total renewable water resources are estimated at 21 km3/year and 3140 m3/year per inhabitant (Frenken 2012). In the long run, climate change is expected to reduce the water inflow in the rivers due to less snowfall in winter and melting glaciers with increasing temperatures. Within the lowlands, large-scale irrigation techniques were introduced during the time of the Soviet Union to mainly establish cotton production. Now, the main crops produced are cotton, rice and vegetables. Wheat production dominates in the dry land areas with still acceptable level of elevation (FAO 2015b). Countrywide, irrigation and livestock accounts for 90 % of the total water withdrawal, whereof 94 % of irrigation water is surface water. Thus, groundwater only plays a minor role. Mainly, the surface water used for irrigation is either pumped from the rivers (35 %), supplied as gravity fed (24 %) or from reservoirs (28 %). Water losses between the source and the fields are reported at 50 – 65 % (Frenken 2012). About 38 % of the main and inter-farm canals are concrete canals. When it comes to on-farm canals, about 65 % are unlined earthen canals and only 13 % are concrete canals. In 2009 about 23 000 ha of the area are salinized by irrigation and 25 000 ha waterlogged by irrigation, which is in total about 7 % of actually irrigated land (647 000 ha). Both problems are seen as main challenges in the future to sustain arable land (FAO 2015b).

After the collapse of the Soviet Union, water reforms developed since then and especially responsibilities of control and allocation of water changed. As in other sectors, the maintenance of irrigation infrastructure drastically transformed from centrally planned system to a farmer managed irrigation canal management. Water, as well as land resources, remains state property and farms have the possibilities to get use rights (Sehring 2009; Abdullaev and Atabaeva 2012). Since 2006, the Law of the Republic of Tajikistan on Water User Associations (WUA) transferred all irrigation related management tasks to Water User Associations (Yakubov and Hassan 2007).

2.2.2 Data collection and empirical methods

We selected two study areas in the main agricultural areas: Bobojon Gafurov in the Soghd province (northern region) and Bokhtar in the Khatlon province (southern region). Both regions are geographically separated by high mountain ranges.

Primary qualitative and quantitative data were collected by the main author from March – May 2013. Two focus-group discussions were conducted in each region, one upstream and one downstream of the watershed with 8 – 12 participants each. The main part of the focus-group discussions included a hands-on participatory mapping, where farmers were asked to draw the irrigation system they are using and to illustrate related problems (see e.g. IFAD 2009; Bernard 2012). This approach, understood as problem-oriented research method, provides insights into participants´ attitudes, perceptions and expectations on water related issues. The mapping allowed for more dynamic discussions, where we aimed to identify major challenges within the administrative and hydrological water boundaries.

Further, the qualitative interviews contributed to adapt the survey, which was subsequently tested in each region before finalization. The survey included questions on 1) farm characteristics, 2) farmers´ land and water management practices, 3) awareness of rights and responsibilities on land and water, 4) attitudes towards strengths and weaknesses of the farming situation. The survey was self-generated using e.g. the Bundle Rights approach (Schlager and Ostrom 1992) to map farmers' property claims and the idea of the Social-Ecological System (Ostrom 2007) to specify the irrigation system (as a common pool resource).

The core analysis of this paper relies on the farm household survey data. As data availability on the farm household level in Tajikistan is limited, our data presented here is very helpful to give insights into the perception of water use and management on the farm level. For the survey we used stratified random selection: (1) two districts in each agricultural region were non-randomly selected; (2) in each district one sub-region was selected; (3) in each sub-region two villages were randomly selected and finally farm households within villages were chosen, according to selection criteria by Bennett et al (1994). Farm households were only selected if they used irrigation water and farm land for at least two years. We have a total sample of 399 farms in one northern (Bobojon Gafurov, N = 222) and one southern district (Bokhtar N= 177). The sample population includes small-scale households and individual family farms of different farm sizes.

We used descriptive statistics presenting the distribution of the different dimensions. We performed different steps to conduct a cluster analysis to derive at a farm typology. First, we applied the single-linkage method to basically control for the outliers. In the second step, we used the Ward method for the cluster analysis to determine how many clusters are actually valid for our study. Here, the Calinski stopping rule was applied and we could determine three clusters . In the third step, we applied a non-hierarchical cluster analysis using K-means. As we only used binary variables we applied the Matching measures in all three steps of the cluster analysis. In total seven variables were used . In addition, we controlled for a low level of correlation between the variables and excluded redundant variables to avoid overrepresentation of some factors.

2.2.3 Developing an Irrigation Water Security Index for Tajikistan

Households play a significant role in terms of current and future water use practices. As described before, the household perspective provides the possibility to show more variance across the different indicators then a national index, especially for a country where small-scale agriculture is the main income source for a large share of the rural population. This perspective further offers the opportunity to determine a specific socio-economic and environmental context where e.g. risks or adaptation options are at hand.

Like the Asian Development Bank (2013) index, we first standardized and assigned scores from 1 – 5 for each variable of the dimensions. The variables of each dimension were added-up and divided by the number of variables. Each variable is considered to increase the risk of water insecurity if they would not be fulfilled. We did not include any weights into our study, which can be however important for further exploration. Adding up the dimensions leads to the overall water security index (WSI). Table 2-1 lists all variables of each dimension and the assigned standardized values and their meanings.

$$H_{WSI} = (Quantity + Quality)/2$$

$$G_{WSI} = (0.5*Transparency + 0.5*Accountability + Participation) / 3$$

$$Hy_{WSI} = (Risk + Abundance) / 2$$

$$WSI = (H_{WSI} + G_{WSI} + Hy_{WSI}) / 3$$

An objective statement of the hydrology dimension (H_{WSI}) is difficult to capture for farmers, especially for smallholders in developing countries, where data availability is rare. Here, we used secondary data and the farm household survey data. The indicator quantity was measured by water availability per capita. As water availability per capita data was not available at the village level in Tajikistan, we weighted the regional variable (data) with the distance of the farm household to the next irrigation water source. The distance relates to the time and efforts individuals devote to make water available for irrigation (Jepson 2014). The larger the distance, the less likely is water security due to reduced availability. This can be a result of higher water access costs (e.g. digging and maintaining canals) or the accumulation of losses from the head to the tail end of a canal. Precipitation figures are not considered as we focus only on surface irrigation areas in our sample.

As data on water quality were not available for the agricultural sector, we consider farmers´ perception on water quality as an approximation (How do you evaluate your irrigation water quality on a scale from 1 -5). Given the subjective nature of this measure, it has to be handled carefully. But still we believe that farmers' perception of water quality can give a valuable indication.

Secondly, the governance dimension (G_{WSI}) reveals the subjective access options of farmers. We applied the three governance principles transparency, accountability and participation (Jacobson et al. 2013) to measure a subjective statement on local governance. The first indicator transparency is linked to the information provided to farmers. Two variables represent transparency. First, we measured farmer´s awareness of responsibilities between the gate and on-farm. Second, transparency is quantified by farmer´s perceptions on equal water distribution among farmers. The accountability indicator "refers to a set of controls, counterweights and supervision modes" (Jacobson et al. 2013). In Tajikistan, farmers using irrigation systems are self-accountable as they have duties to manage and to invest in the systems, especially at the inter-farm and farm level canals. If farmers for instance perceive investment or management as their duty, (we assume) they also have higher accountability and commitment towards good governance of irrigation systems they use. Participation is the third indicator of governance water security. Enhanced participation of farmers in irrigation systems is likely to create more assurance and security over time, helps to ensure sustainability of an irrigation system and builds social capital and can improve equity of water allocation in the long run (Khalkheili and Zamani 2009; Meinzen-Dick 1997). In addition, participation would be important not only at the natural resource use level, but also at the policy making level (Khalkheili and Zamani 2009). If farmers perceive their negotiation claims to water related issues, they participate in the decision-making process to stress their own water needs.

The hybrid dimension (Hy_{WSI}) is captured by two indicators. Risk is one key indicator, which is displayed by water variability in the cropping season. It is important as irrigation water security increases with high water variability. Water variability is measured for the main cropping months (May – August) and the risk increases with more months being evaluated with high variability by the farmers. In addition, subjective assessment of water abundance is considered here as well. According to Jepson (2014), also the perception of water availability is key for water security. If farmers perceive not to have water, this might lead to adaptation or reduction of e.g. producing certain crops. Further, we placed subjective availability within the hybrid dimension as it is influenced by various factor, e.g. also cropping decisions and technology choice.

Non-water related stress factors such as climate change and flooding, also a significant risk for farmers in Tajikistan, were not included in the farm household indicator as these variables affect all farmers more or less similar. Including them will not influence between-farm variation which is the focus of this study.

Table 2-1 Operationalising the three dimensions of irrigation water security

	Variables	**Standardized values**
Hydrology Dimension		
Quantity	Water availability / capita[a] * distance to the next water source	1 < 500 m3/cap 2 500 – 1000 m3/cap 3 1000 – 1500 m3/cap 4 1500 - 2000 m3/cap 5 > 2000 m3/cap
Quality	Evaluation of water quality by farmers (perception)	1 Very Poor 2 Poor 3 Acceptable 4 Good 5 Very Good
Governance Dimension		
Transparency	Awareness of responsibilities for water allocation (gate, primary canal, between canal and farm, on-farm)	1 knowing none of the resp. 2 knowing one 3 knowing two 4 knowing three 5 knowing all

	Equal/transparent distribution of irrigation water (perception)	1 2 3 4 5	Very Poor Poor Acceptable Good Very Good
Accountability	Perceived management claims	1 2 3 4 5	Never Rarely Occasionally Good Very frequently Always
	Perceived investment claims	1 2 3 4 5	Never Rarely Occasionally Good Very frequently Always
Participation	Perceived negotiation claims	1 2 3 4 5	Never Rarely Occasionally Good Very frequently Always
Hybrid Dimension			
Risk	High variability during cropping season (perception)	1 2 3 4 5	High variability: in all months (may-aug) in 3 months in 2 months in 1 months very low variability: never
Subjective Availability	Perception of water abundance	1 2 3 4 5	Not abundant Rarely Occasionally Good Very frequently Always abundant

a = Data source: (FAO 2015a); as threshold we used the (Falkenmark 1989) threshold: >1700 m3/cap = no stress; 1000 -1700 m3/cap = stress; 500 – 1000 m3/cap = scarcity; < 500 m3/cap absolute scarcity

2.3 Results

We first display the results of the overall WSI and its three dimensions and then unpack each. Hence, we determine the different farm typologies and compare the governance and hydrology dimensions across these typologies. Finally, we discuss the results of the relationship between the governance and hydrology dimension of water security.

2.3.1 Results of the three dimensions and the overall WSI

The irrigation water security index is exemplified for two main agricultural regions: Bokhtar and Bobojon Gafurov. The density plots (Figure 2-2) display the distribution of each dimension from being water insecure to water secure (1-5).

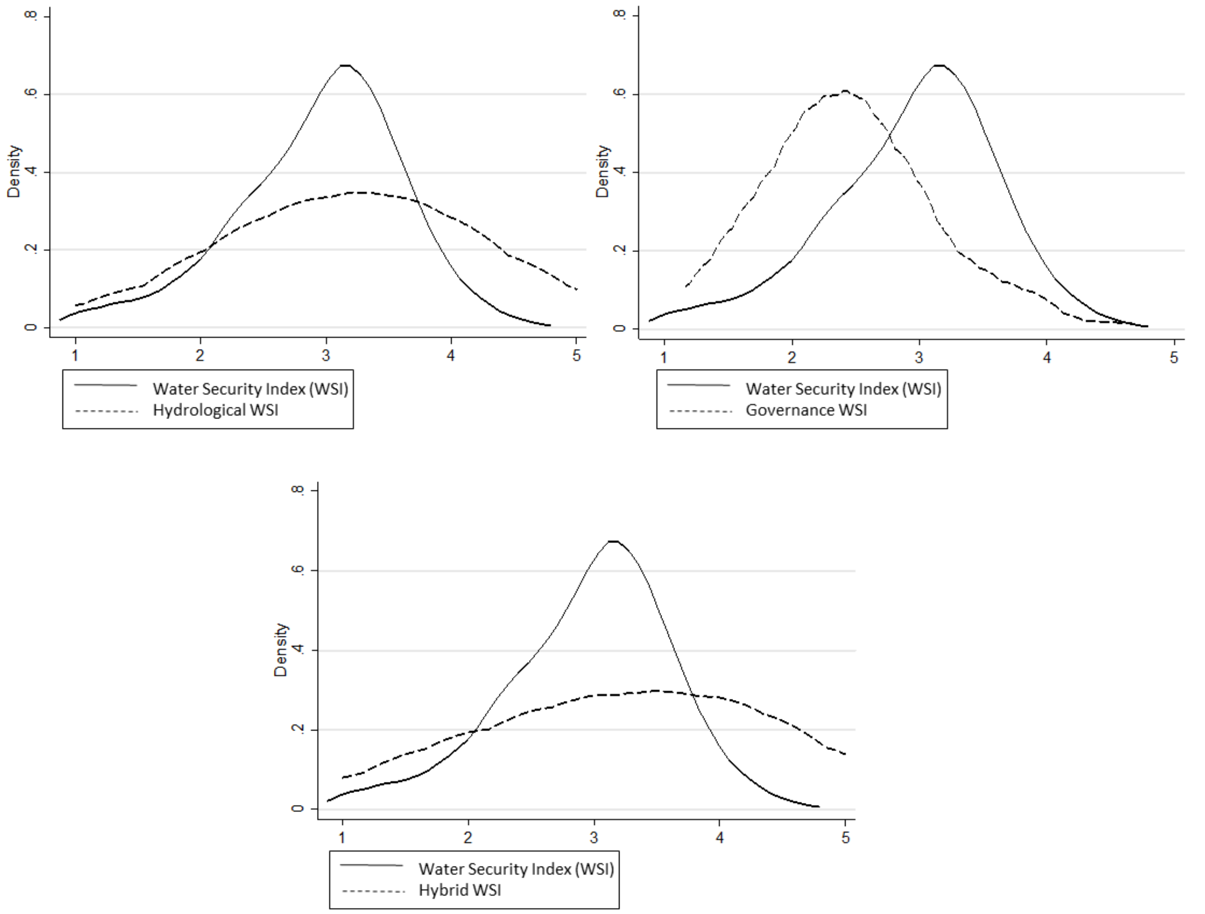

Figure 2-2 Distribution (k-density plots) of the three dimensions of irrigation water security
Source: Survey data 2013, Scale from 1 = insecure to 5 = secure

The results of the three different dimensions (see Table 2-2) emphasize the importance to go beyond the aggregated and one national WSI index. Results between hydrology and governance dimensions differ considerably.

The results of the hydrology dimension show that the mean value is larger (mean 3.19) than the governance dimension (mean 2.45). This supports our assumption, that for a country such as Tajikistan, where naturally water is abundant, another dimension besides hydrology is more decisive to irrigation water in-/security. Here, more than 50 % of the respondents reported a value of more than 3 for water availability. The interviews have shown that lower values are due to the disconnection to the main canals of some farmers or destroyed pumps to lift water from the main canal to further downstream canals. Some of the farm household plots in Tajikistan for instance also rely on irrigation water from drainage canals, which is often very polluted (eutrophication, toxic etc.). In an open survey question on general disadvantages of the village, many farmers addressed low water quality as a major barrier and reason for losses of arable land.

The governance dimension, however, receives lower ratings on average. The water security values of the governance dimension are overall lower than of the hydrology dimension. About 50 % of the surveyed farmers have a lower irrigation water governance security index than 2.2. The two principles of accountability and participation are not met with very low values in negotiation and management claims. Also the interviews showed that participation of farmers e.g. in WUAs remains low. In Bobojon Gafurov, most WUAs were established within administrative boundaries instead of watershed boundaries with a very little number of active members. Another limiting factor for water governance security in Bobojon Gafurov is the issue of transboundary water problems. After the collapse of the Soviet Union, some of the remaining irrigation canals "now" crossed the new borders. For some canals, Bobojon Gafurov now holds the up- and downstream position, with Kyrgyzstan in-between. Especially on the Kyrgyz side, new agricultural land, demanding more irrigation water, has been taken into cultivation.

The third dimension, again, follows a platykurtic distribution around a mean of 3.2. The results of high water variability during the cropping season are not perceived as a major water insecurity stressor. In both districts, the mean value exceeds a level of 3 and about 50 % reach higher values than 3. The results of the perception of water abundance in a way reflect the hydrology dimension of water availability. In addition, there is a significant correlation between the hydrology and hybrid dimension 0.44 (p-value 0.000). In the remaining part we focus on the hydrology and the governance dimension of irrigation water security.

Table 2-2 Descriptive statistics of the three dimensions

	Obs	Mean	Std. Dev.
Water Security Index (WSI)	391	2.95	0.66
Hydrology dimension of WSI	399	3.19	0.92
Water availability / capita * distance to the next source	399	2.87	1.09
Water quality	399	3.50	1.23
Governance dimension of WSI	399	2.45	0.66
Awareness of responsibilities	399	3.18	1.26
Equal distribution of water	399	3.02	1.20
Perceived water management claims	399	2.30	1.68
Perceived water investment claims	399	3.41	1.73
Perceived water negotiation claims	399	1.40	1.11
Hybrid dimension of WSI	391	3.23	1.09
High variability during cropping season	399	3.16	1.22
Perception of water abundance	391	3.28	1.63

Note: 1 = insecure – 5 = secure
Source: own calculation based on Farm Household Survey 2013

2.3.2 Water security for different farm types

Once the different dimensions of irrigation water security are calculated, one is of course interested who belongs to the group of the water secure and insecure farmers. Thus we first conduct a cluster analysis to characterize different farm types and hence analyze the irrigation water security dimensions along this typology.

Table 2-3 **Farm types based on cluster analysis**

	(1) Experienced, small-scale subsistence farms	(2) New medium-scale, market oriented farms	(3) Larger-scale, market oriented cotton farms
Number of cases (%)	189 (47.7%)	144 (36.4 %)	63 (15.9 %)
Mean agricultural land area (ha)	0.5	3.4	18.5
in %			
Producing cotton	0.53	0.00	87.30
Producing wheat	15.34	15.28	44.44
Producing vegetables [a]	76.19	36.11	22.22
Production sold	18.52	52.08	96.83
Water fees are paid	69.84	43.75	73.02
Farm is newly established (< 3 years old, established after 2010)	11.11	83.33	68.25
Good implementation of local land governance	47.62	25.69	58.73
Female farm head	44.44	19.44	17.46

Source: own calculation based on Farm Household Survey 2013
[a] Here, potatoes tomatoes and onions are only included

Table 2-3 describes the three distinct clusters identified. Within one community, all three clusters are always represented. The first cluster of farmers is characterized by very small-scale farmers (also including household farms). Here, only a small share sells their produced crops and subsistence vegetable farming dominates. Almost half of the production units are led by women. In addition, a large share of these farms exist since long time as only about 11 % of these farms were established during the past three years. Thus, this group of farmers is more experienced in farming on this specific plot and maybe better organized within the community. In addition, a considerable share perceives local land governance implemented as good . This production unit can be described as self-organized without influence of externals (e.g. authorities) as it is the case for larger-scale farmers.

The second cluster is characterized by medium-scale farms, producing diverse crops and marketing a considerable share of their production. 83 % of these farms were established during the past 3 years. However, local land governance is only perceived as good by about 25 %. This indicates that they were either struggling to get access to farm land or at the time of the survey still struggling e.g. with local authorities. The third cluster is characterized by large-scale and market oriented farms, whereof 87 % produce cotton. Wheat and vegetable production is as well within the production chain. Farms are mainly male headed and about 68 % have been only established after 2010.

Table 2-4 Hydrology and governance dimensions of water security across farm types

Farm type	WSI	G_{WSI}	H_{WSI}	Correlation coefficient of H_{WSI} and G_{WSI} [a]
(1) Experienced, small-scale subsistence farms	2.93	2.48	3.09	0.31***
(2) New medium-scale, market oriented farms	2.98	2.31	3.38	0.09
(3) Large-Scale, market oriented cotton farms	2.94	2.66	3.02	0.32**
Total	2.95	2.44	3.18	0.19***

Source: own calculation based on Farm Household Survey 2013, a Pearson correlation coefficient with level of significance $p < 0.01$ = ***, $p < 0.05$ = **, $p < 0.10$ = *

The results in Table 2-4 show that the WSI is similar across farm types. Considering the different dimensions, diverse farm groups do not represent one polarised position in irrigation water security, where both dimensions are either extremely high or low. Instead, different dimensions threat the farm types differently in their production.

The group of small-scale farmers have the lowest WSI. However, with regard to H_{WSI} and G_{WSI} they are positioned in the middle. As they are on average more experienced, they might have an advantage compared to more recently evolving farms. Here, often women are farm heads. However, water management and negotiations have been traditionally undertaken by man. This fact can thus lower the water governance security level of that respective farm type.

The lowest value of G_{WSI} can be determined for the second cluster, the medium-scale farmers. Considering their characteristics, they belong to the group of the most recently established farms. New farmers who have worked before on the state and collective farms might have less individual farm management knowledge, including water management, experience. Remarkably, this group of farmers has the highest hydrology dimension value. In addition, only about 43 % actually paid for water.

In contrast, the lowest H_{WSI} value can be determined for the large-scale producers. In contrast, the G_{WSI} values are highest. Some of the large-scale farmers are still organized as and cultivate on the same land as before 1990. Before 1990, collective and state farms were very much subsidised by the state. After 1990, cotton remained an important export crop for Tajikistan. Therefore, remaining cotton farms were (or are still) supported by local authorities, also in terms of water allocation. For instance, during the cotton season, they are in some cases prioritised in some of the surveyed communities. In contrast, they are also very much controlled by the same authorities, e.g. when it comes to often desired crop changes. This illustrates that de facto water abundance can be lower for some farmers. With a more pronounced water security level in terms of governance, the low level of the hydrology dimension can be seemingly compensated. As 97 % of their production has been sold, they are still able to compete with sufficient agricultural production, which is apparently not limited by a lower level of the hydrology dimension.

Both, medium- as well as large-scale farmers produce irrigation intense crops for the market. Hydrological requirements, however, differ between the crops. Vegetables such as potatoes and tomatoes on average need 7500 - 9100 m3/ha with 15-17 irrigation turns in one seasons in Tajikistan. In contrast, cotton requires a considerable but lower share of water with 6000 m3/ha with 8 irrigation turns in one season. Though, to reach reasonable cotton yields, water flow between June and July has to be very exact and reliable. In this case, a higher level of water governance security is very valuable.

A statistically significant correlation between the two subcomponents, H_{WSI} and G_{WSI}, indicates complementarities in both measures. Most interestingly, whereas such relationship is supported by the data for large-scale and small-scale farmers, for the group of medium-scale farmers there seems to be no statistically significant relationship between the two measures. For them, the governance dimensions have been valued the lowest on average, however, here H_{WSI} is highest. The correlation coefficient in Table 2-4 indicates the question if G_{WSI} and H_{WSI} are necessarily complementary for the different clusters of farmers. Overall, the correlation coefficients are rather low. For small-scale farmers a positive and significant correlation between the two dimensions can be determined. The same holds true for the large-scale and commercial farmers. Interestingly, no significant correlation can be determined for the medium-scale farmers, where the hydrology dimension of water security seems to be outstanding. As this is the group with the lowest G_{WSI} value but still with a considerable share of marketed products, we would assume that where de facto water is seemingly more abundant (high H_{WSI}), G_{WSI} can be substituted by sufficient water availability up to a certain level.

Figure 2-3 illustrates the relation between the two dimensions. H_{WSI} especially in the lower ranges (between 1-3) correlates with an increase in G_{WSI} (linear relationship). This interconnectedness can be identified for the first and third farm type. If the hydrology dimension of about 3 is reached, almost no linear relationship can be determined. This indicates a threshold of the aligning capacity between H_{WSI} and G_{WSI}. In contrast, for the new medium-scale farm type, where there is almost no correlation, the water governance security levels off between 2 – 2.5 after reaching a hydrology dimension level of 2.

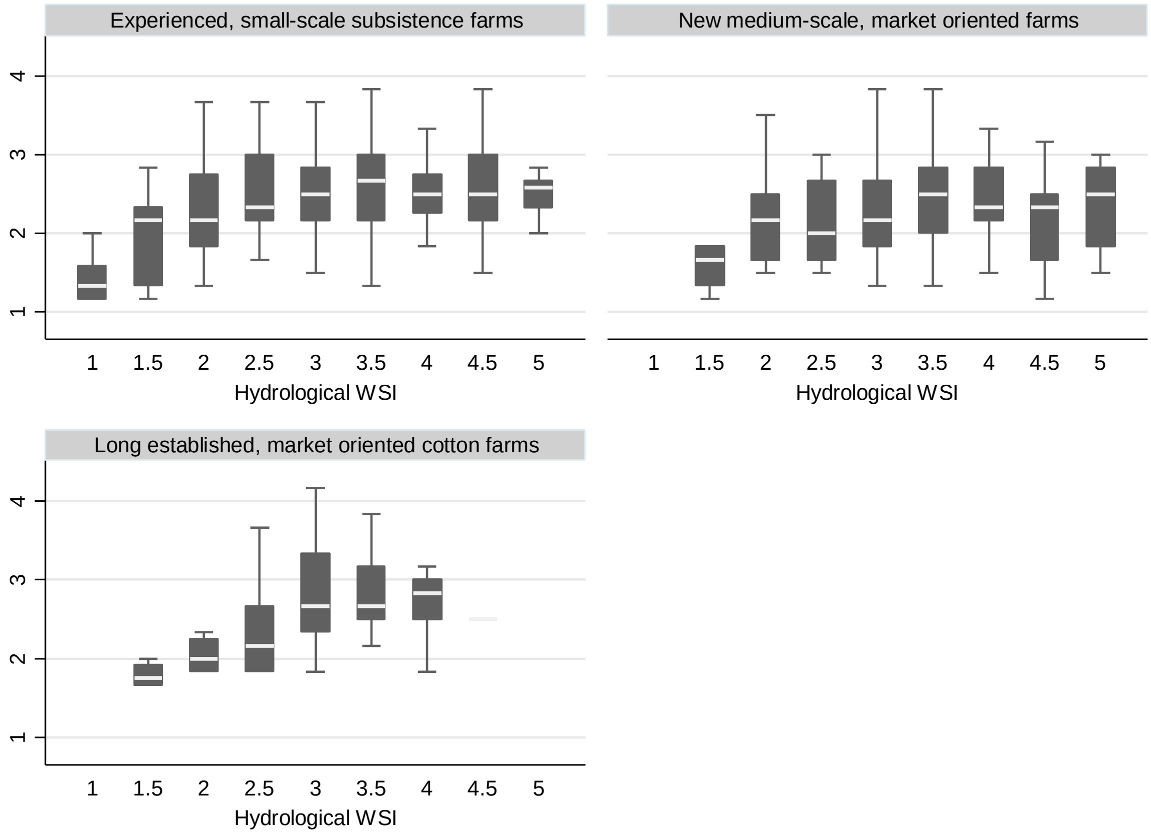

Figure 2-3 Boxplot of hydrology and governance dimensions across farm types

Source: own calculation based on Farm Household Survey 2013

2.4 Discussion

In this paper we analysed three dimensions of irrigation water security that were identified as central for farmers depending on irrigation systems in a semi-arid context, where agriculture is the main income source. The study goes beyond previous studies on regional water security indicators (Jepson 2014) with a particular focus on the irrigation sector. The dimensions and each variable pointed to the (potential) risks of water (in-) security. Similar to water poverty index put forward by Sullivan et al. (2003), our index aims at simplicity. Hence, it can be adapted to other contexts where regional data availability is low.

Obviously, the focus on the agricultural sector comes with the risk of neglecting potential conflict of interest across sectors within one country (Lautze and Manthrithilake 2012). For instance, a high level of water security in agriculture might affect water security for energy production or vice versa. Especially energy is considered an increasing competitor for agriculture, also in the Central Asian context (Scott et al. 2011; Granit et al. 2012).

Jepson (2014) points out that it is important to analyse subjective water security levels alike, because farmers are finally deciding on water use and behaviour. If a farmer perceives to be water insecure, he/she might develop a coping strategy to deal with the perceived limited water availability or even try to avoid certain use practices (Jepson 2014). The limited availability of disaggregated hydrological data imposes constraints upon the analysis presented here, which applies to other studies conducted in similar developing countries, too. This limits the possibility to measure objectively water security at the regional level. Despite these limitations, our index gives for the first time an idea of the hydrological situation of individual farms, here for two selected Tajik regions.

Finally, the cross-sectional household data do not allow testifying long-term impacts, coping strategies regarding sudden disturbances or external shocks. However, we think that the data we use are original to display the de facto situation. From this situation, disadvantaged farmers at a certain time and scale can be identified and addressed.

The following discussion follows upon our initial question, whether the hydrology and governance dimensions are always necessarily complementary. The article does not aim at downplaying one or the other dimensions, rather we wanted to test the fit or unfit of both. Assuming that all farmers in Tajikistan are water abundant is misleading. Overall, farmers are expected to be more resilient when both dimensions overcome a certain threshold of water insecurity. But different levels of the hydrology dimension of water security between farm households were determined. In cases where water is comparably more abundant, it is expected to have the ability to compensate for weaker water governance. As the results show it is also important to look at each dimension separately to interpret the overall aggregated index.

One would assume that the farmers with higher and enhanced hydrological security likewise hold stronger water governance security. Meinzen-Dick (1997), among others, claims that physical improvements to the irrigation system (e.g. lining canals, rehabilitation) provide incentives for the willingness to participate in irrigation management. However, for ongoing participation long-term benefits have to be expected. In addition, participation is labor demanding and not affordable for all farmers. Thus, participation can vary among farmers leading to different governance security levels of farmers. Especially for Tajikistan, investments and active participation is needed to improve the physical infrastructure. The irrigation canals which were constructed during the Soviet period were often not lined. Not lining the canals can be a major hydrological stressor nowadays with long-term effects e.g. on soil salinity. In addition, drainage systems, especially important subsurface drainage to combat soil salinity, were not constructed properly.

As not all groups of farmers are threatened by both dimensions equally, our results do not support the assumption that both dimensions are equally pronounced. Two possible trade-offs are possible. First, if one dimension is less distinctive; the complementary dimension can occur as "coping" mechanism. Second, one dimension could turn less relevant in case the other dimension is sufficiently high and reliable. However, there is no unique direction of causality. For example, governance measures are comparatively low for medium-scale farmers, but here, the hydrology dimension is more distinctive. Given the lowest governance value but still a considerable share of marketed products within this group, we assume that weak governance aspects are substituted by sufficient water availability. This observation is in line with one argument by Meinzen-Dick and Nkonya (2005) who state that when water is abundant, farmers tend to be less concerned about governance issues (such as who else is using the water). However, when water becomes hydrological scarce or the farmer is more relying on on-time irrigation water, such as perceived by the large-scale farmers, governance is seemingly more important and crucial. As the group of large-scale farmers forms the main actor on local and international agricultural markets, these farmers hold the capacity to cope with a seemingly lower hydrology dimension of water security by enforcing their governance situation.

For all three groups we determined that, if both dimensions are lower (between 1-3), a linear relationship exists. But, if the level of the hydrology dimension exceeds 3, a linear relationship with the governance dimension is not valid any longer. Further, water security dimensions of the different farm types are not disconnected (similar as in Jepson 2014). If one farm type holds a more pronounced level of one water security dimension, it is weaker for another farm type. This is not unexpected as e.g. more influential farmers might have the power to exclude others (higher vs lower G_{WSI}). In our case, this other group with a lower degree of G_{WSI}, accordingly has stronger level of water security of the complementary dimension (e.g. H_{WSI}). So there is not always a monotonic relationship.

A non-monotonic relationship could be also identified with the help of the qualitative interviews, where we determined further long-term feedback loops between the dimensions. Here, G_{WSI} was reformed, but H_{WSI} was more difficult to influence. Since 2010 many government initiatives with the help of international donors focus on the establishment of water user associations. However, the de facto hydrological problems (such as increase in water salinity, drought or flood management) are not addressed by these newly established groups. Hence, the active participation in WUAs is low, as improvements of water access and availability are not realized and the hydrology dimension of water security remains low. Thus, the limiting factor, here G_{WSI}, could switch to the other dimension (here H_{WSI}) and hydrological limitations can turn even more relevant in an improved governance situation.

A final aspect to be discussed here is the link between water security and land governance. The group of the most recently established farms perceived the lowest water security level in terms of water governance among all respondents. Another situation can be observed for certain strategically important crops (such as cotton), which are supported by local authorities. Farmers who grow for instance cotton enjoy a higher G_{WSI} (G_{WSI} cotton growers: 2.7; G_{WSI} non-cotton growers: 2.4). However, in the long-run, one has to expect further hydrological threats. The link between land governance and water security has not been studied sufficiently so far. But we expect, similar to Hodgson (2004) and Cotula (2006), that the impact of land use rights become increasingly relevant the scarcer water will be (i.e. H_{WSI} declines). This relationship requires more research.

2.5 Conclusion

Water security is an issue in most arid regions, especially where agricultural production depends on reliable irrigation water flow. In these countries, more extreme events such as floods and droughts are expected to increase hydrological water variability in the coming years. Governance mechanisms would have to act as coping mechanisms. In this analysis water security is defined to consist of different dimensions. Therefore, we also used a multi-dimensional consideration of water security and defined three dimensions: 1) hydrology dimension of water security, 2) governance dimension of water security, 3) hybrid dimension of water security.

Especially the hydrology and the governance dimensions, with its clear conceptual boundaries, helped to point to and prioritize critical aspects of Tajikistan´s water security. The results showed, that different clusters of farmers are threatened by different water security dimensions. Especially water governance security becomes important once the hydrological conditions of water security become insufficient. But in general, the relationship between the governance and hydrology dimensions has to be balanced. Also in cases where water is hydrological available, a proper water governance security is valuable on the long run. It would be valuable to improve the relationship between both dimensions, especially when hydrological conditions are more sufficient.

The hydrology dimension is key to improve agricultural production, e.g. by investing in infrastructure or improvements in drainage canals. This could implicitly cause better subjective water governance security (willingness to invest more, participating more) as farmers directly appreciate improvements in hydrological conditions. But if a certain threshold of the hydrology dimension is reached, implicitly governance security improvements have their limits. Thus, a specific emphasize has to be directed towards improved governance.

As indicated by Sullivan et al. (2003), such a measurement helps policy makers to exactly identify specific factors, where interventions for specific beneficiaries would be needed. However, especially for "donors", their understanding and willingness to invest in both dimensions and not simply take one dimension for granted has to be improved. Of course, for policy makers, it is easier to facilitate improvements in water governance as the hydrology dimension is more static and depends also on natural conditions. However, improvements of the governance dimension might face bigger resistance from the side of previously privileged water users. In turn, improvements of governance conditions could lead to better hydrological conditions as a side-effect.

3 Discrepancies between paper and practice: Tajikistan's property rights and customary claims to land and water[8]

Abstract

Property rights are not always identical with the customary claims that people use as the basis for their actions. Furthermore, customary claims to land and water resources can vary significantly. The objective of this paper is to empirically assess the difference between property rights and farmers' customary claims to land and water resources. After specifying and quantifying the two concepts, we contrast them with each other. With regard to land, actors tend to base their decisions on customary claims and override property rights. With regard to water, we find that the full benefits of property rights are often not recognized.

Keywords: property rights, customary claims, land and water resources, Tajikistan

3.1 Introduction

Across the globe water has become a contested resource and the availability of and access to water play a key role in agricultural land-use options in many arid areas. To ensure efficient and sustainable land and water use, specific governance systems comprising property rights need to be well defined at the national, sub-national and farm level (Binswanger-Mkhize et al. 2011). Accordingly, for irrigated agriculture farmers need to obtain, possess and maintain two sets of rights: one relating to their farmland and one to irrigation water. However, resource use, decision-making and alienation rights differ in their characteristics and in their (transparent) implementation (Bruns et al. 2005; Dinar 2012). Especially transparent implementation is difficult in countries undergoing economic and political reforms, such as transition countries, where rights on paper change more frequently. Beside the fact that the rule of law has changed in many transition countries considerably since 1990 (Feige 1997), the enforcement of laws is often fragile. As a result, Verdery (1997) stresses that fuzzy property exists, where property rights are

[8] This chapter has been submitted in a revised version to the Journal Land Use Policy (currently under review, 04.10.2017) Klümper, F.; Theesfeld, I. and T. Herzfeld: Discrepancies between paper and practice in policy implementation: Tajikistan's property rights and customary claims to land and water.

now often "indistinct, ambiguous and partial" (p.105). However, institutional change constitutes a complex and evolving system.

The property rights approach, as discussed in Bromley (1992), calls for an analysis of rights on paper. However, production practices do not necessarily reflect the property rights which are protected and legally backed up by the state. Farmers may consider customary claims, which are informal but generally recognized, as their reference system. We argue that the more customary claims are in line with property rights, the more security of tenure will increase and that farmers will then invest more in resource management. Hence, productivity increase and sustainable resource use is more likely where rights and claims are congruent. The problem of continual change in formal laws triggers two main questions which we will try to answer in this paper. How do farmers identify their customary claims to land and water and to what extent do these match (or mismatch) with the property rights? In this paper we aim to: 1) conceptualize and map property rights and customary claims from the perspective of various farm types, and; 2) analyze the land and water sectors jointly. The aim and contribution of the paper is set out in more detail below.

Tajikistan is well suited for the study of disentangling property rights and the discrepancies involved in practices of land and water use. In Central Asia, surface irrigation is essential for agricultural production (Akramov and Shreedhar 2012). Since 1990 many structural and institutional problems in the land and water sectors have hindered a more efficient and sustainable agriculture (Rowe 2010; Sehring 2009; Abdullaev and Atabaeva 2012). The continual changes in legislature and the expected discrepancy with customary claims – which even differ among various farm types – indicate a puzzling reference system for the use of land and water.

The remainder of the paper is structured as follows: Section 2 explains the theory of property rights and the differences with the customary claims approach. In addition, the operationalization of the two concepts is presented. In Section 3, we describe the land and water legal frameworks and their reform paths in Tajikistan. After presenting the methodology and introducing the data (Section 4) we analyze the rights on paper and the practices in Section 5. Section 6 discusses the discrepancies and points to differences in customary claims among farm types. Section 7 concludes.

3.2 Bundles of property rights and customary claims

In the following we describe the concepts of property rights and customary claims. Then we elaborate the bundle of rights approach, which is operationalized later. Finally, we derive the hypotheses to be tested in this paper.

3.2.1 Discrepancies between property rights and customary claims

Empirical studies have shown that secure property rights and their enforcement are important for agricultural growth and the welfare of rural households who depend on natural resource use (Bruns et al. 2005; Deininger 2003; Besley 1995; Arnot et al. 2011). The key role of strong property rights, as Alston and Mueller (2008) emphasize, is to empower individuals and provide incentives for investing in a resource in order to maintain its value and to decrease vulnerability. However, there are different concepts of property rights being discussed and analyzed across and within different disciplines.

First we define the key terms to avoid general misconceptions. Bromley (1992; 2006) stresses that *property* is a benefit stream. The related *property right* is “a claim to a benefit stream that some higher body – usually the state – will agree to protect through the assignment of duty to others” (p.2). A resource user holding property rights has duties and enjoys protection. Hodgsons (2014) supports the definition of property rights from a legal perspective, where legal instruments of decision-making and enforcement are approved and granted by an authority.

However, the term *right* is also commonly accepted and associated with the term de facto right (Schlager and Ostrom 1992), which is not a right from the legal perspective (Hodgsons 2014)[9]. We agree with Hodgsons (2014) that the term de facto right is thus somewhat misleading. However, people do also act, invest, and protect a resource due to informal but well-established and widely-accepted rules in use (Ellickson 1986; 1991) and these actions might or might not contravene the law. We propose the notion of *customary claims* to indicate that the regulations “outside” the law are not a right per se. It refers to a reference system which is perceived and generally recognized. We want to differentiate clearly between property rights and customary claims, showing that they can be congruent or not (Schlager and Ostrom 1992; Ellickson 1986, 1991; Alston et al. 2009).

Figure 3-1 illustrates the impact of discrepancies between customary claims and property rights. The resource users’ social context, and endogenous and exogenous influences generate subjective assessments and form their customary claims (Deininger 2003; Wilusz 2010). In addition, formal property rights generate perceptions and affect the customary claims. These are often the perceptions people would refer to if they were asked what backs up their actions. Further, the perception of actor´s characteristics or another actor’s resource or rights often produces an action (Theesfeld 2011). The customary claims can either match or mismatch with property rights. The mismatch can have two different peculiarities. Either customary claims can be overvalued and

[9] For Hodgson (2014) the term de facto right is misleading, and “it obscures the nature and role of real rights in legal and economic systems” (p. 4).

more pronounced than property rights (depicted in Figure 3-1 as PR < CC), or undervalued and less pronounced (depicted in Figure 3-1 as PR > CC). Both peculiarities can result in non-compliant behavior toward rights stated in the law. A discrepancy may be e.g. a result of missing legal knowledge and knowledge transfer (Ellickson 1986). But it can also be a deliberate infringement due to stronger adherence to customs and customary resistance or a lack of trust in government.

Finally, we assume that a mix of customary claims and property rights determines the "habituated actions or "domains of choice" (Bromley 2006, p.44; p.50). This results in different impacts of congruent and non-congruent relationships. For instance, more compliant behavior, which means that actions would be backed up by the law, can lead to long-term investment and thus to increases in productivity. Non-compliant behavior is assumed to increase insecurity and monitoring costs (Leitzel 1997). The outcomes of very strong customary claims can vary. In the future, they could be completely disregarded by policy makers or even lead to institutional change.

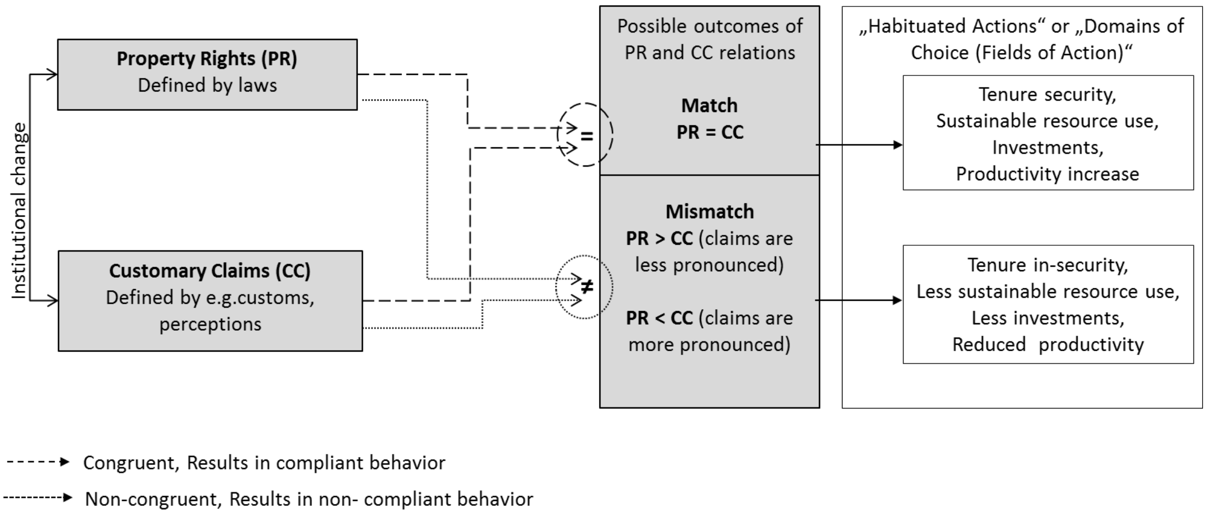

Figure 3-1 **Evolution and impact of discrepancies between property rights and customary claims**

Source: Own Figure

3.2.2 Bundle of Rights as a Quantifying Tool

Arnot et al. (2011) provide a literature review of definitions and measurements for the analysis of property rights for land and tenure security. Most commonly, property rights are measured using one output variable for a legal situation, such as holding a land title (see e.g. Smith 2004; Alston et al. 1996; Bellemare 2013), or the number of titles issued and awareness of rights (Bending 2010). Beside measuring land titles as a proxy for formal rights Bellemare (2013), for instance, measures informal rights by using different dummy variables for the landowner's perceptions of transfer and use rights. Bubb (2013) measures the household's perception of the bundle alienation rights. However, he neglects decision-making and use rights. Another common operationalization of customary claims is presented by van Gelder (2007; 2010), Bending (2010), and Broegaard (2005), where farmers´ perceptions about the likelihood of future resource conflicts, such as expected land reallocation or the probability of losing land, are assessed. In summary, a single proxy or dummy variables are usually used to study either land or water rights.

To overcome the simplified operationalization of a single proxy such as land titles (Broegaard 2005), we quantify the bundle of rights approach by Schlager and Ostrom (1992). The bundle of rights' approach is rarely used to quantify both property rights and customary claims jointly. However, the Rights and Resources Initiative (RRI) (2012) published an operationalized bundle of rights approach, where tenure rights among countries are compared. However, local customary claims are omitted.

According to Meinzen-Dick and Mwangi (2009) we grouped the bundles of rights in three main categories, where each category is characterized by case-dependent bundles, as given below:

1) Use rights: include e.g. access, withdrawal and exploitation rights of resource units. Holding these rights can increase incentives to invest in a resource.

2) Control and decision-making rights: include e.g. management, exclusion and negotiation rights. Holding these rights gives the user power and authority regarding the resource unit.

3) Alienation rights: restrict e.g. rent, selling and transfer rights. These rights can also lead to income generation and increase incentives to invest.

The bundles of rights approach is meant to overcome the oversimplified consideration of resource rights (Alchian and Demsetz 1973), which we criticize in the paper. We further talk of, for instance: 1) access rights, meaning the property rights mentioned in the law, and; 2) customary access claims, stressing also the perception of the farmer which can potentially lead to certain resource use practices.

We think that the best approach is to study property rights and customary rights systematically, allowing for comparisons. The bundle classification allows for case-dependent adaptability. To consider various bundles per se also helps to find nuances among resource users. We operationalize the equivalent bundles for property rights and customary claims to be able to further quantify the discrepancies. In addition, the same groups of farm types can be systematically assessed with regard to land and water. Hence, we are able to ascertain whether an actor is more powerful in terms of strong customary claims and whether this perceived power applies to the land or water sector.

3.2.3 Hypotheses

Land and water governance share similarities in that their institutional environment can be dynamic, especially under resource scarcity and the influence of exogenous pressures on the resources such as population growth, technology development, and political and economic reforms (Alston and Mueller 2008). However, water and land resources differ in their physical characteristics which lead to different institutional requirements. Due to the dynamic physical nature and mobility of water resources it is more difficult to define concrete property rights (Garrick et al. 2013). The high water variability within and between the seasons makes it more complex for users to define rules either on paper or in practice (Bruns et al. 2005). The reasons for this are enforcement and recognition problems (geographical or sectoral), and high variability in availability (Meinzen-Dick 2014). By contrast, land is a static resource and the definition of land rights in laws, inheritance and transfers is much more detailed in many countries than that of water (Hodgson 2004; Cotula 2006). Our first contribution is to analyze the land and water sectors jointly. To date, especially for transition countries, most studies have dealt with land and water property rights separately. We think that, by considering the nexus of resources, we can specifically determine: 1) if land and water rights are equally perceived by the farmers; 2) if one reform is more transparent than the other; 3) if differences among farm types are the same for both resources and which group of farmers is more powerful and has better access to one of the two resources. Furthermore, a systematic analysis of land and water property rights and claims has not yet been applied to the case of Tajikistan. In Tajikistan, individual bundles of rights have been defined over time by different land and water reforms since 1990 (Rowe 2010, Lerman 2012). However, implementation differs between the two sectors.

Thus, we formulate Hypothesis 1:

Hypothesis 1: Customary claims of land resources are more pronounced than customary claims of water resources.

Discrepancies between property rights and claims are omnipresent, but may be of different degrees. We identify three possible identities between rights on paper and in practice. First, we argue that property rights and customary claims can overlap exactly. In this case, the system is more robust and bears fewer risks for farmers than in a conflicting situation. In an overlapping situation farmers´ customary claims are conform to property rights and safeguarded by state legislations (Schlager and Ostrom 1992). Hence, farmers are more willing to invest in sustainable resource use and can increase productivity (Schlager and Ostrom 1992; Gibson et al. 2002). Second, we identify a case where property rights are defined, but customary claims are at a minimum. This is not to be understood as a complete lack of (all) perceived bundle claims, rather that claims are less pronounced while rights are well-defined. Here, farmers do not exploit their full potential to increase productivity (Barsimantov et al. 2011; Bellemare 2013). This is similar to the case where duty bundles are less pronounced, for instance if water management claims are not being perceived as a duty. In this case actual management activity is minimized. In the third category, property rights are not provided to farmers but farmers actually perceive strong customary claims. Consequently, they claim something which is not provided by law. In this situation, actions would not be backed up by the law. Using this analysis, we intend to contribute to the growing literature on property rights, which is still inadequate with regard to actually measuring the discrepancy between property rights and customary claims. Additionally, we aim to conceptualize and map rights and claims from the perspective of various farm types. The core of the analysis builds an operationalizing and quantifying procedure which is finally able to assess the discrepancy between property rights and customary claims for each individual rights type.

The discrepancy between formal and informal rights is extremely high in transition countries (Theesfeld 2004). In Tajikistan, attempts to legally control and regulate the agricultural sector have taken place but the Tajik land and water sectors still face obstacles in de jure implementation. Since independence, property rights have been continually established for both resources as described below; however, implementation is not equally realized across locations, farmers, and resources (Sehring 2009; World Bank 2012; Akramov and Shreedhar 2012). The World Bank (2012) also show that farmers often mistrust the decision-making processes of the official water or land authorities.

Accordingly, we derive Hypothesis 2:

Hypothesis 2: A discrepancy between property rights and customary claims is expected, which is mainly characterized by customary claims being less pronounced although property rights are defined.

As farm restructuring in Tajikistan is ongoing and more individual small-scale farmers rush into the land market, land becomes scarcer and competition increases (Hofman 2013). Due to the need for irrigation, water is also in higher demand. Larger farms are the main actors in the land and water sectors. In particular they can build on their farm management experience and decision-making power stemming from the time of the Soviet collective farms (Lerman and Sedik 2008; Hofman 2013). Based on observations by these authors among others, it is expected that the larger farms which have been the least restructured possess the best networks and influence to enforce the implementation of laws. Therefore, we assume the former collective farms´ past is still decisive for post-Soviet resource management. Furthermore, those farmers who act according to structures corresponding to the time of the former kolkhozes often have stronger ties to local government. They can even establish interest groups, which may result in more influence over the implementation of property rights at the local level (see also Olson 1982) while also holding stronger customary claims. Individual household farms are significantly smaller than reformed kolkhozes. Therefore, farm size and farm type can be used interchangeably.

We derive Hypothesis 3:

Hypothesis 3: The customary claims of the operators of larger farms are more pronounced for both land and water.

3.3 Tajikistan's agricultural sector

Tajikistan is the smallest of the Central Asian countries in terms of population with around 8 million people in 2012 and an area of only about 140,000 km^2 (World Bank 2014a). The limited arable area, which makes up only 6 % of the country's area and is equivalent to 0.1 hectare (ha) of arable land per capita,[10] is mainly located in the lowlands of the Vakhsh and Syr Darya river basins (McKinney and Daene 2004). Precipitation varies greatly among the regions and is highest between September and April. Due to low precipitation in the lowland areas, 85 % of the arable land is irrigated (Akramov and Shreedhar 2012). Especially in the lowlands, where surface water is mainly used, irrigation schemes play a central role in the cotton production of large-scale farms, the commercial crop production of peasants, and in households' food security. In the irrigated lowlands the main crops are cotton, rice and vegetables, whereas in the dry land areas wheat production dominates (FAO 2013). The availability of water in the canals depends very much on the season. Farmers need to cope with the risk of high annual variability ranging from too much water due to meltwaters in spring time to water scarcity in late summer. According to Bucknall et al. (2003) 60 % of the water used for irrigation is pumped from rivers or reservoirs to the canals. The common irrigation technique on a farm and between farms is gravity irrigation.

3.3.1 Reform paths in the land and water sector

After the breakdown of the Soviet Union, the organizational structure of land and water resources changed fundamentally from a centrally planned and state controlled system to decentralized, or even individually managed, systems. Before 1990 all farm land was allocated to kolkhozes (collective farms) and sovkhozes (state farms), which controlled the land and water sectors jointly. They were responsible for the distribution canals between the farms and for on-farm canal maintenance (Hill 2013). The off-farm canals and pumps were controlled and financed by the state authorities. Linked with investments in irrigation infrastructure, large-scale cotton production was introduced during the Soviet time (Rowe 2010). At that time the major share of farming

[10] Compared to (in ha/cap): Uzbekistan: 0.15; Kazakhstan: 1.45; Kyrgyzstan: 0.24; Russia: 0.86 (World Bank 2014b)

activities was targeted toward and organized around the cotton sector and cotton farms had the major influence on the management and control of land and water resources. Cotton is still the dominant crop in the lowlands, producing 60 % of the agricultural output and it is still the leading agricultural export crop (FAO 2013). In 2007, cotton farms used 45 % of the irrigated area in Tajikistan (The Government of Tajikistan 2007).

After 1990, the land and water sectors were affected by very different reforms. Both resources have remained state property. For land, only transferrable (leasing but not selling) rights and inheritable use rights for unlimited time[11] exist (Akramov and Shreedhar 2012; Lerman 2013; World Bank 2012). Land and water sector reforms resulted in two strongly-related challenges for farmers. The first is that the responsibilities of the land and water sectors are separate. The various subsequent reforms have not altered this situation. The second challenge concerns the opaque administrative structures from the farmer's perspective which result from the decentralization of decision-making units (Hill 2013). Although at the national level authorities are defined to manage land and water, farmers at the local level have to refer to multiple responsible authorities which leads to unstandardized management and organization practices (Hill 2013; Sehring 2009).

Comparing the land and water sectors since 1990 (see Table 3-1 and Table 3-2) there have been fewer attempts at, and less enforcement of, reforms in the water sector than in land sector.

Table 3-1 Legal framework and responsibilities in the land sector

Land Sector	
Legal Frameworks	
1st phase (1991)	*Law on Land Reform* (1991): restructuring process from state and collective farms to commercial peasant farms (*dekhan farms*), allocation of land to individual households and former state/collective farm workers.
2nd phase (1996)	*Land Code* (1996): enforcement of the restructuring process to individual farming in 1996 (Akramov and Shreedhar 2012; Lerman and Sedik 2008; Robinson et al. 2008).
	Land reform process remained very slow[12] (Lerman and Sedik 2008). Especially in the cotton growing areas, where investors and rayon administration remained the most powerful in land distribution (Bliss 2010).
	Presidential Decree (1995, further continued in 1997): allocation of presidential land[13] to the very poor.

[11] This is a middle position in Central Asia, between private ownership in Uzbekistan and state control in Turkmenistan

[12] For instance, Hofman and Visser (2014) show that in the two main agricultural regions Sughd and Khatlon, only 9.7 % and 17.4 % of arable land was attributed to dekhan farms in the year 2000.

[13] Presidential land plots are often marginal or unused land, often far from irrigation infrastructure. In total, 75 000 ha land were allocated to households by the Presidential Decree.

3rd phase (2002)	*Law on Dekhan Farms and the Law on Freedom of Farming* (2002) Right to get long-term use rights with formal land certificates. Foreigners can lease land for up to 50 years . Duties have to be fulfilled: paying taxes and cultivating efficiently (Robinson et al. 2008If duties are not fulfilled, the Land Committee can withdraw land. The determinants of inefficiency are not further defined in the Land Code. In 2007, 45 % of arable land was restructured, increasing decline of state and collective farms.
4th phase (2009)	Major push in land reform In 2009, about 75 % of arable land was cultivated by private dekhan farms or household plots (Akramov and Shreedhar 2012). Freedom to Farm Decree: free crop choice was introduced, moving away from cotton quotas[14] (Governmental Decree of the Republic of Tajikistan number 111). Cotton debts[15] were officially abolished (van Atta 2009).
Responsibilities	
National	Land Committee is the main body to apply for land certificates (Hofman 2013) International donors and NGOs are involved in the land reform process
Local	Land Committee representatives at the regional and district levels (Hofman 2013)

Source: Own Elaboration, References indicated in the table

Land reform is still ongoing and is the focus of attention of agrarian reforms. Farm households' knowledge of individual land rights was, and still is, described as limited (Mandler 2013; Akramov and Shreedhar 2012; World Bank 2012).

Past reforms led mainly to three new farm structures: collective farms; dekhan farms (peasant farms);[16] and household farming (Lerman and Sedik 2008). Collective farms rarely exist on paper any longer (Lerman 2012); according to the Land Committee, they used less than 6 % of agricultural land in 2013. Dekhan farms have increased tremendously since 2007-2008 and the Land Committee reports that there were already 86 000 in 2013 on an area of more than 500 000 ha. About 40 % of registered dekhan farms cultivate less than 2 ha, another 40 % 2 – 10 ha and only about 20 % more than 10 ha.[17] In 2009, almost 20 % of arable land was used by household

[14] The law on "freedom of farming" was introduced to transfer decision-making on crop choice to farmers. Previously, authorities enforced quotas on cotton. These quotas regulated that at least 70 % of agricultural land had to be cultivated with cotton. Cotton quotas had a major impact on the increasing debts in the agricultural sector.
[15] The kolkhoz accumulated high debts during the mid-1990s. The majority of cotton farms inherited high cotton debts when their farm was individualized from the former kolkhoz. These debts even increased with the ongoing contracts with cotton futures companies/ginneries. In 2009 the government offset the debts (van Atta 2009).
[16] *Khojagi-i-Dekhoni* : peasant farms defined as individualized, private farms. Official organizational forms are 1) Collective dekhan farms, 2) individual dekhan farms, 3) family dekhan farms (Robinson et al. 2008; World Bank 2012).
[17] All figures on dekhan farms have to be handled carefully; numbers vary a lot between sources. Here, numbers are taken from an interview with the Land Committee conducted by the author in 2013. Literature

(garden) plots. Garden plots were cultivated by 750 000 households with an average size of 0.3 ha (Lerman 2012). A further 75 000 ha were distributed by Presidential Decree number 342/874 to some of the poorest households.

Table 3-2 Legal framework and responsibilities in the water sector

Water Sector	
Legal Framework	
1994	*Constitution of the Republic of Tajikistan* (1994): water was owned exclusively by the state; the state was responsible for the protection and effective use of water resources.
1996	The *Water Code* (1996, 2000), developed by the Ministry of Melioration and Water Economy (MMWE), defined the property rights (UNECE 2012.)
2006	*Law of the Republic of Tajikistan on Water User Associations* (WUA) (2006): aimed at irrigation management transfer to non-commercial forms of organizations such as WUAs (Yakubov and Hassan 2007).
2007	The latest law in 2007 announced an Irrigation Service Fee for gravity-irrigated areas only of US$2.25 for 1,000 m3 and US$3.65 for 1,000 m3 for lift-irrigated areas (World Bank 2012).
Responsibilities	
National and province	The MMWE: responsible for the management of large-scale infrastructure, for (basic) maintenance and for formulating regulations (Rowe 2010); The MMWE is further decentralized to the province level, but has limited influence in irrigation management.
District	Vodkhoz (State Water Resources Department). Other appointed officials of the district handle main irrigation tasks, implement national policies and are responsible for primary canals.
Sub-region	The jamoats (communes/ sub-district authorities) have essential operational and management tasks with certain decision-making powers via scheduling water access; (Sehring 2009; World Bank 2008).
	Increased number of WUAs (often within administrative boundaries). Aim of WUAs: non-profit organizations, responsible for the operation and maintenance of inter-farm level canals, operation within hydrological boundaries (UNECE 2012; Sehring 2009; Yakubov and Hassan 2007).
Local	Water Master (Mirob), at the regional and village level who was already deeply rooted in the pre-soviet water management and also adapted and formalized during kolkhoz time, often still responsible for scheduling and water allocation between farms.
	In some villages, water is organized more informally through the village elders committees, who also organize e.g. neighborhood work in water management originating from pre-Soviet time (World Bank 2008).
	Farmers, some as members of the WUA, fulfill operational and maintenance tasks of secondary and tertiary canals in addition to collecting water fees.

Source: Own Elaboration, References indicated in the table

revealing the number and farm size of dekhan farms mostly rely on statistics between 2005 – 2010 (see for instance Lerman and Sedik 2008; Lerman 2012) but as the main land reform process only started in 2010, more recent numbers better capture the current situation.

Although reforms have taken place and formal responsibilities are defined, many challenges remain in the water sector. More than 50 % of gravity systems and pump stations have deteriorated, which makes the irrigation system inefficient (Akramov and Shreedhar 2012). Most (64.8 %) of the on-farm canal networks are unlined earthen canals which suffer from poor maintenance (Frenken 2012). With respect to the Syr Darya basin, Stucker et al. (2012) report that, due to poor irrigation infrastructure, overall water loss reaches almost 79 %. Up to 65 % of water losses occur between the source and the farmland. Furthermore, a water use efficiency of only 55 – 70 % is reported at the field level (Frenken 2012, p.155).

3.4 Methodology and data

In order to operationalize both concepts of property rights and customary claims for the case at hand, we used quantitative and qualitative data. Here, data for property rights and customary claims were gathered from those who establish the rights/claims. Thus property rights data were gathered at the administrative level. Whereas we collected data on customary claims via a survey at the farm household level. We used a two-step approach for property rights. First, we analyzed secondary data, which were taken from the land and water codes, the two legal frameworks of each sector in Tajikistan. Second, we discussed these findings in expert interviews with members of the official land and water authorities to confirm their validity (eight interviews with authorities of land and water sectors, four focus group discussions with members of regional authorities/WUA). We analyzed the customary claims based on farm household survey data. For both, property rights and customary claims, exactly the same bundles of rights were used (see Table 3-3, columns 2-4). In addition, we used similar evaluation and coding criteria. We deliberately did not provide a dichotomous answer set in the survey.[18] However, although farmers were able to give nuanced answers, rights in the land and water codes were, of course, more precisely defined and the same scale could not be applied for the property rights evaluation. For this, we used a 3-point scale, where one medium category was integrated which determined rights given only with limitations (or occasionally). This is discussed in the results.

Finally, we derived two ordinal scales (see Table 3-3, columns 5-6) treated as quasi-metric to further calculate the discrepancies. We could then determine the match and mismatch between the two concepts.

[18] First, our aim was to determine the nuances between yes and no. Second, we conducted a pre-test of the survey, where we also provided dichotomous answers. However, in these cases farmers often neglected to answer as they were not able to either say yes or no. Each question was formulated similarly to: “Can you (in terms of are you allowed to) access, withdraw from, etc. water/land?”

Table 3-3 Operationalization of the bundle of rights (property rights and customary claims)

	Name of the Bundle of Rights (property rights/ customary claims)	**Land Variables (property rights/ customary claims)**	**Water Variables (property rights/customary claims)**	**Property Rights, *Possible* outcomes for each land and water variable (Source: Land and Water Code)**	**Customary Claims, *Possible* outcomes for each land and water variable (Likert scale) (Source: Survey data)**
Bundle of rights evaluated	Use Rights/ Claims	Access Withdrawal Land-use-change	Access Withdrawal Unlimited-use	1 = never hold the right 3 = have the right occasionally (with limitations) 5 = have the full rights (always)	1 = never hold the claim 2 = rarely hold the claim 3 =occasionally 4 = very frequently 5 = always
	Control and Decision-making Rights/ Claims	Management Investment Exclusion Income-Generating	Management Investment Exclusion Reallocation Negotiating		
	Alienation Rights/ Claims	Reallocation Sell Leasing Inheritance	Sell		

Source: Own Elaboration

The identification of the farm household sample was based on a stratified random selection. First, two districts were non-randomly selected. Both districts are among the main agricultural lowland areas in Tajikistan, with direct surface water access within the two main river basins Vakhsh and Syr Darya. Both districts are close to the two provincial capitals Khujand and Qurgonteppa. Second, in each district we selected all jamoats (commune). Within each jamoat we randomly selected one village and finally households within villages were randomly selected according to the selection criteria of Bennett et al. (1994).[19] Farm households were only selected if they had used irrigation water and farmland for at least two years. We ended up with a total sample of N = 399 farms consisting of 222 in one northern district (Bobojon Gafurov) and 177 in one southern district (Bokhtar). The sample population consisted of household and presidential decree farms, as well as dekhan farms of different farm sizes.

To map the farmers´ customary claims we used, in a *first step*, descriptive statistics for each bundle stick.

[19] Villages were randomly selected with lists. For farm households standard random selection with lists is not possible, which is a typical problem in developing countries (Bennett et al. 1994). Official farm household lists are not available for all villages. Therefore we used a quasi-random selection introduced by Bennett et al. (1994). Here the enumerator starts in the community center, chooses a random direction and selects the first household in this direction. The following houses are randomly selected along that route (Bennett et al. 1994, p.1282).

In the *second step,* we aimed to compare the customary claims with the property rights. We calculated a variable "discrepancy between property rights and customary claims" as follows. (In Table 3-4 the scale and the characteristics of the discrepancy variable are presented.)

Variable "discrepancy" = Variable of property rights (e.g. access rights with possible values 5/3/1) – Variable of customary claims (e.g. customary access claims with possible values 5/4/3/2/1)

Table 3-4 Scale and characteristic of the variable "discrepancy"

Scale	**-4 -3** ←	**-2 -1**	**0**	**1 2**	**3 4** →
Category	**High mismatch**	**Medium mismatch**	**Match**	**Medium mismatch**	**High mismatch**
Description and direction of discrepancy	Do **not** have the property rights, but hold customary claims	Do **not** have the property rights or hold them with limitations, but hold customary claims	No discrepancy, property rights = customary claims	Have property rights with limitations, but do not hold customary claims	Have property rights, but do not hold customary claims, do not maximize their respective potential

Source: Own Elaboration

In the *third* step, we aimed to analyze any possible differences in customary claims among farm types. For data reduction reasons, we grouped each bundle (see Table 3-3, column 2). Each bundle index was operationalized according to the theory construct of the bundle of rights. We decided to separate investment rights for water from the control and decision-making bundle as it was less correlated with the other items. The internal reliability of the scales of each index was tested with Cronbach's Alpha and inter-item correlation.[20] Descriptive statistics for the four groups of different farm sizes within the described categories were applied. Kruskal Wallis tests were undertaken on the data for each index to determine whether the values across the four farm types differed significantly.

We defined four farm types as follows: the household plot users and the presidential decree land-users as the smallest farming unit. Both focus on subsistence farming and formed the first group of farm types. The dekhan farms, as commercial farming units, were further categorized according

[20] The items were considered to represent the bundle of rights. We suggest that alpha values of 0.5 – 0.7 are still acceptable (Streiner 2003; Schmitt 1996). The low value is acceptable as the index only contains small numbers of items, and only a 5-point scale is used. Using the index in any econometric analysis would require stricter assumptions. For our analysis it is more important to keep categories as suggested in the theory (Streiner 2003; Schmitt 1996). We derive the following indices according to the bundles in Water use rights (Cronbachs Alpha 0.6294); Water control and decision-making rights (Cronbachs Alpha: 0.5794); Water investment rights; Water alienation rights; Land-use rights (Cronbachs Alpha: 0.5406); Land control and decision-making rights (Cronbachs Alpha: 0.7052); Land alienation rights (Cronbachs Alpha: 0.7481). Only with regard to the index water use rights, we dropped one item "water appropriation" as correlation reports a number close to zero.

to the size of farmland into three groups of farm types.[21] Table 3-5 summarizes the main characteristics of the four farm types identified. The average farm size for each farm type surveyed was low. For the larger farms, women were often employed as seasonal farm workers during the cotton season. The biggest difference in crops produced among farm types was that the larger the farm, the more cotton and wheat were produced (65 % of dekhan farms > 30 ha produce cotton). Other crops produced by dekhan farms were onions, potatoes, tomatoes, orchards fruits. Households and presidential land users mainly produced tomatoes, potatoes, cucumber and orchards fruits for subsistence.

Table 3-5 Farm type´s characteristics for Bobojon Gafurov and Bokhtar district

	Household/ Presidential Land (N = 261)	**Dekhan Farm < = 5 ha (N= 103)**	**Dekhan Farms > 5-30 ha (N = 18)**	**Dekhan Farms >= 30 ha (N = 17)**	**Total**
Farm size (in ha), mean (sd)	0.1 (0.08)	1.2 (1.1)	15.2 (8.3)	105.1 (107.4)	*5.53 (30.32)*
Number of people working on the farm, mean (sd)	3.4 (2.1)	5.2 (3.9)	13.9 (7.1)	93.9 (106.1)	*8.21 (28.21)*
Share of women working on the farm (%)	61.76	55.77	70.50	61.87	*61.02*
Years of cultivating this land (up to 2013), mean (sd)	42.3 (31.7)	31.4 (33.0)	20.3 (22.2)	39.2 (26.9)	*38.4 (31.9)*
No. of household members, mean (sd)	8.7 (4.5)	7.6 (3.9)	9.4 (5.5)	9.5 (4.3)	*8.51 (4.39)*

Source: own calculation based on Farm Household Survey 2013

3.5 Empirical results

In the following, we present our results in accordance with our three hypotheses.

3.5.1 Description of property rights and customary claims

First, the property rights and customary claims are presented individually for the land sector and subsequently for the water sector (Table 3-6, columns 3-6). We continue by describing the match and mismatch between property rights and customary claims as displayed in Table 3-6 (last three columns).

Land rights: paper and practice

Land property rights are more highly specified in the land code than water rights are and more rights are legally transferred to the farmers. Investment, reallocation and land-use change rights

[21] We are aware of different dekhan farms types currently present in the Tajik context. However, as self-classification of farm types is difficult, and a respondent could not indicate any differences between different legal forms of dekhan farms, using official farm types as indicated on the certificate is not useful.

are limited. The latter can also be connected to the law on dekhan farms, for instance, where it is stated that all land has to be always used efficiently. If large-scale land-use change is intended by the farmer, he/she needs to apply to the local land committee. The rights that are not transferred (e.g. selling rights) or transferred only with limitations (e.g. investment rights) illustrate, especially for dekhan farmers, some contradictions to the law on the freedom of farming.

The results in Table 3-6 (columns 4-6) show that farmers perceived customary claims to be overall stronger for land than for water (mean values > 3.1). The group of customary land claims shows a high standard deviation around the mean for most bundles. The variables, exclusion and reallocation claims, are important factors pointing to perceived power regarding the resource use. For instance, exclusion rights were perceived by 46 %, however, 42 % never felt they had an exclusion claim. This may exemplify different endowments with power, where one group perceives this right but another group does not.

Although it is often stated (e.g. in Rowe 2010; World Bank 2012) that getting access to land is difficult for Tajik farmers, strong customary access claims existed in most surveyed cases. Nevertheless, about 59 % of the surveyed farmers stated that they could not get access to *more* land in the future. The main limiting factors to getting more land are the high costs of land (30.8 %), lack of capacities/manpower (24 %), and lack of knowledge about which authority to contact (11.2 %).

Customary land-use change claims are possessed occasionally, but the results further show a high standard deviation, where about 35 % perceived this claim less than occasionally. Our first explanation is that some larger farms still faced fulfilling some quotas, e.g. for cotton, which limited the right to possession. Thirty-one percent of the dekhan farms felt obliged to produce cotton and, even more surprisingly, 10 % of the dekhan farms reported an obligation to produce orchard fruits. Production of orchard fruits was also seen as limiting perceived land-use change claims during an interview in Bobojon Gafurov, where regional authorities prohibited the cutting of non-yielding fruit trees on a dekhan farm's 2 ha area. The second assumption for the high standard deviation in customary land-use change claims can be explained by the characteristics of those surveyed household plots which mainly produced staple food crops. This form of production only allows for limited land-use change options for the household since subsistence needs to be assured.

Water rights: paper and practice

In the Tajik context, only access, withdrawal and investment rights are transferred to farmers without limitations. All other rights are either given with limitations or not provided at all. Limitations in this regard mean that local water sector authorities are assigned control tasks and limit the farmers' decision-making power. For reallocation and negotiation rights for instance, farmers cannot individually control the volumes available in the canals. Local water authorities need to fulfill the task of up- and downstream water distribution. In particular, control and decision-making rights, which are currently being transferred to WUAs, are still very limited. Compared to land rights, the water sector has more limitations by law.

Overall, the customary water property claims are less pronounced compared to land. Apart from the customary claims to access water, no other property claims were perceived more than occasionally. In general, the data presented in Table 3-6 (columns 4-6) show especially low values for customary control and decision-making claims. Less pronounced claims were related to the diversity and uncertainty of responsibilities in the irrigation sector. Half of the respondents stated that they did not know who was responsible for canal maintenance. Such a high degree of unawareness would very likely be linked to the bad condition of many canals. Beside irrigation canal management, old and destroyed drainage canals constitute a major concern for farmers. In the case study areas, interviews confirmed that the lack of proper drainage canal management, which leads to a rising groundwater table and an increase in soil salinity, limits production potentials and even forces farmers to abandon land.

The results of customary water investment and management claims show a high standard deviation around the mean. Therefore, we can assume that a certain number of farmers were willing to contribute money and labor to improve the system. It is interesting to look at differences between up- and downstream users. Forty-six percent of the downstream users had well-pronounced investment claims, compared with only 37 % of the surveyed upstream users. Improvements in local maintenance downstream are obviously of less value if upstream users do not invest.

The variable customary unlimited-use claims are occasionally perceived. Again the mean value has a high standard deviation. For dekhan farmers, irrigation schedules to limit water volumes have to be established formally, however, our results indicate the potential presence of free riders neglecting the general schedule system. This could be either because they were not part of the negotiation process, or because they simply disregarded the regulations. Concerning the regulation of water volumes, 31.5 % of the respondents claimed that it was their independent decision to decide about water volumes used per irrigation turn. Other actors of regulation mentioned were the State Water Resources Department (Vodkhoz) (19.25 %), WUAs (17.25 %), Jamoats (14.75 %), and Local Large Farms (10.5 %). However, 6 % of the respondents were unable to name the actor in charge.

3.5.2 Discrepancies between property rights and customary claims

The discrepancy values are indicated in the last three columns of Table 3-6 (means, medians and standard deviations).

Overall, the discrepancy values in the land sector indicate more conformity between customary claims and property rights (means and medians = 0 in 5 bundles). But we also find non-conformity in the sense that property rights are not followed but rather abused. This indicates, for instance, enforcement problems which are indicated by a negative sign. This shows that property rights are by law either not defined or defined only with restrictions. However, the surveyed farmers indicated well-pronounced customary claims, which would result in non-compliant behavior. A high discrepancy is given for exclusion and selling, indicating that farmers perceived customary decision-making claims and therefore perceived more power than provided by the law. However, we determined a high standard deviation for the discrepancy variables, which stresses that there is an unequal distribution of farmers complying and not complying with the laws. The interviews further showed that informal land distribution, that is selling land informally to others, took place. Informal land transfers are one option for not going through the more expensive and complex procedure of getting land-use titles. To circumvent access barriers, 14 % of the surveyed farmers rented land unofficially, which also indicates an informal land reallocation process among farmers.

The opposite discrepancy situation can be determined between water rights and customary claims. Most of the discrepancy values, except unlimited use, exclusion and selling, have a positive sign. This means for most bundles that a mismatch exists where property rights were given but customary claims were not held. This shows a lack of law implementation and lower awareness of farmers regarding their water rights, especially with respect to exploiting the full potential of using the resource. Without customary claims in this case, less investment and maintenance will be undertaken, so limiting productivity increases and long-term sustainability efforts.

The results of the discrepancy value unlimited-use rights show an intermediate (-2) discrepancy. This indicates that on average farmers, whether deliberately or not, contravene the law with regard to unlimited-use rights. The result indicates that formal institutions were less strongly enforced in this case. Almost all watersheds, villages or groups of farmers (should) set up yearly or monthly schedules for water use so that overuse of water by certain users cannot occur. Moreover, these schedules are especially important for cotton farmers, due to the water requirements of cotton throughout the year. The schedules are often set up by the Water Master, the jamoats or WUAs. The interviews with jamoats and WUAs illustrated that the power to decide to use water in an unlimited way, neglecting the regulations, was unequally distributed between farmers. Those farmers in the focus group discussions, who stated that they had continued for several years as a kolkhoz growing cotton, enjoyed more unlimited water use. These farmers were either the decision makers within a WUA or had strong ties to the Water Master, giving themselves a certain unassailability.

Table 3-6 Property rights and customary claims

		Property Rights	Customary Claims			Discrepancy Values between Property Rights and Customary Claims		
Bundle Name	**Variable**	**value**	**mean**	**median**	**sd**	**mean**	**median**	**sd**
Use Rights/ Claims	Water Access (Use)	5	4.14	5	1.38	.86	0	1.38
	Water Withdrawal/ Appropriation	5	1.39	1	1.07	3.61	4	1.07
	Water Unlimited-use	1	3.33	4	1.72	-2.33	-3	1.72
Control and Decision-Making Rights/ Claims	Water Management	3	2.29	1	1.68	0.70	2	1.68
	Water Investment (e.g. in Infrastructure or in Quality)	5	3.41	4	1.73	1.59	1	1.73
	Water Exclusion	1	2.44	1	1.72	-1.44	0	1.72
	Water Reallocation	3	1.54	1	1.23	1.46	2	1.23
	Water Negotiate	3	1.40	1	1.11	1.60	2	1.11
Alienation Rights/ Claims	Water Sell	1	1.12	1	0.61	-0.12	0	0.61
Use Rights/ Claims	Land Access (Use)	5	4.78	5	0.78	0.22	0	0.78
	Land Withdrawal/ Appropriation	5	3. 74	5	1.76	1.26	0	1.76
	Land-use Change	3	3.57	5	1.73	-.57	-2	1.73
Control and Decision-Making Rights/ Claims	Land Management	5	4.49	5	1.18	0.51	0	1.18
	Land Investment	3	4.70	5	0.85	-1.70	-2	0.85
	Land Income Generating	5	4.42	5	1.26	0.58	0	1.26
	Land Exclusion	1	3.15	4	1.90	-2.15	-3	1.90
	Land Reallocation	3	3.13	4	1.91	-0.13	-1	1.91
Alienation Rights/ Claims	Land Sell	1	2.91	2	1.94	-1.91	-1	1.94
	Land Leasing	5	4.05	5	1.62	0.95	0	1.56
	Land Inheritance	5	4.05	5	1.56	0.95	0	1.62

Source: Property Rights: Coded from the Land and Water Code; Customary Claims: Farm Household Survey 2013, N=399
Labels Property Rights: 1 No Rights, 3 Have the right occasionally (with limitations), 5 Full Right
Labels Customary Claims: 1 never perceived to have the rights, 2 rarely, 3 occasionally, 4 very frequently, 5 always

3.5.3 Comparing customary claims among farm types

As the previous results have shown, the bundles of customary claims differed substantially across respondents. We analyzed whether differences across farm types could provide one explanation. Table 3-7 presents results of a statistical test of the indices' means across subgroups of farms categorized by size and organizational form.

The customary land claims were more pronounced in the groups of smaller farm sizes. However, interestingly the opposite holds for water claims, which is discussed later. In particular, the customary land decision-making claims were seemingly more pronounced by households and presidential decree land users. Furthermore, the interviews indicated that the larger farms faced more external influence (e.g. by governmental authorities). At the farm level in particular, the regulations by the local authorities on managing and generating income inhibited the farmers' decision-making power. In some cases, larger farmers still faced the obligatory need to produce cotton. Although cotton quotas no longer exist officially, according to our interviews some regional authorities still followed the rule that 70 % of arable land had to be cultivated with cotton. These obligations function rather as informal arrangements and affect customary land-use change claims in particular. According to the interviews, crop choice restrictions were mainly imposed and enforced by the jamoats via a dekhan farm advisor.

However, we have to be aware that, although most customary land claims were less pronounced by larger farms, this does not mean they were less powerful in the community, e.g. also providing land-related services or labor to villagers. The procedure for obtaining land and the incentive to establish a farm is difficult per se and already requires power and decision-making.

For water, the results of the different customary bundle claims show that these were more pronounced in the group of larger farm types (see Table 3-7). Differences in the customary water use claim index can be partly explained by differences in access to primary canals. Forty-two percent of the largest dekhan farms had access to primary canals, whereas only 11 % of households plots used primary canals. However, these primary canals were not only upstream and only 30 % of the largest farms surveyed were located upstream. Therefore, proximity to the canal was not the only reason for stronger customary claims.

The customary decision-making claims and the investment claims demonstrate the main differences among the farm types which are also statistically significant. Interviews with household farms clearly stated that the major determinant of a household's access to water was proximity to the large cotton farms and their investment in the canal systems. The interviews, supported by findings of the World Bank (2008), also showed that water access by smaller households was often connected to providing a labor force to the larger farms controlling the water canals.

Table 3-7 **Difference between indices of bundle of customary claims across farm types in both research areas (Bokhtar and Bobojon Gafurov), Household and Presidential Land-users (N=260), Dekhan Farms < = 5 ha (N=103), Dekhan Farms > 5 ha (N= 18), Dekhan Farms >= 30 (N=17)**

Index (p-value[a])	Farm Type	Mean	Std. Dev.	Min	Max
Water Use Index (0.3092)	Household and Presidential Land	3.804	1.323	1.000	5.000
	Dekhan Farms < = 5 ha	3.573	1.351	1.000	5.000
	Dekhan Farms > 5-30 ha	3.611	1.420	1.000	5.000
	Dekhan Farms >= 30 ha	3.853	1.296	1.000	5.000
Water Decision-Making Index (* 0.0528)	Household and Presidential Land	1.928	0.934	1.000	5.000
	Dekhan Farms < = 5 ha	1.767	0.959	1.000	5.000
	Dekhan Farms > 5-30 ha	2.167	1.088	1.000	5.000
	Dekhan Farms >= 30 ha	2.441	1.267	1.000	5.000
Water Investment Index (***0.0007)	Household and Presidential Land	3.245	1.730	1.000	5.000
	Dekhan Farms < = 5 ha	3.466	1.792	1.000	5.000
	Dekhan Farms > 5-30 ha	4.278	1.127	1.000	5.000
	Dekhan Farms >= 30 ha	4.647	0.996	2.000	5.000
Water Alienation Index (0.3109)	Household and Presidential Land	1.092	0.518	1.000	5.000
	Dekhan Farms < = 5 ha	1.204	0.772	1.000	5.000
	Dekhan Farms > 5-30 ha	1.000	0.000	1.000	1.000
	Dekhan Farms >= 30 ha	1.235	0.970	1.000	5.000
Land-Use Index (***0.0001)	Household and Presidential Land	4.275	0.885	1.667	5.000
	Dekhan Farms < = 5 ha	3.628	1.155	1.000	5.000
	Dekhan Farms > 5-30 ha	3.667	1.079	1.333	5.000
	Dekhan Farms >= 30 ha	3.137	0.850	2.333	5.000
Land Decision-Making Index (***0.0001)	Household and Presidential Land	4.114	0.786	2.000	5.000
	Dekhan Farms < = 5 ha	3.494	1.082	1.000	5.000
	Dekhan Farms > 5-30 ha	3.516	0.807	2.000	5.000
	Dekhan Farms >= 30 ha	3.134	1.022	1.000	5.000

Land Alienation Index (***0.0001)	Household and Presidential Land	4.102	1.204	1.000	5.000
	Dekhan Farms < = 5 ha	2.835	1.470	1.000	5.000
	Dekhan Farms > 5-30 ha	3.370	0.976	1.000	5.000
	Dekhan Farms >= 30 ha	2.451	1.007	1.000	3.667

Source: own calculation based on Farm Household Survey 2013

[a] Level of significance (Kruskal-Wallis Test): p < 0.01 = ***, p < 0.05 = **, p < 0.10= *

3.6 Discussion

Our analysis has shown, on the one hand, how closely linked land and water resources are but, on the other hand, how differently they are regulated, perceived and managed by farmers. The quantification of the bundle of rights' approach allowed these aspects to be scrutinized.

With regard to our first hypothesis, our results show that overall the customary water claims are less pronounced than the customary land claims. Access to farmland is no longer perceived to be a major barrier although it was often mentioned previously (e.g. Rowe 2010; World Bank 2012). This shows one success of land reform, with its primary aim of individualizing former collective farmland. Nevertheless, customary land-use change claims, an important issue for farmers needing to adapt to climate change or to meet market demand, is not well established. Interviews showed that the limitations of land-use change options exist especially for cotton farmers. Cotton is still the dominant cash crop and is a hangover from Soviet agricultural practices. Bubb (2013) stresses that there is a link between cash crop production and individualization, as well as security of property rights. As the interviews revealed, some of the individual dekhan farmers who produced cotton as a cash crop were limited in land-use change options. In this respect, cotton as a cash crop would not result in perceived tenure security.

It is a different story for customary water claims. Results are in line with the findings of Garrick et al. (2013) and Bruns et al. (2005). Meinzen-Dick (2014) emphasizes that, where annual water variability is high, which is the case in Tajikistan, transferring water property rights and strengthening water claims is difficult. Customary water control and decision-making claims are indistinct, which leads to challenges for the operation and maintenance of irrigation infrastructure. The results are water losses and inefficient water allocation. The current strategy for strengthening individual water management is to establish WUAs. However, our interviews showed that WUAs are not an efficient solution for our case study regions. Some of the WUAs in our research areas exist only on paper and active membership is well below the number of registered members. Decision-making is also challenged by the increasing number of canal users. For 47 % of the surveyed farmers, the number of users accessing the same irrigation infrastructure had increased during the previous five years. These new users were mainly smaller dekhan farms (23 %) and household plots (14 %). In this situation, it is more likely that free riding will occur, with users not willing to contribute to infrastructure management, and collective action initiatives such as WUAs will tend to fail. In addition, the reasons for free riding or the absence of investment activities are not simply ignorance, missing capacities, or not being used to investing. For Tajik farmers, the unease of changing something in the current system and bearing the risk of getting fined for this hinders participation in common pool resource management. Interviews in Bobojon Gafurov demonstrated that villagers tried to organize collective action initiatives to reconstruct old canals. However, this initiative was hindered by the local government which introduced an environmental tax on illegal reconstruction.

In our second hypothesis we assumed a high discrepancy between property rights and customary claims. A high discrepancy, where property rights are not recognized, can indicate different scenarios. Of course, it can be a result of lack of transfer of knowledge from state to farmers; however it can also show the non-negligible role of the implementation of formal policies on the ground. This then indicates a certain level of resistance towards formal rules and the acceptance of local authorities implementing national policies. As Broegaard (2005) shows in the case of Madagascar, missing enforcement of the legal land reform and distrust of property rights limit sustainable investments in resource management. Potentially, discrepancies could further result in conflicts and, if farmers were disadvantaged, their farmers' discount rates would increase (i.e. preferences for short-term benefits from resource use would increase).

The results for the land sector show that, on the one hand, several bundles of customary land claims coincide more closely with property rights but, on the other hand, some customary land claims disregard property rights. Five out of eleven variables show a negative discrepancy, which indicates that property rights were not transferred; however they were determined as customary claims by the farmers. Customary claims and local actions are not always backed up by national legislation. Discrepancies can occur due to 1) ignorance or 2) the resistance of farmers. First, farmers are often not aware of specific land laws. After 20 years of land reforms, 8 % still know nothing about their legal rights situation. Second, village unity and local institutions point to a certain form of political resistance with regard to national laws. As Mandler (2013) and Boboyorov (2013) show for their case studies, local institutions of village unity and kinship are of great importance. In some cases, local institutions exist which are more resistant to state policies than new evolving laws.

As Alston and Mueller (2008) mention, property rights become more important with growing resource scarcity; this is the case for arable land in Tajikistan. In addition according to Bubb (2013), transfer rights play a significant role in empowering farmers to recognize the value of land. Transfer rights are currently being discussed in the Tajik land reform process to provide more collateral for Tajik farmers. Currently, illegally renting out land is becoming more popular in several rural areas of Tajikistan (see Hierman and Nekbakhtshoev 2014), which is a problem for long-term sustainable investment and therefore for productivity increase.

The discrepancy level in the water sector points to the fact that the potential is often not fully exploited or perceived in cases where property rights are defined but not perceived as a claim by farmers. Therefore, the implementation of the Water Code with the aim of transferring rights to farmers still lags behind that of the Land Code. Zwarteveen (1997) stresses the importance of communal networks in achieving a high level of compliance between paper and practice. Examples from Mexico and Niger are depicted, where the rules established by networks are even stronger than the formal rules. The interviews with WUAs in Tajikistan have shown that strong networks in the water sector have not yet been established.

Based on our analysis, we conclude that both farm types, small-scale household and large commercial farms, are limited in productivity growth. However, the implementation of rules has different implications for the two natural resources. With regard to the third hypothesis we get a more diversified picture than assumed. In contrast to the water challenges for household plots, the larger farms face difficulties in the land sector. Individual land decision-making is not perceived to be a customary claim by the larger farmers. If land tenure is perceived as insecure, farmers' investment fails to materialize. Soil improvement in particular, which could be achieved by changes in land-use practices or the increased use of external inputs, would add to long-term productivity and sustainability returns. According to Bubb (2013), farm size is one indicator of perceived transfer claims. Based on our results, this is not the case for large dekhan farms, since they have fewer transfer claims in the land sector.

Household farms are especially challenged by limited decision-making and accountability in the water sector. The household farms in Tajikistan are mainly managed by women. As Zwarteveen (1997) analyzes for several developing countries, women as water users are often disadvantaged and are not favored by allocation policies. By contrast, larger farms where the farm managers tended to be men held stronger customary water claims. The farm managers felt they had more negotiation power and could therefore influence or even change the schedule system, which should function on an equal demand basis. The largest farms, as shown in our interviews, were also the main investors in irrigation infrastructure. Due to their knowhow and past experiences, especially in the water sector, large farms could even establish interest groups, which might result in even more influence over the implementation of property rights at the local level for all farm types (see also Olson 1982).

3.7 Conclusion

Despite several reforms of management structures and responsibilities in the land and water sectors in Tajikistan since independence, productivity growth in the agricultural sector is still below its potential. Farmers can now obtain and maintain individual land and water property rights to irrigate their farmland. However, the implementation of property rights is perceived to be still incomplete (Lerman and Sedik 2008; Rowe 2010). This challenges productivity growth, according to Feder and Feeny (1991). However, productivity growth can also be achieved with strong customary claims as shown by Bellemare (2013). These informal claims can be congruent or show discrepancies with the property rights. We further argue that the highest productivity challenges in the land and water sectors emerge if customary claims are either not backed up by legislation or if farmers' customary claims are less pronounced.

Second, we developed and applied the method of quantifying the customary claims in order to contrast these to property rights. We did this in a quantitative way by conceptualizing the bundle of rights' approach for both concepts. Our results were manifold showing different discrepancy levels for different bundles. Whereas the land sector is increasingly being individualized and individual property rights are being transferred to farmers, our results find that water rights are still not transparent enough. Although we do not discuss the reasons for the discrepancies, it has to be mentioned that discrepancies between property rights and customary claims are not only of an institutional nature. Economic barriers can also increase discrepancies. This was shown by the limited choice of production systems (land-use change claims) for household plots that need to ensure subsistence farming for food security reasons. Therefore, for some farm types we can never expect full congruence in some bundles due, for instance, to economic barriers where land-use change options are just not applicable due to the need for staple food production.

With regard to differences among groups of farm types, the results point to the fact that customary water and land control and decision-making claims differ significantly. Interestingly, the group of larger farms holds stronger customary water claims and the group of smaller farms holds stronger customary land claims. However, to make really good use of customary land claims, customary water claims are needed as well, due to the natural conditions.

We would argue that where customary claims are identified as weak or contravene the law, more advanced property rights with adequate implementation mechanisms are required. In addition, the acceptance of formal rules and trust needs to be established by authorities to minimize resistance. Each reform that is ongoing in Tajikistan should include, or at least verify and control for, resource sustainability of the other interlinked resource. For instance, our results show that customary land access claims are already advanced but without long-term and secure water use, as well as control and decision-making claims, agricultural land in Tajikistan is of less value.

Among farm types, property rights should be enforced equally. In the water sector in particular, the role of networks and local elites is still dominated by large-scale farmers, who also invest the most and have the decision-making power over water. Smaller farms also need to be recognized and involved more formally in the new evolving responsibilities, such as the WUAs. The smaller farm types are of importance as their share of gross agricultural output is already greater than their share of land. Additionally, small farms have a crucial impact on local and regional food security. Further integrating smaller farms into the water sector would mobilize more financial resources and create responsibilities for the water sector. However, solely holding strong customary claims and transferring property rights alone is not sufficient. Technical expertise is also needed for Tajik small-scale farmers so that solutions are found for the burden of the largely destroyed irrigation infrastructure and in order to realize the aims of the various past land reforms.

4 The land and water nexus: expanding the SES Framework to link land and water governance[22]

Abstract

So far, the land and water nexus has been primarily addressed from a hydrological and ecological angle, with limited response on the governance interface between the resources. Also in existing frameworks, such as the Social-Ecological-System (SES) Framework, governance interactions between resources are not sufficiently addressed. We therefore propose to adapt the SES framework integrating a nexus perspective: either 1) to add a second-tier "governance nexus" variable inside the governance tier of an irrigation system or 2) to add a second the land resource unit and system outside the irrigation system. We address this gap empirically with a case of Tajikistan based on a farm household survey with 306 farmers. Here, attributes of land reform outcomes affecting new modes of irrigation governance after transition have been identified. The results indicate that specifically formal land tenure has a positive effect on paying for water as well as on the likelihood to invest time and efforts in irrigation infrastructure. Further, perceiving alienation and management claims for land resources increases the probability that farmers are paying for water. We further discuss how land decision-making in the future could be designed to facilitate the willingness to cooperate.

Keywords: land and water nexus, social-ecological-system, governance linkages

4.1 Introduction: the missing land and water interface

Two trends are often discussed in the debate about dynamics of resource use and development: 1) increasing water scarcity and 2) land rush for the best soils. In research, these trends are not sufficiently discussed under a common framework. In contrast to other resource sectors such as

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land and forest (land tenure and forest conservation) (Robinson et al. 2014) the governance link between land and water is often not studied. If limiting the water domain to the irrigation sector, the missing link is even more pronounced. Especially the impact of secure land tenure on local irrigation governance has not been addressed in detail. Some recent exceptions come from the water grabbing debate (see e.g. Theesfeld 2015, Bues and Theesfeld 2012, Rulli et al. 2013). Here, examples are taken from large-scale land acquisitions, but this should not prevent us from looking at small-scale land rush cases and their implications on the water sector as well. Irrigation systems are often studied as an example of community-based management see e.g. (Ostrom and Gardner 1993). Although cooperation within irrigation systems and the social dilemmas groups are facing has frequently been studied, specific links between collective action in irrigation systems and land tenure have not sufficiently been addressed.

Yet, while studying e.g. water scarcity, it is important to follow an integrated approach and to consider complex structures and linkages to other resource sectors (Catherine Allan et al. 2013). Especially the current debate on the global rush for land (Deininger and Byerlee 2011) has shown that the ones interested in land also opt for long-term and secure water access (Rulli et al. 2013). This is especially the case for semi-arid regions or where crops with intensive water needs are grown. These land deals can lead to a change of land use rights, which in turn often impact on irrigation water availability and water governance (see e.g. Theesfeld (forthcoming); Allan et al. 2013; Bues and Theesfeld 2012; Bossio et al. 2012) or on water quality in terms of e.g. water pollution (Arduino et al. 2012). The land rush is not only unique for large-scale, international land acquisition. It can also result from a sudden and quick change in land property structures, as it happened for instance in many transition countries. This change was often accompanied by a formalization of land rights e.g. in form of land certificates. Formalization of land rights is generally aimed to push tenure security, which is however sometimes also disputed (e.g. by Sikor and Müller 2009). Dual tenure systems between formal and informal have evolved frequently (Platteau 1996). In most cases, where land transfers or formalization took place, organized provision of irrigation water was often not taken into consideration (Greenberg 2010). Particularly the ones farming on unregistered land can be threatened additionally by insecure or competitive irrigation water access. Often irrigation water access is considered to be part of the land tenure as a "subsidiary component" (Hodgson 2004, p. 2). Thus, farming on unregistered land can imply insecure water access in the long run. Thus, although there are differences between the resources, "the implications of land rights and land use cannot be ignored in the design of water rights" (Mason and Newborne 2013, p.9).

We empirically break down the discussion to the case of Tajikistan, where irrigated agricultural represents a highly relevant economic activity. The country underwent comparatively more economic and institutional reforms in the agricultural sector than its neighboring countries Uzbekistan and Turkmenistan. So far, most studies on Tajikistan either address the development and outcomes of the land or of the irrigation sector. In Tajikistan, a domestic, small-scale rush for land emerged in that sense that farm restructuring of collective and state farms proceeded in the form of distributing land shares to the member of the collectives and to new evolving farmers (EBRD 2002). Thus, the total number of individual and small-scale farmers increased after 1990s. The process includes a change from large-scale, state farming units to rather small-scale farming due to privatization of former collective and state farms (Lerman 2012). Also water reforms and the implementation are still ongoing. At local scale, this implies a change from state managed to farmer managed irrigation systems that require collective participation of the individual farm households. This participation basically consists of farmers' contribution to 1) water payments and 2) labor contribution to canal maintenance (Akramov and Shreedhar 2012). As Theesfeld (2004) already examined for Bulgaria, the remaining socialist irrigation systems do not always match with new evolving agricultural production units. Land reform with its changes in farm size and organization also challenges the new governance mode of collective water management in the irrigation sector.

We aim to identify attributes of the land resource system affecting new modes of irrigation governance at local scale. This new mode or irrigation governance primarily requires cooperation between farmers. We then discuss how land governance systems in place and land decision-making in the future could be designed to enable sustainable water governance in Tajikistan and how to facilitate the willingness to cooperate.

In the first part of the paper we briefly outline the land-water nexus literature and show how far also heuristic frameworks such as the Social-Ecological-System framework have to be extended by integrating a particular nexus perspective. Followed by this, we introduce the transition process of the land and water sector in Tajikistan. Based on the empirical and theoretical background we formulate four hypotheses. These hypotheses will be tested with farm household data of two lowland regions in Tajikistan using two logit models. Finally, we are able to discuss the results regarding specific linkages between land governance and the willingness of farmers to cooperate in irrigation management.

4.2 The land and water nexus in the SES

Land and water are inextricably linked (Meinzen-Dick and Mwangi 2009, p. 38). But they differ considerably in their physical nature (Hodgson 2004). Sjöstedt (2011) emphasize that many water problems lie outside of the direct setting. In the land and water domain, basically the feedback loops between use practices, soil- and water management have been investigated from a more hydrological perspective. For instance, land use and cover can affect water quality (Moss 2004) or land degradation can reduce water-use efficiency (Rosegrant et al. 2009). Increasing desertification also impacts on groundwater level recharges and run-off, which leads to increasing threats of floods etc. Lower water and soil quality consequently lowers the value of the property (Leggett and Bockstael 2000).

Whereas land resources are increasingly being privatized, irrigation water is regularly managed in a common property regime. These regimes often face cooperation dilemmas of irrigation management, where a group of irrigators jointly access, manage and harvest irrigation water from a common-pool resource (irrigation system) for their individual benefit (Ostrom and Gardner 1993; Ostrom et al. 1999; Cox 2014). Well investigated pitfalls of cooperation are the problem of access asymmetries or fee-riders of non-contributors, especially among head- and tail-end users (Ostrom et al. 1999). Many irrigation systems have also proven to function as a long-lasting and sustainably managed social-ecological system. This is disproving Hardin´s assumption of the tragedy of the commons (Hardin 1968).

Irrigation systems and farmers´ cooperation dilemmas are a frequently addressed topic in the social-ecological-system (SES) literature (Janssen et al. 2007; Anderies et al. 2004). In this respect the SES framework, a heuristic framework to study complex systems, was developed (Ostrom 2007; McGinnis and Ostrom 2014). It allows us to study diverse and very complex resource systems by using a common vocabulary. On the same track it is designed to refer to the specific empirical setting at hand (McGinnis and Ostrom 2014). Initially, the SES was designed to specifically study common-pool resources, the benefits of cooperation or likewise cooperation dilemmas (McGinnis and Ostrom 2014). Compared to previous frameworks in this field, it is suitable to integrate the ecological and social context as well and thus to integrate more complex interactions.

The SES framework first developed by Ostrom (2007) and adapted by McGinnis and Ostrom (2014), consists of eight first-tier variables: Resource System (RS), Resource Unit (RU), Governance Systems (GS) and the Actors (A), which together influence the Action Situation which is determined by the Interaction (I) and the Outcome (O) (Ostrom 2007; McGinnis and Ostrom 2014) (see Figure 4-1). The social, economic, and political settings (S) as well as the related ecosystems (ECO) are also two important tiers, also considered as the contextual factors. According to McGinnis and Ostrom (2014, p. 3) the term tier is used "to denote different logical categories, with lower-level tiers constituting subdivisions within elements of the next tier". In this nested framework we can unpack each first-tier of one system, to multiple second- and third-tier variables. Of course, not all variables have to be analysed for all cases. The selection depends upon the research aim.

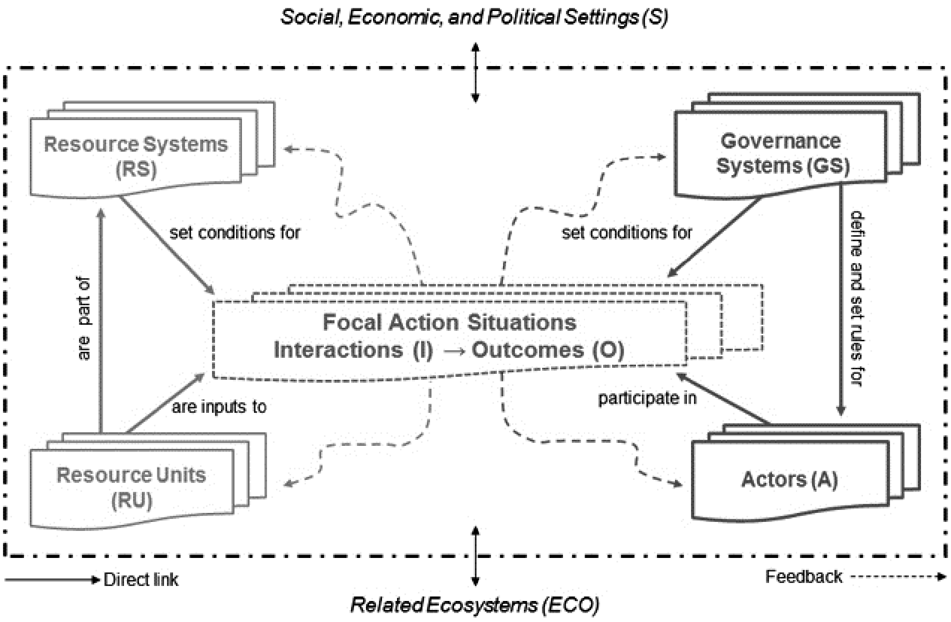

Figure 4-1 Social-ecological system (SES) framework with multiple first-tier components
Source: McGinnis and Ostrom 2014

Most studies that apply the SES framework refer to the robustness and disturbances of only one distinct resource system, e.g. an irrigation system. One second-tier variable of the resource unit refers to the "interaction among resource units", which could imply a nexus of two resources. This variable is rarely defined and considered in the SES discussion so far. According to Delgado-Serrano and Ramos (2015) it describes the identification of the relationship between resources such as competition and collaboration. So, based on this definition this variable would not be sufficient to consider the nexus entirely, because it only focuses on the resource unit and neglects e.g. governance linkages.

Other outside system effects mainly derive from the two components "ecosystem (ECO)" and "social, economic and political system (S)". Both represent so called global variables and include e.g. climatic or economic development conditions. The ECO- as well as S-tiers do not explicitly refer to integrate another resource system. We suggest that for one resource a complementary resource can create disturbances. These disturbances are considered as an uncommon shift of inflow into a resource system (Cox 2014) and generate new outcomes that can also evolve from another resource unit or system.

We propose that an adapted SES Framework is suitable to deal with the natural resource nexus. Here, we see two ways of expanding the SES Framework, either focusing on the governance nexus between land and irrigation water or on the nexus between irrigation governance and land resource unit / system.

Our first suggestion further unpacks the first tier variable "Governance System (GS)" within the irrigation system. Thus, changes only take place within the first tier of the irrigation system itself. So far, well investigated second-tier variables within the GS are property rights systems, monitoring and sanctioning processes or network structures. We suggest adding a new second tier variable "governance nexus" (see Figure 4-2, grey box). Consequently, related third tier variables can be land specific variables: e.g. informal and formal land property rights. Such as other second-tier variables, this one is likewise linked to the action situation as part of the irrigation system (within system linkages).

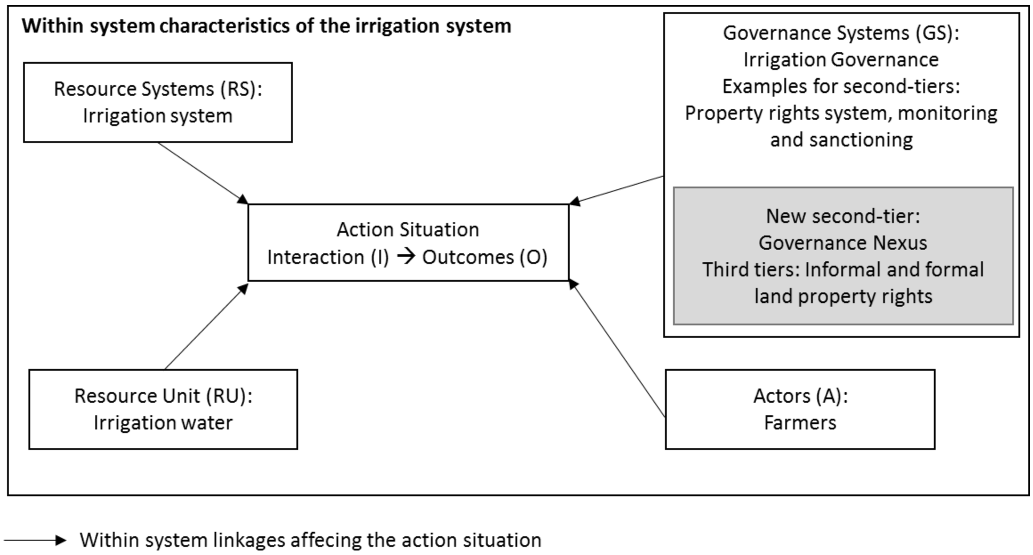

Figure 4-2 Adapted and simplified SES framework integrating land governance

Source: Adapted SES Framework from McGinnis and Ostrom (2014)

Our second suggestion to adapt the SES framework in a land-water nexus perspective would include two resource systems, each with particular resource unit and system characteristics and selected further system specific tiers (see Figure 4-3). Compared to the first suggestion, the GS Box within the irrigation system is not changing. The actors become more central in this regard as they are the linking unit between the land and irrigation system. In an irrigation system, the main actor is the farmer. As the farmer depends on both, land and irrigation water, the farmer becomes the linking unit which is shared by the land and irrigation systems equally. Each system can be very dynamic and they can respond to each other, which would imply that a change of cropping patterns or farm structures can affect certain water governance instruments.

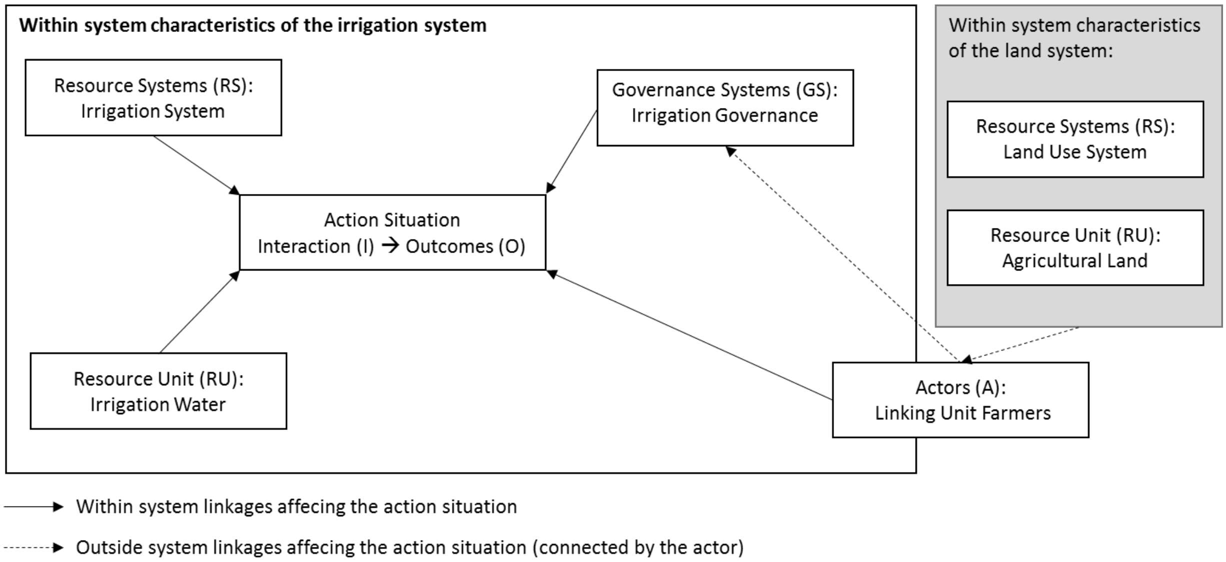

Figure 4-3 Adapted and simplified SES framework with two interlinked resource systems

Source: Adapted SES Framework from McGinnis and Ostrom (2014)

4.2 Land and water in transition in Tajikistan

Tajikistan is a landlocked country in Central Asia with a semi-arid climate, neighbouring Uzbekistan, Kyrgyzstan, China and Afghanistan. For Tajikistan, but in general for the region, the two main rivers Amu Darya and Syr Darya are an important economic and ecological input source. High water variability between the seasons with floods in spring time and droughts in summer are an increasing threat for Tajik agriculture. Tajikistan has two main agricultural areas, which were very much developed during the Soviet time. Due to its water availability, especially cotton production was intensified in the low land regions along the main rivers and still remains an important export crop. Vegetable and wheat production increased during the past years and is also produced now in the lowlands (Hofman and Visser 2014). Many of the rural households nowadays are subsistence farmers using the so called kitchen gardens attached to their houses (Rowe 2009)[23].

Looking at each resource, especially a change of governance has taken place during the past decades, which is briefly outlined here. Both, land and water are state property and use rights for farmers exist. So far, individual farmers are especially limited in their land alienation rights. The use rights for Tajiks however, are long-term and mostly not limited for a certain time period. These use rights can be formalized in land certificates and can be obtained by the (regional) Land Committee. The land reform started with the goal to reorganize former (Soviet) state and collective farms (*sovkhozes*, which was directly managed by the state, and *kolkhozes*, both typically

[23] This part mainly relies on a literature review but also includes some results of the field work conducted in 2013.

more than 1000 ha) into private farms (*dekhan farms*). Now, different farm types exist, generally being defined as household gardens; private peasant farms; collective farms. The latter one however, has been drastically reduced over the past years. Especially after 2009 private farms developed (Hofman and Visser 2014; Lerman 2012). This reform changed the farming sector in the way that many different farm sizes emerged. But farm sizes are now very small with about 40 % of registered private farms cultivating less than 2 ha (Lerman 2012). This restructuring towards many small-scale farmers increased the size of the population using the irrigation canals, especially after 2005 with the major push in land reforms. Water competition is increasing between large-scale, medium-scale and household farmers, whereas the last two have mainly increased in number.

Water reforms likewise started in 1990, but rather slowly. The new water code developed in 2000 only. The rule-making process in water management and the organization has changed from a centralized to a de-centralized system. Most drastic changes happened at the inter-farm and farm level. Irrigation systems are now collectively managed by the farmers, which also changed the rules in use. Collective management can be either formalized, e.g. in Water User Associations (WUA) or informally organized within one community. Overall, between the gate and the on-farm canals, forms of collective action initiatives are in general responsible for water supply (Theesfeld and Kluemper forthcoming). Each Farmer is now self-accountable in terms of investment, maintenance and management of irrigation canals. The operational choice rules sanction that farmers' participation (also in form of investing time, efforts and financial means) is compulsory. Before, irrigation system management and investment have been mainly subsidised and organized by the state.

One major change in water governance has occurred with the introduction of water fees as a new policy instrument to cover operation and maintenance costs. Officially, water payments (irrigation service fees) are calculated by farm size and crop since 2006 (Ministry of Melioration and Water Resources): 0.78 Diram/m^3 in gravity irrigated areas, 1.25 Diram/ m^3 in lift irrigated areas (2.25 US$ for 1000 m^3 and 3.63 US$ for 1000 m^3, respectively) (Akramov and Shreedhar 2012) *Interview with Ministry for Water Melioration 2013*. However, so far the implementation of collecting water fees is weak[24] and huge capital losses to maintain the irrigation infrastructure are frequently reported. For both rules, social monitoring mainly exists among the larger-scale

[24]*Comment from the interviews*: "Water has always been for free, I can take water whenever I want because it has always been like this", not everyone is included (or wants to be included) in water allocation decisions).

farmers. Especially household plot users are often not monitored regarding water use[25] and an official monitoring and sanctioning system is not in place.

4.3 Hypotheses

By means of literature review, we come up with the following hypotheses of possible governance linkages between land and irrigation water systems. The hypotheses are selected to further investigate the two options of the adapted SES frameworks. Hypothesis 1 and 2 refer to the first option where the second tier variable "governance nexus" is added within the irrigation system. Hypothesis 3 and 4 describe the second option where another resource system, here agricultural land, is added and linked via the actors.

Hypothesis 1: Secure land tenure generates the likelihood to cooperate in local irrigation management.

The first hypothesis investigates the necessity of adding a second tier "governance nexus" variable. Correspondingly, we add land tenure as one third-tier variable. We proxy secure land tenure with two variables: 1) formal land titles and 2) access to use more land. The two variables focus on different aspects of tenure. Formal land titles can provide certainty and security to farmers. Land certificates guarantee long-term use rights and the farmer is more motivated to invest in land resources (Brasselle et al. 2002; Besley 1995). A so called "assurance effect" as Brasselle et al. (2002) calls it, can evolve, and returns can be more stable with land tenure security. In addition, previous literature mentioned a "collateralisation effect", where land can be used as collateral and with it, access to credit can be facilitated (Brasselle et al. 2002). As Meinzen-Dick (2014) emphasize, it is especially the strength of incentives and confidence towards rights that can sustain irrigation system. Although she refers to water tenure, we hypothesize, that land tenure security can have further spillover effects to farmers´ likelihood to participate in local water governance. Also Sjöstedt (2011) mentions that "for such investments [in irrigation infrastructure] to take place, citizens need some certainty that they will reap the rewards from their investments. This certainty is suggested to result from property rights to land, i.e., land tenure" (p.134). In addition, if farmers are also able to get access to more land, we expect that they also cooperate more in water governance as they increasingly depend on irrigation water, but also have the financial means to contribute.

Hypothesis 2: Perceived (non-formalized) land tenure enhances the likelihood to cooperate in local irrigation management.

The second hypothesis refers to the second tier "governance nexus" variable as well. To contrast the effect of formal land institutions, we also include perceived land tenure as another third tier

[25] *Comment from the interviews*: "I always withdraw water when it is dark" or "Nobody considers a household as real farmers who need irrigation water – but look at my land!".

variable. These perceptions do not necessarily have to be in line with the rights defined by the land reform. But they indicate whether the farmers perceive to have certain rights. Farmers also act, invest and justify according to their perceptions, reflecting the de facto situation of farmers (Ellickson 1986, 1991). Here, we included again two different aspects of perceived land institutions: alienation and management claims, both are considered as collective-choice rights (Schlager and Ostrom 1992). Perceiving land alienation institutions can create or amplify a "realizability effect" (Brasselle et al. 2002; Besley 1995), where land is an asset and investments in land are improved. To sustain the value of land, likewise a contribution to improve collective water management is expected. Land management reveals the "rights to regulate internal use patterns and transform the resource by making improvements", which is a new attribute for farmers especially in the Central Asian context. It further indicates the possibility to decide over the resource use in time, techniques or even structural change decisions (Schlager and Ostrom 1992).

Hypothesis 3: The larger the farm the greater the likelihood to cooperate in local irrigation management.

Hypothesis 3 refers to the second suggestion of the adapted SES framework and further exemplifies the link between resource unit characteristic and irrigation governance. Considering the leadership and cooperation literature (Jean-Marie Baland and Jean-Philippe Platteau 1999; Vedeld 2000; Olson 1965) analyzed that the once enjoying more endowments than others in the same community are seemingly more willing to contribute to common pool resource management. More endowments, e.g. in terms of larger land plots can - to a certain extent - provide more resources to contribute to irrigation management. CPR studies (e.g. Adhikari 2005, Varughese and Ostrom 2001, 2001) suggest an inverted U-shaped relationship, which means that after a certain size of endowments is reached, contributions to CPR management might decrease again. In our empirical analysis, larger land plots are still comparatively small so that we expect an increase of cooperation with increasing farm size. In addition, in absolute terms, they can also benefit relatively more from improved cooperation in irrigation system.

In some of the transition countries a dual structure of large- and small-scale farming coexist, which also leads to competition in accessing water. Different farm sizes likewise depend on secure water access. However, smaller farms are considered as more vulnerable when it comes to external shocks and their coping strategies are limited (O'Brien et al. 2004; Morton 2007). In addition, especially in transition countries, the former collective and state-farms usually managed the irrigation systems. For some small-scale farmers this perception of responsibilities might still remain and their "knowledge" of cooperative water management is lacking, relying on the contributions by large-scale farmers (often reorganised collective and state farms).

Hypothesis 4: Cotton cultivation correlates with the likelihood to contribute to local irrigation management.

In addition, we include one crop variable that is to describe the land use system (RS) of the land system. This should emphasize a land-use specific water governance mechanism. Of course, causality in this respect can be questioned. Thus, we included only cotton as a crop variable, as cotton production in Tajikistan is still assumed to be "semi-voluntary" and many obligations by local authorities exist. Especially cotton is more sensitive to volatile water supply and precise irrigation techniques are needed. Producing cotton affords a very reliable and on-time water supply during the cropping season. Otherwise production losses are likely. Also because of this, cotton is considered as a very labour demanding crop (Theesfeld and Kluemper forthcoming). Thus, farmers being involved in cotton growing are expected to be more willing to contribute to irrigation management and cooperation of water allocation. The reason is that they need more, but especially more reliable water flow. We assume that in case of growing cotton, farmers´ motivation and labour to invest time in collective irrigation management are more likely.

4.4 Data and Method

Data collection took place in Tajikistan from March – May 2013. For our fieldwork we have selected two districts in the lowlands of Tajikistan: Bobojon Gafurov in the Soghd province (northern region), Bokhtar in the Khatlon province (southern region). In both regions qualitative as well as quantitative data were collected.

A quantitative farm household survey was conducted, which was developed using concepts of the SES (Ostrom 2007) and more specifically the Bundle of Rights approach (Schlager and Ostrom 1992) to map farmers' perceptions. The farm household selection process included 4 steps: 1) non-random selection of one district in two main agricultural oblasts, 2) selection of all sub-regions in each district to cover up- and downstream users within a district, 3) random selection of 1 – 2 villages in each sub-region with lists, 4) quasi-random selection of farm households within the village[26]. Farm households were only selected if they used irrigation water and farm land for at least two years. For this paper we use a total sample of N = 306 farms. The sample population consists of small-scale households and individual family farms of different farm sizes[27].

[26] A standard random selection with lists was not possible as official farm household lists are not available for all villages. A common procedure in developing countries is to start in the community centre, choose a random direction and select the first household in this direction. The following houses are randomly selected along that route (Bennett et al. 1994).

[27] We have only included the farms up to 60 ha. The survey also included about 10 farms with farm sizes between 100 and 300 ha. We considered these farms as outliers for this part of the analysis. We are aware of potential conflicts arising from excluding certain outliers (see Hirschauer et al. in Print). These farms were not excluded to increase the p-value, but because of empirical reasoning. Larger farms often face

The qualitative data were collected by means of participatory methods (participatory mapping) and qualitative in-depth interviews. In total 4 (2 in each region) participatory mappings were organized. In each mapping activity 8 – 12 farmers participated. We include diverse farmers cultivating land on 0.2 – 100 ha and diverse gender of farm household heads. Farmers were asked to draw the irrigation system (e.g. primary and secondary canal, drainage systems, water sources), the distribution of farms as well as land use of their community. Participatory mapping can be understood as problem-oriented research (Martin and Sherington 1997; Chambers 1994). On the one hand, the participatory mapping activities helped us to specifically understand and illustrate the design of local irrigation systems. On the other hand, specific problems raised by the farmers were not pre-determined and included diverse perspectives of various farmers. In addition, further informal qualitative interviews were conducted subsequent to the survey. In total 40 in-depth interviews were held in both regions. All discussions were held in Tajik and translated to English by an interpreter.

To analyze the link between land governance and cooperation in irrigation governance, we performed three steps in our analysis.

1) We start our analysis with descriptive statistics of survey data to introduce household characteristics. This should facilitate to understand further arguments during the analysis.
2) In the next step, we want to provide evidence on the ground of cooperation needs in the Tajik water sector. Here, one of the participatory maps is described in detail. Further, descriptive findings from the farm household survey are displayed.
3) In the third step we specifically test for the link between land governance and cooperation in irrigation management considering the two options of the SES framework. To test the four hypotheses, we ran two logit regressions and estimate the marginal effects for both models. The results are discussed in line with the hypothesis. Further qualitative findings are used to underline and to further explain our quantitative arguments.

4.4.1 Specification of variables

Endogenous variable

We have selected two endogenous variables: 1) paying water fees and 2) labour maintenance efforts. Both variables point to the same phenomenon, which is the change of top-down water governance to participatory, collective water governance during transition. But they emphasize different aspects of individual contribution to improve collectively managed irrigation systems. For both contributions, no legally defined sanctions exist and free riding is possible in both cases.

different irrigation management problems and needs. In addition, most of these farms did not change their land property structure and farm managers remained the same from the former state- and collective farms.

Therefore, also paying water fees can rather be seen as a voluntary contribution. These two different variables also indicate whether our assumptions about the land and water system links tend to be robust between different modes of governance so that we can rather generalize our findings.

The first variable "*paying for water*" describes an invisible form of participation. Paying for water can be formally monitored, but it is invisible to other farmers. Thus, free riders are likewise not directly visible to other farmers, only to the once collecting the fees. For the once contributing, the outcome is also not directly visible. Overall, the collection process is very in-transparent and has been introduced unequally during the past years. The collection of water fees is not organized centrally and in practice is undertaken by different persons or groups (e.g. WUAs, village head). In addition, the timing and frequency of collecting water fees varies between communities. At the end, paying for water can be considered as voluntary and is not a precondition to get water or not. Table 4-1 shows that only 60 % of the surveyed farmers paid for water in 2012. Our survey only includes responses of farm household heads, not shareholder. The latter one would not be responsible to pay for water.

The second dependent variable is "*labour maintenance efforts*" in irrigation infrastructure, where we measure whether farmers contribute to canal investment activities with labour. Here, especially canals maintenance, such as cleaning, is obligatory, but does not include maintenance of primary canals. Similar to water payments, the organization of maintenance differs between the villages. In contrast to the first dependent variable, this variable indicates a visible way of participation in terms of participation and outcome. Farmers are directly involved in management and other community members can directly see their respective contribution. Although formal monitoring by authorities can exist, social monitoring by other farmers is more likely. Not contributing can be negatively evaluated by the community. In addition, for farmers who contribute, the outcome is directly visible as well. But still, as the results in Table 4-1 show, only 55 % contribute with labour to maintain the irrigation infrastructure.

Table 4-1 Descriptive statistic of dependent variables

	(1) Paying for water (N=306)		**(2) Labour maintenance efforts (N=306)**	
	Frequency	Percent	Frequency	Percent
No	110	35.95	140	45.75
Yes	196	64.05	166	54.25

Source: own calculation based on farm household survey 2013

Table 4-2 shows the intersections of farmers who pay for water and likewise contribute with labour to the maintenance of the canals. Although the majority contributes to both, one can also see different contribution behaviours. This also underlines the need to use two different independent variables for cooperation in this empirical context.

Table 4-2 Frequencies intersections between the two dependent variables

	Labour maintenance efforts		
	No	Yes	Total
Paying for water			
No	75	35	110
Yes	65	131	196
Total	140	166	306

Source: own calculation based on farm household survey 2013

Explanatory Variables

In literature, factors influencing collective action, especially in irrigation systems, are frequently discussed. These factors include characteristics of the individual (age, gender), of the group (group size, age of the group, heterogeneity, leadership), the resource characteristics and their external environment (Agrawal and Ostrom 2001). But all of these factors are within resource system variables, describing e.g. the SES of an irrigation system. In this study, we expand this existing SES framework by adding on the one hand the second tier variable "governance nexus" and on the other hand link irrigation governance with outside system linkages depicted by the boxes land resource unit and system. The explanatory variables consist of three groups: 1) land related variables testing the four hypothesis; 2) farm household characteristic as linking unit variable (farm household experience[28]) and 3) control variables of water system variables. Table 4-3 shows the descriptive statistics of all three groups of explanatory variables included. All explanatory variables are selected based on literature review, especially also from collective action theories, as we assume that water-related cooperation theory can inform interactions of land-water governance.

[28] Farming experience, which also reflects their local knowledge assembled over time. Experience with farming implicitly includes experience with irrigation, thus it is not considered as a variable of the land sector.

Table 4-3 Descriptive statistics of explanatory variables

Explanatory variable	Scale and Measure	Mean or percentage	Standard Deviation	Hypo-thesis
1) Land unit and system variables				
Tenure status	Binary, Holding a certificate: 1 = yes, 0 = no	58.82 %		1
Access to use more land	Binary, Possibility to access more land, 1 = yes, 0 = no	43.14 %		1
Alienation claims	Perception of holding land leasing claims,	38.89 %		2
Management claims	Perception of holding land leasing claims,	85.95 %		2
Farm size	Interval, Farm size in ha	3.22	9.83	3
Cotton	Binary, Producing cotton: 1 = yes, 0 = no	17.32 %		4
2) Farm household characteristics (linking unit)				
Farming experience	Interval, Years since farming	33.86	30.66	
3) Irrigation system characteristics (control variables)				
No water in cropping months (2012)	Binary, 1 = yes, 0 = no	11.44 %		
Upstream user	Binary, 1 = yes, 0 = no	27.12 %		
District	Binary, 1 = Bobojon Gafurov, 0 = Bokhtar	44.02 %		

Source: own calculation based on Farm Household Survey 2013

The first group, land related variables includes 6 variables. For two variables (holding certificate and producing cotton) we have additionally included interaction terms (between the land system variable and the district). In both cases we expect the influence of local authorities. Issuing land certificates can for instance depend on the willingness of local authorities to promote tenure rights or to provide information on land reform to the farmers. With regard to cotton production, we also expect regional differences as local elites (authorities or cotton ginneries) can have strong local power mechanisms still binding farmers to produce cotton[29]. In general, Bobojon Gafurov´s agriculture has a longer tradition than in the south of Tajikistan. In the south, the intensive agricultural production was only introduced with the Soviets and a lot of forced migration took place to bring agricultural workers to this region with the beginning of the 60s. Thus, still today it has higher ethnic diversity (Nourzhanov and Bleuer 2013).

[29] For further information on the cotton sector in Tajikistan please see for instance van Atta (2009).

4.5 Results

4.5.1 Socio-economic description of farm households

Table 4-4 describes further descriptive statistics of farm household characteristics that are not included in the model. The majority of farm households in our survey has a male farm household head. On average, women are still the main working force within a farm with about 60 %. Besides agricultural income, remittances contribute substantially to farm household income, 40 % of the sampled population received remittances in the previous years. Of all female headed farm households even 47 % received remittances in the previous year. The average age of the respondents in the sample is 48 years, which indicates that the majority of surveyed farmers experienced Soviet Union time. Only 29 of the surveyed farmers were born around the transition period and even 230 were at least 24 years old when the Soviet Union collapsed. Thus, they could have been farmers beforehand. Our survey shows that about 64 % of surveyed farms were established within the past 5 years (until 2013). The farms in our survey only sold about 30 % of their production on average, which shows that most of the farms use their production for their own consumption. About 13 % of the irrigated land is used for cotton, which has a considerably higher water demand (6000 m^3/ha/year and 8 irrigation turns[30]) than winter wheat (3000 m^3/ha/year and 5 irrigation turns per season). Vegetables, which are here only depicted with tomatoes and potatoes, constitute a considerable share of the agricultural area (22 %), but also need considerable amounts of irrigation water (e.g. tomatoes 9100 m^3/ha/year and 14 irrigation turns).

Table 4-4 Descriptive statistics of farm household characteristics

Descriptive Variables	Mean (Standard deviation) or Percentage
Gender of farm household head (% of women)	32.35 %
Share of female farm workers on one farm	59.81 (26.60)
Age of farm household head	49.57 (13.21)
Number of ≤ 25 years old	19
Number of ≤ 45 years old	106
Number of ≥ 46 years old	181
Receiving remittances (%)	39 %
Farm established within the past 5 years (%)	61.64 %
Share of production sold	36.15 (42.52)
Share of cotton area of irrigated area	13.19 (30.85)
Share of wheat area of irrigated area	12.72 (30.10)
Share of tomato and potato area of irrigated area	21.62 (29.75)
Share of irrigated land	88.01 (21.15)

Source: own calculation based on Farm Household Survey 2013

[30] Data on crop water requirements rely on Soghd AgroServe and specifically consider the crop water requirements in Tajikistan.

4.5.2 Evidences for cooperation needs in the irrigation sector

Figure 4-4 shows the variability of water availability in each month, farmers evaluated for the previous year 2012. Especially in the winter months many farmers evaluated their water situation with having no water at all which was accessible via an irrigation canal. This is a rather normal situation in Tajikistan, as most of the water goes to the reservoirs for electricity supply. Interestingly, with the beginning of March, more farmers also evaluated to have too much water or that water availability is highly variable. Especially from May onwards, both facts are extremely risky for certain crop production such as cotton (main cropping season starts in May/June). The figure further indicates that water availability was not only varying between the months but also between farmers. If farmers in the same community either had no water, too much water or highly variable water availability, it emphasizes the challenge of monitoring and the need for cooperation in water management. Cooperation is however challenged due to the increasing number of experienced and unexperienced farmers, which is supported by our survey. For instance, 38% of the farmers reported an increase of more than 5 users of the same irrigation infrastructure and only 2 % reported a decrease (45 % reported no change). In addition, our survey reports that about 55 % do not know who is responsible to maintain the canal between the primary canal and on-farm, only 25 % report it is the farmers' responsibility.

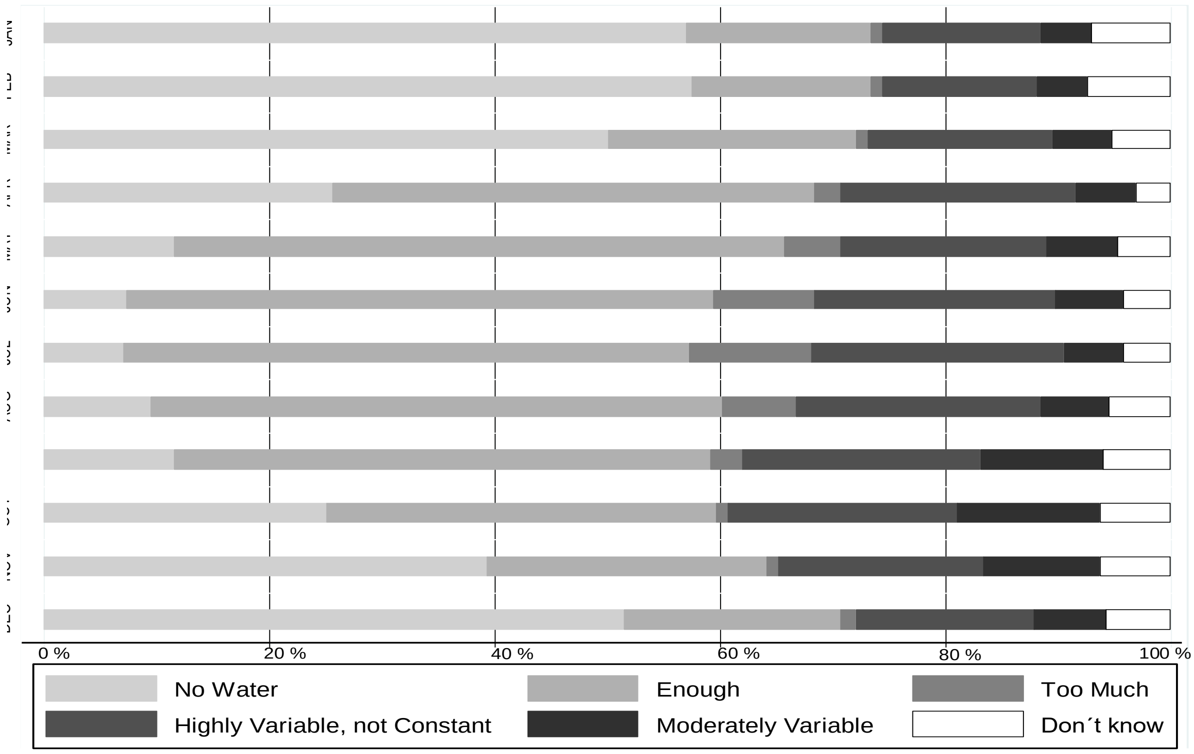

Figure 4-4 Farmers´ evaluation of water variability in each month
Source: own calculation based on Farm Household Survey 2013

Figure 4-5 exemplifies the results of one participatory mapping in Northern Tajikistan. This map aims to illustrate heterogeneity of farm types and point to more evidence of collective action dilemma since land reform. It is of course only a snapshot of one village and cannot fully be transferred to the whole country. Still, during field work, many similar situations were observed and could be replicated by this map.

All of the land on the Tajik side has always been used as agricultural land. This does not hold true for the Kyrgyz side of this specific location, where farming has only been introduced with land reform after 1990. Here, a smaller group of household plots developed close to the border of Kyrgyzstan during the past 5 years. In Tajikistan, the large farm of about 500 ha as well as the location of household plots in the centre of Figure 4-5 has not changed after 1990. All other smaller private farms (upper part of the map) were organized in two larger collective farms during the Soviet time and were reorganized into individual farms since 2007. The irrigation canals as well as the pumps near the dam and the distribution gate were constructed during the Soviet time, mainly to supply the collective farms (500 ha farm and two former collective farms), which were mainly producing cotton at that time. All of the secondary and on-farm canals along the new individual farms were constructed during the past years, however all of them are unlined and farmers report enormous water losses. As only 11 % of the wells in the community are running any longer, irrigation on the household plots also rely on water from the secondary canal. Water fees in the overall community are collected since two years by a local Water User Association, but only among the individual farms. Farm households, which mean households producing a considerable share of agricultural production in their kitchen gardens, so far did not contribute financially in this specific community. So, the heterogeneous farm types contribute differently to the CPR in financial terms. Secondary canal maintenance (cleaning) by the community is organized by the village head on a specific day, mostly in the beginning of the cropping season. Larger farmers complained that this is not sufficient and during the cropping seasons mainly negotiations with direct neighbours about the maintenance situation of canals is taking place. To sum up, the maps illustrates 1) CPR problems in the irrigation sector and 2) new challenges of the CPR that emerged after land reform has been implemented.

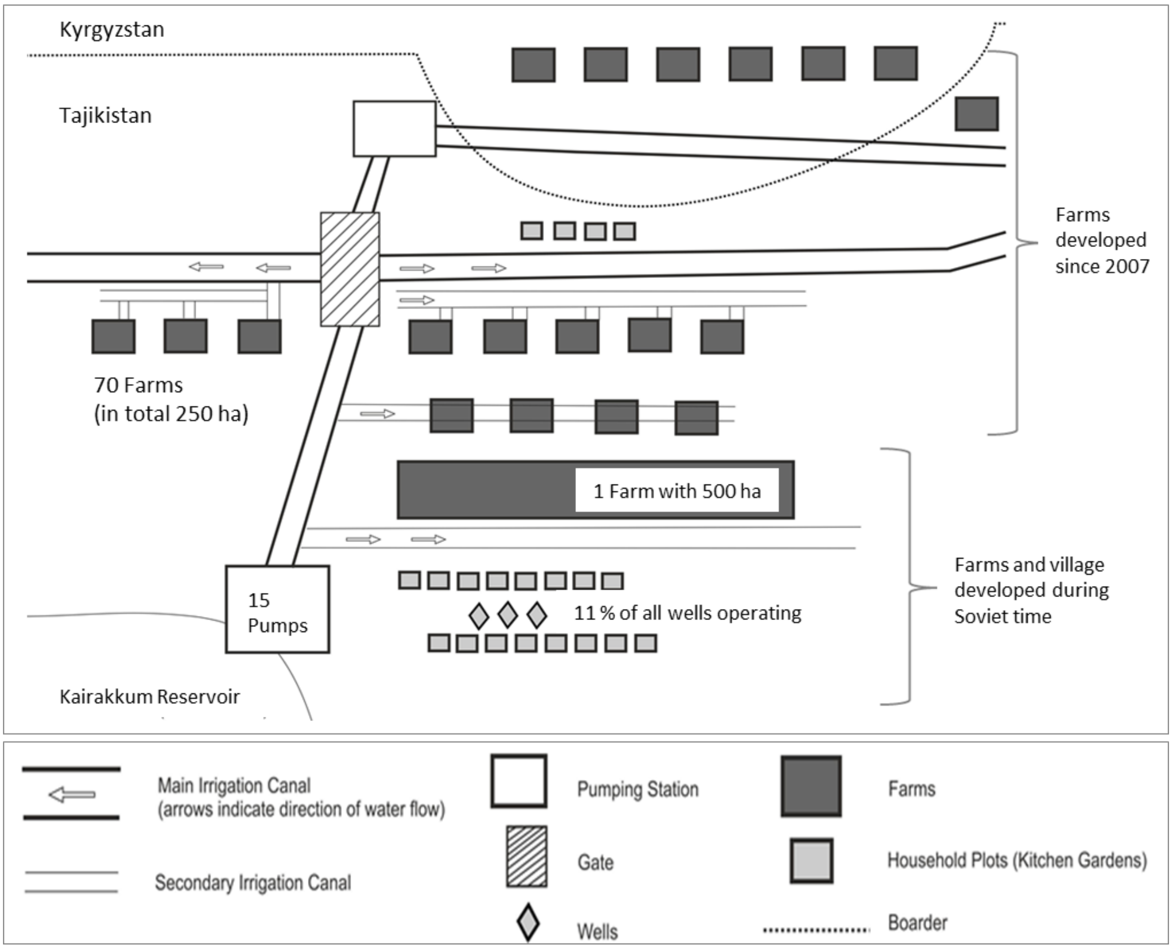

Figure 4-5 Schematic map of an irrigation system in one village of Bobojon Gafurov
Source: The map was originally sketched by hand by the farmers and digitalized afterwards.

4.5.3 Parameters of the land sector and impacts on water governance: regression results

Table 4-5 presents the results of two logit models and the marginal effects explaining farm household's financial contribution for water use and labour contribution to irrigation infrastructure maintenance. The pseudo R^2 for both logit models are significant, explaining 13 % (model 1: paying water fees) and 11 % (model 2: labour maintenance efforts) of the variance of the endogenous variables. The models suggest that it is of importance to consider specific land related variables when studying the probability to contribute to cooperation in water management. The second tier variable "governance nexus", particularly formal land tenure in form of certificates increases the probability to cooperate. Besides, also perceived land management claims especially increase the probability to pay for water. Although the coefficients have the same signs between the two models, different magnitudes between the two modes of cooperation were determined, which is discussed below. Further, we could show that the linking unit variable also show robust results between the models and result in higher probabilities to contribute with labour than on payments. Less robustness between the models can be determined for within system linkages.

Table 4-5 **Logit model estimates**

	(1) Paying for water	(1) Paying for water	(2) Labour maintenance efforts	(2) Labour maintenance efforts
	Coefficient	**Marginal effect**	**Coefficient**	**Marginal effect**
1) Land system variables				
Holding a certificate	0.902**	0.173**	0.913**	0.198**
	(0.384)	(0.0714)	(0.394)	(0.0826)
Holding a certificate * District BG[a]	-0.590		-0.745	
	(0.558)		(0.556)	
Possibility to access more land	0.0708	0.0136	0.533**	0.116**
	(0.271)	(0.0521)	(0.255)	(0.0535)
Perceiving land management claims	1.083**	0.208**	0.380	0.0825
	(0.442)	(0.0821)	(0.387)	(0.0836)
Perceiving land selling claims	0.424	0.0813	0.0708	0.0154
	(0.285)	(0.0541)	(0.270)	(0.0585)
Farm size	0.0501*	0.00962*	0.0509***	0.0111***
	(0.0271)	(0.00500)	(0.0168)	(0.00360)
Producing cotton	0.285	0.0547	-0.562	-0.122
	(0.529)	(0.102)	(0.482)	(0.105)
Producing cotton * District BG[a]	0.0853		1.625**	
	(0.741)		(0.792)	
2) Farm household characteristics (linking unit)				
Farming experience	-0.00257	-0.000494	-0.00964**	-0.00209**
	(0.00427)	(0.000817)	(0.00422)	(0.000886)
3) Irrigation system characteristics (control variables)				
Upstream user	-1.378***	-0.264***	-0.110	-0.0240
	(0.441)	(0.0790)	(0.381)	(0.0828)
No water in cropping season (2012)	-0.209	-0.0402	0.518*	0.113*
	(0.294)	(0.0562)	(0.282)	(0.0600)
District BG (Bobojon Gafurov)	-0.778*	-0.149*	0.978**	0.213**
	(0.419)	(0.0787)	(0.444)	(0.0929)
Constant	-0.407		-1.181**	
	(0.551)		(0.545)	
Pseudo R^2	0.13***		0.11***	
Wald chi^2	40.82		39.50	
Observations	306	306	306	306

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1, BG = Bobojon Gafurov = BG, the results of the variance inflation factor (VIF) shows multicollinearity is not an issue in both models (maximum VIF value 4.1).
[a] = Value of interaction terms cannot change independently of the values of the component terms, thus, no separate effects the interaction can be estimated (Williams 2012, p. 329)
Source: own calculation based on Farm Household Survey 2013

Formal land tenure

Our results identify that formalized land tenure in form of certificates is likely to increase the willingness to cooperate in irrigation systems. These results are even robust between visible and invisible contribution to cooperation. Although the coefficient of the interaction term is not significant, the interaction term between holding a certificate and the district variable shows regional differences (see Appendix A 0-1). In Bokhtar the differences between holding a certificate or not is more pronounced than in Bobojon Gafurov. The probability to contribute to canal maintenance is further strengthened when farmers formally can access more land. Overall, our results support the first hypothesis (H1) that formal land tenure increases the likelihood to cooperate.

Perception on land claims

The two variables indicating farmers´ perception on land management and land selling practices show positive effects on cooperation in irrigation management. In general, the claims do not necessarily have to be backed up by the rule of law, but they need to be well pronounced in farmers´ perception. However, only perceiving management claims significantly contributes to payments. Individual control over and improvements of land use patterns, which has for a long time not been the case in Tajikistan, likewise increases the likelihood that farmers pay for water. This suggests that long-term investments in land resources likewise motivates farmers to contribute also to water payments, which is also considered as a long-term investment, where outcomes are not directly visible. Overall, our results support also the second hypothesis (H2) and specify the assumption that linkages are more pronounced between long-term land claims and long-term investments in water systems.

Farm size

The probability to cooperate is also influenced by an increasing farm size, however the coefficients are rather low in both models. The marginal effect in labour contribution model is slightly higher, which indicates that larger farms rather require ad hoc improvements of canals, which can be better provided through labour contribution. Often, larger farmers are better connected to local authorities who are also in some communities responsible for distributing water and referred to as the main responsibility within a community regarding water management. This can be also considered as a factor of soviet inheritance, farmers that have also maintained most of their assets (machinery), workers and the cropping style that did not change much and the reforms did not have much influence here. Hence, the results support our third hypothesis.

Land use: cotton production

Cotton production is an often discussed, but also sensitive topic in Tajikistan. For several years after the break down of the Soviet Union, farmers had to fulfil cotton quotas. The regulation of cotton production was often supported and controlled by local authorities. According to the qualitative interviews, in some communities, an informal cotton quota is still practiced. Although in our sample we did not identify a significant effect of cotton production on the willingness to contribute, the results are still interesting to consider. Especially when considering the interaction term, which reveals that a significant difference between Bokhtar and Bobojon Gafurov in the labour contribution model. Again, regional differences can be observed (see also Appendix A 0-2). Whereas in Bobojon Gafurov cotton farming increases the probability to participate in canal maintenance, it is the opposite in Bokhtar. For Bokhtar this can imply that cotton farmers, might still be reluctant to contribute to canal maintenance in a collective manner and that they are more supported by local authorities. This can be also supported by observations during the participatory mappings in Bokhtar. In contrast, the payment model also reveals that cotton farmers, who are anyway more controlled, are more likely to contribute and that free ridings are less possible in this regard. Thus, our fourth hypothesis can be only partly supported by the empirical findings.

Farm household characteristic

Similar to the land related variables, farming experiences show overall robust results between the two models. But the linking unit variable has in general stronger effects on labour maintenance, where social monitoring is more likely. Some studies indicate "bad experiences" as a driver of uncooperative behaviour (Cárdenas and Ostrom 2004; Poteete et al. 2010; Rommel et al. 2015). Especially in transition countries, farming experience also reflects whether farmers were already farming during the former Soviet structures or post-Soviet time. Thus, they experienced the transition period including important governance and responsibility changes after 1990. In our case we could determine, that the less farming experience is at hand, the more farmers are willing to contribute to collective irrigation management. Older farmers, or more experienced, might be more influenced by the Soviet style water management system, where the large collective farms, which indeed rather represented pseudo-collective action, were mainly responsible and individual participation was not needed[31].

Irrigation system characteristics

[31] In general, being a younger farmer, might lead to the situation that they are more likely to participate in individual investment activities. This goes in line with e.g. Kvartiuk (2015), who also pointed out that Soviet mental models can still remain and negatively affect cooperation efforts.

The location and water availability in the cropping months (2012) also play a role in our sample. But, differences between the models can be determined. This suggests, that within system variables are less robust between different modes of irrigation governance. Interestingly, being an upstream user only has a positive effect on the likelihood to contribute to labour maintenance efforts, but not on paying for water. Thus, being upstream, seemingly provides more incentives and shows the need to cooperate visibly. In the literature usually downstream users are not willing to pay for water as they face water scarcity, but in our sample also the upstream users are not paying for water. Not having water in the previous cropping seasons seems to have a strong and significant effect on the willingness to contribute financially for the next season. Although the coefficients in the labour contribution model are also negative, they are much lower.

4.6 Discussion and Conclusion

The aim of this paper was to determine linkages between the land and irrigation system, specifically between land system variables and cooperation in irrigation management. Hodgson (2004) underlines that water rights in general over the past decades attracted less attention than land rights. But now, as in many arid climates, where droughts become more frequent, water rights and security are being more discussed, but often still in isolation from each land governance. As far as we know, only a few studies from the land and water grabbing debate specifically addressed the interface.

Our empirical analysis provided first evidence that cooperation in irrigation management is likely to be influenced by specific land system variables. Thus, not only in large-scale land and water grabbing cases such as in Ethiopia (Bues and Theesfeld 2012) or Marocco (Houdret 2012) the link between land and irrigation water can be determined. In contrast, also where changes in land governance are occurring irrigation water governance can be influenced. However, we want to stress, that our analysis only investigated surface irrigation governance depending on cooperation. Especially results of irrigation systems that are differently organized, e.g. private or state-owned can differ from our results.

The empirical part of the paper deals with the case of Tajikistan, which is a very good example to study the land-water interface as agriculture is highly dependent on irrigation and the transition period led to abrupt changes in land and water governance. Individual contribution to cooperate in irrigation management has newly been introduced. Here, especially contributing to water payments and participation in irrigation management are both instruments to cover operation and maintenance costs and to reduce the financial contribution by the state (Meinzen-Dick 1997). Both instruments were selected as dependent variables revealing new local water governance modes in the irrigation sector. The two different cooperation variables indicated robustness between the estimated linkages and supports our assumption to look beyond one resource system. Especially formal land tenure (H1) and perceived management claims (H2) revealed evidence that cooperation can be likewise stimulated by land governance. Formal land tenure is often considered to boost agricultural production, rural development and food security (Barsimantov et al. 2011; Bellemare 2013; Maxwell and Wiebe 1999). Our results further identify that formalized land tenure (certificate) is also linked to cooperation in irrigation systems. Further, we showed the importance to recognize customary claims of farmers in the land sector and to likewise consider their importance in local water governance. Also positive effects of farm size on irrigation cooperation (H3) supports the land-water link. For larger farms, irrigated agriculture is, besides subsistence farming, also an important economic activity and dependency on improved irrigation governance is considered as a long-term need. Scaling up this result to other transition countries, the specific framework to analyse the linkages need to be adapted. For instance, as farm sizes in Tajikistan are comparatively small, transferring the results to e.g. very large-scale irrigated agricultural production in South Kazakhstan might be misleading. Integrating a crop variable to the model is only possible to a certain extent due to the endogeneity question. Thus, we only included cotton. Producing cotton in Tajikistan, or in general in Central Asia, has a very specific connotation, which was for a long time or sometimes still is influenced by authorities. Even our results suggest different results between the regions (H4) and both interaction terms underlined the regional differences especially where local authorities interfere into the land decision-making process.

We focused specifically on the CPR as well as SES literature. In general, we can conclude that also the irrigation-related cooperation literature can potentially help to identify land-water interactions. In the beginning we outlined first conceptual thoughts in how far a heuristic framework such as the SES framework could be extended to catch the interface. McGinnis and Ostrom (2014) already suggested that each “first-tier components to exist in multiple versions” (p.6); e.g. for irrigation systems, already two resource systems of surface and groundwater can exist. This adaptation of the SES only includes one resource. We proposed two ways to study the interface between two resources. This of course, has to be further adapted to a specific research interest. As shown in our example, either the farmer becomes the linking unit between two resource system or a particular second-tier variable land governance need to be added to the first-tier of the irrigation governance box. With this paper, we did not want to point to only one solution to study the interface. The two suggestions were meant to further emphasize the need for a more interlinked consideration of resources, also on the conceptual level. We showed that while including a new resource system, the SES framework is of course challenged in its simplicity and it becomes more complex. In this respect the SES framework is more encompassing and fits to more circumstances. However, we are also aware that it becomes less diagnostic. This goes in line with Theesfeld (11/8/2012), where she stresses that the more encompassing the SES framework will be designed, the less diagnostic in terms of causal relationships it will be. In addition, analysis becomes more complex when the resource system boundary is fuzzier than expected (Agrawal 2001; Cox et al. 2010). For instance, the actors cannot be simply attached to one system. In our example, the actors were outlined as the linking unit between two resource systems. Changing one first tier of the SES framework can imply for instance that also other second or third tiers need to be adapted. This was also discussed by McGinnis and Ostrom (2014) who outlined that when unpacking or changing one first tier can have drawbacks on other first or second tiers. For instance, as they changed the first tier from "Users" to "Actors", also new "Interactions" have to be considered. This also shows that the SES framework was and will be never considered as a static framework. In contrast, it is currently still further developed and even changes of the first tiers are being discussed.

To conclude from the conceptual thoughts and the empirical findings, land governance and specifically formal and informal land tenure in the future should be likewise recognized to enable sustainable water governance in Tajikistan. As the irrigation governance system currently is designed based upon the willingness to cooperate, land governance and farming structures (e.g. farm size and cropping patterns) can motivate farmers also to cooperate in water governance.

5 General Conclusion

The history of intensified irrigated agriculture in Tajikistan goes back to the early 1930s. Thus, also norms and habits over the use of agricultural resources have evolved over time. Especially, use practices of agricultural land and irrigation water have always been interdependent. After the country's independence in 1991, a new mix of remaining traditions, soviet mental models, post-war experience, but also international donor involvement, are now influencing the land and irrigation sector and its organisation. Often a clash between new legislations and old traditions emerged. Although agriculture in the Tajik lowlands has a good potential in terms of agro-ecological conditions, this potential has, so far, not been fully tapped due to various reasons among which weak land or water governance can be named. The land sector faces new governance instruments since 1990 onwards. Farmers can get individual use rights and thus individually decide on land management practices. The pressure of the continuous need to increase agricultural output to meet food and nutrition security remains high especially in the rural areas. So far, the potential of land tenure security to boost agricultural production is not entirely recognized by farmers. Compared to the land sector, the water sector faces similar challenges of ongoing structural changes and implementation of new governance instruments. This turns out to be very difficult as irrigation water distribution and allocation is very complex and demands for good water governance.

This chapter will first synthesize the research findings of the previous main chapters (2-4). Subsequently, limitations of the dissertation and future research needs are presented. Finally, based on the research findings, policy implications are elaborated. The three parts are mainly focusing on the empirical case study of the lowlands of Tajikistan. General comparative findings are carefully directed towards broader research conceptualizations. Further, regional implications for other regions within Tajikistan or similar countries of investigations are explained.

5.1 Synthesis of research findings

The overall research aim of the thesis was to explore the land and water sector jointly and to study the interface of land and water governance in a changing institutional environment for the case of two selected agricultural regions in Tajikistan. The dissertation has shown that a land and water nexus exists and governance linkages have to be revealed, verified and recognized. Therefore, it is not only worth looking at linkages between large-scale land and water grabbing cases, but small-scale land distributions can positively and negatively influence the irrigation sector. In all chapters, governance is considered as a critical dimension and revealed to be imperative in the nexus debate.

Chapter 1 defined the overall problem situation, identified three research gaps and introduced to the empirical case of Tajikistan and outlined the overall research design. The three research gaps were addressed throughout the dissertation in the following way. First, an in-depth analysis of an empirical case study that focussed on ad-hoc, domestic land governance changes was chosen to investigate the land and water nexus (Chapter 2,3,4). So far, only foreign, large-scale land acquisition processes pointed to the land and water nexus. In this thesis the two sectors were identified, compared and interlinkages between the two sectors determined. In addition, the empirical analysis provided original insights into a research area that has been widely underrepresented by the international research community. Tajikistan, besides its untapped agricultural potential and development gaps, is also of geo-political interest since it is located between other Post-Soviet countries under Russian influence, and facing China as a global economic player in the East, as well as bordering the edge to the Arab World, with Afghanistan as its southern neighbour. The second research gap was addressed in Chapter 3 and 4. On the one hand the property rights theory was further discussed and identified as suitable to compare the two sectors in a structured way. On the other hand, Chapter 4 specifically focussed on the SES framework and the CPR theory. Here, the SES framework was presented as a heuristic framework that is able to be adapted to a nexus view. The third research gap was specifically addressed in Chapter 2 and 3, where governance and property rights approaches were operationalised. It has often been postulated that subjective and objective governance, especially on the farm level, is difficult to measure. This dissertation addresses this issue and presents paths for cautiously conceptualizing and thus quantifying existing governance and property rights concepts.

The main results of the three chapters (2-4) are summarized below:

In Chapter 2, the link between land and water is advanced by identifying different land uses and users with varying water security levels. A new irrigation water security index is developed specifically for farm households. This index is s multi-dimensional consideration of irrigation water security, where three dimensions are considered: 1) hydrology, 2) governance, and a 3) hybrid dimension influenced by hydrology and governance. Tajikistan is an interesting case, where naturally water is abundant, but still farmers face risks of water insecurity. Water governance is a very critical dimension in Tajikistan, but it becomes even more central once worsening hydrological conditions are considered. For farm households, the aim would be to have a balanced hydrological and governance security level. Theoretically, if one dimension is underrepresented, the complementary dimension can step in as a coping mechanism. In cases where water availability is hydrologically likely, a proper water governance security is beneficial in the long run. It would be favourable to improve the relationship between both dimensions, especially when hydrological conditions are more advanced. Hydrological water security can trigger better subjective water governance security as farmers directly appreciate improved hydrological water security. Results show that if a certain threshold of hydrological security is exceeded, governance security is not increasing further. One part of the Chapter 2 developed clusters of three distinct farm types: 1) experienced, small-scale subsistence farms, 2) new medium-scale, market oriented farms, 3) larger-scale, market-oriented cotton farms. Although the overall WSI is similar across farm types, the results suggest that different farm types are threatened by different water security dimensions. The group of small-scale farmers are positioned in the middle, with rather low values of the governance and hydrological dimension. Whereas the medium-scale farmers face the lowest governance water security level, especially the large-scale producers are threatened by hydrological water insecurity. The different results of the governance dimensions can be referred to less farm management experiences and less cotton production, which is often supported by local authorities.

In Chapter 3, perceived land and water property rights of individual farmers to irrigate farmland are investigated. It is assumed that agricultural productivity gaps can be partly explained by the existing discrepancy between formal rights and perceived claims. Especially if customary claims are either not backed up by legislation or if farmers' customary claims are less pronounced, farm household's agricultural productivity is expected to be below its potential. The statement that the implementation of land and water reforms is still incomplete can be supported with our analysis. However, distinct differences exist between farm types and the resource sectors. Whereas the land sector is increasingly being individualized and individual property rights are being transferred to farmers, our analysis finds that water rights are still not transparent enough. Interestingly, the group of larger farms holds stronger customary water claims and the group of smaller farms holds stronger customary land claims. Besides the empirical insights of this chapter, also a systematic way of operationalizing the bundle of rights approach was developed. This way of operationalizing is a new method of quantifying the customary claims in order to contrast these to property rights. This systematic analysis is not only of importance for the methodology of single case studies, it can furthermore help to improve comparisons between cases from various contexts.

The aim of Chapter 4 is to determine the nexus of land and water governance. The latter one specifically focusses on new modes of water governance, namely the change from centralized water management to cooperative water management at a local scale. This chapter starts by outlining how the common pool and social-ecological system literature can contribute to study the land and water nexus. Two ways of extending the SES framework are presented: 1) integrating a land resource unit and system to the existing irrigation SES; 2) considering land system as an external influence on the irrigation SES. Extending the SES framework in this regard challenges the diagnostic nature of the framework. But with the empirical results, it is shown that the need for a land-water nexus perspective is reasonable. The empirical results of the Tajik case suggest that especially formal land tenure security positively impacts cooperation behaviour. In this chapter, perceived land claims play a substantial role and thus should be further recognized in water governance. Tajikistan's rural areas are diverse and thus the results also reveal differences for instance, that in southern Tajikistan, holding a certificate has more influence on the willingness to financially contribute to water governance. This can point to different implementation strategies of the land reform at local scale and the influential power of local authorities in place.

5.2 Research limitations and future research

The three main chapters have already addressed specific limitations of each chapter. Here, two main limitations of the overall dissertation and research design are presented: first, data availability and language barriers; second, status-quo research not including past or future expectations. Each limitation is briefly characterised and lessons learned for future research activities are drawn.

Lack of data availability had implications on two different levels of the dissertation: a) during field work and b) during the analysis. Regarding field work, the following problems were encountered. The lack of data availability on the village level, e.g. missing lists of farmers, did not allow for a standard random selection of farm households. Hence, a systematic way to deal with it was used and a common method of quasi-random selection was applied (see e.g. Chapter 3). Language barriers emerged during analysing national statistics as they exist in Russian, Tajik and sometimes in English. The translation of specific terms in these statistics, such as *dekhan farms* or collective farms, is sometimes non-consistent. The work with translators for the conduction of the survey posed another language problem. A certain loss of information can be expected, which is a common problem when working this way. With very intense training of enumerators and ongoing integration of the field work assistant, this problem was carefully addressed and tried to overcome. Especially during the qualitative interviews, information loss has to be considered, which is however less the case for the quantitative survey.

During the analysis, lack of national and regional statistics had to be faced. Especially when it comes to regional or village level data, statistics are not available or were not accessible. With regard to more sensitive topics such as land distribution among households and cotton production, it would have been beneficial to compare or back-up our results with more regional statistics. The lack of data availability had to be faced in Chapter 2, where regional data on hydrological figures would have contributed even more to an objective measurement.

The second limitation is that the survey answers present the perceptions, what farmers believe, feel or think and are willing to share at a specific point of time. Although it was the aim of the dissertation to investigate perceptions of property claims, one has to be careful not to directly transfer these perceptions to actions farmers are undertaking. In addition, the survey and qualitative data provide a glimpse of the current situation at hand. For instance, investigating the value of water to the users, such as the willingness to pay might even change over time depending on the seasons or ad hoc climatic changes in specific locations. To generalise these findings, one has to be very careful, especially in cases where certain answers are more socially acceptable than others (social desirability bias). This bias was recognized and limited as much as possible. For instance, only women were conducting the survey 1) to facilitate the access to the households in case a man is not present and 2) to prevent expected less reliable answers in case a man would survey a female headed household. This strategy has been chosen after an interview with an experienced survey company in Dushanbe. In addition, a longer introduction of our survey and an informal talk in the beginning were aimed to reduce doubtful questions and answers.

All of the limitations have to be dealt with in the future. For foreigners entering an unknown country such as Tajikistan, where especially international research presence is low, will always remain a challenge and data availability, trust and language barriers cannot easily be solved. But they should be carefully considered when conducting such a study. Directly collaborating with e.g. Tajik students might help but of course demand long-term and strong relations between institutes. In general, over the past two years, the political climate for doing international research in Tajikistan did not become more hospitable. This might limit international research activities in the future – depending on the subject. Interdisciplinary or counter-part studies might be helpful in this respect.

In most of the transition countries, long-term analysis is still missing, which would, however, be very insightful to conduct especially after about 20 years of transition. Especially for Tajikistan, it would be interesting to investigate why and how epistemologies of property claims evolve and how they develop in the future. A long term study on property rights and claims can help to identify the evolution and development of claims. From there, one can draw conclusions about long-term developments and prospects (either negative or positive) regarding a) recognition of property claims by law makers; b) equal distribution of property claims among farmers leading to the same production potentials.

With regard to operationalize existing approaches, more research would be needed to make resource governance indicators comparable (between countries, regions but also between smaller units such as farmers). The role of operationalizing and coding existing concepts can be very helpful to specify, identify and scale-up common challenges and common solutions for common pool resource management. Further, replication of results can be easier. However, narrowing down a concept can also lead to information losses, which has to be avoided. This systematic analysis is not only of importance for single case studies, it can further help to better compare between cases in various contexts. Here, research is already ongoing with regard to large-N-studies of common pool resources. Some examples are evolving databases such as the International Forestry Resources and Instututions Database or the Secoial-Ecological Meta-Analysis Database. Current databases however do not integrate a more decomposed consideration of property rights as it has been applied in this thesis.

5.3 Implications for policy makers and practitioners

Fostering land tenure security is not a new phenomenon and several international organisations and donors have promoted this, especially in developing countries. Thus, a set of policies and interventions, which have been tried and tested, exists. The findings of this study suggest to focus on some specific policies, specifically considering a land-water nexus view. In general, improvements of the governance dimension might face bigger resistance from the side of previously privileged users.

Here, mainly specific recommendations for the irrigated lowlands of Tajikistan are referred to. Especially with regard to the implementation of reforms, differences between the regions in Tajikistan, specifically to the autonomous, mountainous regions, exist. Some policies might be transferred to other (transition) contexts, but carefully, which would be up to the policy maker. The policy implications can be divided into three main categories:

1) Consideration of the land and water interface: reforms and perceptions
2) Cooperation in water governance: an example of water payment schemes
3) Transparent implementation of land and water policies and instruments

Consideration of the land and water interface: Reforms and perceptions

For policy makers as well as practitioners it is recommendable to consider the land and water nexus from a governance perspective. The joint use of resources at farm level, should be addressed and facilitated by policy makers at national level as well. But, it has to be stressed that neither a joint land and water reform nor a joint framework can be used as a blue print solution to handle resource scarcity in the future. Yet, a land and water nexus approach at national level would imply a more strategic alignment of the land and water sector as well as a cross-sectoral coordination. This coordination should include to integrate feedback loops of current mismanagement or failure of certain reforms to the complementary sector. Or in contrast, see the potential positive impacts of one resource reform to improved governance of the other resource. For instance, a positive impact is shown by the results in chapter four, where improved tenure security in form of land certificates positively influence collective action behaviour in irrigation systems. A single evaluation of one resource sector is only valid to answer specific one-sector related questions. Especially under large-scale institutional changes, such as for instance the overall transition process, governance changes of different interlinked sectors are important to be considered. Also international projects so far only implemented sector-specific projects in Tajikistan. The regulation and implementation of new land reforms should account for positive benefits and negative disbenefits resulting from the water sector to avoid further risks.

This does not only concern the national policy making level, but likewise the decentralized administrative levels, down to the implementation on the local scale. As Chapter 3 and 4 have shown, perceived property claims for one sector does not simply allow to assume the same bundle of rights for the other sector. Land reforms are not only an instrument to overcome Soviet agricultural systems, but a potential way to push rural areas. If they are implemented transparently they can strengthen local institutions. According to this, farmers can create perceptions and expectations.

For countries such as Tajikistan, where reforms have changed a lot during the past years, it is not simple or not even recommendable to set up another new reform. According to observations during the field work, farmers were often not even interested in information about new reforms anymore or did not recognize them as reliable as they might change anytime soon again. Thus, continuity of and establishing reliable reforms has to be focussed at. But still, considering the interface seems to be reasonable enough for policy makers. So a way how to adapt water policies to land reform outcomes, without creating new “invisible” responsibilities that are not known and not recognized by the farmers is needed. Especially in the water sector, relying on former responsibilities seemed to be important. However, these responsibilities should be trained and guided according to the new needs of the water management systems and not sticking to the Soviet water management system. In general, integrating a new irrigation approach with specific management tasks at the local level can create new jobs and new (irrigation) water specialists.

Cooperation in water governance: an example of (voluntary) water payment schemes

Cooperation among and proactive engagement by farmers in water management is central for water governance. This research has provided insights into the willingness of farmers to cooperate in water management. On the one hand, in several informal discussions, the dynamics and motivations of farmers to contribute to water management and infrastructure development were grasped. These dynamics were however often neglected or even sanctioned by local authorities. Many farmers are simply not used to or willing to contribute to collective water management, as they never had to deal with this before and are still driven by past experiences. For instance, although WUAs have been developed to address this problem, the establishment of these organizations does not inevitably imply full commitment and awareness of farmers being willing to contribute. As Chapter 4 has shown, some mechanisms to increase the willingness to pay can be likewise achieved through land certificates, land management claims and the possibility to access more land. The formalization of land rights, thus formal security of land, in our case is especially of importance for improved water governance. It has to be recognized by policy makers that behavioural changes are not simply introduced with new organizational structures.

Not contributing to water payments is one cooperation problem and it is here considered as an example for policy intervention options. Although a payment scheme for irrigation services has already been established in Tajikistan, it needs to be enforced and accompanied with more transparency to directly show the mid- and long-term benefits of the individual contribution. The largest investments are needed to re-build and construct the basic infrastructure, such as the major canal systems and reinforce the dams which have been constructed during Soviet time (e.g. Nurek and Kairakkum dam). This is especially important for surface water management. Tajikistan has the advantage to benefit from existing infrastructure, but needs to see the potential of it. These infrastructure costs are difficult to be covered by the farmers only. Thus, a new payment scheme is required and different steps need to be considered. First of all, a baseline study or a systematic analysis of the de facto canal maintenance situation would be needed to determine the extent of losses and to specify where new technologies would be needed. In one norther sub-region of Tajikistan, such a study was conducted by the regional administrative office. This study did not only help to analyse the current situation, but to use the results as a tangible guiding principle to be discussed with higher officials. In this region, many farmers referred to this investigation and were aware why they have to contribute as well by means of water payments. This base-line study could include a more detailed (participatory) mapping approach. The outcome of participatory mapping activities during the fieldwork generated strong interests by diverse farm types or WUAs to specifically point to problems and potentials of the current irrigation system.

Currently, paying for water is neither transparent in terms of how it is calculated and who pays how much nor it is correctly monitored. This has to be improved in the future. For instance, water metering to distribute water is often performed based on experiences by a specific group of farmers, based on which, the metering costs are calculated. A more consistent and transparent approach of water payments such as precise volumetric or per-hectare calculation can increase the short-term willingness to pay. A more transparent payment scheme depends on the regional conditions of water infrastructure, and the actual costs of supplying water.

Transparent implementation of land and water policies and instruments

The previous policy recommendations already implicitly pointed to the need for transparent and ongoing information sharing of land and water policies. Transparent information remains an important instrument to control and steer resource use. Especially Chapter 3 has shown, that farmers´ perception regarding land and water rights vary between the resources and farm types. To a certain extent, this can be the result of unequal information among farmers. It is of course not a new policy recommendation, neither for Tajikistan nor for other developing countries. However, this study has again shown that it is of importance.

Let us take the example of an agricultural advisory service as one unit of information sharing. In Tajikistan, especially in Soghd, agricultural advisory services have been successfully introduced. So far, they mainly address agronomic issues. For policy makers the question could be raised whether these official services can include water as well as land governance issues once they already have a good reputation and replicate implementation strategies on water issues as well.

Transparent and continuous information sharing is of course difficult, if policies are continuously being changed as it is the case in Tajikistan. Here, an example of a non-governmental organisation, called Namati, is presented. They specifically work on legal empowerment in the land sector. In various countries, they have introduced so called “community paralegals” that act as legal advocates on the grassroots level. According to Namati, these paralegals “share common characteristics – they are trained in basic law and in skills like mediation, organizing, education, and advocacy. They form a dynamic, creative frontline that can engage formal and traditional institutions alike” (Namati 2015, last accessed 01.03.2016). An important principle is that this person should be trusted and recognized by different instances, not only by authorities or farmers. But a question is then what role do policy makers play in this respect? Policy makers on the one hand might financially support these programs, but on the other hand, especially recognize the importance and facilitate implementations of such paralegal programs. Also in the case of Tajikistan, in each community, there are community members who are well-informed about laws and other legal arrangements. It would be recommendable to build upon existing knowledge networks, and available capacities, not to create new ones. If this well-informed, trusted and socially-accepted person of one community is accepted by policy makers, he/she can act as such a community paralegal to facilitate transparent information sharing.

The three policy recommendations presented above can complement each other. Most relevant for policy making is that solutions for successful irrigation management can be also addressed and achieved by improved land governance, such as secure land tenure. This demands improved communication and coordination between the land and water policy makers. Further, the engagement between policy makers and farmers can reduce discrepancies between paper and practice but also inequalities among different farmers. Improved land tenure security can increase proactive engagement by farmers and increases their water governance security. Overall, the dissertation has shown that considering synergies between the land and water nexus can be a vehicle to not only understand linkages of the two sectors, but to determine positive feedback loops between them. Especially for countries where one resource is abundant and the other one is scarce, such as water abundance and land scarcity in Tajikistan, synergies between the sectors can still increase the potential of agriculture. To look at the nexus should not imply to complicate things more, it rather gives the opportunity to investigate and study new and more effective and efficient solutions to deal with increasing resource scarcity.

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Appendix

Appendix A1: Chapter 4

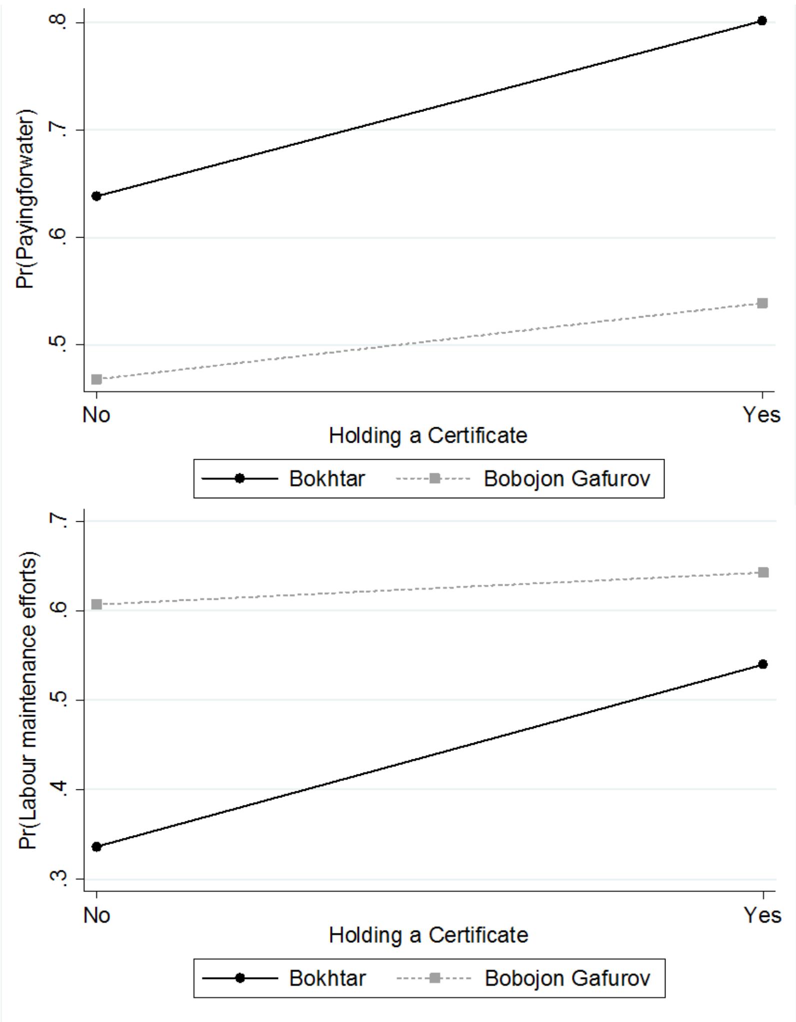

Figure A 0-1 Predictive margins of land certificate and district variable

Source: own calculation based on Farm Household Survey 2013

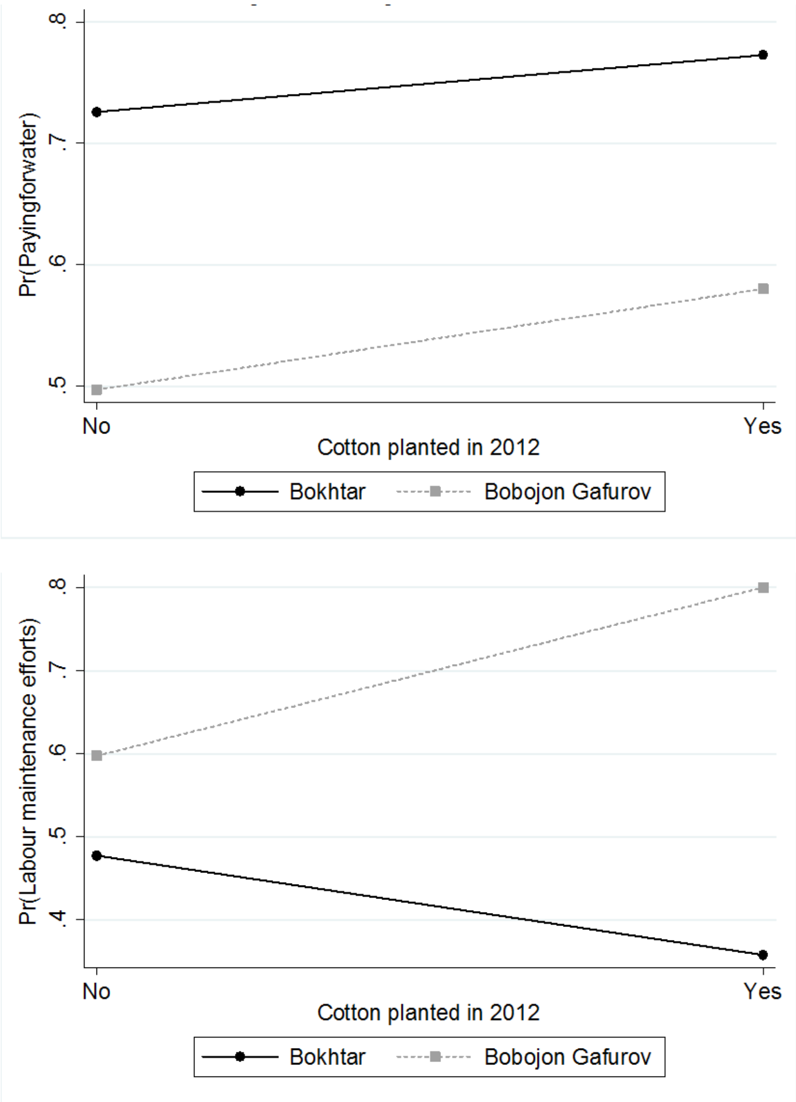

Figure A 0-2 Predictive margins of cotton and the district

Source: own calculation based on Farm Household Survey 2013

Appendix A 2: Farm Household Survey

Assessing the Interface of Land and Water Use and Regulations
Farm Household Survey in Tajikistan

The purpose of the survey is to learn how farmers use their land and water resources for agriculture (not drinking water), how the use is formally and informally regulated and by whom. Therefore two rayons of Tajikistan were chosen, where one of the rayons were chosen. In Tajikistan, the survey is supported by the Tajik Agricultural Research Academy of Science. We are interviewing different farms in your village and in other villages of the rayons. You were randomly selected. The personal information you are providing will not be connected with the other information of the survey. All information will be handled in confidence. This interview will take about 1 hour.

A) GENERAL INFORMATION

A1) a. What type of farm are you running **NOW**? ***If YES = ✓ for Farm Manager, for being a shareholder= X***

Variants	Code	
A presidential land	1	
A household plot	2	
A big garden	3	
A collective dehkan farm (a former kolkhoz, a production cooperative)	4	
A family dekhan farm	5	
An individual dekhan farm	6	
A cooperative\association, comprising individual and extended family farms	7	
A Joint Stock Company	8	
A kolkhoz	9	
A goshoz (sovhoz, uchhoz, mejhoz, plemhoz etc)	10	
Others	11	
Don´t know	99	
If you have a Dekhan Farm, are you a member of an association? If YES = ✓	15	

A2) a. Please fill the **FULL** table.

	Number	Unit (ha, sotka, m2)
a. Size of total agricultural land used		
b. Size of Irrigated agricultural land		
c. Size of Not irrigated land / Dry land		
d. Size of Cropland		
e. Size of Pasture		
f. Size of Fallow Land		
g. Size of Land mentioned on the certificate		
h. Size of Household plot near house		
i. Size of (officially) Rented / leased land		
j. Size of (unofficially) Rented / leased land		
k. Size of Community owned land (household does not lease it individually)		
l. Other		
m. Livestock Owned (please specify)		---------------------

b. Has the size of irrigated land changed since the past 5 years?
___ Increase ___ Decrease _____NO change
c. Besides your own farm, are you a FARM WORKER in a big farm?
___ Yes ___ No

A3) a. Could you get access to use more land if you wanted to? Use ✓
___ Yes ___ No
b. How far is the next big farm (proximity to next big farm, e.g. cotton farm):
Number_____________________________Unit____________
c. Has land lately being reallocated in your neighborhood?
___ Yes ___ No

A4) **IF NO**: Please read the following statements and indicate with ✓ ?

	Code	
I do not know which authority I have to contact	1	
The process (legal aspects, registration) is too complicated	2	
Obtaining more land is too expensive	3	
Debts on arable land are too high	4	
We do not have enough manpower to cultivate more	5	
No machinery to work on it	6	
I want to avoid negotiations about water	7	
I want to avoid negotiations about land	8	
Other reason (specify)	9	

A5) a. Do you currently rent out land to others? *Use* ✓
___ Yes ___ No
b. If **YES**, how many hectares? *Write down a number*: ___________ , _________Unit (ha, sot).

A6) How many people are cultivating land on this farm? Write down numbers for each.
a. Total No of people (men, women, children, from the HH and others) _________
b. Farm workers (**Hired Farm Workers not from your family**) _________
c. Men (all) _________; d. Women (all) ________
e. Number of Shareholders _________

A7) When was your farm established as it is organized now? (WHEN DID YOU STARTED FARMING ON THIS PLOT?) __________

A8) a. Is this farm reorganized? *Use* ✓ ___ Yes ___ No
b. or newly established***? Use*** ✓ ___ Yes ___ No

A9) a. What **profit** did you make in 2012 on your farm *(99 for don´t know)*
_____________ Somoni

B) <u>LAND AND WATER **USE** AND **ATTRIBUTES**</u>

B2) Crops choice and production in 2012 (**if questions a does not have ✓, then questions b. – g. do not have to be answered)**

	Cotton	Whea	Rice	Corn	Onions	Potatoe s	Carrots	Tomatoes	Cabbage	Sunflower	Cucumber	Orchards/ nuts	Vineyards	Other
a. Was this crop planted in 2012 *Use for YES* ✓ ?														
b. How many hectares of each crop were planted? in ha ***(if another unit is used, please indicate here_________)***														
c. What was the total yield of the crop (in kg)? ***(if another unit is used, please indicate here_________)***														
d. How much was sold of each crop (in kg)? ***(if another unit is used, please indicate__________)***														
e. What was the average price for each **kg** crop? ***(if another unit is used, please indicate__________)***														
g. Which crops need to be irrigated? *(1=needs a lot water; 2 = moderately water intense; 3 = less water intense, 4= needs no water)*														
h. Have you always produced this crop? (*1= yes, 2= have stopped producing it, 3= have newly introduced it in the cropping plan*)														
g. Which crops are important for the following categories? *(1= economic importance, 2= food security importance, 3= obligatory to produce it)*														

B3) a. Which source of water are you using for irrigation? (***Only choose ONE, Use ✓***)

	Code	
Only Groundwater	1	
Only Surface Water	2	
Only Rainwater	3	
A mix of ground- and surfacewater	4	
Other (indicate)	5	
Don´t know	99	

b. Which irrigation technique do you apply on your farm? (examples: drip irrigation, gravity irrigation, etc.)
Write down the technique: ____

B4) Irrigation Infrastructure:
a. What irrigation infrastructure do you **directly** use on your farm?
b. What is the distance from your farm to the canal, pump or well you are using?

	a. What do you use? Write down a number for: *(1 = Yes with direct access to canal on to land,1A= Yes, but not direct access to canal on land, 2 = Sometimes with direct access to canal on to land, 99= Don´t know)*		b. Distance between Farm and Infrastructure *(in m)*
Primary Canal			
Secondary Canal			
Tertiary Canal			
Other Canals			
Direct River Access			
Cistern (as rainwater tank)			
Pumps (also indicate the Number)		Number:	
Wells (also indicate the Number)		Number:	

c. How many people are using the same **direct** water infrastructure you are using? Write down a number.
_______ (*99 for don´t know*)

d. If you are an irrigation canal user, where is your farm located along the canal? ***Use*** ✓

At the beginning of the canal	1	
Between the beginning and the middle	2	
In the middle of the canal	3	
Between the middle and the end	4	
At the end of the canal	5	
Don´t Know	6	

e. Has the number of users of the same infrastructure changed during the last 5 years? Use ✓

Increase of 1 to 2 users	1	
Increase up to 5 users	2	
Increase of more than 5 users	3	
Decrease of 5 users	4	
Decrease of 1 – 2 users	5	
The same number of users	6	
Don´t Know	7	

f. If YES, who, in terms of, which farm types, are those new users? (Example: dekhan farms, household farms etc.)
____

B5) a. At what time a day do you irrigate? Time: __________, __________, ____________
b. For how many hours per day_______________
c. How many days per week _________________

B6) Is the water sufficient to irrigate all your land? Use ✓
___ Yes ___ No

B10) In 2012: in which month of the year, do you had… (please write down the months)

a. enough water	

b. no water	
c. too much	
d. not constant, highly variable	
e. moderately variable	
f. Don´t know	

C) LAND AND WATER **TENURE/ REGULATIONS**

C1) Please mention in one sentence what secure land and water rights mean to you?

C3) a. Which **person** decides on your volume of water? ***Use*** ✓

Water User Association	
Own decision	
Responsible Person for Water on the Farm	
Hukumat	
Jamoat	
Vodkhoz/ Water Canal	

b. Which person ***opens*** the gate for your water supply? ________________________

c. Which person ***maintains*** (cleans etc.) the…

Main Canal ______________

Canal between Main and on Farm Canal ______________

On Farm Infrastructure ______________

Pump ______________

C4) Does your farm has a **certificate** that proves ownership of the land you are using? Use ✓

Yes, issued to me	Yes, issued to someone else	No	Other documents proofing land tenure, ***please specify***	Do not know
1	2	3	4	99

C4) a. If **YES (1 or 2)**, since when do you have the certificate? ___________

b. If **YES (1 or 2)** For how many years in total? ___________

c. If **YES (1 or 2)** , how many months did it take to get it? ___________

d. If **YES (1 or 2)** What has changed since you are holding a certificate? Use ✓

	Code	
Buying machines	1	
Soil improvement	2	
Invested in water infrastructure	3	
Became a member of a WUA	4	
Became member of a Farmer Association	5	
More variance in crop production	6	
I can better negotiate on land allocation	7	
I can better apply for more land plots	8	
Nothing has changed	9	
Others, please list:		

C5) Farm level costs for Land and Water in Somoni, please write down the amount in Somoni. PLEASE FILL ALL

Getting Land Certificate (once)	
Managing Land (annual), INPUT COSTS (FERTILIZER; MACHINES etc.)	

Land Taxes (annual)	
Become a member in a WUA (entry costs paid once)	
WUA Membership fees (regular)	
Managing Water Infrastructure (**not** via WUA) (annual)	
If you use pumps, how much do you pay for the electricity?	
Water Fees	

b. How is the water charged? Use ✓

Payment per size of irrigated land		
Payment per volume of water used (metering of water)		
Payment for one month of free water access		
Payment only for WUA, water access is for free		
Free access to water		
Others		Specify:

c. Are the water **payments** written down in a document? Use ✓
___ Yes ___ No
If **YES**, where?________________________

C7) Would you agree to the following statements?
a. I think the land reform is good implemented.

1	2	3	4	5	99
Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Do not know

C8a) Which of the following statements are true for you? Use ✓

	Land
The land allocated to me was too small	
The land allocated to me was of low quality	
High registration costs	
I was not fully informed about my rights	
Large landowners had better chance to get land	
Others, please specify	

C9) a. Please evaluate the criteria of the water and land situation on your farm. **COMPLETE** the table Use ✓

	a.	1	2	3	4	5	88
		Very Good	Good	Acceptable	Poor	Very Poor	No opinion
Water	Sufficient						
	Sheltered						
	Continuous						
	Good Quality						
	Equitable Distribution of water volumes between farmers						
	Implementations of Local Regulations						
	Implementations of WUA						
Land	Sufficient						
	Sheltered						
	Long-term						
	Good Quality						
	Equitable Distribution between farmers						
	Implementations of Local Regulations						

c. Please evaluate the same criteria of the water and land situation on your farm **10 years ago**. **COMPLETE** the table Use ✓

	a.	1	2	3	4	5	88
		Very Good	Good	Acceptable	Poor	Very Poor	No opinion
Water	Sufficient						
	Sheltered						

	Continuous						
	Good Quality						
	Equitable Distribution of water volumes between farmers						
	Implementations of Local Regulations						
	Implementations of WUA						
Land	Sufficient						
	Sheltered						
	Long-term						
	Good Quality						
	Equitable Distribution between farmers						
	Implementations of Local Regulations						

D1) Please rank the following criteria. **COMPLETE** the table Use ✓

WATER	**Always**	**Very Frequently - Depending on the season (less variable)**	**Occasionally – very variable**	**Rarely**	**Never**	**Others**
Can you/Are you allowed to use/ access water for irrigation?						
Can you/Are you allowed appropriate the water?						
Can you/Are you allowed manage water (on own perception)?						
Can you/ are you allowed to invest in irrigation systems?						
Can you/ Are you allowed to exclude others from using same water infrastructure?						
Can you/Are you allowed to reallocate water to others?						
Can you/Are you allowed to sell water to others?						
Can you/ are you allowed to negotiate on others water volume?						
Can you/ Are you allowed to use as much water as you like?						

LAND	**Always**	**Very Frequently - Depending on the season (less variable)**	**Occasionally – very variable**	**Rarely**	**Never**	**Others**
Can you/Are you allowed to use ALL your land for agriculture						
Can you/ Are you allowed to appropriate your land						
Can you/ Are you allowed to manage land on own perception						
Can you/ Are you allowed to improve (investing) in better quality land						
Can you/Are you allowed to exclude others from using land around your farm						
Can you/Are you allowed to reallocate land to others?						
Can you/Are you allowed to sell land to others?						
Can you/Are you allowed to inherit your land?						
Can you/Are you allowed to lease out land?						

Can you derive full income from the land output?						
Can you/Are you allowed to change the land use (crops)?						

D2) Where could you recognized the biggest changes during the last 5 years? (***Use – for negative change, + for positive change***)

	Land	Water
Access		
Use		
Management		
Exclusion		
Alienation		

D3) **Compared to other villages**, what are your a. advantages and b. disadvantages of YOUR land and water situation?

Advantage	Disadvantage

E) <u>**OUTLOOK** OF LAND AND WATER ACCESS</u>

E1) Some countries allow farmers to buy and sell land rights. Would you favor or oppose?
___ Favor ___ Oppose

E2) IMAGINE: If you knew that the land is "owned" (not only use rights) by you, how would this affect your water situation?

E3) IMAGINE: If you knew that your water would be stolen by others, how would you react?

E4) What key steps need to be taken in the next 25 years to ensure sufficient. water:

E5) Imagine, Can the following persons increase water and land conflicts? Use ✓

	not a problem	somewhat of a problem	a serious problem
Increase of Population			
Foreigners			
Former villagers returning to claim land			
Family Members claiming land			
Others			

F) <u>FARM DETAILS</u>

ID (Enumerator 1 starts with X1, X2, etc. Enumerator 2 starts with Y1, Y2, etc. Enumerator 3 starts with Z1, Z2, etc.)	
Phone No	
Gender	

Age	
No of HH members	
How much remittance do you get in one year? (voluntary questions), if not answered, ask whether they get remittances at all, yes or no	
Do you get Non-Farm income?	
Are you born in this village?	
Date of Interview	
Jamoat and Village	
District	
~~Enumerator~~	
Language of communication	

PLEASE ALWAYS MAKE SOME NOTES AFTER THE INTERVIEW (was there something special, were you interrupted etc.):

Appendix A 3: Focus Group Discussion/ Participatory Mapping Guideline

- *The purpose of this study is to learn about the land and especially water management in your village*

- *The information you give us is completely confidential, and we will not associate your name with anything you say in the focus group.*

- *We would like to take some notes during the focus groups so that we can make sure to capture the thoughts, opinions, and ideas we hear from the group. No names will be attached to the focus groups*

Logistics
- Focus group will last about 1 1/2 hours
- Feel free to move around
- Help yourself to refreshments

Materials and supplies for focus groups
- Pads & Pencils for each participant
- Three big papers
- Paper notebook for note-taking
- Refreshments

Introduction:

1. Welcome
   Introduce yourself

2. Some Ground Rules
   - Everyone should participate.
   - Information provided in the focus group must be kept confidential
   - Stay with the group and please don't have side conversations
   - Have fun

3. Ask the group if there are any questions before we get started, and address those questions.

START:

A. *MAIN TASKS OF THE WUA*

For this, we use one white big sheet (this will be prepared in advance)

With different colours we write down:

a. Characteristics of the WUA (since when?, how many members (active and non-active), entry costs, regular payments, how was this group established?)
   Characteristics of the villages (number of population, number of dekhan farms, main crops)
b. Main tasks of the WUA, what are the responsibilities?
c. What are the main formal working rules of the WUA (membership rules)? (codified texts, law)
d. What are the main customs and non-written rules? How do you decide when (at what time) a farmer can irrigate?
e. GENERAL: What are the water costs in your jamoat? How much IS paid per m3? How much would have to be paid?

   - What group or individual is responsible for making decisions about the given amount of water?
   - Who participates in making decisions by a given group?
   - How are decisions made by that group?

B. *PARTICIPATORY MAPPING*

For this, we use a second white big sheet, different colours

a. Ask the individual or the group to draw the boundaries of the geographic unit – the village. **each** participant can indicate and write down the name of the village
b. Draw the basic outline of the local area, for example, roads, or rivers and irrigation canals
c. Draw the gates of the irrigation canal, how is water distributed? Where does the water come from? Upstream and Downstream levels? Has it always been like that? Where were the old canals?
d. Outline roughly the different farm types existing in your village? (Where are the very big farms? Etc.)
e. Can you draw more canals which you would like to install in the future?

Passing questions:

- What are good examples for efficient water use and management?
- Which are the problems your community is confronted with (related to water or land)?
- Where are these problems located?
- Potentially: *Who* is responsible for these problems?
- Are problems connected to each other? How do the problems influence each other?
- What are the strength of your WUA?
- What could be improved in your WUA?
- Do you know examples of other WUA where it is not working at all? What could be reasons?

Appendix A 4: Jamoat Interview Guideline

A) GENERAL INFORMATION

District	
Name of the Village	
Communication Language	
Date of Interview	
Population of the Village 2012/2013	
Population of the Village 1990	
What is the ha size of agricultural land in your village?	
What is the ha size of irrigated agricultural land in your village?	
Details of Village location (Water Sources, Distance to next city)	
What is the share of people earning the major income from agriculture?	

Land and Water

B1) What specific environmental and social events in the past had impacts on land and water?

On Land and Water Use:____
On Land and Water Rights:____
On Land and Water Distribution:____

B2) Who is responsible in your village for:

Regulating Land use __________
Issuing Land use certificates __________
Regulating Water distribution a. Opening the Gates __________
b. Maintaining Canals __________
Issuing Water Certificates __________

B3) How many land certificates have been distributed since the land code?

Type__________ No_______ Average Farm size __________ha
Type__________ No_______ Average Farm size __________ha
Type__________ No_______ Average Farm size __________ha
Type__________ No_______ Average Farm size __________ha

Extra sheet: Looking on a Map, can you please explain…

Open questions:

a. *Could you please explain the "village structure"?*
b. *How is land distribution organized?*
c. *How many different farm types exist, can you give me examples where they are located?*
d. *Where are the largest farms?*
e. *Where are the cotton farms?*
f. *Which sources of water do they use?*
g. *Can you specify the reorganization process in your village?*
h. *What are the main problems of land and water USE?*
i. *What are the main problems of land and water availability for farmers?*
j. *What are the main problems for obtaining formal land and water access (legal certificates)?*
k. *Who (which farm type) has those problems (going one by one)?*

Changes in Land Use and Users

C1)

a. *During the last years, could you recognize farmers using larger land plots?*
b. *Could you recognize any form of land use changes in your village? Do you think it changed the water consumption?*
c. *What type of land are they using? (Unused land or land already cultivated beforehand by other farmers?)*
d. *Are those farmers, who are using larger land plots now, from your village? Where are they from?*
e. *How did the change in farm size and land users affect your village according to land distribution and land conflicts?*
f. *Are there smaller or bigger disputes about water in your village?*
g. *What are the consequences of leasing large land plots by new farmers on the water access by smaller farms?*

C2) ***Imagine****:*

a. *If there would be large farms established, would you be part of the land allocation/ distribution decision making process?*
b. *How could you be able to determine which land to use by "others" or not? On which legal documents you could rely on?*
c. *What could be direct benefits and problems for "old" farmers in your village if outsiders increasingly use land in your village?*
d. *Would you be in favor of more "outside" investments? Why?*

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ACADEMIC BACKGROUND

Since Jan 2012 — **Institute of Agricultural and Nutritional Science, Martin- Luther-University (MLU) Halle-Wittenberg, Germany**

PhD Programme in *Agricultural Science*
PhD Thesis: The Land and Water Nexus in a transition context: The case of Tajikistan
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March 2009 - Oct 2011 — **Faculty of Agriculture and Horticulture, Humboldt University Berlin, Germany**

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Bachelor of Science in *Applied Geography* (Minor: Economics), October 2008
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Eidesstattliche Erklärung

Hiermit erkläre ich an Eides statt, dass ich die vorliegende Arbeit selbständig und ohne fremde Hilfe verfasst habe, keine anderen als die von mir angegebenen Quellen und Hilfsmittel benutzt habe und die den benutzten Werken wörtlich oder inhaltlich entnommenen Stellen als solche kenntlich gemacht habe.

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Emlichheim, 04.10.2017