

Resilience and Adaptability in the lower Amudarya river basin, Central Asia

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Abstract

The current water management regime in the Amudarya river basin, Central Asia, has proven to be rather resistant to change despite external and internal pressures caused by recent political, environmental or donor induced developments in the region. The poor ability of the social-ecological system (SES) in the river basin to adapt to ongoing ecological and political changes seems to decrease the resilience of the social-ecological system to internal and external shocks, which was evident e.g. in the impacts of a severe drought in 2000/2001. By analyzing the resistance of the current system to change and first attempts of institutional change in land and water management in the Amudarya river basin based on historic developments we determine drivers of policy and institutional change as well as structural factors and mechanisms that act as barriers to change. Does the reform process in water management increase the resilience of the SES to changes in resource availability?

The analysis reveals structures and processes of the social-ecological system that contribute to its current inflexibility and resistance to change. They are rooted in the history of the social-ecological system in the river basin, such as the economic dependence on cotton and other agricultural products and the state-centered management approach. The centralization of power and competences reduces the capacity of the system to react on the adequate scale. This is aggravated by a loss of transparency, compe-

tence and knowledge caused by the transition process. However, there are opportunities for change and adaptation, rooted in the large restoration capacity of the ecosystems as well as in the increasing awareness and growing experience in designing and dealing with new institutional structures, especially at the local level, and the high flexibility of the system once a decision is taken at the national level.

Introduction

The current water management regime in the Amudarya river basin, Central Asia, has proven to be rather resistant to change despite external and internal pressures caused by recent political, environmental or donor induced developments in the region. With the breakup of the Soviet Union the political and socio-economic boundary conditions on the river basin as well as national scale have changed significantly. Moreover, environmental degradation caused by overuse and mismanagement of the region's water resources has strongly affected agricultural productivity and the living conditions in the river basin. However, especially in Uzbekistan, little adaptation measures and only few reforms in water management have been carried out so far. Consequently the current water management institutions are becoming more and more inadequate to cope with the new situation. The potential effects of climate change on the flow regime of the river might aggravate the situation even more.

Water is a strategic and vital resource for all river basin countries because of their strong reliance on irrigated agriculture. Today more than 90% of the region's water resources are used in the agricultural sector with well-known consequences for riverine ecosystems and the Aral Sea. The ecological and the social system in the river basin are strongly linked by their water needs. Measures for a sustainable resource use that maintains or enhances the resilience of the system thus have to take those interdependencies into account. The poor ability of the current social-ecological system (SES) in the river basin to adapt to ongoing ecological and political changes seems to decrease the resilience of the social-ecological system to internal and external shocks, which was evident e.g. in the impacts of a severe drought in 2000/2001. By analyzing the resistance of the current system to change and first attempts of institutional change in land and water management in the Amudarya river basin based on historic developments we determine drivers of policy and institutional change as well as structural factors and mechanisms that act as barriers to change. We are interested in how the capacity of the system to cope with resource variability

has changed over the past 40 years, especially in the time since independence and which measures might move it to a more sustainable state. Does the reform process in water management increase the resilience of the SES to changes in resource availability?

Our analysis of the social-ecological system in the river basin and its adaptive capacity is based on the concept of complex adaptive systems whose behavior is inherently unpredictable as change can happen by surprise (Levin 1998, Pahl-Wostl 2007). Special attention is put on the interactions between social and ecological components of the system, because they largely determine the behavior of the system (Anderies et al. 2004). It is often the nature of those interactions that determines the capacity of a system to adequately respond to stress and adapt to change (Schlüter and Pahl-Wostl, 2007). The ability of a system to respond to external and internal change, i.e. the resilience of the system, is a key component of complex adaptive systems and at the center of this analysis. Resilience “*determines the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist*” (Holling 1973). Within the social component of the system actors through their actions determine the adaptive capacity of the system as a whole (Walker et al. 2004). Adaptive management approaches aim to introduce measures and initiate institutional change that enhances the adaptive capacity of a social-ecological system to cope with uncertainty and a changing environment (Pahl-Wostl 2007) and thus increase its resilience.

The goal of the paper is to identify the role of linkages between ecological and social processes in shaping developments in the river basin and to assess the potential of the ongoing water management reforms in Uzbekistan to increase the capacity of the water system to cope with institutional and environmental change. For this we analyze drivers of institutional and ecological dynamics in the lower Amudarya river basin and responses of the social system to pressures from the larger ecological and institutional settings. We are especially interested in identifying linkages between the ecological and social systems that enable an adequate response of the coupled system to external change and internal pressures. With respect to time we focus on the period after independence of the Central Asian Republics from the Soviet Union in 1991 taking environmental and socio-economic developments prior to independence into account where they are necessary to understand recent trends. As to the social system emphasis is put on institutions in land and water management at the national level in Uzbekistan. On the ecological side we focus on the semi-natural ecosystems in the delta area, as well as water and land resources in the Uzbek province Khorezm and the Uzbek Autonomous Republic of Karakalpakstan (Figure

1). Being in the downstream reaches of the Amudarya river those areas are some of the most severely impacted by resources and environmental degradation.

The analysis presented here is based on series of interviews with policy makers and stakeholders in land and water management in Uzbekistan, on a study of international donor involvement in the Aral Sea basin, and participation of both authors in several small and large scale socio-economic and ecological research and development projects in the Aral Sea Basin. After a short introduction to the current water management situation and problems in the river basin we present an analysis of major historical events and the dynamics of ecological and institutional change. We then discuss their interactions or lack of thereof with respect to their impacts on the current state of the river basin and its potential development and identify factors that act as barriers for adaptive change.

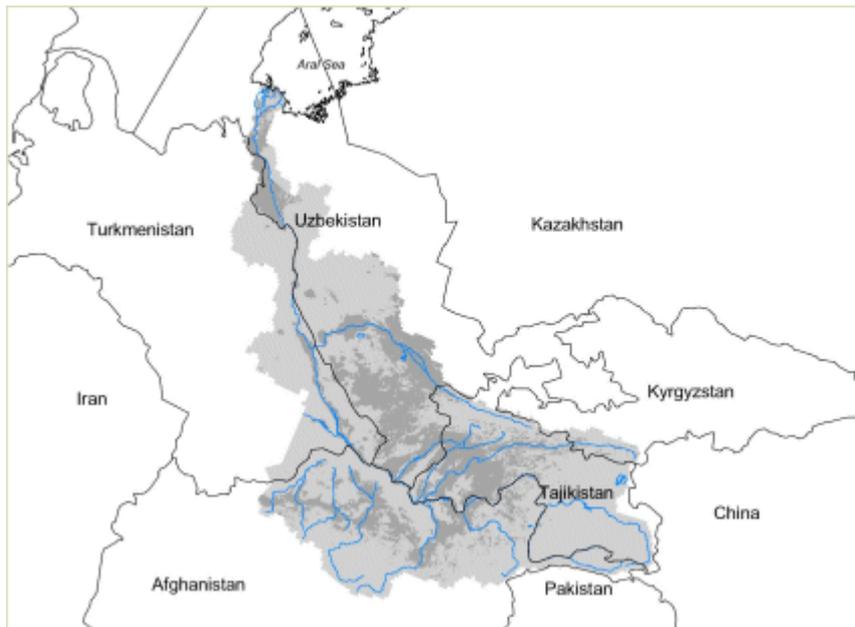


Fig. 1: Map of the Amudarya river basin (Source: Earth Trends 2002 World Resources Institute)

The current river basin and water management situation

The current situation of the Amudarya river basin is characterized and determined by the overuse of land and surface water resources which began with the massive expansion of the irrigated cotton monoculture under Soviet rule since the 1960s. In Uzbekistan the area under cultivation (most of it irrigated) increased from 0.42 million ha in 1913 to 2.3 million ha in 1970 and more than 4 million ha in 1990 (Herrfahrdt 2004). Since independence the area under irrigation has been relatively stable at about 4.2 million ha (FAO Aquastat 2007, GEF WEMP Regional Report 2002). The main source of irrigation water is surface water from the two main rivers in Central Asia, the Amudarya and the Syrdarya. The result of the increasing withdrawals was a massive change in the river flow regime from a natural to a managed one, especially since the 1960s. It led to the desiccation of the Aral Sea and desertification of the river delta with all its devastating consequences observable today such as loss of wetland ecosystem services, decreasing agricultural yields due to toxic dust storms, loss of biodiversity, health problems etc.

Since becoming independent in 1991 Uzbekistan has undergone a gradual transition process from a Soviet command economy towards a new economy, which so far is not very clearly defined (Pomfret 2000) and which has not significantly improved the resources management in the Amudarya river basin. The economy still highly depends on irrigated agriculture and especially on cotton production and export: in 2001 agriculture contributed 30% to GDP (Spoor 2004), with the result that about 93% of the available water is used for the agricultural sector.

Land reform and the dismantling of the state farms only gained momentum at the end of the 1990s and will soon be completed, but there is still no private land ownership and the restrictive state procurement system is largely still in place, obliging the farmers to grow cotton and wheat and to sell most of their harvest at low prices to the state.

Since Soviet times water management was subordinate to the needs of agriculture and especially cotton production (Yalcin / Mollinga 2007, Yalcin / Mollinga 2006). Consequently water sector reforms lag behind the land reform process. They were only slowly introduced since the year 2000 as a response to changes in the agricultural sector (Yalcin / Mollinga 2007) when land reform made the Soviet water management administration unsuitable to serve thousands of newly established small farming entities and thus water users. The water sector reform process gained some momentum since the introduction of the basin principle in 2003, when So-

viet style province and district water management departments were reorganized and renamed.

Timeline of historical events

In this section we present a timeline of major external and internal events and developments in the river basin and on the national level in Uzbekistan since independence and analyze their causal or temporal interrelations. Figure 2 gives an overview of major developments and events in the ecological as well as social systems (macro and mesoscale) which will be discussed below.

Impact of the social on the ecological system

The event in the social system with the most impact on the ecological system was probably the decision of the Soviet rulers to make Central Asia and especially the Uzbek SSSR the primary producer of (irrigated) cotton. In order to fulfill the ambitious plans irrigation canals had to be built in a hasty manner using low quality, cheap materials (Obertreis 2007). This and the often-lacking drainage infrastructure lead to high inefficiencies which in the following caused a number of environmental problems that slowly built up over the decades. Among them are salinization of soils and water-logging. The abstraction of huge amounts of water from the Amudarya strongly influenced the river flow regime with severe impacts on riverine and instream ecosystems in the river basin. The reduction of inflow to the Aral Sea caused its desiccation and the desertification of wetland and aquatic ecosystems in the Amudarya delta region. In the early 1960s there were approximately 2,600 lakes in the Amudarya delta but this had fallen to only 400 by 1985 (Kreuzberg-Mukhina 2006). Many (indigenous) species have gone extinct or are close to extinction, among them for example the Tugai forests along the river and in the Amudarya delta, which during the last century decreased by 90% from the originally 300,000 ha of Tugai forest (Schlüter et al. 2006).

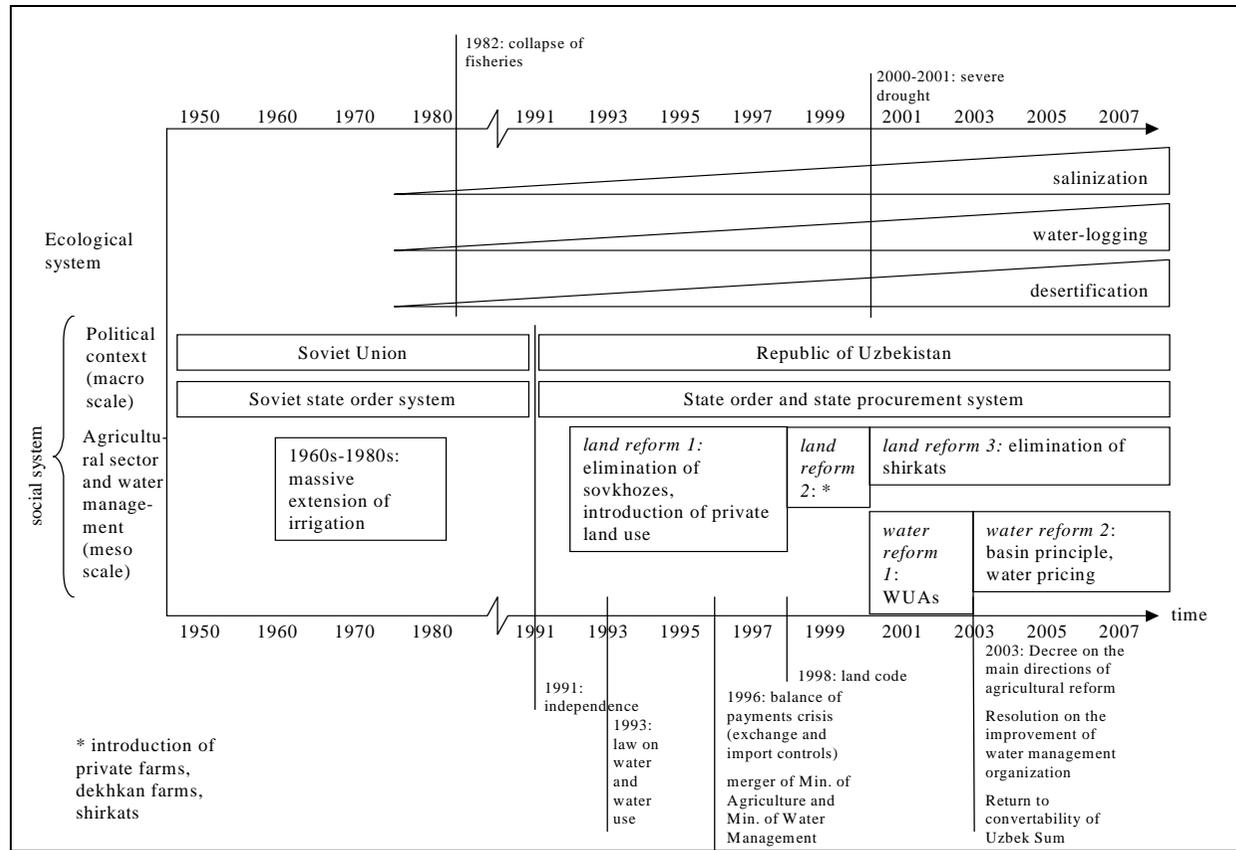


Fig. 2. Time line of major events in the social-ecological system

Apart from these slowly progressing processes (and at least partly a consequence of these) a number of single events can be detected that – combined with the (lacking) response of the social system – indicate the decreasing resilience of the social-ecological system. One of the first and most striking events was the collapse of the Aral Sea fisheries in 1982. This collapse caused the formerly prosperous fishing and fish canning industry (which processed between 50,000 and 300,000 t fish per year) at the shore of the Aral Sea to break down. Another indicator of the reduced resilience of the ecological system towards extreme events was the extreme drought that occurred in 2000 and 2001 in the lower reaches of the Amudarya and the delta causing not only huge economic losses but also further damaging the ecosystems.

Social system: macro scale developments since independence

Since Uzbekistan became independent in 1991 a number of events and dynamics at the political and economic scale influenced the situation of agriculture and water management in the republic. Even though Uzbekistan was among the “slow reformers” from the onset, during the first years of independence the government was committed to liberalize its economy: price controls were reduced, foreign trade liberalized and exchange restrictions lifted (Pomfret 2000). This policy changed, however, in 1996 with the emergence of a balance of payments crisis. Increasing consumer goods imports, growing inflation, increasing foreign debt and a poor cotton harvest combined with falling world market prices for cotton had put the economy under pressure. In the following the government adjusted its reform course and strived towards a restrictive and largely state controlled economy for example by introducing “draconic exchange controls” and import restrictions (Pomfret 2000, Wagstyl 2003). These measures were only partly lifted in recent years.

According to official data the economy is growing at rates between 3.8% (2000) and 7.4% (2004) per year (UNDP 2006). Despite the growing GDP it seems that this growth does not trickle down to the poor. Estimates by the World Bank show that about 27.5% of the Uzbek population lives below the poverty line (World Bank 2003a). At the same time almost 70% of the poor live in rural areas and are employed in the agricultural sector (Müller 2003a). Apart from economic factors (such as lower market prices for agricultural products and delayed payment of salaries from *shirkats*) decreasing soil productivity, which is directly linked to water scarcity, in-

creasing soil salinity and water-logging, is identified as the main reason for (growing) poverty in the rural areas (Herrfahrdt 2004).

Social system: developments in agriculture and water management

Agricultural reforms: The process of agricultural reform can be divided into three phases (Hofman 2007). The first phase (1991-1997) was dominated by the dismantling of state farms (*sovkhoses*) into collective farms (*kolkhozes*) and the introduction of cooperative farms (*shirkats*). This phase also saw the continuation of the state order system (at least for cotton and wheat) that had been in place since in the 1920s the Soviet administration transformed traditional water management and agricultural production into a government regulated system with centrally controlled production targets (O'Hara 2000).

The state order system on cotton has been transferred from Soviet times to ensure government control over production and a constant stream of revenues from agriculture to balance the lack of inflow of financial resources from Moscow. In Uzbekistan the importance of the agricultural sector and specifically of cotton for the state budget is very high (see example on state order below). After independence the state order for wheat gained in importance to increase wheat production and achieve food self-sufficiency. An ecological side effect of the increase in wheat production was a decrease in water use, because wheat is a less water intensive crop, however, this effect was hardly visible.

The second phase of reforms began with the adoption of the new land code in 1998 and the new legislation on the organizational forms of agricultural entities (*shirkats*, private farms and *dekhkan* farms, i.e. peasant farms). *Shirkats* were envisaged to become the most efficient organizations in the agricultural sector – which soon turned out to be unrealistic due to lack of incentives and an institutional environment which was still dominated by Soviet rules. The new land code did not alter property rights for land: Still all land belongs to the state and land ownership is only possible as a leasehold (Republic of Uzbekistan 1998).

During the third phase of land reform beginning in 2003 (and given the poor performance of the *shirkats*) private farms were envisaged to become the principle model for agricultural production. Until the end of 2006 the remaining *shirkats* were dismantled. Even though the state had now handed over most of the formerly state-owned agricultural farms to private owners, through the state order system and property rights on land it re-

tained strong control over land and agricultural production. Within the state order system the state obliges farmers to grow cotton or wheat at most of their cultivated area and sell it to the state for state procurement prices at a fraction of world market prices (cf. detailed example below).

Water sector reforms: Through most of the 1990s water management remained unchanged. The law on water and water use (1993) mainly confirmed Soviet water management institutions. Water for irrigation remained free of charge (despite a neglectable water tax) and water resources remained state property as they were in Soviet times (Republic of Uzbekistan 1993). A significant institutional change occurred however in 1996, when the Ministry of Agriculture and the Ministry of Water Resources (MAWR) were merged to become the Ministry of Agriculture and Water Resources. According to Yalcin and Mollinga the need for a centralization of agriculture and water issues in one organization and the continuing quarrels between the two independent ministries over water allocation were among the main reasons for the merger (Yalcin / Mollinga 2006).

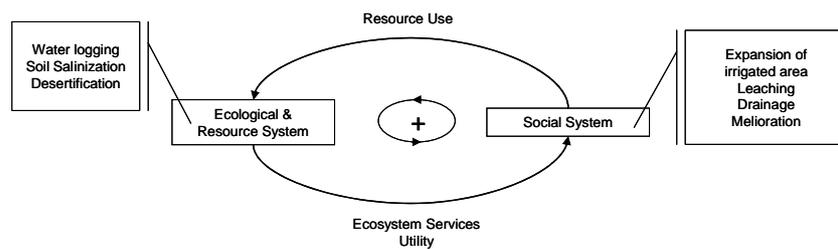
Further change was initiated with the experimental introduction of a new form of water management institution namely the Water User Associations (WUAs) since 2000. During this first phase of water sector reform the lower Amudarya region (Khorezm province) served as experimenting ground for the introduction of WUAs. Following the emergence of thousands of new farm entities a new level of water administration had to be introduced to relieve the district water management departments of the task of calculating water needs and allocating water to thousands new water users.

The reforms in the water sector gained new momentum and thus entered the second phase with the decree on the main directions of agricultural reform in 2003, which stipulated that water management be organized along the basin principle and which foresaw the introduction of market principles for water use (Republic of Uzbekistan 2003a, Republic of Uzbekistan 2003b). In the following the province water management organizations were replaced by Basin Irrigation System Management units (BUIS). BUIS were established along hydrological boundaries, i.e. along river basins and canals instead of administrative boundaries of the provinces. Water user associations that were so far only experimented with were envisaged as the main organization of local water management.

Interactions between the ecological and social system over time

Human land and water use had massive impacts on the ecological system in the river basin but was also itself influenced by the subsequent changes in the state of the resource and ecological systems. In the following we analyze interactions and feedbacks between social and ecological dynamics, e.g. the availability and state of water and land resources on the one hand and institutional and policy change on the other to determine where and how one system component reacted to changes in the respective other system. Figure 3 exemplifies those linkages for the underlying resource use and degradation processes (Figure 3a) and the recent institutional changes (Figure 3b).

A) Underlying dynamics



B) Dynamics since independence

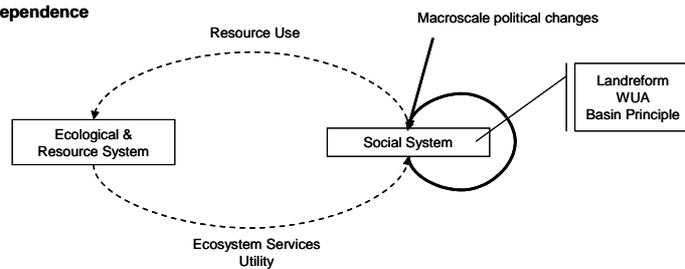


Fig. 3. Interactions between the ecological and social system. A) Underlying ecosystem and resource use dynamics (social system) feedback loop that continues until today, B) Social dynamics after independence that take place based on the underlying dynamics described in A. The thickness of the arrows indicates intensity and importance of the interactions.

As described above, in the past 30 years resource overuse and bad management practices such as poor irrigation infrastructure and techniques as well as over-irrigation caused water-logging, salinization of agricultural land and desertification (Figure 3a). This reduced the flow of ecosystem services from the ecological and resource system to the social system. To mitigate the decline in agricultural production the social system responded with further development of virgin lands and technical measures such as establishment of a drainage system, leaching of the soils prior to irrigation, and soil melioration measures. Several of them, such as land development and leaching, contributed to a further increase of the use of the land and water resources. Leaching needs large amounts of water to keep the soil salinity down in the root zone. In fact a large part of this water is used to flush the salts from the soil surface; of this a substantial portion (often about 40% of the total amount diverted) disappears into the surface drainage system (WB DIWIP project).

In general, those response activities were aimed at eliminating the results of resource deterioration, but did not address its causes. The region entered into a positive feedback loop of environmental degradation, which initiated further expansion of irrigated land and technical interventions to maintain production levels causing further degradation (Figure 3a). This cycle was maintained by the demands of Moscow for cotton deliveries. While in the short term the response of the social system improved its situation and ensured a stable flow of ecosystem services and economic rents, in the long run it caused further degradation and severely aggravated the situation. While planners realized the consequences of their activities, they often believed that in time there would be technical measures to mitigate the problems. The region still remains in this vicious cycle today.

The economic consequences of resource and ecosystem degradation are severe. In Karakalpakstan in 1999 95% of the irrigated lands are salinized to some degree, in Khorezm province all irrigated area suffers from salinization (GEF WEMP Uzbek National Report 2001). The trend is increasing at a fast speed, e.g. the amount of saline areas in Uzbekistan increased by 26% from 1990-1999. By 1999 80% of the irrigated area in the delta area (Khorezm and Karakalpakstan) had shallow watertables (Jakubov and Usmanov 2001). The total costs of salinization and water-logging for Uzbekistan (including the value of crop loss, costs for leaching, the operation and maintenance of drainage system and the value of abandoned land) are estimated at 529 million US\$/year or about 32% of the economic value of potential crop production (GEF WEMP Regional Report 2002). Moreover, deteriorating irrigation infrastructure and lack of finances for its maintenance and operation aggravated the situation even more. Overall, environ-

mental degradation has significantly lowered the living conditions of those living in the areas most affected and made them more vulnerable to ecological, economic and social stresses, as apparent e.g. during the drought in 2000/2001.

This was the overall ecological and economic situation in the river basin when the Soviet Union broke apart in 1991. For the riverine countries of the Amudarya river independence was a sudden and not necessarily desired event that happened without much of their own contribution. The land and subsequent water reforms in Uzbekistan after independence were a reaction to the new political situation and a (half-hearted) attempt at a transition to a more market-based economy. Institutional changes in the water sector were rather motivated by external events or changes in the social system itself than by the need to address the deterioration and overuse of the resource base. New water management institutions were initiated e.g. through the interests of individual leaders (e.g. introduction of the basin principle in water management, see below) or forced by the need for adaptation to changes in another sector, e.g. the need to cope with an increasing number of individual farmers created through the land reform (e.g. establishment of Water User Associations). Their effectiveness in changing water management practices was often rather low because the institutional boundary conditions were not taken into account. We illustrate the triggers and causes of those institutional dynamics in detail with the following examples:

Example state order: Through the state order system of buying cotton and wheat for low prices from farmers and exporting it for much higher world market prices the government was able to compensate for foregone budget support from Moscow following independence (which in 1990 amounted to about 20% of the budget, Herrfahrdt 2004). As a consequence the Uzbek government became highly dependent on these transfers from agriculture. In the mid-1990s the government earned revenue in the amount of eight to ten percent of GDP through state procurement (Pomfret 2000) and today cotton exports account for about half of the hard currency earnings (ICG 2003) thus impeding substantial change or at least making any reform that alters this arrangement highly unattractive. In addition to these disincentives it seems that state officials profit from these arrangements as well (ICG 2005) and that vested interests have been created in favor of the perpetuation of the state order system.

Even though state procurement quotas have been lowered from 100% (1991) to 50% (2002) for cotton and from 95% (1991) to 30% (2002) for wheat, this change remained a change on paper since at the same time the demanded output for cotton per hectare has been significantly increased by

the government (Spoor 2004). Thus de facto farmers still have to hand over the largest part of their production to the state for minimum state order procurement prices.

Example WUAs: The introduction of WUAs and the later countrywide implementation of these new organizations was favored by several incidents. First, the need for a new form of local water management could no longer be ignored since inefficient water distribution affected agricultural output. Second, several donors such as the World Bank, Asian Development Bank, USAID etc. were lobbying for decentralization of water management and WUAs in particular and offered to provide financial support for their introduction. Third, apart from external pressure there was support for the concept from within the Ministry of Agriculture and Water Resources (MAWR): a MAWR official was convinced of the concept during an excursion to Italy and used his position, contacts and family ties to lobby for the introduction of WUAs (Yalcin / Mollinga 2007). These circumstances and the strong dominance of the state in the process supported the relatively quick and countrywide implementation of WUAs - at least on paper. Despite the fact that there is still huge room for improvement concerning the functioning of WUAs and their role as independent actors within the water governance framework, farmers (notwithstanding their first reservations towards these new state-induced organizations) recently began to acknowledge WUAs' function as an efficient provider of water and training.

Example Basin Principle: Generally, the basin principle of water management is expected to improve water management through its focus on hydrographic instead of administrative boundaries and a reduction of administrative overload. This should lead to more transparency and increased capacity to detect and react to problems in resource availability or allocation. The introduction of this new institution in Uzbekistan was initiated by the water department within the MAWR, which seems to be struggling for more influence over the agricultural sector (especially after the merger of the agricultural and the water ministries). With a hydrography oriented management the water department intended to reduce the power of the local governors (*khokims*) over water allocation. The *khokims* are still held responsible for the fulfilling of the state order in their district and thus have a high interest in water management issues. They use their influence and power for intervening in water allocation, thus adding uncertainty and reducing the transparency of the water management system. However, with the state order system still in place and the governors responsible to fulfill the production targets, they strongly resisted giving up any control over

water allocation. One of the main goals of the institutional change in water allocation planning was thus not reached because of constraints of the larger institutional settings. It remains to be seen what other effects of this reform on water allocation practices are.

Example wetland restoration: An example for policies and measures that were indeed initiated to mitigate the severe changes in the ecological system especially in the most affected regions of the former delta area of the Aral Sea (Karakalpakstan) was the construction of polders in two bays of the former Aral Sea (Muynak bay and Sarbas) beginning with interstate environmental activities in 1994. While they were mainly planned as storage of excess water in high water years they also created new water bodies for fisheries which had been the main income source for the local population in northern Karakalpakstan. However, the productivity of those lakes is a function of water inflow which remains highly unstable. Another attempt at wetland restoration was carried out under the umbrella of a large project of the Worldbank. Here, a scheme and infrastructure for the mixture of drainage and freshwater inflow was worked out to maintain water levels and an acceptable salinity in an important wetland, a potential Ramsar site, in the western part of the delta (Sudoche wetland). However, the institutional arrangements to secure the necessary freshwater inflow and a sustainable exploitation of the biological resources of the wetland were only insufficiently developed. Thus, while the project was a success in re-establishing the wetland and providing the local population with new livelihood options its sustainability in the long run, especially as the number and extent of drought years might increase, is not sure. The successful restoration of the wetland motivated the Uzbek government to further develop wetland restoration schemes for the delta to increase water storage capacity and, as a side effect, improve local livelihoods through the provision of wetland ecosystem services. But, again the lack of sufficient institutional arrangements for the exploitation of the biological resources and the fact that their water requirements are not considered in water allocation, limits the success of those measures.

While the reforms in land and water management slowly adapted the social system to the new political and socio-economic situation they were not aimed at nor suited to address the growing deterioration of land and water resources and loss of valuable ecosystem services provided by the semi-natural ecosystems in the river basin. The few restoration measures mentioned above fall short because their water supply and sustainable use is not taken care of. The underlying cycle of overuse and degradation of resources as described above was neither addressed nor broken. As before, problems caused by resource degradation and increasing man-made water

shortage were mainly addressed by technical measures aimed at maintaining the current agricultural productivity.

In recent years the need for water saving measures and behavior is increasingly stressed by donors and national authorities; however their implementation on the ground is rudimentary and a change in perception of water as a limited resource has so far only little taken place, e.g. in high water years people don't see a need to save water. Donor involvement in its beginning phase also focused on technical approaches to mitigate the problems in agriculture and water management such as improved drainage, new irrigation techniques, etc. and only later increased activities addressing institutional and social aspects of water management. Many policy-makers in the region see an increase in water use efficiency, which given the huge losses in the current irrigation system of more than 70% (transportation losses, GEF WEMP Regional Report 2002) is certainly possible, as the main solution to all problems in the region. This efficiency increase would allow the continuation of the current water use and free resources for further expansion of irrigated agriculture or other uses.

The only case where there is a direct response of the institutional sphere to ecological dynamics/events is in the case of extreme events such as droughts and floods. These trigger an immediate response of the social system in form of emergency measures such as a ban on rice planting and a reduction of water limits for all regions. However, once the drought situation has passed the old management practices are in place again. Thus there is an ad hoc reaction to an actual threat which has been elaborated as a result of recent severe drought events. A long term strategy or institutions to deal with the high variability in water flows and the growing water scarcity, e.g. reuse of drainage waters, diversification of agricultural production, change to less water intensive crops, diversification of water use, etc. has not been developed.

Resilience and adaptability of the social-ecological system

There have been significant ecological changes in the river basin, i.e. desertification, soil salinization, change in groundwater level, but an adequate response of water and land management is so far lacking. The analysis above shows that resource overuse and ecological degradation in the river basin (at least in the Uzbek part of it) continues much as it was before the breakup of the Soviet Union. The cycle of declining productivity, leading to actions to mitigate the decline, leading to further decline is well

know in many other settings (Perrings 1989, Anderies et al. 2006). Institutional change in the agricultural and water sectors in Uzbekistan since independence has been only very limited and mainly aimed at coping with external and internal forces of the political and social system. Compared to Soviet times the quality of change or adaptation of the social system has changed insofar as institutional changes have been introduced and added to the formerly mainly technical answers to environmental change (e.g. drainage, leaching). Nevertheless, only in a few examples was there an institutional response to changes in resource or ecological dynamics, e.g. it has been indicated by some interview partners that the development of water sector reforms have to some extent been pushed by the extreme drought in 2000/2001. In most cases other **drivers** such as changes in the agricultural sector or internal power plays between different departments of the Uzbek Ministry of Agriculture and Water Resources have played a maybe stronger role in motivating the introduction of new institutions such as the basin principle. It was mainly the transition process by very slowly introducing land reforms in the agricultural sector by the end of the 1990 eventually triggering reforms in the water sector because the old institutions were not capable any longer to cope with the new situation. Thus, in general, none of the institutional changes observed can be attributed to changes in the ecological or resource system (maybe with an exception of the water reform in 2003, see above).

The system is locked in a state that is to a large extent still determined by the legacies of the Soviet Union. The massive extension of irrigated agriculture, the following high dependence on the agricultural sector and the neglect of the development of other sectors such as industry during Soviet times largely contributed to this lock-in effect. Regionalism and patronage networks that prevailed from before Soviet times and continued to function during Soviet time are still in place and function as significant **barriers** to change. Through them vested interests were created and perpetuated after independence, which now highly influence if not political decisions themselves than at least their implementation on the ground. These mechanisms (powerful economic forces and vested interests) have mainly contributed to keeping the social system on an unsustainable trajectory and thus limiting its choices (path dependence) (Anderies 2006). The persistence of the state order is thus a major hindrance to paramount reform efforts making it the key element determining the direction of institutional change in the Uzbek water sector (Yalcin / Mollinga 2007). The decision to stick to the state order system and the rents it created for many persons in powerful positions combined with the high dependence of the social system on the agricultural sector has created a strong path dependence which will be very difficult to break.

Nevertheless, the resistance of the current system to carry out significant changes in land and water use to adapt to the current ecological and larger political situation is **reducing the resilience** of the social-ecological system in the river basin to changes in resource availability. Structural changes of the social system that are needed to establish the conditions for sustainable resource use have so far been avoided. The social system changes slowly and incrementally, often only on paper but not factual, driven by internal and external (political and economic) drivers. The observed changes can thus not be termed "adaptation" in the sense that they are suitable to tackle the core of the problem, i.e. overuse of resources and by doing so increase the resilience of the system (Walker et al. 2004). As Pahl-Wostl puts it: "*In the long term, adaptive management needs to establish the ability to change system structure - e.g. change to other types of crops and change life-styles or the allocation of water quota to certain users*" (Pahl-Wostl 2007). The institutional change observed in land and water management in Uzbekistan so far was aimed to provide the necessary conditions to ensure a stable production level of cotton and expand wheat production to achieve food self-sufficiency. The small adjustments that have been carried out where the underlying power structures and vested interests are not touched are rather increasing the vulnerability of the system to external and internal shocks by e.g. leading to increased poverty and a decreasing health status of the rural population. Thus, with time the system is moving on its unfavorable trajectory towards a position where it is becoming more and more vulnerable to losing major desirable functions and characteristics.

The low performance of the current water management regime can to some extent be explained by a mismatch of the functioning of the resource and management regimes, as well as mismatches between different scales of the social system. The responses or adaptation that aim at short-term remedy are not adequate to tackle the pressing problems, addresses them at the wrong scale or only insufficiently. The new institutions were ineffective because they did not take the institutional or political boundary conditions into account. For example a land reform that "privatizes" land has been introduced but there are no secure use rights. As a result there are few incentives for investments in melioration and irrigation and drainage infrastructure and thus the intended benefits of the reform are not realized. Moreover, the lack of transparency in decision-making and supply security created a situation of everybody taking as much as he can. The absence of control over actual water use aggravates unequal access and distribution. Another example are the Water User Associations which cannot function as long as the power of the local governors is not reduced and water prices are not introduced and widely accepted by the people. Market institutions

such as water markets, water prices, land markets etc., which are needed to make the already implemented institutions such as private farms, WUAs etc. work properly, are lacking and it is not clear whether they will be implemented soon (there are experiments with water pricing ongoing for several years now, but with few results so far).

There is a **need for transition or real adaptation** (not only reorganization of management) under institutional boundary conditions that enable those changes. Given today's high dependence on agricultural production and the societal conditions described above one might speculate that once the economic losses from mismanagement and overuse of natural resources are high enough to threaten state budgets and existing rents the political willingness to engage in comprehensive reforms might rise. It is questionable though how long it will take until this point is reached and if the system by that time has still enough capacity and time to reorganize and prevent a collapse. Besides, the system will continue to be subject to external pressures such as climate change and policy changes in other riverine countries which force it to react.

Our analysis has shown that the link from changes in the ecological/resource system to institutional changes in the social system, which is essential to facilitate adaptive responses, is missing. The connection between these subsystems has to be reestablished in order to provide the conditions for sustainable management and an increase in resilience. This could be accomplished through developing institutions that are geared to influence resource use and provide incentives for a sustainable use of the region's resources. This might be achieved through awareness raising about the interrelationships in the system, by diversification of water use through giving other water users rights to the resources, and maybe also by numbering the economic losses of unsustainable resource use to the social system. Given that official growth rates in GDP can be trusted, the current high economic growth could be used to at least ease the state order system without causing much harm to the state budget. In addition, reducing the increased vulnerability of both the social and the ecological system towards external and internal shocks is important, e.g. through restoring ecological processes, providing health services and alternative income opportunities in rural areas etc.

However, there are opportunities for change and adaptation, rooted in the large restoration capacity of the ecosystems as well as in the increasing awareness and growing experience in designing and dealing with new institutional and organizational structures, especially at the local level, and the high flexibility of the system once a decision is taken at the national level. Despite the large ecological damage the restoration capacity of the ecosystems in the Amudarya delta region, e.g. after the severe draught in

2000/2001 has proven to be rather high. By taking the needs of the ecological system into account in water management, the productivity and sustainability of those systems can be greatly enhanced.

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