

Institutional resilience in water governance reforms: The case of Uzbekistan

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Abstract

Changes in the ecological system, such as climate change, and changes in the social system, such as political and economic transformation processes, put water governance regimes under pressure. These regimes must either have at their disposal the needed resilience to cope with these changes and adapt or face the need to transform into another regime configuration which is better suited to cope with these changes. These options entail different levels of institutional continuity and change. Three types of balances between institutional continuity and change in social-ecological systems are elaborated: persistence, adaptive change and transformative change. This paper addresses the challenge of water sector institutions to provide for continuity on the one hand while meeting the need to change and adapt to new circumstances (such as climate change or political and economic transformation) on the other hand. Uzbekistan, which has accumulated intense pressure for change both in the social and the ecological system, serves as a case study. Highly unsustainable use of water resources and cotton monoculture put high pressure on the ecological system. One of the consequences, the desiccation of the Aral Sea, has major negative repercussions in the social system (increasing unemployment and decreasing health status of the population). Since the breakdown of the Soviet Union political and economic reforms have taken place rather reluctantly and have not triggered comprehensive changes in the water governance regime. Minor changes have been introduced at the local level, but the system has not yet departed from its unsustainable path of development. The paper concludes that the Uzbek water sector is rather resistant to change and comprises only a low level of institutional resilience. By applying the concepts of adaptive cycles and panarchy to institutions and water governance reform processes in Uzbekistan some drivers of these processes are identified.

1 Introduction

In many countries the current and future impacts of climate change on water resources require a transformation of the water governance systems to increase the resilience and adaptive capacity. Transformative change occurs as a result of either ecological crisis (including shifts in the ecological system) or shifts within the social system (such as new institutions, social values, economic or political change). In Uzbekistan ecological crisis (desiccation of the Aral Sea and the beginning impact of climate change) and a shift in the social system (break-down of the Soviet Union) can be attested. Central Asia has been exposed to changes in its climate regime for several decades. The desiccation of the Aral Sea as a consequence of massive water abstraction from its contributories has led to significant regional climate change (Nikulina 2006, 84).

Climate change is likely to diminish the overall amount of water available in the region, reduce the stabilising effect of glaciers on water supply and shift the peak flows in rivers to times less favourable for irrigated agriculture (Cruz et al. 2007, 477; Savitsky et al. 2008, 335). At the same time water demand is expected to rise due to population growth. These factors render the Uzbek social-ecological system (SES) highly vulnerable to the impacts of climate change and call for immediate changes in water use and governance.

Similarly, pressure for change accumulated in the social system due to inappropriate management techniques and governance modes. In the Soviet Union the *“hierarchical structure of society and strong belief in economic growth, technological advances and scientific rationality affected attitudes and shaped environmental policies”* (Dunbar 2002, 4). The premise of the primacy of humans over nature implicated the idea of humans reshaping nature (Obertreis 2007, 169). This and a tendency to ignore local conditions and favour a “one size fits all” approach (Obertreis 2007, 166-167), contributed to a disconnect of the social and the ecological system. The Central Asian water governance system was geared towards centralised decision-making with the aim of supplying water to collective farms for cotton production (Veldwisch 2008 cited in Abdullaev et al. 2008, 91). The performance of irrigated agriculture (and thus also of water management, which was subordinate to the agricultural sector) was measured with only one indicator: cotton produced per hectare. Other factors such as a sustainable and efficient (water) resource use were not an issue (Abdullaev et al. date unknown, 3; Abdullaev 2004, 21).

The above described setting of a hierarchical and highly centralised system led some to describe the Soviet system as highly maladaptive (Holling / Gunderson 2002, 31). After the breakdown of the Soviet Union the water governance regime needed to undergo fundamental change. Firstly, since water governance structures had to be adapted to the political changes. Secondly, because they had proven to be highly unsustainable and led to the desiccation of the Aral Sea – one of the world’s largest ecological disasters.

Thus a window of opportunity and incentives for transformative institutional change were given in Uzbekistan. With the continuous reorganization and reform of the social system and

the increased impact of climate change, these incentives for change are expected to increase in the future.

However, even though incentives and need for transformation are high, no significant transformation of the water sector can be attested despite large deficiencies of its governance structures and processes regarding adaptive capacity (e.g. lacks in horizontal and polycentric governance, insufficient flexibility of institutions and a lack of stakeholder participation).

Resilience theory provides a tool for analysing this lack of change (i.e. persistence) in the Uzbek social system (Herrfahrdt-Pähle 2010). The possibility to link change (and the lack thereof) not only across different levels and time but also across social and ecological systems is a major strength of resilience theory and the panarchy concept in particular (Gunderson / Holling 2002; cf. below). A number of nested and interacting adaptive cycles at different levels of a system are called a panarchy. This concept allows structuring and analysing complex processes of social change while acknowledging the relevance of environmental change and integrating it in the analysis. Especially the notion of change cascading through a panarchy can help to identify links and missing links across levels. By applying the concepts of adaptive cycles and panarchy to institutions and water governance reform processes in Uzbekistan some drivers of these processes are identified.

The presented results are based on a literature review and field research undertaken as part of the NeWater (New Approaches to Adaptive Water Management under Uncertainty) project. During the field research in Uzbekistan (2006 and 2007) empirical data was generated with the help of semi-structured interviews and group discussions with experts, decision-makers and stakeholders as well as participatory observation.

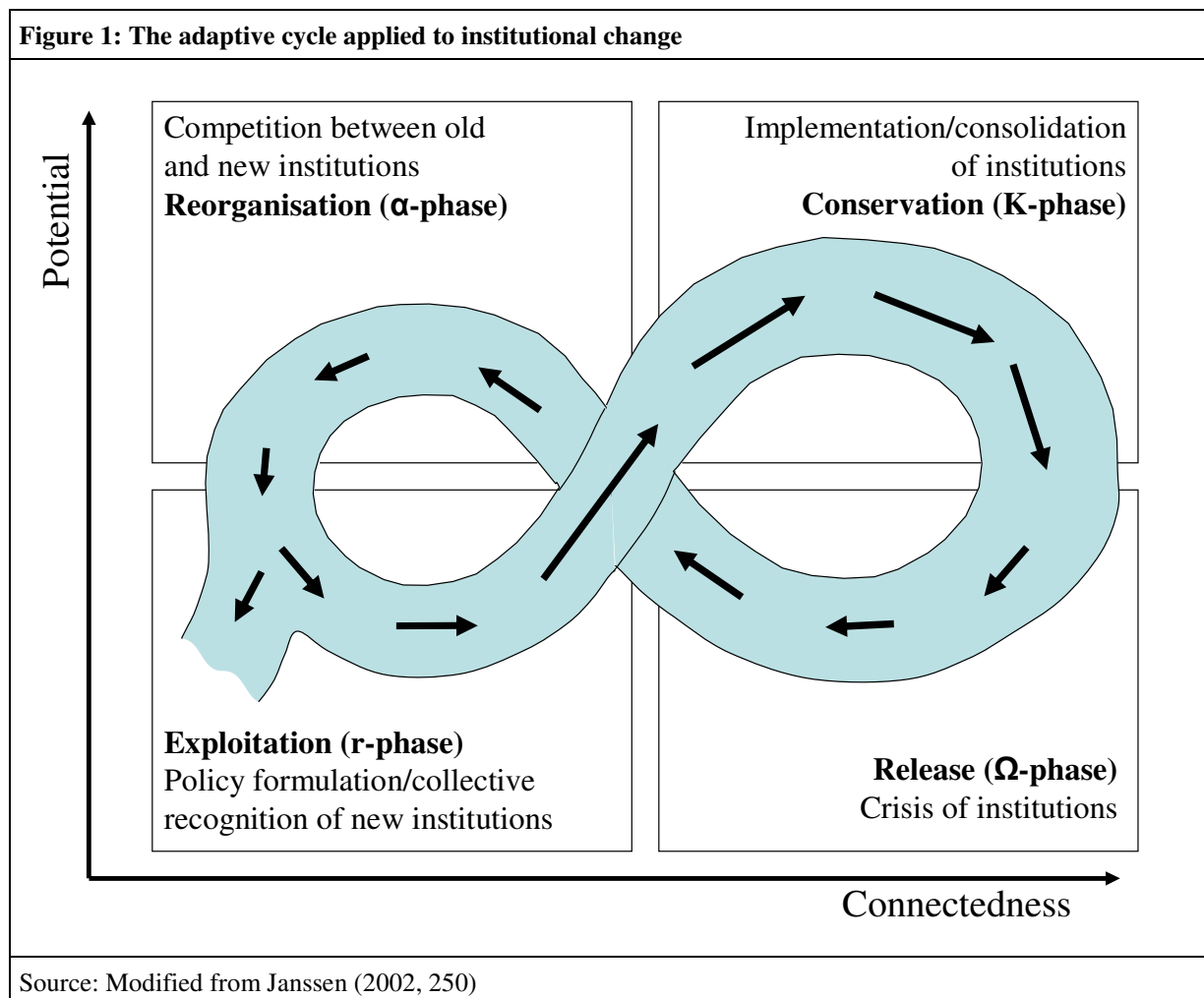
2 Change in social-ecological systems: Persistence, adaptation and transformation

One concept dealing with the resilience of social-ecological systems (SES) and the varying amounts of continuity and change of a system over time is that of a number of adaptive cycles forming a panarchy (e.g. Holling / Gunderson 2002). In the following this concept is applied to institutions as an interface between the social and the ecological system. Institutions are defined as *“the rules of the game in a society; more formally, they are the humanly devised constraints that shape human interaction. In consequence they structure incentives in exchange, whether political, social, or economic”* (North 1997, 2).

2.1 The institutional adaptive cycle and institutional panarchy

The concept of the adaptive cycle can be used as a heuristic model of change and a tool to structure and analyse processes of institutional change. It is assumed that similarly to ecological systems, social systems and institutions pass through an adaptive cycle consisting

of a frontloop (the phases of exploitation and conservation) and a backloop (the phases of release and reorganisation; Redman / Kinzig 2003; Aoki 2007; Janssen 2002; cf. Figure 1). While the frontloop emphasises growth and stability, the backloop is characterised by change and variability. The adaptive cycle operates in a two-dimensional space of connectedness and potential. “*Connectedness refers to the strength of internal links or relationships that mediate external variability*” (Bohensky 2008, 9). Potential is the amount of capital that is bound in the system and can enable change. In social systems this can be knowledge, innovations, trust, networks or governance structures, infrastructure and legal frameworks (Holling / Gunderson 2002, 49). High potential means that the potential for other use is high but at the same time this capital is tightly controlled by the elements (actors) in the system (Holling / Gunderson 2002, 35).

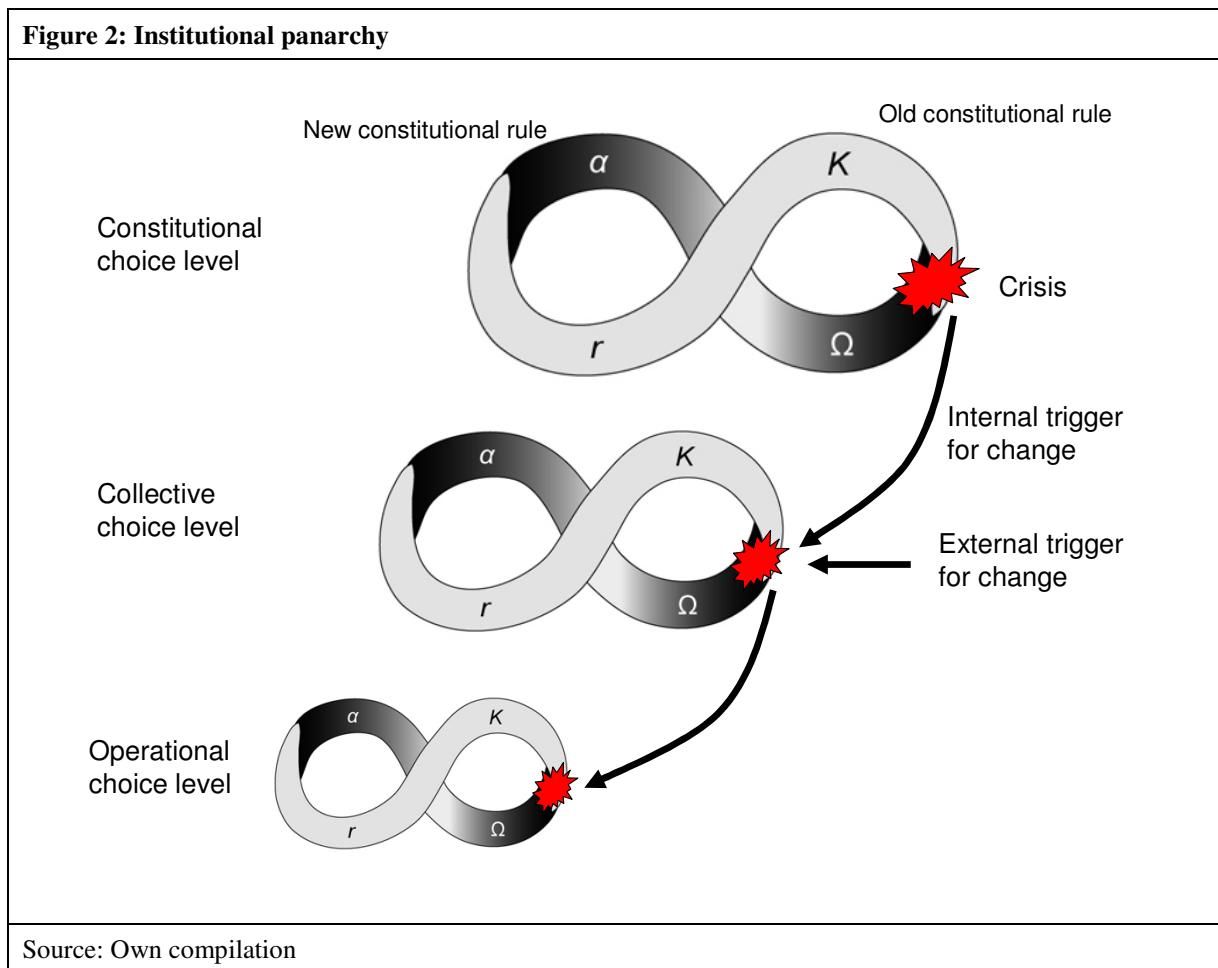


In the process of implementing new institutional regimes (and the consolidation of these logically consistent sets of institutions) a new institutional stability domain is established. The new institutions are integrated with the older institutional setting and connectedness increases (r- to K-phase). With increased connectedness the possible options for introducing new

institutions are reduced and path dependence arises. Over time inconsistencies between institutional settings become obvious, leading to the destabilization of the underlying beliefs and eventually to a crisis of the institutions (Ω -phase; Aoki 2007, 20). This crisis serves as what institutionalists call a shock. It may interrupt the path dependent process, which dominated the frontloop of the cycle (i.e. the r- to K-phase) and is the phase of “creative destruction” (Schumpeter 1911/1934 cited in Aoki 2007, 22). This is the phase that supports the introduction of change and thus favours the increase of the adaptive capacity. A change in the social system, i.e. in its institutional setting comes about. The following competition between several policy alternatives and old and new institutions (α -phase; Aoki 2007, 20), is a critical phase for institutional change. Institutions may either not or only gradually change, adjust to the new situation (adaptation) or flip to a completely different institutional setting (transformation; Holling / Sanderson 1996, 71; Janssen 2002, 250; cf. below). The configuration of new institutions marks the transition to the r-phase, the policy formulation. If the system produces new institutions that substantially change system functioning, it enters another adaptive cycle. After the new rule or institutional setting is collectively recognized the process starts all over again with the implementation of the new setting.

The application of the adaptive cycle to institutional change suggests that comprehensive new policies and institutional settings (i.e. institutional change or even transformation) can mainly occur after crisis has occurred, i.e. during the backloop of the cycle (Carpenter / Brock / Ludwig 2002, 192; Gunderson et al. 2002, 4; Garmestani / Allen / Gunderson 2009, 2). Crisis or surprise may not only originate from within the social system (i.e. internal trigger for change such as economic crisis or technological progress). It can also be connected to the emergence of crisis in the ecological system (i.e. external trigger for change such as natural disasters like droughts or floods). Notwithstanding the good conditions for change during the backloop, various obstacles to change exist. Among them are path dependence, a general conservatism of organizations, vested interests and the instrumentalisation of uncertainties to prevent change (Gunderson 2003, 42).

In a complex system such as a social system a number of adaptive cycles operate simultaneously and are nested into each other. A set of nested adaptive cycles has been called a panarchy (Gunderson / Holling 2002). The cycles are connected such that the slower moving cycles provide stability (memory) to the lower, faster moving cycles, which innovate and may introduce change to the higher, slower levels (revolt; Holling / Gunderson / Peterson 2002, 75; cf. Figure 2). Referring to the three options following a crisis mentioned above, three types of change (or lack thereof) can be identified: persistence, adaptation and transformation.



2.2 Persistence

A system persists, if – after the disturbance – it returns to its former setup, repeating the former adaptive cycle and ignoring possible need for change (backlash into old, inflexible institutions – rigidity).

A system that reorganises after a disturbance without changing its state variables, feedbacks and scales (i.e. levels) in operation essentially returns to its original configuration (Gunderson et al. 2006, 3). In this situation of persistence marginal adjustments can be attested at best. These often affect operational rules such as modes of water distribution and mainly serve the preservation of the institutions.

Such a persistent system is appropriate and well adapted in a stable environment that does not expose the social system to much change. With uncertainty and surprise increasing, as can currently be observed through climate change, systems must change and become more flexible and adaptive (i.e. resilient; Handmer / Dovers 2009, 190). A high degree of continuity in a changing environment is related to a low level of resilience since the system is not sufficiently reacting to a changed environment and subsequently not improving. Institutions

“that do not adapt become locked in a command-and-control syndrome that can be remarkably persistent” (Gunderson / Holling / Light 1995, 497). This state has been termed pathological resilience. As a consequence, potential for change accumulates and small disturbances such as a prolonged drought may cause major inefficiencies or even collapse (if, for example, drought relief schemes have not been developed or updated).

2.3 Adaptive change

A social system responding to shifts in ecological or social regimes has been termed adaptive (Gunderson et al. 2006, 3). A regime shift is characterised by a change of feedbacks and structure of the respective system (Walker et al. 2006, 3), while the state variables or functions of the system remain the same (Abel / Cumming / Anderies 2006, 2). The range of possible movements that can occur without a change in function is the regime or the domain of attraction (Garmestani / Allen / Gunderson 2009, 2). A resilient system disposes of the ability to learn from a disturbance and retain the main system functions. When recovering from disturbance it adapts and reconfigures in a slightly different system state. This is often related to a shift in collective choice rules, such as the competences of Water User Associations. Adaptive change thus points to a balance of continuity and change: *“there must also be some sort of shifting balance between stabilizing and destabilizing forces reflecting the degree and intensity of internal controls and the degree of influence of external variability”* (Holling / Gunderson 2002, 32). Adaptive change is the appropriate solution for a system facing a slowly changing environment.

In terms of the institutional adaptive cycle metaphor adaptive change takes place, if the amount of shock following a crisis does not exceed the institutional resilience of the system. In the search for alternative institutional settings old and new institutions compete. Finally, a new set of institutions is recognized, which seems to fit the demands better (adaptation). This reconfiguration or backloop of the cycle comprises the self-organizing ability of the system and its effectiveness determines the resilience of the institutional setting (Folke et al. 1998).

A system may, however, also be confronted with a broad mismatch between its functions and its environment either because the (environmental or social) conditions change quickly or because adaptation has been neglected. In this case the system needs to transform and switch to a different system configuration.

2.4 Transformative change

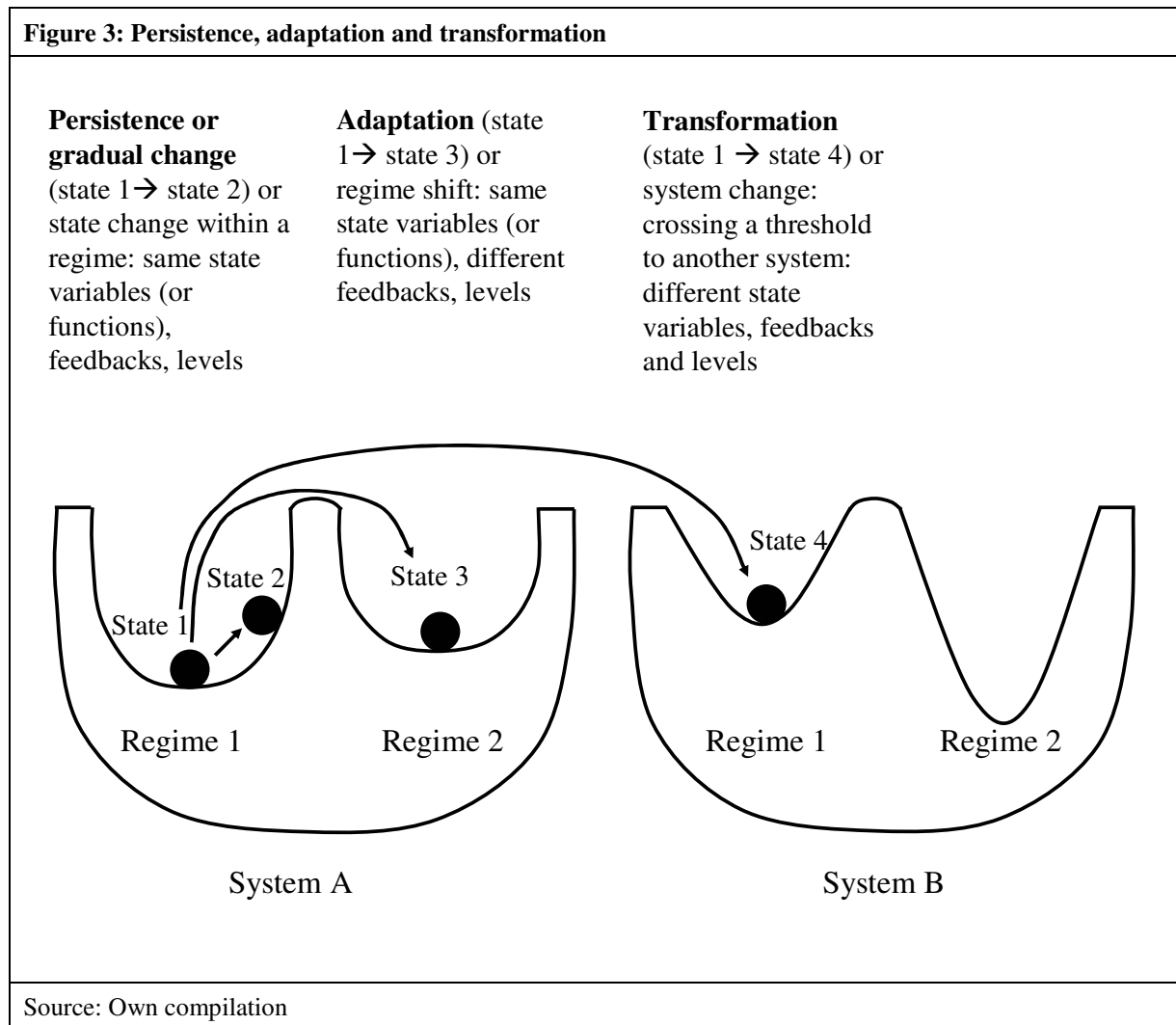
In contrast to adaptive change transformation describes the ability of a social system to create a fundamentally new system (Gunderson et al. 2006, 2). It is thus not merely reacting to a regime shift in the ecological or social system (e.g. climate change or a political regime shift) by increasing the fit of the current social system to the new conditions but it reconfigures its own parameters comprehensively. Accordingly, a transformation is characterised by a switch

to a new system across a threshold. An example would be a change in constitutional rules such as the national water law. The new system differs from the old through different kinds of feedbacks, structures and functions (Walker et al. 2006, 3) or state variables (Abel / Cumming / Anderies 2006, 2). Such changes are generally accompanied by paradigm change such as a shift from command-and-control to decentralised, participatory water governance. The capacity to fundamentally change a system is especially needed when a SES is trapped in a highly resistant and undesirable regime and adaptation is no option (Walker et al. 2006, 3).

Even though transformative change may occur at any phase of the adaptive cycle (since the cycle is not necessarily sequential; Abel / Cumming / Anderies 2006, 19) it is assumed that such change occurs more easily during or following a crisis (Ω -phase) and that it is difficult to initiate transformative change from within the conservation phase (Abel / Cumming / Anderies 2006, 20). The reorganisation (α -phase) serves “*as a window of opportunity for evolving complex adaptive systems*” (Abel / Cumming / Anderies 2006, 20). Once a transformation is entered at one level of the panarchy, these changes may cascade and change the whole panarchy (Walker et al. 2004, 3). However, transformative change of one part of the system strongly relies on sources of resilience in other parts of the system that provide memory and stability (Carl Folke, personal communication, 09.03.2010). Ideally the new system disposes of a higher level of (institutional) resilience.

Regarding the adaptation of water governance regimes to the challenges of climate change, in most cases a transformation of the system is required. This requires a broad change of higher levels of institutional panarchy (constitutional rules) and a change of system functions (e.g. participation, polycentric, redundant). In this sense the stabilising function of the slower levels needs to be overcome. A change of the higher levels (i.e. at national level – change of the water law and maybe even the constitution) is required to enable transformative change.

In terms of the adaptive cycle metaphor transformation occurs, if the amount of shock exceeded the institutional resilience of the system. The system arrives at a bifurcation (Folke et al. 1998), leaves the current configuration and flips to another regime configuration, i.e. into another adaptive cycle. This flip means the discontinuation of much of the former path dependent process. The above described three types of change are depicted in Figure 3.



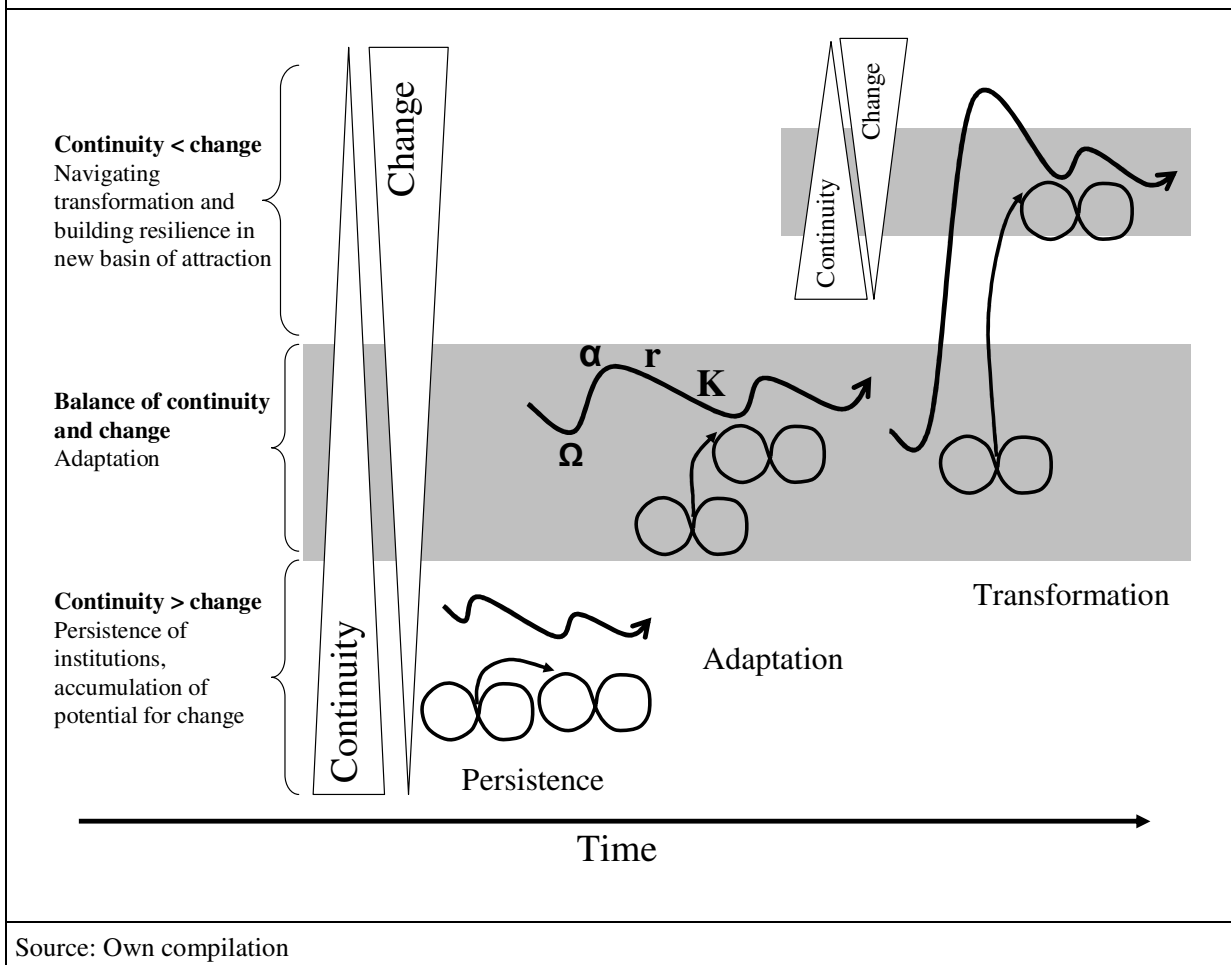
2.5 Institutional resilience: The balance of continuity and change in SES

Even during transformation a certain level of continuity and persistence are necessary to prevent the system from chaotic reactions and loss of useful properties. Similarly even during consolidation and high levels of persistence institutions need to display a certain degree of flexibility and openness to change. Thus the amount of continuity and change varies within a certain corridor and in relation to the phase the system is currently undergoing. During the backloop (Ω - to α -phase) of the adaptive cycle the amount of change increases, while during consolidation phases of the frontloop (r - to K -phase) the amount of continuity is higher than the amount of change. Figure 4 depicts adaptive cycles and the three types of change, which have been elaborated upon above.

Accordingly, institutions (or rather institutional arrangements) are resilient if they are stable enough in the short term to fulfil their task of reducing uncertainty regarding the possible

reactions of actors and thus providing other actors with security for planning. At the same time, resilient institutions need to have enough flexibility in the medium to long term to react to the uncertainties of a changing environment or changes in the social system. A more regular adaptation of institutions will probably entail smaller changes. It is important here to find the balance between continuity and change in order not only to be able to adapt to a changed situation but also not to change the institutional setting so often that stakeholders lose their trust in the functioning and continuity of the institutional setup.

Applied to water governance, on the one hand, strong and reliable institutions are needed to establish and sustain a functioning water governance system. On the other, the increasingly uncertain environment forces social systems and institutions to become more adaptive – that is more flexible and open to change – in order to be able to admit innovation and adapt to new circumstances. The task thus is to find the appropriate balance between innovation and conservation in any given situation of the water governance regime. *„Systems where change is not allowed will almost certainly generate surprise and crisis. Systems that allow too much change and novelty will suffer loss of memory”* (Berkes / Colding / Folke 2003, 376). This (evolving or dynamic) equilibrium of continuity and change would then constitute a preferred level of institutional resilience. Such an equilibrium can be achieved through a mix of institutions that have a stabilising role and those that preserve flexibility (Ebbesson in press). This mix of flexible and stable institutions can occur at one level or be spread across levels with institutions at one level being more rigid and those at another level more flexible.

Figure 4: Continuity and change in adaptive cycles within SES

3 Case study Uzbekistan: Marginal water governance reforms and decreasing institutional resilience

Located in the heart of Central Asia, the Republic of Uzbekistan once belonged to the Soviet Union. The country is characterised by a semi-arid climate and most of the available water is generated in neighbouring countries. The Uzbek economy is dominated by large-scale irrigated agriculture, mainly of cotton but also wheat, which was introduced during Soviet times. The state budget depends heavily on revenues and foreign currency generated through cotton exports. Inefficient water infrastructure and institutions have led to the desiccation of the Aral Sea – a major ecological disaster.

3.1 The institutional panarchy

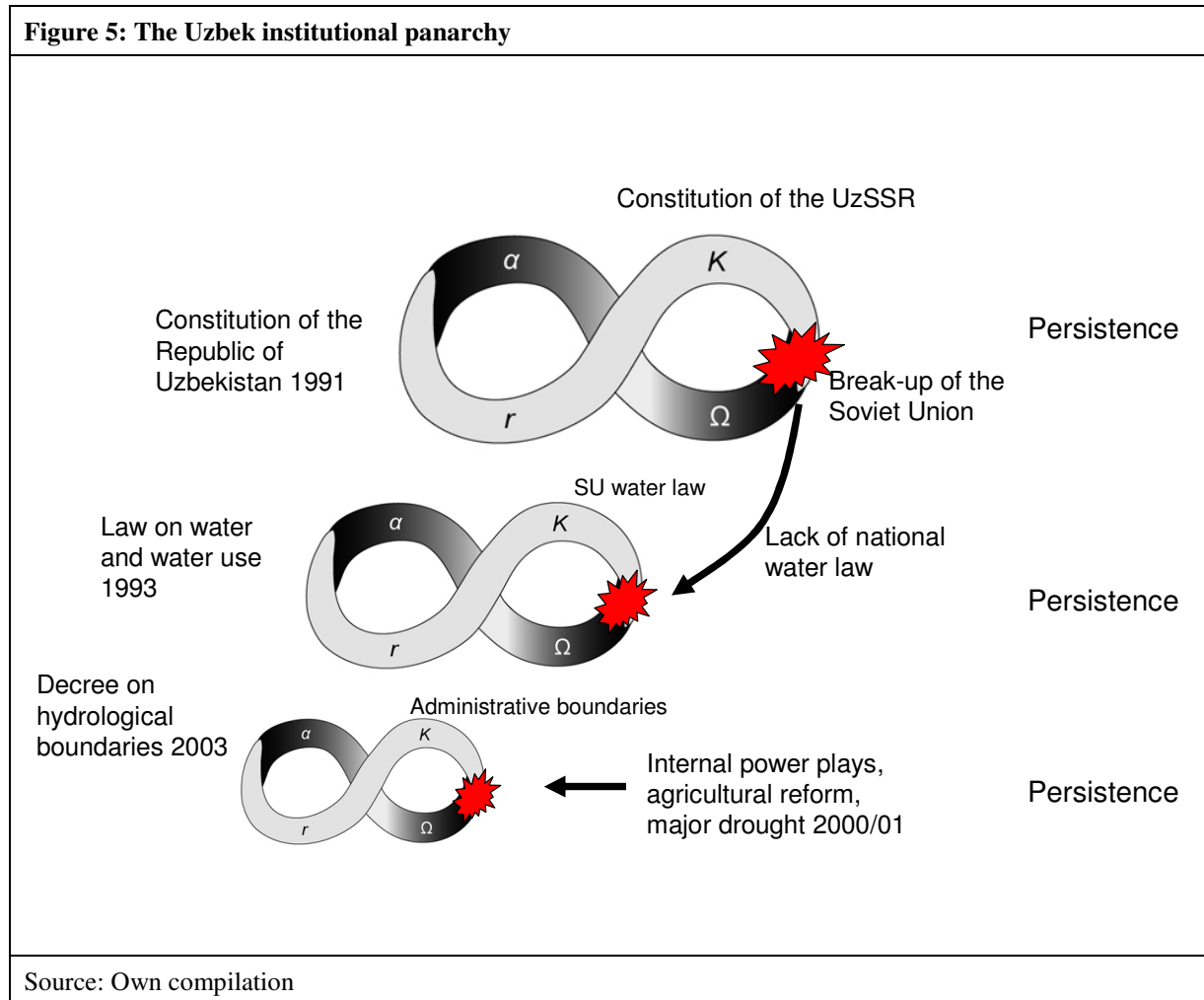
With the end of the Soviet Union the political system of the Uzbek SSR and its institutions faced a major crisis. In the following reorganisation phase the Soviet constitution was replaced with a democratic constitution. Thus on paper the political system changed from centralised, command-and-control, single-party rule towards a democratic, multi-party system. However, significant deficits have to be attested regarding the implementation of democratic principles such as civil rights, rule of law and the separation of powers (Schoeller-Schletter 2008, 19). The state administration remains rigid and inflexible, with strong centralistic structures and an authoritarian management style (Yalcin 2005; Pashkun 2003, 14). The centralisation of power renders public administration slow (because even minor issues are decided by central government), devoid of democratic checks and balances and providing little incentives for reforms (Pashkun 2003, 21). At the political level the system was highly resilient – reorganising in a similar configuration (despite having implemented a democratic constitution) after the shock of the breakdown of the Soviet Union. Thus, despite a change in formal institutions, structures and modes of governance have barely changed. Powerful feedback loops such as the incentives created for elites in form of rents from cotton monoculture (and the resulting lack of political will for change), the general attitude of the population towards change and the lack of experience with democratic structures as well as the lack of innovation keep the system on its unsustainable path. The rigidities observed at the national level translate to the lower levels of administration.

Uzbekistan is also perceived as a relatively poor performer concerning its transition to a market based system (Bertelsmann Foundation 2004). The President rejects any radical reforms and regularly underlines his course of gradual change towards a socially oriented market economy (Pashkun 2003, 14). In the agricultural sector, which is by far the main water user and thus closely related to the water sector, mechanisms such as the state order remained in place. The land reforms which were undertaken did not question these structures and mechanisms. Even in 2003, when several reform initiatives in the water and the agricultural sectors coincided, these have not been used to adapt or even transform the system in order to increase its resilience.

Since water is the main input for the agricultural sector, which is the backbone of the Uzbek economy, the need to establish a national water law was apparent after independence. The new law on water was mainly derived from Soviet water law and did not provide incentives for change. Instead (superficial) change in the water sector was motivated by external drivers (e.g. land reform) or internal power plays (e.g. between the Department of Agriculture and the Department of Water Management).

From Figure 5 it becomes evident that the Uzbek SES is not only largely preserving structures and feedbacks but also that the levels of the institutional panarchy are disconnected. Change remains incremental and isolated at lower levels of the panarchy. Since changes are marginal and disconnected they do not serve as triggers for change at other levels of the panarchy, i.e. change does not cascade. Instead the triggers for (marginal) change are often not only diverse

and external to the adaptive cycle in question but also to the institutional panarchy as a whole. The result is a patchwork of unconnected and isolated institutional change initiated to serve the purposes of the administration and ruling elite instead of providing solutions for the challenges of the social and the ecological system (e.g. poverty and environmental degradation). This means that the Uzbek social system despite being classified as transition country has not yet entered transformative change.



3.2 Institutional resilience of the Uzbek social-ecological system: A rigidity trap

Uzbekistan is an example of pathological resource management (Gunderson / Pritchard 2002, 3-4). Soviet water managers were successful in achieving the narrowly defined goal of providing enough water for cotton monoculture in the Central Asian republics. This success encouraged the rapid enlargement of irrigated agriculture in the region and the overuse of water resources. As a result of this one-sided approach to resource management, Uzbekistan

today is highly dependent on agricultural production, especially of cotton, and the unsustainable use of its water resources.

After independence, the Uzbek agricultural sector has served as a “shock absorber” (Weinthal 2002, 196) of the SES. It absorbed a large amount of labour and provided foreign exchange in the absence of transfers from Moscow. The persistence of cotton monoculture and the decoupling of the social and the ecological system helped to stabilise the social system and thus prevented its collapse. This de-coupling of the social from the ecological system originating in Soviet times can be observed in many parts of society. The most prominent and devastating example is the desiccation of the Aral Sea. Despite causing not only severe ecological but also economic and social damages this problem has been neglected over decades. It has only begun to be addressed in the late 1980s and has not led to significant changes in production patterns (Glazovsky 1995). The stabilisation of the social system happened to the further detriment of the ecological system thus decreasing the resilience of the SES as a whole (Schlüter / Herrfahrtdt-Pähle submitted).

The possible impacts of climate change have emerged on the political agenda recently and do not range high in priority. Decision makers have only recently begun to realise the connection between climate change and water resources. In 2009 the government took a first step and initiated a call for a climate change adaptation strategy for the water sector (Sadoff / Muller 2009, 67).

The low capacity of the current water management regime to deal with the old and emerging challenges can be explained to some extent by a mismatch of the functioning of the resource and management regimes, as well as mismatches between different levels of the social system. The Uzbek social system and its water sector in particular focus their attention and operation on internal processes and power plays as well as the mediation of climate variability. Reactions to crises such as drought are short-term oriented rather than focussing on the long-term functioning of the system. Huntjens et al. quote a decision maker from the middle water hierarchy: “*We are only preparing for one or two years ahead, there are no preparations for the far future*” (Huntjens et al. 2008, 82). Uzbek water governance is thus merely solving current and acute problems, while disregarding longer-term problems such as the impact of climate change on water resources. For example water is rationed and reused during drought years, and rice planting is prohibited. Both measures are appropriate from a short-term perspective. However, much more far-reaching adaptation measures (e.g. the reduction of water use of the agricultural sector) and even transformation in the form of a general shift in production patterns are required with a view to the degree of the ecological crisis. Furthermore, there are many ways to circumvent these regulations through patronage networks.

Many of the new institutions are ineffective in changing water management practices because they do not take institutional or political boundary conditions into account (Walker et al. 2009). The changes that are initiated take place on the wrong scale and at the wrong level: For example change of institutions at the local level (introduction of WUA) is not mirrored and

supported by introducing the matching institutions at the national level (WUA law) or changing surrounding institutions and boundary conditions (e.g. the responsibility of local governors for agricultural production, which leads to their interference in local water distribution). This mode of incremental change has been termed “patching up” (Genschel 1997, 46). It refers to the strategy of not replacing an institution with a new one but rather compensating for its inefficiencies with a new institution (i.e. “adding new rooms to the old house”). Thus the inappropriate water law is patched up with a number of decrees that introduce WUA and hydrological boundaries instead of drafting a new water law. The institutional regime thus represents high long-term continuity (Soviet water law prevailing), while change is introduced rather on the short term through presidential decrees (WUA, basin management; Yalcin 2005, 28). Thus the institutional changes in the water sector at best increase the short-term resilience of the social system to the detriment of long-term resilience of the SES.

In Uzbekistan pressure for rapid change is building up because the social system is firstly unable to react to feedback on crisis from the ecological system (such as the desiccation of the Aral Sea, change in hydrographs and precipitation) and secondly ignores and suppresses pressure for change from within the social system (e.g. political opponents are prosecuted and jailed; ICG 2007, 7; Collins 2002, 150). The Uzbek social system possesses a low adaptive capacity and has proven unable to adapt to changes in the ecological system. It seems unlikely that it is going to establish the missing link and react appropriately to the challenges of climate change and decreasing water availability in the future. Instead it is likely to continue to cling to the current mode of economic activity and employ ever more desperate measures to keep it in place, indicating a rigidity trap, similar to the one described for the Western Australian agricultural region (Allison / Hobbs 2004).

A system locked in a **rigidity trap** strongly resists disturbances, beyond the point where this is adaptive. “*Rigidity traps occur in social–ecological systems when institutions become highly connected, self-reinforcing, and inflexible*” (Gunderson and Holling 2002, cited in Carpenter / Brock 2008, 2) and “*where management by command and control severely reduces diversity, and forces of power and profit are mutually reinforcing*” (Carpenter / Brock 2008, 2-3). This is often the case when social systems highly depend upon a single resource and try to stabilise the provision of this resource by reducing variation in resource dynamics (Carpenter / Brock 2008, 2).

In the Uzbek case decreasing cotton yields are the result of the degradation of soils and water scarcity but also a lack of incentives to increase the productivity within the state order system (Abdullaev / Giordano / Rasulov 2007, 104). The current institutional setting does not allow for other more productive uses of soil and water (e.g. other crops) or even options other than agriculture (e.g. tourism or solar energy). Instead even more effort is put into conserving a highly unsustainable system. For example, students and even school children are forced to pick cotton in an attempt to compensate for low yields and broken machinery (Cannell 2007). In 2009 school children were reportedly forced to grow cotton seedlings at home to support farmers because unusually heavy rains had washed away the seeds (Najibullah 2009). After

the International Monetary Fund (IMF) had pressed the Uzbek government to align its cotton prices to world market prices this resulted in modest changes in cotton prices. In some provinces the foregone “revenue” was compensated for by tripling property taxes (Peyrouse 2009, 9). These examples show the desperate measures that are taken to keep the system going despite other dynamics.

A system in a rigidity trap represents properties such as a high connectedness, a high potential and high resistance to change. A high potential results from highly efficient social control, suppressing innovation (Holling / Gunderson / Peterson 2002, 95-96). The high potential or (social and cultural) capital of the Uzbek social system for enabling change is for example reflected in its extended social networks, but also in high levels of literacy and scientific knowledge and its complex governance structures dating from Soviet times (Pashkun 2003, 45). However, this potential is restricted because governance structures do no longer fit the changed circumstances since independence and sources of innovation are eliminated thus supporting the current lock-in situation.

The already high connectedness of the Uzbek social system is increasing, leading to what has been termed overconnectedness (Holling / Gunderson 2002, 35). The agricultural and the water sector are strongly connected, with a clear dominance of the agricultural sector. This overconnectedness makes it almost impossible to introduce change at one point of the system without changing the whole system. A lack of secure land rights leads to little incentives to invest in irrigation infrastructure, which is deteriorating, thus negatively influencing water use efficiency. In the future, increasing climate variability is more likely to put harvests at risk. Farmers unable to meet state order targets risk losing their land. To be able to fulfil the (often unrealistic) targets cotton is often excessively irrigated to increase cotton weight for the harvest (Wall 2006). This practice in turn adds to inefficiency and overuse of water. Thus the primacy of the state order drives developments in the water sector (Yalcin 2005, 30). The rising connectedness implies increasing rigidity and a low sensitivity towards change and crisis in the ecological system. Also the political and the economic spheres are highly intertwined since the cotton revenue partly enters the national budget while the larger part is reportedly channelled to political elites (Carmel 2005, 605; ICG 2007, 4; ICG 2005, 4-5).

The social system is highly resistant to change. The current system resists carrying out the necessary structural changes in land and water use at the national level and thus adapting to the current ecological and larger political situation. Change is rather motivated by perpetuating the current mode of production and sustaining the rents it creates. At the same time and as a consequence of these properties the resilience of the SES continuously decreases due to the continuing overuse of resources, leading to an increased vulnerability to shocks and disturbance. Given these dimensions of adaptive change the system has become brittle and a minor disturbance (such as an extended drought and/or local water conflicts) could push the system over a threshold and make it reorganise.

Given the current unsustainable state of the system, its rigid institutional setup and the mismatch between the social and the ecological systems, adaptation will not be sufficient to

ensure its continued functioning. A transformation of the SES is needed. Such a transformation would have to question and change current patterns of economic activity and resource use and lead to less water-intensive modes of production. This could for example include abandoning low productivity soils, switching to other less water-intensive crops, developing tourism and/or exploring the possibility of solar energy production. Given today's strong 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 great enough to threaten state budgets and existing rents, the political willingness to engage in comprehensive reforms might rise. With a view to the still relatively low levels of discontent among the population, rooted in the fatalism which is part of the Uzbek culture, however, it is questionable how long it will take until this point is reached and whether the system by that time will still have enough capacity and time to reorganize and prevent a collapse. In addition, the system will continue to be subject to external pressures such as climate change, world economic crisis and policy changes in other riparian countries which have the potential to push the system nearer to (or even over) a threshold into an even less desirable configuration.

4 Conclusion

In Uzbekistan high pressure for change has accumulated over the decades as it was locked in a highly resilient and maladaptive regime. The Uzbek social system disregarded environmental change during Soviet times and has been overusing its water resources for decades. Comprehensive change of the whole system (including slowly moving variables at the national level) is required, since incremental change or adaptation would not be sufficient to tackle the mounting problems. A window of opportunity opened and the country set out to transform its political and economic structures in after independence in 1991.

However, Uzbekistan's reform efforts remained superficial so far – in the political and economic sphere and in the water sector. Water governance remains state-centred, hierarchical, subordinate to agricultural production and driven by vested interests. As a consequence of historic developments in the agricultural sector and the strong feedbacks they created, the social-ecological system is locked into a state that is to a large extent still determined by the legacies of the Soviet Union. The massive expansion of irrigated agriculture, the following heavy 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. Vested interests created and perpetuated after independence now strongly influence, if not political decisions, than at least their implementation on the ground. The institutional change observed in Uzbekistan so far has been aimed at ensuring a stable production level of cotton and expanding wheat production to achieve food self-sufficiency. Small adjustments have been carried out in cases where underlying power structures and vested interests were either not touched or could be supported through the changes. This

underlines the importance of informal institutions and their power to overrule formal institutions in the water sector and beyond.

The Uzbek water governance regime has not been able to use the window of opportunity that opened with its independence from the Soviet Union. Instead its institutional resilience and adaptive capacity continue to decrease through rigid institutions, lack of participation and transparency and a strongly hierarchical and centralised water governance regime. The strong feedback loops created by the patronage networks and vested interests and their skimming of cotton revenues continue to prevent learning and the innovation needed at the national level to transform the system towards a more sustainable resource use. Thus state officials such as local and regional governors (*khokim*) have vested interests in the status quo that provides them with access to economic resources in the form of cotton rents and power. These mechanisms (powerful economic forces and vested interests) have contributed to keeping the social system on an unsustainable trajectory and limiting its choices. This increases the vulnerability of the system to external and internal shocks. Thus, with time the system is moving on an unfavourable trajectory towards a position where it is becoming more and more vulnerable to losing major desirable functions and characteristics. Institutional change that is taking place at a local level, e.g. through the slowly growing acceptance of Water User Associations (WUA), is constrained by the rigidity of boundary conditions (e.g. state order, patronage networks, dominance of the agricultural sector). Given the centralized decision-making that still prevails today, resilience and transformability at the national level are needed to enable the lower levels to adapt and change.

The findings underline the role of an enabling environment for comprehensive water governance reforms. The Uzbek case study illustrates important drivers of institutional change or the lack thereof such as informal institutions (e.g. patronage networks, vested interests), path dependence and the lacking demand for change by the constituencies. Without supportive structures at all levels of the institutional panarchy water governance reform efforts seem to be difficult to accomplish. This indicates the need to supplement and balance bottom-up developments with top-down movements. Thus water governance reforms should be facilitated by a comprehensive institutional reform effort at the national level, which is complemented with a reasonable amount of public participation. Only a consistent approach to adaptation at all levels and scales will help to cope with the challenges climate change increasingly entails for the sustainable use of water resources.

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