Water governance, resilience and global environmental change – a reassessment of integrated water resources management (IWRM)

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Abstract Integrated Water Resource Management (IWRM) is gaining increased acceptance among water policy makers and researchers as a way to create more effective governance institutions, leading towards integrated water development solutions for poverty alleviation, while addressing social, economic and environmental aspects of water challenges. However, global environmental change poses fundamental challenges to water policy makers as it implies vast scientific, and hence, policy uncertainty; its implications for international water governance initiatives remain unspecified, effectively hindering dialogue on how current IWRM initiatives should be modified. This paper addresses the lag between our growing understanding of resilient interconnected freshwater resources (and their governance) and the reforms being promoted by policy makers. In particular, there is a need to rethink some of IWRM’s key components to better tackle the challenges posed by the complex behaviour of interconnected social-ecological systems and global environmental change.

Keywords Global environmental change; governance; IWRM; resilience; water policy

Introduction
Water crisis is in many senses a crisis of water governance. Integrated Water Resource Management (IWRM) is gaining an increased acceptance among policy makers and water policy researchers on a global scale as a way to create more effective water governance institutions (e.g. Jonch-Clausen, 2004; GWP, 2004:3). At best, IWRM is able to work towards integrated water development solutions for poverty alleviation and address the social, economic and environmental aspects of water challenges.

Global Environmental Change (GEC) poses fundamental challenges to water policy makers as it implies vast scientific, and in the end vast policy uncertainty. Although the need to modify water management and institutions to tackle the challenges posed by complexity, uncertainty and global environmental change have been discussed earlier in (Clark, 2002; Folke, 2003; Pahl-Wostl, 2007; Gunderson et al., 2006; Falkenmark, 2003), none have specified the implications for ongoing international water governance initiatives, a fact that effectively hinders a much-needed dialogue on how current IWRM initiatives can be modified to better harness the implications of global environmental change.

The following paper is an attempt to bridge this gap, and intends to bring to light the substantial lag between our increased understanding of the features of resilient interconnected freshwater resources and their governance, and the reforms being promoted by policy makers at several policy scales. I discuss this through a “resilience lens”, i.e. by focusing on the capacity of social-ecological systems to deal with environmental and societal change, and to reorganize after shocks and surprises (Gunderson and Holling, 2002; Folke, 2006). The main argument is that there is a need to rethink some of IWRM’s key components to better harness the challenges posed by the complex behaviour of...
interconnected social-ecological systems (Gunderson and Holling, 2002) and global environmental change.

**Governing dynamic freshwater systems – taking thresholds, cross-scale interactions, and persistent uncertainty seriously**

Changes currently experienced by the Earth System do not add up in a linear manner, but instead can trigger sudden and surprising changes in social-ecological systems and ecosystem services (Steffen et al., 2004; Millennium Ecosystem Assessment, 2005).

Freshwater is not an exception (Foley et al., 2003; Pahl-Wostl, 2007). What is interesting is that the effects of GEC - such as changes in mean temperature, loss of biodiversity, changes in ecosystem function and services – can seriously undermine the capacity of freshwater systems to cope with stresses and shocks such as droughts, floods, anthropogenic pollution, loss of biodiversity and landscape modifications. It also seems likely that GEC might trigger or increase the frequency of the same kind of compounded shocks.

This creates a twofold impact on freshwater systems that is loss of resilience in freshwater systems, as well as an increased frequency and intensity of perturbations. This twofold impact can result in abrupt irreversible shifts in freshwater resources, a point that has been elaborated in detail for other biophysical systems (Nystrom et al., 2000; Paine et al., 1998). Research that supports this notion is provided by (EC-JRC, 2005) in their detailed elaboration of possible regime shifts in lake and coastal systems linked to climate change; (Scheffer et al., 2001) elaborate how small climatic changes can trigger major regime shifts in lake systems leading to an elimination of clear water states; (Schröter et al., 2005) elaborate the projected decreases in ecosystem services due to GEC; and (Chapin et al., 1998) and (Cramer et al., 2001) elaborate how changes in ecosystem function affect water quantity and quality.

Sometimes these shifts are practically irreversible. These changes denoted “regime shifts” can have vast social, economic and ecological implication, and are far from uncommon in water resources. A number of studies elaborate this mechanism in lake systems (Carpenter and Cottingham, 2002), coastal areas (Troell et al., 2005) and oceans such as the Baltic Sea (Jansson and Jansson, 2002). In numerous cases, the regime shifts are resilient, a fact that can counter restoration efforts hence creating a situation where the shift is practically irreversible (Carpenter and Cottingham, 2002; Folke et al., 2004).

How to avoid crossing these critical yet uncertain thresholds in freshwater resources as well in the interconnected biophysical landscape is a critical question that is being targeted by scientists, but also needs to be addressed by water policy makers and managers.

**Harnessing uncertainty – institutional and organizational implications**

Water managers and policy makers deal with uncertainty on a daily basis. This does however not imply that the strategies used today will be successful in dealing with the sometimes surprising impacts of GEC. The institutional and organizational mechanisms needed to build a capacity to deal with change, uncertainty and surprises have been elaborated extensively by (e.g. Gunderson and Holling, 2002; Folke et al., 2005; Berkes et al., 2003), and can not be discussed in detail here. They can be summarized in three interlinked points:

1. **Harnessing system dynamics.** Water managers should not only try to keep an eye on change in the parameters defining water quantity and quality, but also try to assess the major social, ecological and economical drivers, possible “surprises”, and provide rough estimates for the thresholds in freshwater systems. Without a thorough understanding of these dynamics, conventional monitoring activities could miss the increasing risk that the
water system is becoming more vulnerable to the impacts of climate variability and change as a result of its motion towards a threshold that is difficult or impossible to reverse (for examples see Carpenter et al., 2001; Peterson et al., 2003; Walker et al., 2002).

II. Linking scales. As lessons learned from other social-ecological systems reveal, crises often occur at the junction of large-scale processes and changing local variability (Holling 1986). Hence institutions at different scales need to communicate and exchange information with one another especially as stakeholders and policy-makers find themselves responding to the local effects of changes in climate, global markets, and political initiatives (e.g. Gibson et al. 2000). This means that information in water governance needs to flow not only from the top to the bottom, but also in the diverse direction to be able to secure the fast response of agencies and policy makers at higher institutional levels in times of extreme events (Dietz et al., 2003).

III. Promoting learning and treating policy as experiments. Another implication is that water governance initiatives should put more emphasis on establishing methodologies to test hypotheses concerning uncertainties in the water system, and allow for experimentation with different strategies for freshwater resources management. Governance according to this perspective is used as a tool not only to change the system, but as a continuous learning-by-doing process that recognizes public participation and joint learning (Schluster et al., 2003; Folke et al., 2005). Worth highlighting here is that these experiments can be applied not just to the natural resource, but also to water governance initiatives themselves (Habron, 2003; Ostrom, 2005).

Resilience and water governance - IWRM at the international policy arena
How different is the suggested governance approach from conventional IWRM when it comes to tangible operative water management and policy? The answer will depend heavily on how we define the ambitions of IWRM. Here I discuss IWRM as a strategic approach to water management, rather than looking at its specific implementation and impacts on the field. Although this certainly is a limitation, the scope of the material analyzed is still able to provide interesting insights on how ongoing IWRM initiatives can and should be used to tackle the challenges posed by global environmental change.

The number of policy documents, policy briefs, guideline documents and tools concerning IWRM is nonetheless overwhelming. Here I have strategically chosen actors that represent both international water “think-tanks” and regional water policy makers. The actors are the Global Water Partnership, the World Bank, the United Nations Development Programme (UNDP) through its project Cap-Net (Capacity Building for Integrated Water Resources Management), the Asian Development Bank (ADB), the African Development Bank (AfDB), and the Inter-American Development Bank (IDB).

It should be recognized that there are a number of recommendations in all papers that are likely to strengthen the countries capacity to cope with the impacts of climate variability and change. More precisely, aiming to integrate the management of linked natural systems (GWP, 2000), integrate national policy-development (ADB, 2003; AfDB, 2000; GWP, 2000; Jonch-Clausen, 2004; Cap-Net, 2006; [http://www.cap-net.org/iwrm_tutorial/6_1.htm [accessed 2006-03-29]], IDB, 1998), link bottom-up with top-down strategies (GWP, 2000; ADB, 2003; Cap-Net, 2006; [http://www.cap-net.org/iwrm_tutorial/3_3.htm [accessed 2006-03-29]]), at the same time as continuous monitoring, environmental impact and risk assessments is promoted (GWP, 2000; Cap-Net, 2006), are all important components in dealing with the impacts with climate variability and change.
On the other hand, it is also clear that the recommendations in all the documents assume away the dynamics of freshwater systems. Hence they miss out emerging water related risks resulting from global environmental change. The argument is elaborated in the following section.

Freshwater dynamics and IWRM
First, none of the papers recognize the need to assess the thresholds, the key drivers and major uncertainties that determine a freshwater system’s ability to uphold vital ecosystem services and social welfare. As an example, although all emphasize and elaborate the need of environmental monitoring activities, impact indicators, and creating a “water resources knowledge base” (IDB, 1998; GWP, 2004; GWP, 2000; Jonch-Clausen, 2004; World Bank, 1993; ADB, 2003; AfDB, 2000; Cap-Net, 2006[http://www.cap-net.org/iwrm_tutorial/1_3.htm [accessed 2006-03-29]]), none of them recognize the need of conducting assessments of potentially serious abrupt and irreversible regime shifts. The implications are not trivial. If the frequency, intensity or coverage of climate variability shifts as a result of global environmental change, whether these events are likely to result in irreversible regime shifts should be vital information for water managers (c.f. Steffen et al., 2004; Millennium Ecosystem Assessment, 2005).

Second, all actors fail to acknowledge the need to develop water policy strategies that are able to adapt, or cope with “surprises”, and uncertainty in freshwater systems. This becomes most clear in the discussion of the creation of IWRM plans and the IWRM-cycle. As an example, although the need to design iterative water planning processes is discussed extensively in (Jonch-Clausen, 2004; GWP, 2004; World Bank, 1993; ADB, 2003; AfDB, 2000), none of the documents provides any guidance on how to “plan” in a context where both social and ecological uncertainties are vast.

Again, consider the uncertainties in water planning activities created by the undetermined impacts of global environmental change. Many of the fundamental components of the IWRM process (such as “Build Commitment to Reform Process”, “Prepare Strategy and Action Plan” and “Build Commitment to Actions” summarized in Jonch-Clausen, 2004 and GWP, 2004) will be difficult, or even impossible to achieve without explicit strategies that help water policy makers and communities to achieve consensus and collective action despite uncertainty (Galaz, 2005). In addition, all documents fail to recognize that climate induced surprises such as flash floods, previously inexperienced droughts, and unexpected changes in freshwater quality, can seriously undermine carefully negotiated water plans, one fundamental component in the IWRM process. How to restructure, and renegotiate IWRM-plans after such events in collaboration with stakeholders under vast social and ecological uncertainties is a challenge worth far more attention in international water policy-guideline documents aiming to harness global environmental change.

Third, proponents of IWRM tend to be strong advocates for stakeholder participation (e.g. IDB, 1998; GWP, 2000; Jonch-Clausen, 2004; GWP, 2004; World Bank, 1993; ADB, 2003; AfDB, 2000; Cap-Net, 2006[http://www.cap-net.org/iwrm_tutorial/3_3.htm [accessed 2006-03-29]]). At the same time, none of them recognize the need to promote collaborative learning processes. The difference between stakeholder participation and social learning might seem small, yet the practical implications are important. IWRM approaches seem to promote stakeholder participation as a way to legitimize water plans, to mobilize support for the implementation process, and to get more accurate qualitative assessments (ibid). Collaborative learning processes on the other hand are advanced to combine scientific with local knowledge, to jointly assess the drivers and thresholds of
the system and as a key component in creating a common understanding of the major uncertainties in the system (see Walker et al., 2002; Berkes et al., 2003 for examples).

Fourth, IWRM-processes are often presented as a dynamic process that “aims at laying down a framework for a continuing and adaptive process of strategic and coordinated action” (GWP, 2004), or as “an ongoing learning and development process” (Jonch-Clausen, 2004; see also GWP, 2000; ADB, 2003; IDB, 1998). However, none of the documents discuss the need to cope with uncertainty by treating policy as experiments. On the contrary, the recommendations build on the bold assumption that policy is realized in a non-changing natural and social environment, and assumed by policy makers with a close to perfect causal understanding of the world (e.g. Cap-Net, 2006(http://www.cap-net.org/iwrm_tutorial/6_1.htm [accessed 2006-03-29])). As discussed earlier, treating policy as experiments from which managers can learn is a requisite in dealing with change and vast uncertainties such as those created by global environmental change (c.f. Ostrom, 1999, 2005; Folke et al., 2005).

Fifth, capacity building is often identified as a key element in promoting IWRM-processes (e.g. GWP, 2000; Jonch-Clausen, 2004; Rogers and Hall, 2003; World Bank, 1993; ADB, 2003; AfDB, 2000; Cap-Net, 2006(http://www.cap-net.org/iwrm_tutorial/5_3.htm [accessed 2006-03-29]), IDB, 1998). “Capacity building” in IWRM initiatives focus on institutional and policy improvement, monitoring and evaluations skills. These initiatives do however, not aim at enhancing the capacity of water managers and water dependent communities to deal with the local implications of climatic change. Building this sort of capacity requires strengthening by IWRM hitherto ignored organizational and social components (e.g. GWP, 2000), such as the promotion of social capital (Pretty, 2003; Adger, 2003; Berkes and Seixas, 2005), the stimulation of social learning aiming to understand system dynamics (Tompkins and Adger, 2004; Schluster et al., 2003; Walker and Meyers, 2004), and nurturing social networks (Cutter et al., 2003; Woolcock and Narayan, 2000).

Sixth, it is also worth noting that the problem-solving capacity of catchment-based governance promoted by IWRM is likely to be drastically challenged when shocks to the water system resulting from global environmental change induced extreme events (Re Munich, 2006; Steffen et al., 2004), risk to cascade and trigger crisis and non-linear behaviour in social, ecological or economical domains that clearly surpass the scale of the river basin and the scale of catchment based social networks (c.f. Kinzig et al., 2006; Moench and Dixit, 2004). Kinzig and others (2006) provide a number of illustrations of the governance challenges posed by cascade effects. Projections of the social, economic and ecological state in the Australian wheat-belt display a number of interacting thresholds. Abrupt shifts from sufficient soil humidity to saline soils and from freshwater to saline ecosystems, might make agriculture a non-viable activity at a regional scale and trigger migration, unemployment and the weakening of social capital. Hence many of the existing strategies to cope with e.g. extreme weather events require a policy-integration different from that usually promoted by conventional IWRM approaches (e.g. Cap-Net, 2006; World Bank, 1993; GWP, 2000). As an example, the possibility to migrate in times of drought or flooding, strategies to achieve income diversification, nurturing social networks and social capital, etc. (c.f. Moench and Dixit, 2004; Adger, 1999) are all risk-reducing policy initiatives that will require different collaboration patterns among state agencies and civil society.

Reassessing the three pillars of IWRM
The need to realize a more integrated management of water resources should not be underestimated. There is nonetheless also a serious need to take the dynamics of
freshwater systems in an era of global environmental change seriously. The implication of the argument presented here is not to discard IWRM altogether, but rather to rethink some of its key components in the light of our increased understanding of the features of interconnected freshwater resources and their governance. The interesting question is obviously which components, and in what ways. The general principles of IWRM are numerous, yet four Dublin principles seem to stand out as “they have been carefully formulated through an international consultative process […]” (GWP, 2000). I will discuss three of the four principles in detail, as these seem to be those mostly affected by the perspective offered in this paper. (This is not to say that gender aspects are unimportant in increasing the capacity of water governance to tackle the impacts of global environmental change. The challenge is that resilience scholars have yet to integrate gender issues).

Pillar I. Freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment
This pillar identifies water as a fundamental and finite resource, but also the need to create a “water sensitive political economy” and “co-ordinated policy making at all levels” (GWP, 2000).

Taking the dynamics of freshwater systems seriously in an era of global environmental change however, also implies a need to recognize that water resources do not respond to change in a smooth way. Freshwater resources with diminished resilience can move beyond thresholds that are difficult and even impossible to reverse resulting in less social welfare, or a collapse in the whole system. The first pillar also needs to recognize that freshwater resources are subject to cross-scale interactions as they are strongly interconnected with other ecological and social systems at diverse geographical and time scales. This implies that freshwater governance must be able to harness high uncertainty and surprises resulting from these interactions. One suggested strategy is to promote co-ordinated policy making across sectors and levels and policy experiments, learning and adaptive approaches to water governance.

Pillar II. Water development and management should be based on a participatory approach, involving users, planners and policymakers at all levels
This second pillar highlights the need to involve stakeholders in the decision-making process. From a perspective where water resources are viewed as dynamic and vulnerable to global environmental change, this second pillar should recognize the need to promote stakeholder participation as a way to deal with uncertainty, change and “surprises” in freshwater resources. That is, not only is stakeholder participation needed to achieve “long-lasting and common agreement” (GWP, 2000), but also as a process that: 1) combines local knowledge with scientific expertise and promotes joint learning processes to better understand the dynamics of freshwater resources, that is threshold behaviour, key drivers and major uncertainties, 2) builds a joint capacity to better cope with, or recover from surprises and extreme events by nurturing the evolution of social networks and social capital amongst stakeholders and water managers, 3) builds a joint capacity to monitor and adapt to gradual change in water resources, or in social, economical, political or ecological conditions vital for nurturing the resilience of freshwater resources.

Pillar III. Water has an economic value in all its competing uses and should be recognized as an economic good
This third pillar highlights the problems created by viewing water as a free good. This principle points out the need to manage water demand and supply by using economic instruments (GWP, 2000) and/or recognizing and setting up water rights-based
management systems (World Bank, 1993, 2004). The argument that water should be treated as an economic good has gained wide acceptance by a number of international water policy actors such as the World Bank (Bauer, 2005), the Inter-American Development Bank (IDB, 1998) and the Asian Development Bank (ADB, 2003).

Yet the non-linear dynamics of these systems seem to challenge the efficiency of assigning property rights (Dasgupta and Ma¨ ler, 2004). More precisely, recognizing that freshwater systems are complex and interconnected also implies realizing that minor disturbances can move the system to a new degraded and practically irreversible state. For example, compounded perturbations transforming an oligotrophic water system into a eutrophic lake, or a system where modifications in the landscape irreversibly affect the flows of blue and green water (c.f. Falkenmark, 2003), respond in a stable fashion to further disturbances but it now moves toward a new equilibrium state with less social welfare. Property rights to goods and services allocated before crossing the threshold are no longer available, and the assumptions of the economic model are no longer valid (Limburg et al., 2002). The increased potential for regime shifts, surprises and conflict resulting from uncertain hydrological changes, and the desires of competing water users for certainty, flexibility and protection of environmental values call for a much closer examination of the ways in which economic tools and incentives can be used to facilitate or hinder adjustment to the effects of GEC.

Conclusion
It should be highlighted that the argument is not that all realized IWRM-approaches throughout the world fail to recognize the interconnected dynamical and non-linear characteristic of freshwater resources. What is argued is however, that IWRM as a strategic approach as represented in key global policy documents, does not seem to strengthen water governance in such a direction. The analysis shows that there is a substantial lag between advances in research on what constitutes resilient interconnected freshwater resources and their governance, and what is being promoted by policy makers at several policy scales, from the international to the national arena. Ongoing IWRM-processes provide an important window of opportunity to build a capacity to tackle the challenges posed by global environmental change. But only with a number of important adjustments.

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