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Sustainable and adaptive governance of water resources

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Abstract: Since the 1990s the sustainability concept, i.e. addressing social, economic, environmental and inter-generational issues, is widely acknowledged as guiding principle of natural resource management and governance. In the water sector this is reflected in Integrated Water Resource Management (IWRM), which aims at integrated, economically, socially and environmentally sustainable use of water resources. Faced with climate change, governance of natural resources is confronted with unprecedented situations and past experience may no longer provide reliable guidance for the future. This has been termed the adaptation deficit of water resource management. The question arises in how far IWRM is able to deal with challenges such as decreasing water availability and uncertainty in water supply. To maintain the long-term sustainability of the water sector, its ability to adapt to unforeseen events needs to increase, i.e. (as part of disaster risk management) adaptation needs to become integral part of the governance of water resources. Governance structures need to be developed which enable stakeholders to cope with the challenges and uncertainties of climate change. Increasing both the sustainability and the adaptive capacity will thus be one of the major future challenges for the water sector and serve as contributions to disaster risk management. This paper addresses the question in how far IWRM besides supporting the sustainable management of water resources is prepared for increasing the adaptive capacity of the water sector. This is achieved by examining the features of IWRM regarding their contribution towards increasing the adaptive capacity of water governance regimes. The paper also identifies additional features which would be required for further increasing the adaptive capacity of water governance and management.

Keywords: IWRM, adaptation, water governance, disaster risk management, climate change

1. Introduction

Water increasingly becomes a scarce resource in many parts of the world. The demand for water rises due to population growth, economic development and the increasing recognition of the environment as a legitimate water user. In many places this trend collides with a decrease in available water resources mainly driven by the impact of climate change [1]. The need for adaptation is especially high in the water sector, which will be particularly affected by climate change. First, climate change is likely to result in decreasing runoff in many parts of the world. For example for South Africa, climate change models suggest that a 20% decrease in precipitation might lead to a decrease of up to 70% of the runoff in some parts of the Orange-Senqu River Basin, which serves as a major water source for irrigation agriculture [2]. These trends in water availability are likely to exacerbate existing poverty and health problems (thus increasing the vulnerability of affected people) and make a sustainable use of water resources even more imperative. Second, the unexpected weather- and water-related extreme events such as droughts and floods are projected to occur more often, become even more extreme and result in more fatalities and damages [3].

These developments call for improved abilities to cope with such events. To achieve sustainable water use adaptation to climate change needs to become integral part of water management [4, 5].

Since the 1990s the sustainability concept, i.e. addressing social, economic, environmental and inter-generational aspects of development [6], is widely acknowledged as guiding principle of natural resource management and governance. In the water sector this is reflected in Integrated Water Resource Management (IWRM), which aims at integrated, economically, socially and environmentally sustainable management of water resources [7], and more recently the sustainable governance of water resources [8], [9]. In the water sector adaptive IWRM can serve this goal.

The impact of climate change on water resources confronts IWRM with the need to cope with uncertainties as well as gradual and abrupt change [10]. Climate change models are still afflicted with considerable uncertainties, especially concerning local projections of climate change impacts. Furthermore, other uncertainties arise since management of natural resources is confronted with unprecedented situations and past experience may no longer provide reliable guidance for the future [11]. These challenges have been termed the current and future adaptation deficit of water resource management [12]. Only if the ability of the water sector to adapt to unforeseen events is increased, i.e. if adaptation becomes integral part of the management of water resources, can a long-term sustainable use of water and sustainable development be achieved [13]. Governance structures need to be developed which enable stakeholders to cope with the challenges and uncertainties of climate change. Increasing both the sustainability and the adaptability will thus be one of the major future challenges for the water sector.

This paper addresses the question in how far current water governance approaches and particularly IWRM is prepared for increasing the adaptability of the water sector. It also identifies features from the literature on adaptive governance and adaptive management, which would be required for further

increasing the adaptability of water governance regimes. Finally, it outlines potential directions of future research on making water governance adaptive.

2. From sustainable to adaptive water governance

In recent years the relevance of governance issues has been increasingly acknowledged in the formerly rather technically dominated sphere of water management. Water governance has been defined as the range of political, social, economic and administrative systems in place to develop, provide and manage water resources at different levels of social organization [14]. Water governance refers to the rules or institutions and rule-setting procedures (e.g. the rules determining how water should be allocated in a catchment; [15]. Within a governance process visions are provided and trade-offs handled in order to find an acceptable position in balancing these trade-offs. In contrast to this, water management is concerned with applying these rules or institutions (e.g. distributing water in the catchment) and operationalizing the vision, i.e. with the practical aspects of water allocation [16]. Thus while water governance is about „the forms and processes by and through which one arrives at settled social rules“, water management is about „the forms and processes by and through which one applies settled social rules“ [17]. In the following the focus is on water governance and the contributions of IWRM towards making water governance sustainable and adaptive.

3. Sustainable water governance: IWRM

Since the Dublin Statement on Water and Sustainable Development [18] and the proliferation of Integrated Water Resource Management (IWRM; [7] the sustainable use of water resources has become one of the central aims of water governance and management. Sustainable water governance in general and IWRM in particular highlight the need for social, economic and ecological sustainability in governing and managing water resources [19]. Prevalent features of IWRM are: participation, equity and integration (social sustainability), efficiency and coherence (economic sustainability), accountability and transparency (political sustainability) and ecological sustainability and responsiveness in the ecological context (e.g. [7], [19], [20], [21]. These features are reflected in many water policies and laws around the world such as the South African National Water Act [22].

In addition to this broad, integrated approach to water management the increasing impact of climate change on water resources recently led to calls for innovative and adaptive ways of governing water resources [23], [24], [25], [26], [27]. IWRM and adaptive governance partly overlap (e.g. by stressing the importance of participation and integration), however, adaptive governance adds some features which are not yet reflected in IWRM and even may contradict it. For example while IWRM emphasizes the need for planning, efficiency and coherent strategies, adaptive governance favors addressing the uncertainties in water availability through flexible solutions and redundancy [28]. This section examines in how far the features of IWRM listed above increase the adaptability of water governance structures. The following section suggests additional features, which are needed to make water governance regimes adaptive to the challenges of climate change.

2.1 The social dimension of IWRM: participation, equity and integration

Broad stakeholder participation is regarded an essential feature in making water governance regimes adaptive [29], [30]. Through participation different kinds of knowledge concerning ecosystem functioning and management practices (including local and traditional knowledge) can be integrated in management decisions and water policies thus making them more effective and increasing the range of possible options. Participation gives underrepresented groups the chance to raise their issues and claim their rights. Through this process trust and a shared understanding can be built and social learning be fostered [31]. Participation refers both to the involvement of stakeholders in decision-making processes at different levels of administration (e.g. for developing a water use strategy) and the equitable and participative access to and ownership and use of water resources to provide all citizens with equal opportunities to sustain their well-being.

Closely related, IWRM demands equity, equitable participation and access to water resources (Saravanan et al. 2009). Resulting effects, such as lowering infectious diseases and shifting resources from fetching water to productive uses and education, increase the adaptability of a society (Appleton and Smout 2003).

The importance of integration or interplay between institutions and organizations for sustainable and adaptive governance of natural resources has been frequently underlined [32], [33], [34]. Horizontal interplay refers to institutions that facilitate cooperation and linkages (e.g. the exchange of knowledge and information) among organizations at the same level of administration (e.g. ministries, local water management organizations) as well as cross-sectoral and cross-disciplinary thinking [35]. It foresees that e.g. ministries concerned with water management tasks or local water management organizations, such as Water User Associations (WUA), exchange information, thus allowing for new adaptation measures to spread quickly. This is increasingly important for identifying and sharing best practices in decentralized governance systems.

The demand for multi-level or vertical governance structures has been underlined for both IWRM and adaptive water governance [36], [34]. Multi-level governance is based on the assumption that complex issues such as water governance can only be achieved through the integration, interaction and cooperation of the different levels of a governance system. Adaptive governance mechanisms work across levels, include state and non-state actors, and integrate the local, provincial, national and international administrative levels. However, multi-level governance does not necessarily imply the linear organization of administrative levels, which is more crisis-prone or susceptible to risk, since the failure of one feature can break the system [37]; cf. also [38].

2.2 The economic dimension of IWRM: efficiency and coherence

The efficient use of natural, human and financial resources is a prerequisite of sustainable and adaptive water governance, especially in the context of developing countries, which more often than not are not well endowed with any of them. Limited resources will be even more strained under the conditions of adaptation to climate change. Besides economic efficiency this includes environmental and political efficiency, e.g. minimizing environmental inefficiencies of water management such as over- or under-allocation and providing a socially accepted and affordable level of access to water resources and sanitation.

One requirement for effective and efficient governance of resources is coherence, i.e. the consistency of the features of a governance regime [39]. This can regard the coherence of governance

levels, strategies and instruments or responsibilities and decision-making as well as the coherence between actors [40], [39]. Policy coherence is especially important regarding water since water issues cut across sectors, boundaries, and administrative levels. In the context of decreasing water availability, it gains importance in many river basins across the world.

2.3 The political dimension of IWRM: accountability and transparency

Water governance in general and IWRM in particular require clear responsibilities and obligations as well as sanctions for the violation of rules. Water governance organizations are bound by the rules which have been formulated by legislatures for the governance and management of water resources and their actions should be authorized by law [41]. Authorities that can be made responsible for their actions (and inaction) both by superior bodies (upwards accountability) and by the public (downwards accountability) tend to pursue a more equitable distribution of benefits and thus enhance the sustainability and adaptive capacity of a social system [31].

Accountability is supported by transparency, i.e. accessible policy formulation, the disclosure of organizational structures, water management procedures and strategies as well as monitoring data [42]. Transparency and accountability increase the predictability of system behavior. They create trust and confidence in organizations and institutions of water allocation and distribution and thus in the social system and its functioning. The stability and predictability of the social system can act as a counterbalance for an increasingly uncertain ecological system.

2.4 The ecological dimension of IWRM: sustainability and responsiveness

The emphasis on sustainability and responsiveness introduces the time scale to sustainable and adaptive water governance. Sustainable water governance does not only serve present water users but also takes the demands of future water users into account [14]. This includes governing (surface water and groundwater) resources in such a way that overuse and pollution are minimized and that enough water is provided to support ecosystems (environmental flows; [43]. Policies and institutions which are oriented towards curbing demand, keeping in mind present and future interests of water users increase the room of manoeuvre and the adaptability in times of drought or other extreme events.

In a changing environment responsiveness of the social system gain importance [44]. IWRM recognizes the need to anticipate long-term effects of present interventions, and (especially when this is not or not sufficiently possible) to monitor effects during implementation and adjust measures if necessary. Past experience and current changes in the ecological system need to be monitored and taken into account. This includes the ability to recognize changes in the water system (e.g. decreasing water availability, overuse of groundwater resources or increasing water pollution), and take timely and adequate measures to react to these changes.

3. Adaptive water governance

As shown above, governing water resources sustainably as reflected in IWRM in many ways simultaneously increases the adaptability of water governance regimes. However, the institutional and organizational setup and its adaptive capacity seem to be inadequately addressed in the sustainability and IWRM framework. This includes the adaptability of the governance structures, i.e. their ability to

cope with unexpected events (both in magnitude and direction). To prevent mismanagement and be able to timely react to unforeseen events, the polycentricity, flexibility and redundancy of governance structures, management institutions and organizations should be increased [45].

3.1 Polycentricity

Unlike monocentric systems polycentric governance structures are characterized by multiple centers of power. Polycentric governance structures are characterized by multiple interacting centers of power with different purpose, organization, spatial location and many degrees of freedom at different levels [34]. These degrees of freedom permit the development of locally appropriate institutions [31]. Furthermore the capacity for learning and coping with change is assumed to be higher in polycentric regimes [23].

Assuming that non-linear polycentric governance structures are better geared to react to non-linear ecological crises than linear governance structures [37], polycentric organizations and institutions enable a better fit between the social and the ecological system and thus allow for more timely and adequate responses to change [31]. For example, the impacts of climate change on water resources are likely to vary across a country, thus calling for individual adaptation measures in different regions. These are more likely to develop in a loosely connected, polycentric governance context than within a monocentric setting.

3.2 Redundancy

Contrary to mainstream economic thinking, it is increasingly acknowledged that redundant structures do not necessarily lead to inefficiency but may even improve system performance – especially if system performance is not measured in terms of short-term output but rather in terms of long-term capacity to deal with risk and uncertainty and adapt to change [37]. In ecosystems, redundancy of species guarantees ecosystem resilience and stability and prevents ecosystem failure [46]. Redundant species are not primarily needed to provide ecosystem functioning and services because they provide functions to the ecosystem similar to those of other species. But they are able to replace other species once these fail or become extinct. Thus redundancy resembles one of the core principles of evolution and can potentially ensure the survival of the system in times of crisis.

Assuming that this concept can be applied to social systems, the overlap and redundancy of institutions may increase the capacity of a system for diverse responses to a problem [47]. This implies that one institution can provide the same (or a similar) function as a second one and replace it once the second one became ineffective through crisis and change. Redundancy may refer to the overlap of institutions or functions of organizations or the prevalence of similar subsystems [37]. The doubling of institutions and a modest overlap of functions support the spreading of risks and also help to absorb disturbances [16]. Moreover, governance structures that mirror ecosystem structures are more likely to identify system failure and adequately respond to it [37]. Redundant functions and organizations may thus not contribute to system functioning under normal conditions but may provide relevant functions and information during unpredictable events, thus increasing the adaptive capacity of water governance regimes.

3.3 Flexibility

The adaptive capacity of water governance regimes can be increased through flexible institutions, which offer mechanisms that provide for the adjustment of procedures and structures to new (environmental) conditions and new (scientific) knowledge [36]. Flexible institutions allow feedback and monitor implementation, i.e. they enable learning from past experience and support actors to quickly identify inefficient practices and rules and the need for changing them. However, too much flexibility may also have negative repercussions. Systems which do not allow change will probably generate surprise and crisis, while systems which allow too much change will lose social memory [48]. On the one hand the increasingly uncertain environment forces social systems and institutions to become more adaptive – that is, flexible and open to change. On the other hand strong and reliable institutions are needed to establish and sustain a functioning water governance system.

4. Synergies and trade-offs

Many of the above-described features of sustainable and adaptive water governance are closely interlinked and difficult to examine in isolation. Some of the features produce synergies, while trade-offs and tensions exist between others. For example, polycentric governance may facilitate redundancy and experimenting because of a large number of independent units, thus fostering adaptive capacity of the water governance regime [23], [49], 184). However, since the doubling of functions and subsystems is costly, with a view to efficiency there is a need to identify the optimal level of redundancy [37]. Since it is often difficult to identify the kind of redundancy in advance that will generate positive effects in a crisis, redundancy should be limited to those cases where it can be achieved with low costs. Polycentric governance in institutional set-ups and structures may act to the detriment of efficiency and coherence by increasing transaction costs for coordination. It may also negatively affect accountability in case of newly established high-level, specialized government bodies [23]. Similarly overlapping, redundant and flexible water governance structures may render accountable and transparent policy making difficult, while at the same time they may enhance responsiveness and ecological sustainability of water policies.

Public participation on the one hand adds legitimacy and transparency for stakeholders, fosters social learning, and improves water governance through knowledge exchange [23]. On the other hand, it is often costly (in terms of human and financial resources), thus negatively affecting efficiency. Likewise it might be difficult to arrange for participatory governance structures that allow for accountability (who is responsible for decisions taken with large involvement of stakeholders?) or to establish flexible institutions that remain sufficiently transparent. A high level of participation and decentralization may render governance structures less flexible and adaptive [10].

From a short-term perspective most of these trade-offs seem inevitable. With a longer term (sustainability) perspective, which takes not only the functioning of the social system but also that of the ecological system into account, these features are not necessarily mutually exclusive. The trade-off of participation and efficiency may at least partly dissolve when taking a longer term perspective. Participation can help produce adaptive solutions that take local contexts and knowledge into account, are supported by stakeholders, and tend to be easier to implement and sustain than decisions taken in a top-down approach. Likewise redundant institutions or governance structures may prove useful and pay off in times of crisis. Polycentric structures can become effective and efficient once trust between the actors has developed over time [23].

The aim should be to find ways to achieve one goal while not negatively affecting the others. In those cases where this cannot be achieved, good governance mechanisms should provide for a societal negotiation process which aims at finding an acceptable level of negative effects. Examples are the trade-offs between participation and accountability or between the increasing costs of cooperation and coordination with increasingly redundant and polycentric structures.

In line with this, sustainable and adaptive water governance should not be understood as a "one size fits all"-approach, but rather as one leaving room for adjusting the features to local needs. The optimal amount of one or the other feature will differ in different cultural, social, political and economic contexts. The respective contexts also determine the relevance of a certain set of features, which might not be the same in two countries. Also different stages of development may require an emphasis on different sets of features, i.e. the composition and accentuation of features in a particular case may change over time. For example the creation of trust through transparency and accountability may be a precondition for meaningful participation. However, it is also assumed that – regardless of the socio-economic situation – a certain level of each of these features is required for rendering a water governance regime sustainable and adaptive. For example the provision of a certain level of flexibility of institutions should be provided in order to ensure the ability to react to disturbance.

5. Conclusions

The consequences of climate change underline the importance of governing water resources sustainably while at the same time disclosing the limitations of the sustainability concept regarding uncertainty and extreme events. Subsequently governing water resources adaptively is becoming a crucial additional element of sustainable development. Some features of IWRM and sustainable governance of water resources such as participation, integration, efficiency and ecological sustainability clearly serve to increase the adaptive capacity of the water governance regime by putting decision-making on a broader basis or incorporating environmental consequences of water policies. However, sustainability and IWRM do not seem to be sufficiently equipped to cope with uncertainties in water supply or unexpected extreme events especially regarding governance structures. Since technical measures can only be part of the solution it has been argued for an expansion of IWRM [50], [51] and complement it with features of adaptive governance [16], [52], which are geared towards increasing the adaptive capacity of governance structures. This includes addressing the institutional and organizational dimension of water management and features such as polycentricity, redundancy and flexibility.

However, merging sustainable with adaptive governance produces synergies and trade-offs, not all of which resolve by a longer term perspective. The literature does not yet sufficiently acknowledge and address these synergies and trade-offs [10]. The tasks for future research on integrating sustainable and adaptive water governance concepts include: Firstly identify best practices how to use synergies and minimize trade-offs. Secondly – acknowledging that there is no one size fits all solution – identify under which circumstances it is useful to put an emphasis on either sustainability or adaptability. For example if climate change implies a disproportionate increase in extreme events in a region, can it be useful to emphasize features such as polycentricity and flexibility while neglecting efficiency and coherence? Resulting from this is thirdly the question how water governance can switch between modes of sustainability and adaptability. For example what would be useful mechanisms to shortcut

comprehensive participation and integration mechanisms when experiencing extreme events? More generally, there is a need to further explore these issues on the ground and test the features and the implementation of sustainable and adaptive water governance empirically. Such integrated and adaptive approaches are needed to tackle the complexities and uncertainties related to a changing environment and enable the sustainable use and governance of water resources.

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