

# Climate change, sustainable water management and institutional adaptation in rural sub-Saharan Africa

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**Abstract** Much current work on climate adaptation options vis-à-vis water management in rural sub-Saharan Africa has tended to focus more on technological and infrastructural alternatives and less on institutional alternatives. Yet, vulnerability to climate variability and change in these contexts is a function not just of biophysical outcomes but also of institutional factors that can vary significantly at relatively finer scales. This paper seeks to contribute towards closing this gap by examining institutional options for sustainable water management in rural SSA in the context of climate change and variability. It explores challenges for transforming water-related institutions and puts forward institutional alternatives towards adapting to increasingly complex conditions created by climate change and variability. The paper suggests revisiting the Integrated Water Resources Management approach which has dominated water institutional debates and reforms in Africa over the recent past, towards actively adopting resilience and adaptive management lenses in crafting water institutional development initiatives.

**Keywords** Climate change · Water management · Institutional adaptation · IWRM · Resilience · Adaptive management

## 1 Introduction

Climate change is now well recognized as a physical and global reality. The Intergovernmental Panel on Climate Change (IPCC 2007, 2014) notes that even under the most optimistic scenarios of coordinated global action to reduce further emissions of greenhouse gasses into the atmosphere, an era of rapid and accelerating climate change is inevitable.

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The global average surface air temperature is predicted to increase by between 1.4 and 5.8 °C by 2100, and temperatures in sub-Saharan Africa are projected to rise faster than the global average increase during the twenty-first century (IPCC 2014). Temperature projections over west Africa for the end of the twenty-first century from both the Coupled Model Intercomparison Project Phase 3 (CMIP 3) General Circulation Models (GCMs) and CMIP 5 GCMs, for example, range between 3 and 6 °C above the late twentieth-century baseline, whilst mean land surface warming in southern Africa is projected to exceed the global mean land surface temperature increase in all seasons (ibid). Such a scenario worsens water stress and scarcity in these regions. Water is the resource that will mainly be impacted by climate change as there is going to be a decline in both quantity and quality (IPCC 2007; Baba et al. 2011). It is estimated that by 2020, up to 250 million Africans will experience water stress due to climate change (Alliance for a Green Revolution in Africa 2014). Already, over southern Africa, a reduction in late austral summer precipitation has been reported over its western parts, extending from Namibia through Angola, and towards the Congo, during the second half of the twentieth century (IPCC 2014).

Sustainable water management is critical for climate adaptation in most of rural sub-Saharan Africa (SSA) since water is at the centre of most people's livelihoods—involving such activities as rainfed agriculture, livestock rearing and market gardening. In the same vein, the core manifestations of climate variability and change in the region (e.g. gradual changes in mean temperatures and precipitation, greater range in seasonal and interannual variation, and increasing frequency and intensity of extreme weather events) are all directly and indirectly water and water resource-related (cf. Tompkins and Adger 2004). These manifestations, for example, correlate with both slow-onset hazards such as erratic rainfall, droughts, water table changes, and increasing temperatures and rapidly unfolding phenomena such as floods and storms (Agrawal 2008). Water is, therefore, the main medium through which climate change impacts are being felt and will continue to be experienced (Cook et al. 2010). Sustainable water management under changing and variable climatic conditions, however, demands responsive and adaptive institutions since water management takes place within primarily local and national institutional set-ups. Water institutions are, therefore, critical to how people manage dynamics brought about by climate variability and change, which makes it important to ensure that those institutions are themselves adaptive and resilient (ibid; Mensah 2014; Ludwig et al. 2009).

This paper, therefore, brings to the fore the centrality of institutional adaptation vis-à-vis sustainable water and water resource management in rural SSA, particularly as it relates to water-related institutions' flexibility and innovativeness in dealing with increasing uncertainties due to climate change and variability, improving fairness in resource allocation, improving mechanisms of rule and regulation enforcement, cross-scale linkages and institutional collaboration as well as the provision of necessary support to households and communities in aspects like information and skills development. The paper moves away from a focus on technological and infrastructural alternatives, which has dominated much analysis on climate adaptation in the SSA water sector in the recent past (e.g. Cervigni et al. 2015; McCartney et al. 2013; Jeuland 2010; Callaway et al. 2009; Petermann 2008) towards flagging the importance of an equally concerted focus on institutional alternatives (cf. Merrey and Cook 2012).

This analysis also comes in the background of the recognition that climate change is impacting SSA more than any other sub-region in the world due to its economies being largely based on climate-sensitive crop–livestock and agro-pastoral production systems, and also due to low adaptive capacities of SSA countries and communities (cf. Barnard et al. 2014; Mensah 2014; Kotir 2011; Nelson et al. 2009). The low adaptive capacities of

SSA countries and communities are associated with, amongst other factors, increasing water scarcity and land degradation, catalysed by deforestation, population growth, poor governance, global energy and food trends, and other externalities (Amede and Haileslassie 2011), hence making the identification and understanding of viable adaptation solutions and alternatives in such contexts urgent.

## 2 Analytical framing and methodological approach

This paper is based on a review of relevant literature (journal articles, books, theses, manuscripts) around sustainable water management in rural SSA as well as options and alternatives for adapting water-related institutions therein and enabling them to respond to new demands and complexities brought about by climate change and variability. A central thesis of the paper is that water management under climate change and variability should now be concerned with complex, dynamic and often unpredictable systems and that institutions involved in water management in rural SSA, as the primary vehicles for overseeing water access, use and infrastructural maintenance and rehabilitation, should adapt to these dynamics. Analysis revolved around three axes, namely (a) an understanding of sustainable water management under a variable and changing climate in an African context, (b) an examination of institutional challenges for sustainable water management under climate variability and change in rural SSA, and (c) a discussion of institutional alternatives towards sustainable water management in these contexts, including ideas on how to implement those alternatives on the ground. Discussions also include case studies in different SSA countries vis-à-vis both the current water management situation and the implementation of suggested alternatives.

## 3 Sustainable water management in a changing climate

Water management is a continuously adaptive enterprise, involving ongoing responses to changes in demands, hydrological information, technologies, the structure of the economy and society's perspectives on the economy and the environment (IPCC 1996; Pahl-Wostl et al. 2007; Engle et al. 2011). Increasing climate variability and change is the latest factor placing water management under the spotlight, particularly in natural-resource dependent, sub-humid and semi-arid marginalized areas (as most rural communities in SSA). Shortages in supply, uncertain changes in replenishment rates for both surface water and groundwater, and deterioration of quality that reduces both usability and health safety issues are expected to soar (Nkem et al. 2011). In addition, climate variability and change is likely to intensify the current challenges of water scarcity and water competition within and between communities and nations, particularly those countries linked by trans-boundary aquifers (UNECA 2011). As Cook et al. (2010) write, climate change will shift weather and water patterns with greater frequency and to greater extremes such that future situations will be less predictable and more difficult to manage, exacerbating underlying stresses and presenting new risks.

Sustainable water management has to do with balancing the interaction between water availability, households and communities water needs, and the integrity of water resources. It involves investments towards capacity extension in water access and use, ensuring the efficient and equitable operation of existing water systems for optimal use, ensuring the

continued maintenance and rehabilitation of water systems, as well as modification in management processes and demands towards reconciling social justice and environmental integrity concerns (cf. IPCC 1996; Loucks 2000; EPRI 2010). Whilst past and current water management focus in most of rural SSA has been/is mainly concerned with understanding the reconciling of competing demands for limited water resources and amongst competing water users, an increasingly warmer world will demand even more innovative water management strategies as both rainfed and irrigated crops as well as livestock production will require more water, which may not be available due to various adverse climatic processes. Stakhiv (2011) argues that contemporary water management systems in Africa, as embedded in the broader framework of integrated water resources management (IWRM), are not designed to deliver services or protect livelihoods against the full range of uncertain and unexpected events under what is understood to be contemporary climate variability. He notes that they are, rather, simply designed to minimize the combination of risks and costs of a wide range of hazards to society, whilst maximizing benefits.

If water managers in rural SSA are to tackle water (and related) problems brought about by climate variability and change in a meaningful and more sustainable way, then a substantially responsive water management decision and evaluation approach needs to be devised, which should, paradoxically, be based on a foundation of existing IWRM principles and evaluation techniques (ibid). As Nkem et al. (2011) write, addressing water needs for a warming continent will require a ‘smart’ approach that integrates the management of the risks surrounding current demands and supplies with long-term needs and future risks in providing place-based solutions. This approach, (which, as already noted, should be an adaptation of existing IWRM principles and techniques), has to accommodate uncertain scenarios and ‘focus less on optimal outcomes (but) more on “satisficing”—that is, producing robust solutions that may not meet strict economic efficiency tests, but are still risk-cost effective’ (Stakhiv 2011: 1186).

#### **4 Institutional challenges for sustainable water management under climate variability and change in rural SSA**

As noted earlier, water management takes place within broad local and national institutional set-ups. The uncertainties and demands exerted on water management by climate variability and change are, therefore, essentially institutional challenges. Institutions in this work are taken to mean formal and informal rules and regulations, including structures, compliance procedures, societal and cultural behavioural norms as well as symbolic meanings through which people govern, organize and cooperate to achieve particular purposes around water and water resources (cf. North 1990; Mehta et al. 1999). Institutional arrangements structure risks and sensitivity to climate hazards, facilitate or impede individual and collective responses, and shape the outcomes of such responses (Agrawal 2008). Key institutional challenges vis-à-vis water management in the context of climate variability and change in rural SSA revolve around balancing demand management, regulating control, maintaining cultural norms (particularly at the local level) and fulfilling economic as well as ecological fundamentals at and across different scales (i.e. local, national and international scales). These challenges are driven by three main factors, namely the complexity of the institutional environment, the complexity of the vulnerability

context as well as predetermined and long-standing goals and worldviews in these contexts. These factors are expounded in the following discussions.

#### 4.1 Complexity of the institutional environment

One major factor constraining water-related institutional arrangements in rural SSA and making their responsiveness to uncertainties and demands brought about by climate variability and change more challenging is their complex nature. This manifests in what Merrey et al. (2007) term the three pluralities, namely (a) multiple actors and organizations involved in water decision-making, (b) multiple rules and procedures applicable to a specific issue, and (c) multi-functionality of water resource systems and the range of values attached to these functions.

The institutional environment is, therefore, characterized by ‘overlapping and sometimes competing networks of actors, rules, functions and organisations’ (ibid: 212). In most rural SSA contexts, the management of water and water resources is overseen by formal government institutions (as exemplified by transboundary regulations, national water laws and regulations, national water boards, rural district council by-laws as well as catchment and sub-catchment council) and traditional institutions (built along cultural set-ups and social relations overseen by such authorities as chiefs, headmen, village heads and spirit mediums), alongside private concerns and an emerging strong civil society which is donor-financed (cf. Water Research Commission 2010) (see Table 1). In South Africa for example, the Ministry of Water in charge of implementing IWRM has had to contend with other important processes and departments which it has little control over but which are directly linked to water such as those of agriculture and land reform (Mehta et al. 2014). This has, many a time, led to friction amongst the different institutions in the implementation of IWRM in many areas. The Inkomati Water Management Area in the north-eastern province of Mpumalanga is a case in point—where the presence of several institutions with overlapping mandates led to problems in water reform processes due to such challenges as the prevalence of ‘silo thinking’ as well as real and perceived power imbalances between the various institutions leading to lack of institutional cooperation and widespread mistrust and opposition (ibid; Denby 2013).

There is also the issue of the transboundary nature of water resources in Africa, with an estimated 90 % of all Africa’s surface freshwater resources being located in river basins

**Table 1** Water institutional arrangements in SSA

Type	Formal government	Traditional	Private	Civic
Scale	International/national/local	Local	National/local	National/local
Examples	Transboundary regulations National water laws and regulations National water boards Rural District Council by-laws Catchment and sub-catchment councils	Chiefs Headmen Village heads Spirit mediums Customary and local beliefs and practices	Farmer associations	Non-governmental organizations Cooperatives

and lakes that are shared between two or more countries (UNDP 2006). This creates challenges for water institutions vis-à-vis different water laws and policies in different countries on the same resource, as well as competing national interests. As Goulden et al. (2009) write, water institutions and governance structures sometimes differ significantly both within and between countries, and this can either hinder or facilitate moves towards sustainable water management in the context of a changing and variable climate in rural SSA.

Due to these varied and complex institutional arrangements, the (institutional) environment becomes a highly contested terrain characterized by a range of different negotiation arenas. In most cases, communication channels at and across different scales of water management also become cumbersome, and roles and responsibilities of different institutions at and across different scales usually become unclear. This complex arrangement of a variety of institutions, often with varied objectives, can thus complicate manoeuvres towards the creation of innovative, proactive and flexible water management systems and processes that are able to adequately facilitate responses to the effects of climate variability and change (and other stressors) at the local level.

Related to this is the spatial scale problem. Most water management initiatives in rural SSA have been crafted around a watershed perspective and informed by the view of a watershed as one ecological unit. Yet, most water institutions in these environments often operate within political boundaries that do not reflect the physical boundaries of a watershed (cf. Cook et al. 2010). For example, water reforms as driven by IWRM principles in Zimbabwe in the late 1990s included the formation of catchment and sub-catchment councils as platforms for collective stakeholder water resource management in a catchment area. Catchment boundaries were drawn as based more on major river systems than on political administrative boundaries, with, for example, one catchment (Mazoe Catchment) spanning three provinces (i.e. Mashonaland Central, Mashonaland East and Manicaland Provinces), and one sub-catchment (Odzi sub-catchment under Save Catchment Area) straddling five rural districts in Manicaland Province (i.e. Nyanga, Makoni, Mutasa, Mutare and Chimanimani), thus setting the scene for clashes between authorities operating strictly within political boundaries and those operating within the newly created catchment arrangements (cf. Manzungu and Kujinga 2002; Chereni 2007). The spatial scale challenge is further amplified by such factors as inherent water-sharing problems and power imbalances created by the interplay of natural and economic resources between upstream and downstream water users (Cook et al. 2010).

## 4.2 Complexity of vulnerability contexts

As noted in the introduction section, water-related institutions in rural SSA have to contend with managing water and water resources in contexts bedevilled by other multiple and reinforcing stresses and shocks, apart from climate variability and change. This complicates their efforts towards sustainable water management and, in most cases, limits their financial, technical and, in some cases, policy/regulation implementation capacities. As Schulze (2011: 640) notes, climate change does not occur on a 'clean sheet' of virgin catchments not yet impacted upon by human interventions on the land, but is an added stressor on already water-stressed catchments 'with often complex land uses, often complex water-engineered systems and a strong socio-political as well as economic historical footprint'. Institutions involved in water management in rural SSA therefore have to undertake decisions and management actions in the context of other dynamic vulnerabilities such as poor infrastructure, low technological capacity, endemic poverty, macro-

economic challenges, demographic changes, land-use change, poor national governance and political instability. In Zimbabwe for example, the implementation of the controversial and chaotic 'fast-track' land reform programme by the government beginning February 2000 and the ensuing political and economic crisis led to the suspension of donor support (from the governments of the Netherlands, Germany, Sweden and the UK) for the water sector in the country—support which had largely driven key water institutional reform processes over the preceding years (Mehta et al. 2014). Drivers of water in rural SSA such as droughts, water table changes, storm surges and flash floods are also increasingly interacting amongst themselves creating a new set of uncertainties and associated risks as well as a diverse and complex variety of combinations, placing further strain on institutions involved in water management (UNESCO 2012).

### 4.3 Predetermined and long-standing goals, values and patterns of behaviour

Water-related institutions in rural SSA are also constrained by prior commitments to predetermined goals that embody long-standing values, and established patterns of behaviour vis-à-vis such aspects as water resource rights, entitlements and access (cf. Adger 2000). These long-standing goals, values and patterns of behaviour manifest either formally through regulations, legislation and permits or informally through cultural beliefs, local social practices and contextual worldviews. Whilst these goals, values and patterns of behaviour are themselves constantly evolving, they, many a time, may also cause institutional inertia. This is partly because of bureaucratic red tape which characterizes particularly formal institutions in these contexts, leading to difficulties in managing unforeseen risks and changing established goals, values and patterns of behaviour, and partly because these goals, values and patterns of behaviour may, particularly in the case of traditional institutions, embody and reinforce power relationships and their legitimacy, helping maintain the status quo and privileges of certain groups over others. Revisiting and changing them to suit emerging climate dynamics towards sustainable water management practices and processes can, therefore, be a huge challenge (ibid).

## 5 Institutional alternatives

Institutional alternatives for sustainable water management under a variable and changing climate in rural SSA have to take into account the understanding that under conditions of uncertainty, it is no longer possible to rely on a single framework, standardized procedure or rigidly defined pathway. Institutions formulating water resource management strategies that integrate climate change and variability concerns should be prepared to employ a variety of tools, in different combinations, to reduce vulnerability as well as enhance system resiliency and robustness (Stakhiv 2011). Clearly, the dynamics brought about by the climate change and variability factor, taking place in situations of both a complex institutional environment and a complex vulnerability context (as discussed in the previous section), require alternatives with multipronged strategies. Water-related institutions in rural SSA, therefore, now have to be sufficiently innovative, flexible and proactive to account not only for the increasing uncertainties in both water supply and demand due to the effects of climate variability and change, but also for implications of these increasing uncertainties in as far as access, rights and entitlements between and amongst different water uses and users is concerned.

As Schulze (2011) articulates, responses to climate change with respect to water issues in rural SSA, for example, sit between the so-called higher level of intentional, proactive, long-term, anticipatory and strategic initiatives and that of 'lower levels' where responses are more spontaneous, reactive, and crisis-driven, depending on context. The 'higher-level' initiatives are mainly driven by central government through, for example, endeavouring to meet national environmental and related policy goals as well as international obligations and commitments such as to the United Nations Framework Convention on Climate Change (UNFCCC). 'Lower-level' initiatives are those undertaken at the local community and/or household levels as mainly driven by such factors as local knowledge and experiences and/or bottom-up activities as initiated by local community organizations and/or non-governmental organizations (cf. *ibid.*).

Institutions involved in water resource management in rural SSA, at their different levels, therefore, need to adapt towards embracing more complex and uncertain scenarios created by the climate change and variability factor. Institutional adaptation in this case can be defined as being the net outcome of the evolution of institutions within the wider social environment, along with institutional inertia (Adger 2000). It essentially relates to changing or augmenting the 'soft' capacities of communication, trust-building, diplomacy, networking, making sense of messy social situations, political advocacy and leadership towards moderating potential damages and/or taking advantage of opportunities associated with climate change (Woodhill 2010). It is a process that speaks to strengthening relationships and adopting mindsets that enable innovation and resilience in communities, organizations and societies (*ibid.*).

This paper suggests two main considerations vis-à-vis institutional adaptation towards sustainable and climate-resilient water management in rural SSA. The first has to do with revisiting IWRM principles dominantly used in most contemporary water management systems in Africa, and the second involves actively incorporating resilience and adaptive management principles in water and water resource management processes and approaches. Issues raised in discussions on these alternatives are not necessarily new with respect to water management reform debates in recent years (see, e.g. Martinez-Santos et al. 2014; Giordano and Shah 2014; Merrey and Cook 2012; Pollard and du Toit 2011; Biswas 2008); however, as options directly focused on dealing with the climate variability and change problem vis-à-vis water institutions in rural SSA, they extend and enrich discussions in this area.

## 5.1 Revisiting the IWRM approach

In the past two decades, the concept of IWRM has dominated water reform discussions and processes in Africa, with institutions being created and others being aligned to dovetail with IWRM principles. IWRM is defined by the Global Water Partnership (GWP 2000) as a process which promotes the coordinated development and management of water, land and related resources in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital resources. It is geared towards decentralizing institutions around major river basins or a particular watershed scale, and joining together various elements of water resource planning such as ground-water and surface water, water quantity and quality, and socio-economic, hydrological, and ecological aspects of water management (Engle et al. 2011).

Though presented as a means for 'reconciling basic human needs, ensuring access and equity, with economic development and the imperative of ecological integrity, while respecting transboundary commitments' (van der Zaag 2005:868), the IWRM approach has



faced heavy criticisms in various fora and publications over the recent past. A particular concern is that it is a highly normative discourse which prescribes a long list of activities without contextualizing critical issues such as basin management, environmental flows, subsidiarity and participation amongst other issues (van Koppen and Schreiner 2014). Other criticisms have revolved around the concern that IWRM has been put forward as a 'neutral' process without much recognition of the political nature of water management, yet 'water management is never "neutral," "technical" or an end in itself' (Swatuk 2005: 872). The International Development Research Centre (IDRC 2010) also notes that the effectiveness of IWRM appears to have been based on the presence of predictable water supplies; whilst the UNDP Water Governance Facility (2012: 5) acknowledges that though the IWRM approach is guided by a balanced concern for economic efficiency, environmental sustainability and social equity, 'in practice, the social equity goal is often given less priority when water allocation decisions are made'. Given these various concerns surrounding IWRM as noted above, whilst it appears to be a valid guide to research and scientific understanding as well as a relevant systems theory approach that explains the interconnectedness of people, ecosystems and hydrology in a river basin (cf. Merrey 2008), using van der Zaag (2005)'s terminology, it, however, becomes an 'elusive' and 'fuzzy' concept for informing and guiding sustainable water management in the context of emerging social, environmental and livelihoods dynamics caused by the climate change and variability factor in rural SSA contexts.

Institutional adaptation for sustainable water management under climate change and variability, therefore, demands revisiting the IWRM approach towards establishing and advancing ideals, values, patterns of behaviour and processes that promote context-specific, flexible and innovative navigation of complexity, self-reflection, collaborative learning and recognition of the inherently contentious and political nature of institutional transformation (cf. Merrey et al. 2007; Woodhill 2010). Certain key IWRM principles such as stakeholder participation, interconnectedness of water users, equitable access to water resources and the ecological integrity imperative may form some of the pillars of the institutional adaptation drive towards sustainable water management under a changing and variable climate in rural SSA. This drive can, however, be made successful through approaching water institutional development using resilience and adaptive management lenses, as shall be discussed in the following subsection.

## **5.2 Approaching water institutional development using resilience and adaptive management lenses**

As coming out in previous discussions in this paper, it should be noted that the institutional network involved in water management in rural SSA is, by nature, essentially a complex adaptive system. This means it is a 'dynamic network of many agents...acting in parallel, constantly acting and reacting to what other agents are doing' (Woodhill 2010: 53). As part of this complex adaptive system operating in complex and increasingly uncertain environments, water-related institutions in rural SSA, therefore, need to embrace complexity vis-à-vis adapting towards sustainable water management practices. This implies adopting very different ways of thinking, planning, implementing, monitoring and evaluating initiatives related to water and water resource use, access, rights and entitlements. Complexity thinking is a component of the resilience approach to dealing with change and it means accepting unpredictability and uncertainty, and acknowledging a multitude of perspectives in decision-making (Simonsen et al. 2014).

Resilience focuses on dealing with change, and adapting and transforming in response to that change (ibid). The resilience approach emerged from ecology in the 1960s and early 1970s, and it emphasizes nonlinear dynamics, thresholds, uncertainty and surprise. It focuses on how periods of gradual change interplay with periods of rapid change and how such dynamics interact across temporal and spatial scales (Jansen et al. 2007). Developing and transforming water-related institutions using a resilience lens is, therefore, key for institutional adaptation in rural SSA. This requires moving towards a culture that tolerates continuous processes of change in unpredictable directions, including far-reaching institutional adjustments, which may include such initiatives as flexible legislation that allows for experimenting in different contexts, tailor-made context-specific solutions, critical self-reflexivity amongst actors, as well as genuine decentralization of decision-making authority (cf. Termeer et al. 2013).

Whilst resilience is the broad approach vis-à-vis adapting in uncertain and constantly changing conditions and environments, adaptive management is the component of resilience directly focused on management options in contexts of change and uncertainty. Allen et al. (2011) write that whilst adaptive management has been referenced both implicitly and explicitly for more than 50 years, there has remained imperfect realization of adaptive management in real-world natural resource management decisions despite this illustrious theoretical history. Adaptive management focuses on flexible process-based learning as an integral part of decision-making, experimental approaches to resource management, collaboration in a polycentric governance system as well as recognition of context-specific dynamics (cf. Simonsen et al. 2014; Huitema et al. 2009).

Process-based learning, in this case, can be encouraged through the establishment of routine forums or platforms that bring together water stakeholders within and across communities sharing water resources, and that have entrenched feedback processes. These participatory forums, which can take the form of public meetings and/or workshops at and across different institutional scales, can provide knowledge and legitimacy in revising and changing rules, ideals and practices as well as resolving conflicts that may arise from time to time (Bruns and Meinzen-Dick 2005). Most importantly, such routine forums will inculcate and instil a social learning culture which is critical as institutions tend towards routines (van der Zaag 2008). In this case, adaptive management becomes a channel for water institutional adaptation by putting in place both learning processes and the conditions needed for learning processes to take place (cf. Pahl-Wostl et al. 2007). In their study of water institutional reform in the Letaba Catchment in Limpopo Province, South Africa—featuring process-based learning, self-organization and feedback loops in water resource use and management—Pollard and du Toit (2011) noted at least three factors that were key in the success of such arrangements. These included (a) the role of leadership with authority (a champion), (b) the availability of benchmarks against which to monitor, and (c) communication and the ability to self-regulate. They noted that as stakeholders started to seriously engage in participatory forums, historically distrustful—and even hitherto acrimonious—sectoral positions began to change once people met routinely and planned collectively.

These routine forums can also be platforms for experimentation. Experimentation in adaptive management implies the probing of the system to be managed, monitoring its responses and adjusting interventions on the basis of findings (Huitema et al. 2009). Unexpected outcomes are not seen as failures, but as opportunities for learning (ibid). The focus shifts from prioritizing rigid principles of water management, towards identifying and prioritizing problems and finding solutions in an integrated perspective (Merrey 2008). Processes such as scenario planning (within the mentioned routine participatory forums)

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**Box 1** Implementing resilient and adaptive management on the ground

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Implementation of a resource management concept of the nature of adaptive management (AM) is a balancing act—on one hand reflecting the ideal, and on the other hand learning and dealing with foreseeable and unforeseeable challenges. AM is a process to cope with uncertainty on an understanding centred on a learning model where, in the case of this analysis for example, water management actions are taken not only to manage but also explicitly to learn about the process governing the system as a way of dealing with uncertainty and promoting adaptive capacity. The framework is such that resource managers integrate research, policy and regulation formulation and implementation as well as local practice in discharging their mandate. Successful water institutional reform in the Great Ruaha River basin in the southern highlands of Tanzania, as reviewed by Lankford et al. (2007), brings out typical examples of ‘best practices’ towards functional adaptive water management systems. Some of the key elements within that reform exercise included (1) the use of water experts in explaining to and informing local communities about water laws and policies but involving participatory and inclusive discussions in reviewing their findings and applying them to their area, (2) the use of inclusive stakeholder deliberative tools and processes (e.g. workshops), (3) support to the Basin office via a river basin decision aid that gives the option for managing water and water rights whilst allowing stakeholders to assess the outcomes, and (4) providing social learning to water users using educational and conflict resolution tools, as well as local farmers’ own experimentation and observations as a means to determine perspectives on water-sharing and management. (Sources: Lankford et al. 2007; Medema et al. 2008)

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come to the fore in exploring and evaluating alternative pathways, and assessing the intended and unintended consequences of different institutional transformation alternatives (Simonsen et al. 2014). Box 1 expands on the implementation of adaptive management ideas on the ground.

Institutional adaptation through adaptive management lenses recognizes that the success or failure of changing values, ideals, policies and organizations is also dependent on contextual dynamics. Change initiatives therefore need to factor in local socio-cultural, political and ecological dynamics and how to manoeuvre around these dynamics. Changing long-standing arrangements, practices and worldviews around water resource use, access, rights and entitlements in rural SSA, for example, may, in most cases, mean challenging, disturbing and/or overthrowing existing power relations as well as threatening the position of those who benefit from the status quo (Merrey et al. 2007). Such a process, therefore, requires skilful leadership and a structured process. This process may involve, for instance, identifying champions within existing national and local water institutional set-ups, who will help to create, revise and oversee visions of institutional objectives and reforms that are informed by resilience and adaptive management principles (ibid). In essence, institutional adaptation for sustainable water management as guided by resilience and adaptive management principles requires investments in capacities needed for facilitation processes, multi-stakeholder engagement and collaborative learning, and this means developing the qualities of leaders and water managers so that they are able to recognize the value of, support, and execute such processes (Woodhill 2010).

## 6 Conclusion

This discussion has explored institutional alternatives towards sustainable water management in the context of climate variability and change in rural SSA. It argues for a shift from IWRM principles, which have dominated much water institutional reform in Africa over the last decade, towards the use of resilience and adaptive management lenses in

developing and transforming water-related institutions in these contexts. The paper submits that resilience and adaptive management principles can help bring about flexible, innovative and proactive institutions which are able to deal with the increasingly complex and uncertain environments obtaining in rural SSA due to the climate change and variability factor. The paper, however, recognizes that transforming water institutional arrangements in this direction is essentially a political project and no simple task as it may involve upsetting existing authority structures and established interests. It, therefore, recommends the development of both individual and collective capacities towards the establishment of these resilient and adaptive institutional processes.

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