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climate and development

South African water governance between administrative and hydrological boundaries

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Climate change poses major threats to South Africa. The country depends heavily on surface water and its water resources are already under stress. Against this background one possible adaptation measure is a holistic approach and the management of water according to the basin principle. This article examines current water sector reforms and especially the transformation from administrative to hydrological boundaries. It concludes that this transformation might help to make the South African water governance system more adaptive to climate change. However, the analysis shows that the transformation towards hydrological boundaries is affected by a number of trade-offs. These are the trade-offs between, firstly, (a) the improved fit between the social and the ecological system and (b) the misfit between scales within the social system. Secondly, a trade-off exists between (a) correct classification along hydrological boundaries (holistic approach) and (b) a feasible size for effective management, meaningful stakeholder participation and financial viability, which may require a splitting and merging of hydrological entities and thus a violation of the hydrological principle. These trade-offs can only be met through a combination of intense communication, cooperation and coordinated action between the involved organizations.

Keywords: adaptation; Catchment Management Agencies; climate change; hydrological boundaries; South Africa; water governance; water management

1. Introduction: Water availability and climate change in South Africa[1]

South Africa is a semi-arid country facing huge water resource constraints. It is largely dependent on surface water abstraction and water resources are highly developed. At the same time it shares six river basins with a number of neighbouring countries whose water demand is also increasing (Ashton et al., 2008). These factors make the South African water governance system highly vulnerable to changes in water availability. The Department of Water Affairs (DWA)[2] estimates that by 2025 South Africa will be classified as chronically water scarce (Muller, d.u.).

Climate change is one of the key drivers of these developments (Bauer and Scholz, 2010). The drainage of southern African rivers will be particularly affected by climate change. In the south-western Cape, annual streamflow could decrease by between 14 and 32% (New, 2002). A 20% decrease in precipitation might lead to a decrease of up to 70% of the drainage of the lower Orange-Senqu River, which serves as a major water source for irrigated agriculture (de Wit and Stankiewicz, 2006).

Decreasing water availability affects not only ecological systems (e.g. wetlands) but also social systems, especially the economy (e.g. agriculture).[3] In South Africa, where a large portion of bulk water supply is stored behind large dams, water supplies are vulnerable to changed precipitation patterns and increased evaporation (DEAT, 2004). These challenges of climate change underline the fact that current and expected changes to ecological systems need to be mirrored in appropriate actions in social systems. Governance

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structures and institutions might no longer be adequate. For example, continuing with a supply approach to water management is likely to fail in a situation of decreasing water availability and growing demands.

In recent years basin management has been proposed as one element for addressing these issues. It ensures taking a systemic, hydrological approach and looking at the problem from the point of view of the resource. Through a basin perspective it is easier to understand physical, environmental, social and economic influences on water resources.

This article examines the current water sector reforms in South Africa, and especially the transformation from administrative to hydrological boundaries. It centres on the question of whether this transformation will help to make the South African water governance system more adaptive to climate change. The next section deals with the concepts of fit, interplay and scale, used to analyse the introduction of basin management in South Africa. Section 3 gives an overview of the current reform processes in South African water governance. Section 4 focuses on the mismatches between hydrological and administrative boundaries and highlights the arising opportunities and trade-offs. The final section provides an assessment of the reform process and its contribution to increasing the adaptive capacity of South African water governance. The article draws on field research undertaken in South Africa in 2006 within the NeWater project.

2. Adaptation to climate change: The dimensions of fit, interplay and scale

Young has proposed the concepts of fit, interplay and scale for analysing the institutional dimensions of environmental change (Young, 2002). Institutions are an important interface between the social and the ecological system because they regulate the use, overuse and pollution of the resource.

Young assumes that the effectiveness of management increases the closer the fit between the ecological system and the social system, and especially the institutions managing it (Young, 2002). The problem of fit can occur on various scales such as the temporal, spatial or functional (Folke et al., 2007). Spatial fit, for example, refers to the match between resource boundaries and the boundaries of the organization managing and administering that resource (Moss, 2007). A lack of spatial or temporal fit is associated with poor resource management, which negatively affects a system's adaptive capacity (e.g. in the face of climate change).

The interaction between institutions is called interplay. With reference to the spatial scale of institutions, horizontal interplay denotes the interaction (coordination and cooperation, but also conflict) among institutions and organizations that are situated at the same level of social organization (e.g. local level water management and spatial planning). Vertical interplay, in contrast, is associated with the interaction of institutions and organizations at different levels of social organization (so-called cross-level interaction, e.g. between local, province and national levels).

This article frames the concept of 'scale' in terms of the different dimensions of a phenomenon and how they interact. Scale is defined as 'the spatial, temporal, quantitative, or analytical dimensions used to measure and study any phenomenon, and levels as the units of analysis that are located at different positions on a scale' (Lebel and Imamura, 2006). Scale refers here to the different dimensions of water resource management, which can be examined from the point of view of the temporal, spatial, institutional or jurisdictional scale (Cash et al., 2006). Distinguishing among scales and levels makes it possible to identify mismatches between scales and levels. A scale mismatch exists when one scale (e.g. of the ecological system) interacts with another scale (e.g. of the social system) in such a way that the functioning of the combined social-ecological system is compromised or even disrupted. A possible result of such mismatches is the mismanagement of natural resources and a subsequent loss of

adaptive capacity and resilience in the social as well as in the ecological system. The rapid changes to ecological systems brought about by climate change open up new mismatches and aggravate existing ones, thus underlining the urgency of learning and building resilience.

Figure 1 illustrates the concepts of fit, interplay and scale as applied to water governance. The water-related part of the ecological system is depicted along the spatial scale (i.e. different water entities) while the social system is represented through the institutional (different forms of institutions) and jurisdictional scales (different administrative units). Both the institutional and the jurisdictional scales relate to water governance.

Historically, water administrative bodies have been organized along administrative boundaries, even though river catchments often do not obey administrative logic. Thus, water administrative bodies have often failed to fit with the properties of the ecosystem they manage. Management failures such as a lack of cooperation, participation and transparency are partly rooted in this mismatch (Bohensky, 2008). For example, it is difficult to enforce water quality regulations and water abstraction rules where two or more water management bodies are in charge of different sections of one river. Water basin management represents an effort to align the spatial fit between the boundaries of the water body and the social institutions and organizations administering it.

3. South African water governance: The introduction of hydrological boundaries

South Africa has undergone comprehensive political and economic reform since the end of apartheid in 1994. The Constitution adopted in 1996 guarantees the right to water for every citizen, stating that 'everyone has the right to have access to … sufficient food and water' (Republic of South Africa, 1996). It further obliges the state to 'achieve the progressive realisation of each of these rights' (Republic of South Africa, 1996). Before 1994, water management and governance in South Africa were characterized by a

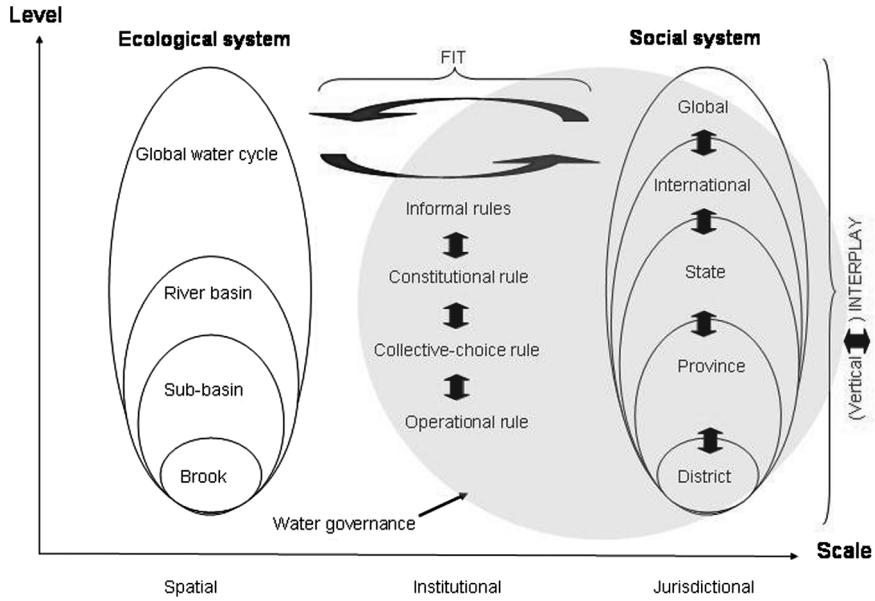

FIGURE 1 Scales and levels in social and ecological systems: the question of fit, interplay and scale

Source: Author's compilation.

technocratic approach based on supply management, a subsidized water infrastructure and technical solutions (Kranz et al., 2005). Water law and water rights mirrored the apartheid system. The owner of a piece of land was entitled to use all water on (surface water) or under (groundwater) his land property. This meant that large parts of the population remained without legal water rights, because about 87% of the land belonged to the minority white population (Seetal and Quibell, 2005). National water legislation in South Africa was not coherent. The responsibility for water supply and water management was fragmented among a number of different departments and other organizations.

On top of the constitutional changes the water law has been completely revised, starting with the White Paper on a national water policy (DWAF, 1997) and resulting in the Water Services Act (Republic of South Africa, 1997) and the National Water Act (Republic of South Africa, 1998). Water law foresees the transformation towards a holistic, decentralized and participatory approach to water management with the aim of increasing water use efficiency. The Water Act, inter alia, calls for the transformation from a water management system based on administrative boundaries towards management along hydrological boundaries. This includes the restructuring of the water management bodies of the DWA, the introduction of 19 Catchment Management Agencies (CMAs) at the intermediate level, and Water User Associations (WUAs) at the local level.

The Water Services Act and the National Water Act have established a dual structure of water management and governance in South Africa. While the responsibilities for drinking water supply and sanitation are vested with the local government, the management, protection and use of the water resources remain the domain of the central government (DWA).

Among the major concerns of the new South African Government is access to safe drinking water for all. To achieve this goal, the Water Act foresees the implementation of the Reserve (consisting of a social and an ecological reserve) to prioritize human needs and the environmental integrity of the system in relation to other uses. The 'basic human needs reserve' guarantees a minimum of 25 litres of water per person per day. The 'ecological reserve' was established to assure sufficient provision of ecological flows.

Water services in the country are provided by water service authorities (WSAs) (i.e. local government). The dichotomy of the water acts and their different rationales as regards content and spatial dimensions (i.e. hydrological versus administrative boundaries) mean that two different logics are at work within the jurisdictional scale (i.e. ecological sustainability versus economic development).

3.1. Catchment Management Agencies

At the national level the DWA is the operational arm of the Ministry of Water Affairs. It is responsible for facilitating the equitable, sustainable and efficient use of water resources (James, 2003). In order to achieve this goal, DWA set up regional offices at the province level. Until 1994 the responsibility for water supply and sanitation rested with homeland governments and local municipalities (DWAF, 2004a). In 1994 DWA was mandated to provide water services and develop the needed infrastructure (DWAF, 2004a). It was decided that in the long term water services would be assigned to the newly established local government.

The new water legislation required that the country be divided into 19 water management areas (WMAs; Figure 2). The original intention was that these WMAs would follow hydrological boundaries. In each WMA the establishment of a managing body, the CMA, is currently under way. So far DWA has received nine out of 19 proposals for the establishment of CMA, of which five have been accepted. Two CMAs are established and working (DWAF, 2009a; Sabine Stuart-Hill, personal communication, 06.04.2009). In WMAs without a CMA, DWA is responsible for fulfilling the CMA's role (DWAF, d.u.). The CMAs will take over many of the functions of

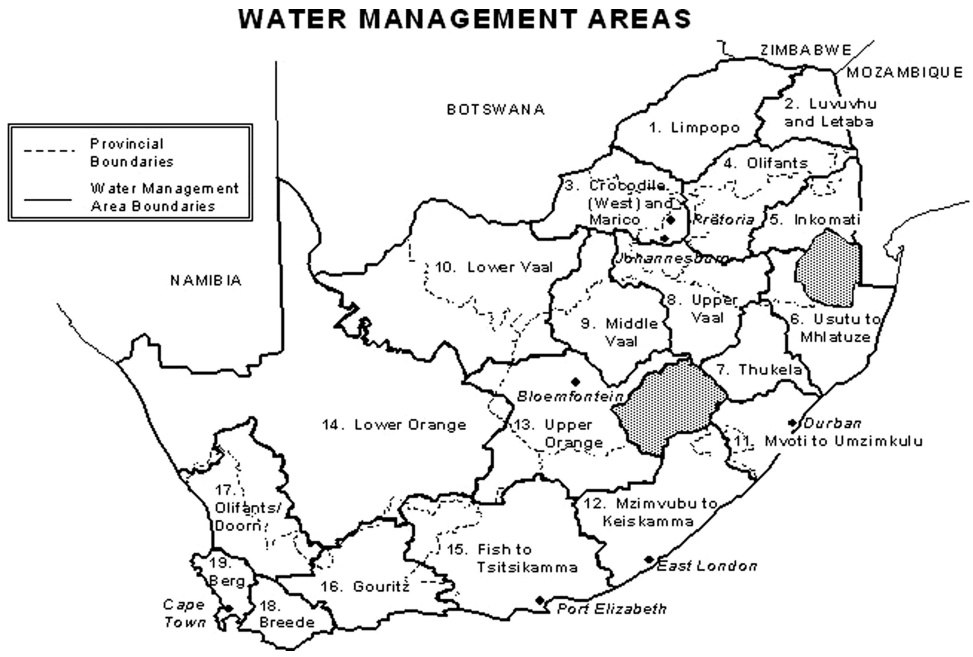

FIGURE 2 WMAs in South Africa
Source: DWAF (1999).

water management and allocation currently assigned to the regional offices of DWA.

The task of each CMA is to manage the water resources of the country across different types of use through coordinating the activities of the water users and water management organizations and promoting community participation in water management. To fulfil this role, the CMAs are obliged to develop a Catchment Management Strategy (CMS; Republic of South Africa, 1998). These strategies are based on an analysis of the available amount of water and water allocation plans in the relevant catchment (DWAF, 2007). Since the CMAs are still being set up, this planning instrument does not yet exist in most CMAs (cf. Stuart-Hill in this special issue). Instead, the more general Internal Strategic Perspective (ISP) prepared by DWA can be used for planning (DWAF, 2007).

The implementation of CMAs has turned out to be very complex and demanding, because it requires the creation of a whole set of new organizations and institutions. As a consequence, the WMAs were ranked according to priority, that is, those with an already relatively high level of stakeholder capacity and willingness to get involved (Rowlston et al., 2000) and the most urgent water management problems that needed to be solved. The priority catchment areas now serve as pilot projects.

Even though it was envisioned that the new water management bodies would follow the hydrological principle, in some cases the Ministry digressed from this principle. In fact, the Water Act demands that while establishing WMAs, social and economic development patterns, efficiency considerations and communal interests within the area in question must be taken into account as well as the hydrological catchment boundaries (Republic of South Africa, 1998). '... Potential for integrated catchment management in a hydrological sense will be conditioned by the boundaries of the WMA which are likely to be made as much on political or administrative criteria as they are on hydrological ones' (Brown and Woodhouse, 2004). Some examples for this digression from the hydrological principle due to economic, social or geophysical constraints include the following.

Dividing a catchment into several WMAs

Often river basins are too large to be managed as one hydrological unit. In such cases the demand for fit between ecosystem boundaries and institutional arrangements is compromised by spatial scale. For example, the Orange-Senqu River was divided into two WMAs and the Vaal River into the Upper, Middle and Lower Vaal WMAs. It was argued that the WMAs would have become too big to administer with one management body. Consequently, it is difficult to utilize the benefits of the basin approach immediately. This shortcoming is met to a certain degree, however, by the ISPs. DWA has prepared these documents for every WMA. In the cases of the Vaal and Orange rivers, overarching ISPs for the entire catchments exist (e.g. DWAF, 2004b). These documents support a coherent approach to water management despite the institutional split.

Merging catchments into one WMA

The opposite approach was taken for some rather small catchments with the argument of economic efficiency. For example, the Inkomati WMA consists of three different catchments. In this case, local stakeholders preferred the establishment of three separate WMAs. DWA nevertheless opted for one WMA. It was argued that the number of WMAs needs to be restricted in order to be able to provide all of them with technical support staff from DWA (Brown and Woodhouse, 2004). The basin approach, however, seeks to avoid the management of separate basins through the same organization in order to avoid a 'one-size-fits-all' approach to water management that does not mirror the ecological heterogeneity of river basins (Cumming et al., 2006). For example, the three catchments of the Inkomati represent separate hydrological as well as socio-political and economic contexts, while representation within the CMA is based on sectors (Waalewijn et al., 2005).

Transfer of units from one hydrological unit to another

Examples of digression from the hydrological principle can also be found at the lower level of sub-catchments. One example is the Douglas irrigation board, situated near the confluence of the Vaal and Orange rivers, and hydrologically part of the Vaal river catchment; nevertheless it became part of the Lower Orange WMA. When the boundaries of the catchment management areas were established by DWA, the plans were published for public comment. In the first draft, Douglas belonged to the Vaal WMA and the boundary between the Upper and Lower Orange WMA was foreseen at the van der Kloof Dam upstream from the confluence of the Orange and the Vaal. This was controversial because 70–80 km downstream from the dam there were property owners and farmers, who received water from both the river and from canals feeding from the dam. These farmers and property owners would have had two organizations talking to them about water supply and management. To avoid this, the next gauging station was identified as the demarcation between the two WMAs. This was the Douglas area, which is situated on the Vaal River but receives most of its water from the Orange River. After consultations with the Douglas irrigation board, it appeared that Douglas was more part of the Lower Orange even though it was situated in the Vaal catchment. Thus the Douglas area was included in the Lower Orange WMA instead of the Vaal and now demarcates the border of the Upper and Lower Orange WMA. In this case, water management infrastructure made the digression from the hydrological principle necessary.

The problem of fit also occurs when the focus is broadened from surface water to groundwater management. Even though groundwater does not play a major role in South African water management, it has nevertheless been neglected during the creation of WMAs. The catchment areas were mainly drawn up with regard to surface water boundaries. Therefore their design does not consider groundwater aquifers and their relation to and interaction with surface water bodies. This is problematic since groundwater aquifers often run across the surface water's hydrological boundaries and connect two or more surface water bodies, and thus also WMAs (Warner

et al., 2008). Pollution from the Gauteng groundwater aquifer, for example, stretches into the Crocodile WMA, and influences its groundwater quality.

Also of concern regarding the interaction and connectedness of water bodies are water transfer schemes and ephemeral rivers. South Africa has a comprehensive network of (transboundary) water transfer schemes, which connect otherwise distinct basins. One example is the 80-km-long Orange Fish Tunnel, which connects the Orange River basin with the Fish to Tsitsikamma WMA. According to the basin management approach, these mega-basins would have to be managed as one entity or require close coordination procedures for planning and management. Likewise, ephemeral rivers that do not flow constantly put the hydrological boundaries' approach to the test. An example is the Nossob River, which originates in Botswana and is a tributary of the Orange-Senqu River. The fact that the Nossob River was last flowing in 1989 has led to discussions on whether Botswana qualifies as a basin state and should be a member of the transboundary basin management organization ORASECOM.

The transformation to basin management also caused a number of problems with prevailing administrative boundaries. Since the delineation of the WMAs (and thus also of the CMAs) is based on hydrological boundaries, the new management entities often cut across district and province boundaries (James, 2003). Owing to these overlaps, it is difficult to make use of the three-tiered administrative system (national, province and municipality level) for establishing CMAs and supporting them once they are in place (cf. the example in Section 4).

3.2. Water service authorities

While the CMA is responsible for water resources management and agricultural water use, individual and industrial water use is managed by water service authorities (WSA)s, that is, municipalities (DWAF, 2002). The Constitution introduced local government as the third tier of South African government.

Municipalities are obliged to develop Integrated Development Plans (IDPs) that commit local government to a strong development focus. IDPs aim at coordinating different spheres of government and integrating and harmonizing sectoral plans for water, land use and the environment (Zenani, 2006). The part of each IDP dealing with water services is called the Water Services Development Plan (WSDP). These plans address drinking water supply and sanitation and are designed to 'ensure effective, efficient, affordable, and sustainable access to water services' (Dlamini, 2007). Water demands other than for drinking water (e.g. for irrigated agriculture) are not reflected in the WSDPs. WSDPs should always be based on information provided by the respective CMA about the water available in the basin.

In addition to these direct linkages between planning instruments of local government and the CMA, a number of indirect linkages exist. Among them are Spatial Development Initiatives, Economic Development Strategies and Environmental Implementation Plans (DWAF, 2001; Mazibuko and Pegram, 2006b), which need to be prepared by local government and affect issues such as water infrastructure, environmental management and water allocation plans. The institutional relationships between the DWA regional office, the CMA and local government are depicted in Figure 3.

4. The mismatch between hydrological and administrative boundaries: Opportunities and trade-offs

While the transformation towards water management along hydrological boundaries improves the fit between the governance regime and water resources, it creates a number of problems of fit, interplay and scale. These mainly concern the cooperation of the newly established CMAs with other water management organizations, especially local government. Because the rationale of WMAs is mainly based on catchments or basins and largely disregards administrative boundaries, the hydrological fit creates spatial

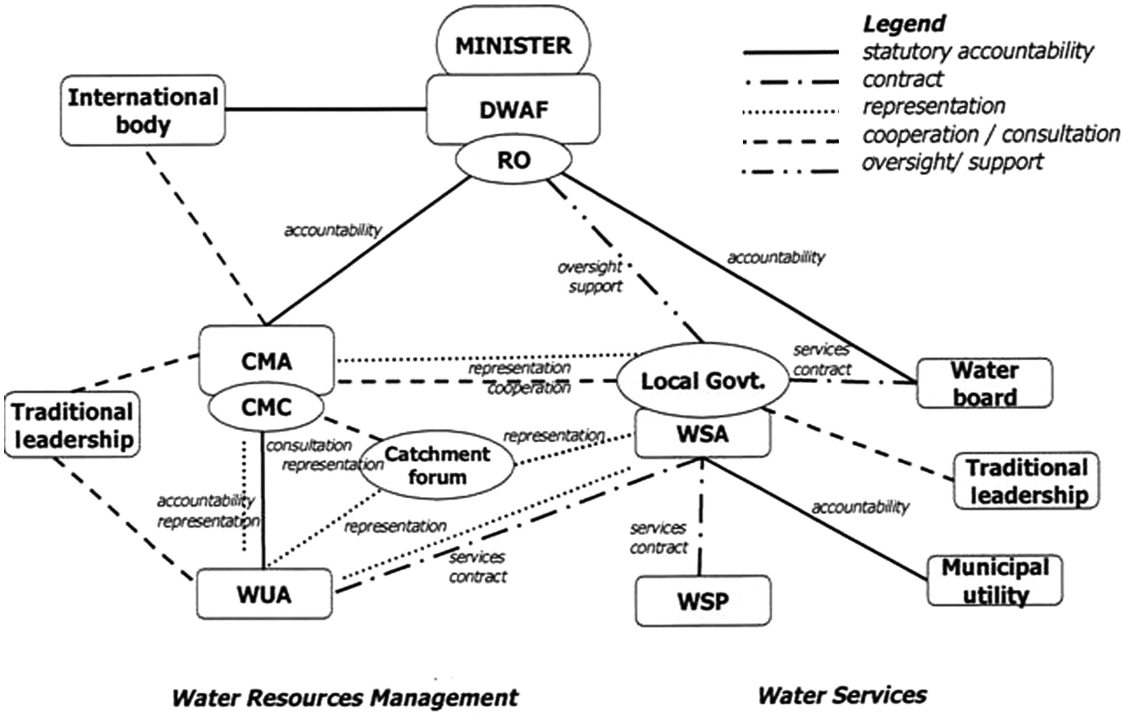

FIGURE 3 Institutional relationships of water sector institutions
Source: Mazibuko and Pegram (2006a).

mismatches with regard to other spheres and sectors (e.g. water services and agriculture). These mismatches are not sufficiently addressed. For example, district municipalities that lie across catchment boundaries can belong to two different CMAs and draw on water allocation from both. Two CMAs are responsible for providing water to the Bushbuckridge district municipality in the Sand River catchment. Theoretically the municipality has to disaggregate the water use data not only according to the number of people living in each catchment (in view of the basic needs reserve) but also according to their respective water use (in view of the overall water distributed; Pollard and du Toit, 2005). This disaggregation implies huge administrative costs. Cape Town is a similar case. While it receives water from a dam in the Breede Overberg Water Management Area, it is situated on the territory of the Berg River WMA and its wastewater is also released into the Berg River WMA (Mazibuko and Pegram, 2006a). In these cases of spatial mismatch, the interplay between organizations is a critical factor.

There is some lack of coordination and communication both within the DWA (between divisions dealing with water services and water resource management), and between the DWA and the WSA. 'There are currently no specified procedures and rules that guide cooperation between these institutions [i.e. CMAs and local government]. Cooperation is based on capacity and levels of understanding of legislation and strategies by individuals within these institutions' (Mazibuko and Pegram, 2006a). Minimal relations between DWA and local government, and a low understanding of the interrelatedness of water services and water resource management, have been found not only within local governments but also within the DWA (Mazibuko and Pegram, 2006a). Also, no clear communication and coordination mechanisms

between DWA and future CMAs seem to be envisaged.

There is a need for integration of programmes, plans and activities, especially in regard to the CMAs, which must integrate organizations from several provinces and municipalities (Karar, 2003). It is important to emphasize that the need to coordinate water resources management with water provision (i.e. the need for interplay) exists irrespective of the perfect fit of the administering agencies. The boundary mismatch between WSAs and CMAs only serves to further underline this need, and probably makes cooperation more difficult.

Forms of cooperation to foster the interplay between CMAs and local governments range from participation and informal cooperation to formal cooperation and joint development of management plans (Mazibuko and Pegram, 2006a). One way to improve communication and cooperation between CMAs and local governments is the inclusion of local government officials on the governing boards of CMAs, as foreseen in the National Water Resource Strategy (DWAF, 2004c) and in the National Water Act (Republic of South Africa, 1998). However, implementation in WMAs, which may include up to 20 municipalities, will be rather difficult without overstretching the governing boards and resulting in overrepresentation of local government (Mazibuko and Pegram, 2006a). In this case, the establishment of a special forum for local government could be a solution. Such fora are voluntary bodies created to support the establishment and subsequent functioning of CMAs through stakeholder participation and interaction with other (not water-related) organizations (DWAF, 2004c).

It is not clear, however, how cooperation will come about. Local government is clearly overburdened with the task, and in most WMAs it will take a few more years until CMAs are established and working. It is also questionable whether the regional offices of DWA will be able to fulfil this task since they are overburdened with the CMA establishment and lack the appropriate capacity and the skills.

The following example from the Upper and Lower Orange WMA (see Figure 4) illustrates further the complicated picture of organizational competencies at different levels and scales and the need for coordinated action. The regional offices of the DWA in Bloemfontein (Free State) and Kimberley (Northern Cape) have divisions responsible (1) for water resources management, which they will transfer to the CMAs once the latter have been established, and (2) for providing policies, regulations and support for water services, while the actual provision of water services rests with the municipalities. The Bloemfontein DWA division dealing with water resources management works in four provinces touching on the Upper Orange WMA. The Northern Cape DWA regional office in Kimberley is responsible for the Lower Orange WMA. Any problem that arises concerning river pollution in the Northern Cape and within the Upper Orange WMA is the responsibility of water resources management, since the water problem relates to a river (case A in Figure 4). In this case it is not the regional DWA office in the related province (Kimberley) which is in charge, but rather another regional office of DWA (Bloemfontein), which is responsible for the Upper Orange WMA. But if a problem with drinking water pollution arises in the same area, the DWA regional office of the Northern Cape takes care of it since drinking water issues are administered along administrative boundaries. In this case DWA would not be responsible, but rather the relevant municipality in charge of water services. Consequently, had the drinking water problem occurred in the Lower Orange WMA but within the Free State territory, DWA Bloemfontein and the Free State municipality would have been in charge (case B in Figure 4). These examples show the importance of interplay between authorities at the water resource and water service scales because of the mismatch of their respective boundaries.

An example of the mismatch between hydrological and administrative boundaries is the economic viability of the new entities. Some WMAs like the Upper Vaal, which include Johannesburg and Pretoria, have a high proportion of domestic

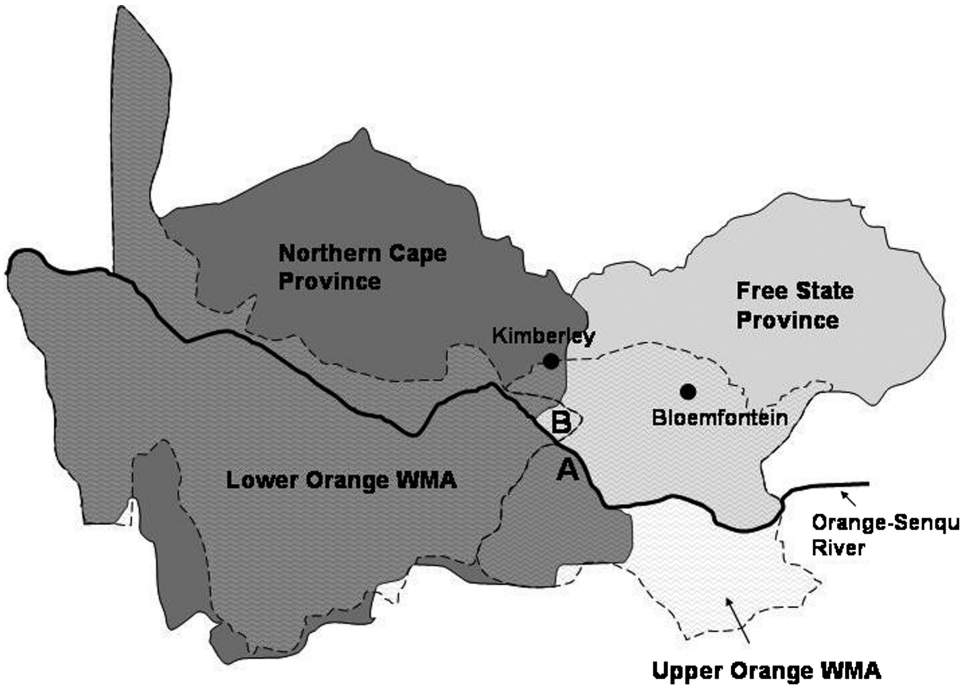

FIGURE 4 Mismatch of hydrological and administrative boundaries in the Upper and Lower Orange WMAs

Source: Author's compilation.

and industrial water use and will thus be able to sustain themselves through water charges, while others will have problems raising funds. In the Lower Vaal, where stock farming prevails, it will be difficult to sustain a CMA by water charges alone.

There are also mismatches on the temporal scale. The provisions of the Water Service Act build upon existing organizations (local government). Thus, a relatively quick implementation of institutional requirements was possible (even though physical requirements such as infrastructure lag far behind and many municipalities lack capacity). In contrast, the implementation of the National Water Act requires that new institutions and organizations are set up, while infrastructure remains for the most part unchanged. This problem is reflected in the two key planning instruments for water management. WSDPs should be in line with and build on the provisions of the CMS. With most CMAs still not functioning, the development of Catchment Management Strategies is not yet under way in most WMAs. Thus WSDPs must be designed in a vacuum without meaningful recognition of the resource base. They do not adequately address the water resource management (supply) side and are merely based on water demand (Pollard and du Toit, 2005). This shortcoming will become more noticeable due to climate change and decreasing water availability.

In addition, it seems that in many municipalities the sense of responsibility for and knowledge about water issues are rather low. In these municipalities water use often exceeds availability. Municipalities are often overburdened with their new responsibilities, understaffed and poorly skilled (Mackintosh et al., 2004). Given the task of building capacities and mastering their numerous tasks with limited finances and human resources, they are mostly overburdened with communicating and aligning their actions

and plans with a number of other organizations. 'Local municipality has not yet prioritised learning as an important aspect in management, not because they do not realise its significance, but because they are to still get the ball rolling with regard to basic services provision. "The municipality is not trying to learn lessons; we are trying to provide services"' (Dlamini, 2007).

In an attempt to solve some of the mismatches, there have been calls to revise the CMA boundaries. The National Water Resource Strategy explicitly states that 'the boundaries are not irrevocably fixed . . . and can be changed if necessary as management experience and understanding of hydrologic systems grows, to achieve greater efficiency or effectiveness' (DWAF, 2004c). Reducing the number of CMAs to 11 or nine (from 19) is currently being discussed (Sabine Stuart-Hill, personal communication, 06.04.2009). This would align the number of CMAs with the nine DWA regional offices. On the one hand, this could be used as an opportunity to increase the fit between the CMA boundaries and the administrative boundaries. On the other hand, it might – and probably would – lead to a much stronger standing of the DWA in catchment management than originally envisaged, and thus curtail the CMAs' independence.

DWA has also suggested that some CMA tasks (such as water use licensing) be transferred from future CMAs to local government agencies. But the licensing of water use is directly linked to the amount of water available within the catchment and is related more to hydrological than to administrative boundaries. Therefore such a step would not solve the problems of mismatch, not to speak of the additional onus it would place on an overburdened local government.

The improvement of interplay through intensive communication and cooperation is key to overcoming the friction caused by the transformation to hydrological boundaries. This need is underlined by the consequences of climate change and the uncertainty it entails for future water availability and extreme climate events. It relates to the interplay within the water sector (divisions of DWA) and between the water sector and other sectors (e.g. CMAs and local

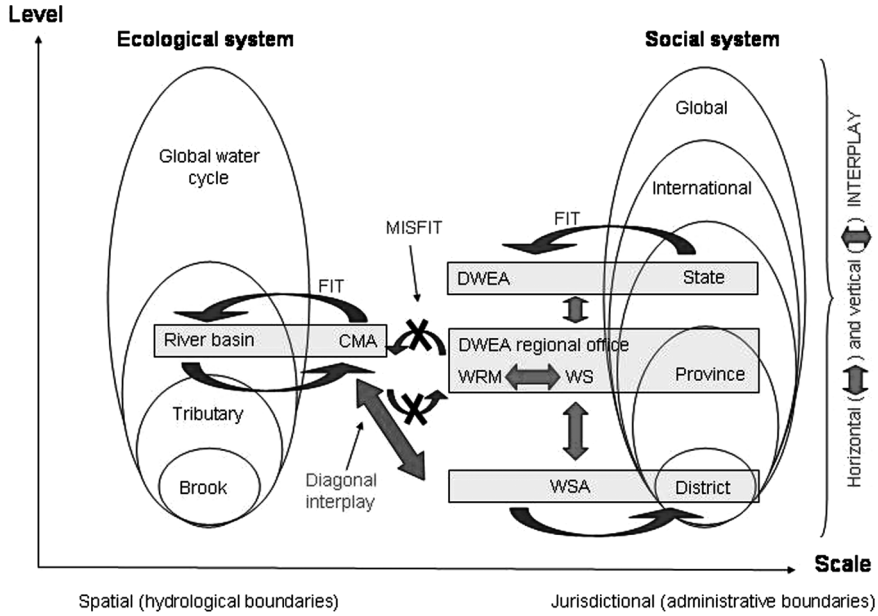

FIGURE 5 The fit and mismatch of hydrological boundaries
Source: Author's compilation.

government). The South African Constitution stresses the need for cooperative governance among the three tiers of governance (Republic of South Africa, 1996). This is especially important for rural water management and water development (Schreiner and van Koppen, 2001). Cooperation and communication between WSAs and water resource management agencies should be most intense at the lower management levels, since water management has largely been devolved to this level and it is where most friction occurs. CMAs and WSAs need to cooperate closely, which is also acknowledged in the National Water Resource Strategy: 'Relationships between the agencies [CMAs] and local authorities will need to ensure that there is a high degree of integration between water resources management and water service provision' (DWAF, 2004c). For example, they have to align their water allocation plans, since WSA allocation plans (i.e. WSDPs) are required to comply with the contents of the CMS of the CMA (James, 2003). Interestingly, it is neither vertical interplay (between levels of administration) nor horizontal interplay (between organizations at the same level but on different scales) that is necessary in this context. Rather it is diagonal interplay, since the interactions occur across levels (local – catchment) and on various scales (water resources – water services) simultaneously (see Figure 5).

5. Conclusion

South Africa has made progress in reforming its water sector. It has established a highly ambitious body of legislation and is now struggling with its implementation. The situation shows how difficult it is to implement basin management and delineate WMAs in the face of social, administrative, economic and biogeophysical realities such as overlaps of groundwater and surface water boundaries, blurred boundaries (water transfer schemes) and the dynamic nature of ecosystems, making the requirement of 'fit' a moving target.

Climate change is likely to aggravate these challenges. The increasing frequency of extreme events such as floods and droughts will mean an even more uneven distribution of water availability over time, making a steady supply of water for social use and sufficient water for the ecological system even more difficult. Rising temperatures (and thus increased evaporation of water bodies and evapotranspiration of plants) will be associated with increased water demand on the part of both social and ecological systems, while many catchments approach closure. It has to be noted, however, that these effects can to a certain degree be met by the complex technical water management system. With its extended system of national and international water transfer schemes and dams, South Africa has a relatively extensive adaptive capacity. However, the benefits of these technical solutions are limited: firstly in the face of expected sharp decreases of river runoff, leading to a reduced amount of water available for capture, storage and transfer; secondly in the face of increasing demand resulting from population growth and economic development; and thirdly in view of the paucity of suitable sites and financial resources for realizing large-scale water infrastructure projects. It has been calculated for the major South African catchments that water availability per capita is going to decrease despite the planned development of water infrastructure by 2025 (Ashton et al., 2008).

These considerations suggest that the adaptive capacity of the water sector can be further increased by improved water governance. This includes a switch from supply to demand management and the possible redistribution of water rights in the face of limited resources. Water management along hydrological boundaries is an appropriate means to increase water use efficiency. The spatial differentiation of extreme events in different regions of the country calls for a flexible, polycentric and decentralized approach to water governance. The CMA concept includes these features, and (if fully implemented) would be a useful instrument for increasing the adaptive capacity and resilience of South African water governance. The fact that impacts of climate change can already be detected

in some parts of the country underlines the urgency of learning and building resilience, especially since the current experience with water sector reform shows how long comprehensive institutional change takes.

The South African case shows how complex management tasks can become due to social, administrative, economic and biogeophysical realities. It underlines, for example, the need to adjust development plans and to communicate and coordinate activities across agencies and sectors. 'Problems of vertical and horizontal interplay between newly established institutions at basin scale and those organized at traditional administrative boundaries (e.g. spatial planning, agriculture) prove to be a barrier for implementing integrated management approaches' (Pahl-Wostl, 2009). Trade-offs exist between a correct classification along hydrological boundaries (holistic approach) and a feasible size for effective management, meaningful stakeholder participation and financial viability, which may require splitting and merging of hydrological entities and thus violation of the hydrological principle (e.g. Orange-Senqu River). These trade-offs cannot be resolved, but addressed through a combination of intense communication, cooperation and coordinated action between the involved organizations.

Problems of fit, interplay and scale arise because of:

- Mismatch on the spatial and jurisdictional scale (hydrological versus administrative boundaries). The new legislation has produced dual structures of water governance at the catchment level. The result is coherent legislation at the national level, but the split-up of competencies is transferred from the national to the catchment and local levels.
- Mismatch on the temporal scale. The delineation of WMAs was undertaken without being able to establish in due time CMAs as the managing organizations (leading to a functional mismatch). This has resulted in different stages of implementation of local government and CMAs, mainly due to the slow and lengthy process of CMA implementation (problem of sequencing).
- Necessarily different rationales of the CMSs (sustainability and water availability) and the WSDPs (water demand and local (economic) development) and the necessity for these documents to closely interact and build upon each other. The instruments for local development planning (IDP and its component the WSDP) and water management (CMSs) are not harmonized. While the WSDP is dealing with water demand, the CMS is concerned with water supply and sustainability. Despite these different rationales, they should be very closely linked and 'talk to each other' (problems of interplay).

Since 'the perfect spatial fit does not exist ... we need to consider the territorial unit of the river basin in a broader context of overlapping social, economic, political and physical spaces' (Moss, 2007). Thus the South African approach seems to be a reasonable one, integrating as it does more than mere hydrological reasoning when creating WMAs and, where necessary, digressing from the hydrological principle to recognize necessities on other scales. The National Water Resource Strategy accordingly lists a number of factors that have influenced the delineation of WMA boundaries, among them institutional efficiency of CMAs, self-sufficiency of CMAs, the location of centres of economic activity and water-related expertise, social development patterns and the distribution of water infrastructure (DWAF, 2004c). In line with this, Folke et al. conclude 'the optimal "fit" between institutions and the resources they govern may not be the tightest fit' (Folke et al., 2007). Consequently, a certain amount of mismatch also has to be tolerated regarding groundwater–surface water interaction and basin transfers.

However, the institutional boundaries of the water resource management organizations and water services do serve their primary task: namely to manage the water resource in the case of the CMA, that is, follow hydrological

boundaries, and to provide water to municipalities (i.e. the need to follow and fit administrative boundaries). Thus the spatial fit of CMAs and WSAs is correct. It is rather the interplay between these organizations that is problematic (even though the mismatch of spatial scales will prevail until all CMAs are in place due to the administrative logic of DWA regional offices). It has to be concluded with Moss that the problem of fit between administrative and hydrological boundaries has been solved here at the expense of problems of interplay between water and other relevant institutions (Moss, 2007). Thus the fit between the social and the ecological system is only one factor influencing the proper functioning and the effectiveness of water resource management. Issues of interplay and scale are equally important. Similarly, an increased fit between resource boundaries and the organizations directly managing each resource might imply negative effects for the interplay of these organizations with other organizations. Such negative effects can be observed in the horizontal interplay (e.g. between divisions of DWA or between WSAs) and the diagonal interplay (between CMAs/DWA and local governments). The lack of cooperation between divisions of DWA is likely to even increase once the CMAs are established and become part of different organizations. Therefore DWA should attempt to overcome this division before CMAs are operational. DWA is aware of these shortcomings: in its recent Water for Growth and Development Framework, it underlines the importance of strengthening the institutional capacity especially at the level of the CMAs (DWAF, 2009b).

What can be learned from this for the adaptive capacity of South African water governance? The new water legislation offers a point of departure for making South African water governance more adaptive. The introduction of hydrological boundaries in the legislation in order to increase the fit between the resource and the institutions and organizations managing it, together with the flexible implementation of these boundaries, is an important step in this direction. Nevertheless, it is too early to judge if hydrological boundaries and CMAs will be fully implemented and thus the potential for an increased adaptive capacity of water management realized. Apparently, large parts of the needed institutional arrangements for adaptive management (except for the CMAs) and the required institutional environment are in place (e.g. the flexibility to provide water services outside jurisdictional boundaries, provisions for disaster management plans, fora for local government involvement in CMA decision making). The deficits lie mainly in their effective use. Another main deficit in the process is communication; therefore, a special effort should be made to address policy coordination and to integrate planning and coordination between departments and other organizations (de Coning, 2006).

Furthermore, CMAs, which should take the role of a central player in water management and governance, are so far largely not operational. As long as CMAs do not fulfil their roles as coordinators and facilitators of all water-related activities in the catchments, deficits of interplay are likely to prevail. Thus a quick (though not hasty) implementation of CMAs is recommended. This should, however, not be at the expense of reducing their number to nine and thus limiting the potential of CMAs to help address problems of interplay and scale, as well as to negotiate and make informed trade-offs on fundamental issues such as strategic decisions on future water use and the reallocation of water use rights.

Fully functioning CMAs would increase the diversity and complexity of the South African water governance system and may thus contribute to improving the functional fit between the ecosystem and the governance system. However, this improvement will not emerge automatically, but only if the diversity and complexity are used to foster multilevel and polycentric governance that learns from different sources and so provides for innovative reactions in the face of surprises (Galaz et al., 2008). It is too early to judge, however, if the decentralization of water governance and the establishment

of new governance units such as CMAs and WUAs will be used to increase the adaptive capacity of the water sector. If not used properly, these developments might increase the complexity of the regime without increasing adaptive capacity, instead slowing down the momentum of innovation (Galaz et al., 2008). Talk of decreasing the number of CMAs to match the number of DWA regional offices could be an indication of this, and could curb the CMAs' independence and room to manoeuvre even before they have been implemented.

In contrast to this, the implementation of CMAs as envisaged in the National Water Act would be a step towards polycentric governance and would thus potentially support the adaptive capacity of water governance. Once implemented and functioning properly, CMAs could even have the potential to develop into so-called bridging organizations (Folke et al., 2005; Cash et al., 2006) that 'provide . . . an arena for trust-building, social learning, sense-making, identification of common interests, vertical and/or horizontal collaboration, and conflict resolution' (Galaz et al., 2008). In the role of an intermediary between levels and scales, they could become an important player in the adaptive management of water resources.

However, this can only be achieved if a number of problems related to boundary problems are addressed. The decentralization of water governance (i.e. the devolution of water services to the municipal level) has increased the problem of interplay as well as the problem of fit among the involved organizations because it has increased the number of relevant (administrative) boundaries and organizations. Together with the introduction of basin management, this leads to problems of interplay. These problems are so far insufficiently addressed by practitioners and by scientific research. Many volumes advocating IWRM and basin management, for example, do not deal with the friction between organizations organized along administrative and hydrological boundaries (e.g. GWP, 2009). The interplay, communication and coordination of these organizations across levels and on various scales is essential for achieving efficient water management that can support adaptive water governance.

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Notes

1. For a conceptually and empirically extended version of this article, see Herrfahrdt-Pähle (forthcoming).
2. Before the 2009 elections and the subsequent rebuilding of the government, the department was called Department of Water Affairs and Forestry (DWAF). In the following, DWA will be used for the department irrespective of the time referred to.
3. In the following, a distinction is made between the ecological system (referring to the natural environment and in this case especially rivers) and the social system (referring to the human made structures and settings, including social, economic and political aspects). The social and the ecological system are closely linked and together constitute one social-ecological system (Berkes et al., 2003).

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