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Introducing Catchment Management

The case of South Africa

Elke Herrfahrdt-Pähle

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Abstract

Climate change poses a major threat for a country like South Africa, which depends heavily on surface water and whose 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 paper examines current water sector reforms and especially the transition from administrative to hydrological boundaries. It concludes that this transition might serve as a building block for making the South African water governance system more adaptive to climate change. However, the analysis shows that the transition towards hydrological boundaries is afflicted with a number of trade-offs. These are firstly the trade-off between (1) the improved fit between the social and the ecological system and (2) the misfit between scales within the social system. Secondly a trade-off exists between (1) a correct classification along hydrological boundaries (holistic approach) and (2) 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 organisations.

Contents

Figures

Abbreviations

CMA	Catchment Management Agency
CMC	Catchment Management Committee
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
IDP	Integrated Development Plan
ISP	Internal Strategic Perspective
IWRM	Integrated Water Resources Management
RO	Regional office
WMA	Water Management Area
WSA	Water Service Authority
WSDP	Water Services Development Plan
WSP	Water Service Provider
WUA	Water User Association

1 Water availability and climate change in South Africa

South Africa is a semi-arid country facing huge constraints regarding its water resources. It is characterised by relatively low mean annual precipitation (495 mm in 2007; FAO 2009) and a high variability of precipitation (Ernst / Schulze 2008). The country is to a large extent dependent on surface water abstraction and water resources are highly developed, leaving little scope for increasing the water supply. At the same time South Africa shares six river basins with a number of neighbouring countries whose water demand is also increasing (Ashton / Hardwick / Breen 2008). These factors make the South African water governance system highly vulnerable to changes in the availability of water. As a consequence, water resources are already highly stressed today in some parts of the country. With annually about 1,099 m^3 water available per person, South Africa is termed a water-scarce country (Backeberg 2005). Within the next two to three decades, the country is expected to fall short of 1,000 m^3 of available water per person per year, indicating water stress (DoA 2005). The Department of Water Affairs (DWA)[1] estimates accordingly that by 2025 South Africa will be classified as chronically water-scarce, with an average of 730 m^3 of water available per person per year (Muller s. a.).

One of the drivers of the above-described development is climate change. According to the Intergovernmental Panel on Climate Change, changes in runoff and hydrology due to climate change can already be detected in southern Africa today (Boko et al. 2007). For example, a significant average positive trend in annual mean temperatures of 0.13°C per decade was detected for South Africa for the period between 1960 and 2003 (Kruger / Shongwe 2004). The interannual variability of precipitation has been found to have increased, resulting in higher rainfall anomalies and more intense and widespread droughts (Boko et al. 2007). Generally increased precipitation is expected in the eastern parts of the country while models suggest that the western parts will become drier (Midgley et al. 2007).

Some evidence suggests that the drainage of southern African rivers will be particularly affected by climate change (Mukheibir 2007). In a simulation, New (New 2002) found that in the south-western Cape annual streamflow can decrease by between 14 and 32% due to reduced precipitation (New 2002). Similarly, scientists at the University of Cape Town found that 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 / Stankiewicz 2006). Because of these and other research results the southwestern part of South Africa has been identified as a “climate change hotspot” (Ernst / Schulze 2008).

Decreasing water availability affects not only the ecological system (e. g. wetlands) but also the social system and especially the economy (e. g. agriculture)[2]. Actually, a number

1 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.

2 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 man-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 / Colding / Folke 2003).

of southern African countries have already experienced setbacks concerning energy supply in recent years with implications for industrial output (Pottinger 2006). 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 of the ecological system need to be mirrored in appropriate actions within the social system. Adaptation and an increase of adaptive capacity are necessary to be able to cope with decreasing water availability, increasing variability of rainfall, decreasing crop yields and food security. This requires urgent adaptation of the water management sector, including technical adaptation measures such as (cautiously) building additional dams to increase the storage capacities, adjusting disaster management plans, introducing drought-tolerant crop varieties or less water-intense irrigation methods such as drip irrigation. At the same time, adaptation to climate change is also a challenge for the water governance regime. The governance structures and institutions (i. e. rules) might at least partly be no longer adequate to deal with these changes in the ecological system and their impact on the social system. For example a continued supply approach to water management is likely to prove inadequate in a situation of decreasing water availability and growing demands. Thus increasing the efficiency of water management (e. g. through management along hydrological boundaries) becomes even more important in the context of climate change.

Parallel to these developments since the mid 1990s, Integrated Water Resources Management (IWRM) – a holistic approach to water governance with the aim of increasing the water use efficiency – has been widely proposed (GWP 1999; Pahl-Wostl / Sendzimir 2005; Neubert et al. 2005; Gumbo / van der Zaag 2001). IWRM aims at integrating various sectors, water uses and users (GWP 2006). One element of the concept is the management of the resource according to the basin principle (Medema / Jeffrey 2005). It ensures taking a systemic, hydrological approach and looking at the problem from the point of view of the resource, i. e. the water body (GWP 1999). It has been acknowledged that through a basin perspective it is easier to understand physical, environmental, social and economic influences on water resources (Bandaragoda 2000). "*It [basin management] allows for comprehensive problem analysis and the internalization of otherwise externalized problems as they arise, for instance, from up- and downstream relations*" (Pahl-Wostl / Gupta / Petry 2008).

Since the mid 1990s South Africa has been undertaking comprehensive water governance reforms based on the IWRM concept with the aim of increasing water use efficiency, promoting equitable access to water, and achieving sustainable use of the resource. Among other things these reforms encompass the introduction of basin management.

This paper examines the current water sector reforms and especially the transition from administrative to hydrological boundaries. It centres on the question whether this transition might serve as a building block for making the South African water governance system more adaptive to the challenges of climate change. The analysis shows that the transition towards water management along hydrological boundaries is afflicted with a number of trade-offs. Related to the problem of fit, i. e. the congruence of or compatibility between ecosystems and institutional arrangements, is the trade-off between (1) the increased fit of social and ecological systems (and higher efficiency of water management through the transition towards hydrological boundaries) and (2) the misfit between scales (i. e. the spatial or temporal dimensions, see below) within the social system (between

Catchment Management Agencies and municipal/provincial boundaries, which leads to friction in management and a problem of interplay, i. e. interactions between institutions). In other words, the fit of the social with the ecological system comes at the expense of a misfit or mismatch of scales in the social system (water resource management vs. water service provision) and of scales regarding the ecological system (groundwater vs. surface water). Another trade-off exists between (1) a correct classification along hydrological boundaries (holistic approach) and (2) a feasible size for effective management, meaningful stakeholder participation and financial viability, all of which may require splitting and merging hydrological entities and thus a violation of the hydrological principle (e. g. the Orange-Senqu River).

This paper is organised into five main chapters, of which this is the first. The next chapter deals with the concepts of fit, interplay and scale used to analyse the introduction of basin management in South Africa. It is suggested that an improved fit of the institutions and the resource they are managing leads to more efficient management that is better able to react to changes and surprises, such as extreme climatic events. The third chapter gives an overview of the current reform processes in South African water governance with special attention to the process of transition from administrative to hydrological boundaries and the problems associated with this process. The fourth chapter focuses on the misfits between hydrological and administrative boundaries and highlights the arising opportunities and trade-offs. The final chapter concludes with an assessment of the reform process regarding its contribution for increasing the adaptive capacity of South African water governance. The paper draws on field research undertaken in South Africa in 2006 within the NeWater project (New Approaches to Adaptive Water Management under Uncertainty).

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). "*The effectiveness of environmental and resource regimes or [...] the capacity of these arrangements to prevent undesirable environmental changes and to solve environmental problems [...] is determined in considerable measure by the degree to which they are compatible with the biogeophysical systems with which they interact*" (Young 2002). According to Young's analysis, institutions are one relevant element for the management of natural resources.[3] They serve as an important link or interface between the social and the ecological system because institutions regulate the use, overuse and pollution of the resource.[4] Institutions and more broadly speaking water governance as the part of the social system linking it to the ecological system are at the centre of this paper.

3 Institutions are defined here as "*the rules of the game in a society; more formally, they are the humanly devised constraints that shape human interaction. In consequence they structure incentives in exchange, whether political, social, or economic*" (North 1997). Following Saleth and Dinar, institutions include the governance structure and organisations, i. e. the institutional arrangement (Saleth / Dinar 2004).

4 The social system (in contrast to the ecological system) is defined here as encompassing all man-made structures, relations and objects, encompassing social and economic aspects.

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. "*(…) the problem of fit deals with congruence or compatibility between ecosystems and institutional arrangements created to manage human activities affecting these systems*" (Young 2002). The problem of fit can occur on various scales such as the temporal, spatial or functional (Folke et al. 2007; Cumming / Cumming / Redman 2006). The temporal fit relates to the different time scales of e. g. the water cycle and the political system and electoral cycles. Thus the effects of climate change on water availability and precipitation patterns occur on time scales of hundreds to thousands of years, while the political systems in place to regulate e. g. CO_2-emissions operate on time scales of a few years. This misfit of time scales renders an effective and timely response towards climate change, e. g. in the form of adaptation strategies, difficult.

Spatial fit in turn refers to the matchup between resource boundaries and the boundaries of the organisation managing and administering the resource (Moss 2007). A lack of (spatial or temporal) fit is associated with poor resource management results, which in turn negatively affect the adaptive capacity of the system, e. g. in the face of climate change.[5] If for example different segments of a catchment are managed by different organisations, this may lead to overuse of water resources and reduced environmental flows.

Functional fit relates to the congruence of the mechanisms of resource use in place within the social system and the ecosystem properties or functions that are addressed through them (Cumming / Cumming / Redman 2006). A functional misfit results, for example, if the population in a catchment uses more water than can be sustainably reproduced within the catchment (e. g. due to high subsidies on water).

The interaction between institutions is called interplay (Young 2002). Here a distinction is made between horizontal interplay or fragmentation and vertical interplay or fragmentation (Pahl-Wostl 2006). With reference to the spatial scale of institutions, horizontal interplay denotes the interaction (coordination, cooperation but also conflict) among institutions and organisations which are situated at the same level of social organization such as the local level (e. g. water management, spatial planning). Vertical interplay in contrast is associated with the interaction of institutions and organisations located at different levels of social organization (so-called cross-level interaction, e. g. between local, province and national levels). In addition to this, a distinction can be made between the vertical interplay of adjacent or remote institutions or organisations (Young 2002). Thus the interaction between organisations at different levels and in different sectors (e. g. between the national water management department and the province agricultural department) qualifies as remote vertical interplay.

In this paper the concept of scale is framed 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*" (Gibson et al. 2000, cited in

5 The term "adaptive capacity" focuses on the ability or potential of a system to adjust to (climate) change (Levina / Tirpak 2006; Svendsen / Künkel 2008). It thus centres on the preparedness of a system to meet a (potential) threat or impact.

Lebel / Imamura 2006). Scale refers to the different dimensions of water resource management, which can for example be examined from the viewpoint of

- the temporal scale, i. e. a temporal point of view (e. g. distinguishing between time intervals such as days, years, decades and centuries),

- the spatial scale, i. e. a point of view of location and extension (e. g. distinguishing between the global, national, sub-national and local levels),

- the institutional scale, i. e. an institutional point of view (e. g. distinguishing between constitutional rules, collective choice rules and operational rules) and

- the jurisdictional scale, i. e. an administrational point of view (e. g. state, province, municipality; Cash et al. 2006).[6]

Distinguishing among these scales and levels makes identifying mismatches between scales and levels possible. 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, thus leading to inefficiency. This can be the case for example, if the natural resource and the resource management institutions that are linked to the jurisdictional scale do not refer to the same geographic area (Borowski et al. 2008). As a consequence "*mismatched organizations are frequently confronted with ecological situations in which they do not understand the nature of the problem, are incapable of managing effectively, or lack the necessary power to achieve the scale of management that is required*" (Cumming / Cumming / Redman 2006). One possible result of such mismatches is the mismanagement of natural resources and subsequently a loss of adaptive capacity of the social system as well as a loss of resilience of the ecological system. "*Recognizing and resolving scale mismatches is thus an important aspect of building resilience in social-ecological systems*" (Cumming / Cumming / Redman 2006). At the same time the rapid change of the ecological system through climate change opens up new mismatches and aggravates existing ones, thus underlining the urgency of learning and the need of building resilience.

The concepts of fit, interplay and scale are applied to the water management sector in Figure 1. 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 scale form that part of the social system which is of particular relevance for this paper (i. e. water governance).

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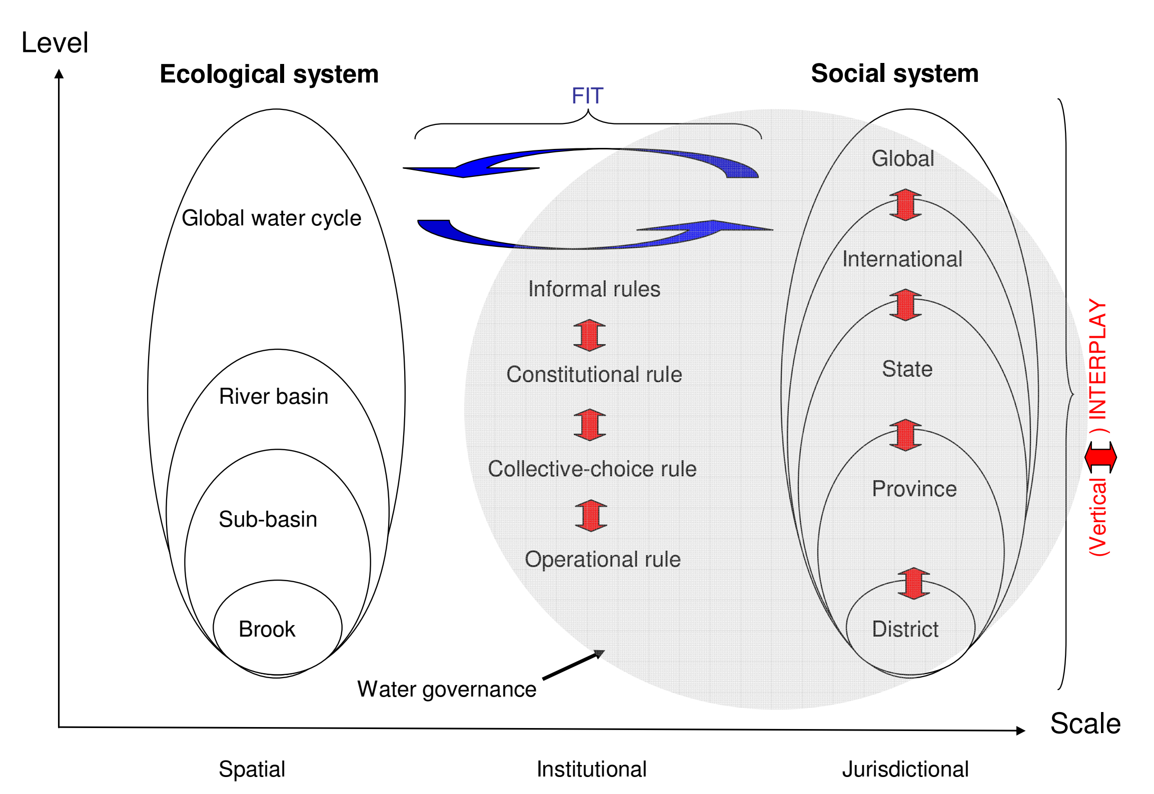
6 This scale could also be termed "spatial scale", since it refers to both geographical location and extension. For reasons of more precision and for distinguishing between the dimensions of analysis in the social and ecological systems it is termed "jurisdictional scale" here with reference to Cash and colleagues (Cash et al. 2006). Young's concept of scale slightly differs from the formulations used for scale in this paper, since he puts major emphasis on the possibility (or rather impossibility) of scaling up or down institutional arrangements (Young 2002).

Figure 1: Scales and levels in social and ecological systems: The question of fit, interplay and scale



Source: own compilation

Historically, water administrative bodies have been organised along administrative boundaries even though river catchments often do not obey this administrative logic.[7] Jurisdictional boundaries are "*the product of a range of political, economic, and cultural forces. It is a rare instance in which ecological considerations played a significant role in determining jurisdictional boundaries*" (Young 2002). Thus the institutions governing water resources have often failed to fit the ecosystem properties. This mismatch of the spatial scale (hydrological boundaries in the ecological system) and the jurisdictional scale (administrative boundaries in the social system) encompasses inefficiency as well as conflicting and contradictory competencies of the managing agencies with regard to the managed water body. Management failures such as a lack of cooperation, participation and transparency are partly rooted in this mismatch (Huitema et al. 2009; Bohensky 2008). The consequence of such a scale mismatch can be a functional mismatch in the form of overuse or pollution of the resource. For example, it is difficult to enforce water quality regulations and water abstraction rules in a situation where two or more water management bodies are in charge of different sections of one river and thus upstream-downstream relations and tensions cannot be addressed within one administrative body. "*The need for water management on hydrological boundaries is mainly triggered by the growing competition for water or by the need to co-operate in an upstream-downstream relation for*

7 This is not to speak of political boundaries, which often also cut across catchments or run along rivers. South Africa, for example, shares its major rivers with its neighbouring countries (e. g. Orange-Senqu, Limpopo, Inkomati).

flood control or both" (Jaspers 2003). Both of these triggers are going to become further pronounced due to the impact of climate change on water resources.

Following these insights a prominent point for many water governance reform programs around the world currently is the organisation of water management bodies along hydrological boundaries. Basin management and the application of the hydrological principle represent an effort to align the spatial fit between the boundaries of the water body and the social institutions and organisations administering this ecosystem (Lehtonen / Karlsson 2006) under the assumption that water resource management thus becomes more effective and reactive. This would also serve the aim of adaptation to climate change, since such an institutional water management arrangement better fits the natural requirements and boundaries of the resource. But this approach is also afflicted with some shortcomings. It is argued in this paper that the strict realisation of hydrological boundaries is often not feasible due to natural or economic conditions. Even if it is possible, it creates a number of mismatches within the social system. Some researchers therefore complement this call for an increased fit with the call for more flexible approaches to water governance, adapting it to the physical, socio-economic and institutional characteristics of the basin in question (Moss 2007; Young 2002). In addition to the need for a better fit of the resource and the institutions managing it, this underlines the importance of interplay between institutions within and beyond the water sector for effective and adaptive water governance.

3 South African water governance: The introduction of catchment management

South Africa has been undergoing comprehensive political and economic reform processes since the end of the Apartheid era in 1994. The new Constitution adopted in 1996 guarantees the right to water for every citizen. In its Bill of Rights it states 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).

Prior to 1994, water management and governance in South Africa were characterised by a technocratic approach based upon supply management, a subsidised water infrastructure, and technical solutions (Kranz et al. 2005). Water law and water rights mirrored the Apartheid system. Water legislation and water rights followed the Roman riparian rights principle, i. e. the owner of a piece of land was entitled to use all water on (surface water) or under (groundwater) his land property. This provision entailed that large parts of the population remained without legal water rights, since about 87% of the land belonged to the minority of the white population (Seetal / 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 organisations. For example the Department of Water Affairs (DWA) was only responsible for managing irrigation water and forestry issues, while water service provision rested with homeland governments and local municipalities (DWAF 2004a). As a consequence, water quality and water service provision differed largely between white and non-white dominated settlements as well as between urban and rural areas (Folifac 2007).

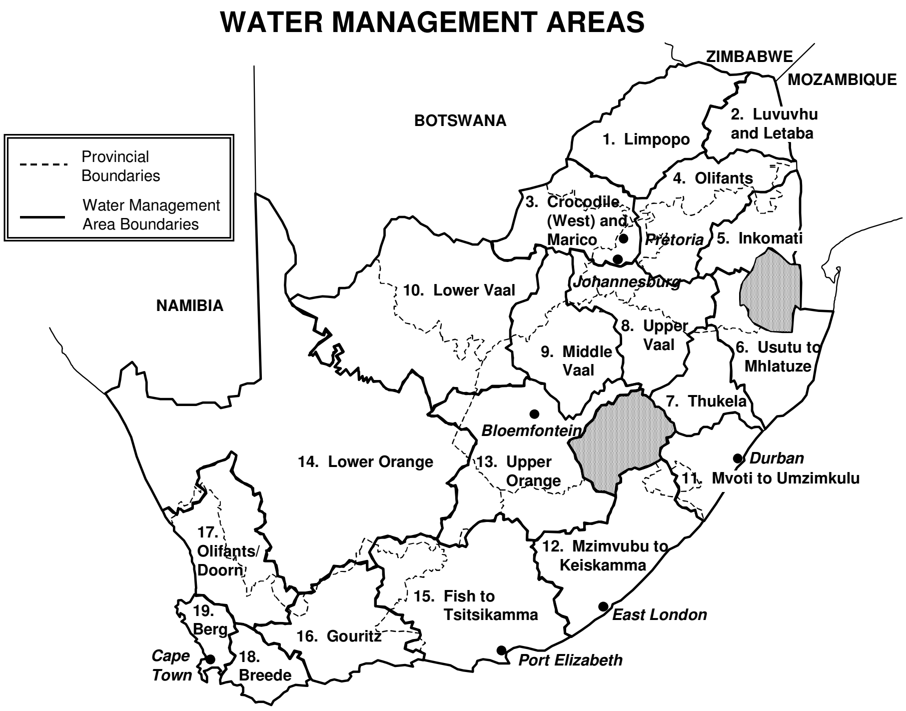
Along with the constitutional changes the water law has been completely revised, starting with the white paper on a national water policy (DWAF 1997) and resulting in the Water Services Act (1997) and the National Water Act (1998). Water law is now based on the premises of equitable access to water as well as sustainable and efficient use of water. It foresees the transition towards a holistic, decentralised and participatory approach to water management with the aim of increasing water use efficiency. The Water Act *inter alia* calls for the transition from a water management system based on riparian rights and administrative boundaries towards licensing of water use and catchment management, i. e. water management along hydrological boundaries (Seetal 2005). This includes the restructuring of the water management bodies of the DWA, the introduction of 19 Catchment Management Agencies (CMA) at the intermediate level, and Water User Associations (WUA) at the local level respectively (see Figure 2). Thus water use is no longer tied to land entitlements but rather to a license which is provided with regard to water availability in the relevant catchment area and limited to a maximum of 40 years.

With the Water Services Act and the National Water Act a dual structure of water management and governance has been established in South Africa. While the responsibility for drinking water supply and sanitation are vested with the newly established local government, the management, protection and use of the water resources remains a domain of the central government (DWA), which may delegate certain aspects of management to Catchment Management Agencies (CMA).

According to the National Water Resources Strategy (DWAF 2004c) water management in South Africa is organised on three tiers: the Department of Water Affairs and Forestry at the national level, the Catchment Management Agencies (CMA) at the catchment level, and the Water User Associations (WUA) at the lowest level. Even though they will not be completely replaced by CMA, the role of the regional offices of the DWA at province level is not adequately referred to in most water governance documents. Often reference is made to the changing role of the DWA from a regulating and implementing agency towards a provider of policies and strategies, including national policy making, developing regulatory frameworks, and dealing with international water management issues (DWAF 2004c). It remains unclear what this means for the regional offices, which were mainly involved in policy implementation, operation and maintenance in the past.

Among the major concerns of the new political administration is the provision of the population with access to safe drinking water. To achieve this goal, the Act foresees the implementation of the Reserve (consisting of a social and an ecological reserve) to prioritise human needs and environmental integrity of the system in relation to other uses, e. g. agricultural and industrial use. The “basic human needs reserve” guarantees a minimum of 25 litres of water per person per day and the “ecological reserve” was established to assure sufficient provision of ecological flows (Hamann / O'Riordan 2000). DWA claims that between 1994 and 2004 13.4 million people received access to safe drinking water and 6.9 million people received access to basic sanitation (DWAF 2004a). Even though good progress was made with connecting large parts of the population to piped water in the 1990s it has been stated that many of these infrastructure developments are inoperable today due to a lack of operational and maintenance capacity, inefficient cost recovery, the absence of institutional arrangements, and vandalism (Mukheibir 2007).

Figure 2: Water Management Areas in South Africa



Source: DWAF (1999)

Water services in the country are provided by water service authorities, i. e. local government. The dichotomy of the water acts and their different rationales as regards content and spatial dimensions (i. e. hydrological vs. administrative boundaries) lead to the conceptualisation of two different logics within the jurisdictional scale (i. e. ecological sustainability vs. economic development). The next sections of this paper provide an overview of the responsibilities of CMA and Water Service Authorities (WSA) and their interplay.

3.1 Catchment Management Agencies

At the national level the Department of Water Affairs (DWA) is the operational arm of the Minister of Water and Environmental Affairs. It is responsible for facilitating the equitable, sustainable and efficient use of the country's water resources (James 2003).[8] In order to achieve this goal, DWA disposes of regional offices at the province level. As mentioned above, until 1994 the responsibility for water supply and sanitation rested with homeland governments and local municipalities and there was no national department in charge of

8 When speaking of water as a resource, the Water Act refers to all sources of water, including water courses, surface water, estuaries and aquifers (Republic of South Africa 1998).

the issue (DWAF 2004a).[9] In 1994 DWA was mandated to provide water services and develop the needed infrastructure (DWAF 2004a), while it was decided that in the long term water services be assigned with the newly established local government.

The new water legislation required that the country be divided into 19 Water Management Areas (WMA). The original intention was that these WMA would follow hydrological boundaries in accordance with the internationally accepted principle of basin or catchment management. In each Water Management Area the establishment of a managing body, the Catchment Management Agency (CMA), is currently under way. So far DWA has received 9 out of 19 proposals for the establishment of CMA, of which five have been accepted. Two CMA are established and working (DWAF 2009a; personal communication Stuart-Hill, 06.04.2009). In Water Management Areas without a CMA, DWA is responsible for fulfilling the CMA's role (DWAF s.a.-a).[10] The CMA will take over many of the functions of water management and allocation currently assigned to the regional offices of DWA. In the long term, the transfer of parts of the DWA's regional offices to the CMA is foreseen.

A CMA is responsible for "*protection, use, development, conservation, management and control of the water resources in its water management area*" (Republic of South Africa, 1998). The task of each CMA is to manage the water resources of the country across different types of uses through coordinating the activities of the water users and water management organisations and promoting community participation in water management. To fulfil this coordinating role, the CMA are obliged to develop a Catchment Management Strategy (Republic of South Africa 1998; DWAF s.a.-b).[11] These strategies are based on an analysis of the available amount of water and water allocation plans in the relevant catchment, and take sustainability aspects into account (DWAF 2007). Since the CMA are still being set up, this planning instrument does not yet exist in most CMA (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 CMA turned out to be very complex and demanding, because it requires the creation of a whole set of new organisations and institutions. As a consequence, the Water Management Areas were ranked according to priority, i. e. those with an already relatively high level of stakeholder capacity and willingness to get involved (Rowlston / Barta / Mokonyane 2000) and the most urgent water management problems that needed to be solved. The priority catchment areas (among others the Inkomati and the Crocodile) 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 Minister, for well-established reasons, digressed

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9 Traditional leadership used to be responsible for water services provision in the so-called homelands and until today is often still involved in local water management (Pollard / du Toit 2005). The South African Constitution recognises traditional leadership as one element of government (Mazibuko / Pegram 2006a). By way of simplicity in the following analysis the influence of tribal authority is not considered.

10 When reference is made in the following to CMA, this means the CMA or regional office of DWAF where a CMA does not yet exist.

11 A detailed description of the development of a framework for Catchment Management Strategies is given in DWAF (2001) and DWAF (2007).

from this principle. In fact, the Water Act demands that while establishing Water Management Areas not only the hydrological catchment boundaries must be taken into account but also social and economic development patterns, efficiency considerations, and communal interests within the area in question (Republic of South Africa 1998). "*It is important, therefore, to acknowledge that potential for integrated catchment management in a hydrological sense will be conditioned by the boundaries of the water management area which are likely to be made as much on political or administrative criteria as they are on hydrological ones*" (Brown / Woodhouse 2004). Some examples for this digression from the hydrological principle due to economic, social or geophysical constraints include:

Dividing a catchment into several Water Management Areas (WMA): Often river basins are too large to be managed as one hydrological unit. In these cases the demand for the fit between ecosystem boundaries and institutional arrangements is compromised by the problem of spatial scale (Jaspers 2003). For example, the Orange-Senqu river was divided into two WMA (Upper and Lower Orange) and the Vaal river into the Upper, Middle and Lower Vaal WMA. It was argued that the Water Management Areas would otherwise have become too big and difficult to administer with one management body (field notes). Consequently it is difficult to utilise the benefits of the basin approach in these Water Management Areas in an immediate fashion. This shortcoming is met to a certain degree, however, by the Internal Strategic Perspectives (ISP). DWA has prepared these documents for every Water Management Area; apart from transmitting DWA's "*understanding of the strategic needs and direction for each Water Management Area*" (DWAF 2007), they give an overview of water availability and use in each Water Management Area. In case of the Vaal and Orange rivers, for example, overarching ISP for the whole catchments exist (e. g. Internal Strategic Perspective: Vaal River System Overarching; DWAF 2004b). These documents support a coherent approach to water management despite the institutional split. Since ISP are, however, provided by the DWA head office, their focus is rather broad.

Merging catchments into one Water Management Area (WMA): The opposite approach was taken for some rather small catchments with the argument of economic efficiency. For example the Inkomati Water Management Area consists of three different catchments. In this case, local stakeholders preferred the establishment of three separate Water Management Areas. DWA nevertheless opted for one WMA and took this decision at the national level. It was argued that the number of Water Management Areas needs to be restricted in order to be able to provide all of them with technical support staff from DWA (Brown / Woodhouse 2004). The basin approach, however, seeks to avoid the management of separate basins through the same organisation in order to avoid a "one-size-fits-all" approach to water management that does not mirror the ecological heterogeneity of river basins (Cumming / Cumming / Redman 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 (Chikozho 2005; Waalewijn / Wester / van Straaten 2005).

Transfer of units from one hydrological unit to another: Examples for the digression from the hydrological principle can also be found at the lower level of sub-catchments. One example is the Douglas irrigation board, which is situated near the confluence of the Vaal and Orange rivers, and hydrologically is 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. But 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 organisations talking to them simultaneously regarding water supply and management: The Upper and Lower Orange CMA. To avoid this situation the next gauging station was identified as the demarcation between the two Water Management Areas. 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 being 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 (field notes). In this case, water management infrastructure made the digression from the hydrological principle necessary.

The problem of fit regarding hydrological boundaries also occurs in another sense 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 often been neglected during the creation of Water Management Areas. The catchment areas were mainly drawn up with regard to surface water boundaries. Therefore their design does not take groundwater aquifers and their relation and interaction with surface water bodies into consideration.[12] This is problematic in some cases. Groundwater aquifers often run across the surface water's hydrological boundaries and connect two or more surface water bodies and thus also Water Management Areas (Warner / Wester / Bolding 2008). The Gauteng groundwater aquifer, for example, stretches into the Crocodile WMA, and pollution in Gauteng influences groundwater quality in the Crocodile WMA (field notes). In some places with dropping groundwater tables Water User Associations are now being established for groundwater management (field notes).

Further topics of concern regarding the interaction and connectedness of water bodies are water transfer schemes and ephemeral rivers. South Africa disposes of a comprehensive network of water transfer schemes (including transboundary 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 Water Management Area. 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. On the other hand, ephemeral rivers that do not flow constantly put the hydrological boundaries' approach to the test. An example is the Nossob river, which originates in Botwsana and is a tributary of the Orange-Senqu river. The fact that the Nossob river was last flowing in 1989 has given rise to discussions on whether Botswana qualifies as a basin state and should be a member of the transboundary basin management organisation ORASECOM (field notes).

12 For a comprehensive overview on the neglect of groundwater management in IWRM cf. Niemann (2005).

In addition to these problems of fit with other hydrological boundaries, the transition to basin management also entailed a number of problems with prevailing administrative boundaries. Since the delineation of the Water Management Areas (and thus also of the CMA) is based on hydrological boundaries, the new management entities often cut across district and province boundaries (James 2003). For example the province of Free State falls into five Water Management Areas (Upper and Lower Orange; Upper, Middle and Lower Vaal). Due to these overlaps it is at least difficult to make use of the three-tiered administrative system (national, province and municipality level) for establishing CMA and supporting them once they are in place (cf. example in section 4).

3.2 Water Service Authorities

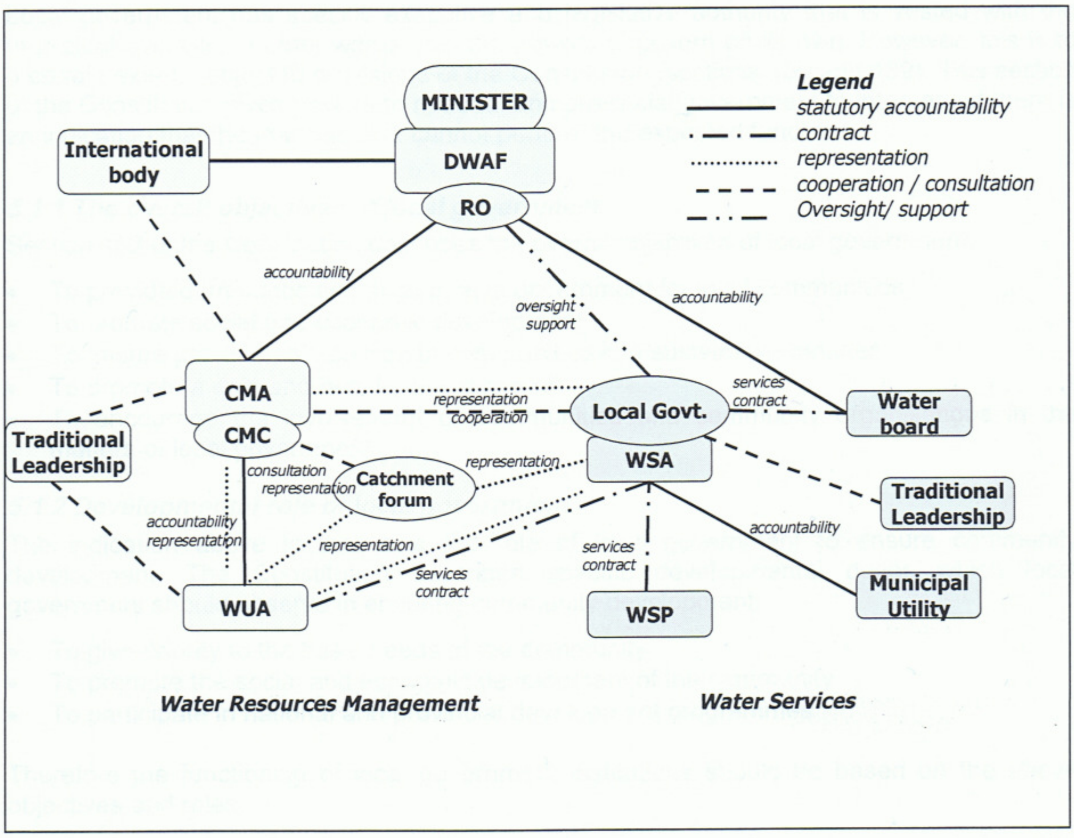
While the CMA is responsible for water resources management and agricultural water use, individual and industrial water use is managed by Water Services Authorities (WSA), i. e. municipalities (DWAF 2002).[13] The Constitution (Republic of South Africa 1996) introduced local government as the third tier of South African government with its own competencies. After a transition period and the reshaping of municipalities through the "Local Government: Municipal Demarcation Act" (1998) this third tier took on its present shape after the local government elections in December 2000. It is the responsibility of local government to provide basic services such as drinking water and sanitation to all citizens (Republic of South Africa 1996; Republic of South Africa 1997; Dlamini 2007).

Municipalities are obliged to develop Integrated Development Plans (IDP), which are geared to commit local government to a strong development focus (Nyalunga, 2006). IDP aim at coordinating different spheres of government and integrating and harmonising sectoral plans for water, land use and the environment (Zenani 2006). The part of each IDP dealing with water services is called 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). Other water demands than drinking water (e. g. for irrigated agriculture) are not reflected in the WSDP. Water Services Development Plans 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, for example, Spatial Development Initiatives, Economic Development Strategies and Environmental Implementation Plans (DWAF 2001; Mazibuko / Pegram 2006b) which need to be prepared by local government and affect water issues such as water infrastructure, environmental management, water allocation plans etc. The institutional relationships between the DWA regional office, the CMA, and local government are depicted in Figure 3.

13 The South African Constitution distinguishes between three types of municipalities (Category A – metro, Category B – local and Category C – district; Republic of South Africa 1996), which may carry out different tasks in water service provision. By way of simplification no distinction is made between these types of municipalities in the following.

Figure 3: Institutional relationships of water sector institutions



Source: Mazibuko / Pegram (2006a)

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

While the transition towards water management along hydrological boundaries improves the fit between the governance regime and water resources, it also creates a number of problems of fit, interplay and scale, which mainly concern the cooperation of the newly established CMA with other operational organisations of water management and allocation, especially local government. As mentioned above, the rationale of water management areas is mainly that of catchments or basins and largely disregards administrative boundaries of municipalities and districts. The fit in hydrological terms thus creates problems of misfit with regard to other spheres and sectors that are related to water resource management, e. g. water services and agriculture, and which are not sufficiently addressed. An example for this spatial misfit is the water supply in district municipalities which lie across catchment boundaries and thus belong to more than one catchment area. If a municipality belongs to two different CMA, it can draw on water allocation from both of these CMA. For example two CMA are responsible for providing water to the Buckridge district municipality in the Sand river catchment. It follows that 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 / du Toit 2005). This disaggregation of water use data along the hydrological boundary implies huge administrative transaction costs. A similar case is reported for the city of Cape Town. While it receives water from a dam in the Breede Overberg Water Management Area (WMA), it is situated on the territory of the Berg River WMA and its wastewater is also released to the Berg River WMA (Mazibuko / Pegram 2006a). In these cases of spatial misfit the interplay between the organisations is a critical factor.

Not surprisingly, a lack of coordination and communication has been detected both within DWA between divisions dealing with water services and water resource management and between DWA and WSA. Mazibuko and Pegram state that "*there are currently no specified procedures and rules that guide cooperation between these institutions* [i. e. CMA and local government]. *Cooperation is based on capacity and levels of understanding of legislation and strategies by individuals within these institutions*" (Mazibuko / Pegram 2006a). In a case study they found that only minimal relations between DWA and local government were detectable, and understanding of the interrelatedness of water services and water resource management was low not only within local governments but also within DWA (Mazibuko / Pegram 2006a). Even within one organisation such as DWA, the communication and cooperation between those divisions concerned with water resources management and those dealing with water services is very limited and conflictive (field notes). Also no clear communication and coordination mechanisms between DWA and future CMA seem to be envisaged.

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

Forms of cooperation to foster the interplay between CMA and local governments range from participation and informal cooperation to formal cooperation and joint development of management plans (Mazibuko / Pegram 2006a). One way to intensify and facilitate communication and cooperation between CMA and local governments is the inclusion of local government officials on governing boards of CMA, as foreseen in the National Water Resource Strategy (DWAF 2004c) and in the National Water Act (Republic of South Africa 1998). However, implementation in Water Management Areas, which may include up to 20 municipalities, will be rather difficult without overstretching the governing boards and resulting in overrepresentation of local government (Mazibuko / 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 CMA through stakeholder participation and interaction with other (not water-related) organisations (DWAF 2004c).

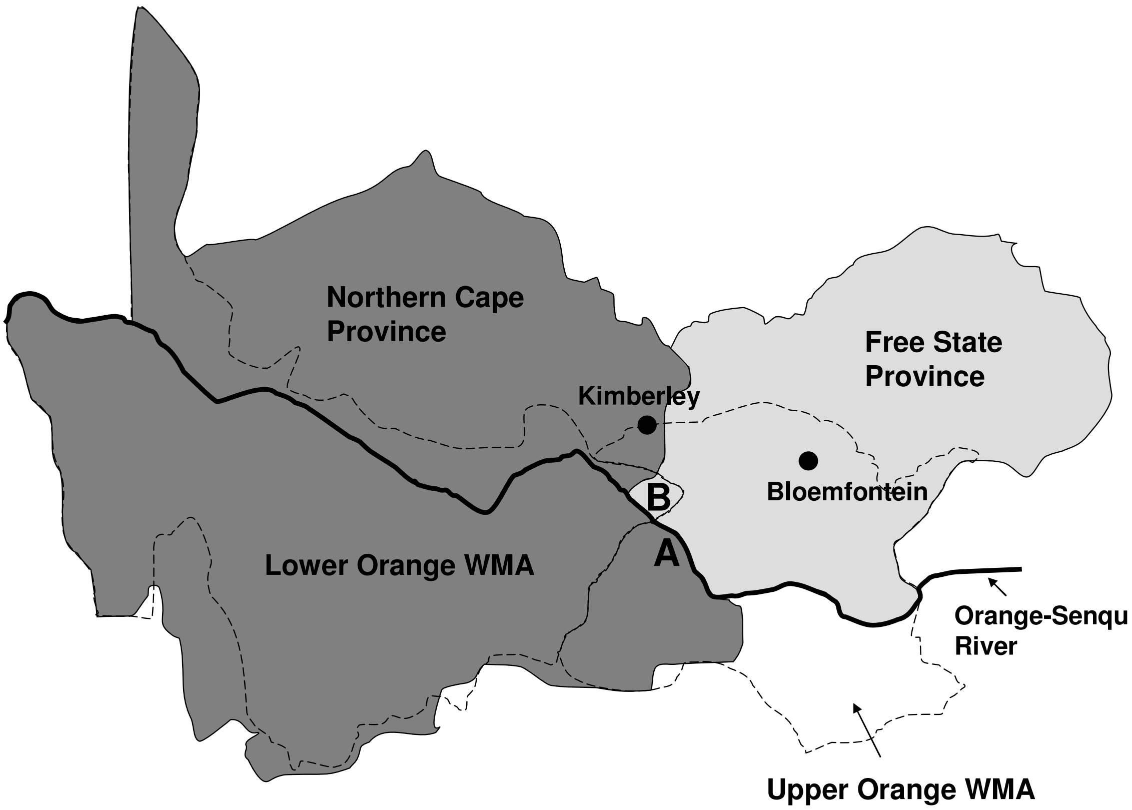
It is not clear however, how cooperation should come about. Local government is clearly overburdened with the task, and in most Water Management Areas it will take a few more years until CMA are established and working. It is also questionable whether the regional offices of DWA will be able to fulfil this task since they are overburdened with the CMA establishment and mostly lack not only the capacities but also the skills to facilitate cooperation.

However, water legislation provides for the needed flexibility in that it allows a water service authority to "*provide services outside its area of jurisdiction, provided its ability to service its own area is not prejudiced*" (Rowlston / Barta / Mokonyane 2000). Therefore WSA may prospectively grow in the future and provide water to municipalities within their province but within another CMA, thus potentially reducing friction between administrative and hydrological scales.

The complicated picture of organizational competencies at different levels and on different scales and the need for coordinated action can be further illustrated with the following example from the Upper and Lower Orange WMA (cf. figure 4). The regional offices of DWA in Bloemfontein (Free State) and Kimberley (Northern Cape) have divisions responsible (1) for water resources management, which they will transfer to the CMA once the latter have been established, and (2) for providing policies, regulations and support regarding 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 which touch upon the Upper Orange WMA. The Northern Cape DWA regional office in Kimberley is responsible for the Lower Orange WMA. Any problem which arises concerning river pollution in the Northern Cape and within the Upper Orange WMA falls into 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 regional office in the related province (Kimberley – Northern Cape) which is in charge, but rather another regional office of DWA (Bloemfontein – Free State), which is responsible for the Upper Orange WMA, even though the problem has occurred in a different province. 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. DWA would not even be responsible in this case but rather the relevant municipality which is 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 the interplay between authorities at the water resource scale and the water service scale because of the misfit of their respective boundaries.

An example of the mismatch between hydrological and administrative boundaries concerns the economic viability of the new entities. Some Water Management Areas like the Upper Vaal, which include Johannesburg and Pretoria, have a high proportion of domestic and industrial use of the water supply and will thus be able to sustain themselves due to water charges, while others will have problems raising the required funds. In the Lower Vaal, for example, where stock farming prevails, it will be difficult to sustain a CMA by water charges alone (field notes).

Figure 4: Mismatch of hydrological and administrative boundaries in the Upper and Lower Orange Water Management Areas (WMA)



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Apart from this, mismatches on the temporal scale can also be detected. The provisions of the Water Service Act build upon existing organisations (local government). Thus a relatively quick implementation regarding institutional requirements was possible (even though physical requirements such as infrastructure lag far behind and in many municipalities capacities are lacking). In contrast, the implementation of the National Water Act requires the establishment of new institutions and organisations, while the respective infrastructure is basically in place. This problem of sequencing is also reflected in the two key planning instruments for water management. As mentioned above, local government is obliged to prepare a Water Service Development Plan (WSDP) based on the amount of water available in the basin. This plan should be in line with and build upon the provisions of the Catchment Management Strategy. With most CMA still not functioning, the development of Catchment Management Plans is not yet under way in most Water Management Areas. Thus Water Sector Development Plans have to be designed in a vacuum without meaningful recognition of the resource base. They do not adequately address the water resource management (water supply) side and are merely based on water demand in each respective municipality (Pollard / du Toit 2005).[14] This shortcoming will become even more pronounced due to climate change and decreasing water availability.

In addition it seems that in many municipalities the sense of responsibility for water issues and related capacities and knowledge are rather low. In these municipalities, water use often exceeds water availability, leading to overuse and depletion of water resources (field notes). 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 the responsibility of communicating and aligning their actions and plans with a number of other organisations. "*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 misfits there have been calls to revise the CMA boundaries. The National Water Resource Strategy explicitly states that "*the boundaries are not irrevocably fixed for all time, and can be changed if necessary as management experience and understanding of hydrologic systems grows, to achieve greater efficiency or effectiveness*" (DWAF 2004c). At the moment the reduction of the number of CMA from 19 to 11 or 9 is being discussed (personal communication Stuart-Hill, 06.04.2009). This would align the number of CMA 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 in water service delivery. On the other it might – and probably would – lead to a much stronger standing of the DWA in catchment management in the future than originally envisaged und thus curtail the CMA's independence.

In addition, provincial boundaries, which came into existence with the constitution in 1996, are subject to debate from time to time (cf. de Villiers 2007). But it is neither likely to become a viable option to return to administrative boundaries for water management nor is it politically acceptable or economically feasible to arrange for civil administration along hydrological boundaries. A certain amount of misfit will thus remain.

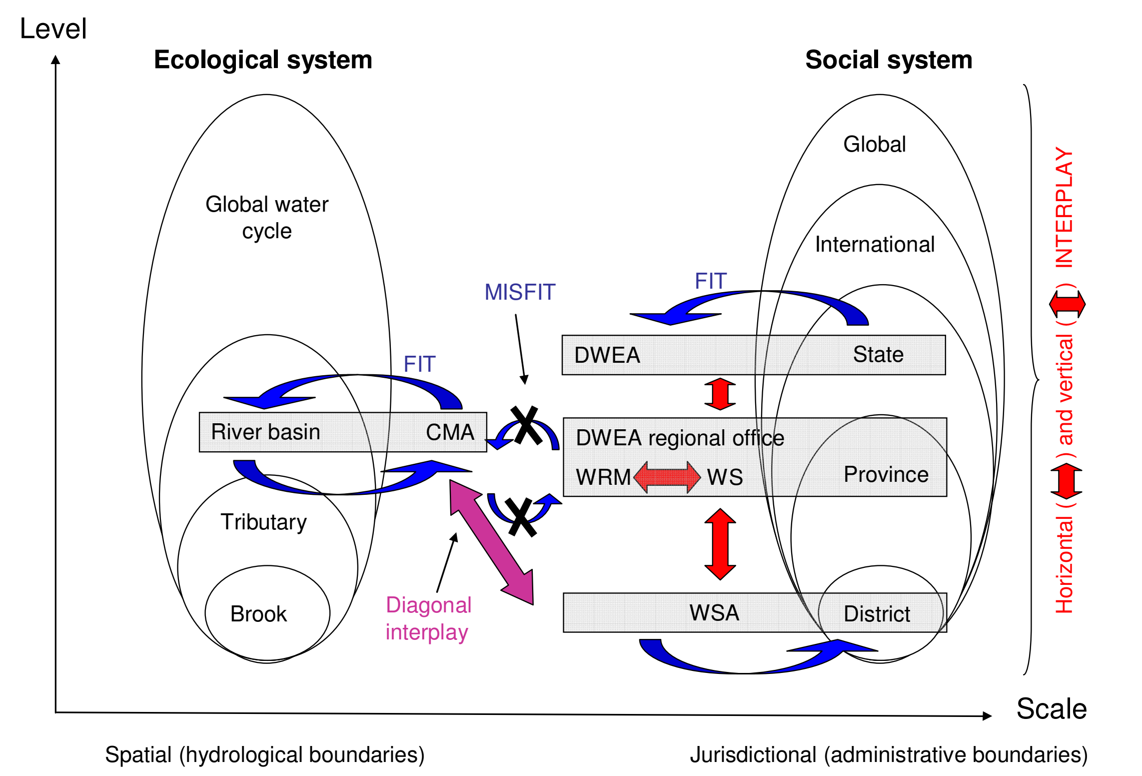
It has also been suggested by the DWA that some CMA tasks (such as water use licensing) be transferred from future CMA to local government agencies (field notes). But the licensing of water use is directly linked to the amount of water available within the catchment and is related more to hydrological than to administrative boundaries. Therefore such a step would not solve the problems of misfit, not to speak of the additional burden it would mean for an already overburdened local government.

Since a certain amount of misfit remains among the water management organisations, the improvement of interplay through intensive communication and cooperation is a key to overcoming the friction caused by the transition towards hydrological boundaries. This need for coordination and communication is underlined by the consequences of climate change and the uncertainty it entails regarding future water availability and extreme cli-

14 It is not clear if Internal Strategic Perspectives (ISPs) are used by other organisations such as local governments to support their planning.

mate events. It relates to the interplay within the water sector (divisions of DWA) and between the water sector and other sectors (e. g. CMA and local governments). The South African constitution underlines 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 / van Koppen 2001). Cooperation and communication between water service authorities (WSA) 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 most frictions occur at this level. CMA and WSA need to cooperate closely, which is also acknowledged in the National Water Resource Strategy: "*Relationships between the agencies* [CMA] *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. Water Services Development Plans) are required to comply with the contents of the Catchment Management Strategy of the CMA (James 2003). Interestingly, it is neither vertical interplay (between levels of administration) nor horizontal interplay (between organisations at the same level but on different scales) that is necessary in this context. Rather one should speak of diagonal interplay, since the interactions occur across levels (local – catchment) and on various scales (water resources – water services) simultaneously (see Figure 5).

Figure 5: The fit and misfit of hydrological boundaries



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5 Conclusion

South Africa has made progress in reforming its water sector. It has established a highly ambitious body of water legislation and is now struggling with its implementation. The situation in South Africa shows how difficult it is to implement basin management and delineate Water Management Areas 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 (Lehtonen / Karlsson 2006).

The effects of climate change are likely to aggravate these challenges. The increasing frequency of extreme events such as floods and droughts entails an even more uneven distribution of water availability across time, thus making a steady supply of water for social uses and sufficient water provision for the ecological system even more difficult. Rising temperatures (and thus increased evaporation of water bodies and evapotranspiration of plants) are going to 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 disposes of 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 realising 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 / Hardwick / Breen 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 governance and decentralised approach to water governance. The CMA concept includes these features of an adaptive water management and (if fully implemented) would thus be a useful instrument for increasing the adaptive capacity and resilience of the South African water governance. The fact that first impacts of climate change can already be detected in some parts of the country underlines the urgency of learning and building resilience. This is even more the case since the current experience with water sector reforms shows how long comprehensive institutional change takes.

The South African case exemplifies how complex management tasks 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 can not be resolved but addressed through a combination of intense communication, cooperation and coordinated action between the involved organisations.

Problems of fit, interplay and scale arise because of:

- Misfits on the spatial and jurisdictional scale (hydrological vs. 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.
- Misfits on the temporal scale. The delineation of Water Management Areas was undertaken without being able to establish CMA as the managing organisations in due time (leading to a functional mismatch). This has resulted in different stages of implementation of local government and CMA, mainly due to the slow and time consuming process of CMA implementation (problem of sequencing).
- Necessarily different rationales of the Catchment Management Strategies (sustainability and water availability) and the Water Service Development Plans (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 Water Service Development Plan) and water management (Catchment Management Strategies) are not harmonised. While the Water Service Development Plan is dealing with water demand, the Catchment Management Strategy 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 Water Management Areas and, where necessary, digressing from the hydrological principle to recognise necessities on other scales. The National Water Resource Strategy accordingly lists a number of factors that have influenced the delineation of Water Management Area boundaries, among them: institutional efficiency of CMA, self-sufficiency of CMA, 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 misfit also has to be tolerated regarding groundwater-surface water interaction and basin transfers.

It needs to be stressed, however, that the institutional boundaries of the organisations in place for water resource management and water services serve the requirements of their primary task, namely to manage the water resource in the case of the CMA, i. e. follow hydrological boundaries, and to provide water to municipalities, i. e. the need to follow and fit administrative boundaries. Thus the spatial fit between CMA and WSA is correct; it is rather the interplay between these organisations, which is problematic (even though the mismatch of spatial scales will prevail until all CMA 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 just as important. Similarly it is argued that an increased fit between resource boundaries and the organisations directly managing each resource might imply negative effects on the interplay of these organisations with other organisations (Lehtonen / Karlsson 2006). Such negative effects can be observed in South Africa concerning the horizontal interplay (e. g. between divisions of DWA or between WSA) and the diagonal interplay (between CMA/DWA and local governments). The lack of cooperation between divisions of DWA is likely to even increase once the CMA are established and become part of different organisations. Therefore DWA should attempt to overcome this division before CMA become operational. It has to be acknowledged that DWA is aware of these shortcomings. In its recent Water for Growth and Development Framework the importance of strengthening the institutional capacity especially at the level of the CMA is underlined (DWAF 2009b).

What can be learned from this with a view to the adaptive capacity of South African water governance? The new water legislation offers a good point of departure for making South African water governance more adaptive to climate change. The introduction of hydrological boundaries in the legislation in order to increase the fit between the resource and the institutions and organisations 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 CMA will be fully implemented and thus the potential for an increased adaptive capacity of water management realised. Apparently, large parts of the needed institutional arrangements for adaptive management (except for the CMA) 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. Communication seems to be one of the main deficits in the process. Therefore special effort needs to be made to address policy coordination and the integration of planning and coordination between departments and other organisations (de Coning 2006).

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

Fully functioning CMA 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 (Galaz et al. 2008). However, this increase in functional fit will not emerge automatically, but only if the diversity and complexity are used to foster multi-level and polycentric governance, learning from different sources and thus providing for innovative reactions in the face of surprises (Galaz et al. 2008). It is too early to judge, however, if in South Africa the decentralisation of water governance and the establishment of new governance units such as CMA and WUA will be used to increase the adaptive capacity of the water sector and its ability to cope with uncertainty and surprises, which are likely to increase with progressing climate change. If not used properly, these developments might just as well increase the complexity of the regime without increasing the adaptive capacity, thus slowing down the momentum of innovation instead (Galaz et al. 2008). Indications for this direction are thoughts about decreasing the number of CMA to match the number of DWA regional offices. This step could curb the future CMA' independence and room to manoeuvre even before they have been implemented.

In contrast to this, the implementation of CMA as envisaged in the National Water Act would be a step towards polycentric governance and thus potentially support the adaptive capacity of South African water governance. Once implemented and functioning properly, CMA could even have the potential to develop into so-called bridging organisations (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 regarding the adaptive management of water resources.

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

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