Scale and consequences – the limits of the river basin as a management unit

Mike Muller

ABSTRACT

Contrary to dominant paradigms, the river basin is not the obvious unit within which to undertake water management given the diversity of functions inherent in water resource management. The Southern African experience is presented to illustrate issues that may arise when using the river basin for different functions. Functions best addressed at a larger ‘problem-shed’ level are identified and it is explained why some other functions should rather be performed at smaller, sub-basin scales. Using recent work on water governance, which emphasise polycentricity and network governance, it is suggested that a better understanding of the appropriate scales for different functions will support activities such as planning, monitoring and the protection of the aquatic environment that may best be focused at river basin scale.

Key words | environmental management, river basin, social-ecological systems, Southern Africa, sustainable development, water resource management

INTRODUCTION

Much academic and practitioner-oriented literature focuses on the river basin as a unit of planning, management and governance. The ‘Dublin Principles’ stated unequivocally that ‘The most appropriate geographical entity for the planning and management of water resources is the river basin, including surface and groundwater’ (ICWE 1992). This was subsequently promoted by funding organisations as sanctioned discourse, not to be questioned.

This paper draws attention to the limits of the river basin as a geographic unit for water management and supports the emerging view that the river basin should not be the primary scale for water management. This does not deny the importance of the basin level but rather recognises that water resource management is most successful when it links effectively with the different scales at which interested parties operate.

The methodological approach is simple. Since form should follow function, the paper outlines the diverse range of functions that comprise water resource management. It then sets out issues of form, the different scales at which these functions might be performed. It then tests the suggestion for scales of management other than the river basin by reviewing the experience of different jurisdictions and geographies.

Water resource management is not a static activity. In this Anthropocene age, over 50% of landscapes have been significantly altered by human activity. Water resource systems have also been substantially altered, a trend that will continue as populations grow and societies get richer. The management of water resources must adapt to these broad processes and conventional wisdom, dominant paradigms and comfortable solutions are unlikely to provide the basis for addressing future challenges. South and Southern Africa provide ample evidence for this thesis and experience from this and other regions is presented in support of the paper’s arguments.
THE PURPOSE AND FUNCTIONS OF WATER RESOURCE MANAGEMENT

It is important to start with clarity about terminologies, distinguishing between ‘water governance’ and ‘water resources management’. One definition of ‘water resource management’ is ‘the activity of planning, developing, distributing and managing the optimum use of water resources’ with water uses for domestic and industrial purposes seen as part of a wider ‘water cycle’.

The Organisation for Economic Co-operation and Development (OECD) defines water governance as ‘the range of political, institutional and administrative rules, practices and processes (formal and informal) through which decisions are taken and implemented, stakeholders can articulate their interests and have their concerns considered, and decision-makers are held accountable for water management’ (OECD 2015: 5).

This could include a wide range of direct management activities. For the purpose of this paper, water resource management includes the governance of the activities undertaken. However, it differentiates between activities focused on the natural resource and activities undertaken to provide water-related services to specific users. This is consistent with the legal and institutional arrangements in many jurisdictions, including South Africa (South Africa 1998).

The management of water resources is intended to achieve goals which vary between societies and also change over time. So, the purpose of South Africa’s National Water Act is stated to be: ‘... to ensure that the nation’s water resources are protected, used, developed, conserved, managed and controlled’. In outlining the factors that have to be taken into account, it lists goals ranging from ‘meeting the basic human needs of present and future generations’, ‘promoting the efficient, sustainable and beneficial use of water in the public interest’, ‘protecting aquatic and associated ecosystems and their biological diversity’, ‘meeting international obligations’ and ‘managing floods and droughts’.

While details differ between jurisdictions, it helps to identify the generic set of activities that comprise the process of water resource management. These include, water resource:

- **planning,** which has to be undertaken in order to determine trends in resource use and availability, which will in turn inform the development of options to meet emerging needs and address resource protection;  
- **allocation,** which has to be undertaken on a systematic basis in order to ensure that water use achieves society’s objectives within the constraints imposed by the resource itself;  
- **development,** the construction of storage, transmission and treatment infrastructure to increase the amount of water available, transport it to where it is required as well as to maintain its quality;  
- **systems operation,** which grows in importance as the extent and complexity of infrastructure increases;  
- **protection,** taking into account society’s objectives in relation to the environmental condition of the resource;  
- **control,** to ensure that allocations are made and protection regulations are complied with and that systems are correctly operated in line with set rules.

Listing these goals and activities illustrates the complexity underlying the simple phrase ‘water resource management’ and the multiplicity of decisions and actions that need to be organised. Aside from overall questions of power, control and relationships between institutions and activities, a primary organisational consideration is the scale at which activities should be undertaken.

THE GEOGRAPHICAL SCALES FOR WATER MANAGEMENT

No single institutional arrangement serves the purposes of water resource management in different national contexts. The resource itself is dynamic and unpredictable requiring flexible, adaptive and resilient approaches to its management. A particular challenge is that the scales at which water flows and is used cut across political and administrative boundaries, areas of economic activity and through social and cultural groupings. This creates a difficult context for management.

One option for the scale at which water resource management functions can be organised is the physical river basin. (For the purposes of this paper, river basin...
catchment are used interchangeably.) But should large tributaries be considered basins in their own right, and managed separately to the main stream? Groundwater systems may have different boundaries to surface water. Under certain climatic conditions, water may flow between river basins.

Another obvious scale is that of political and administrative institutions such as local governments, states or provinces as well as national governments and their administrations. These institutions have formal governance and administrative structures in place and enjoy significant political legitimacy. Many perform water resource management functions; they may build dams for local supply, channel rivers for flood protection or navigation and often act to protect water resources from pollution.

Smaller units also have a place. A large municipality may encompass many small communities that use local water resources in different ways, whether for fishing, recreation, farming or domestic purposes (or any combination of these). These communities offer a useful scale for some water resource management functions. In agriculture, water user associations often allocate and control the water use of a group of farmers as well as managing their collective irrigation system.

Critically, the appropriate scale for particular functions is subject to changes in the wider context. Not only is there no obvious ‘right scale’ for a particular set of management functions but that scale may change over time as societies evolve.

HOW SCALE AND FUNCTION ARE MATCHED – THEORETICAL PERSPECTIVES ON PRACTICAL CHALLENGES

Water resource management has to effect the matrix of functions outlined above. Given a ‘clean slate’ opportunity, a generic approach would, first, specify the goals of management; determine the functions needed to achieve them; and consider the appropriate geographic scale at which to undertake them. In practice, account would be taken of available institutions as well as the feasibility of new organisational arrangements.

Even for a single function, this approach will often prove simplistic as the ‘allocation’ function illustrates. This requires decisions about who may use how much water, under what conditions. But the determination of available water requires analysis of data from long-term monitoring. Levels of assurance must be determined – while cities and major industries need very reliable supplies; farmers may accept a supply failure every 5 or 10 years. Environmental flows must be agreed, within a policy framework that is likely to change over time.

Water uses are no less complex – South Africa’s National Water Act (South Africa 1998 S:28) identifies 11 generic water uses, ranging from taking water from a resource to the use of the resource for recreational purposes. Some uses, such as irrigation, are inherently consumptive. Non-consumptive uses may return some flow to the resource, but in what quantities and at what quality? What are the existing uses and will they be affected by a new allocation or ‘licence to use’?

Given this scope, activities required for allocation are unlikely to be performed at a single scale. Collection, compilation and analysis of long-period datasets is often best centralised. Knowledge of actual water use must be gained on site. A local presence is needed to enforce allocation conditions but may be best at arm’s-length from the actual users, to ensure objectivity.

As a consequence, a range of institutions is often required. In South Africa, a national Department of Water monitors and compiles data on river flows and undertakes analysis to determine water availability. It also sets environmental flows, in consultation with relevant local stakeholders. This information enables a determination of how much water is available for allocation.

Operational information about water use typically comes from local institutions. For domestic and commercial supply, these may be municipalities or regional bulk service providers. Irrigation water is allocated to water user associations. These institutions can provide detailed information about water use within a bulk allocation from a national or river basin authority. In times of shortage, the local institutions will distribute bulk restrictions between their users (Muller 2012). Thus, just for the allocation function, a constellation of five potential institutions is identified, only one of which is at a river basin scale.

This pattern is repeated for many water resource management functions with overlapping responsibilities between institutions working at different scales. The
functions are often not conducive to neat divisions between overarching policy (national) and detailed implementation (local) since some specialised operational work may best be undertaken at a national level.

This complexity has been confirmed by Ostrom, who showed that complex ‘common pool’ systems of natural resources such as water were often best (and most effectively) managed by organised communities at the local level (Ostrom 1990). Her argument was simple: they know each other, can look over each other’s fences to see what neighbours are doing, and have a stronger incentive to make the system work than a distant administrator.

Ostrom suggested that groups like this should be encouraged and enabled to undertake self-management. But she also acknowledged that such systems could seldom operate in a vacuum and that local management usually needed support from other institutions, in a larger framework, forming what she called a ‘polycentric’ system. It might look chaotic but the presence of a variety of public and private agencies working at multiple scales had proved to be effective (Ostrom 2010) and was not necessarily dysfunctional. As she explained,

‘Polycentric systems are characterized by multiple governing authorities at differing scales rather than a monocentric unit. Each unit within a polycentric system exercises considerable independence to make norms and rules within a specific domain… Participants in a polycentric system have the advantage of using local knowledge and learning from others who are also engaged in trial-and-error learning processes. … No governance system is perfect, but polycentric systems have considerable advantages given their mechanisms for mutual monitoring, learning, and adaptation of better strategies over time.’

Ideally, organisational structures for water resource management would be guided by formal analysis, informed by the systematic frameworks offered by Ostrom (2011), supported by the application of the principle that ‘form follows function’. In practice, organisational form must also reflect power and interests (Gellerman 1990), leading organisations like the EU and the World Bank to use ‘political economy analysis’ (European Commission 2012) to understand contestation over institutional options for water management.

**DRIVERS OF RIVER BASIN APPROACHES**

This background helps to explain why river basin approaches have become so dominant over the past few decades and why they are now being challenged.

**Historical precedent for river basins as a scale of resource management**

Historical precedent is an obvious driver of basin approaches. From China to Egypt and Latin America, many great civilisations grew up along and around major rivers and the efforts to achieve control over the rivers have been seen as the very origin of the centralised state (Wittfogel 1953). It also made sense for water uses such as navigation to be governed within the frame of the river basin. Today’s Central Commission for Navigation on the Rhine (CCNR), one of the world’s first formal international organisations, was established to guarantee security of navigation on the Rhine in support of trade and economic activity. Yet this river basin focus was soon blurred. The CCNR’s management functions changed over time as European inland navigation ceased to be a function of natural waterways. With European river basins now linked by canal networks, inland navigation is managed at national and regional scales rather than at basin scale.

Twentieth-century expansion of colonial settlement in the USA confronted challenges of water availability which further reduced the primacy of the river basin. The development of inter-basin transfers in the western USA is well known and documented. The limits of the river basin as a management scale are also illustrated by the Tennessee Valley Authority (TVA) programme. While often presented as an icon of river-basin-scale management, the TVA’s history presents a different perspective. It was established in 1933, part of Roosevelt’s ‘New Deal’ to promote economic activity in impoverished regions. While many economic activities were the mandate of state governments, the TVA’s navigation and flood protection functions enabled wider federal government intervention,
since these functions crossed state boundaries (Jones 1961; Schaffer 1984).

When Roosevelt appointed experts to consider the appropriate scale for further regional development efforts, they found few points of agreement, save for the conclusion that ‘... except for a narrow range of development operations, the river basin is one of the poorest types of units which might be selected.’ But, as Meyer & Foster (2000) observe, this advice was ignored by the Federal government, which had taken the river basin development path for legal and constitutional reasons rather than because of any inherent technical logic.

A similar study 60 years later considered how the boundaries of governance regions could best be configured to support the new political priority of environmental management. The river basin again fared poorly. Some respondents even suggested that the river basin as a management scale was an idea whose time had gone (Foster & Meyer 2000). One problem was that:

‘Most of the definitions of ecological regions did not account for human variables, or included them only as forces needing to be regulated in order to prevent disruptions of the ideal ecological patterns.’

This conclusion mirrors the growing critique of the use of river basin scales as the basic unit of water resource management. It puts the natural resource at the centre and treats human activity as an impact and disruption to be controlled. This does not reflect the priorities of most modern societies.

**Environment, development and Dublin’s ‘integrated water resource management’ (IWRM)**

So why then the 1992 turn to the river basin as ‘the most appropriate geographical entity for the planning and management of water resources’? The 1977 UN Mar del Plata Conference on Water had already suggested a broad institutional architecture in which certain functions would be undertaken at basin level with others managed within political jurisdictions, local and national:

‘Dublin IWRM’ with its basin management focus emerged at the 1992 World Summit on Sustainable Development (WSSD), at a time of acute tension between the developmental objectives of poorer countries and the environmental objectives of richer countries. The focus on the basin as the primary scale of management was a key difference between Agenda 21, the agreed WSSD conclusions, and the proposals of a preparatory expert meeting in Dublin. (Other areas of difference included the status of water as an economic good, the role of infrastructure development and the extent of ‘stakeholder’ participation water management.) However, the ‘Dublin Principles’ were subsequently adopted as policy by many developed country donors’ (Muller 2015).

**The scale/participation nexus in environmental governance – scaling for exclusivity**

The Dublin version of IWRM reflected the efforts of environmental organisations to develop water governance approaches whose scales would strengthen their influence by privileging the involvement of groups that supported their agendas. The logic was that many interest groups would participate in economic development planning processes that include water-resource-related issues. In such processes, environment and water actors would have limited impact. However, fewer non-water actors would join processes focused solely on water resource management, even though their proposals would often have extensive social and economic impacts.

The scale at which issues are considered, and the exclusion that could be achieved by changing the scale, helps to explain the enthusiasm for river basin organisations and the reported dominance of science by advocacy (Mukhtarov & Gerlak 2013). Aside from Foster & Meyer’s (2000) longitudinal review in the USA, there is substantial literature on the desirability of conducting environmental governance within environmental regions (Bäckstrand et al. 2010; Elliott 2011; Giraut 2011). The strategy behind the participation/scale nexus became increasingly overt with the World Commission on Dams, described by activist academics as ‘an experiment in decentering the authority of the state in world politics’ (McCully 2001; Conca 2002). These authors stated as a goal, the achievement of management scales...
that would give greater priority to environmental protection than to resource development and use. Conca’s water governance objective was the development of ‘instruments of governance without government’ to stop people from ‘pushing rivers around’ (Conca 2006).

However, this political advantage of the river basin scale could not trump other considerations. The Global Environmental Facility was encouraged to recognise the limitations of their river- and regional-based approach (Söderbaum & Granit 2014). Other scholars called for a more careful consideration of the implications of environmental regionalism and governance (Balsiger 2011).

The ‘special case’ of trans-boundary rivers

As global recognition of the limits of the river basin approach grew at national level, environmental advocates turned to the regional scale and focused on trans-boundary rivers, shared between a number of sovereign countries (Conca 2012). These present a special case. Each country will eventually be affected to some degree by the other’s water resource management activities. In such circumstances, there is an obvious need to share information, coordinate action and, in some cases, to agree on limits to the action of individual countries.

One response was to promote the establishment of international river basin organisations. However, the powers and functions of these organisations were contested. In the 1990s, attempts were made to give them ‘super-sovereign’ powers to set and enforce water resource management policy across countries. One example of this was the Southern African Development Community (SADC) Protocol on Shared Rivers which sought to establish River Basin Commissions and Authorities for all shared rivers, with extensive powers over many elements of water resource management (SADC 1995).

This prescriptive approach reflected negotiations on the UN Convention on International Watercourses where, despite intense lobbying from environmental interest groups, it was rejected (McCaffrey 2001). The SADC Protocol was subsequently amended to reflect a more flexible approach which simply encouraged countries to develop appropriate institutions for cooperation and coordination (SADC 2000). SADC provides examples of the efforts to use a river basin focus to enforce environmental constraints on national development activities. The Okavango is the region’s third largest river, whose waters are almost entirely unused. Although the Okavango River Commission (OKACOM) comprises the three member states, its activities depend heavily on external support. Through this external channel, a programme was promoted explicitly focusing on the ‘people of the river’ as key stakeholders (OKACOM 2017). This definition excluded from participation in water management hundreds of thousands of people in Angola, Namibia and Botswana who could benefit from the use of the river but who lived outside its physical catchment.

Evidence now suggests that, in many contexts, the basin scale is of limited relevance for management decision-making. One carefully documented example is the highly contested Euphrates River where three overlapping scales have been identified – national states, ethnic group areas and the river basins. Here, it has been asserted that ‘the river basin scale is largely nonfunctional … the real negotiation processes and power struggles do not take place at river basin scale, but in different arenas at different scales, aptly described by the concept of polycentricity, a concept now widely applied for basins like the Rhine and Mekong’ (Warner et al. 2014).

This supports broader perspectives from the field of inter-governmental cooperation where it has been noted that negotiations are often easier if there is a package of items under discussion, since this enables cross-sectoral trade-offs to be made. In consequence, even international organisations like the IUCN, which often focuses its work at a river basin level, acknowledge that ‘… often the level of political integration is not there’ (Jackson 2011).

The social-ecological system is a ‘problem-shed’ not the watershed

Given the evident constraints, it is not surprising that alternatives have emerged to the river basin as the preferred scale for water resource management. A helpful suggestion is that management should be focused on a ‘problem-shed’ rather than a ‘watershed’. This concept arose in the USA, where in 1981, most river basin commissions were disbanded. As Light & Wodraska (1990) describe,
‘…there were 18 federal agencies in 7 departments and 7 independent agencies, and 25 separate water programs with some 70 separate appropriations accounts. In Congress there are 23 committees and subcommittees. Federal rules and regulations now number around 200. There are reportedly 123 interstate compacts dealing with water appropriations, bridges, ports, and environmental protection. At the state and local level, experts have tabulated over 100,000 entities of every size and description engaged in some aspect of water management.’

They suggested that ‘…new ways must be envisioned for multiple governments and agencies to work collaboratively in policy areas that are “greater-than-local,” “problemshed,” or “systems level” in perspective and design. Once formed, such structures must support rather than frustrate or impede the water resource solutions which can protect and preserve our nation in the future’ (Light & Wodraska 1990).

This concept, theoretically akin to Ostrom’s formal ‘polycentricism’, has been widely commended. The Harvard review of environmental regions noted ‘… the need for flexibility and variety in regional arrangements, and the tendency of different environmental processes and problems to occur within different “problem-sheds” (Meyer & Foster 2000). This conclusion has been supported by the emergence of the socio-ecological system as a broad paradigm through which to interrogate the interaction between people and the natural environment and is further reinforced by the emergence of systems of network governance (Rhodes 2007).

This approach reflects current practice in South Africa where the patterns of resource utilisation do not match the boundaries of river systems (Jacobs 2010) and where water management is organised around demand centres rather than around basins. One example is the Lesotho Highlands Water Project, jointly implemented by Lesotho and South Africa rather than with the involvement of the Orange-Senqu River basin organisation to serve an area that encompasses four major river catchments. Another is the current Songwe River development between Tanzania and Malawi, a tributary of the Zambezi which, because it flows into Lake Malawi, is not even discussed as a Zambezi River project.

CONCLUSIONS: THERE IS STILL NO GENERIC CASE FOR RIVER BASIN MANAGEMENT

This review suggests that there is no generic reason for water resource management to be undertaken primarily at river basin level. This finding simply restates the conclusions reached in the USA in the 1930s, at the Mar del Plata UN Conference on Water in the 1970s and even the WSSD’s Agenda 21. Yet, following the 1992 WSSD, these conclusions were ignored. In the international context, river-basin-focused approaches were strongly promoted.

This is now changing, as witnessed by the conclusion of the OECD that, given the complexity of water resource management and the variety of different contexts and social preferences under which it is undertaken, there can be no single prescription for the approach to be adopted. While some water resource management functions should be performed at the scale of the river basin, many others should not and river basin institutions should not be assumed to be the primary focus of water resource management. Local allocation and control may best be exercised at the level of individual schemes or river reaches and tributaries. Overall allocation frameworks can be set by national government. Levels of environmental protection should be set by the people affected, who may be in a small local area within a river basin or include large communities outside its boundaries. Finally, rather than promoting institutional structures that will be amenable to their priorities, environmentalists seeking to protect aquatic ecosystems should accept that they are just one group of many with legitimate interests in the management of water resources as complex systems.

REFERENCES


Gellerman, S. W. 1990 *In organizations, as in architecture, form follows function*. *Organisational Dynamics* **18** (3), 57–68. doi: 10.1016/0090-2616(90)90064-V.


First received 3 February 2018; accepted in revised form 24 May 2018. Available online 8 June 2018.