The future of urban water management in South Africa: achieving water sensitivity
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ABSTRACT

South Africa (RSA) is a water scarce country challenged with transforming its unsustainably resource-intensive economy whilst also addressing the legacy of Apartheid. The adequate provision of water to RSA’s citizens is one of the most significant challenges facing the country – and if a water crisis is to be averted, existing systems will need to be managed effectively. This will include ensuring that the plans and strategies within each sector related to water management – e.g. the National Development Plan (NDP) and the National Water Resource Strategy 2 (NWRS-2) – are aimed towards a common goal. This paper introduces a framework for achieving water sensitive settlements in RSA; defines what ‘water sensitivity’ means within the SA context; and discusses the relevance of this framework in relation to the NWRS-2 and the NDP, both of which could be seen as providing a complementary vision for the management of specific aspects of water resources management in RSA. The paper concludes by motivating for the adoption of the framework as a means of meeting the challenges facing the urban water management sector in SA and the goals embedded in the NDP and NWRS-2.

Key words | National Water Resource Strategy 2 (NWRS-2), urban water, water sensitive settlement (WSS), Water Sensitive Urban Design (WSUD)

INTRODUCTION

South Africa (RSA) is a water scarce country challenged with transforming its unsustainably resource-intensive economy whilst also addressing the legacy of Apartheid (DWA 2013). The adequate provision of water to RSA’s citizens is one of the most significant challenges facing the country. If a water crisis is to be averted, existing systems will need to be managed effectively (Muller et al. 2009), in terms of quantity of resources as well as quality. This is particularly relevant in the rapidly urbanising areas owing to the fact that they are hubs of economic growth, and could without proper management become major drivers for increased water demand. The various existing plans and strategies within the different sectors related to urban water thus need to be aligned to ensure that they are aimed towards a common goal of decoupling future economic growth from resource consumption. Two important documents have recently been released in RSA which should be used to guide management of the water sector. The first is the National Development Plan (NDP), issued by the National Planning Commission (RSA 2011a) with the aim of setting an overarching plan to eliminate poverty and reduce inequality. The second – the National Water Resource Strategy 2 (NWRS-2), published by the Department of Water Affairs – ‘sets the strategic direction for water resources management in the country over the next 20 years, with a particular focus on priorities and objectives for the period 2013–2017’ (DWA 2013). A third potentially important document, the draft framework for transitioning to water sensitive settlements (WSSs) in RSA (hereafter referred to as the Framework), was released during the same period (Fisher-Jeffes et al. 2012a). The Framework is being developed as part of a South African Water Research Commission (WRC) project aimed at contextualising Water Sensitive Urban Design (WSUD) for a developing

doi: 10.2166/ws.2014.060
country such as RSA and presenting a vision for the future of urban water management in the country. This paper explores how these three documents relate to each other and concludes by motivating for the adoption of the Framework as a means of meeting the challenges facing the urban water management sector, and achieving the goals of the NDP and the NWRS-2 with respect to urban areas in RSA.

**URBAN WATER MANAGEMENT AND THE NATIONAL DEVELOPMENT PLAN (NDP)**

The Diagnostic Report of the National Planning Commission sets out RSA’s achievements and shortcomings since 1994 – and highlights major developmental challenges in terms of inadequate infrastructure, poor quality education, high levels of unemployment, a resource-intensive economy, a failing public health system, poor quality public services and high levels of corruption (RSA 201b). The report acknowledges that the country should approach development differently, with growth and development, and reducing poverty and inequality, as core elements: ‘It requires shifting from a paradigm of entitlement to a development paradigm that promotes the development of capabilities, the creation of opportunities and the participation of all citizens’ (RSA 201b). In other words, the new approach requires that people are active champions of their own development, and that government should work to develop the capabilities required, and provide the opportunities for people to live the lives they desire.

The NDP’s vision in respect of water services focuses on the alignment of the country’s social and economic development with available water resources, and the protection of the natural environment through the prevention of excessive abstraction and pollution (RSA 201a). Amongst others, it states that: ‘Before 2030, all South Africans will have affordable access to sufficient, safe water and hygienic sanitation to live healthy and dignified lives …. The country’s economic and social development will reflect an understanding of and an alignment with available water resources … All main urban centres will have a reliable supply of water to meet their needs … The natural water environment will be protected to prevent excessive abstraction and pollution’. It is important to note that this does not mean that economic growth is necessarily coupled with water demand; rather that RSA needs to find innovative ways of decoupling growth from the consumption of resources. Urban centres are not guaranteed unlimited access to water, but access that is ‘sufficient’, ‘reliable’, and that will ‘affordably meet their needs’. As will be discussed in the following section, it is intended that the goals of the NDP will be met through implementation of the second National Water Resources Strategy (NWRS-2) document (DWA 2013).

**THE NATIONAL WATER RESOURCE STRATEGY**

‘South Africa, despite being a freshwater-scarce country, has sufficient water resources potential to meet its short to medium term requirements. The key challenge … is about mastering the art and science of unlocking potential resources, ensuring timeous accessibility, facilitating sector and business viability, ensuring sustainable water delivery and management as well as effective governance’ (DWA 2013). Much has changed in the RSA water sector in the two decades since 1994, with substantial new policy and legislation providing a progressive water management framework. However, implementation has been slow, particularly in relation to equity and redress in access to water, and water conservation and demand management. The 1st National Water Resource Strategy (NWRS-1), published in 2004 in response to the National Water Act (Act 36 of 1998), has recently been re-drafted as the 2nd National Water Resource Strategy (NWRS-2). Similar to the first edition which set out the ‘blue print’ for Integrated Water Resource Management (IWRM), the NWRS-2 provides an overview of the state of RSA’s water resources, the challenges and opportunities facing the water sector, and sets out the strategic direction for water resources management in the country over the next 20 years, with a particular focus on priorities and objectives for the 5-year period 2013–2017 (DWA 2013). It is the primary mechanism to manage water across all sectors towards achieving Government's development objectives. In particular it addresses concerns that RSA’s socio-economic growth will potentially be restricted if water security, resource quality and associated water management issues are not resolved. The vision underpinning the NWRS-2 is centred on the notion of
A healthy, ecologically sustainable and protected water environment, and includes the following (DWA 2013):

- A democratic, people-centred nation with equitable social and economic development enabled through equitable, sustainable and effective water management.
- Water valued and recognised as a strategic national asset and fulfilling its central role in society and the economy.
- A prosperous society enjoying the benefits of clean water and hygienic sanitation services.
- A healthy, ecologically sustainable and protected water environment.

This vision reflects and builds upon the principles of equity, efficiency and environmental sustainability that underpin the National Water Policy and National Water Act, both of which are founded on the principles of IWRM.

‘Although the regulatory framework and institutional arrangements have changed since the advent of democracy, one aspect remains constant: water scarcity – whether quantitative, qualitative or both – which originates as much from inefficient use and poor management as from real physical limits and the potential impacts of climate change’ (DWA 2013). The NWRS-2 has attempted to address this issue through identifying five key management approaches, i.e. responding to specific socio-economic drivers; implementing a resource mix; ensuring access to water through effective implementation arrangements; sustainable service delivery through effective business management; and sustainable resource management through effective protection and conservation and proficient governance. There are several challenges with these approaches, however, including a lack of ownership and accountability with respect to water and the fact that the role and status of water are not appreciated by many people. Inadequate funding and limited capacity are key problems in the management of water in RSA (Fisher-Jeffes et al. 2012b; DWA 2013). Specific interventions have been highlighted for the facilitation of the NWRS-2 vision in the short to medium term and to avert a potential water crisis. Eleven over-arching core strategies are identified to address water resource concerns and guide future water management and development in the country (DWA 2013). These core strategies comprise the framework and context for a large number of very specific strategic actions to be undertaken across the water and related sectors over the 5-year period 2013-2017.

**FRAMEWORK FOR TRANSITIONING TO WATER SENSITIVE SETTLEMENTS**

In partial response to the NWRS, the WRC of South Africa appointed the Urban Water Management research unit at the University of Cape Town in 2010 to develop guidelines for WSUD in South Africa – including a suitable theoretical framework. The research team used the conceptual urban water management transitions framework developed by Brown et al. (2009) for visualising and ‘benchmarking’ evolution towards a Water Sensitive City (WSC) through adoption of WSUD as a starting point. However, whilst the WSC vision is relevant to RSA and may assist in addressing some of the challenges facing the country’s water sector, it needs to be contextualised for the unique development challenges RSA faces. This includes expanding the definition of ‘city’ to include a broad range of settlement types so as to motivate for adopting a context-specific vision for WSS. It also requires clear recognition of how various stakeholders might work collaboratively to address the range of water security concerns facing the country. As a consequence, the new urban water management framework for RSA was developed with the assistance of key experts and stakeholders in academia, industry and local government through a series of workshops and individual interviews as described below.

A key finding was that the concept of ‘water sensitive’, and the challenges and opportunities for ‘water sensitivity’, are context specific and that the tools and designs developed for/in RSA and other developing countries will likely vary from those implemented in developed countries.

**Development of the Framework**

The Framework was developed between 2011 and 2013 as detailed in Armitage et al. (2014) using a form of Learning Alliance (LA) approach – which may be described as ‘bring(ing) together a range of complementary actors to discuss complex issues and look for ways forward’ (Butterworth et al. 2011). The LA comprised researchers and academics from: the Universities of Cape Town,
Stellenbosch and the Witwatersrand, representatives from industry, and municipal officials from the Cities of Cape Town, eThekwini (Durban), Johannesburg and Tshwane (Pretoria). Individual interviews were also undertaken with officials from these four cities.

The LA’s collective and extended discussions took place over approximately 15 meetings. All meetings were documented and minutes circulated to the entire LA via the project website and by email. Members were encouraged to comment and submit suggestions. These were then reviewed and, where considered appropriate, incorporated into the Framework.

Water sensitivity and WSS

Water sensitivity in RSA is defined in Armitage et al. (2014) as the management of the country’s urban water resources – through the integration of the various disciplines of engineering, social and environmental sciences – based on the following five principles selected from the National Water Act (RSA 1998), the NWRS-2, the RSA Constitution (RSA 1996) and the Dublin Principles (UN 1992):

- RSA is a water scarce country.
- Access to adequate potable water is a basic human right.
- Management of water to be based on a participatory approach involving stakeholders at all levels.
- Water has an economic value in all its competing uses and should be recognised as an economic good – including the recognition of ecosystem’s provision of goods and services.
- Water is a finite and vulnerable resource, essential to sustaining all life and supporting development and the environment at large.

A WSS is thus one where water is managed and treated in a manner which reflects the principles of water sensitivity. Historically, water systems have been developed using a linear design approach, i.e. source, treat, transport, distribute, collect, treat and dispose. This technologically-driven and resource-intensive approach is removed from the citizens it serves, resulting in technocratic solutions and the fragmentation of the management of the urban water cycle. WSSs require a cyclical, systems approach which, in simple terms, assumes that everything in the world is connected.

The Framework

The Framework has four complementary components as follows.

Research component. On-going research, as well as capacity building, is needed to develop RSA-relevant guidelines for the realisation of WSSs. The notion of the ‘4T’ approach (tools, transfer, tactics and trials) was thus conceptualised as a useful, cyclical strategy to support the promotion and adoption of WSUD (Armitage et al. 2014). It includes the: on-going development of tools (manuals, guidelines, etc.); transfer of knowledge to appropriate officials; adoption of various tactics for encouraging WSUD implementation (such as the adopting of new policies relating to urban water management within individual cities); and testing through various trials (pilot studies, small-scale developments, etc.).

Vision component. The Brown et al. (2009) framework postulates six transition states for urban water management – with their associated socio-political drivers and delivery functions – that are used to underpin the development of policy and to benchmark a city’s progress (either forwards or backwards) at a macro scale. Most formally-developed areas in RSA cities fit their classification of ‘drained cities’. Probably as a consequence of being envisaged mostly for cities in the developed world, the Brown et al. (2009) transition framework, however, does not take into account the impact of a number of uniquely RSA factors (Fisher-Jeffes et al. 2012b), e.g. the legacy of Apartheid – that resulted in significant backlogs in infrastructure to large segments of the population, resulting in, e.g., poorly-serviced informal settlements – that the government is attempting to address. It has thus been adapted for the RSA context as shown in Figure 1.

Figure 1 provides a vision of how it may be possible to effect the transition of both formal and informal areas as follows.

- Formal (brownfield) areas: Currently developed as drained settlements, these areas should attempt to transition through retrofitting in a water sensitive manner.
- Informal areas (currently developed as water supply settlements with limited sanitation): Should be developed in as water sensitive a manner as possible, negating the need at a later stage to retrofit. The use of water sensitive
technologies could also result in a range of secondary benefits for these communities, e.g. employment (see WHO 2007).

- Greenfield developments: Should be done in as water sensitive manner as possible from the outset.

**Implementation component.** The various aspects required for transitioning towards WSSs are: policy development; the establishment of more appropriate institutional structures; community participation; construction of infrastructure; and operation and maintenance. One very important consideration in RSA is how to effect the transition in the context of limited resources – both human and financial. It would be unreasonable to expect a municipality with limited funding and capacity to immediately retrofit all of its urban water systems. Using the analogy of Maslow’s hierarchy of needs (Maslow 1943), municipalities need to ensure that they are at least meeting the physical water needs of their residents whilst attempting to provide services which help transition to the ultimate goal: water sensitive settlements. A municipality cannot be expected to focus on establishing ecosystem sustainability and intergenerational equity unless it can simultaneously provide adequate and safe water to its citizens. Where it is not possible to incorporate the principles of water sensitivity (for example, the emergency provision of water services), municipalities should target their initiatives with the underlying philosophy of: ‘Do what you can with what you have’. Municipalities can therefore begin by strengthening local legislation and regulations to encourage this transition.

**Narrative component.** Narratives ‘... simplify and offer a stable vision and interpretation of reality and are able to rally diverse people around particular story lines’ (Molle 2008). This narrative expresses why a WSS is needed; how it can be implemented; and what the outcome should be. The WSS narrative for RSA has been developed to tie together the other three components of the Framework, so that at the very least all stakeholders should understand and engage with the idea of a WSS as follows:

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**Figure 1** | RSA’s transition to WSSs: ‘two histories, one future’ (adapted from Brown et al. 2009).

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DISCUSSION

The NDP envisages ‘a South Africa where everyone feels free yet bonded to others; where everyone embraces their full potential, a country where opportunity is determined not by birth, but by ability, education and hard work’ (RSA 2011a). The NWRS-2’s vision ‘reflects and builds upon the principles of equity, efficiency and environmental sustainability that underpin the National Water Policy and National Water Act’ (DWA 2013). Both the NWRS-2 and the NDP propose the adoption of ‘developmental water management’, where water is a crucial aspect of equitable social and economic development and where Government has a critical role in ensuring that this takes place (DWA 2013). Despite this, and a general acknowledgement that RSA is a water stressed country, water resources are still not receiving the priority status and attention they deserve (DWA 2013). The NWRS-2 and the Framework both note that by adopting a more holistic approach towards water availability, use and management, water resources can be defined in a much broader context. This will, however, require that the NWRS-2 is developed further and implemented with strong scientific support, good social dynamics analysis and innovative technological and systems solutions (Naidoo 2013). An increased emphasis on the creation of water sensitive settlements is therefore inevitable, as visualised in the Framework.

Water resources and total water cycle management

While water security is a major concern, there is no reason why RSA should experience a water crisis provided that existing systems are managed effectively (Muller et al. 2009). Department of Water Affairs (DWA) recognises that traditional water management approaches are insufficient to deal with the growing water demand and the increasingly complex water sector (DWA 2013). The promotion of water use efficiency, demand management, improved water governance, optimisation of existing water resources including groundwater and seawater, rainwater harvesting, reuse of water, resource protection and recharge, should result in RSA having adequate water resource potential to meet its requirements (DWA 2013). However, the NWRS-2 has taken a high level, traditional approach to water resource management. The focus has been on ensuring adequate water for growth, with desalination implied as the next option for bulk water supply. The NWRS-2 highlights the need to include alternative water sources in its bulk water calculations, but this seems to be little more than an unsupported statement designed to avert criticism for not considering alternatives to surface water. Further, the possible alternatives for supplying urban areas are not considered in any depth; for example, ‘the DWA has therefore focused its planning efforts on the metropolitan areas where the needs are most urgent’ (DWA 2013 p. 10), but there is no explicit strategic plan in the NWRS-2. In terms of water demand the NDP does not make provision for water for all desired uses; rather that there should be sufficient water to meet the needs of people at an affordable price, without negative impact on the environment. It is worth questioning, therefore, why the NWRS-2 has such a clear argument for desalination – which the NWRS-2 notes as expensive. At the same time there is limited focus on rainwater harvesting, and no consideration of the potential of stormwater as a resource. As a result, the significant impacts and consequences of urban runoff/stormwater and the potential to use strategies such as Sustainable Drainage Systems (SuDS) are not considered in the NWRS-2.

The NWRS-2 does not provide an adequately comprehensive approach to managing the total water cycle. Whilst the Framework does not discuss the different
alternative resources – based on the fact that it is simply a framework – the WSUD approach it motivates for encourages water management authorities to find fit-for-purpose solutions that recognise the importance of the total water cycle and its impacts on other sectors. This is important, as finding innovative solutions to ensure water security is unlikely be a ‘one size fits all’ solution. Instead a ‘fit-for-purpose’ approach to WSSs is required. The NWRS-2 should include the concepts of WSUD and WSSs as a critical component of the strategy that deals with the planning, design and development of cities.

**Economics**

The NWRS-2 discusses the total economic value of water and the need to cover total costs, but this is undermined by its failure to consider stormwater management and highlight the total economic costs of alternative water sources within the strategy. Also, municipalities currently face significant funding shortfalls and many costs are effectively externalised on to the environment – but the NWRS-2 ignores both of these considerations. While the NWRS-2 details the economic theory relevant to the water sector, practically it fails to address the complexities of the urban environment. The shift of focus to WSSs advanced by the Framework has the potential to address this weakness.

**Water-Energy-Food nexus**

The NWRS-2 briefly highlights the challenges relating to the Water-Food-Energy nexus; i.e. balancing the need to ensure food and water security and energy with the need for social development. It mentions the possibility of importing food, resulting in a reduced need for irrigation (DWA 2015), but this could decrease the country’s food security. The generation of energy is water intensive. Therefore the use of energy intensive methods – such as desalination – to produce water is a counterproductive approach in a water-stressed country. Furthermore, RSA already faces an energy crisis, so using energy intensive methods to generate potable water will exacerbate this and effectively decrease water security. It is therefore important, once again, that the ‘fit-for-purpose’ approach to water management central to WSS and WSUD is adopted. WSUD aims to take advantage of ecosystem goods and services by ‘greening’ cities. One advantage of ‘greening’ is its impact on the heat island effect (Coutts et al. 2012), resulting in a reduction in energy consumption for cooling. In this case the adoption of the WSS vision would speak directly to the NWRS-2 call for integrated planning.

**Capacity building**

The NDP, NWRS-2 and Framework all agree that there is a need to develop capacity if RSA is to implement any of these strategies. The NWRS-2 further identifies that the successful implementation of the strategy will depend on, *inter alia*, gathering adequate and reliable information; adhering to adopted policies and procedures; and the deployment of appropriately skilled people. The Framework suggests that there is a need to develop the tools, transfer the knowledge, encourage implementation through various tactics, e.g. the requirement to meet given water quality criteria, and undertake trials to test new technologies and approaches. None of the documents, however, provides guidance as to how or who will be responsible for co-ordinating these activities. The role of a regulator, or research and educational co-ordinator, may be necessary.

**What the Framework for transitioning to WSS in RSA offers**

The Framework for transitioning to WSSs offers RSA an idealistic goal to which urban water systems should aim. Further, it provides a path for moving towards achieving this. While it may never be possible to fully achieve this ultimate objective, having a vision ensures that alternatives to conventional urban water management systems will always be considered, e.g. stormwater harvesting versus desalination. In other words, local authorities are encouraged to continuously attempt to improve urban water planning, design and management in order to move ‘closer’ to achieving WSSs. The Framework encourages water management authorities to consider water as a vital resource, and one which is used in a ‘fit-for-purpose’ manner. The research, vision, implementation and narrative approaches can be used to engage the various stakeholders in an effort to manage the many challenges facing the country’s urban
Water sector by developing multi-functional urban areas that are resilient and adaptable to change, as well as addressing development and equity issues. The Framework has been developed to specifically encourage inter- and trans-disciplinary work. The narrative is central to this, whilst allowing sufficient room for individuals to develop context-specific innovative solutions.

CONCLUSION

Water underpins the socio-economic development of RSA; a reliable supply of water in sufficient quantities at the desired quality is critical to economic growth, social development and job creation (DWA 2015). The adequate provision of water to RSA’s citizens is one of the most significant challenges facing the country. Numerous authors have highlighted the devastating consequences water shortages will have on the country’s economy and its citizens in general. It is therefore important that water is optimally managed in all sectors and at all levels within RSA. It is also important that the plans and strategies within each sector and at all levels work towards a common goal which will ensure water security.

The NDP, NWRS-2 and Framework all provide input into the management of water resources in RSA. Each document should be seen within the context in which it was developed, but together they provide a comprehensive vision for the future management of water resources in RSA. The NDP sets a broad strategy and a number of ambitious goals for the development of a desirable future for RSA. Water is one component, but the document does not, and is not meant to, deal with the details of managing water. It does, however, include providing affordable, sufficient and safe water to meet the needs of the population while ensuring limited negative environmental impacts. The NWRS2 addresses many of these goals from a national perspective and provides a strategy for managing the water resources of the country at a catchment scale (through the implementation of catchment management agencies). It does not deal with, or set a vision for, the management of water within an urban setting, however. The Framework focuses on urban water management – a sector which is inadequately dealt with in the NWRS2 – and sets a vision for transforming RSA’s towns and cities into WSSs in line with the ideals of both the NDP and NWRS-2. In future revisions to the NWRS-2, the Framework should be incorporated and a greater focus should be placed on urban water management.

There is a need for national government (through the DWA) to offer guidance, capacity and policies to support local authorities in the planning and design of urban settlements. The Framework – were it to be adopted by the DWA as the vision for managing urbanised areas in RSA – is the first step. It sets the vision and addresses how RSA can move forward in terms of achieving this vision. The Framework offers a means to: improve the protection and restoration of urban environments; safeguard water security; enhance public health and economic sustainability in the urban setting; increase social and institutional investment into urban water management; and actively lead in exploring a suite of appropriate, sustainable social technologies in a transition to water sensitive settlements. It is worth noting that whilst the Framework being developed is specifically geared for the RSA context, the lessons learnt from this process can be widely applied in other developing countries facing similar challenges (e.g. limited capacity, limited resources, etc.). This research has highlighted the importance of fully understanding the context, especially in developing countries which attempt to adopt concepts of holistic and integrated water management practices – however valid – being advanced in developed countries. WSSs have been proposed as the ultimate objective, but what this means in different country contexts is important and, as such, defining key terms and determining the linkages to relevant policy and strategies within the context is crucial.

ACKNOWLEDGEMENT

This research has been funded by the South African WRC under Contract No. K5/2071.

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First received 3 July 2013; accepted in revised form 19 May 2014. Available online 4 June 2014