This paper is part of the Proceedings of the 3rd International Conference on Design, Construction, Maintenance, Monitoring and Control of Urban Water Systems (UW 2016)
www.witconferences.com

Water sensitive cities in South Africa: developing a Community of Practice

K. Carden, D. Ellis & N. P. Armitage
Urban Water Management Research Unit,
University of Cape Town, South Africa

Abstract

South Africa is a rapidly-urbanising developing country with complex water management challenges, both in terms of significant resource shortages as well as access to water-based services, with associated negative impacts on surface and groundwater quality. Alternative approaches to conventional water management which aim to facilitate a change from 'water-wasteful' to 'water-sensitive' environments are required if serious economic and socio-political threats are to be averted. As a first step towards advancing this vision for South African cities, a Water Sensitive Design (WSD) Community of Practice programme was established in 2014, with the aim of highlighting the critical linkages between the various aspects of this new paradigm through engagement with a wide range of stakeholders. The main focus areas have been the establishment of a project register to aid in the broad consolidation of WSD practices throughout the country, the development of an information transfer system, awareness-raising and training activities (using the recently-published implementation framework and guidelines for the adoption of WSD in South Africa, and including the development and monitoring of appropriate Learning Alliances and other information-exchange platforms), and scoping studies to identify the main drivers and barriers associated with implementing WSD into the planning and implementing environment at local and national government level. Initial findings indicate that the Community of Practice programme has the potential to generate a new understanding about innovative practices and reflexive learning within WSD in South Africa, and to develop knowledge connected to policy development and change to influence planning and design towards water sensitive cities.
Keywords: water sensitive urban design, Community of Practice, Learning Alliances, water sensitive cities.

WIT Transactions on The Built Environment, Vol 165, © 2016 WIT Press
www.witpress.com, ISSN 1743-3509 (on-line)
doi:10.2495/UW160051

1 Introduction

Africa has the highest rate of population growth in the world; it is predicted that by 2050 the number of people on the continent will more than double, from 1.1 billion to 2.4 billion – with almost 60% (1.33 billion) of these people living in urban centres [1]. South Africa has followed a similar trend, with significant population growth between 1990 (36.1 million) and 2014 (54 million) as a result of high fertility and in-migration rates. Already more than 63% of the population live in urban centres – from small towns with populations of 15,000 or less to large cities and metros with populations of many millions [2], and it is estimated that this proportion could increase to over 80% by 2050 [3]. Major population increases, concomitant with rapid urbanisation, not only affects domestic water demand; it also increases demand for economy-boosting agricultural, industrial, commercial and mining outputs – all of which depend on the availability of water of a suitable quality. Water security is thus an issue of major concern, particularly since climate change has the potential to worsen systemic water shortages over the medium to long term South Africa is already '… *severely constrained by low rainfall, limited underground aquifers, and reliance on significant water transfers from neighbouring countries*' [4], with most surface water resources fully allocated. Added to this problem of significant resource shortages is the growing burden of wastewater generated by both the burgeoning population and by the increasing demands of the resource-based industrial and mining sectors; compromised water treatment leading to increased pollution of surface and groundwater; and complex as well as fragmented institutional structures. A legacy of general disregard for the value of water – both economic and socio-cultural – has compounded these issues [5]. The deteriorating quantity and quality of SA's water resources is particularly problematic as these systems affect quality of life as well as reliable production of food, energy and ecological services, all of which are critically important for the country's social and economic development.

It is thus evident that, with both the impact and frequency of future water management risks set to increase, methods to lower these impacts (through adaptation and mitigation) need to be sought; in other words, alternative, systems-based approaches to conventional management of water supply and modes of ensuring water quality are required. New models of water capture, provision, treatment and governance need to be explored and developed to improve and enhance the effectiveness of interaction between the multiple actors who determine water use. In particular, the approach is required to transform 'water-wasteful' habitats to those that are 'water-sensitive' – where water is managed, treated and value is extracted from contaminated water, in a sustainable manner. Water Sensitive Urban Design (WSUD) – referred to in South Africa as Water Sensitive Design (WSD) to allow for a broader focus on the development of not only urban and peri-urban communities, but also those in rural environments – is such an approach. It integrates water cycle management with the built environment through planning and urban design, providing multiple benefits and opportunities to overcome challenges with water management [6]. WSD is thus a systems-based approach that promotes the development of blue-green infrastructure, including:

Sustainable Drainage Systems (SuDS), Alternative Water Resources (AWR) and Water Conservation/Water Demand Management (WC/WDM) techniques.

The implementation framework and guidelines for the adoption of WSD in South Africa [7] have recently been published and provide a comprehensive summary of the WSD concept including its principles, strategies and application to water management and urban design. WSD is seen as the enabler, which could move South African institutions and local authorities closer to meeting developmental goals. If South Africa is to advance the notion of WSD, however, there will need to be a societal openness to embracing a water sensitive design vision as part of its broader developmental vision. This is likely to involve, *inter alia*, re-organizing planning departments and processes, adopting new technologies and adapting old technologies, reviewing and applying new policy and legislation, building capacity (skills, competencies and judgment), initiating demonstrators for technology transfer with partners, actors and stakeholders and ensuring that the principles of WSD are increasingly rapidly understood and accepted by on-the-ground water users.

In early 2014, the South African Water Research Commission (WRC) – as part of a suite of research projects aligned to a newly-formed 'Water Sensitive Design Lighthouse' aimed at advancing a water sensitive design vision for the country – called for proposals regarding the development and management of a WSD Community of Practice (CoP) programme. The overall objective of the programme is to identify and disseminate the necessary information to 'tell a clear story' about WSD in South Africa, such that the critical linkages between the various aspects of this new water management paradigm are highlighted during engagement with a wide range of cross-disciplinary stakeholders. In particular, the CoP attempts to address the notion of managing the complexity inherent in an approach such as WSD, in order to develop an intellectual contribution in this regard, and to ensure that it can influence planning and the alignment of governance aspects at a high level. The Urban Water Management (UWM) research unit at the University of Cape Town was awarded a 5-year contract to establish this CoP programme – to advance the implementation of WSD in South Africa, and in particular, the knowledge sharing and capacity development required to encourage a paradigm shift in the water sector. Another WSD Lighthouse project, 'A feasibility study to evaluate the potential of using WSD design principles to strengthen planning for water sensitive cities of the future' is also currently being undertaken by the UWM research unit, and aligns directly with the CoP as it aims to test the WSD concept and framework within selected catchments and/or municipalities around South Africa.

2 Background literature

As has been described, conventional approaches to urban water management may not be sustainable in the long term and a change in approach is required. Chocat *et al*. [8] stress that increasing awareness amongst all stakeholder groups will be key to influencing the radical shift in thinking required – and that this could even require that some experts in the water area '*de-learn*' so that they could embrace

a broader vision. Abbott *et al*. [6] identify various 'agents of change' as being needed to help the promotion, delivery and adoption of WSD including: the presence of a coordinating body; reliable science, research and training; the presence of WSD champions; a supportive planning/design process and legislation; and strategic funding and incentives. The WSD CoP is the proposed vehicle for providing the sorts of opportunities for engagement, shared learning and capacity building that are required with respect to meeting these objectives in the South African context. The following sections provide a brief introduction to the concepts inherent in the CoP approach.

2.1 Communities of Practice

According to Wenger [9], communities of practice are groups of people who share a concern or passion for something they do and who interact regularly in order to learn how to do it better. The concept has been taken up in various contexts – business, organisational design, government, education, professional organisations, development projects, and civil society – and includes: peer to peer collaborative networking; willing participation of members; focus on learning and building capacity; and engagement in sharing knowledge, developing expertise and solving problems [10]. The Cooperative Research Centre for Water Sensitive Cities (CRCWSC) based at Monash University in Melbourne is a useful example of a well-functioning CoP in this field. The CRCWSC was established in 2012 with the objective of changing the way cities are built – through building awareness of the valuable contribution that water makes to economic growth and development [11]. The CRCWSC is involved in a large number of research projects across multiple disciplines, including a range of stakeholders from government, water utilities, industry, urban developers and academia. It aims to '*support the transition towards a water sensitive city ... by developing inter-disciplinary knowledge and providing ... the processes and pathways to assist organisations achieve their own sustainable, resilient, productive, liveable urban places*' [11].

2.2 Learning Alliances

One of the ways of raising the profile of WSD amongst the South African engineering fraternity, as well as with national and local government officials, planners, and developers is to establish Learning Alliances (LAs) in different towns/cities in order to link the various actors in these urban water systems and promote shared learning and innovation around sustainable water management practices. LAs, or '*platforms that bring together stakeholders from a range of institutions: Municipalities, service providers, universities, and in some cases NGOs and user groups – to think, act and learn together, using action research to test ideas*' [12], are one way of raising awareness about WSD; they allow researchers, local stakeholders and users to work together to create shared visions, analyse options and develop new strategies for the management of diverse forms of infrastructure, including urban water systems. In other words, they are a way of achieving the required trans-disciplinarity for WSD. The purpose of a LA is to do

things differently in order to have more impact on policy and practice – this is achieved through the skilled facilitation of a locally-derived and managed action approach [13].

Linked to the Learning Alliance approach is the concept of 'shared' or 'social' learning, which draws on concepts of resilience thinking and 'social-ecological systems' (SES) to promote learning/co-production of knowledge; build networks across scales and sectors; build stakeholder capacity; and spark innovative responses to problems [14]. 'Shared' learning is geared towards addressing complex problems under conditions of uncertainty, and seeks to engage stakeholders in a structured process of exchanges. The potential role of social learning as a mechanism for managing water resources has been frequently highlighted over the past decade [15–17] and is characterised by shared interest, joint activities, discussions and sharing of information to enable a Community of Practice to learn from each other. A compelling argument for this approach is offered by Pahl-Wostl *et al.* [18] and Blackmore [16] who suggest that the transition towards sustainable strategies in water resources management is best achieved by moving from the need to deploy more information through scientific research that feeds into informing policy and expert cycles, to an adaptive management approach that is embedded in social learning processes. The challenge in South African water management is to create an enabling environment first and foremost. This challenge is exceptionally difficult, however, as improved water provision and services have to be provided in an environment of poverty set within a weak/fragile institutional domain where there are limitations in centralised and hierarchical stakeholder participation, inadequate human resources and capacity, and where water pollution and water supply problems are increasing [19, 20].

3 Method

The overall aim of the WSD CoP programme is to *'strengthen the researcher/ stakeholder and implementer interface in order to leverage partnerships and facilitate, manage and document technology transfer opportunities from the planning and design phases through to the piloting (adapting) and implementation phases'* [21]. This has been achieved by addressing the research objectives in four main focus areas:

i) Scoping potential and current WSD projects in South Africa;
ii) Develop and maintain 'Learning Alliances';
iii) Develop platforms to drive WSD mechanisms (e.g. WSD project database and website); and
iv) Consolidate and disseminate WSD project and other related information.

An initial scoping process was undertaken to identify existing WSD implementation projects throughout the country and consolidate this information into a project register (by way of the online database and website, www.wsud.co.za). 21 developments were selected for detailed review as project case studies in an attempt to identify the drivers and barriers to the uptake of WSD

(specifically the SuDS and AWR infrastructure components) in these areas. The project-specific drivers that were common throughout multiple case studies were grouped into broad categories and a simplistic sensitivity analysis was carried out to rank the influence of different driver categories per case study. Sensitivity analyses involved evaluating each driver's importance per case study on a scale of 1–5; where 1 represented a negligible influence and 5 a critical influence. Drivers were then ranked by location/municipal type and by land-use type; as defined by the data captured in the WSD project register.

Awareness-raising and training activities associated with the CoP are addressed in multiple ways alongside the development and monitoring of appropriate WSD Learning Alliances and/or municipal task groups; i.e. writing articles, press statements, 'blogs' and opinion pieces; as well as presenting at conferences and holding workshops and seminars on different aspects of WSD. In order to provide specific opportunities for engagement and to drive WSD mechanisms on a broader scale, the UWM research unit is involved in several WSD-related information exchange platforms around the country.

The use of multiple case studies in this CoP is an attempt to consider and develop/modify existing social learning and Learning Alliance frameworks in an attempt to address the gap between conceptual theory and practical implementation and to provide more general insights into the mechanisms, structures and outcomes of social learning in this regard.

4 CoP activities

Selected outcomes of some of the activities relating to the four focus areas of this research are presented in the following sections.

4.1 WSD scoping study

A total of six drivers common to all 21 reviewed case studies were found to influence WSD uptake in these developments. The importance of each driver and the types of systems incorporated varied considerably from project to project, but the results from the sensitivity analyses on two components, SuDS and AWR, highlight the relative ranking of each identified driver (Table 1). The identified drivers are briefly described as follows:

i) Approval/legislation mechanisms – refers to the development approval processes at local authority level, and the enabling legislation that promotes the inclusion of WSD.
ii) Institutional champions – individuals within responsible institutions that are instrumental in promoting the uptake of WSD.
iii) Economic incentives – refers to the uptake of WSD due to the perceived benefit provided in terms of return on (socially responsible) investments.
iv) Green Building rating tools – refers to WSD implementation as a result of attempting to secure a desired green building rating through fulfilment of stipulated credit requirements.

v) Physical constraints – site-specific physical constraints that lead to the adoption or promotion of WSD; e.g. downstream stormwater infrastructure capacity limitations; space restrictions; stringent water quality standards; pre-existing and protected buildings; zoning restrictions; and/or difficult site locations.
vi) Sensitive environments – downstream environments that are dependent on the continued supply of surface and groundwater of appropriate quantity and/or quality coming from a particular site or precinct; e.g. wetlands, dry coastal forests, estuaries, and conservation areas.

Table 1: Driver sensitivity analysis.

Rank	Sustainable Drainage Systems	Alternative Water Resources
1	Approval/legislation mechanisms	Economic incentives
2	Institutional champions	Institutional champions
3	Economic incentives	Green Building rating tools
4	Green Building rating tools	Sensitive environments
5	Physical constraints	Physical constraints
6	Sensitive environments	Approval/legislation mechanisms

In due course, the study will summarise where key opportunities and challenges ('barriers and drivers') lie and recommend as to how these can be exploited and addressed by role players in the CoP, thus aiding the broader dissemination of WSD in the country. The information and findings will be distributed via the project website and database, thus aiding the transfer of knowledge to a greater audience.

4.2 Social learning and Learning Alliances

In order to be able to demonstrate the positive influence of coordinating bodies (such as Learning Alliances and other stakeholder groupings) and 'champions' in terms of raising awareness about WSD and facilitating change, several different local-level social learning activities are being monitored and assessed. Ultimately, a more comprehensive national 'alliance' will need to be formed, including representatives from national/local government, the private sector and academics, based on the knowledge gained from the local activities; specifically with respect to how they are set up and maintained, and how 'champions' within these structures can be identified and encouraged to contribute.

4.2.1 Liesbeek Life Plan

The 'Liesbeek Life Plan' is a collaboration of researchers, members of the public, local authority officials and practitioners aimed at developing a framework plan to guide the building of ecological and social resilience in the currently degraded Liesbeek River catchment in Cape Town. Phase 1 of the project started in late 2014 with the re-conceptualisation of the design and form of the Liesbeek River

at four selected sites. The concept plan is geared towards assessing the potential for the implementation of WSD options; specifically aimed at alleviating flooding, improving river quality, increasing biodiversity, and enhancing the amenity value of the river corridor. This is achieved mainly through the use of SuDS components at the local and regional-scale, including: filter strips, swales, bio-retention areas, infiltration trenches, detention/retention ponds, and constructed wetlands. Additional opportunities for intervention in terms of creating multi-functional public spaces and improving river connectivity have also been explored.

Phase 2 of the project began in September 2015 and is expected to be completed by December 2016. It involves the incorporation of existing data (e.g. flow, water quality, social survey data, land use data, and planning ordinances) into consolidated reports on each of the four chosen intervention sites along the river. These reports will be then incorporated into a book on the Liesbeek River that will explore the history of the river, community involvement, accomplishments, and future plans and planning for the river. This is being done in an attempt to provide a coherent philosophy and argument to fundraisers and investors, including the City of Cape Town, in contributing towards the planned interventions.

4.2.2 SuDS transitions in the City of Johannesburg

A form of Learning Alliance was initiated at the City of Johannesburg (CoJ) during 2014, in the form of a 'transition experiment' [22]. The main objectives of this study were to explore the potential for Johannesburg to transition towards water-resilient futures through approaches such as SuDS, and to evaluate and understand the dynamics that exist in the city's urban water management sector, the drivers for change and the possibilities for addressing infrastructure deficits as well as sustainability and resilience concerns simultaneously. The research methodology included interviews, observation, document analysis and site visits, in an effort to highlight the required transformation activities. Ongoing research will focus on the establishment of the necessary platforms within CoJ, where diverse actors (including municipal officials, planners and private developers) may engage on issues such as sustainability and water management, and specifically on the establishment of a water-specific vision.

4.3 Platforms to drive WSD mechanisms

The various ongoing research projects being undertaken around the feasibility of WSD strategies – particularly in respect of the use of alternative water resources – will be used as dialogue platforms to assess where and how WSD can be implemented in South Africa, and what the likely impacts will be. One of these dialogues is aimed at assessing the various barriers, drivers and challenges (i.e. social impacts) to local-level WSD strategies in an environment of social deprivation; i.e. developing an understanding of the potential for transforming socially-divided (*Apartheid*-style) settlements in which the integration of water resources through the use of WSD becomes fundamental to their design. The feasibility case studies to be used as a basis for the dialogues session include: integrating rainwater/drainage into the urban water cycle; Managed Aquifer Recharge (MAR) with a view to providing a supplementary water supply on the

Cape Flats; an assessment of the effectiveness of the water conservation and water demand management (WC&WDM) strategies employed by the City of Cape Town; and an assessment of the potential benefits of waterscapes/green infrastructure on property values.

Another platform for driving WSD mechanisms is the establishment of a training facility in water resource management and a strategic hub for WSD in the country. This is currently being planned in partnership with the Western Cape government, in the form of a SuDS demonstration centre at a decommissioned wastewater treatment works in the town of Franschhoek, about 70 km east of Cape Town. The existing plant is being retrofitted to create a facility that will showcase, research and demonstrate examples of SuDS, as well as integrating leading green architecture and passive design to create living infrastructure that not only has minimum environmental impact, but which protects and restores the surrounding environment.

4.4 WSD dissemination activities

The development of the WSD information sharing platform (including the website and database) is multi-faceted and includes a range of activities aimed at engaging a broad range of stakeholders – including, *inter alia*, writing media releases and opinion pieces, raising awareness amongst members of the public, targeted training events and technical workshops/seminars, presenting at conferences, and academic publishing. Another way of ensuring that the recently-published WSD framework and guidelines are as widely disseminated as possible is to integrate them as part of the typical design standards and green rating systems in a South African context to promote the sustainable management of water resources. From a planning regulatory perspective, the documents that are deemed to be most relevant to the success of entrenching WSD into the implementing environment are the National Building Regulations, the Road Drainage Manual [23], and the Guidelines for Human Settlement Planning and Design/'Red Book' [24] (currently being updated). Discussions have been initiated with the relevant personnel at the institutions responsible for these documents in an attempt to determine how WSD principles can be included.

4.4.1 WSUD water-saving household game

One of the central principles of WSD is the use of water in a 'fit for purpose' manner. Whilst such an approach usually still involves the use of centralised distribution systems, WSD also encourages the use and management of alternative water sources at a household scale. Further, WSD requires a user (at any scale) to decide how and for what purpose different sources of water will be used; essentially asking individuals to make trade-offs. These concepts are unfamiliar to most South Africans and a decision was thus taken to develop a simple 'game' that could provide a means of educating/informing people of the range of different sources of water that could potentially be used at household scale, and also what an appropriate 'mix' of sources could be.

The household water-saving game is an interactive, computer-based game which can be played either as an individual or as a group, and comprises a

simulation activity involving various scenarios that are determined by diminishing water resources and growing demands from within a specified catchment. The players are required to invest wisely in household technologies and strategies so as to ensure that water consumption is contained within the water availability threshold within the catchment. The game is currently being upgraded onto a web-based platform which is intended to improve interaction and accessibility across a range of platforms – from mobile devices to desktops.

4.4.2 WSD/SuDS seminar series

As part of the ongoing activities for the CoP, a seminar series is planned once every two years, aimed at 'spreading the message' of WSD and disseminating current research and/or policy findings. An international expert in WSD is invited to provide specific subject-related input to these seminars which are held in the main urban centres around South Africa. Each visit includes a 1-day general seminar on WSD, and is widely advertised to all interested parties including planners, engineers, environmental specialists, project managers, academics, policy specialists, urban designers etc. The seminars are followed by targeted discussions on these issues with key stakeholders in the relevant town or city with a view to creating and/or monitoring progress of any Learning Alliances that may have been established. The first of these seminar series was held in late 2015, entitled 'Sustainable Drainage Systems (SuDS)/Water Sensitive Design (WSD) – implementation, operation and management'.

5 Preliminary findings

The WSD CoP is the proposed vehicle for providing the sorts of opportunities for engagement, shared learning and capacity building that are required with respect to meeting the objectives of the WRC Water Sensitive Design Lighthouse. This project was thus aimed at creating an interface with all relevant actors who together with research partners test the concepts, framework and options of WSD in the South African context. Initial findings indicate that the CoP is contributing to the development of knowledge by:

- Demonstrating the positive influence of coordinating bodies (such as Learning Alliances and other stakeholder groupings) and 'champions' in terms of raising awareness about WSD and facilitating change.
- Generating strategic evidence of how WSD implementation projects might create new efficiencies, as well as a new understanding about innovative practices and reflexive learning within WSD.
- Developing knowledge connected to policy development and change to influence planning and design towards water sensitive cities.
- Developing an understanding of the potential for transforming socially-divided settlements through the implementation of WSD.

As has been highlighted, whilst empirical research only forms a small part of the overall methodological approach in terms of developing this CoP, it is nonetheless critical that the results from any associated WSD research are taken

into account when developing the relevant platforms to share information and drive WSD uptake. The next phase of the project will thus include a detailed review of the institutional challenges associated with implementing WSD into the planning and implementing environment – following on from the preliminary research work undertaken as part of the development of the framework and guidelines for WSD in South Africa. This will be used to develop knowledge connected to the national, local and inter-governmental policy environment required to influence planning and design for WSD in SA. Ongoing research will also include consideration of existing supporting strategies.

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