Efficient Water Resources Management in South Africa

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Abstract

Efficient water resources management involves the coordinated development and management of water, land and aquatic ecosystems in order to maximise the resultant economy and social welfare in an equitable and sustainable manner. This paper discusses the different components of water resources management as they apply to the South African context. A discussion of the different water use categories is presented covering domestic for both urban and rural users, industrial, mining, hydropower and irrigation uses. A top priority water user is the environment and as such the Reserve is allocated water ahead of all other uses to supply ecological flows and basic human needs riparian to the rivers. The law requires that ecological flows be released from dam reservoirs to meet the requirements of both the river and estuary. South Africa is a water scarce country, with mean annual rainfall of approximately 500 mm compared to the global average of 860 mm. Coupled with the challenge of generally low rainfall, there is wide variability in rainfall received as one moves from the wet eastern regions to the dry western regions. For instance, the mean annual rainfall received in the Karoo areas in the western catchments is about 300 mm, while catchments draining to the eastern coast receive annual rainfall of around 805 mm. As a result, inter-basin transfers within South Africa as well as transfers from neighbouring countries are common. Due to the scarcity of water, water conservation and demand management has become the de facto supply augmentation of first choice in all urban areas. Besides water scarcity, some of the major challenges facing South African water managers include frequent droughts, flooding, sedimentation and the impacts of climate change. Water pollution (specifically the problem of acid mine drainage), illegal water abstractions and the water allocation reform that was introduced to conform to the government goal of transformation that is intended to redress the injustice inflicted by the Apartheid system adopted by the former South African Government between 1948 and 1994 (a period of 46 years!). Surface-groundwater interaction means surface water pollution in some places is transmitted to groundwater aquifers, thereby limiting the full exploitation potential of groundwater resources. Salinity is also a problem with groundwater in coastal regions due to sea water intrusion. Pollution of groundwater is a real challenge since Groundwater is the most economical water resource for most small towns and rural villages. For water management purposes, the country is divided into nineteen water management areas that are run by catchment management agencies. The setting up of catchment management agencies is in

progress. The legislative framework is well developed, with the National Water Act (Act No. 36 of 1998) together with the Environmental Management Act (Act No. 107 of 1998) being the dominant pieces of legislation. Based on the provisions of the National Water Act, a National Water Resources Strategy was developed and is currently undergoing review to capture current government thrust for economic and social development and also to benefit from new scientific thinking.

Key words: Efficient water resources management, National water Act, Reserve, Environmental management Act

Introduction

There is growing awareness that comprehensive water resources management is needed because, fresh water resources are limited; those limited fresh water resources are becoming more and more polluted which becomes unfit for human consumption and also the ecosystem; those limited fresh water resources have to be divided amongst competing needs and demands in society; as a result of that, many citizens do not have access to sufficient and safe fresh water resources. Engineering, economic, social, ecological and legal aspects need to be considered, as well as quantitative and qualitative aspects, and supply and demand. Moreover, the management cycle (planning, monitoring, operation & maintenance, etc.) needs to be consistent (Savenije and van der Zaag, 2008).

Savenije and van der Zaag, 2008 indicated in their studies that, due to the nature of water in which applicable to South African context, the water management has to take account of the following dimensions.

1. the water resources, or the natural dimension, taking the entire hydrological cycle into account, including stock and flows, as well as water quantity and water quality; distinguishing, for example, rainfall, soil moisture, water in rivers, lakes, and aquifers, in wetlands and estuaries, considering also return flows, etc.
2. the water users, the human dimension, all economic interests and stakeholders;
3. the spatial scale, including
   - the spatial distribution of water resources and uses (e.g. well-watered upstream watersheds and arid plains downstream)
   - the various spatial scales at which water is being managed, i.e. individual user, user groups (e.g. user boards), watershed, catchment, (international) basin; and the institutional arrangements that exist at these various scales;
4. the temporal scale; taking into account the temporal variation in availability of and demand for water resources, but also the physical structures that have been built to even out fluctuations and to better match the supply with demand.

The water resources management deals with finding suitable compromises between policy principles that sometimes are conflicting with each other and with the different aspects (dimensions) of integrated water resource management (IWRM) (Savenije and van der Zaag, 2002). The Southern

Africa Vision for water has been formulated as a desired future characterised by: ‘‘Equitable and sustainable utilisation of water for social, environmental justice, regional integration and economic benefit for present and future generations. And the South Africa white paper on water resources has been summarised as follows: ‘water for all for ever”.

Both examples from Southern Africa clearly demonstrate that there are two overriding issues that cut across IWRM however the latter is understood, namely: sustainability and the public interest. Relating to sustainability is: the maintenance of environmental quality (including water quality), financial sustainability (cost recovery), good governance (effective democratic control mechanisms) and the institutional capacity (capacity building, human resources, management instruments, appropriate policy and legal frameworks). Relating to the public interest are: equity (the basic right of access of people to water resources), poverty alleviation (the responsibility of society to nurture the interests of the least advantaged), gender (the central role of women in managing water; at the local level and beyond), security (protection against floods, droughts and hazards), food security and health (Savenije and Van der Zaag, 2008).

Sustainable water resource management

In the study of Loucks (2000), sustainable water resources management is a concept that emphasizes the need to consider the long-term future as well as the present. Water resource systems that are managed to satisfy the changing demands placed on them, now and on into the future, without system degradation can be called sustainable. He further explained that, sustainable water resource systems are those designed and managed to fully contribute to the objectives of society, now and in the future, while maintaining their ecological, environmental, and hydrological integrity.

Where are we as South Africa nation in term of sustainable water resource management?

Sustainability is a broad name. It’s intimately related to various measures of risk and uncertainty about a future we cannot know or predict. However, as individuals can surely influence. The Department of Water Affairs as water agency, need to take consideration of the uncertainties resulting in factors affecting water resource management and appropriately revise the policies periodically based on the outcomes. Recognizing that some management objectives will change over time and based on the outcomes, it should be taken into consideration that the adaptability or robustness of the systems that are designed and operated to the management may inevitable changes in the quantity and quality of the resource being managed.

River connections for efficient water resource management

Sustainable water development and management is a critical component of development for all societies (Otieno and Ochieng, 2004). The linkage between natural resources around Southern Africa has become part of the integrated water resource management (IWRM) development. In the study of Snaddon *et al* (2008), Davies *et al (*1992) define an Inter basin Transfer as the transfer of water from one geographically distinct river catchment or basin to another, or from one river reach to another. This definition convers intra- basin transfers or the transfer of water within catchment boundaries as well as inter- basin transfer across catchment boundaries. In Southern Africa, inter basin water transfers are increasingly being used to reconcile the problems of water distribution which form part of the efficient water management within the region. Africa has a large number of international river basins. Of the 263 known international river basins that exist globally, 63 are found in Africa (Turton *et al*., 2006). Many rivers in Southern Africa are shared resources, flowing through or between more than one province or country. The combined effect of climate uncertainties, rapid population growth and inefficient water infrastructure is increasing the pressure on the river ecosystem of the region (Snaddon *et al.,* 2008).

Problems of water supply in South Africa

In South Africa, problems of over abstraction, salination, acid- mine waste pollution, organic pollution from urban effluents, pesticide and herbicide misuse and acid- rain fallout are all exacerbating the problem of water supply for the major supply agency, the Department of Water Affairs (DWA). In the study of Alexander (1985), South African rivers have been shown to be highly variable in terms of their hydrology with problems for water storage engineering. While on the other hand, studies made by Davies (1995) have indicated that the South African rivers are unpredictable due to climate uncertainty as a feature of land scape. Conley (1995) also pointed out that the unpredictability of the incidence of drought on a year-by year basis makes water resource planning and management extremely difficult exercise.

Inter- basin transfer in South Africa

With the high population and urban distribution throughout the region, the extreme variability of rainfall and climate pattern and generally high evaporation rates across the region, engineers turned their focus on the creation of redistribution networks/ systems in the form of IBTs from areas of perceived (surplus) to those in deficit. In South African provinces, Cape Town for instance, some 98% of water supplied to the city comes from way beyond its boaders, from Riviersonderend, Berg, Eerste and Steinbras. Similar situation exist in other provinces in South Africa and these include, Johannesburg, Pretoria, Durban, Pietermaritzburg, Bloemfontein and for many others elsewhere in the region such as Botswana, Namibia and Zimbabwe (Snaddon *et al.,* 2008). Inter – basin Transfer (IBTs) has become a mean of planning, developing and efficient managing water resources.

Water management and climate change

Water resource management is exposed to the challenge of the uncertainty of climate changes, which is very influential on the strategies and procedure followed as well as the current and future outcomes. An integrated approach which precisely take into account human, environment and technological concerns as well as their interdependency, should be adopted in the water resource management (Pahl – Wostl, 2007). In South Africa, this will mean that Ground water and Surface water as the country's main economical water resources; such approach should be adopted in making water policy and water resource management.

Climate change have a significant impact on the water resource management through affecting the water supply and demand, water quality, agricultural production, loss of biodiversity and human or community behaviour (Archer, 2010). Changing rainfall patterns, rising atmospheric temperatures, frequent flooding especially along the coastal regions of South Africa and drought during dry seasons are the examples of climate change effects on the water resource management, and also a reflection of how limiting climate change could be on water activities if not accounted for.

Water management and water reuse

According to Gumbo (2004), in his research, Johannesburg was one of the cities which were found to have about 40 – 60 % of unaccounted for water during the years 2003 and 2004. This is due to poor management of the demand and allocation of water, and also misuse of water like illegal abstractions and unreported leakages.

Storm water and waste water like sewage, mining waste water are the main sources of water reuse in urban areas and industries. However for a country that has seasonal rainfall like South Africa, storm water availability will also be seasonal. Hence in some parts of South Africa, rainwater harvesting has been incorporated especially in schools where the collected water is used for gardening and sanitation, but the effectiveness and efficiency is still affected by the climate variability and seasonal changes.

Water is a renewable resource, however its demand is influenced by population growth, urban and industrial developments. An overview produced by Mine Metallurgical Association of South Africa and DWA, showed that the total new water required in the next decade (2023) is about 60% more than what is used currently (2013) as shown in Figure 1, (van den Berg, 2009). This shows the need for integrated management strategies for the sustainable water recycling and reuse, and to identify the water resources which could be developed further. Water demands will always increase, generally for consumption and indutrial use. Figure 1 does not show any projection or graph that is specific to the agricaultural production, which put a huge demand on water supply especially for a growing population and economy. Keeping in mind that water used for irrigation is as good as consumed and

can not be reused, and hence it shows that the future new water demand could be higher than predicted.

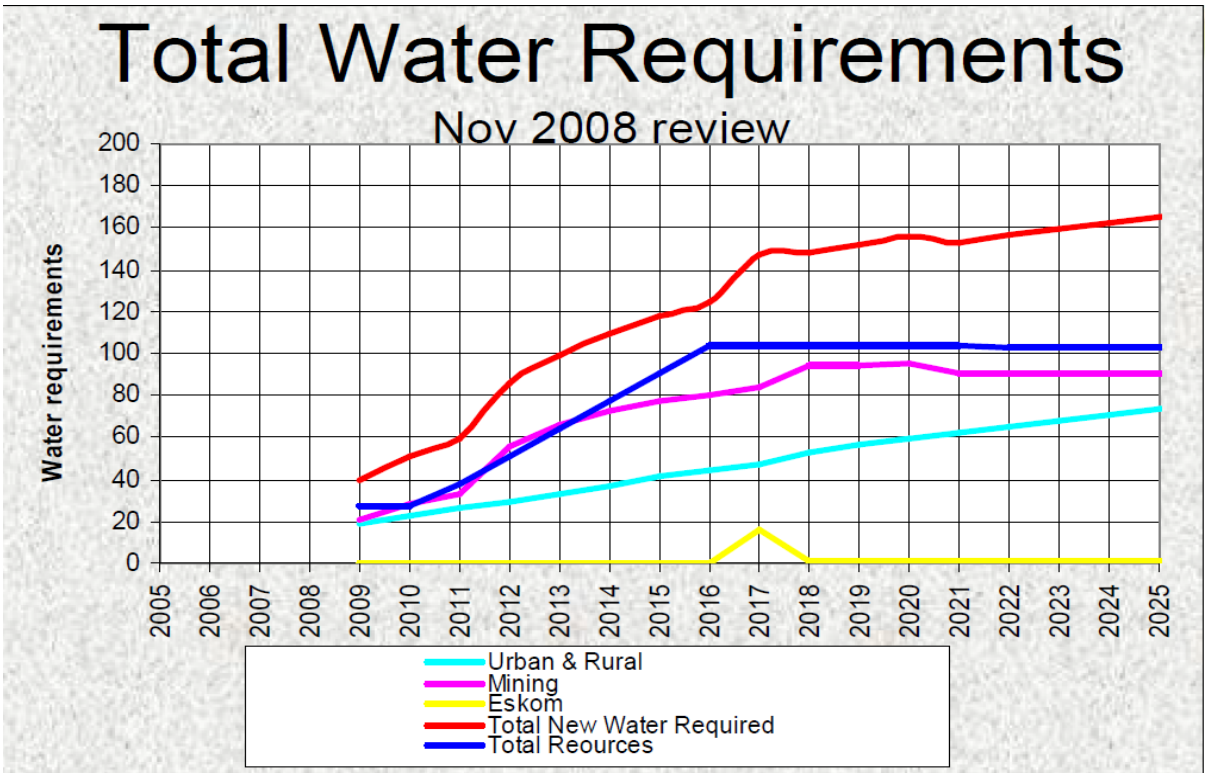

Figure 1: Total Water Requirements, [Overview of water resources in South Africa, Mine Metallurgical Association of South Africa and DWA]

Green water infrastructure sustainability and management

One of the challenges facing South Africa is the provision of protective designs of water resource infrastructure, securing ecosystem, animal and human life for the sake of the country's developing economy. Concerning both urban and rural infrastructure, it is very imperative to provide sustainable designs of the water infrastructures as they are affected by the increasing population, developments and even the available water resource management strategies.

Large impervious areas and developments in urban areas have a significant influence on the hydrological cycle in such ways like the reduction in infiltration and ground water recharge, and high peak flows, sedimentation and pollutants carried over into rivers (Niemczynowicz, 1999). Hence there is a great need for the sustainable water infrastructure like accommodative drainage system as an integrated management solution to control the storm water which often results in flooding.

About 70 % of annual rainfall runoff in South Africa is captured in dams, which serve as surface water storage resources and drought control structures supplying the majority of the urban, industrial and agricultural needs (Claassen, 2010). However sedimentation, which shows un-sustainability, is a major common problem in most of the dams, as it reduces the storage capacity and the water quality. Another major thread to the existing storage infrastructure is the contaminants and pollutants into dams, which as explained above originates from the urban runoff and carried to dams by rivers and streams. Poor management and control of sediments, contaminants and pollutants compromises the sustainable functionality of the dam or any other storage structure (Claassen, 2010).

Desalination

This is a capital - and energy intensive source of freshwater that would be out of reach of many rural communities and many developing countries' budgets. Ultra filtration technology was widely developed in South Africa to deal with the wide range of industrial and mining pollutants. Although there is great potential for augmenting South Africa's water supply by desalinating sea water and groundwater, the cost are way expensive (about 3 to 4 times more expensive than conventional methods of obtaining freshwater (Otieno and Ochieng, 2004). As a result of this, this state-of-the art technology has not yet applied to domestic water supply except in exceptional cases in South Africa. In addition to this, the water agency, the "Department of water Affairs" has not yet implemented a policy on desalination and this may be due to the fact that the technology is not feasible.

Efficient water management and socio- economic impacts

Discussion and Conclusion

It is logical to start with research, then develop policy, educate the water users and then put to practice the integrated water resource management strategy. Research institutes within and outside DWA, in the areas of mathematics and scientific modelling, environmental studies, geographic and climatological studies, biological studies, hydrological and ecological studies, social and economic studies should be involved, of course with research outputs based on the adoption of integrated water resource management in South Africa. Benefits of incorporating climate change in the water resource management are definitely sustainable, as the losses are minimised.

Increasing water recycling and reuse by developing relevant infrastructure, although costly, will increase conservation of water as a resource and also serves as a green solution to the high water demand challenge. Some water reuse projects like the rain water harvesting operate at reasonable costs, and it could feasible to adopt and implicate them at larger scales and not only at schools but also in the industrial and business work places.

Integrated water resource management needs a holistic long term approach. This must be supported by legislations, agreed quality standards, collaboration and perhaps international finance to enable projects relating to sustainable water and management to take place. Given all these issues and challenges with respect to the planning and management of sustainable water resource systems, it is appropriate to ask what can and should be done. No single profession pretends to know enough to answer that question. However, with inputs from a multiplicity of professionals and the interested and affected public, resource managers and decision makers can identify more clearly just what may be done to achieve higher levels of sustainability in specific situations. Collaborative projects from government, industries and academic should take place. Water resource systems designed and managed to fully contribute to the objectives of society, now and in the future, while maintaining their ecological, environmental, and hydrological integrity.

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