Water development in South Africa

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Location: South Africa

"The objective of managing the quantity, quality and reliability of the Nation's water resources is to achieve optimum, long-term, environmentally sustainable social and economic benefit for society from their use".

Principle 7 of the National Water Policy

Challenge and objectives

South Africa's water resources are, in global terms, scarce and extremely limited: average rainfall (450 mm per year) is well below the world average (of about 860 mm), evaporation is comparatively high, no truly large or navigable rivers exist, the combined runoff (of 49 billion cubic metres per year) is less than half of that of the Zambezi River, the closest large river to South Africa. In addition South Africa is also poorly endowed with groundwater and the natural availability of water across the country is highly uneven with more than 60% of the river flow arising from only 20% of the land. Four of South Africa's main rivers are shared with other countries, which together drain about 60% of the country's land area and contribute about 40% of its total surface runoff (river flow).

Most urban and industrial development took place in locations remote from large watercourses, dictated either by the occurrence of mineral riches or influenced by the political dispensation of the past. Some irrigation were also established during times that water was still relatively abundant and little incentive existed for seeking the most beneficial application thereof. As a result, in several river basins the requirements for water already far exceeds its natural availability, and widely-spread and often large-scale transfers of water across catchments have therefore, been implemented.

South Africa depends mainly on surface water resources for most of its urban, industrial and irrigation requirements. The use of water is dominated by irrigation, amounting to over 60% of the total water use in the country, the bulk of which is used consumptively. Water requirements for urban and domestic use account for nearly 30%, with the remainder being used for mining, bulk industries and as cooling water for power generation. Afforestation, which intercepts large quantities of water before it reaches the streams or rivers, is more dominant in the wetter parts of the country.

Water quality has deteriorated in the rivers or river reaches receiving large quantities of effluent. Some rivers with relatively high salinity (brackish) water occur in the dryer parts of the country. Major sources of pollution of surface waters are agricultural drainage and runoff, urban runoff and effluent return flows, industries, mining and rural settlements with insufficient sanitation services. The most important of these currently are insufficiently treated urban effluent and acid mine drainage. Pollution of groundwater mainly results from mining activities and human settlements. Water is also extensively re-used in South Africa, adding nearly 20% to the yield available from the surface water resources.

The water sector (and implicitly also water security) comprises a wide diversity of interests, physical components, authorities, stakeholders, inter-dependencies, externalities and other factors. The situation with respect to water security in South Africa is quite diverse, ranging from high levels of services and security in most of the large metropolitan areas, to severe and immediate risks in less developed and rural areas. The more important aspects with relation to economic growth and environmental sustainability are:

- The larger surface water systems that supply water to the main urban, industrial and mining centres are well managed at a high level of sophistication.[1] However, delays have been experienced with respect to the implementation of some large new water resource developments, which are partly attributable to a lack of sufficient institutional capacity.[2] These delays, if not contained, could have some negative impacts on the potential for economic growth.

- Water quality in many of the country's surface streams has been severely compromised by the inadequate treatment and control of effluent discharges and urban/agricultural runoff. This poses serious environmental, health and economic risks in many places. The situation is largely attributable to a lack of institutional capacity for the monitoring and enforcement of standards, as well an insufficient technical capacity for the operation and maintenance of treatment facilities.

- The general efficiency of water use still leaves much scope for improvements, especially with respect to irrigated agriculture and losses from municipal distribution systems. This

[1] Many of the smaller surface water schemes and groundwater developments are poorly managed with resultant high risks of failure.

[2] The government tends to under spend available funds due to lack of institutional capacity.

results in more water being used than actually needed, with resulting increases in the risk of failure to supply.

- The abstraction of water for irrigation is poorly managed and controlled, largely as a result of insufficient institutional capacity. This has serious impacts on the ability to manage environmental flows and also negatively impacts on the overall efficiency of water resources management.

South Africa, because of its general aridity and high variability of rainfall in space and time, is especially vulnerable to changes in water availability. Indications from global circulation models (GCMs) are that greater variability in rainfall and climatic conditions may be expected. This includes the likelihood of an increase in the duration of dry spells in the interior and north eastern areas of the country, also more intense rainfall and the possibility of more frequent and severe flood events. The probable net effect would be greater variability in runoff and therefore of the usable portion of runoff, together with reduced recharge of groundwater. Specifically, there is growing consensus amongst the scientific community that rainfall over the south western part of the country can be expected to significantly decline and become highly variable over the coming decades.

South Africa has strong and enabling water legislation, well developed infrastructure, leading water resources technologies and management capability, and a sound track record. Given the political commitment together with some strengthening of institutional and technical resources, it undoubtedly has the ability to ensure that sufficient water of appropriate quality will be available in future to sustain a strong and growing economy, high social standards and healthy ecosystems.

Response: improving the allocation of water resources

The National Water Act gives highest priority to water for the 'Reserve', which includes water for basic human needs and for the natural environment. Thereafter international obligations as agreed with neighbouring countries must be respected and honoured. Beyond this, water should be allocated by public authorities and by river basin to ensure that the greatest overall social and economic benefits are achieved. Consideration must not only be given to this primary aim, but also to potential disbenefits to society where water is made available to competing optional uses. This applies both to long-term allocations for water use as well as to short-term curtailments in supply during periods of drought and temporary shortage. Where surplus or unused water exists, prioritisation applies, provided that the water is not used wastefully.

The priorities are listed in the National Water Resource Strategy in descending order of importance, although the order may vary under particular circumstances:

1. Provision for the Reserve;
2. International agreements and obligations;
3. Water for social needs, such as poverty alleviation, primary domestic needs and uses that will contribute to maintaining a social stability and achieving greater racial and gender equity;
4. Water for uses that are strategically important to the national economy (such as power generation),
5. Water for general economic use, which includes commercial irrigation and forestry. In this category, allocation is best dictated by the economic efficiency of use. With the introduction of water trading, demand will automatically adjust over time to reflect the value of water in particular uses; and,
6. Uses of water not measureable in economic terms. This may include convenience uses and some private water uses for recreational purposes, which are likely to be of low priority.

Once these general principles have been established, the overall strategy to cope with water scarcity is to improve the overall efficiency with which water is allocated and used among the different places and activities. Water allocation can be improved between the different economic activities, the overall economic uses and the environment and, finally, between the different places in the territory including opening the displacement of agricultural production to neighbour countries. The potential gains of this strategy have been highlighted by various research projects assessing the value of water.

- Results confirm agriculture as both the main water user and the sector with a higher potential to save water for the environment and for other more productive uses. Nevertheless forward and backward linkages of agriculture as a supplier of raw materials and demanding of labour and inputs need to be properly accounted for.

- Sufficient provision was not made in the past for environmental water requirements and that in many cases water resources have been over allocated. Although the legal and institutional framework for addressing the situation is in place, it will remain a complex and extended process. The reservation of water for environmental purposes obviously reduces the potential availability of water for economic uses, with resultant socio-economic implications. Quantifying the environmental water requirements should therefore not be based on scientific assessment only, but needs to be augmented by assessments of the potential economic and social implications, and subjected to due public involvement.

- South Africa is well known for its extensive network of large scale schemes for the transfer of water from areas of surplus to areas of deficit; and to where the greatest benefits are to be achieved. Water resources over much of the country have been linked through inter-catchment transfers and are managed as large integrated systems, thereby reducing the potential risks of failure through the combined utilisation of resources and the balancing of climatic variability over large geographic areas (Basson and van Rooyen, 2001).

- A concept which could have far reaching mutual benefit for the southern African region, would be to move some of the water intensive and low water efficient production to countries with more favourable climate and soils. An order of 25 million hectares of high potential rain-fed cropping land could be available for this purpose (DWAF, 2010). In comparison, irrigated agriculture in South Africa covers the order of 1 million hectares. Such an initiative should fit well into the agenda of the Southern African Development Community (SADC) towards promoting greater trade and co-operation amongst these countries. It should also lead to the establishment/expansion of local agro-industries as well as other economic linkages, together with related infrastructure and other investments.

The National Water Resource Strategy requires that a range of possible solutions be investigated whenever there is a shortage of water or a need for additional water, taking account of the availability of surface and groundwater and the interactions between them, and the integration of water quantity and water quality issues. The main policy options to be considered include:

- Demand side measures to increase water availability and improve the efficiency of water use.

- Re-allocation of water, including the possibility of moving water from lower to higher benefit uses by trading water use authorisations.

- Supply side measures through the construction of new dams and related infrastructure, including inter-catchment transfers.

The significant impacts of all development options and other interventions need to be assessed. Social and environmental considerations need to be accorded the same attention as those of a technical, financial and economic nature; the aim being to ensure that the overall benefits arising from such actions will exceed the cost and that the benefits and costs will be distributed equitably. Given the blend of tangible and intangible factors to be considered, public participation forms an important corner stone of the process to be followed.

There are two representative cases of how the growth in water requirements can be met in future:

- One is for an inland area around Johannesburg and the Gauteng Province, which is supplied with water from the Vaal River System, and represents more than half of the economic output of South Africa. For the Vaal River System, the target is to bring new interventions on line to meet the growth in water requirements after having first implemented water conservation and Water Demand Management (WC/WDM) measures. Evidence shows that further inter-catchment transfers still offer the lowest cost options for the augmentation of water resources serving the inland parts of South Africa (Note: The figures have been omitted). This does not imply however, that these would necessarily be the overall best options to be implemented. In particular, due consideration needs to be given to the possible re-allocation of water.

- A second case is the Cape Town area on the coast together with some surrounding developments. A totally different situation applies to the coastal Western Cape area (Note: The figures have been omitted). This area, being more remote from large rivers and not having the same benefits of scale of the Johannesburg/Gauteng area, is totally dependent on the development of modest inland resources (surface and ground water), the re-use of water and desalination of seawater. A rather pronounced drop in the availably of the water resources already developed is expected due to provisions for environmental water requirements (EWR), together with a provision for the possible impacts of climate change.[3]

Conclusions from both cases, together with similar findings for other parts of South Africa, are that water can be made available to meet the future needs in all the major urban and industrial centres in South Africa, although at steeply increasing costs in most cases. Comparisons of the unit reference values (URVs) to the economic value of water indicate that the unit cost of water from some new water resource developments will substantially exceed the economic value of some existing water uses; most notably irrigated agriculture.[4] The re-allocation of water could therefore offer a feasible alternative to some new resource developments and augmentation schemes. It is projected that water resources across the country will become even more inter-connected and inter-dependent in future (Note: The figures have been omitted).

What role for economic instruments?

[3] Indications are that the Western Cape is likely to be the area in South Africa that may soonest and most severely be affected by climate change.

[4] Although the URVs and economic values are based on different financial and economic approaches and are not intended to be directly comparable, they at least provide a broad indication of the relative costs and economic values/benefits.

Water is not freely tradeable in South Africa; moreover water use licences or authorisations may be transferred on a temporary basis for one year in the case of water for irrigation, and permission may be granted for an extension of a further year. Permanent transfers may be affected by one user offering to surrender all or part of an allocation to facilitate a licence application by another prospective user (DWAF, 2004). Transfers of this nature constitute trade in water use authorisations, and require new licence applications, which will be subject to all relevant requirements of the Act relating to applications for licences, including the need for a Reserve determination if one has not already been carried out. Permanent transfers become effective only when the new licence is granted. They may be authorised only by a responsible authority, which may attach different conditions to the new licence than were attached to the surrendered licence. One such condition may be that the new user must pay compensation to the original licence holder, which could be viewed as a form of market related trading. Both the temporary or permanent transfer of water use licences are only permissible when the original and transferred water use are from the same resource.

The price of water in South Africa largely remains an administered item. Prices are mostly seen as a partial cost recovery instrument rather than an incentive to encourage the more efficient use of water, water conservation or a shift from lower to higher value uses. Exceptions are the new stand-alone water resource developments for economic use, such as mining, where the full cost of water from such development is to be carried by the users.

The principle of striving to achieve the overall best utilisation of water which forms one of the corner stones of the National Water Resource Strategy for South Africa, should not be restricted to the geographic confines of the country, but should also be viewed in a regional and more broadly in a global context.

A number of major socio-economic constraints to the exploitation of this potential have been indentified, that would need to be addressed (DWAF, 2010). These include land tenure issues,[5] the high rural population spread presenting a challenge to commercialisation of agriculture, poor or lacking infrastructure and general services (e.g. training and research). As experience shows in other countries, measures would have to be taken to accompany structural adjustment of the South African agricultural sector. A proactive role of the respective governments is needed to bring such regional co-operation to fruition. It would inherently be a long-term initiative to allow time for the gradual introduction of the necessary social and economic adjustments to be made.

[5] The majority of the high potential land in neighbouring countries is occupied by subsistence farmers on commonly owned land.

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Annex

Economic value of water

Various project related studies have been conducted in South Africa towards assessing the economic value of water. The main approach used was to determine sectoral water utilisation efficiencies by means of a "water multiplier' analysis, to obtain an indication of the relative importance of water in production by some of the water use sectors and sub-sectors of the economy (Basson *et al*., 2010).

As a broad comparison, national multipliers were determined per million m^3 unit of water used, expressed as employment opportunities and Gross Domestic Product (GDP) supported. Distinction was made between high, mid and low level jobs, based on the skills levels required to produce the output (Table 1).

Table 1. Economic returns from water use, South Africa
(per million m^3 water used)

Sector	**High-level jobs**	**Mid-level jobs**	**Low-level jobs**	**GDP (ZAR million)**[a]
Agriculture (general)[b]	10	30	210	13
Gold Mining	650	2 880	11 900	1 600
General manufacturing	6 800	27 000	28 000	6 700
Pulp and paper	25 000	79 000	81 000	23 000
Beverages	38 000	131 000	158 000	37 000
Glass products[c]	233 000	716 000	836 000	250 000

a) Expressed in 2009 values
b) Least efficient (includes irrigation, rain-fed and livestock farming)
c) Most efficient
Source: Basson *et al*., 2010

<u>The results show agriculture as the most inefficient user of water</u>. Gold mining and general manufacturing could serve as being representative of water use efficiencies in the mining and manufacturing sectors. It is important to note that the results are based on national statistics, and therefore reflect the average performance of the different sectors.

Wide variations around these averages are bound to occur, but they are unlikely to change the essence of the results, considering the very large difference between agriculture and the following sector in the ranking.

Similar outcomes were obtained with respect to a new water resource development in the Olifants River catchment (Table 2).

Table 2. Economic returns from water use, Olifants River catchment
(per million m^3 water used)

Sector	Gross Value Added (GVA) (ZAR million)	Employment
Agriculture (irrigation)	20	200
Mining	370	3 300

Source: Basson *et al* (2010)

Similar results were obtained by comparing the utilisation efficiencies of water in different geographic areas. In this case the economic benefits of allocating the water to the Orange and Fish/Sundays River region, where the economic activity is dominated by irrigated agriculture, were compared with the benefits achievable by applying the same volumes of water to the diversified and industrialised economy of Gauteng, the central industrialised province. The results of the analysis indicated that allocating water for use in the industrialised areas rather than for irrigated agriculture, will, from an economic point of view, render the highest returns (Table 3).

Table 3. Economic returns from water use, Orange River and Gauteng areas
(per million m^3 water used)

Factor	Irrigated Agriculture[a]	Diversified Industry[b]	Ratio[c]
Production (ZAR million)	2.1	510	1:240
Employment	24	1 940	1:80

a) Orange River area
b) Gauteng area
c) The ratio refers to diversified industry having 240 (or 80) times greater returns than irrigated agriculture.

Source: Basson *et al* (2010)

Inter catchment transfers

Based on the probalistic assessment of the likelihood and severity of drought in specific areas for example, water is transferred to areas that may be suffering from severe drought conditions, from areas where the prevailing conditions are less critical. A high level of sophistication has been reached in this regard, and substantial greater utility is thus obtained from South Africa's water resources than the sum of the component parts (Box 1).

Box 1. Gains from inter-catchment transfer

A prime example of the benefits of the systems approach for the management of inter-catchment transfers is offered by the Thukela-Vaal Transfer Scheme. In this case an average volume of 530 million m^3/a is transferred from the Thukela River Basin to the Vaal River Basin, at a transfer rate that may vary from zero to a maximum of 630 million m^3/a. By properly managing the storages and times of transfer, a resultant increase in yield in the Vaal River System of 736 million m^3/a is achieved, whilst the residual yield in the Thukela system is reduced by only 377 million m^3/a.

The total quantity of water physically transferred in South Africa from one catchment to another currently amounts to 3 500 million m^3/a. In comparison, the total surface water yield is approximately 110 000 million m^3/a.

Water curtailments during times of severe drought are also incrementally introduced based on probabilistic grounds, and selectively applied to different user groups and economic sectors, in order to minimise the economic and social impacts of such measures.

The same technical, environmental, social and economic considerations as are applicable to any other water resource development and use of water are applicable to inter-catchment transfers of water. Some specific considerations are:

- The allocation of water away from a catchment can only be justified if it results in an overall benefit from a national perspective.
- The inter-catchment transfer of water may have unique impacts on natural ecosystems that extend beyond those associated with in-catchment developments. Specific consideration needs to be given to the possible transfer of organisms/species and changes in habitat conditions. The potential risks and impacts with respect to the transfer of species are more

pronounced with the transfer of water between river basins, than between catchments within the same river basin.

- The transfer of water for the express purpose of meeting environmental water requirements in the receiving catchment is not supported.

Given the relative scarcity of water in South Africa, most large scale water resource developments are inherently multipurpose schemes, which also facilitates the better utilisation of the benefits of scale. A recent example is the Olifants River Water Resource Development Project in the north-eastern part of the country.

The project is located in a valley adjacent to a very dry plateau where about 250 000 people live in scattered communities, with totally insufficient availability of water. To construct a single-purpose dam and water supply network for domestic purposes only, would have been exorbitantly expensive and unaffordable to the predominantly poor households on the plateau. By linking the domestic water supplies to some large scale water resource development for mining purposes, almost halved the unit cost of water from the scheme.

A further opportunity was then identified, with the visionary linking of a proposed 1 500 MW pumped storage hydro-electric scheme to the water resource development project, and using the pumped storage scheme to also lift water up the escarpment for domestic use.

The scheme, now under construction, will also serve to stabilise flow downstream for environmental purposes. Specific consideration was given to the potential impacts on the Kruger National Park, (South Africa’s premier conservation area which is located further downstream) and also to how the yield from the Massinger Dam in Mozambique would be affected.