Is Water Shedding Next?

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Abstract

South Africa is in the grip of an electricity crisis marked by a euphemism known as "load shedding". The demand for electricity has grown to the point that the supply reserve margin is often under threat, necessitating the electricity supplier to cut supply to some areas for various periods of time, or to shed load. This is a condition previously unknown to South Africa since the country has enjoyed electricity security from the mid-1950s. Are we, however, heading in the same direction when considering water? Is water shedding inevitable?

We ask these questions since South Africa is a country classified has having chronic water shortages, a condition exacerbated by climate change and the rapidly increasing demand for water. Can we avert a water shedding crisis by being proactive? In this paper we address this issue by applying a Computable General Equilibrium (CGE) model using an integrated database comprising South Africa's Social Accounting Matrix (SAM) and sectoral water use balances. We refer to AsgiSA, the governments' Accelerated and Shared Growth Initiative in South Africa, and conclude that continuing business as usual will indeed lead to a situation where water shedding will be inevitable.

Unlike electricity, however, water security is much more serious from livelihood, health and socio-economic development perspectives since there are no substitutes for it, although its influence is not directly and immediately visible. This delayed effect can create a degree of comfort and ill-founded complacency leading to non-action, whereas there is an urgent need for proactive measures.

JEL codes: D58, Q5.

1 Introduction

South Africa is currently in the grip of an electricity crisis euphemistically known as "load shedding". The demand for electricity has grown to the point that the supply reserve margin is often under threat, necessitating the electricity supplier to cut supply to some areas for various periods of time, or to shed load. This is a condition previously unknown to South Africa since the country has enjoyed electricity security from the mid-1950s. But the last power plant was built about 25 years ago and since then neither supply augmentation nor any meaningful form of demand-side management has been applied. The current electricity crisis is being dealt with at the highest possible level through a president-announced task team investigating and initiating an electricity security plan. Although commendable, this initiative is, in its nature, reactive. Are we heading in the same direction when considering water? Is water shedding inevitable? Can we avert such a crisis by being proactive? We address these questions by providing a background to the water sector, then highlighting the six water-intensive AsgiSA (Accelerated Shared Growth Initiative of South Africa) projects, followed by a discussion of the data, the model and the results.

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In this paper we refer to a number of studies predicting water shortages in South Africa in future. This paper takes a specific program of the South African government and tests the impact of the program on the availability of water in the near future. It does not merely extrapolate supply and demand figures from the past, but uses a (CGE) model of the South African economy to simulate specific effects that AsgiSA would have on the availability of water in the country, as well as the effects of water taxes on certain industries.

2 Background

DWAF (2004) estimates that in 2000, South Africa had a total reliable surface water supply of 13,226 million m^3. In the same year, the nation used 13,041 million m^3, leaving a surplus of only 186 million m^3 or 1.4% of the supply (at 98% assurance of supply) for that year. Additionally, 12 of the country's 19 water catchments recorded water deficits, which have only been offset by an intricate system of engineered inter-basin water transfer schemes. These worrisome statistics are supported by the Water Resource Accounts produced by Statistics South Africa (2006). In theory, as the remaining annual supply of a vital natural resource approaches zero – crossing clearly identifiable thresholds of scarcity – the marginal value of the resource approaches infinity (Farley and Gaddis, 2007). This implies that the economic value of the last 1.4% of unutilised water resource becomes very high, far exceeding that of the prevailing bulk water tariff, which is a cost recovery-based tariff.

Moreover, the meagre water reserve mentioned above actually includes the water imported from neighbouring Lesotho through large-scale engineering projects involving large dams and tunnels, among other things. Unutilised domestic sources of water are limited to two river catchments in the ecologically sensitive and relatively undeveloped Eastern Cape province. Water supply constraints are therefore an issue with unparalleled economic development implications. Other supply options are limited, but include further water importation from Lesotho, and additionally, from the distant Congo River, and/or desalination of seawater. All three options would be costly and capital intensive, and the implementation thereof would have a significant effect on water tariffs with the result of making drinking water less accessible to those who are most in need. In other words, only 1.4% of South Africa's water yield is currently available to address the demands of the poor, most of whom do not currently have any access to potable piped water. But what are the likely impacts of AsgiSA and the introduction of the AsgiSA projects on this surplus, or meagre unallocated, water? We return to this question shortly.

2.1 *Surface water use*

Irrigation agriculture – consuming 62% – is by far the largest single surface water user, with agriculture and forestry combined consuming 65% of the total available water resource (see Figure 1) (SSA, 2006). Large-scale farmers use 95% of agriculture's share, predominantly for irrigation (Schreiner and Van Koppen, 2002). Much of the irrigation is provided by way of central pivot systems, supported by intricate channels and water reservoirs (dams) developed more than 50 years ago. In a country where about 90% of the annual precipitation is used in the form of evapotranspiration and deep seepage due to climatic and geological conditions (CSIR, 2001), central pivot systems are an extremely inefficient means of irrigation. Additionally, central pivot systems could lead to excessive irrigation causing the salination of the soil, something South Africa is very susceptible to. Irrigation's surface water use has also increased steadily from 7,630 million m^3 in 1995 to 7,921million m^3 in 2000, an increase of 291 million m^3, or 4%. This represents 160% of the total water surplus remaining at the end of 2000. The official water use for 2005 has not yet been released, but if the volume of water used for irrigation increased by the same margin, without any compensatory reduction in water use by other sectors, then there must have been a deficit for the country as a whole. Furthermore, the total increase in water consumption for all sectors from 1995 to 2000 was 348 million m^3, which implies that irrigation's portion of the increase was 84%! Based on these figures, surface water use is increasing rapidly and there are no signs of a decline in use in any other sector.

[Insert Figure 1 here]

2.2 *Ground water use*

In addition to the increased use of surface water, the use of ground water is increasing rapidly as well (Vegter, 2001; Botha, 2005). Vegter (2001) estimates that by 1999 there were approximately 1,1 million water boreholes in the country, compared to only 225 000 recorded on the National Groundwater Database. From drilling data and agricultural records, Vegter (2001) calculates that the ground water use in 1999 was about 3,360 million m^3 per year and increasing at 3.4% per year. The estimated use at the end of 2001 was approximately 3,850 million m^3, which is 49% of the surface water usage. The exploitable ground water usage for 2000 is estimated at 9,500 million m^3 (SSA, 2006), which implies that ground water usage at that stage was about 41% of the potential. This allows room for some further development, but clearly the surplus is dwindling fast. In fact, if water abstraction of both surface and ground water has increased so quickly in recent years, it is primarily to drive the development of agriculture, mainly in the horticulture and animal production sectors, as will be seen below.

2.3 *Water: The limiting factor*

Clearly the growth in demand for water compared to the supply constraints is leading to an untenable situation and implies not only that water conservation would have to be applied, but also that profound efforts at redistribution of water would have to take place. This is a fact recognised by DWAF (2004) who states that, given the demographic trends, South Africa as a whole is likely to have a water deficit of approximately 1.7% by 2025. The amount of surplus water available for utilisation of any kind is therefore declining fast, implying that water is becoming a very scarce resource – even the limiting factor to development – as eloquently articulated by Scholes (2001) in the following words (see also Daly and Farley, 2004; Aronson et al., 2006; Farley and Daly, 2006):

> *The availability of water of acceptable quality is predicted to be the single greatest and most urgent development constraint facing South Africa. Virtually all the surface waters are already committed for use, and water is imported from neighbouring countries. Groundwater resources are quite limited; maintaining their quality and using them sustainably is a key issue.*

Water use cannot continue to grow at current rates indefinitely given the supply constraints, the likely decline in the water availability due to changes in climatic conditions, and the socio-economic and demographic pressure to increase the use of potable water for domestic use and to allocate water to higher value-added industries (Blignaut et al., in press). Something has to change, and fast.

For the time being, the effect on agriculture of the changes in climatic conditions over the past four decades – notably the 6% decline in mean annual rainfall – has been mitigated by the aggressive increase in irrigation from both surface and ground water resources. The conventional methods of irrigation will have to change, as these can no longer hedge agricultural production from the impacts of changes in climate, and may well lead to degradation and salinisation of soils, judging from experience in other hot and dry regions. Come what may, water is going to become increasingly less available for agriculture. This will have obvious implications for food security, future irrigation methods, the type and structure of agriculture production, the way in which land reform is being conducted, and the rural economy in general. These are all major and complex issues that cannot be addressed fully within the scope of this paper. Instead, in the next section we focus on the effects that AsgiSA could have on water demand.

3 AsgiSA

AsgiSA's stated objective is to accelerate economic growth and seek to distribute the benefits thereof so that all people might share in the growing prosperity of the country. AsgiSA states (The Presidency, n.d.):

> *Government's investigations, supported by some independent research, indicate that the growth rate needed for us to achieve our social objectives is around 5% on average between 2004 and 2014. Realistically assessing the capabilities of the economy and the international environment, we have set a two-phase target. In the first phase, between 2005 and 2009, we seek an annual growth rate that averages 4,5% or higher. In the second phase, between 2010 and 2014, we seek an average growth rate of at least 6% of gross domestic product (GDP).*

To achieve these stated targets, AsgiSA listed 12 flagship projects in the *AsgiSA Summary document*. These projects should contribute significantly towards achieving the above-mentioned growth targets and are as follows (The Presidency, n.d.):

1. A biofuel initiative that will cover at least Northern Cape, Free State, KwaZulu-Natal, Eastern Cape and Mpumalanga;
2. The Makhathini Cassava and Sugar Project in KwaZulu-Natal;
3. A national livestock project that would particularly focus on the Northern Cape and North-West;
4. The Umzimvubu Catchment and Timber Industries Development Initiative in the Eastern Cape;
5. The Dilokong Platinum Corridor to integrate development located around the planned De Hoop Dam in Limpopo;
6. A water reticulation project for Mokopane-Vaalwater-Marken in Limpopo;
7. The proposed Square Kilometre Array and linked projects in the Northern Cape;
8. The Cape Flats Infrastructure Project in the Western Cape;
9. A diamond and gemstone jewellery project in the Northern Cape;
10. A Moloto Corridor Rail Project, mostly in Mpumalanga;
11. Gauteng-Durban Corridor including Johannesburg City Deep, Harrismith Hub and Durban Dube Trade Port; and
12. The Johannesburg International Airport Logistics Hub and Industrial Development Zone in Gauteng.

While it is hardly possible to criticise the AsgiSA's objective and ideals stated, it is disconcerting, however, that the first six projects listed above are all water-intensive. It seems as if these projects were identified in complete isolation from the fact that South Africa is a water-scarce and arid country, considering the profile of water availability provided earlier. The question is: What would the likely impact of the first six projects be on water availability?

4 Materials and Method

4.1 The Model

The model which is used is called UPGEM[1], the University of Pretoria's Computable General Equilibrium (CGE) Model of South Africa. This model is similar to the ORANI-G model of the Australian economy, which is fully presented and explained by Horridge (2002). It also has a theoretical structure that is typical of most static CGE models and consists of equations describing producers' demands for produced inputs and primary factors; producers' supplies of commodities; demands for inputs for capital formation; household demands; export demands; government demands; the relationship of basic values to production costs and to purchasers' prices; market-clearing conditions for commodities and primary factors; and numerous other macro-economic variables and price indices[2]. Conventional, neoclassical assumptions drive all private agents' behaviour in the model. Producers minimise cost while consumers maximise utility, resulting in the corresponding demand and supply equations of the model. The agents are assumed to be price takers, with producers operating in competitive markets, which prevent the earning of pure profits. In general, the static model with its overall Leontief production structure allows for limited substitution on the production side, and more substitution possibilities in consumption. It has constant elasticity of substitution (CES) substructures for (i) the choice of labour, capital and land, (ii) the choice of the different labour types in the model, and (iii) the choice of imported and domestic inputs into the production process. Household demand is modelled as a linear expenditure system that differentiates between necessities and luxury goods, while households' choices between imported and domestic goods are modelled using the CES structure.

4.2 Data

The CGE model is based on the 1998 Social Accounting Matrix of South Africa. It shows the linkages between all players in the economy, such as industries, households, the government and the foreign sector. To model the effects of policy scenarios on water demand, some additional data was required (see Table 1). In principle, for each industry we added the following:

- The quantity of "taxable water" used. This roughly corresponds to raw water abstracted from rivers, but also includes rain falling on tree plantations.
- A semi-elasticity showing how water intensity (water per output) might change in response to a change in volumetric water charges.

[insert Table 1 near here]

Column 1 of Table 1 indicates three main types of sector. Those marked A are in the agricultural sector – large users of water who pay various volumetric charges. Those marked B are bulk users of non-potable water. Unmarked sectors are mostly consumers of potable water delivered by water utilities. We distributed the raw water used by the (municipal) water industry among remaining industrial and household users of treated water. For forestry we have incorporated an estimate of the streamflow loss caused by exotic species (as compared to native species). Column 2 of Table 1 shows quantities of water used. Column 3 shows a range of water tariffs (for 2002) following a survey done among large water utilities, and Column 4 shows elasticities derived from various sources. We estimated semi-elasticities (Column 5) that should be interpreted as the percentage change in water use per unit change in the marginal cost of water, adapted to allow for sector specific variations.

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[1] The model has been widely used in academic journals, and also described. Please see Van Heerden *et al.*, 2006a and 2006b.

[2] This description was taken from Van Heerden *et al.* (2008) where exactly the same model was used.

4.3 The scenarios

The modelling task at hand was to determine the economy-wide impacts on GDP, employment, and water consumption for each of the following three scenarios:

1. In Scenario 1, we inject R1 billion into each of nine sectors linked to the twelve AsgiSA projects listed above. These sectors are:
    - Dryfield agriculture (project 1)
    - Irrigation horticulture (project 2)
    - Livestock (project 3)
    - Timber (project 4)
    - Other mining (project 5)
    - The water sector (project 6)
    - Communication (project 7)
    - Construction (projects 8 and 10–12) and
    - Other non-metal minerals (project 9).
2. In Scenario 2, we increased all water tariffs by 1 c/m^3, including water that has not been taxed or priced before. This would include all registered water used from rivers or from boreholes. Such an increase in tariffs would result in a decrease in water demand of 2,51%. The tax would, however, also have other detrimental effects on the economy, such as a decrease in GDP of 0,011% and a decrease in unskilled employment of 0,028%, among others. It shows one possible way of saving water that would be needed by the industries that would be stimulated in the AsgiSA program. It should be noted that the purpose of this paper is not to find the best way to save water, but rather to illustrate that any government initiative to stimulate growth needs to take the effects on available water into consideration.
3. In Scenario 3, we recycle the revenue collected from the increased or new water tariffs (Scenario 2) back to the "AsgiSA" sectors, and report the net effects on GDP, unskilled employment, and water demand. Recycling this revenue (which is about R175 million, and hence much smaller than R1 billion) would stimulate the various industries and have positive effects on GDP and unskilled employment. The way the recycling is done in the model is by shocking real government revenue to decrease by R175 million, while the overall indirect tax rate per industry is allowed to adjust downwards until the target amount of revenue is reached.

5 Results

The results of modelling the scenarios as described above are depicted in Table 2. Should government invest R1 billion in each of the nine sectors, the total increase in GDP would be 0,53% with the largest contribution coming from the livestock and timber plantation sectors. Employment of unskilled labour would increase by 1,3%, mainly from the aforementioned two sectors as well, but water demand would increase by 2,2%, mainly from the irrigation, timber and water provisioning sectors. The fact of the matter is, however, that the increase in demand for water would outstrip its contribution to GDP by several orders of magnitude and, what is more, this increase is 50% more than the current available surplus supply of water of 1,4%. This does not imply that these projects could not be implemented; it only states that once they are implemented there would be less water for other projects, such as delivering potable water to the thousands of households that do not have such luxury. Another pertinent point is that the water intensity of the nine sectors is far from the same. Approximately 91% of the total 2,2% increase in water demand originates from three sectors only namely irrigation agriculture (0,78%), timber (0,627%) and the water sector (0,584%). While their combined impact on water consumption is 2%, their contribution to GDP is only 0,22% and to employment of unskilled labour only 0,6%. The impact on water consumption is therefore disproportionately more than their impact on the general economy – i.e. the AsgiSA objectives. This illustrates the fact that when considering projects, the sectors selected matter.

[insert Table 2 near here]

Should one increase water tariffs uniformly across the first six, and water intensive, sectors by 1 c/m^3 without recycling the revenue, the decline in GDP is 0,011%, while the decrease in water demand is 2,51%. The decline in the GDP is much less than the reduction in water consumption.

The third column of Table 2 shows that almost all the water saved in Scenario 2 remains saved even if the water tax revenue is recycled. Four industries show "GDP dividends", which means that the net effect of the combined water tax and revenue recycling scheme is positive on GDP. These industries are Livestock, Timber, Water and Communication. Four industries show "Unskilled labour dividends" in that the combined policies would have net employment effects for the economy as a whole, namely Irrigation Horticulture, Livestock, Timber and Water. The latter three industries therefore show "triple dividends" since they show GDP dividends, employment dividends and water saving dividends. Remember that the net effect on the government budget is neutral, since all the revenue that is collected through the water tariffs is recycled back into the economy.

6 Conclusion

AsgiSA implies targeting some economic industries or sectors to stimulate growth. In this paper we argue that the stimulation of any industry would increase the demand for water as input into the production process. To illustrate this we have shown that a hypothetical injection into the economy of R1 billion stimulation to each of nine targeted industries, would lead to a deficit in the available amount of water. It would therefore be physically impossible to stimulate the nine industries as planned, unless the necessary water supplies were re-allocated from other sectors. We "found" enough water for the AsgiSA initiatives from a 1 c/m^3 surcharge on all water demanded in the economy. (We did not use the most efficient method to save water, but taxed all water equally to show our point.) The water tax would decrease the total water demand sufficiently to provide for the AsgiSA initiatives, and have some savings left over. Moreover, if we recycle the water tax revenues towards the nine AsgiSA industries, the negative impact of the water tax is diminished in terms of GDP and employment effects, while a large net saving of water remains.

This analysis shows that macro-economic planning and the design of economic development strategies cannot be done in isolation from considering natural resource constraints. Natural capital is increasingly the limiting factor to development and any investment in economic development should take serious cognisance of these limitations. Here we have not even considered the impacts of climate change (Blignaut et al., in press) and the prevalence and spread of invasive alien plants (Blignaut et al., 2007). Climate change and invasive alien plants are likely to have a detrimental impact on the availability of existing water resources and are likely to reduce the water supply. It is estimated that invasive alien plants by themselves could consume as much as 16% of water in the near future if left unchecked (Cullis et al., 2007).

This does not imply that AsgiSA should not continue seeking sectors and projects to investment in, but that it should consider resource constraints in an integrative manner. Opportunities should be explored that, through investing in natural capital, will stimulate economic development, create jobs and augment the dwindling supply of natural resources. So, is water shedding next? The answer would be positive if macro-economic decision-making is not conducted in such a way as to acknowledge and plan with implicit resource constraints and bio-physical and hydrological patterns and features. Water shedding's feedback loop, however, is likely to be much more delayed than that of electricity and will not be directly and immediately observed. This might lead to non-action and ill-founded complacency while immediate action is required.

References

[1] Aronson J, Blignaut JN, Milton SJ and Clewell AF (2006) Natural capital: The limiting factor. *Ecological Engineering* 28, 1–5.

[2] Blignaut JN, Ueckerman L and Aronson J (In press) Agriculture production's sensitivity to changes in climate in South Africa. *South African Journal of Science*.

[3] Blignaut JN, Marais C and Turpie J (2007) Determining a charge for the clearing of invasive alien plant species to augment water supply in South Africa. *WaterSA* 33(1) 27–34.

[4] Botha FS (2005) *A proposed method to implement a groundwater resource information project (GRIP) in rural communities, South Africa* (Unpublished PhD). Department of Geohydrology, Faculty of Natural Science and Agriculture, University of the Free State, Bloemfontein.

[5] Council for Scientific and Industrial Research (CSIR) (2001) *Water Resource Accounts for South Africa.* Report to Statistics South Africa and The Department of Environment Affairs and Tourism. Report number ENV-P-C 2001-050. CSIR, Pretoria.

[6] Cullis J, Görgens A and Marais C (2007). A strategic study of the impact of invasive alien vegetation in the mountain catchment areas and riparian zones of South Africa on total surface water yield. *WaterSA* 33(1) 35–42.

[7] Daly HE and Farley J (2004) *Ecological economics*. Island Press, Washington DC.

[8] DBSA (2000) *Environmental impacts of the forestry sector in South Africa with specific reference to water resources*. CSIR Report, ENV-P-C 99016.

[9] Department of Water Affairs and Forestry (DWAF) (2004) *National Water Resource Strategy*. DWAF, Pretoria.

[10] Farley J and Daly HE (2006) Natural capital: The limiting factor: A reply to Aronson, Blignaut, Milton and Clewell. *Ecological engineering* 28, 6–10.

[11] Farley J and Gaddis E (2007). Restoring Natural Capital: An Ecological Economics Assessment. In Aronson J, Milton S and Blignaut JN (Eds) *Restoring Natural Capital: Science, Business and Practice*. Island Press: Washington, DC.

[12] Horridge M (2002) *ORANI-G: a generic single-country computable general equilibrium model*. Edition prepared for the Practical GE Modelling Course, June 17–21.

[13] Le Maitre DC, Versveld DB, Chapman RA (2000) The impact of invading alien plants on surface water resources in South Africa: a preliminary assessment. *WaterSA* 26(3) 397–408.

[14] Renzetti S (1992) Estimating the structure of industrial water demands: the case of Canadian manufacturing. *Land Economics* 68(4).

[15] Scholes R (2001) Global Terrestrial Observing System: Regional Implementation Plan for *Southern Africa*. GTOS-21. CSIR, Pretoria.

[16] Schreiner B and Van Koppen B (2002) Catchment Management Agencies for poverty eradication in South Africa. *Physics and Chemistry of the Earth* 27, 969–976.

[17] Statistics South Africa (SSA) (2006) *Water resource accounts for South Africa: 1995 & 2000.* SSA, Pretoria.

[18] The Presidency (n.d.) *AsgiSA Summary document.* Available at: http://www.info.gov.za/asgisa/asgisa.htm (accessed February 2008).

[19] Van Heerden JH, Blignaut JN and Horridge M (2008) Integrated water and economic modelling of the impacts of water market instruments on the South African economy. *Ecological economics* 66(1) 105–116.

[20] Van Heerden JH, Gerlagh R, Blignaut JN, Horridge M, Hess S, Mabugu R and Mabugu MR (2006a) Searching for Triple Dividends in South Africa: Fighting CO2 Pollution and Poverty while Promoting Growth. *The Energy Journal* 26(2), 113–141.

[21] Van Heerden JH, Blignaut JN, Mabugu M, Gerlagh R, Hess S, Tol RSJ, Horridge M, Mabugu R, De Wit MP and Letsoalo A (2006b) Redistributing environmental tax revenue to reduce poverty in South Africa: the cases of energy and water. *South African Journal of Economic and Management Sciences* 9(4), 537–552.

[22] Veck GA, Bill MR (2000) *Estimation of the residential price elasticity of demand for water by means of a contingent valuation approach.* Water Research Commission Report No: 790/1/00.

[23] Vegter JR (2001) *Groundwater Development in South Africa and an introduction to the hydrogeology of the groundwater regions.* WRC document TT 134/00. WRC, Pretoria.

Table 1: Taxable water, water tariffs (2002) and the semi-elasticity for water demand

	(1)	(2) Taxable water (million m^3)	(3) Water tariff (R/m^3)	(4) Elasticity	(5) Semi-elasticity
Irrigated field	A	7 152	0.10	-0.25	-44.20
Dry field	A	0	0.10	-0.15	0.00
Irrigated horticulture	A	3 400	0.10	-0.25	-44.20
Dry horticulture	A	0	0.10	-0.15	0.00
Livestock	A	191	0.10	-0.15	-37.73
Forestry		1 673	1.80	n.a.	0.00
Other Agric	A	25	0.10	-0.15	-26.54
Coal	B	40.3	2.12	-0.32	-47.654
Gold	B	284.8	2.12	-0.32	-47.654
Crude, petroleum & gas	B	0.74	2.12	-0.48	-88.02
Other mining	B	368.3	2.12	-0.32	-47.654
Food		376.4	4.00	-0.39	-49.050
Textiles		104.4	4.00	-0.33	-41.325
Footwear		0	4.00	-0.33	-41.325
Chemicals & rubber	B	59.4	2.12	-0.15	-22.576
Petroleum refineries	B	92	2.12	-0.48	-70.656
Other non-metal minerals	B	44	2.79	-0.32	-43.986
Iron & steel	B	56.21	2.79	-0.27	-37.017
Non-ferrous metal	B	14.04	2.79	-0.27	-37.017
Other metal products	B	60	2.79	-0.27	-37.017
Other machinery		37.27	4.00	-0.25	-47.500
Electricity machinery		6.23	4.00	-0.38	-47.713
Radio		0	4.00	-0.38	-47.713
Transport equip		20.42	4.00	-0.38	-47.713
Wood, paper & pulp	B	157.5	2.12	-0.59	-86.609
Other manufacturing		13	4.00	-0.38	-47.713
Electricity	B	208	2.12	-0.80	-328.17
Water	B	5 906.0	2.12	-0.60	-88.302
Construction		167.12	4.00	-0.38	-47.713
Trade		491.4	4.00	-0.19	-23.750
Hotels		319.8	6.11	-0.19	-22.110
Transport services		497.11	6.11	-0.19	-22.110
Community services		175.8	6.11	-0.19	-22.110
Financial Institutions		281.3	6.11	-0.19	-22.110
Real estate		662	6.11	-0.19	-22.110
Business activities		26.2	6.11	-0.19	-22.110
General government		524.76	6.11	-0.19	-22.110
Health services		331.3	6.11	-0.19	-22.110
Other service activities		198.74	6.11	-0.19	-22.110

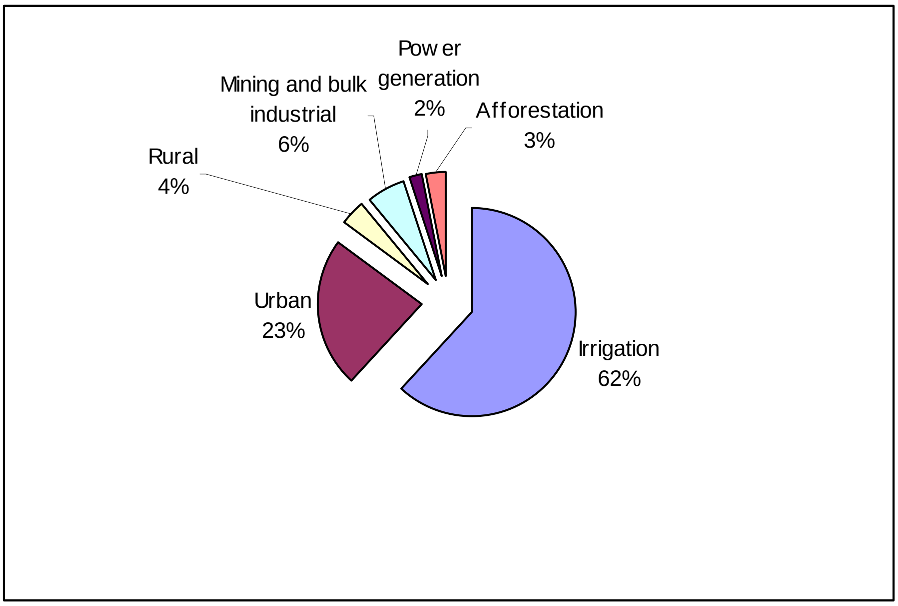
Note: Sectors marked A are agricultural – large users of water who pay little in the form of volumetric charges. Those marked B are bulk users of non-potable water.

Sources: Semi-elasticities are derived from DWAF's water tariff table and survey conducted among large water utilities, DBSA, 2000; Renzetti, 1992; Veck and Bill, 2000; and Le Maitre et al., 2000.

Table 2: Results from modelling the implementation of the nine water intensive AsgiSA projects on GDP, employment, and water demand

	% change in		
	GDP	**Unskilled labour**	**Water use**
Scenario 1: Injection of R1b in			
- Dryfield agriculture	0.037	0.112	0.025
- Irrigation horticulture	0.054	0.183	0.780
- Livestock	0.091	0.223	0.099
- Timber	0.093	0.250	0.627
- Other mining	0.045	0.098	0.021
- Water sector	0.070	0.161	0.584
- Communication	0.070	0.112	0.037
- Construction	0.022	0.041	0.010
- Other non-metal minerals	0.050	0.116	0.014
Total	**0.533**	**1.295**	**2.196**
Scenario 2: Water tariff increase 1 c/m^3	-0.011	-0.028	-2.51
Scenario 3: Water revenue recycled to: (net results)			
- Dryfield agriculture	-0.0040	-0.0081	-2.51
- Irrigation horticulture	-0.0011	+0.0043	-2.38
- Livestock	+0.0054	+0.0112	-2.49
- Timber	+0.0057	+0.0160	-2.40
- Other mining	-0.0026	-0.0106	-2.51
- Water sector	+0.0018	+0.0004	-2.41
- Communication	+0.0018	-0.0082	-2.51
- Construction	-0.0067	-0.0205	-2.51
- Other non-metal minerals	-0.0017	-0.0075	-2.51

Figure 1: **Water requirements by sector in South Africa in 2000**



Source: SSA 2006.