NATIONAL WATER AND SANITATION MASTER PLAN

Abstract - Water and the Economy

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Definitions

"average price" means the average price that all buyers would be willing to pay

"basic water supply" means a supply of 25kl/day per person or 6kl/household per month

"behavioural issues" means the behaviour of a person or community or business or mine with respect to water use, such as whether they treat water as a scarce resource and conserve it, or alternatively whether they do not value it and waste it, whether they pollute the source, and whether they install illegal connections etc.

"direct re-use" means that wastewater is treated in a wastewater treatment works to a standard fit for use and redistributed without being released into a stream

"economic benefit of water" means recognizing that water has value in competing uses. Managing it as an economic good means that water will be allocated across competing uses in a way that maximizes or optimizes the net benefits achieved from that amount of water

"free of charge" means water supplied is not paid for by a user or recipient

"free of cost" means water that is not necessarily free of charge, but costs are still incurred in producing potable water that is lost in leaks or provided free of charge

"gross domestic product" means the way a country's economy is measured in its National Accounts by an indicator called the Gross Domestic Product (GDP)

"indirect re-use" means when treated or untreated waste water or grey water is released into a stream and abstracted downstream in diluted form as raw water

"marginal cost" means the cost of supplying the additional unit

"marginal price" means the price the last buyer would be willing to pay for one additional unit

"non-use value of water" means the value that people assign to economic goods (including public goods) even if they never have and never will use it. It is distinguished from use value, which people derive from direct use of the good. The concept is most commonly applied to the value of natural and built resources.

"re-used water" means direct re-use

"value of water" see economic benefit of water

“water as basic human need” means that access to a minimum quantity of water is essential for life and well being and is included in South Africa as a Constitutional Right. Regulations under the Water Services Act give effect to this right by providing for a minimum basic water supply of 25kl/day per person or 6kl/household per month

“water as economic good” means see economic benefit of water

1. OVERVIEW OF THE VALUE OF WATER IN SOUTH AFRICA

1.1 INTRODUCTION

While the physical management of water is relatively well understood, this is not necessarily the case with the cost of supplying water and its contribution or value to the economy.

The purpose of this brief overview is to give a broad economic foundation to decisions that are to be made in finalising the National Water and Sanitation Master Plan (NW&SMP).

The overview first describes important economic concepts and then drills down into the use of water in the primary sectors of the economy.

Access to water is key to economic prosperity and better living standards. Human beings, manufacturing activities, commercial farms, and mining processes all need water to thrive. Lack of water means no economic activities will happen and the people will be in a constant state of poverty.

The National Water and Sanitation Master Plan indicates that South Africa is facing a water crisis caused by insufficient water infrastructure maintenance and investment, recurrent droughts driven by climatic variation, inequities in access to water and sanitation, deteriorating water quality, and a lack of skilled water engineers. This water crisis is already having significant impacts on the economy inter alia as follows:

- Impact on revenue generation and the cost of treating water;
- Productivity losses;
- Declining Economic growth;
- Health and hygiene impacts;
- Impact on Tourism;
- Access to water for productive uses (water use authorisations).

Increasing competition for water-use in the urban, agricultural, and industrial sectors, including through population growth and the migration to higher levels of service, has resulted in severe pressures on water resources, with some cities and towns already experiencing water shortfalls. The question can be asked: What will be the impact of a doomsday scenario where multiple cities run out of water (reached day zero) due to an extreme climatic event? This question has not been well analysed, but it is postulated that an extreme climatic event would be similar to an extreme wave event (tsunami), or earthquake event or weather event (cyclone), but perhaps covering a larger geographic area (regional instead of local) and over an extended time duration (perhaps years instead of months). Perhaps even comparable to a civil war. Depending on severity, services could breakdown, formal work could cease, and there could be forced mass migration.

The National Water and Sanitation Master Plan consequently provides for the implementation of a number of water resource schemes and the use of desalination and re-use to supplement the national water supply in order to mitigate the effect of drought.

Water resources management is linked to geo-spatial considerations. There are often large spatial differences in terms of the availability and use of water resources between the different river catchments of a country, especially in “water stressed” countries such as South Africa. The use of national averages is not always a good reflection of the status in a particular catchment. Consequently, the river basin or catchment is the universally recognized unit of management for Integrated Water Resource Management (IWRM).

However, this brief overview merely looks at the national picture. Catchment Management Strategies should develop economic pictures for specific catchments.

1.2 WATER AS AN ECONOMIC GOOD

A primary debate is whether, or perhaps rather to what extent, water should be treated as an economic good.

Most stakeholders would probably instinctively accept that water sold to agriculture and industry is an economic good and treated by these users as an input cost.

Many stakeholders would similarly agree that water set aside for the environment and for basic human needs should not be treated as an economic good.

While perhaps not as clear cut as the above, it could be predicted that most stakeholders would be ambivalent to the proposition that water sold for domestic use in excess of basic human needs, such as gardening or pool filling, would have the characteristics of an economic good.

However, in South Africa, the prices charged for water often does not reflect its economic or market value primarily because water is a State allocated good, it is heavily regulated, and its various uses are not all treated as if they are using the same commodity or finite resource.

It has been argued that the price charged for water often does not even reflect its full cost of production (storage, treatment, distribution), never mind its economic scarcity as a resource.

The techniques often used for estimating the value of water are sometimes not linked to the National Accounts (GDP calculations).

1.3 WATER AS A SOCIAL GOOD

The legal right of all consumers to a basic water supply assigns a social value to water. Access to potable water leads to sustainable communities and improving people's social being which translates to the social value of water.

Water must as least serve the dual but interrelated purposes of satisfying the social requirements of the population, and of meeting the demand of a growing economy.

1.4 GROSS DOMESTIC PRODUCT (GDP)

Generally, a country's economy is measured in its National Accounts by an indicator called the Gross Domestic Product (GDP), and this indicator is perhaps more commonly communicated by the Reserve Bank or Stats SA as being the percentage change in the GDP from one period to the next, e.g. annualised 3% growth in GDP for the quarter.

The standard approach to calculating the GDP of a country is by means of the following formula:

GDP = Consumption + Investment Spending + Government Consumption + Exports Less Imports

The GDP has its counterpart, the Gross National Income (GNI), and although the figures should theoretically be the same, there are sometimes differences, and the GNI is less widely reported.

1.5 INFORMATION REQUIRED TO PROPERLY ACCOUNT FOR THE IMPACT OF WATER ON THE ECONOMY

To properly understand the interaction between the allocation, payment for and flows of water and the contribution of water to the economy, the following information would ideally be required (adapted from, and supplemented to, the System of Environmental-Economic Accounting for Water developed by the United Nations 2008):

1. The volume and quantity of water supplied to, and discharged from:
   a) households up to the amount of the basic water requirement;
   b) households above the basic water requirement to households;
   c) commercial-industrial users;
   d) agriculture;
   e) forestry;
   f) energy generation;
   g) mining;
   h) re-use of water;
2. The loss of water through leaks;
3. The cost of collection/storage, purification, distribution and treatment of water for each of the above uses being:
4. The capital investment in infrastructure to produce each of the above supplies;
5. The O&M costs to produce each of the above supplies;
6. The financing of these costs,
7. The water tariff/charges charged to each of the above sectors or for each of the above supplies;
8. The actual revenue collected from the water tariff; and
9. The contribution of each of the above user-sectors to the economy.

1.6 POLICY DISCRETION

The quantum and distribution of the economic benefit of water, and the growth of the economy is not unaffected by policies such as the National Water and Sanitation Master Plan.

Government can and does influence the magnitude of the economic benefit of water, and the distribution of that benefit, through the following decisions:

- Allocating water resources efficiently.
  - The value of water to the economy, or the country's GDP, is affected by the quantity of water used for various purposes, including domestic, agriculture, manufacturing, mining, energy generation, as well as the quantity of wastewater and effluents generated;
- Improving water efficiency;
  - Such as reducing leakage and improving the water efficiency of energy generation, manufacturing or irrigation systems, and improving the efficiency of institutions and of schemes;
- Getting the most value for money from investing in infrastructure and operating and maintaining water systems; and
- Charging economically reflective tariffs.

1.7 WATER PRICING

Two pricing concepts are important to understanding any discussion on economics:

1. Average price is the average price that all buyers would be willing to pay, and it has its equivalent in the average cost of the water supply. Average cost is simply calculated by dividing the total sales by the total cost to produce those sales. Capital costs are annualised for that purpose using financial concepts such as Return on Assets, depreciation etc.

   - Average pricing will give financial break even but will not be a good indicator of whether the next scheme gives a positive cost – benefit ratio.

2. Marginal price is the price the last buyer would be willing to pay for one additional unit and marginal cost is the cost of supplying that additional unit. For example, the unit price of water transferred from the next phase of the LHWP would be a good proxy for the marginal cost of augmenting the Vaal River System;

- Marginal pricing reflects a competitive market, meaning that a supplier would not be prepared to supply one unit more unless the user was prepared to pay the additional cost of that additional unit.
- In simple terms, in an ideal market, the State would not build a new dam unless the users were prepared to pay the marginal cost of water from that additional dam, which would generally be above the average cost or the then current cost of supplying water.
- For example, if the price of water paid by users for each Kl supplied from LHWP Ph 2 was less than the cost of producing each Kl supplied from LHWP and all other financial considerations being equal, the State or the Trading Account or TCTA would be financially worse off if it build LHWP Phase 2.

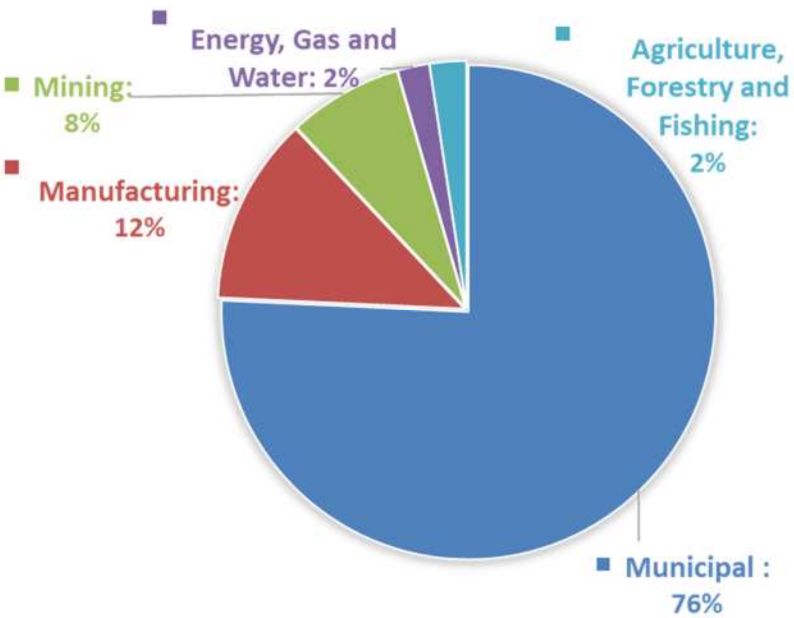
2. CURRENT SITUATION IN SOUTH AFRICA

The GDP of South Africa was approximately R4,3 trillion in 2017. The split in sector contributions to the GDP during 2017 is illustrated within Figure 2-1: Sector Contributions to GDP 2017 below. Stats SA states that the largest negative contributors to growth in GDP in 2017 were the agriculture, mining and manufacturing industries and the main positive contributions came from finance, real estate and business services and government.

(GDP in South Africa is reported in 2010 base year Rands. The above figures were inflated to base year 2017 equivalents).

In order to grow the economy, investment in terms of water should be directed to those sectors that would stimulate sustainable economic growth.

Figure 2-1: Sector Contributions to GDP 2017



Source: Stats SA, Statistical Release P0441, 2018

The real values are included within Table 2-1: Value added by Sector.

Table 2-1: Value added by Sector

Agriculture, forestry and fishing	Mining	Manufac-turing	Electricity, gas and water	Municipal (Tourism, Transport, Finance, Government Services, Personal Services)
(Rand billion)				
R75 185	R234 305	R384 036	R65 018	R2 081 872

The NW&SMP reports that agriculture is the main water user as illustrated within Figure 2-2: Water Use per Sector below.

Figure 2-2: Water Use per Sector

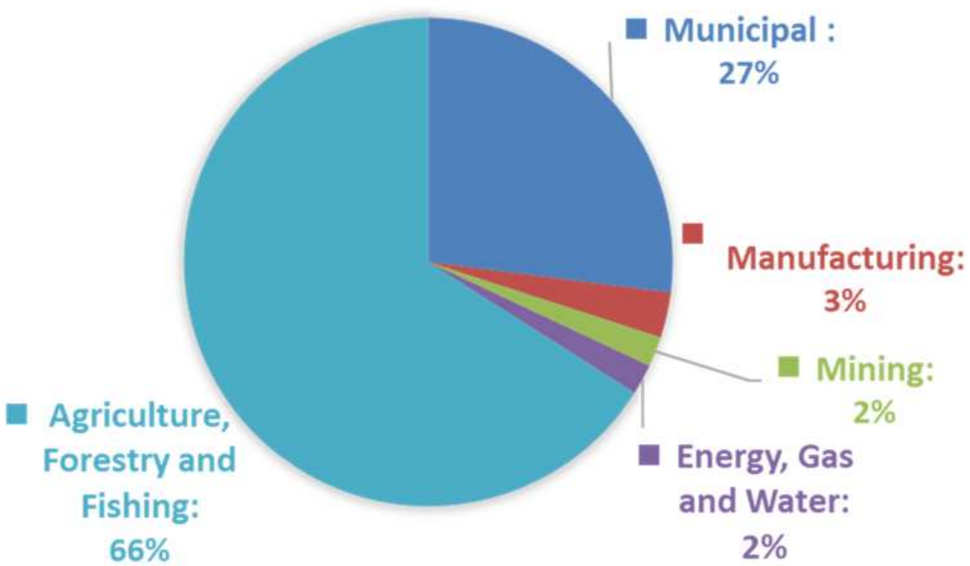
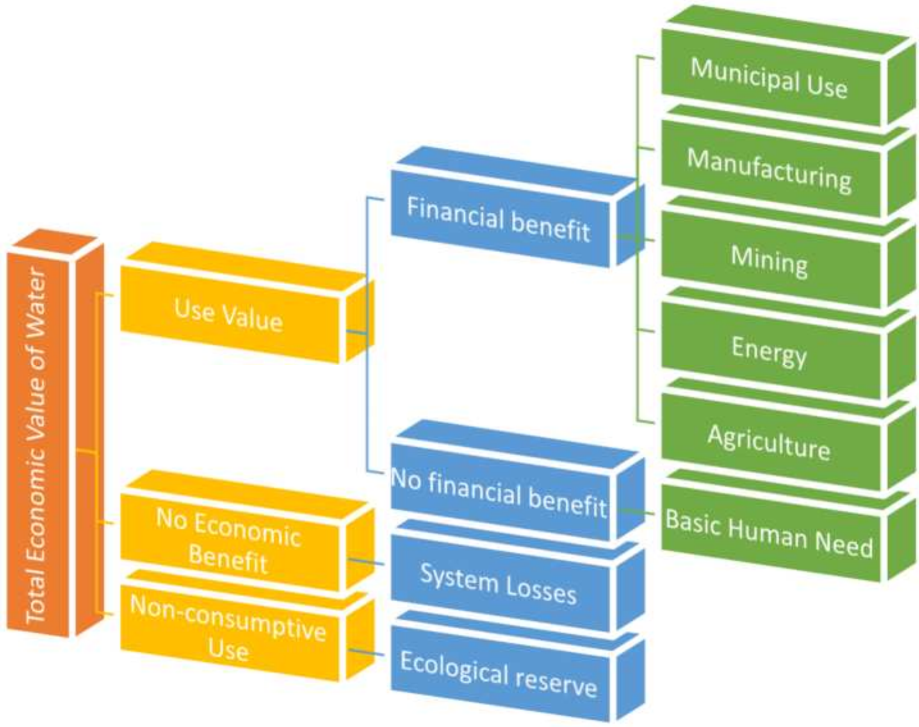


Figure 2-3: Total economic and environmental value of water overleaf illustrates that not all water is currently sold. Water for basic human needs is supplied free of charge, but of course not free of cost.

Similarly, water lost from the system (system losses) is not sold, but is also not free of cost. However, unlike water for basic human needs, system losses have no social or economic benefit.

Some water is not abstracted and supplied, but provision is made for leaving a desired minimum quantity or a reserve in the streams or in the lakes, such as water for ecological use. This document does not however account for the non-use value of water such as the indirect, but substantial, economic benefit of the environment. That would be a separate exercise.

Figure 2-3: Total economic and environmental value of water

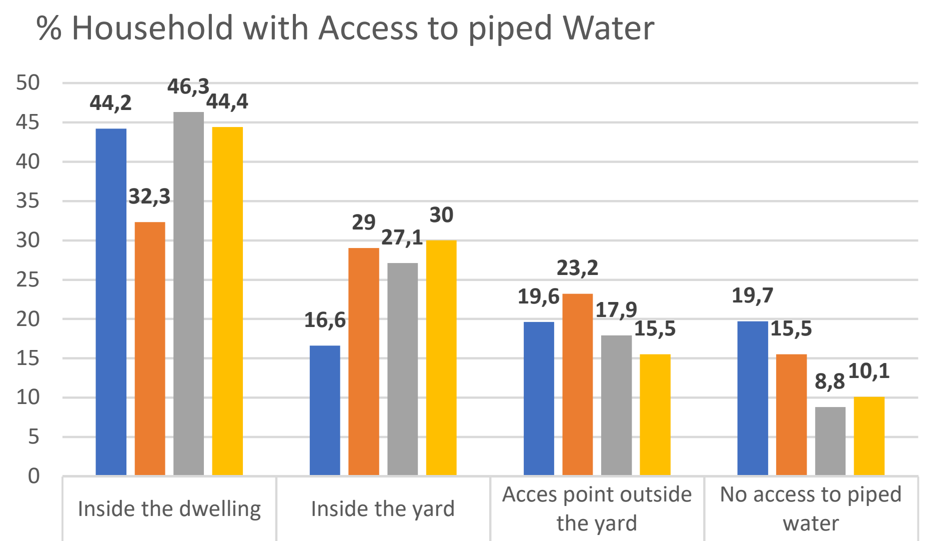


2.1 HOUSEHOLD SUPPLY AND UNACCOUNTED-FOR OR NON-REVENUE WATER

In South Africa, all users have a Constitutional right to a basic water supply, which the State has quantified as being 6 kl per household per month (25 l/c/d) (GN 509 of 2001, reg 3(b)), although a strong motivation was given to the Constitutional Court in the JHB Water – Mazibuko Constitutional Court case that 50 l/c/d might be a more appropriate figure.

The Constitutional right of all consumers assigns a social value to water as access to potable water leads to sustainable communities. The Community Survey 2016 reported that approximately 15% of households have access to piped water from a communal pipe, and the remaining 74% have a piped supply inside the yard or dwelling. However, approximately 10% of households still do not have access to piped water. The status of households' access to potable water is illustrated within Figure 2-4: Percentage of households by access to piped water below.

Figure 2-4: Percentage of households by access to piped water



	Inside the dwelling	Inside the yard	Acces point outside the yard	No access to piped water
Census 1996	44,2	16,6	19,6	19,7
Census 2001	32,3	29	23,2	15,5
Census 2011	46,3	27,1	17,9	8,8
Community Survey 2016	44,4	30	15,5	10,1

Source: Community Survey 2016 Statistical release P0301

Current unaccounted for, or non-revenue, water supplied by municipalities is estimated to be in the order of 46%. (Mckenzie R; Siqalaba ZN; Wegelin WA, August 2012). Actually, the real figure is not known as municipalities do not report on their water balance as required by the regulations under Section 9 of the Water Services Act. This lack of reporting will be remedied to some extent if the No-Drop programme is restarted. The high values for non-revenue or unaccounted water is not restricted to rural areas, and nor is the average a true reflection of what is happening in all areas.

A typical urban situation is found in Orange Farm in JHB:

- The total supply to Orange farm is 26 912 901 kl per annum to 49,824 properties.
- 89% of the supply is non-revenue water (NRW).
- A large component of NRW is attributed to unbilled unmetered consumption and physical losses due to mains and property leaks. Only 10% of losses are attributable to leaking mains.
- Addressing the Orange Farm NRW would cost in the order of R375 million has a potential of saving 9 Ml per annum which is equivalent to some R55 million per annum, and has the additional benefit of increasing revenue.

Similar examples of non-metered areas abound in other Metropolitan Areas and in municipalities across South Africa.

If the consumption is not limited to 6 kl per household per month and the consumption is not measured on each individual stand then the policy of a free 6 kl per household month is irrelevant in areas such as Orange Farm.

In real terms, all of the water supplied to Orange Farm is being supplied for free.

The market forces do not favourably consider whether a municipality agrees that water is an economic good or not.

2.2 A BASIC UNDERSTANDING OF SUPPLY AND DEMAND CURVES – "ECONOMICS 101"

The next few sections use supply and demand curves to explain likely economic-market behaviour when a specific water user group is charged a price that is not cost-reflective.

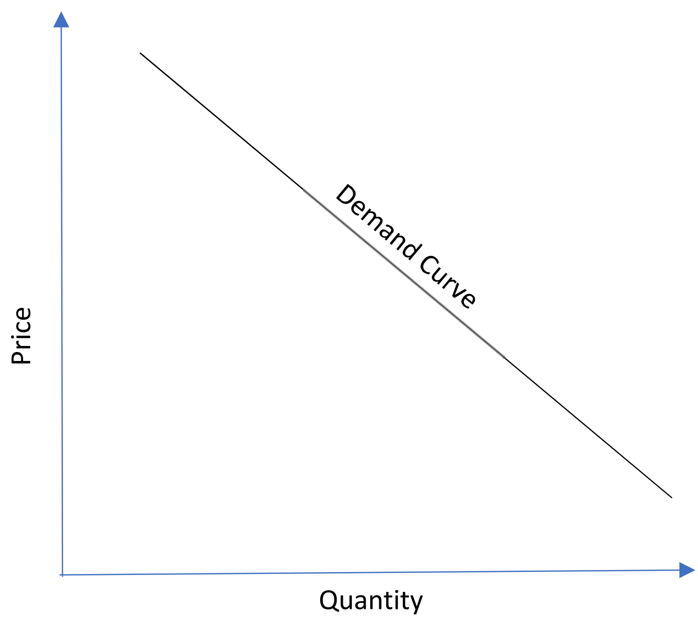
Certain fundamental economic principles are discussed here as an introduction in order to facilitate an understanding of what follows.

The Demand Curve

In the Figure 2-5: The Demand Curve below, price is measured along the vertical axis, and supply along the horizontal axis.

The demand curve reflects the quantity of a product or commodity that users will demand at different prices.

Figure 2-5: The Demand Curve



The demand curve generally slopes from top left to bottom right. The reason being that the cheaper the price the greater quantity users/purchasers will demand, and the higher the price the less quantity the users will demand.

For example if the price of fuel or water or wine rose from R3 per litre to R20 per litre, the quantity demanded would fall.

Alternatively, if the price fell from R20 per liter to R3 per liter then the demand (or quantity demanded) would increase.

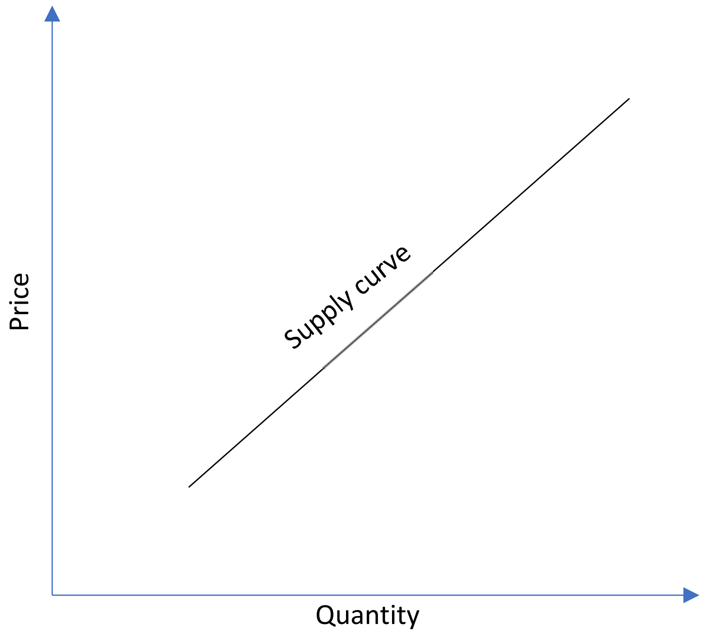
The supply curve

The supply curve is the counterpart to the demand curve.

The supply curve reflects the quantity of product or commodity that suppliers would supply at different prices.

The supply curve rises from bottom left to top right. The reason is that the higher the price the greater the quantity that suppliers would be prepared to supply.

Figure 2-6: The Supply Curve



For example, if the price of fuel or water or wine rose in price from R3 to R20 per litre then it would be profitable for more supply to enter the market and the supply would increase, and conversely if the price fell from R20 to R3 then some suppliers would exit the market and the supply (or quantity of product supplied) would decrease.

Equilibrium price

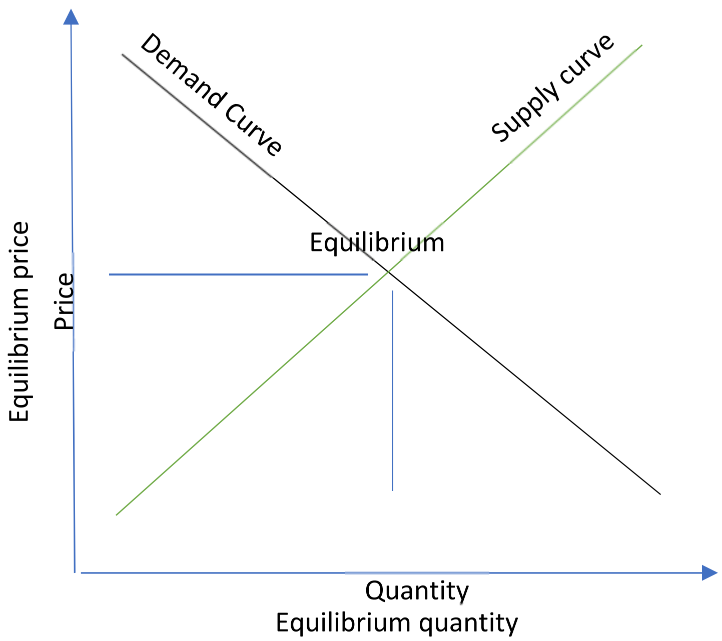
If the demand and the supply curve are shown on the same graph, then it intersects at a point. This is the point where supply and demand are in equilibrium.

Figure 2-7: Equilibrium Price

At the equilibrium price, suppliers are prepared to supply the same quantity as the quantity demanded by users, i.e. the equilibrium quantity.

In other words, the market would clear; there would be no excess demand, and there would be no excess supply and the equilibrium price.

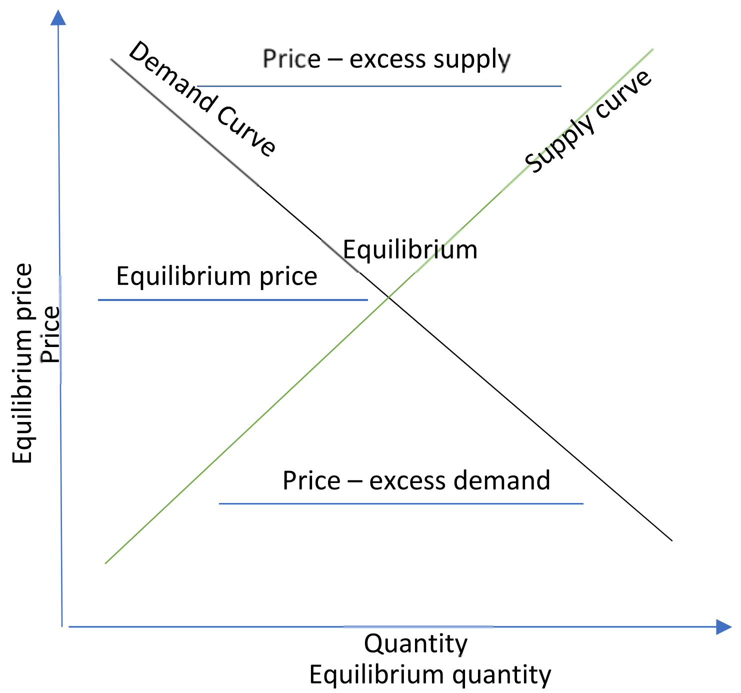
As explained Figure 2-7: Equilibrium Price, in a perfect market, prices would move towards the equilibrium, resulting in an equilibrium of demand and supply.



Implications of too high a price or too low a price

As shown in the Figure 2-8: Implications of Price below; if the price was higher than the equilibrium price, there would be excess supply, i.e. unsold goods. Over time some of the supply would leave the market and the price would move towards the equilibrium price.

Figure 2-8: Implications of Price



If the price was below the equilibrium price, there would be excess demand, or alternatively a supply deficit, or too few goods for sale. Over time the demand would compete for the limited supply, the price would move up towards the equilibrium price, and this higher price would attract additional supply into the market.

This point of equilibrium is a price of trade-off. Suppliers want a higher price but they cannot sell all of their goods at the higher price, and users want a lower price, but the market will not supply them with sufficient goods at a lower price.

Any price above or below the market price will not self-sustain. A higher price than the equilibrium price will require subsidies to either sustain/increase the demand or reduce the local market supply (export subsidies), and a lower price than the equilibrium price will require rationing or regulations or other constraints to limit the demand, or supplier subsidies to increase the otherwise non-profitable supply.

In summary then, in a perfect market the price would move towards the equilibrium price, a price where the demand and supply are equal, unless there was intervention. The further the price from the equilibrium price the greater the intervention required to retain the non-market reflective price. And in certain era's, where governments tried to defy the market completely, such as insisting that bread be supplied free, the result was large scale starvation and unrest and toppling of governments.

Market forces reflect human nature on the demand side and the profit-survival motive of suppliers. Market forces cannot be wished away by political choice, no more than can the weather and other forces of nature.

Now how does this economic theory apply to the water sector?

The economics of supply and demand in the water sector

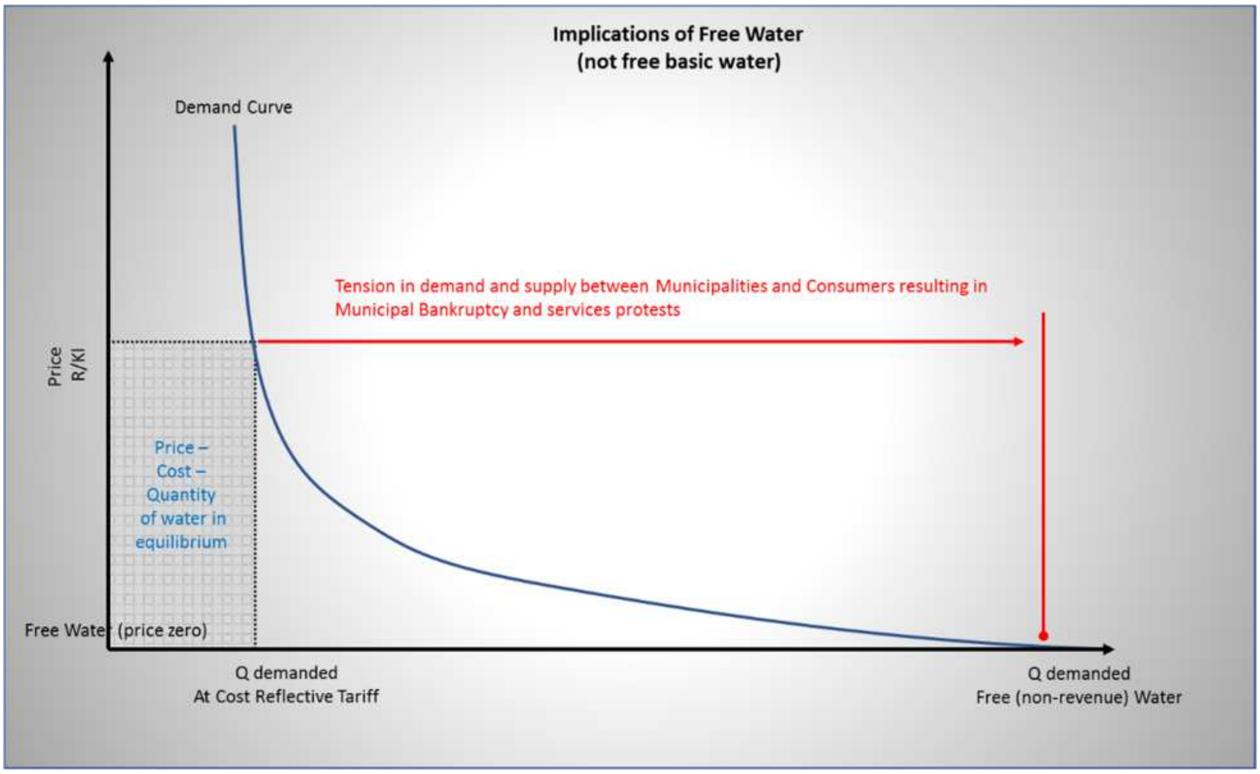
Figure 2-9: Free Water below illustrates the following:

- If water is given for free then users will have a demand for more than their fair allocation;
- The municipality will suffer a decrease in revenue and be able to afford to supply less than a fair allocation;
- Demand will exceed supply;

- The dams will run empty that will have a disastrous impact on the overall economy;
- Users will be unhappy that would lead to violence and services protests.

If, however the grants are transferred directly to users and not to institutions, and users are compelled to pay for every drop of their water, then they would need to decide how to spend or allocate their money, and unnecessary water use would be one of those supply – demand decisions that users would have to make.

Figure 2-9: Free Water



To understand the above graph the following should be noted:

- The vertical axis is the price charged for water.
- The horizontal axis is the volume of water used.
- The demand curve generally falls from top left to bottom right because users demand more water when the price is lower, or alternatively demand less water when the price is higher.
- The shaded rectangle indicates a point on the demand curve where the price is such that the municipality is able to supply that volume of water at that price, and where the users are satisfied with the amount of water that they are getting at that price. In other words, it indicates a price where there would be supply-demand equilibrium.
- However, on the far right of the demand curve water is supplied for free, either by default such as in Orange Farm, or intentionally. At this, zero price, water demand is far higher than a basic water supply. At this zero price, the municipality cannot afford to supply the volume of water demanded. There is thus tension between supply and demand.

2.3 IRRIGATION

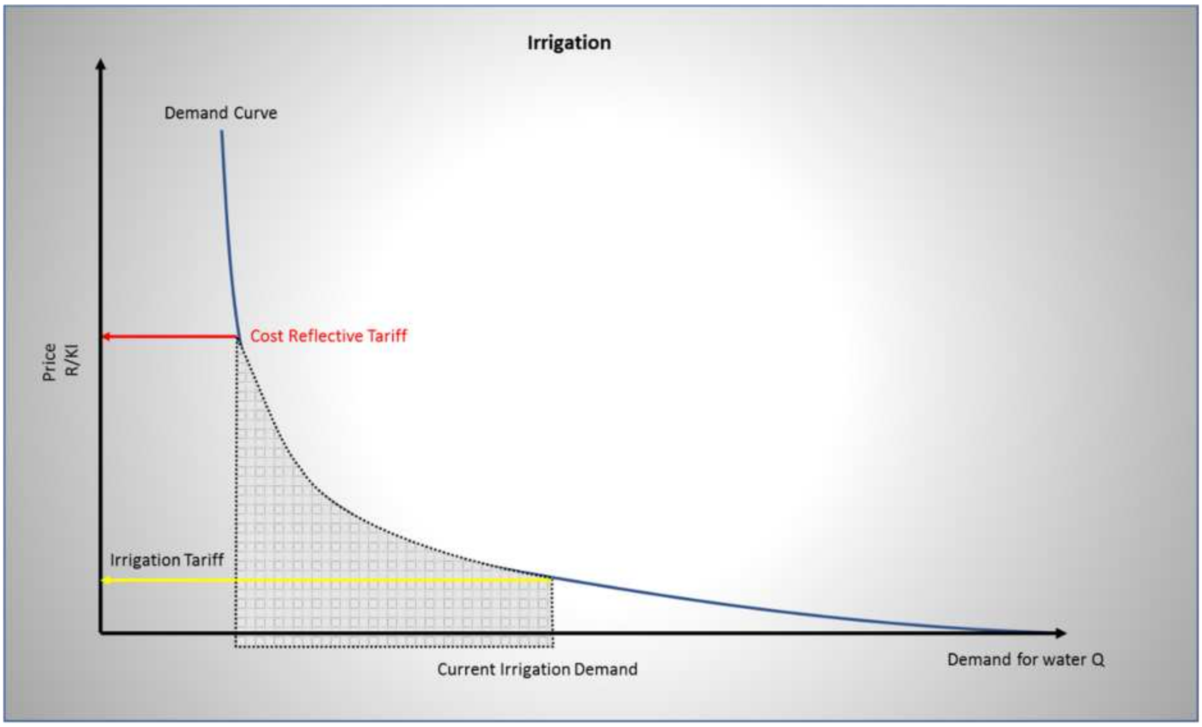
Irrigators do not pay the water resource infrastructure charge.

Irrigators, with a few exceptions, pay a few cents per kilolitres for their raw water, even in the Vaal River Catchment, and Berg Water Catchments. Domestic and Industrial Users pay a much higher charge. For example, the irrigation raw water charge in the Vaal River is in the order of 2.21 c/kl and in the Orange River in the order of 3.34 c/kl, and in the Berg River (Voelvlei Dam) as low as 1.52 c/kl (DWS, 2018).

Raw water charge for domestic and industrial users is 305.50 c/kl out of the Vaal River and 62.05 c/kl for the City of Cape Town from the Berg River (Voelvlei Dam) (DWS, 2018).

In addition, CMA charges between 0.8 c/kl and 2.81 c/kl for irrigation and between 1.49 c/kl and 4.72 c/kl for domestic and industrial use (DWS, 2018). The difference in the amount charged for water is exacerbated in that domestic and industrial users pay against a volumetrically measured consumption while irrigators pay for a deemed or registered consumption, meaning irrigation use is not measured for the purposes of charging them.

Figure 2-10: Implications of undercharging for irrigation



Again, the market forces will ignore all sentiment, but the following should be taken into account:

- Irrigators generally (with few exceptions) pay far less than the average cost of water;
- Irrigation use is not insubstantial;
- Lawful irrigation abstraction uses approximately 60% of total water use in South Africa; and
- Unlawful irrigation abstraction is not quantified, but may be substantial.

The country plans to spend billions of Rand adding to the total water supply to meet the increase in domestic and industrial use while irrigators will use their full water allocation as long as the marginal net value of the crop per kl exceeds the one, two or three cents per kl cost of the irrigation water.

There is little incentive for irrigators to spend the equivalent marginal billions of Rand to save the equivalent of the marginal or additional supply. However, while the pricing signal of a relatively low water price for irrigation exists, other regulatory steps such as enforcement of water metering will be necessary to manage water inefficiencies by irrigators.

To understand the above graph the following should be noted:

- The demand falls from top left to bottom right.
- The cost reflective tariff shown in red is the break even cost-price at which water can be supplied.
- The irrigation tariff shown in yellow is far lower than a cost reflective tariff shown in red.
- The irrigation demand would thus be higher than the demand would be if the cost reflective tariff was charged.
- Charging irrigators less than the cost of supplying the water is a form of hidden subsidy and encourages over-use of water.

2.4 INDUSTRIAL USE

Industrial users pay a charge that is far higher than the average cost of producing water as shown in the previous section, about twenty to one hundred times the charge paid by irrigators for indistinguishable raw water.

Industrial users cross subsidise irrigation and cross-subsidise leakage and other non-revenue water.

Perhaps other regulated input costs in South Africa, such as energy, transport, security, rates and taxes are also inflated through inefficiencies and skewed regulated pricing.

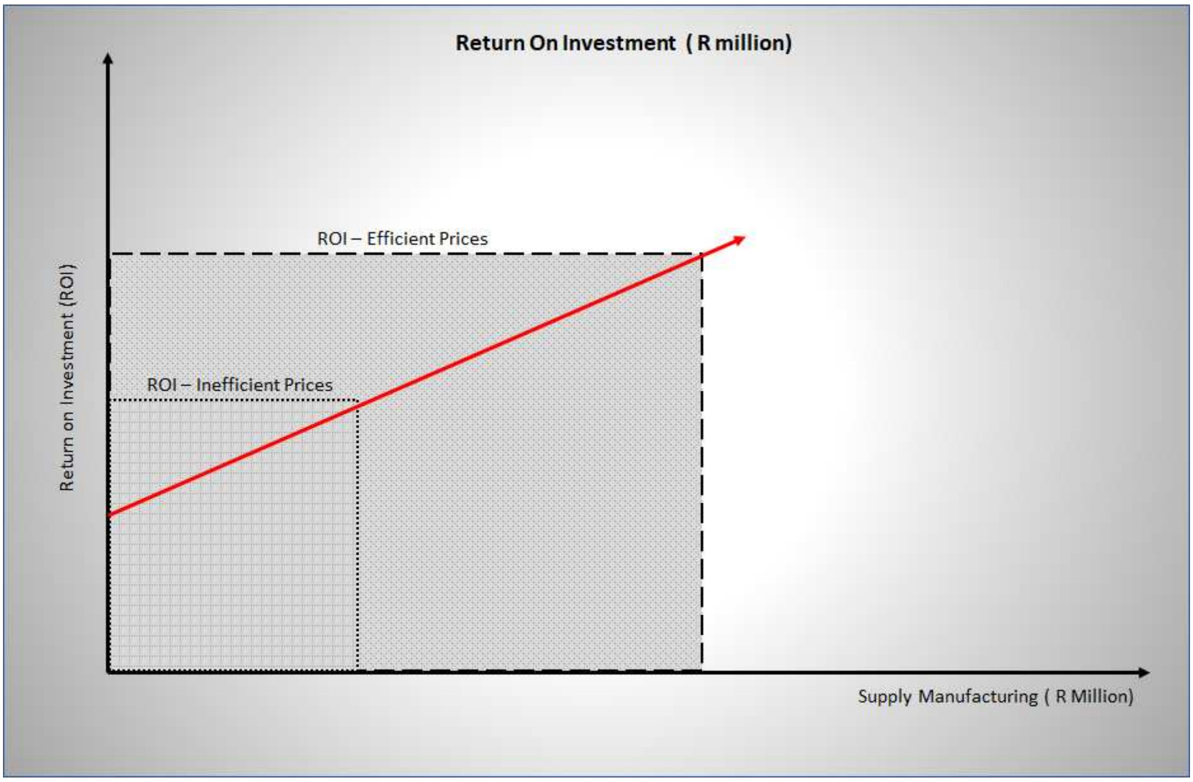
Again, the market forces will ignore all sentiment and ideology. The industrial investor in making investment decisions will consider its projected Return on Investment (ROI).

The ROI is merely a product of revenue and costs, and investment decisions are made by comparing marginal costs with marginal revenue. All input costs subtract from the ROI. In other words the higher the input costs the lower the RoI, the lower the supply.

Figure 2-11 Implications of inflated costs shows, if the cost of water and other regulated inputs such as energy are artificially inflated through inefficiencies, under recovery from other sectors etc, the market forces will result in under-investment.

It could thus be anticipated that industrialists in South Africa who are heavily dependent on water are underinvesting relative to their agricultural counterparts

Figure 2-11 Implications of inflated costs



To understand the above graph the following should be noted:

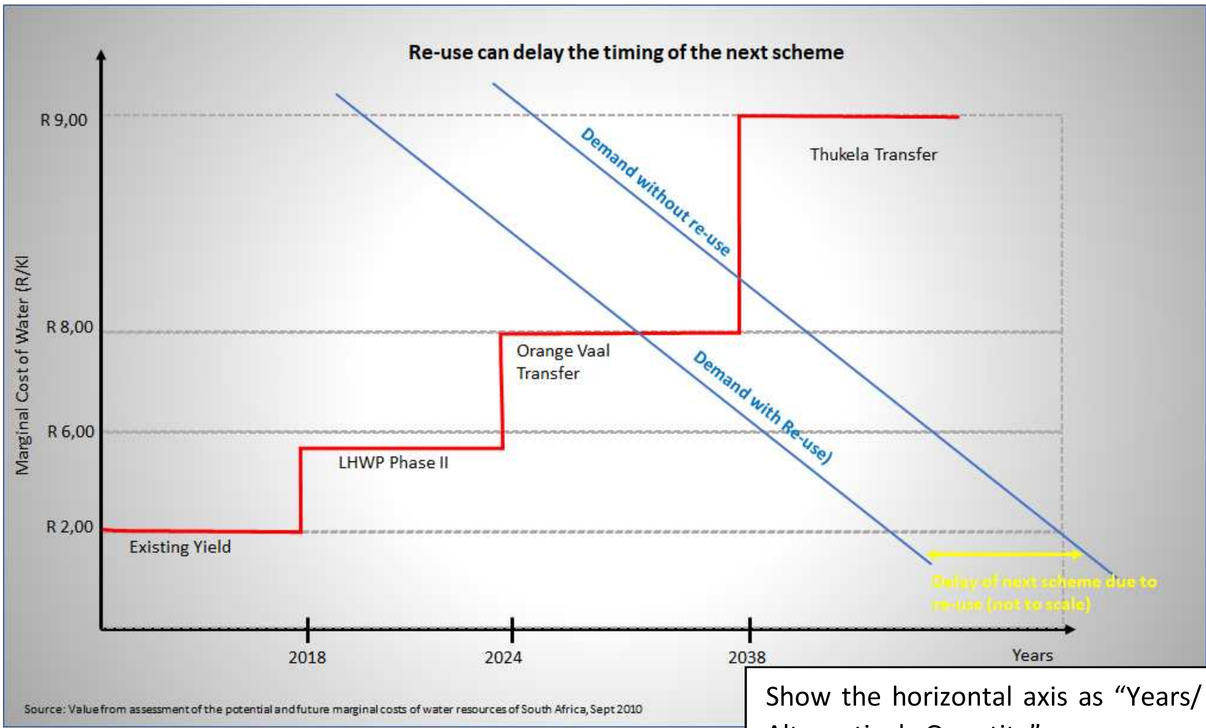
- The vertical axis is the return on investment that manufacturing firms could earn in different cost environments.
- The higher the cost (eg. of water, or electricity, or transport) the lower the ROI.
- The horizontal axis is the value of manufacturing output.
- The diagonal arrow is the supply curve of manufacturers.
- The supply curve rises from bottom left to top right because the higher the ROI (or lower the costs) the more goods manufacturers will produce.
- The supply at efficient or low prices and hence high ROI is higher than the supply at inefficient or high prices and hence low ROI.

2.5 RE-USE, DESALINATION AND WATER CONDERVATION AND DEMAND MANAGEMENT AS ECONOMIC ALTERNATIVES TO NEW SCHEMES

Re-use and desalination makes more water available for use and can delay the timing of the next scheme.

The greater the quantity of water that is re-used, the less the demand for water from conventional sources.

Figure 2-12: Re-use and desalination



Show the horizontal axis as "Years/ Alternatively Quantity"

The graph above is a schematic representation of augmentation to the Vaal River system, i.e. it shows the addition of new sources of water supply to the system.

To understand the above graph the following should be noted:

- All costs and volumes are demonstrative only. The actual costs and volumes will differ from those shown.
- The vertical axis is the marginal cost of supplying water, i.e. the cost of supplying water from each new scheme.
- The horizontal axis is the year (current/existing being 2018). The horizontal axis could alternatively be seen as Quantity, because each new scheme provides additional water to the system, although the scale would change.

The next scheme planned to be built to supply this system (Vaal System) is LHWP Phase II and it will be sufficient augmentation of the system until 2024, when the next scheme will be required.

- The scheme that is planned to follow LHWP Phase II is the Orange Vaal Transfer and it in turn will be followed by the Thukela Transfer. (Note that the order of schemes is also only demonstrative and might differ.)
- Each new scheme has a higher marginal cost than the previous scheme. The reason is that the cheaper next source is accessed before the next more expensive source.

If the horizontal axis showing years is replaced with Quantity, then the effect of desalination and re-use on the demand-supply equation, could be examined.

The two diagonal parallel blue lines are the demand curves at a particular point in time. The gross demand curve on the right is the total demand. The demand curve on the left is the residual demand after re-use. In other words, the more that water is re-used, the less the volume of water that has to be abstracted from the source to meet the demand.

The demand curve is at a particular point in time. Over time the population and economic activity increases and the whole demand curve shifts to the right.

If the demand curve on the right without re-use was the demand curve at say 2038, then the Thukela Transfer should have already been implemented otherwise there would be a shortfall between demand at R8.00 and the aggregated supply available from the previous schemes including the Orange Vaal Transfer.

If however re-use was already implemented then the demand curve on the left, ie with re-use, shows that in 2038 at a price of R8.00 the supply still exceeds the demand and the Thukela Transfer would not have been required yet. In other words, the re-use of water delayed the need for Thukela Transfer.

Re-use, Water Conservation and Demand Management (WCDM) and the implementation of new schemes are alternative ways of meeting demand and supply. The economically most efficient approach is to choose the next option with the lowest marginal cost.

For example, in an area with 89 % unaccounted for water it will probably be cheaper in the short term to reduce wastage than to implement re-use or desalination or to build a new scheme.

Over time, as the relatively cheap to fix leaks have been resolved, re-use or building new schemes might then again be competitive next options.

Figure 2-13: Re-use and Water Losses

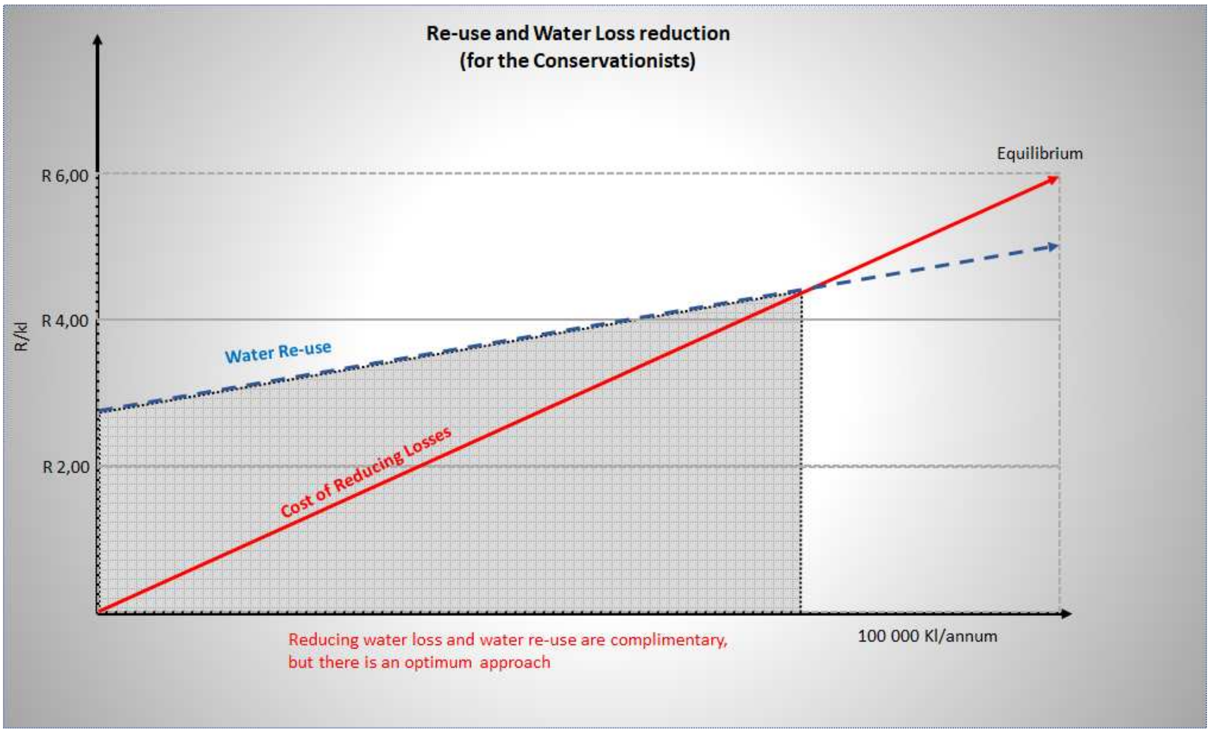


Figure 2-10 above shows that the cost of reducing leakage or losses is at first relatively cheap, even compared to re-use.

In other word, some sources of losses such as broken pipes may be easy to address and that relatively large savings can be gained for relatively small expenditure.

However, once the easy problems have been addressed, it becomes more and more difficult and more and more expensive to save even more water through loss reduction.

At some volume of savings (perhaps when system losses have been reduced to 15%) there will be cheaper options available, such as re-use.

And similarly, once the major sources of effluent are directly re-used, the price of increasing the volume of re-use will be more expensive than the next cheaper option which could be desalination of sea water or perhaps additional storage dams.

3. AGGREGATED WATER SUPPLY AND ECONOMIC BENEFIT COMPARISON

This section should be read together with the Table 3-3: Value of Raw water overleaf.

3.1 INPUTS

The Water use requirements for South Africa in the table below are taken from Volume 2 of the NWSMP:

Table 3-1: Water Use Requirements (Source: DWS Directorate: National Water Resources Planning – NWRP)

No	User sector	2015 requirements* (million m^3/a)
1	Agriculture (irrigation and livestock watering)	9 000
2	Municipal (industries, commerce, urban and rural domestic)	4 447
3	Strategic/Power generation	362
4	Mining and bulk industrial	876
5	International obligations	178
6	Afforestation	431
	Total	15 294

- Water for the environment as enshrined the National Water Act, 1998 take priority over all the other water uses, hence, in most instance water available is shown after the provision for the ecological water requirements, as discussed in section 8.

From the table above it is evident that agriculture is the largest user at 9 000 million m^3/a, followed by municipal and domestic use at 4 447 million m^3/a.

Assurance of Supply

In South Africa, water resource development projects have been designed, developed and operated with allocation criteria or standard operating rules that allow for user classification and their tolerance to failure of water supply.

Water for power generation is seen as strategically important and is provided with the highest assurance of supply (99.5 %) (which translates to 1: 200-year risk of failure). Water to meet international obligations is also given a high priority. These priorities are built into the determination of the operating rules. **Table 3-2** presents a simplified typical user classification for different water users.

Table 3-2: Simplified assurance of supply per user sector

User sector	Assurance of supply	
	Recurrence interval	Annual reliability %
Strategic (power generation)	1:200	99.5%
Domestic – basic	1:200	99.5%
Industrial	1:100	99%
Domestic – other	1:50	98%
Irrigation – high value	1:20	95%
Irrigation – cash crops	1:10	90%

The calculations that follow do not specifically take into account the difference is assurance of supply. The figures used are in any case estimates and as will be seem the difference of 0.5% between the level of assurance of supply between domestic and industrial is a bit misleading if industrial is supplied out of a municipal water scheme, and the difference in assurance between the Domestic-other and Irrigation-high value of 5% is far more precise than the aggregated water demand figures that are reflected below.

Source of GDP data

The GDP figures used in the calculations that follow are taken from Table 1 the Stats SA Statistical Release P0441 Gross Domestic Product First Quarter 2018, as reflected in the table below.

Table 1 – Industry value added and GDP (constant 2010 prices, seasonally adjusted and annualised)

	Agriculture, forestry and fishing	Mining	Manufac-turing	Electricity, gas and water	Construc-tion	Trade, catering and accommo-dation	Transport, storage and communi-cation	Finance, real estate and business services	General govern-ment services	Personal services	Total value added at basic prices	Taxes less subsidies	GDP at market prices
	R million												
2012	68 093	221 990	377 330	68 733	98 329	400 938	243 188	562 042	436 466	155 472	2 632 583	268 495	**2 901 078**
2013	71 143	230 772	381 173	68 289	102 818	408 968	250 129	576 707	450 348	159 530	2 699 878	273 297	**2 973 175**
2014	75 982	226 791	382 498	67 622	106 403	414 826	258 906	592 352	464 664	162 367	2 752 410	275 680	**3 028 090**
2015	71 153	233 745	381 149	66 479	108 362	422 502	262 498	607 581	469 224	164 047	2 786 739	280 096	**3 066 835**
2016	63 869	224 016	384 615	64 918	109 524	429 641	264 599	621 798	475 795	166 465	2 805 240	278 934	**3 084 174**
2017	75 185	234 305	384 036	65 018	109 185	426 935	268 494	633 413	477 386	168 459	2 842 416	282 471	**3 124 887**
	R million (seasonally adjusted and annualised)												
2014 Q3	76 674	225 456	379 027	67 464	106 525	416 678	260 152	594 156	466 674	162 705	2 755 513	275 782	**3 031 295**
2014 Q4	78 083	233 129	386 607	67 762	107 200	416 433	262 515	600 800	468 410	163 045	2 783 984	280 231	**3 064 215**
2015 Q1	75 725	239 800	384 370	68 201	107 839	420 552	262 666	603 974	467 705	163 413	2 794 245	283 173	**3 077 418**
2015 Q2	71 531	235 381	378 046	66 813	108 219	420 620	262 781	606 417	468 541	163 821	2 782 170	279 179	**3 061 349**
2015 Q3	69 296	229 324	382 339	65 440	108 514	422 649	262 786	609 174	469 759	164 340	2 783 620	279 429	**3 063 049**
2015 Q4	68 061	230 475	379 839	65 463	108 877	426 187	261 760	610 758	470 889	164 612	2 786 921	278 606	**3 065 526**
2016 Q1	65 859	217 739	380 967	64 903	109 201	428 462	261 994	614 906	472 777	165 297	2 782 104	277 193	**3 059 297**
2016 Q2	63 889	226 007	388 509	64 723	109 324	430 437	263 782	620 241	474 563	166 185	2 807 660	278 783	**3 086 443**
2016 Q3	63 194	229 120	385 721	64 660	109 663	428 531	265 278	623 995	477 185	166 920	2 814 267	279 711	**3 093 979**
2016 Q4	62 536	223 197	383 263	65 384	109 909	431 133	267 341	628 050	478 654	167 459	2 816 927	280 049	**3 096 976**
2017 Q1	66 287	229 931	379 226	64 451	109 591	424 977	266 460	627 273	478 074	167 576	2 813 846	279 558	**3 093 404**
2017 Q2	71 695	234 297	381 977	65 719	109 406	425 975	268 192	632 099	475 728	168 264	2 833 353	282 374	**3 115 727**
2017 Q3	78 139	237 834	385 426	64 690	109 065	425 884	268 729	635 145	477 036	168 786	2 850 734	282 452	**3 133 186**
2017 Q4	84 617	235 158	389 517	65 212	108 678	430 905	270 593	639 135	478 705	169 209	2 871 730	285 501	**3 157 231**
2018 Q1	78 967	229 122	383 150	65 133	108 162	427 474	271 184	640 883	480 862	169 730	2 854 666	285 224	**3 139 890**

Gross domestic product, first quarter 2018

Note that the figures in the above table are in constant 2010 prices. The figures used in the calculations below have been escalated to 2017.

From the table above it is also evident that the difference between GDP at Market Prices (last column) and Total Industry Value Added (third last column) is explained by taxes and subsidies (second last column). There is a misconception amongst some that Total Industry Value Added is a completely different indicator and is much newer and much more accurate than GDP figures; whereas as can be seen from the table Total Industry Value Added is in fact a component of GDP that does not take into account taxes and subsidies.

Just as the caclulations below do not attempt to allocate levels of assurance because of complexities of allocation in the municipal sphere, so there has been no attempt to allocate taxes and subsidies between the industries making up the GDP.

As will be seen in the results, the differences in the GDP contribution of industries per Kl water is vastly different and these refinements would not change the picture.

Also, the water demand figures are not that accurate because municipalities do not report currently on their water balance.

Similarly, there is some discretion by those who complete the forms as to which industry they belong to and the allocation of Value Add to specific industries is also not precise. For example, a consulting firm may work in the transport, water and legal fields and might chose to indicate the whole of the firm's income by a code that reflects either transport, or water, or legal services, or professional services,

Multiplier effect

It can be shown that nearly every industry contributes to the inputs or outputs of every other industry.

For example, energy and fuel and water and transport can easily be identified as inputs to every other industry.

Agriculture is also an input and an output of other industries, in that water and energy are inputs to agriculture, but agricultural produce is processed in factories, sold retail, and is an important input in catering services.

PhD's have been written, and are still being written on input-output analysis, and the interaction of various industries and the quantum of the multiplier effect.

The figures used in these calculations are the Industry value added as reported by Stats SA. The multiplier impact of one industry on another has not been calculated, and this should be taken into consideration when interpreting the results.

Table 3-3 below shows a broad comparison between the amount charged for water, the cost of providing that water, and the benefit to the GDP (Industry Value Added) derived from supplying that water. Table 3-3 does not pretend to be an accurate Economic Account of Water Use in South Africa. Table 3-3 is also aggregated on a national level and should preferably be built up from the Catchment or River Basin level.

The reader may not agree with all of the calculations in Table 3-3 and may wish to run his or her own scenarios. Such scenario building will add to the value of the debate on the value of water, the allocation of water and the pricing of water. There is not only one correct way of analysing the figures and nor is there only one way of interpreting the results. The authors are merely requesting that the analysis be viewed with an open mind and that the readers feel comfortable to do their own analysis for their own unique applications.

However, even in its current coarse form, Table 3-3 proves to be extremely instructive:

Row 1 shows the total water supply to various sectors of the economy. **15 116 Mm³/a**

Row 2 shows the growth of water supply in the economy between now and 2030 using two simple assumptions, namely 0% growth in supply to agriculture and 2% p.a. growth in all other sectors, including in the population. **2%/a**

Row 10 shows the investment in water resource infrastructure required to meet that **R 802 b**

growth in supply.

It is assumed that all users use at least a basic water supply (6 kl/household/ month) [Row 1, column 2] while some of the households and many institutions and businesses use the remainder of the municipal supply.

Table 3-3: Value of Raw water

	Sector	1 Total	2 Basic Domestic Supply (6 kl per household per month)	3 Higher than basic Domestic Supply (total domestic supply less 6 kl per household per month)	4 Non-revenue water - municipal	5 Manufacturing	6 Mining	7 Energy, Gas and Water	8 Agriculture, Forestry and Fishing	9 Afforestation	Reference
1	Water Supply (million m^3/a).	15 116	1 161	1 418	1 868	526	350	362	9 000	431	Volume 2 Action plan, Table 3.3
2	Growth in water supply (2019 to 2030)	1 384	283	345	455	128	85	88	0	0	Generally 2% allowed in model
3	Replacement Asset Value Water Resources Infrastructure (R million)	R584 000	R44 846	R54 802	R72 159	R20 306	R13 538	R13 986	R347 711	R16 651	Strategic framework: Allocated by current water supply
4	Asset value annualised (R million)	R59 482	R4 568	R5 582	R7 350	R2 068	R1 379	R1 424	R35 415	R1 696	PMT @ 8% 20 years

	Sector	1 Total	2 Basic Domestic Supply (6 kl per household per month)	3 Higher than basic Domestic Supply (total domestic supply less 6 kl per household per month)	4 Non-revenue water - municipal	5 Manufacturing	6 Mining	7 Energy, Gas and Water	8 Agriculture, Forestry and Fishing	9 Afforestation	Reference
5	Carrying value of assets Trading Entity (R million)	R92 625	R7 113	R8 692	R11 445	R3 221	R2 147	R2 218	R55 148	R2 641	Estimated National Expenditure (ENE) 2017/18 (Budget Vote 36) less Receivables
6	Carrying value of assets annualised (R million)	R9 434	R724	R885	R1 166	R328	R219	R226	R5 617	R269	PMT @ 8% 20 years
7	Investment in raw water infrastructure projected from 2019 to 2030 (R million)	R360 185	R73 544	R89 870	R118 335	R33 300	R22 200	R22 935	R0	R0	Allocated by growth in water supply

	Sector	1 Total	2 Basic Domestic Supply (6 kl per household per month)	3 Higher than basic Domestic Supply (total domestic supply less 6 kl per household per month)	4 Non-revenue water - municipal	5 Manufacturing	6 Mining	7 Energy, Gas and Water	8 Agriculture, Forestry and Fishing	9 Afforestation	Reference
8	Investment 2019-2030 annualised (R million)	R36 686	R7 491	R9 154	R12 053	R3 392	R2 261	R2 336	R0	R0	PMT 8% 20 years
9	DWS Administrative expenditure (R million)	R1 650	R127	R155	R204	R57	R38	R40	R982	R47	ENE 2017/18: Allocated by current water supply
10	Water planning and information management (Rand million)	R802	R62	R75	R99	R28	R19	R19	R478	R23	ENE 2017/18: Allocated by current water supply
11	Operations of Water Resources (R million)	R173	R13	R16	R21	R6	R4	R4	R103	R5	ENE 2017/18 from with

	Sector	1 Total	2 Basic Domestic Supply (6 kl per household per month)	3 Higher than basic Domestic Supply (total domestic supply less 6 kl per household per month)	4 Non-revenue water - municipal	5 Manufacturing	6 Mining	7 Energy, Gas and Water	8 Agriculture, Forestry and Fishing	9 Afforestation	Reference
											infra development: Allocated by current Water Supply
12	Water sector regulation (R million)	R394	R30	R37	R49	R14	R9	R9	R235	R11	ENE 2017/18: Allocated by current water supply
13	Water Trading Entity (R million)	R7 709	R592	R723	R953	R268	R179	R185	R4 590	R220	ENE 2017/18 less depreciation: Allocated by current

	Sector	1 Total	2 Basic Domestic Supply (6 kl per household per month)	3 Higher than basic Domestic Supply (total domestic supply less 6 kl per household per month)	4 Non-revenue water - municipal	5 Manufacturing	6 Mining	7 Energy, Gas and Water	8 Agriculture, Forestry and Fishing	9 Afforestation	Reference
											water supply
14	TCTA expenditure excl deptr and interest (R million)	R5 517	R424	R518	R682	R192	R128	R132	R3 285	R157	ENE 2017/18 less depreciation and interest: Allocated by current water supply
15	Revenue sale of raw water: Water Trading Entity (R million)	R9 431									ENE 2017/18

	Sector	1 Total	2 Basic Domestic Supply (6 kl per household per month)	3 Higher than basic Domestic Supply (total domestic supply less 6 kl per household per month)	4 Non-revenue water - municipal	5 Manufacturing	6 Mining	7 Energy, Gas and Water	8 Agriculture, Forestry and Fishing	9 Afforestation	Reference
16	Industry value added and GDP (2010 constant prices (R million)	R2 842 416	Basic right	R2 083 872	R0	R384 036	R234 305	R65 018	R75 185	Included agric	Stats SA - many categories supplied by municipalities
17	Industry value added and GDP inflated to 2017/18 prices (R million)	R4 151 520	-	R3 043 621	R0	R560 908	R342 217	R94 963	R109 812	-	1,46
18											
19	Indicators										
20	Indicative financial cost of raw water (R million)	R24 029	R1 845	R2 255	R2 969	R836	R557	R575	R14 307	R685	Uses carrying

	Sector	1 Total	2 Basic Domestic Supply (6 kl per household per month)	3 Higher than basic Domestic Supply (total domestic supply less 6 kl per household per month)	4 Non-revenue water - municipal	5 Manufacturing	6 Mining	7 Energy, Gas and Water	8 Agriculture, Forestry and Fishing	9 Afforestation	Reference
											value of assets
21	Indicative financial cost of raw water per unit (R/kl)	R1,59	R1,59	R1,59	R1,59	R1,59	R1,59	R1,59	R1,59	R1,59	Uses carrying value of assets
22	Indicative economic cost of raw water (R million)	R74 077	R5 689	R6 951	R9 153	R2 576	R1 717	R1 774	R44 105	R2 112	Uses replacement value of assets
23	Indicative economic cost of water (Rand per kl)	R4,90	R4,90	R4,90	R4,90	R4,90	R4,90	R4,90	R4,90	R4,90	Uses replacement value of assets
24	Average revenue received for raw water used (R/kl)	0,62									

	Sector	1 Total	2 Basic Domestic Supply (6 kl per household per month)	3 Higher than basic Domestic Supply (total domestic supply less 6 kl per household per month)	4 Non-revenue water - municipal	5 Manufacturing	6 Mining	7 Energy, Gas and Water	8 Agriculture, Forestry and Fishing	9 Afforestation	Reference
25	Typical raw water charge (R/kl)		R0.00	R0.62 to R3.05	R0.62 to R3.05	R0.62 to R3.05	R0.62 to R3.05	R0.62 to R3.05	R0.0152 to R0.0334		
26	GDP contribution per Kl (Rand per kl)	R274.64	Basic right	R2145.70	R0,00	R1067.18	R976.65	R262.33	R11.64	Included in agric	
27	Investment in infrastructure annualised per kl growth in supply (R per kl)	R26,51	R26,51	R26,51	R26,51	R26,51	R26,51	R26,51			This is an indication of marginal cost
28	Capital cost of addressing unaccounted for water (R per kl saved)				R41,67						Assuming R375 m capital investment in Orange Farm can save 9 ML per annum

	Sector	1 Total	2 Basic Domestic Supply (6 kl per household per month)	3 Higher than basic Domestic Supply (total domestic supply less 6 kl per household per month)	4 Non-revenue water - municipal	5 Manufacturing	6 Mining	7 Energy, Gas and Water	8 Agriculture, Forestry and Fishing	9 Afforestation	Reference
29	Annualised capital cost of addressing unaccounted for water per kl saved (R/kl saved)				R4,24						.
	Notes:	16 122 thousand households in RSA in 2015									

There are two ways of assessing the asset value of the water resource infrastructure, either as the cost of replacing the asset today [Row 3] R 59,4 b or the carrying value of the asset of the institutions balance sheet [Row 4]. R584 b

Capital investment costs have been converted into their annual equivalent by assuming the repayment of the asset over 20 years at an interest rate of 8% p.a. [Row 7, R 360 b Row 9]. R 1,65b

The annual costs associated with operating, administering, regulating and planning for the water resource schemes are shown in rows 9, R 1,65b 10, R 802m 11, R 173m 12, R 394m 13, R 7,7 b and 14]. R 5,5 b

Row 15 R 9,4 b shows the revenue from the sale of raw water received by the Water Trading Entity.

3.2 RESULTS

Row 16 R 2,8 tr and 17 R 4,1 tr shows the Industry Value added GDP of each of the user sectors in 2010 Rands and 2018 Rands.

The GDP of the sector supplied by municipalities is extremely high because it is the catch all for all sectors that are supplied with municipal water, such as government, commerce, trading, finance, transport etc. [Row 17, column 3]. R 3,043b

Some of the manufacturing GDP may also be supplied out of the municipal systems and so this figure may be overstated [Row 17, Column 5]. R 561 b

Although water lost to the system has a cost of production, there is R 188/Kl zero GDP benefit from water R 0,62 /Kl that is lost, i.e. NRW [Row 26, Column 24] but there surely some of this non-revenue water that is actually supplying a basic need.

All of the costs and the GDP figures have been 15 116 Mm³/a allocated to the various sectors according to the volume of water R 360,1b supplied [Row 1], with the exception of the Investment in building new 2%/a infrastructure between now and 2030 [Row 7] which has been distributed according to the growth in water supply between now and 2030 [Row 2].

Notwithstanding all of the qualifications, and assumptions, the resulting indicators tell us the following [Row 19 to 29]:

The indicative financial cost of providing raw water could be in the order of R1.59 c/kl [Row 21] and the economic cost could be in the order of R4.90 c/kl. [Row 23]

The average revenue for raw water used is in the order of R0.62 c/kl [Row 24, column 1].

Figure 3-1: GDP contribution per Kl supplied

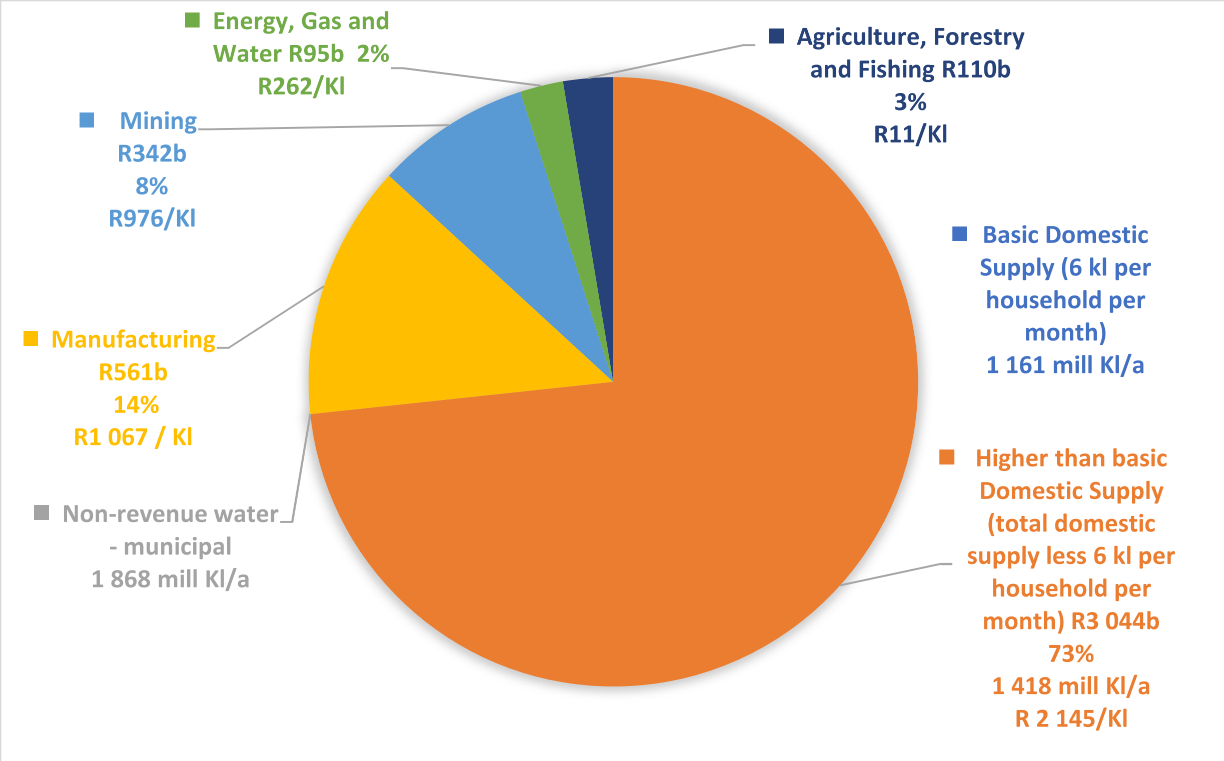


Figure 3-1: GDP contribution per Kl supplied illustrates the average GDP contribution of the sector supplied per kl used is in the order of R274 / kl and varies substantially from a low of R11 for irrigation and agriculture to R262 / kl for energy, R976 per kl for mining, and between R1 067 and R2 145 per kl for manufacturing and municipal supply [Row 26].

How to interpret the average GDP contribution per sector supplied with water is a matter for debate. All multiplier effects are ignored.

Nevertheless, it does appear that irrigation, being the largest water use sector [Row 1], and the sector paying the lowest tariff [Row 25], does not contribute as much GDP per kl used as the other sectors [Row 26, column 8]. Note that this calculation does not take into account the value of food security or the multiplier effect of irrigation. It is merely a reflection on the aggregated Value Add of the agricultural industry per Kl of water. Also, the type of agriculture and its contribution varies substantially depending on location and crop type. Table grapes may for example give a much larger contribution per Kl than for example lucerne, and as such an aggregated analysis such as this one may be misleading when estimating specific benefits in specific planted areas.

It is also evident that Non-revenue municipal water contributes nothing to GDP [Row 26, column 4], and would cost approximately R4.24 / kl to address [Row28, column 4], which is substantially less than the R26.51 / kl it costs to build new schemes.

4. CONCLUSION

Perhaps the following conclusions can be drawn:

- Addressing non-revenue water is currently cheaper than building new schemes to the extent that this makes physical sense in a specific catchment.

- Irrigation uses a large percentage of the total water supply, but does not provide the direct value added GDP return that other uses provide. This observation does not take into account the other benefits of irrigation, such as labour creation and food security, and also ignores the downstream industrial/manufacturing/ transportation multipliers.
- The economic cost of supplying water and the marginal economic cost of supplying water is higher than the current revenue.

Perhaps the most important conclusion might be that this brief analysis is a strong motivation to do a proper thorough economically sound analysis in which the whole water supply chain is analysed.

5. RECOMMENDATIONS

The following recommendations are suggested:

- Invest in reducing unaccounted for and non-revenue water as motivated in the National Water and Sanitation Master Plan;
- Enforce measurement of irrigation water and encourage more efficient use of irrigation water;
- Include a detailed catchment specific analysis of the relative contribution to the GDP of each sector of the economy and the relative water use of each sector as a consideration when prioritising investment in water infrastructure; and
- Enhance this brief study by including an analysis of the whole water supply chain – possibly using WRC – and an analysis of each mega project currently planned.

6. WHERE TO DIRECT A R100 BN INVESTMENT SCENARIO

The State President has a vision of raising funds for investment in South Africa to reignite the economy. The question to be answered is where should the water sector invest say R100 billionn if it were made available. In partial answer, the following should be noted:

- *Water is a catalyst, together with energy and transport infrastructure, that greases the economy.*
- *It is also understood that industries are more willing to commit large capital investments to areas where water and energy are secure and transport is reliable.*
- *To make a water resource investment decision using the old paradigms of the relatively few direct jobs created during construction, and during the lifetime operations of the infrastructure, is missing the larger economic picture. Those jobs are generally short term and relatively few.*
- *The investment decision should be made on the longer term benefit and use of the water.*
- *Consequently, if growing the economy was the most important consideration for the infrastructure spend, then such a large water resource investment strategy should primarily be directed at securing the water supplies of Johannesburg and Tshwane, Msunduzi and eThekwini, Cape Town, Nelson Mandela Bay and Mangaung where the economic return per Kl is the highest.*
- *These investments would include water conservation and demand management, but also the mega projects that are already on the planning table and that have been delayed partly due to financial constraints, namely LHWP Ph II, uMkomazi Water Transfer, Cape Town Desalination, Orange River pipelines to Mangaung and so forth.*

In other words, the priority actions as scheduled in the NWSMP should be prioritised.

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