

TRIPLE DIVIDENDS OF WATER CONSUMPTION CHARGES IN SOUTH AFRICA¹

Anthony Letsoalo^a, James Blignaut^c, Theuns de Wet^c, Martin de Wit^b, Sebastiaan Hess^d,

Richard S.J. Tol^{d, e, f}, Jan van Heerden^c*

^a CSIR, Environmentek, Pretoria, South Africa

^b CSIR, Environmentek, Stellenbosch, South Africa

^c University of Pretoria, Faculty of Economics and Management Sciences, Pretoria, South Africa

^d Vrije Universiteit, Institute for Environmental Studies, Amsterdam, The Netherlands

^e Research unit Sustainability and Global Change, Hamburg University and Centre for Marine and Atmospheric Science, Hamburg, Germany

^f Carnegie Mellon University, Department of Engineering and Public Policy, Pittsburgh, PA, USA

* Corresponding author: Richard Tol, FNU / ZMK / UniHH, Bundesstrasse 55, 20146 Hamburg, Germany, tol@dkrz.de.

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Abstract

The South African government is exploring ways to address water scarcity problems by introducing a water resource management charge on the quantity of water used in sectors such as irrigated agriculture, mining and forestry. It is expected that a more efficient water allocation, lower use and a positive impact on poverty can be achieved. This paper reports on the validity of these claims by applying a computable general equilibrium model to analyse the triple dividend of water consumption charges in South Africa: reduced water use, more rapid economic growth, and a more equal income distribution. It is shown that the appropriate, budget-neutral combination of water charges, particularly on irrigated agriculture and coal mining, and reduced indirect taxes, particularly on food, would yield triple dividends.

Key words

water scarcity, water charges, triple dividend, poverty alleviation, computable general equilibrium model

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1 Introduction

Among South Africa's many problems, water scarcity, poverty and an unequal income distribution loom large. The South African government is considering to reduce water use by levying charges. Less water scarcity is the first dividend of such a policy. The revenues from these water charges could be used to stimulate economic growth. This would be the second dividend. The double dividend literature (e.g., Goulder *et al.*, 1997) shows that this requires careful policy design. Faster economic growth may well reduce absolute poverty. However, the tax revenues can also be used to change the income distribution. This would be the third dividend. It would require even more care in policy design. In this paper, we explore the three potentials dividends of water charges in South Africa.

Above, we phrase water charges and revenue recycling in terms of triple dividends. This is in line with the economic literature. In business administration (e.g., Gray and Bebbington, 2003), this is phrased as the triple bottom line: care for people (our third dividend), profit (our second) and the planet (our first). In the literature on sustainable development (e.g., Bell and Morse, 2003), the same question is phrased as the three pillars of sustainability, viz., environmental quality (planet), economic growth (profit), and social justice (people). To our knowledge, this paper is the first to assess all three pillars of sustainability using a single, consistent framework for analysis.

This paper analyses the proposal of the South African government to reduce water consumption by introducing water resource management charges². The costs and benefits of these additional water charges to the South African economy are estimated with a particular emphasis on poverty reduction, through recycling the water charges revenue into higher real income to the poor³.

The literature on the use and availability of water, socio-economic indicators and water policies in South Africa is reviewed in Section 2. Section 3 focuses on the concept of double dividend and its application to environmental taxation. The model and data used in this paper,

² This is not a Pigouvian tax (Pigou, 1920); we analyse the water charges currently discussed by the government.

including simulation results, are presented in Section 4 and discussed in Section 5. Section 6 concludes the paper.

2 Water scarcity and poverty in South Africa

South Africa is classified as a semi-arid country. Precipitation has fluctuated over the years (see Figure 1) with an average of 500 mm³ per annum, well below the world average of about 860 mm per year (DWA 2002). The total flow of all the rivers in the country amounts to approximately 49 200 million m³ per year. The National Water Resource Strategy estimates the total water requirement for the year 2000 at 13 280 million m³, excluding environmental requirements. In addition, South Africa is poorly endowed with groundwater because most of the country is underlain by hard rock formations that do not contain any major groundwater aquifers (DWA 2002).

Figure 2 describes water requirements by sector in South Africa with the agricultural sector the largest consumer at 59 per cent. Large-scale farmers primarily use 95 per cent of irrigation water and small-scale farmers the remainder (Schreiner and van Koppen 2002). Afforestation requires 4 per cent of the total water requirement and rural and urban populations 4 per cent and 25 per cent, respectively. Mining and bulk industrial, and power generation use 8 per cent in aggregate.

Water resources are essential to transform society towards social and environmental justice and poverty eradication (Schreiner and van Koppen 2002). Rural people require water for drinking, hygiene, cooking and for productive purposes such as farming, livestock, forestry, fisheries and small-scale industries to deal with income poverty. Almost 50 per cent of the South African population is poor in terms of income, spending less than R353 per adult equivalent per month and about 70 per cent of these poor live in rural areas (Schreiner and van Koppen 2002).

Table 1 demonstrates a number of selected socio-economic indicators in South Africa in 2001. About 23 per cent of the rural population depend on remittances and pensions, and 32 per cent depend on pensions and grants. In addition, approximately only 24 per cent of rural people have access to piped water on site, while only 15 per cent have access to sanitation. An additional charge on water used by economic sectors might lead to more effective allocation,

a lower use of water resources and a positive impact on poverty alleviation. It translates into more water available for drinking, hygiene and productive activities, which might increase income for the poor and reduce the number of people affected by poverty. However, this study only addresses poverty reduction options and not inequality.

The above discussion demonstrates the scarcity of water in South Africa as well as the prevalence of poverty. The next question is how water resources are managed. To that effect, consensus was reached at the Dublin Conference on Water and the Environment that water should be regarded as an economic good (Briscoe 1996, Savenije and van der Zaag 2001, Perry *et al.* 1997). There are two schools of thought on the economic value of water (Savenije and van der Zaag 2001, Perry *et al.* 1997). The first school maintains that water should be allocated to its best uses by being priced at its economic value - the same as other private goods that are allocated through competitive market pricing. The second school maintains that water should be exempted from competitive market pricing and treated as a basic human need, which does not necessarily involve financial transactions. This paper adopts the position that water should be priced at its economic value, while still ensuring access to water resources to poor people. The value of water is the maximum amount water users are willing to pay for the use of this resource such that marginal cost and marginal benefit are equal (Briscoe 1996 and Perry *et al.*, 2001).

In South Africa, according to the National Water Act (Act No 36 of 1998), the government is regarded as the public trustee of the nation's water resources and “must ensure that water is protected, used, developed, conserved, managed and controlled in a sustainable and equitable manner, for the benefit of all persons” (MacKay 2003). Under previous legislation in South Africa, pricing of water did not generally take into account the real cost of managing water, the cost of water supply and the scarcity value of water (MacKay 2003:64). The government financed the capital costs of their water schemes supplying agricultural water users, some urban bulk water suppliers and industrial users. In addition, operation and maintenance costs are often not fully recovered from these water users (MacKay 2003:64-65).

The principle behind current water pricing policy in South Africa is that payment for water should be at a level reflecting its scarcity except for water required to meet basic human needs. Currently 25 litres of water per day per person is assumed to meet these needs. The pricing policy is structured into three tiers (CSIR 2001):

- First tier: raw water tariffs administered by DWAF for the sale of water to Water Boards.
- Second tier: water boards set the wholesale price of water to bulk water users like municipalities and industries such as Eskom and Sasol.
- Third tier: municipalities determine the price of water to charge end-users such as households and industries.

A rise in raw water tariffs will automatically lead to an increase in the price in the second and third tiers. According to the Water Act, all water users should be registered and pay for the water. Water use is classified into three kinds: *schedule 1 authorisation*, which grants lawful access for reasonable domestic use; small gardening and livestock watering without paying water tariffs or charges; *general authorisation* – by which water use is authorised for a group of water users as long as certain minimum requirements are met; and *water use licence* – individual water users should apply to DWAF for a licence to use water, and where water should preferably be allocated to those users generating the highest social, economic or environmental value and equity.

Water pricing can be based on a number of pricing strategies that include full supply cost, full economic cost and full cost of water (Figure 3). The South African government is introducing a water resource management charge to recover some of the costs for water management and to reflect water scarcity in the country. This means that the government is moving towards full economic costs of water by taking into account the supply cost and opportunity cost of water.

3 Double dividend: A literature review

According to the double dividend theory, the revenues of environmental taxes can be used to lower other (distortionary) taxes, and therefore lower the economic cost of the environmental tax. The positive effects of lowering other taxes could even outweigh the negative effects of a rise in environmental taxes. This is when the double dividend occurs: both the environment (first dividend) and the economy (second dividend) will be in better shape than before the environmental tax reform. Policy-makers who want to use environmental taxes to curb

pollution, but find it hard to sell a drop in GDP or employment would of course, welcome this. It also explains why the double dividend theory has become a popular research theme.

In the early phases of the double dividend theory, bold statements were made about the general validity or invalidity of the theory. These statements were, respectively, based on partial models of the economy and simple one-factor GE models that assumed competitive markets (see e.g. Pearce (1991) and Bovenberg and De Mooij (1994)). Later analysis focused on multiple production factor models and allowed for a distorted labour market. This analysis led to more nuanced statements about the possibility of a double dividend and will be discussed in the next two sections.

3.1 Multiple production factors

The one-factor models claimed it was impossible to attain a double dividend because the environmental tax would be more distortionary (just looking from an economic viewpoint and abstaining from environmental benefits) than the factor tax it replaced (Bovenberg and de Mooij, 1994; Goulder et al., 1997). Adding another production factor (usually capital; the one-factor models used only labour) to the modelled economy introduced the possibility of inefficiencies in the tax system. From a tax-efficiency point of view taxes on the two production factors should have the same marginal efficiency costs or marginal excess burden (MEB), that is the loss of overall production efficiency due to taxation⁴. If the MEBs are not the same, reducing this difference reduces the distortions in the economy caused by taxation.

In the double dividend literature this inefficiency is "used" to create possible economic gains from the introduction of an environmental tax. This happens if the environmental tax shifts the tax burden from the over-taxed factor (with the higher MEB) to the under-taxed factor (with the lower MEB). As stated by Goulder (1994), the gain is larger if (i) the difference in MEBs is larger; (ii) the burden of the environmental tax falls mainly on the under-taxed factor; and (iii) the recycling of revenues mainly reduces the burden of the over-taxed factor.

⁴ The MEB of a labour tax depends on its level and on the (compensated) wage elasticity of labour supply: the larger this elasticity, the greater the distortion. For a capital tax in a closed economy it is again its level and the intertemporal elasticity of substitution in consumption: the larger the elasticity, the larger the distortion along the intertemporal dimension (the margin of choice between consuming today and consuming in future).

Substitution elasticities between labour, capital and water (the scarce resource) are also important. With capital fixed, this factor should be a poor substitute for water, while labour should be a good substitute. With an elastic capital supply, it is the other way around (De Mooij and Bovenberg, 1998).

This efficiency gain has to be large enough to overcome the negative effects that are inherent to an environmental tax (its narrowness, and the extra distortionary costs that arise from taxing inputs or goods instead of taxing production factors directly)⁵.

The effects of tax shifting have also been studied with empirical GE models. Goulder (1995), Bovenberg and Goulder (1997) and Jorgenson and Wilcoxon (1993) all study the results of a revenue neutral environmental tax reform for the United States with an intertemporal numerical GE analysis. Goulder (1995), and Bovenberg and Goulder (1997) fail to find a double dividend. In all their scenarios the environmental tax is more distortionary than the taxes it replaces and the economic costs of the tax reform are therefore always positive. The main reason for this is the relative narrowness of the environmental tax. Jorgenson and Wilcoxon (1993) do find a double dividend under certain conditions. Irrespective of the end result, the costs or benefits of the tax reform varied with the scenario chosen, and they moved in line with Goulder's (1994) expectations: the costs were lower, the larger the difference in MEB, and the more the tax burden was shifted from the over-taxed to the under-taxed factor.

3.2 Non-competitive markets: involuntary unemployment

The second main improvement to the double dividend analysis was the inclusion of involuntary unemployment. In the literature involuntary unemployment has been incorporated in the GE analysis in several different ways, but usually some model of wage bargaining between firms and workers is used. Bovenberg and van der Ploeg (1998), for instance, use a search model of the labour market with individual worker-firm bargaining. In another paper Strand (1998) assumes a monopoly union that unilaterally determines the wage, after which a fixed number of firms determine employment. In Koskela, Schöb and Sinn (1998) a

⁵ The broader the tax base the lower the distortion. Environmental taxes, however, are relatively narrow by nature and on purpose because they are meant to change specific behaviour (Goulder, 1994). In the theoretical tax literature, taxes on intermediate inputs generally have larger welfare costs than do equal-revenue taxes on primary factors because they distort both the intermediate input choice and factor markets, instead of just distorting factor markets (Goulder, 1995: 288).

monopolistic firm determines employment, this time after bargaining over wages with a small trade union.

In these papers, a double dividend depends on the effect of the green tax reform on the bargaining positions of firms and workers. For employment (not necessarily welfare) to increase, producer wages have to decrease, and this happens if workers' bargaining position deteriorates or that of the firm(s) improve. This is the case if workers' outside options (e.g. income under unemployment or in the informal sector) worsens or if the firm's labour demand becomes more elastic with respect to wages. Another way to reduce wages is to shift the tax burden to the unemployed as is done in the paper by Bovenberg and van der Ploeg (1998).

3.3 Distributional effects

Besides raising revenue, the most important function of taxation is the (re)distribution of income between members of society. This distribution is also the main reason why tax systems deviate from optimality (in the absence of externalities it would be optimal to have a lump sum tax). Unfortunately, the way an environmental tax reform affects distribution is not studied in much detail in the double dividend literature. The scarce information we do have points in the direction of a small negative distributional effect, but this, of course, depends on the specific form of the tax return (see for example Ekins and Barker (2001) and Bach *et al.* (2002))⁶.

Shifting the tax burden to the unemployed or those working in the informal sector, as is done in Bovenberg and van der Ploeg (1998) to increase employment, will obviously have negative income effects on the lowest income groups.

Concluding, a double dividend seems possible but is by no means certain or automatic. The initial situation regarding existing taxes and distortions in the labour market, together with the specific form of the tax reform, will determine the ultimate outcome. In policy terms, a double dividend can be achieved if the tax reform is smart. Tax reforms that ignore pre-existing distortions but are designed on alternative criteria (e.g., political considerations) would probably not result in a double dividend. By extrapolation, a third dividend (income distribution in our case) would place even greater demands on policy design.

4 Model, data and scenarios

The model used here is called UPGEM, which stands for the University of Pretoria Computable General Equilibrium Model of South Africa. It is similar to the computable general equilibrium ORANI-G model of the Australian economy, and is written and solved using GEMPACK (Harrison and Pearson 1996), a flexible system for solving CGE models. It is a static model with an overall Leontief production structure, and CES sub-structures for (i) the choice between labour, capital and land, (ii) the choice between the different labour types in the model, and (iii) the choice between 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' choice between imported and domestic goods is modelled using the CES structure.

The model is based on the official 1998 social accounting matrix (SAM) of South Africa, published by StatsSA (SSA 2001). This SAM divides households in 12 income and four ethnic groups, and distinguishes 27 sectors. For the purpose of this study, the energy and water intensive sectors are split further to arrive at 39 sectors. The elasticities used for the CES functions in the model have been taken from De Wet (2003). The model's closure rules reflect a short-run time horizon. The capital stock is assumed fixed, while the rate of return on capital is allowed to change. Labour supply is modelled in the typical ORANI way, by assuming fixed real wages in the short run, implying perfectly elastic labour supply. The supply of land is also assumed inelastic.

With reference to the macroeconomic variables, it is assumed that aggregate investment, government consumption and inventories are exogenous, while consumption and the trade balance are endogenous. Consumption is a function of post-tax wage income by household and race group, while imports and exports have CES demand functions of relative prices. This specification allows us insight into the effect of the suggested policies on South Africa's consumption and competitiveness. All technological change variables and all tax rates are exogenous in the closure. Finally, the nominal exchange rate is set to be the numeraire in each of the simulations.

⁶ However, this would again diminish the increased efficiency of the tax system and could, depending on the measures taken, forestall a double dividend.

The water supply and use accounts of the CSIR (2001) were used to create a vector of “Taxable water” for each industry in the SAM, as well as a vector of “Extra water charges” that may be charged on volumes of water used. The former is a vector of water volumes that include all taxable water, namely water extracted from underground or rivers, or water received from the formal water sector. Variables are also defined for taxable water used, and extra water charges, to be able to calculate changes in total revenue raised, and changes in water demand.

The core water equation added to the UPGEM model (2b) is derived as the revenue raised is equal to the rate per volume times the volume of water (X):

$$R = T.X \quad (1)$$

UPGEM works in percentage or absolute change form, and not in absolute levels. From equation (1) above the change in revenue (dR) is approximately equal to the tax rate (T) times the change in the base (dX) plus the base (X) times the change in the rate (dT):

$$dR = T.dX + X.dT = T.X.x/100 + X.dT = R.x/100 + X.dT \quad (2b)$$

with x the percentage change in X⁷. Equation (2) is used in the model to calculate the absolute changes in revenue received from charges on water consumption by all industries. The changes in the tax rates are exogenous, and shocked according to various scenarios outlined below. All the other variables are entered into, or calculated by the model. Note that variable x is the percentage change in water consumption by industries, and it is an endogenous variable, that is, calculated by the model. We expect that an additional charge on water will lead to a decrease in water consumption. Total revenue from the extra water charges is added to total government revenue.

The following scenarios were tested using the UPGEM model to try and adhere to the suggestions proposed by water authorities and experts:

- (i) A surcharge of 10c per m³ water used by forestry;
- (ii) A surcharge of 10c per m³ water used by irrigated agriculture; and
- (iii) A surcharge of 10c per m³ water used by all mining industries.

⁷ If x is the percentage change in X, then we know $x = 100 \cdot dX/X$, so that $dX = x.X/100$

On the recycling side three simulations were performed:

- (iv) A decrease in the overall level of direct taxation on capital and labour;
- (v) A decrease in the overall level of sales tax on household consumption; and
- (vi) A decrease in the sales tax rate on food to households.

No unambiguous improvement in consumption levels of all race groups in the poorest three household groups was found by any one of the scenarios, so that we had to refine the scenarios further. Irrigated agriculture was split into field crops and horticulture, and the results reported separately. Mining was also split into three components – gold, coal, and other mining – and results are reported separately as well.

This results in eight scenarios of water chargers, and three scenarios of revenue recycling. Rather than simulating $8 \times 3 = 24$ scenarios, we use the additive property of a CGE under small shocks. To this end, we normalised the water consumption, economic growth and income distribution effects of the water charge scenarios by the respective revenues, and did the same thing for the revenue scenarios. The impact of water charge plus recycling is closely approximated by the sum of the impact of water charge and the impact of revenue recycling.

4.3 Simulation results

4.3.1 Environmental effects

The first of the dividends is the environmental dividend reaped.

below illustrates that all the simulations do yield the first dividend, whether the revenue collected is recycled through a direct or indirect tax break. The first dividend here is a net decrease in the amount of water consumed per unit of real government revenue. Additional charge on water consumption always leads to a decrease in water demand. All needed for the environmental dividend to occur is that the increase in water consumption that results from a direct or indirect tax break is less than the decrease due to the water charge. The model results as shown in

indicate that this is expected to be the case.

The water charge increases the price of water and directly affects the amount of water consumed. The model predicts that the water charge will lead to a decline in water consumption in the forestry and irrigated agriculture sector by 32 per cent and 6 per cent per billion Rand tax revenue received, respectively. Water consumption by the mining sector will decrease by only 3 per cent per billion Rand. The decrease in water consumption as a result of water charge is greater than an increase in water consumption because of tax breaks, thereby yielding the environmental dividend. However, a tax break affects all commodities, not only water. Consumers will use the extra income to demand more of all commodities, including water. However, water is a necessity, and the demand for it will increase very little, as the results in table show.

4.3.2 Economic effects

The second dividend is the effect on the total economy, and is determined using the concept of marginal excess burden. The marginal excess burden (MEB) is defined as:

$$\text{MEB} = \text{change in real GDP divided by the change in real government revenue}$$

The MEB's for all eight water charge policy measures as well as the three recycling measures are given in Table 3 below, and compared. A double dividend is indicated by a + in the table, when the increase in real GDP per unit of real government revenue lost as a result of a tax break (recycling policy) is larger than the decrease in real GDP per unit of real government revenue collected from a new water charge.

A charge on water consumed by the mining industry led to a decrease in real GDP by 54.7 cents per Rand of real government revenue collected from the tax. Recycling via a direct or indirect tax break or a tax break on food led to a GDP increase by 58.6, 72.2 and 70.3 cents per Rand of real government revenue forsaken by government respectively. This gives a net gain to the economy. However, if only gold mining were paying the water charge, it would not render a double dividend, and neither would coal mining with the direct tax break as method of recycling. Other mining industries give quite a different result from coal and gold mining in that GDP only decreases by 25 cents per Rand extra water charged. An additional charge on water consumption by irrigated agriculture renders double dividends, whether the tax is levied on field crops only, or horticultural crops, or on both. The damage done in terms of MEB is smaller with field crops than horticulture. However, none of the three recycling schemes is able to undo the damage of additional water charges on forestry.

The percentage change in total employment per unit of real government revenue collected was also calculated, and the plusses and minuses follow exactly the same pattern as in Table 3 above. That is, employment and GDP per unit of real government revenue are closely related to each other. The explanation is simply that the total production function in the model has Leontief and CES characteristics in terms of intermediate and primary inputs, so that GDP and employment will always move in the same direction as a result of an exogenous shock.

4.3.3 Poverty effects

The criterion used to measure an improvement in poverty levels is the percentage change in total real consumption of the three poorest household groups in the economy, by race. The model has eleven household groups and four race groups and it calculates consumption for each group by commodity, as well as total consumption. The results of total consumption for the poorest household group is given in Table 4, but the results for the poorest three groups are similar, so that the table would be representative of all three also.

We found that some policy combinations render a net improvement for one race group while they have detrimental effects on another. The only water charge that could be recycled through a general direct or indirect tax break, in a way that would benefit all four race groups within the poorest groups of households, is a tax on water consumption by mining industries

other than gold and coal. However, all the environmental taxes except one would render the poverty dividend if they are combined with a tax break on food.

On the irrigated agriculture side it helps much to differentiate between water charge on field crops and on horticultural crops separately. We found that a tax on irrigated horticultural crops has a more severe influence on the consumption of the poorest groups, in that at least one group is made worse off with this tax, while with irrigated field crops at most one group is made worse off.

5 Discussion of results

Extra water charges on forestry are detrimental to three of the four race groups in the poorest household group, including Africans who comprise close to 90 per cent of this group. The eight key commodities that Africans spend the most of their income on are – in order of importance - food, petroleum, real estate, textiles, electricity, transport services, other manufacturing and agricultural goods.

The direct impact of extra water charges on forestry is firstly an increase in the cost of the forestry industry and hence its prices, and secondly on wood, paper and pulp, which is part of other manufacturing. The agricultural sector is the largest intermediate supplier to the food industry, and food is the most important commodity to all households – rich and poor. Other manufacturing is also high on poor consumers' priority list, and these two channels turn out to be significant in having the detrimental effect on the poor.

Extra water charges on mining do not have a direct effect on households in the same way as on forestry and irrigated agriculture. Households do buy some coal, but no gold or other mining goods, so that there are no direct effects on households from the latter two industries. They influence consumers through the downstream effects on industries who buy the outputs of the mining industries.

The effect from the mining industry as a whole comes mostly from more expensive coal, through two obvious channels. African households consume coal directly, and they consume much electricity, for which coal is the most important intermediate input. The gold mining industry has indirect effects only: it sells gold to other manufacturing, which is a key

commodity for households. Three of its most important suppliers of intermediate goods are petroleum, electricity and other manufacturing – all three key commodities for the poor.

The results that appear in Table 4 also take into consideration recycling, and the effects described above should be compared to the increases in consumption of various commodities due to recycling. In general the recycling benefits all industries, while the environmental taxes harm a few industries severely, and affecting others marginally. The recycling of revenue allows consumers to have more of all commodities, and hence also more of all their key commodities of which they consume the most. The default net outcome of the combined policy options – water charges and recycling – should therefore be beneficial to the consumers, unless the environmental effects are focused on a few key commodities, and outweigh the recycling effects. The extra water charges on other mining are a case in point. There is no direct negative effect on consumers since they do not buy other mining commodities. The most important indirect effects are on petroleum, basic iron and steel and construction, of which only the first is important on the consumers' list. Hence the results demonstrate positive net effects on consumption by the poor for all three recycling schemes.

Extra water charges on irrigated agriculture directly increase the cost of field and horticultural production. Field and horticultural products comprise a large proportion of agricultural commodities, and an increase in their prices directly affects the prices of industries buying them as intermediate inputs. The four largest demanders of agricultural goods are food, other manufacturing, petroleum and textiles, all important to poor households. The only recycling scheme that is able to offset the decrease in consumption due to water charges on agriculture, is a decrease in the food tax rate. Food is the most important consumer good for poor households, and it is to be expected that cheaper food would dominate the tax on an industry only indirectly linked to poor households.

The good news with a water charge policy that involves irrigated field crops is that Africans are made better off, despite the way of recycling used. They comprise more than 89 per cent of total consumption in their six most important commodities, and a very high proportion of all commodities consumed by the poorest groups. The Coloureds consume less than 10 per cent of all commodities in the poorest group and is the only group to be harmed by a tax on irrigated field crops.

All the simulation results are summarised in Table 5. The first plus in each cell shows the first dividend, namely the environmental effect, which is positive in all cases. The second plus or minus shows whether a double dividend on GDP and employment has been achieved with the combination of policies, while the third plus or minus shows a triple dividend on poverty reduction. There are quite a number of policy combinations that render double dividends, but we are interested in poverty reduction with environmental management. With both a direct tax break and a general decrease in the sales tax rate for households, the only triple dividends are obtained through a water charge on Other Mining. However, six of the eight environmental tax policy measures render triple dividends with a decrease in the tax rate on food to households.

6 Conclusion

The simulation results presented in this paper are satisfactory. The large water users are irrigated agriculture and it is (politically) important that a tax on water used by irrigated agriculture would render the desired triple dividends for all four-race groups, if the revenue is properly recycled. A tax of irrigated agriculture does render double dividends with all three recycling schemes (direct taxes, indirect taxes, food taxes), and a triple dividend with the one of the three (food taxes). An additional water charge on the mining sector, particularly coal and other mining, stand a high chance of yielding dividends in terms of less water used, positive impacts on poverty reduction amongst the poor and positive impacts on the economy. Again, a reduction in indirect taxes, particularly on food, is more effective than a reduction of direct taxation. A more detailed analysis with more specific charges needs to be carried out to further substantiate this conclusion.

We show that there can be a triple dividend of water policy, simultaneously reducing water scarcity, improving economic growth, and reducing poverty. Smart policy design could improve all three pillars of sustainability, viz. the environment (planet), the economy (profit), and society (people). Methodologically, this study goes beyond water in South Africa. Water is but one environmental problem, and South Africa is among many countries in which environment, economic and social problems coincide. The methods used in this paper could gainfully be used in other contexts and other places to study policy interventions for sustainable development.

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TABLE 1 *Selected socio-economic indicators: 2001*

	National	Rural
Unemployment rate (%):		
Official (restricted) definition	26.4	33.9
Unofficial (expanded) definition	37.0	52.2
Portion of household (%):		
with piped water in the dwelling or on site	65.7	24.3
using mainly wood for cooking	19.6	53.8
using mainly electricity for cooking	52.5	18.3
using mainly paraffin for cooking	21.1	19.2
with access to hygienic sanitation	62.2	18.0
where refuse / rubbish is removed by a local authority	54.8	15.5
with access to telephone	33.7	22.3
within 14 minutes of nearest clinic	36.3	20.8
within 14 minutes of nearest primary school	54.3	41.7
within 14 minutes of nearest food market	50.9	40.1
dependent on remittances	13.8	23.5
dependent on pensions and grants	17.8	32.2
with a radio	79.1	72.2
with a TV	56.4	35.0

Source: Statistics South Africa (2002)

TABLE 2 *Marginal change in water consumption, and an indication of scenarios that result in a water dividend (numbers present % change water per 10 million Rand tax revenue)*

		Recycling scheme		
		Direct tax break	Indirect tax break	Food tax break
Environmental tax		0.0007	0.0009	0.0009
Tax on Forestry water	0.316	+	+	+
Tax on Mining water	0.026	+	+	+
Gold mining	0.028	+	+	+
Coal mining	0.026	+	+	+
Other mining	0.025	+	+	+
Tax on Irrigated Agriculture	0.055	+	+	+
Field crops	0.066	+	+	+
Horticulture	0.033	+	+	+

TABLE 3 *Marginal excess burdens of different tax instruments, for GDP, and an indication of scenarios that result in a GDP dividend*

		Recycling scheme		
		Direct tax break	Indirect tax break	Food tax break
Environmental tax		0.586	0.722	0.703
Tax on Forestry water	0.825	—	—	—
Tax on Mining water	0.547	+	+	+
Gold mining	0.964	—	—	—
Coal mining	0.658	—	+	+
Other mining	0.249	+	+	+
Tax on Irrigated Agriculture	0.372	+	+	+
Field crops	0.338	+	+	+
Horticulture	0.442	+	+	+

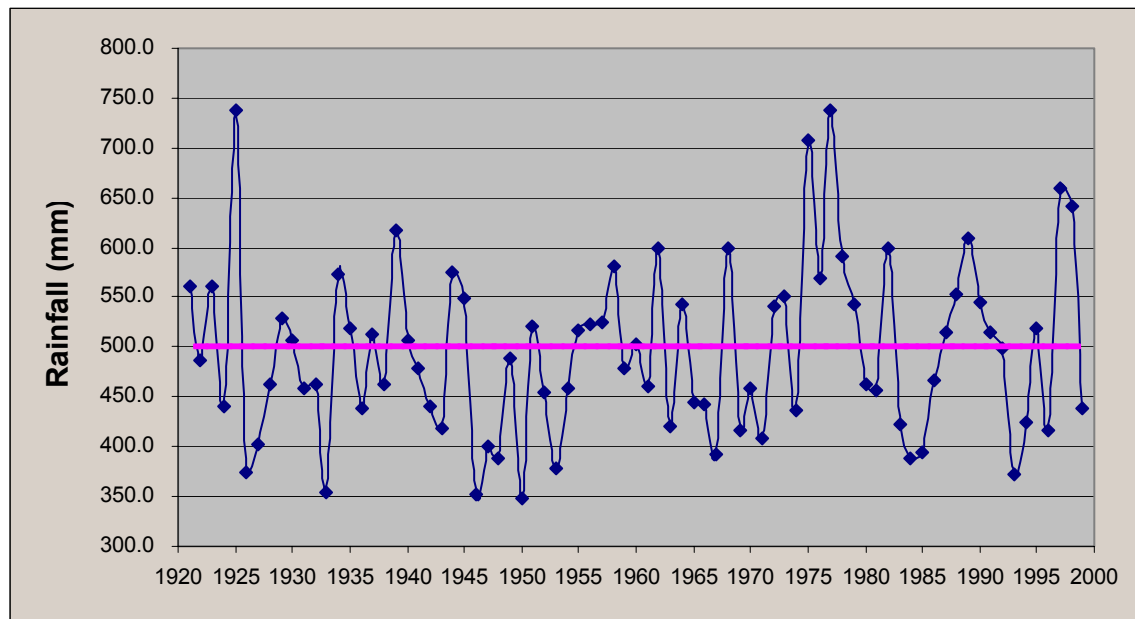
TABLE 4 *Marginal change in poverty (% change in real consumption of poorest household group per billion Rand tax revenue), and an indication of scenarios that result in a poverty dividend*

		Recycling scheme		
		Direct tax break	Indirect tax break	Food tax break
Environmental tax		0.104	0.133	0.403
Tax on Forestry water	0.291	–	–	+
Tax on Mining water	0.285	–	–	+
Gold mining	0.568	–	–	–
Coal mining	0.268	–	–	+
Other mining	0.092	+	+	+
Tax on Irrigated Agriculture	0.196	–	–	+
Field crops	0.175	–	–	+
Horticulture	0.239	–	–	+

TABLE 5 *Summary of dividends (greenhouse gas emissions, GDP and employment, and poverty)*

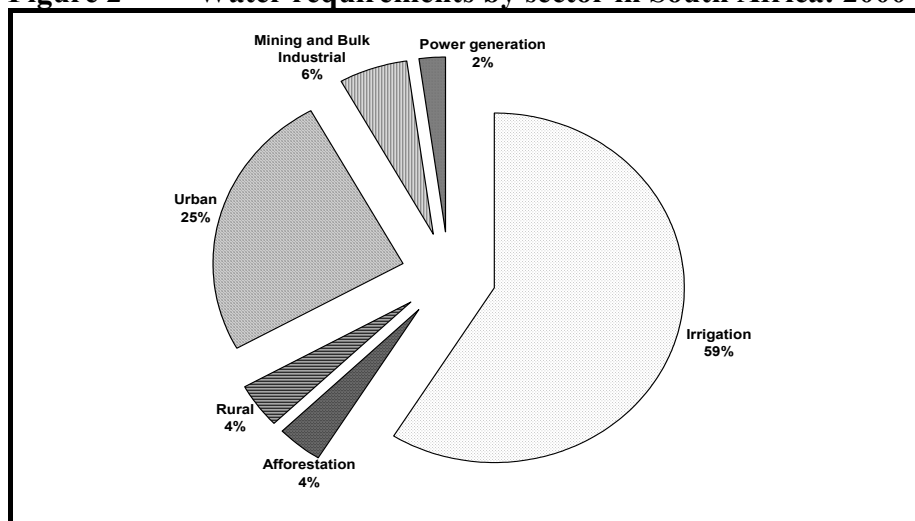
		Recycling scheme		
		Direct tax break	Indirect tax break	Food tax break
Environmental tax				
Tax on Forestry water		+ – –	+ – –	+ – +
Tax on Mining water		+ + –	+ + –	+ + +
Gold mining		+ – –	+ – –	+ – –
Coal mining		+ – –	+ + –	+ + +
Other mining		+ + +	+ + +	+ + +
Tax on Irrigated Agriculture		+ + –	+ + –	+ + +
Field crops		+ + –	+ + –	+ + +
Horticulture		+ + –	+ + –	+ + +

Figure 1 Precipitation in South Africa (1922-1999)



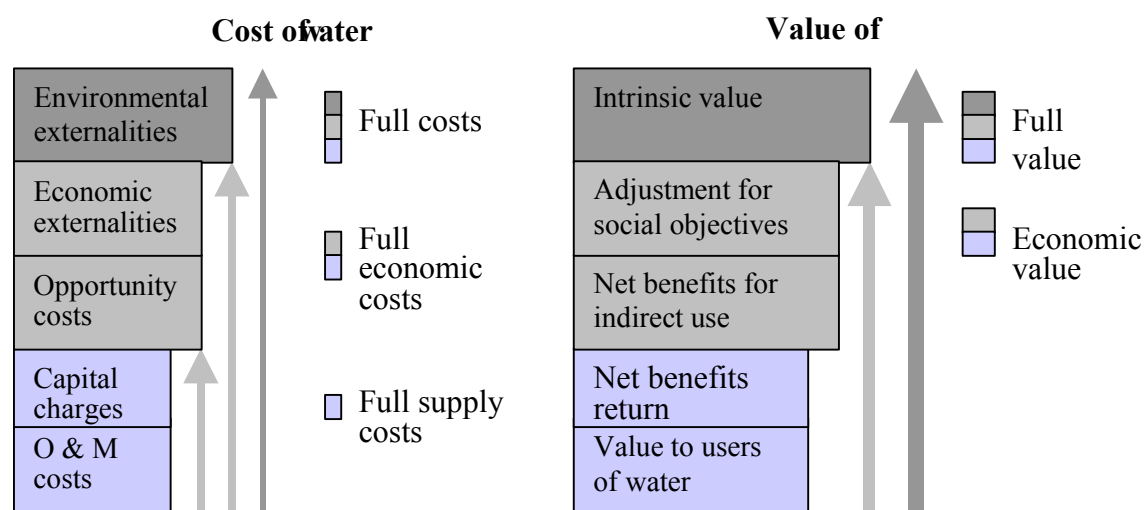
Source: CSIR (2001).

Figure 2 Water requirements by sector in South Africa: 2000



Source: DWAF (2002)

Figure 3: Underlying principles for the cost and value of water



Source: King (2004), adapted from Rogers, de Silva and Bhatia (2001)

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