CHAPTER FIVE

SECTORAL WATER USE IN SOUTH AFRICA: EQUITY VERSUS EFFICIENCY

5.1 INTRODUCTION

The issue of water scarcity and the challenge to increase the efficiency of sectoral water use has been discussed in detail in the preceding chapters. In chapters three and four the sectoral water demand functions were estimated and the sectoral price and output elasticities and marginal values of water computed. From the estimated sectoral elasticities and marginal values of water, water pricing and allocation policies that can potentially improve water use efficiency were recommended at both global and South Africa levels. However, the analytical procedure in both cases made no attempt to investigate equity issues together with the efficiency considerations discussed. In the realm of institutional analysis of critical natural resource use, socio-economic criteria for efficient resource management require that the interest of all the stakeholders involved in the use of the resource must be taken into consideration. As a result, there is the need to investigate the economy-wide socio-economic consequences of implementing inter-sectoral water reallocation policies on the basis of efficiency considerations.

As the population is growing in South Africa, the need to increase food production and to maintain a sustainable economic growth and environment increases the demand on the nation’s water resource, while the supply of this resource is projected to be inelastic.

Irrigation water requirement in South Africa accounts for about 62 percent of the total water requirements, while the agriculture sector as a whole accounts for only about four percent of the GDP, and employs about 11 percent of the total number of employees (DWAF 2004). Moreover, empirical results from chapters three and four indicate that agriculture has the lowest marginal value of water, while manufacturing, mining and the services sectors comparatively have higher marginal values.

From the above indications the policy of reallocating water from the agriculture to the non-agriculture sectors on the basis of their respective marginal values might be seen as a viable policy to promote sustainable economic growth and employment. However, the rationality of this policy may be questioned if the forward and backward inter-sectoral linkages, as well as transmission mechanisms to different household categories, through factor payments are not incorporated into the valuation framework. The question is therefore, not only how much does a particular sector contribute to the GDP of an economy, but also how best can scarce water resources be allocated to improve the standard of living of the critical population. This addresses the issue of efficiency, as well as equity and sustainability. It thus justifies the inclusion of social and environmental values of water into the economic valuation framework. Against this background, this chapter is designed to critically analyze the economy-wide inter-sectoral water reallocation on the basis of economic efficiency in South Africa. Specifically, using the social accounting matrix framework, the study:

i) analyzes the contribution of water to the various economic activities,

ii) estimates, using marginal values of water, the economy-wide impact of reallocating water from agriculture to the non-agriculture sectors

iii) recommends the water allocation strategy that is likely to promote efficiency and social equity.

The purpose of this chapter is to investigate whether a trade-off exists between efficiency and equity policies of inter-sectoral water use in South Africa and to investigate the socio-economic consequences of this trade-off.

The next section briefly describes the general features of a social accounting matrix (SAM) and the generic SAM for South Africa. It also explains how the 1999 SAM for South Africa was updated and aggregated for the purpose of this study. Section 5.3 explains the theoretical framework and the modeling procedure, while section 5.4 presents and discusses the model results, and section 5.5 presents a brief summary and conclusions of the chapter

5.2 THE FEATURES OF THE SOUTH AFRICAN SAM

This section briefly describes the generic features of the South African SAM. It then explains how the 1999 South African SAM was updated to reflect 2003 accounts and how these accounts were aggregated for the purpose of the current study.

5.2.1 The features of the SAM

The SAM constructed for this study is an updated version of the generic 1998 SAM developed by Thurlow and van Seventer (2002). The 43 activities and 43 commodities were consistent with time series data compiled by South Africa's Trade and Industrial Policy Strategies (TIPS). Therefore the 1998 entries for activities and commodities were updated to reflect the 2003 using the supply and use tables extracted from the TIPS data set.

The factor inputs entries were also updated to reflect the 2003 figures from the TIPS data set. The information on household income and expenditure patterns was provided by Statistics South Africa from the 2003 census. Information on government's income and expenditure accounts, investment and international trade was provided by the South African Reserved Bank's publications (SARB, 2002). The detailed structure of the generic SAM for South Africa is found in Thurlow and van Seventer (2002). Because most sectors have self water supply source, the water supply information from the municipalities' billing records grossly understates the use of the resource by the production sectors and households. These entries were therefore replaced by the water resource management strategy (WRMS) registration information and the information from Statistics South Africa's water resource accounts STATSA (2004).

For the purpose of this study the updated SAM was aggregated to 14 activities or commodities, three primary factors of production, enterprises account, five household categories, government account, investment and the rest of the world.

The agriculture sector, consisting of agriculture (crop production and animal husbandry), forestry and fishing accounts, were aggregated to agriculture, while coal, gold, uranium and other mining were aggregated to mining activities/commodities. The manufacturing sector, consisting of 43 activities and 43 commodities were aggregated to 12 activities/commodities accounts comprising agro-industries (food, beverage and tobacco manufacturing); leather products and wearing apparel (textile, wearing apparel, leather and leather products and footwear); paper and paper products (paper, paper products, printing, recording and recorded media); petrol; chemicals (basic and other chemicals); heavy manufacturing (non-metallic minerals, basic iron and steel, basic non-ferrous metals and metals products excluding machinery); machinery and equipment (machinery and equipment, electrical machinery and apparatus, television, radio and communication equipments, motor vehicles and spare parts and professional and scientific equipments); electricity; water; construction (building, civil engineering and other construction); services (wholesale and retail trade, catering and accommodation, transport and storage, communication, business, medical, dental and veterinary, other professional and general government services); and other manufacturing. The aggregations reflect the structure of water use intensity by the sectors and sub-sectors.

The capital; three labour (unskilled, medium-skilled and high-skilled); and enterprises accounts in generic SAM were retained; but the 14 household accounts in the original SAM were aggregated to five accounts. The highly disaggregated household accounts do not show much differences in the income structure between one category and the one immediately below or above it. The first two deciles reflect the households earning below 20 percent of the national income. The third and fourth deciles show those earning between 20 and 40 percent of total income, while the fifth and sixth deciles reflect middle-income households that are between 40 and 80 percent of the total income in South Africa. The rich households earn more than 80 percent of the total household income in South Africa. The majority of the population of South Africa is in the first two categories, and less than three percent is in the tenth deciles. Most of the poor households' income comes from the wages of unskilled labourers and transfers from semi-skilled labour (Thurlow and van Seventer, 2002). These households are the historically disadvantaged individuals, whose past and current economic situation can hardly enable them to get out of the poverty trap.

This explains why this category of households highly depends on welfare programmes and various levels of subsistence activities for their economic survival.

Government accounts, which were broken down into expenditure and income accounts (four accounts) in the original SAM were aggregated to net government account. Savings and investment and the rest of the world accounts were retained. Table 7D in the appendix presents the aggregated SAM used in this study.

5.3 THE THEORETICAL FRAMEWORK AND MODELING PROCEDURE

This section explains the theory which underlies the use of input-output and social accounting matrices. It also explains how the model can be applied to investigate economy-wide impact of economic policies with specific reference to the impact of inter-sectoral water reallocation on sectoral output, value added and households' income distribution in South Africa.

5.3.1 The theoretical framework

Input-output and social accounting matrix models have been extensively used in the early literature to analyze inter-sectoral growth linkages in an economy (Juana, 2006; Juana and Mabugu, 2005; Bautista *et al.* 2002; Delgado *et al.* 1998; Sadoulet and de Janvry, 1995). The analysis of this type of interaction among sectors and institutions require economy-wide frameworks (Sadoulet and de Janvry 1995). The SAM framework can be used to analyze the impact of an exogenous shock on the economy. In this chapter the SAM framework is used to assess the impact of water reallocation from low to high values uses on output growth, factor remuneration or gross value added, job creation/losses, and households' income generation and distribution.

The study computes the SAM multipliers using the material balance equation, developed in Sadoulet and de Janvry (1995); and used by Bautista *et al.* (2002); Juana (2006) and Juana and Mabugu (2005). The basic materials balance equation can be specified as:

$$Y^{l} = AY^{l} + F \tag{5.1}$$

Where 'Y^{l}' is an nx1 column vector of total sectoral output, 'A' is an n x n matrix of direct technical coefficients for the endogenous factors and 'F' is an nx1 column vector of final demand. The dimension of the 'A' matrix coincides with the number of accounts considered for the purpose of SAM analysis. Solving for 'Y^{l}' from equation 1 leads to:

$$Y^{l} = (I - A)^{-1} F \tag{5.2}$$

Where 'I' is the identity matrix and '$(I-A)^{-1}$' is the Leontief inverse. The input-output model is concerned with solving for the sectoral output levels (Y) that satisfy final demand for those output levels (F), given the inter-industry structure of production or the intermediate input requirements of the production sectors (A). Given the inter-sectoral transactions matrix (A), the model is used to determine the production plan which is consistent with a desired final demand vector (F). The above equation can be used to derive various types of multipliers, the most common of which are the production and income multipliers. Equation 2 can be reduced to:

$$Y^{l} = M^{l} F \quad where\ M^{l} = (1 - A)^{-1} \tag{5.3}$$

Therefore, 'M^{l}' is the input-output multiplier matrix, referred to in literature as the Leontief inverse. The vectors 'Y^{l}' and 'F' represent sectoral output and final demand respectively. Equation 5.3 can be used to calculate the endogenous incomes associated with any changes in the total exogenous accounts, given the multiplier matrix. It can also be used to analyze the effects on output arising from exogenous shocks, such as changes in investment or government expenditure or the rest of the world. Each cell in the multiplier matrix 'M^l' interprets the total income change in the row account induced by an exogenous income injection in the column account. In the production sectors, the multipliers indicate how a unit increase in the sector's production due to exogenous shocks stimulates economy-wide output growth.

Equation 5.3 can be extended to the SAM multiplier matrix by the inclusion of the primary factors and the consumption accounts into input-output accounts. The inclusion of these accounts aim at incorporating feedbacks from rents to consumption to new production originating from an exogenous inflow. Let 'A_m' be the enlarged square matrix of direct propensities computed from the SAM and 'M^s' the enlarged inverse (SAM multiplier) matrix. Then 'M^s' can be computed as:

$$Y^s = M^s F, \; where \; M^s = (I - A_m)^{-1} \qquad (5.4)$$

Equation 5.4 solves for the equilibrium level of all endogenous accounts which result from a shock or exogenous injections, from changes in the elements of the exogenous accounts. The multiplier matrix 'M^s' measures the direct and indirect impacts of the incorporated endogenous links and reduces to 'M^l' when the dimension 'm' of the 'A_m' matrix corresponds to 'A' (Boughanmi *et al.* 2002). Any difference between 'M^s' and 'M^l', is due to the induced effect which is taken into account by 'M^s', but not by 'M^l' (Juana, 2006 and Juana and Mabugu, 2005:250).

Economic multipliers estimate the economy-wide impact of a change in an exogenous account on intermediate and final demand. This induces changes in sectoral output levels, value added and income generation in a specified economy, such as a state or a province. These changes suggest a strict cause-effect relationship (Tanjuakio *et al*., 1996). In this study, the model estimates the economy-wide impact of reallocating water among the production sectors on the basis of their respective marginal values of water. Water reallocation on the basis of marginal values is an exogenous policy shock, aimed at improving the efficiency of sectoral water use.

There are four types of multipliers in the existing literature: i) the direct or production multiplier, which captures the immediate impact of the initial change in the output level of the industry or industries being analyzed; ii) the indirect or income multiplier, which captures the increased purchase of inputs required by industries to produce the additional output to meet the change in final demand; iii) The induced multiplier, which measures changes in household spending, resulting from the changes in employment generated by the direct and indirect multipliers; and iv) the total impact multiplier, which is an aggregate of the direct, indirect and induced effects (Boughanmi *et al*. 2002).

Given the multiplier matrix $(1\text{-A})^{-1}$ and the final demand for goods and services, the output level that satisfies the demand can be computed by multiplying the multiplier matrix by the final demand. That is

$$(1-A)^{-1} * F = Y^{1} \qquad (5.5)$$

Equation 5.5 is used to validate the computed multipliers and also shows the impact of exogenous shocks to the entries in the social accounting matrix on output, through its impact on the coefficient matrix, hence the multipliers. To capture the changes in output, the former level of output before the shock is subtracted from the new level of output after the exogenous shock. The difference shows the change in output resulting from the shock, which alters the level of intermediate demand in different ways for the various sectors, hence the different elements in the coefficient matrix. The change in output resulting from the reallocation of water from one sector to the other is shown as:

$$\Delta Y_i = (1 - A_2)^{-1} * F - (1 - A_1)^{-1} * F = [(1 - A_2)^{-1} - (1 - A_1)^{-1}] * F \qquad (5.6)$$

Where ΔY_i represents the change in sectoral output for sector 'i' which results from the change in the level of water allocation and its impact on the technical coefficients matrix (A_1 to A_2) that result from the shocks applied to the SAM. Equation 5.6 shows the change in output arising from changes in the entries due to policy implementation, which in turn lead to increases or decreases in intermediate input requirements. The technical coefficients change because the shocks lead to a change in the input requirements. This has consequences for the production sectors. This framework is used to investigate the impact of reallocating water from agriculture sector to the non-agriculture sectors on output, employment, factor payments and households' income generation and redistribution.

Reallocation of water from agriculture to the non-agriculture sectors directly leads to a decline in the output of the agriculture sector. This leads to a decrease in the technical input requirements for the agriculture sector, which is directly or indirectly transmitted to the other production sectors. Firstly, all the sectors that produce these inputs are impacted directly, the intermediate demand for their output declines, resulting in the decline in the production of those intermediate inputs, and consequently the output from these non-agriculture sectors are expected to decline. Secondly, sectors that directly depend on the output of the agriculture sector for their intermediate input requirements are also impacted. A decline in the production of these inputs leads to a decrease in the use of these inputs or a switch to their importation from more expensive sources. The degree of impact depends on the inter-industry dependency between these sectors and the agriculture sector. For example; the food, beverages and tobacco manufacturing sector, which uses inputs from agriculture and the services sector, which supplies the intermediate inputs for agriculture are impacted more by a decline in agriculture's output than the mining, electricity and construction sectors.

The changes in output that result from water reallocation from low to high-value uses have some significant impact on the use of primary factors. However, within the short-run the use of capital is assumed to be constant, but the employment of labourers is immediately impacted by the level of change in sectoral output. The increase or decrease in output will lead to hiring or firing labourers respectively in the production sectors. The outputs of sectors that gain from the water reallocation are expected to increase, while those of agriculture and the highly inter-dependent sectors are expected to decline. Workers are laid-off in sectors with declining outputs and hired by the sectors with increasing output. The net effect leads to either job creation or losses. The wage is assumed to be constant and the quantity /value of output per worker is used as the coefficient to determine the number of workers hired or fired by every sector as result of the policy implementation (Sadoulet and de Janvry 1995). This relationship is explained by equation 5.7.

$$L = \kappa Y \tag{5.7}$$

Where 'L_i' is the number of labourers employed by sector 'i', 'Y' is the output produced by this number of labourers (other primary factors are assumed to be constant in the short-run) and *k* the coefficient indicating the number of labourers required to produce a unit of output. Therefore, any change in output (ΔY) affects the number of labourers employed by the constant coefficient *k*.

$$\Delta L = \kappa \Delta Y \tag{5.8}$$

Using this, the study investigates the number of jobs created or lost due to the reallocation of water from low to high-value uses.

5.3.2 The simulation techniques

The main purpose of this chapter is to investigate whether water reallocation from the agriculture (which has the least marginal value of water), to the other sectors on the basis of sectoral marginal values of water will simultaneously promote water use efficiency and social equity. Efficiency in this context refers to growth in output and value added at factor cost, while social equity refers to job creation and the income generation and redistribution in favour of the low-income households. This study considers equity to the benefits of efficient water use and not equity in access to the physical asset. Therefore, after computing the social accounting matrix multipliers using the steps explained in section 5.3.1, a specified quantity of water is experimentally reallocated from the agriculture sector to the non-agriculture sectors using the computed sectoral marginal values of water as coefficients of this reallocation mechanism. These sectoral marginal values were estimated in chapter four and are reported in column 3 of Table 4.3. Water is reallocated from the agriculture sector because agriculture has the least marginal value of water. The following experiments are carried out.

Scenario 1: Forty percent of total water used in the agriculture sector is reallocated to the other production sectors on the basis of their respective marginal values. This is done by multiplying the total quantity to be allocated by the coefficient in column 2 of Table 5.1. These coefficients are based on the sectoral marginal values computed in chapter four and reported in column 3 of Table 4.3. The total coefficient is 1.000. Sectors with higher coefficients like leather and wearing apparel, and construction receive more of the reallocated water from agriculture than those with lower coefficients. The simulation results of this experiment are presented in Tables 5.1, 5.2, 5.3, 5.4 and 5.5.

Scenario 2: This follows the same procedure in scenario 1, but instead of 40 percent of total volume of water, only 20 percent is reallocated and distributed among the other production sectors on the basis of the estimated sectoral marginal values of water.

Scenario 3: Follows all of scenario 1, but only 10 percent of water used in the agriculture sector is transferred and distributed among the other production sectors on the basis of the estimated sectoral marginal values of water.

Scenario 4: The same procedure as in scenario 1, but only five percent of the total water used in the agriculture sector is transferred and distributed among the other production sectors on the basis of the estimated sectoral marginal values of water.

All the simulation results of these experiments are presented in Tables 5.1, 5.2 and 5.3, 5.4 and 5.5

5.4 PRESENTATION AND DISCUSSION OF SIMULATION RESULTS

The section is divided into two parts. The first part discusses the contribution of water to output growth, factor remuneration and households' income generation, while part two discusses the impact of reallocating water from agriculture to the other on output growth, job creation/losses, factor remuneration and households' income generation under the different scenarios discussed in sub-section 5.3.2

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The marginal values which are used in the simulation were econometrically estimated and computed in chapter four, using the two-stage model and marginal productivity approach. The computed marginal values show that the machinery and equipment manufacturing sector has the highest marginal value of water, followed by petroleum, heavy manufacturing, services, and mining respectively. The marginal value of water in the chemicals, leather and wearing apparel, and agriculture sectors are among the least.

5.4.1 Contribution of water to economic activities in South Africa

Column 13 of Table C2 in Appendix 3 presents the contribution of water to the economy generally, and specifically to output growth, factor remuneration and households' income generation. The multipliers show that for every Rand increase in investment in the water sector, output grows by about R6.67, while payments to the primary factors of production increase by R1.49 and R1.01 is generated as households' income. In terms of output growth, water contributes more to the services sector than the others; followed by agro-industries. The agriculture sector is again among the sectors that have the least direct contribution from water, although it is the most intensive user of water.

Water's contribution to factor remuneration is highest for capital, followed by unskilled, medium-skilled and skilled labour respectively. Overall, water does not contribute as much to value added as it does to output growth. Since the contribution of water to agriculture and the marginal value of water in this sector are minimal, there is enough justification to reallocate water from agriculture to the other sectors.

5.4.2 Reallocating water among the production sectors on the basis of efficiency

The simulation results of the experiments described in sub-section 5.3.2 are presented in the Tables 5.1 and 5.2. The study first discusses the impact on output growth, followed by the impact on employment and value added at factor costs and finally, households' income generation and redistribution.

5.4.2.1 Impact of water reallocation on output

The simulation results show that the reallocation of 40 percent of water from agriculture to the non-agriculture sectors can potentially lead to an overall decline of R1028.34 million in sectoral output. However, output increases in some sectors, while it declines in the others. It declines by R3516.88 million in the agriculture sector, R226.90 million in the food, beverages and tobacco manufacturing sector and R93.51 million in the services sector. Conversely, output increases by R1020.55 million in the mining sector, R889.41 in the leather and wearing apparel sector and R531.8 million in other manufacturing. Details about the absolute changes in output due to water reallocation from agriculture to the other sectors are presented in Column 4 of Table 5.1. The overall net decline in output is about

0.03 percent, which suggests that the decline in agricultural and the allied sectors' output are not offset by the increase in the receiving sectors' output. Output declines by 3.27 percent in the agriculture sector. Details about the percentage changes in output due to 40 percent water reallocation from agriculture to the non agriculture sectors are reported in Column 3 of Table 5.2.

Table 5.1: The contribution of water to sectoral output under different allocation scenarios

Sectors	Coefficients	Base output (Rm)	Water reallocation scenarios and changes in sectoral output			
	(2)	(3)	40% (4)	20% (5)	10% (6)	5% (7)
Agriculture(1)	-	107 549.3	(3516.88)	(2296.01)	(1231.43)	(410.42)
Mining	0.0298	18 6475.6	1020.55	853.41	736.62	299.36
Agro-industry	0.1680	23 8395.7	(226.90)	(156.40)	-89.6	45.85
Leather & wearing	0.2358	80 312.64	889.44	436.42	350.55	125.80
Paper, pulp & printing	0.0264	79 506.52	65.48	50.69	9.69	4.15
Petroleum	0.0551	82 195.24	44.71	27.88	17.33	2.29
Chemicals	0.0135	148 622.5	7.36	6.058	5.94	4.97
Heavy manufacturing	0.0479	175 957.8	45.84	35.99	24.58	2.95
Machinery& equipments	0.0754	295 222.1	36.34	44.17	28.33	3.62
Other manufacturing	0.0370	100 214.2	531.83	409.9	497.86	249.97
Electricity	0.0109	57 311.97	131.50	13.04	1.28	1.07
Water	-	18 218.11	0.05	0.53	0.52	0.43
Construction	0.2591	150 434.8	35.91	26.47	25.95	15.17
Services	0.0408	1 824 883.0	(93.51)	7.5	32.73	479.73
Total change in sectoral	**1.0000**	**3 545 299.03**	**(1028.34)**	**(540.37)**	**410.62**	**824.90**

In the second scenario where only 20 percent of water in the agriculture sector was reallocated to the non-agriculture sectors on the basis of their respective marginal values, overall output declines by R540.37 million. This figure represent about 0.015 percent decline in output from the base figure. Output declines in the agriculture and food, beverages and tobacco manufacturing sectors. The potential decline in the agricultural sector's output is R2296.01 million or 2.135 percent of the base output of this sector. In the food, beverages and tobacco manufacturing sector output declines by R156.40 million, which accounts for 0.066 percent of the sector's base output. However, the services sector is not significantly affected by this experiment.

Table 5.2: Impact of water reallocation on sectoral output under different scenarios

Sectors	Base output	Water reallocation scenarios and percentage changes in sectoral output			
		40%	20%	10%	5%
(1)	(3)	(4)	(5)	(6)	(7)
Agriculture	107 549.30	(3.270)	(2.135)	(1.145)	(0.382)
Mining	186 475.60	0.547	0.458	0.395	0.161
Agro-industry	238 395.70	(0.095)	(0.066)	(0.038)	0.019
Leather & wearing apparel	80 312.64	1.107	0.543	0.436	0.157
Paper, pulp & printing	79 506.52	0.082	0.064	0.012	0.005
Petroleum	82 195.24	0.054	0.034	0.021	0.003
Chemicals	148 622.50	0.005	0.004	0.004	0.003
Heavy manufacturing	175 957.80	0.026	0.020	0.014	0.002
Machinery& equipments	295 222.10	0.012	0.015	0.010	0.001
Other manufacturing	100 214.20	0.531	0.409	0.497	0.249
Electricity	57 311.97	0.229	0.023	0.002	0.002
Water	18 218.11	0.000	0.003	0.003	0.002
Construction	150 434.80	0.024	0.018	0.017	0.010
Services	1 824 883.00	(0.005)	(0.000)	0.002	0.026
Total change in sectoral output	**3 545 299.03**	**(0.029)**	**(0.015)**	**0.012**	**0.023**

As in the first experiment the outputs of most of the receiving sectors increase as expected, though this increase does not offset the decline in the losing sectors. Specifically, the output of the mining sector increases by R853.41 million, which is 0.46 percent of the base output, while the leather and wearing apparels output increases by R436.42 million. Details about the absolute output increase or decrease is reported in column 5 Table 5.1 and the percentage increases or decreases are reported in column 4 of Table 5.2.

The third experiment investigates the possible impact of a ten percent water reallocation from agriculture to the non-agriculture sectors on the basis of their marginal values. Unlike the first and second scenarios, this result of this experiment shows a net increase in output of R410.62 million. This indicates a 0.012 percent increase in output from the base output. As in the first two scenarios the outputs of the agriculture and food, beverage and tobacco manufacturing sectors decline by R1 231.01 million and R89.62 million respectively. The output decline in agriculture is approximately 1.145 percent of the base output, while that of food, beverages and tobacco manufacturing accounts for 0.038 percent of the base output. However, the outputs of the other non-agriculture sectors increased. The most prominent potential increase is recorded in the mining sector of R736.62 million, which accounts for 0.395 percent of the base output in that sector. This is followed by increases in the output of other manufacturing and leather products and wearing apparel sectors. These recorded R497.86 million and R350.55 million increases in output respectively. Overall the result of the experiment indicates a net increase of R410.62 million, which is 0.012 percent of total base sectoral output.

The results of the fourth scenario, which investigates the impact of a five percent reallocation of water from the agriculture sector to the non-agriculture sectors, are presented in Column 7 of Table 5.1 and the percentage interpretations are presented in Column 6 of Table 5.2. The results show a possible decline in agricultural output by R410.42 million which is 0.382 percent decline in base output. However, unlike the other scenarios, this experiment records an increase in the output of all the other non-agriculture sectors including services and food, beverages and tobacco manufacturing sectors. The overall impact records a net increase in output of R824.90 million, which is 0.023 percent increase in total base output. While the decline in agricultural output is minimal at thus level of water transfer, the increase in the output of the non-agriculture sectors leads to high net increase in overall output, though the percentage reallocation of water was minimal.

There are two possible reasons for the experimental results reported in Tables 5.1 and 5.2: the inter-sectoral linkages and the absorptive capacity of the receiving sectors. Firstly, the agriculture sector has forward and backward linkages with the other sectors in the economy. Output from the agriculture sector serves as input in the other sectors. The most prominent of these is the food, beverages and tobacco manufacturing. A decline in the output of the agriculture sector means that the intermediate inputs it provides for the food, beverages and tobacco manufacturing also declines, which reduces the production capacity of this sector as indicated by the results of the first three experiments. This is true for all the other sectors, except that this forward linkage is not strong enough to alter the production pattern of the other sectors. Agriculture also buys intermediate inputs from the other sectors. The most prominent of these is the services sector. Hence, any decline in the output of the agriculture sector implies that less intermediate inputs from the services sector are used, leading to a decline in the output of the services sector. Therefore, though these highly inter-dependent sectors receive water from the agriculture sector, their outputs decline. This is explained by the results of the first two scenarios. If the decline in the output of the agriculture sector is not quite significant to alter the production activities of these highly dependent sectors, they sectors can absorb the shock and still maintain a net increase in the output, to supply other sectors. This is explained by the results of the third and fourth scenarios.

Secondly, while some sectors have high marginal values of water, they are not intensive users of the resource. Hence, their capacity to absorb the reallocated water from the agriculture sector is quite limited. Therefore, the addition to output resulting from the addition of water is likely to be minimal when the receiving sectors' absorptive capacities are exceeded. This is true for machinery and equipments, chemical manufacturing, construction and heavy metal manufacturing sectors. The increase in the output of these sectors resulting from the reallocation of water from the agriculture sectors does not offset the decline in the output of the agriculture sector. To institute water use efficiency, the experimental results show that the percentage of agricultural water to be reallocated should not exceed ten percent. When this is exceeded the allocation is inefficient, as it leads to net output decline.

5.4.2.2 Impact of water reallocation on factor remuneration

This sub-section explains the impact of water reallocation from the agriculture to the non-agriculture sectors on payment to the primary factors of production. As output falls, the remuneration to the factors of production is affected. Within the short-run capital investment is not as significantly affected as the remuneration to employees.

A forty percent transfer of water from the agriculture sector to the non-agriculture sectors significantly alters total remuneration to both skilled and unskilled labourers.

Table 5.3: Impact of water reallocation on factor remuneration under the different scenarios

Primary factors	Base remuneration	Water reallocation scenarios			
		40%	20%	10%	5%
(1)	(2)	(3)	(4)	(5)	(6)
Capital	370 416.37	0.713	0.691	0.478	0.07
		0.000%	*0.000%*	*0.000%*	*0.000%*
Unskilled labour	141 514.46	(765.57)	(420.03)	(217.005)	50.00
		(0.541%)	*(0.287%)*	*(0.153%)*	*0.035*
Medium skilled labour	169 071.87	331.17	256.45	226.27	80.58
		0.196%	*0.152%*	*0.134%*	*0.048%*
High skilled labour	86 538.55	24.43	16.08	3.07	0.03
		0.028%	*0.019%*	*0.004%*	*0.000%*
Total impact on factor remuneration	**767 541.25**	**(409.256)**	**(146.801)**	**12.815**	**130.688**
		(0.053%)	***(0.019%)***	***0.002%***	***0.017%***

This experiment records a reduction in total wage bill to unskilled labourers by R765.57 million, which is 0.54 percent of the base wage bill, while the wage bill of both medium and high skilled labourers increase by R331.17 million (0.2 percent) and R24.43 million (0.03 percent) respectively. However, the overall effect shows a decline in factor remuneration by R409.26 million, which is 0.05 percent of the base remuneration package. Similarly, the transfer of twenty percent of water from agriculture to the non-agriculture sectors shows that total factor payments decline by R146.80 million. As in the first scenario, the wages of unskilled labourers decline by R420.03 million (0.29 percent), while those of medium and high skilled labourers increase by R256.45 million and R16.08 million respectively indicating 0.15 percent and 0.019 percent increase from the base figures.

Unlike the first and second scenarios, the third scenario indicates a net increase in factor remuneration by R12.82 million, which is 0.002 percent of the base remuneration. As in the first and second scenarios, the wages of unskilled labourers decline, but this is offset by the increase in the total remuneration to medium and high skilled labourers.

The fourth scenario shows the same pattern but with a higher net increase in factor payments of R130.69 million, which shows a percentage increase of 0.02 percent in the total base remuneration.

The possible reason for this pattern of change in factor remuneration is that the majority of the employees in the agriculture sector are unskilled labourers. When output in this sector declines, most of those laid off are these unskilled labourers and the non-agriculture sectors cannot absorb all those laid-off by the agriculture sector. The manufacturing sector for example requires medium level skilled individuals for most of the technical operations. The mining sector alone cannot absorb most of the laid-off labourers. This leads to a significant decline in the unskilled labour remuneration.

The fourth experiment indicates that with a minimum reallocation of water, the number of labourers laid-off in the agriculture sector is absorbed by the non-agriculture sectors that benefit from the reallocation, leading to net increase in factor remuneration.

5.4.2.3 Water reallocation and employment in the economy

The alterations in output due to water reallocation from the agriculture to the non-agriculture sectors have consequences for job creation or losses in an economy characterized with a high level of unemployment. As explained in the theoretical framework, a decline in sectoral output leads to loss of jobs in that sector and an increase in sectoral output stimulates job creation. As already shown in section 5.4.2.1 with a significant transfer of water from agriculture to the non-agriculture sectors, the outputs of the agriculture, food, beverages and tobacco manufacturing and the services sectors decline while the output of the other non-agriculture sectors increase. The potential jobs that will be created or lost due to the experiments are reported in Table 5.3.

In the first experiment, a 40 percent reallocation of water from agriculture to the non-agriculture sectors results in a potential loss of 7081 jobs. Because of the decline in the agriculture sector's output, 24 427 jobs are lost in this sector, while most of the non-agriculture sectors create jobs as result of the increase in their outputs. The potential job losses outweigh the potential jobs created. This results in a net job loss. Details are reported in Column 2 of Table 5.4.

The second scenario shows a net job loss of 2127, with 15 367 jobs lost in the agriculture sector and 406 potential job losses in the food, beverage and tobacco manufacturing sector. The other sectors record a potential of 13 646 jobs created. The potential job losses outweigh the potential jobs that can be created by this experiment. Details are reported in column 3 of Table 5.4

The third experiment records 143 net jobs created. The agriculture sector records 12 551 job losses, but the jobs created by the other sectors outweigh the job losses. This implies that a ten percent water reallocation from the agriculture sector to the non-agriculture sectors can lead to job losses in the agriculture sector and job creation in the non-agriculture sectors. In the last experiment, reallocation of five percent of water from agriculture to the non-agriculture sectors potentially leads to 260 net jobs.

Table 5.4: Water reallocation and job creation under different scenarios

Sectors (1)	Water reallocation scenarios and Job losses/creation			
	40% (2)[4]	20% (3)	10% (4)	5% (5)
Agriculture	(24 427)	(15 367)	(12 551)	(7 452)
Mining	7 587	5 672	4 032	1 639
Agro-industry	(589)	(406)	30	119
Leather & wearing apparel	8 278	6 062	5 262	1 171
Paper, pulp & printing	237	184	35	15
Petroleum	38	24	15	2
Chemicals	14	11	11	9
Heavy manufacturing	169	133	91	11
Machinery& equipments	76	92	59	8
Other manufacturing	1 698	1 209	2 733	798
Electricity	365	36	4	3
Construction	222	163	160	94
Services	(749)	60	262	3843
Total change in sectoral output	**(7 081)**	**(2 127)**	**143**	**260**

[4] Numbers in parenthesis are negative

The experiments show that when a minimum quantity of water is reallocated from agriculture to the non-agriculture sectors on the basis of marginal values, the potential exists for jobs to be created. If these minimum quantities are exceeded, the sectoral output and factor payments are expected to decline, leading to net job losses. The job losses in the agricultural sector are not necessary taken up by the non-agriculture sectors because of differences in skill requirements in these sectors. While the agriculture sector employs more unskilled labourers, the manufacturing, mining and construction sectors require more medium and high skilled labourers.

5.4.2.4 Water reallocation and households' income generation and distribution.

The potential alterations in output and the possible impacts on factor payments and job creation/losses have some implications for the generation and distribution of households' incomes. The potential impact of each of the four experiments on households' income generation and distribution is analyzed for the five household categories in South Africa, according to their economic status. The results are reported in Table 5.5

The results of the first experiment show a net decrease in households' income by R304.826 million, which is 0.051 percent of the total households' base income. This means that a forty percent reallocation of water from the agriculture to the non-agriculture sectors can possibly lead to total decline in households' income by R304.286 million. The analysis shows that the least-income and low-income households' incomes decline by R169.879 million (0.961 percent of base income) and R467.723 (1.394 percent of base income) respectively.

Table 5.5: Impact of water reallocation on households' income under different scenarios

Household category (1)	Base household Income (2)	Water reallocation scenarios 40% (3)	20% (4)	10% (5)	5% (6)
Least-income households	17 674.926	(169.879)	(145.035)	(72.724)	(47.017)
		(0.961%)	*(0.821%)*	(0.411%)	*(0.266%)*
Low-income households	33 553.951	(467.723)	(402.002)	(257.937)	(126.001)
		(1.394%)	*(1.198%)*	*(0.769%)*	*(0.376%)*
Middle-income households	281 996.433	220.936	179.332	115.366	102.158
		0.078%	*0.064%*	*0.041%*	*0.036%*
High-income households	146 835.814	101.388	93.983	130.727	96.315
		0.069%	*0.064%*	*0.089%*	*0.066%*
Highest-income households	114 287.263	10.992	8.765	6.926	3.357
		0.010%	*0.008%*	*0.006%*	*0.003%*
Total impact on households income	**594 348.035**	**(304.286)**	**(264.957)**	**(77.642)**	**28.812**
		(0.051%)	***(0.045%)***	***(0.013%)***	***0.005%***

While the incomes of the two lowest-income households decline, the potential exists for the incomes of the middle, high and highest-income households to increase. However, this increase is not enough to dampen the effect of the decline in the incomes of the lowest-income households. Detailed potential impact of the experiment on households’ income is presented in Column 3 of Table 5.5.

A similar pattern of result is displayed for a twenty percent reallocation of water from the agriculture to the non-agriculture sectors. This shows a potential decline in households’ income by R264.957 million. The income of the two low-income households declines by R145.035 million and R402.002 million. The middle and high-income households’ incomes is expected to increase, although the potential increase is less than the decline in the lowest-income households' incomes. Column 4 of Table 5.5 records the detailed potential impact.

Although the magnitude of net decline in households' income is not as much as in the first and second experiments, the third experiment also records similar pattern of impact. This implies that even with only ten percent reallocation of water from the agriculture to the non-agriculture sectors, poor households are still expected to loss income, while the gain in income by the middle and high-income households is not enough to generate a net increase in households' income.

The results of the fourth simulation record a net increase households' income, although the incomes of the poor households decline. In the fourth scenario, where only five percent of water is reallocated to the non-agriculture sectors, the middle and high-income households' incomes has the potential of increasing more than the decline in the lowest-income households' income. This can only lead to a welfare gain if the winners are ready to adequately compensate the losers.

When output falls in the agriculture sector, the sectors that use agricultural output as intermediate inputs and those that supply the required intermediate input for agriculture are directly affected. The outputs of the non-dependent sectors are expected to increase. Whether the increase outweighs the decrease, the net effect depends on both the quantity of water reallocated from agriculture to the non-agriculture sectors and the absorptive capacity of the receiving sectors. The experimental results show that this leads to a decline in the output of these sectors. The results also indicate that for a positive net increase in output water transfer from the agriculture sector should not exceed ten percent. Five percent reallocation has a greater positive impact on output than ten percent.

Alterations in output have direct consequences for factor remuneration, employment and households' income generation and distribution. Sectors that potentially benefit from the water reallocation experience output growth, while the potential losers experience output decline. Those with the potential to increase output employ more labourers, while the sectors with a potential decline in output lay-off labourers. The net effect may lead to job creation if the winners create more jobs than the number of jobs lost, or job losses if the winners cannot absorb all the labourers laid-off by agriculture and its allied sectors. The simulation results show that at if the ten percent level of water reallocation is exceeded more jobs are lost than created. This impact, when translated into monetary terms, indicates the alterations in wages, and consequently households' income. The experimental results indicate that the total wage bill for unskilled labourers declines in the first three scenarios and has minimal increase of 0.035 percent in the last experiment. The total wage bills for the medium and highly-skilled labourers increase in all the scenarios. This increase is not large enough to compensate for the decrease in the wage bill of the unskilled labourers in the first two experiments, leading to a net decline in labour remuneration. This is directly transferred to the households' income generation. Because the majority of the unskilled labourers are the lowest-income households, a decline in unskilled labourers total wage bill leads to a decline in the income of the lowest-income households although in some of the scenarios, there is a positive net household income generated. This may be due to increased remittances from the middle-income earners, the majority of whom are medium skilled labourers.

5.5 SUMMARY AND CONCLUSIONS

Using the traditional SAM multiplier analysis, this study analyzed the contribution of water to the various sectoral activities and estimated the potential impact of reallocating water from agriculture to the non-agriculture sectors on the basis of the marginal revenue of water in the various non-agriculture sectors.

The findings show that although agriculture's marginal returns to water use in South Africa is not as high as the manufacturing and mining sectors; it plays a major role in income generation and creating jobs for the low-income households in the country. It has forward and backward linkages in the economy, which are not captured in the direct impact analysis. Therefore, any water reallocation strategy that significantly alters the production structure in this sector will be transmitted to the most vulnerable population in the economy. All the simulation results show that any level of water transfer from agriculture to the other sectors significantly alters agricultural output and consequently leads to a decline in the incomes of most vulnerable households (least-income and low-income households), making them poorer. The results also show any level of water transfer from agriculture leads to net job losses. This means that the number of jobs lost in the agriculture sector are not created in the non-agriculture sectors to effect a not job creation.

The simulation model used assumes strict linearity and constant prices are constant. It also assumes that causal relationships among sectors, factors of production and institutions are purely demand determined. The simulation results could be different if a combination of linear and non-linear relationships is used in the modeling procedure. Also by relaxing the assumption of constant prices and allowing price flexibility in both the factor and output markets may lead to different simulation results. There is also the need to show how households respond to changes in the level of income by altering their expenditure patterns. These require the use of a Computable General Equilibrium model to investigate the impact of inter-sectoral water allocation policies on the economy.