Chapter 6: Conclusions, Implications and Limitations of the Study

6.1 Conclusions and Implications

This study evaluated the economic and environmental costs and benefits of changes in water policies and management regimes in the Crocodile River Catchment, employing a SAM framework. The study particularly focussed on assessing the effects of water demand management regimes on the catchment economy. The cost and benefit analysis scenarios generated information about:

- The direct and indirect impacts of various WDM policies on the economy and the environment.
- The importance of environmental-economic models in water cost benefit modelling.

6.1.1 The direct and indirect impacts of various WDM policies on the economy and the environment

In sections 2.2.2 and 3.2 of this study, water demand management was defined to consist of two phases of intervention. The first phase deals with regulatory aspects of WDM, whereas the second phase deals with water allocation according to its scarcity value. As these two phases are implemented, water users can expect to experience a range of WDM measures that will impact on the way they use water. The study evaluated five water policies and other water management considerations:

1 - The effect of water re-allocations between various sectors,

2 - The effect of water pricing policies,

3 - The effect of environmental externalities,

4 - The prediction of absolute water scarcity,

5 - The investigation of the effect of a water-metering programme on water trade.

A discussion on each of these follows:

1 - The effect of water re-allocations between various sectors:

Economic, social and environmental activities are governed by a very large, and very complex, integrated set of transactions. Individual transactions occur at a micro-economic level: they are made in the context of the decision-makers' individual needs and environment. However, every transaction has, to a lesser or greater extent, a multiplier effect which indirectly affects the transactions of other decision-makers:

- Water allocations between large primary water users impact widely on the economy. New water allocations can have widely realised positive effects, whereas re-allocations may have widely distributed negative impacts in the sector losing water, and also in its associated value adding sectors. This is especially true for agricultural activities, which support such long value chains of economic activity.
- Changes in economic conditions, such as a change in a commodity price due to a drought or exchange rate fluctuations, can radically change the economy-wide impact of a water re-allocation.
- Longer, resource intensive, value chains, with their larger value addition components, have been shown to have generally higher environmental impacts. This confirms the findings of an earlier WRC study (Crafford et al, 2002).
- Policy implementation decisions have to be made based on sound, verified water use data. It was shown how new scientific data changed the estimated economy-wide effect of a water transaction between eucalypt forestry and sugar cane farming: improved estimates of forestry water use had an effect of 0.003% on total economic output in a simulated sugar-forestry water transaction. As new research is done on water use patterns of various land uses, data will therefore have to be continuously updated to ensure that the correct conclusions are drawn.

The results of this study have shown the complexity of economic and environmental transactions taking place in an economic system, and the resultant multiplier effects of WDM decisions. As such an economic system comprises of a multitude of individuals making decisions at a micro-economic level, it will be important for policy-makers to decentralize water use decision-making as far as possible. Water users carry the ultimate economic risk of their decisions, and appropriate WDM policies should transfer the risk of water scarcity to water users. For instance, section 5.1.1 discussed how a drop in the price of oranges could negate a water re-allocation from an alternative land use to oranges. With the volatility of the Rand since 1998, and the subsequent impact on exporters, such a scenario is entirely possible. Properly regulated water markets may play an important role in putting a value to scarce water resources.

2 - *The effect of water pricing policies*

The price responsiveness of various sectors is determined to a large extent by the elasticity estimates used. In the scenarios simulated in this study, price elasticities of -0.6 and -1.0 were used for irrigated agriculture and forestry respectively, and -0.6 for industrial water users.

In the agricultural sector, the simulated reduction of subsidies and changes in water tariff strategies (such as a catchment management charge for forestry), did not have a major effect on the economy or result in major water savings. The possible reasons for this are:

- the high level of integration of agricultural value chains;
- the long rotation periods of these crops;
- the relatively small incremental changes in tariffs that were brought about by the pricing policies: for instance, irrigation water tariffs increased by only 0.3-0.5 cents per cubic metre and the forestry water charge was R2/hectare. These subsidy changes therefore did not have a major impact on the cost of business of these sectors.

On the other hand, industrial water users were much more price responsive to an inflation based increase in water tariff. An inflation-based increase in water tariff of 10% was simulated, which meant that the cost of water of the large water-using industries increased by 10%. Such an increase impacted relatively more on the cost of their business that was the case for the agriculture sector.

It has to be recognised that accurate elasticity estimation is important to ensure that tariff policies achieve its goals.

The subsidy reduction and tariff changes experiments done in this study showed that the achievement of a NWA principle such as full cost recovery, does not necessarily achieve water savings. If a water scarcity situation occurs in a specific catchment area and water demand has to be reduced, an appropriate set of pricing policy interventions need to be targeted towards reduction of demand. For instance, policy-makers have to quantify the water use by the various sectors, understand the economic and other contributions of these sectors, identify those sectors where water savings can be achieved most effectively and then design and implement water pricing policies appropriate for each individual sector.

3 - The effect of environmental externalities

It was demonstrated how a carbon tax may reduce economic activity, and subsequently decrease water demand. A carbon tax of R20/ton levied on carbon-generating activities, and intending to reduce CO_2 equivalent emissions by 0.8%, reduced water demand by 1,215,000m^3, and economic output by 0.026%. Alternatively, WDM policies may have a positive effect on carbon emissions if it leads to a decrease in economic activity in an industry with high carbon emission levels.

In this scenario, an environmental protection policy had the unintended consequence of reducing water demand. There is therefore a need to assess the integrative effects of various policies.

4 - The prediction of absolute water scarcity

A combination of factors causes situations of water scarcity in various parts of South Africa. The variability of rainfall, location of economic activities and the existence of water supply infrastructure determine the water demand and supply in specific catchments. Therefore some in some catchments demand are catching up with water supply at a faster rate than in others. WDM measures are therefore necessary policy interventions for South Africa. The implementation of WDM measures do however need to be taken with great care and planning, as they could have major impacts on the economy. Catchments that face absolute water scarcity situations require well-planned, targeted interventions, and immediate implementation.

5 - The investigation of the effect of a water- metering programme on water trade

Metering of the quantity of water use is desirable for water management as it provides incentives for efficient water use. However, the net benefits of water metering installation programmes have to be assessed to ensure a net positive effect on the economy and the environment. It was estimated that a comprehensive water metering system could increase the cost of irrigation water by 300%. The benefits gained from the metering system should outweigh this increase in water cost.

Moving towards the second phase of WDM, water trading, will bring about complex new water management situations. In order to prepare for this, the various transaction costs of water trading (of which water metering is an example) need to be assessed and planned for. These transaction costs need to be limited to a level where the benefits accrued from water savings and productive allocation of water yields an economy-wide benefit. If not, water trading will fail as a WDM mechanism.

6.1.2 The importance of environmental-economic models in water cost benefit modelling

WDM implementation decisions are mostly made at a catchment level, which is a much smaller geographical unit than the provincial level. The economy may also differ in structure from that of a province. In addition, economic value chains span across catchment boundaries and therefore the economic and environmental impacts related to water management decisions may differ widely from catchment to catchment and between catchment and provincial levels. WDM policy makers and implementers include DWAF, CMAs and WUAs. Therefore, in facing complex water management problems, a SAM framework can be a helpful tool, to ensure that the equity, efficiency and sustainability principles of the NWA are adhered to. A regional SAM will be a worthwhile tool, especially at the CMA level, to assess regional economic effects of market and policy changes, and to help determine the approach of absolute water scarcity for the WMA.

It is therefore evident that policy decisions, which are implemented at a macro-economic level, and could have a major direct impact a wide range of economic sectors, should be carefully considered as it could have unintended consequences.

In order to make WDM decisions that adhere to the NWA principles of equity, efficiency and sustainability, decision-makers require tools, such as appropriate SAMs to inform their decision-making process. These tools can, however, only be effective if decision-making parameters and management objectives are clearly defined, and accurate data are used.

A regional economy, such as a CMA, may use a SAM to do strategic planning of various water demand management interventions and other assess various economic and environmental effects:

- a CMA may for instance use a SAM to determine the parameters for water use in order to manage water scarcity risk;
- they may use a SAM to decide whether and where trading may be appropriate (if benefits outweigh transaction costs);
- a SAM can be used as a tool to provide valuable information about the structure of the CMA or WUA economy with which direct and indirect impacts of water management decisions may be simulated.

6.2 Limitations of the study

- SAM modelling is limited by its nature as it presents an accounting framework where the relationships between various economic and environmental sectors are represented by linear functions. This has important implications for using the model to forecast impacts of policy changes, as it does not allow for input substitution resulting from a price change in a particular sector. Also, it does not allow for changes (improvement) in technology which take place from year to year. Both these limitations are of importance as the base data used by Conningarth for their Inkomati SAM were 1993 data, and since then, South Africa has become a more open economy – therefore agriculture and forestry sectors have become exposed to international pricing policies, and export/impart competition.

- The linearity constraint of the SAM also implies that the analyses done here are static, and does not take into account the dynamic price fluctuations experienced by many of the commodity markets discussed in this study.
- Research determining marginal values of water is a necessity for proper determination of pricing and efficiency allocations.
- The SAM model developed here was based purely on the secondary data sources described in Chapter 4 and was not verified against primary data.
- Assumptions used naturally also impose limitations. The following assumptions were made during the development of the SAM modelling:
    - The structure of the Crocodile River Catchment economy in 1998 was the same as that of the Komati study area as presented in the Conningarth SAM (Conningarth, 2000). This has important implications as Nelspruit, the major economic hub in the Crocodile River Cathment, fell oustside the Komati study area.
    - The structures of the forestry, sub-tropical fruit and sugar value chains for the Crocodile River Catchment economy in 1998, were assumed to be identical to the structures of these chains in the Mpumalanga study area as presented in the Hassan WRC study (Crafford et al. 2003).
    - The elasticity values used were sourced from secondary sources. Not enough information was available on elasticities, and more research on this is required.
    - The environmental indicators and impacts (**e**) used in the study, excluding the water use impacts, were identical to those of the USA economy.
- Only a first step was made into quantifying environmental impacts. Only point source environmental impacts can be meaningfully analysed. Point source data require that the relation between economic activity and environmental impact can be quantified by a measured coefficient, and such data is in most cases not available. In addition, environmental data are often indicators data of which the actual impacts, say on ecosystem functioning or human health (e.g. probability of respiratory disease in a specific community due to air pollution) are not known.