

EXECUTIVE SUMMARY

1. BACKGROUND AND MOTIVATION

A study comparing the economic efficiency of water use by sub-tropical fruits, forest plantations and sugar cane in the Crocodile River catchment was completed in 1999 with funding from the Water Research Commission (WRC) (Olbrich and Hassan 1999). This study analysed water use efficiency based on direct economic benefits generated in specific primary production activities (forestry, irrigated sugarcane and five irrigated sub-tropical fruits), i.e. at the farm level. Accordingly, indirect economic benefits realized upstream or downstream from the primary sector in question were not accounted for. The social costs and benefits of the major environmental impacts of the studied activities were also not investigated. As the demand for water by the agricultural production activities remain central to future economic development and efficiency of resource use in the Crocodile River catchment, a follow-up study was commissioned by the WRC. The aims of the present study were therefore to account for total economic benefits (direct and indirect) of water use in the catchment, and to investigate the environmental (natural) and social costs and benefits of the studied activities.

1.2 OBJECTIVES OF THE STUDY

The specific objectives of this research project were as follows:

- To refine data on water use within the respective sectors, and within their value chains;
- To quantify water use per crop per sector;
- To obtain representative figures of full private costs for small and large growers in each sector;
- To establish forward and backward linkages for each sector;
- To examine product flows;
- To determine external (public) effects – economic, social and environmental costs and benefits. (It was understood that the term “environmental” referred to in the contract was used in the context of the natural environment.)

1.3 APPROACH AND METHODOLOGY

The point of departure of the study was the mapping and quantification of the value chains of each of the three land use types analysed: forestry, irrigated sugarcane and five irrigated sub-tropical fruit types. This was done in a two-stage process where, firstly, the product flows of the relevant land uses were mapped through the identification of forward and backward linkages. Secondly, each value addition activity was quantified in terms of price, intermediate consumption and value added, through extensive survey and primary data collection in each of the three value chains in Mpumalanga.

Economic, social and environmental impact analyses were then completed for each value chain. *Direct impacts* were defined as the economic, social and environmental impacts occurring within each of the land uses (i.e. at farm level) as the result of an event such as a water trade-off decision. *Indirect impacts* were defined as the resultant impacts occurring in the forward and backward linkages of the respective value chains. The *economic impact analysis* set out to measure and compare total economic benefits (direct and indirect) from water use by plantation forestry, irrigated sugarcane and five types of irrigated subtropical fruit (oranges, grapefruit, bananas, avocados, mangoes) in the Crocodile River catchment. The *environmental impact analysis* identified the value chain of direct and indirect product flows within each sector. This was used as a basis from which to build a hybrid life-cycle assessment of the respective sectors and focused on the environmental aspects of the life-cycle analysis. The *social impact analysis* set out to measure the impact of the respective value chains on households and individuals. This part of the study examined direct and indirect employment and enterprise linkages, and assessed the external social benefits and costs on households that result from these three land uses. Finally, a *comparative analysis* of the results was done in order to combine the outputs from each of the economic, social and environmental analyses into one model where some of the trade-offs involved in water allocation and associated policy implications could be assessed.

The above approach required an intensive data acquisition process, matrix-based spreadsheet modelling involving transfer studies, a validation process and analyses of results.

1.4 CONCLUSIONS

Water apportionment decisions remain, for the largest part, dependent on accurate water use information. This study has shown for instance how estimates of forestry water use figures changed with the adoption of new forest hydrology modelling data. The measurement of irrigation water use remains an important issue in the determination of actual on farm water use, and prediction models for this are not adequate. Comparative analysis of forestry and irrigation water use must be done carefully, as the terminology and definitions used in forest hydrology and irrigation planning are

different. Water use per ton of product in the respective value chains, defined as indirect water use for the purposes of this study, are very small in comparison to the direct crop water use.

This study revealed the importance of considering indirect economic benefits in comparing the social worthiness of alternative productive uses of water and other economic resources. This was especially evident from the value added (VAD) and employment multiplier effects, which were between 2 and 20-fold larger than the direct benefits. The multiplier effects were more pronounced for the longer value chains, i.e. those that comprised of more intermediate value adding activities between the farm and the final consumer.

The study also provided insight into the trade-offs between economic production and environmental emissions and resource use. The value chains with larger economic and employment yields usually went hand in hand with higher energy use and larger emission factors. Interestingly, the value chains with larger environmental impacts (in this case pine and eucalypt forestry and sugarcane) also produced potentially significant environmental benefits. In the case of forestry, its carbon sequestration ability significantly outweighed its greenhouse emissions impact. In the case of sugar, the use of bagasse as a major energy source reduced net energy requirements of the sugar value chain considerably. All three the land uses also had the potential to produce benefits to society through effective management of natural ecosystems on their estates or management units.

The broader social impacts of the value chains were much more difficult to quantify than the economic, employment and environmental impacts. Within the terms of reference of the study, vulnerable households were the key social group that was focussed on. Vulnerable households were regarded as poor, mostly Black, rural households with low education levels. It was concluded that the three land uses under discussion had large impacts on these households as the bulk of employment opportunities (expressed in man-days per ton) was supplied to them. The effect of these employment opportunities on household income and social adaptive capacity remain an important variable, but was not researched due to data constraints.

Importantly, the study also showed the value of data transfer studies when policy decisions have to be made in the absence of comprehensive primary data. It has to be noted that, in spite of the effort made to obtain best available data, considerable data inadequacies existed. In a study of this nature, where data from many different sources are compared, high quality, homogenous data is required. Unfortunately the unavailability of such data was one of the limitations to the study (see section 8.3)

1.5 EXTENT TO WHICH THE OBJECTIVES HAVE BEEN MET

- To refine data on water use within the respective sectors, and within their value chains:

This was completed satisfactorily through the value chain analyses, and through intensive primary data collection.

- To quantify water use per crop per sector:

Plantation forestry water use was refined satisfactorily, using updated (2002) plantation water models. The determination of net irrigation of sub-tropical fruits was investigated, but was not completed, based on data deficiencies and modelling complexities. The rationale for this is explained in section 5.3.1.

- To obtain representative figures of full private costs for small and large growers in each sector:

This was completed satisfactorily through the value chain analyses, and through intensive primary data collection.

- To establish forward and backward linkages for each sector:

This was completed satisfactorily through the value chain analyses, and through intensive primary data collection.

- To examine product flows:

This was completed satisfactorily through the value chain analyses, and through intensive primary data collection.

- To determine external (public) effects:

The environmental and social costs and benefits were determined through qualitative and quantitative methods, and yielded satisfactory results. This part of the study showed, however, that much more research is required to enable comprehensive internalisation of external effects.

1.6 RECOMMENDATIONS FOR FURTHER RESEARCH

Two avenues of future work were identified:

- The environmental and social externalities identified here can be linked to a Social Accounting Matrix in order to model the effects of various water policy decisions.
- Research is required on selected pilot study areas in order to generate a comprehensive data base from which benefit transfer studies may be done to inform water policy decision-making.

1.7 CAPACITY BUILDING REPORT

It is expected that one M.Sc. degree will be forthcoming from the final report.

Project Members	Role	Approximate Time Spent	Institution, Designation	Highest qualification at time of Research
Bekker, Simon	Project Design	<1%	University of Stellenbosch, Professor	PhD
Crafford, Jackie	Project Leader, Researcher; Data Acquisition	~ 18%	CSIR, Environmentek	MSc
Damon, Margot	Researcher and Development of Chapter 2 & 6	~16%	CSIR, Environmentek – Internship programme	Hons
De Wit, Martin	Development of Chapter 7 & 8	~4%	CSIR, Environmentek	PhD
Dicks, Mark	Data Acquisition	~4%	CSIR, Environmentek	Hons
Gouws, Marnus	Data Acquisition	~4%	University of Pretoria, Student	Hons
Hassan, Rashid	Project Design and Development of Chapter 4	~10%	University of Pretoria, Professor	PhD
King, Nicola	Researcher and Development of Chapter 5	~16%	CSIR, Environmentek	MSc
Kruger, Fred	Project Design	<1%	Private Consultant	PhD
Meyer, Ferdi	Data Acquisition	~4%	University of Pretoria, Student	Hons
Olbrich, Bernie	Project Design and Researcher on Chapter 6	~10%	Private Consultant	PhD
Rapholo, Blondie	Data Acquisition and Editing	~4%	CSIR, Environmentek – Internship programme	Hons
Van der Merwe, Marna	Data Acquisition	~4%	CSIR, Environmentek	MSc

1.8 ARCHIVING OF DATA

Environmental impact coefficients are available in Excel spreadsheet format.

1.9 KNOWLEDGE TRANSFER

The knowledge resulting from this study relate mostly to water policy formulation for national government, catchment management agencies and water user associations. In addition, knowledge in terms of adaptation strategies for industries was developed. It is proposed that the key findings of this report be communicated to these stakeholders through direct mail or other personal contact, and that follow-up actions be undertaken as warranted by stakeholder feedback.

ACKNOWLEDGEMENTS

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“A comparison of the economic efficiency of water use of plantations, irrigated sugarcane and sub-tropical fruits – a case study of the Crocodile River Catchment, Mpumalanga Province.”

The steering committee responsible for this project consisted of the following persons:

Dr G R Backeberg	Water Research Commission (Chairman)
Mr H Maaren	Water Research Commission
Mr JG Crafford	CSIR, Environmentek
Mr JM Bosch	CSIR, Environmentek
Prof MF Viljoen	University of the Free State
Dr AB Emmet	Human Sciences Research Council
Dr SF du Plessis	Agricultural Research Council
Prof PJT Roberts	Forestry SA
Mr EJ Schmidt	SA Sugar Association
Mr M Warren	Department of Water Affairs and Forestry

The project team would like to acknowledge the contribution of Mr Hugo Maaren to this project, who sadly passed away shortly before the completion of the final report. Mr Maaren has, over many years, made very significant contributions to water research in SA, and his presence will be sorely missed.

We would also like to express our appreciation to the steering committee for their guidance during the course of this project. In particular, we would like to thank Dr Backeberg for his assistance in guiding the project. We would also like to thank Dr F Kruger (Fred Kruger Consulting) and Prof S Bekker (University of Stellenbosch) for their assistance in designing the environmental and social components of the study.

The study required intensive data collection, during which the project team received tremendous industry assistance. We would like to extend our appreciation to the following representatives of the Forestry, Sugarcane and Sub-tropical fruit sectors, for their assistance.

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