Comprehensive Reserve Determination Study for Selected Water Resources (Rivers, Groundwater and Wetlands) in the INKOMATI WATER MANAGEMENT AREA, Mpumalanga

PROJECT NO: WP 9133

Socio Economic Present State Evaluation Report

INKOMATI

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COMPREHENSIVE RESERVE DETERMINATION STUDY FOR SELECTED WATER RESOURCES (RIVERS, GROUNDWATER AND WETLANDS) IN THE INKOMATI WATER MANAGEMENT AREA. MPUMALANGA

SABIE AND CROCODILE RIVER SYSTEMS : SOCIO ECONOMIC PRESENT STATE EVALUATION REPORT

Approved for Rivers for Africa by:

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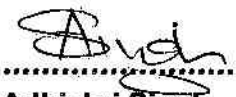
Delana Louw
Technical Project Manager



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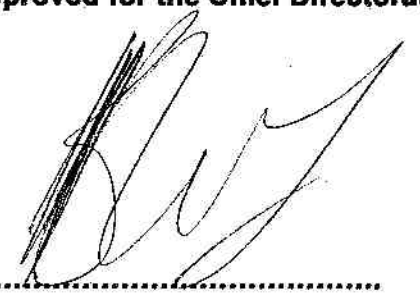
Adhishri Singh
Administrative Project Manager

Approved for the Chief Directorate: Resource Directed Measures by:



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Barbara Weston
Study Manager

Reports as part of this project:

Report no	Report title
26/8/3/10/12/001	Comprehensive Reserve Determination Study for selected water resources in the Inkomati WMA, Mpumalanga: Inception report
26/8/3/10/12/002	Comprehensive Reserve Determination Study for selected water resources in the Inkomati WMA, Mpumalanga: Desktop EcoClassification report
26/8/3/10/12/003	Newsletters
26/8/3/10/12/004	Comprehensive Reserve Determination Study for selected water resources in the Inkomati WMA, Mpumalanga: Basic Human Needs Reserve report
26/8/3/10/12/005	Comprehensive Reserve Determination Study for selected water resources in the Inkomati WMA, Mpumalanga: Groundwater report
26/8/3/10/12/006	Comprehensive Reserve Determination Study for selected water resources in the Inkomati WMA, Mpumalanga: Resource Unit report
26/8/3/10/12/007	Comprehensive Reserve Determination Study for selected water resources in the Inkomati WMA, Mpumalanga: Desktop Estimation report
26/8/3/10/12/008	Comprehensive Reserve Determination Study for selected water resources in the Inkomati WMA, Mpumalanga: Wetland report
26/8/3/10/12/009	Comprehensive Reserve Determination Study for selected water resources in the Inkomati WMA, Mpumalanga: EcoClassification report
26/8/3/10/12/010	Comprehensive Reserve Determination Study for selected water resources in the Inkomati WMA, Mpumalanga: EWR scenario report
26/8/3/10/12/011	Comprehensive Reserve Determination Study for selected water resources in the Inkomati WMA, Mpumalanga: Operation scenarios and consequences report
26/8/3/10/12/012	Comprehensive Reserve Determination Study for selected water resources in the Inkomati WMA, Mpumalanga: EcoSpecs report
26/8/3/10/12/013	**Comprehensive Reserve Determination Study for selected water resources in the Inkomati WMA, Mpumalanga: Socio Economic Present State Evaluation Report**
26/8/3/10/12/014	Comprehensive Reserve Determination Study for selected water resources in the Inkomati WMA, Mpumalanga: Training audit and report
26/8/3/10/12/015	Comprehensive Reserve Determination Study for selected water resources in the Inkomati WMA, Mpumalanga: Main report
26/8/3/10/12/016	Comprehensive Reserve Determination Study for selected water resources in the Inkomati WMA, Mpumalanga: Electronic information and data

Bold indicates this report

REFERENCES

This report is to be referred in bibliographies as:

Department of Water Affairs, South Africa. 2010. Comprehensive Reserve Determination Study for Selected Water Resources (Rivers, Groundwater and Wetlands) in the Inkomati Water Management Area, Mpumalanga. Sabie and Crocodile Systems: Socio Economic Present State Evaluation Report. Authored by W Mullins (Conningarth Economists) and T Tlou RDM Report no 26/8/3/10/12/013.

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ABBREVIATIONS AND ACRONYMS

Combud	- Computer Based Budgets
DWAF	- Department of Water Affairs and Forestry
EZ	- Economic Zone
GDP	- Gross Domestic Product
MEIM	- Macro Economic Impact Model
SAM	- Social Accounting Matrix
TIH	- Total Income Household
TSB	- Transvaal Sugar
WMA	- Water Management Area
WRC	- Water Research Commission

1 INTRODUCTION

1.1 BACKGROUND

The Department of Water Affairs (DWAF), Chief Directorate: Resource Directed Measures (CD:RDM) identified the Inkomati Water Management Area (WMA) as an area requiring a comprehensive Reserve assessment in the light of the initiation of the Compulsory Licensing Process in the WMA and the proposed construction of the Montrose and Mountain View Dams. This comprehensive assessment will assist DWA in making informed decisions regarding the authorisation of future water use and to determine the magnitude of the impacts of the present and proposed developments.

This report addressed the identification and quantification of the economic and commodity benefits derived from the water use in the Crocodile and Sabie/Sand Sub-Catchments of the WMA. The primary sectors that are identified are irrigation agriculture, forestry and mining. The secondary industries that will be analysed are the raw water user industries and major municipal based water users.

1.2 MACRO-ECONOMIC RATIONALE FOR DETERMINING THE VALUE OF WATER

The environmentally sustainable development and management of water resources of the Crocodile River and Sabie/Sand River systems is a critical and complex issue if one takes into account the vast potential for economic development within the catchment which requires water to ensure that the development does take place and can also be sustained. It is technically challenging and often entails difficult trade-offs between social, economic and political considerations. Typically, the environment is treated as a marginal issue when actually it is a key to ensure sustainable water management.

Of all the resources that are important to human beings, perhaps the one most under pressure in Southern Africa is water. Traditionally, the focus has always been on water quantity, having had enough in order to do what was required. At present the concern is the health of our aquatic ecosystems, as well as the human consumption needs, both being dependent on the availability and the quality of the water. Water is a basic requirement to a large number of values that are important to humans. In addition to its direct and immediate life-supporting attributes, it is also essential for the continued functioning of most other ecosystems in the natural environment. The level of human impact on the natural world is now so great that in many situations it has become necessary to deliberately set aside a proportion of the available water so that the environment and its ecosystems can continue to function.

Water used for this purpose is described by the all embracing term ‘environmental water’. However, as this study shows, the umbrella description includes a large variety of different strategies, aims and situations.

The Crocodile River and the Sabie / Sand River catchments face a number of water resource challenges. Greatest of these challenges is sharing scarce water resources between various competing needs. Already, a large part of the catchment is threatened by water scarcity or an already over allocation of water – and yet there are new needs for water that must still be met.
The management of the Crocodile River and the Sabie/Sand River systems is increasingly pressured to take a holistic or integrated approach to the problem. It is clear that a return to pre-development environmental conditions, ‘the river’s natural state’, is not a management option.

There is, therefore, a need to balance the development in the Crocodile River and the Sabie / Sand River systems by ensuring that the functioning of the ecological system, within the catchment, is at least not further degraded or at best improved. In order to do that it is imperative that the value of the water, where it is withdrawn from the system for use as a factor of production, is determined.

For the society and the managers responsible for any particular hydrological system, the central questions are:

- What are the values that should shape water management and, more specifically,
- That once the aims are defined for a particular hydrological system, how they can be achieved?

This report provides the economic baseline of the current water allocation status in the Crocodile East and the Sabie/Sand sub-catchments and is intended to provide the basis to evaluate the implication, so as to contribute to the debate on these issues.

1.3 OBJECTIVES OF THE STUDY

The specific objectives of this study as outlined in the terms of reference are to:

- Identify the sectors directly and indirectly using water from the Crocodile River and the Sabie/Sand River systems.
- Determine economic zones (EZs) in the Crocodile River and Sabie/Sand River systems and current water allocation to each category of use.
- Determine an appropriate valuation technique for each use category.
- Analyse economic value of water use by each category.

1.4 STRUCTURE OF THE REPORT

The report is divided into the following sections:

- Introduction.
- Approach and Methodology.
- Crocodile East Sub-Catchment.
- Sabie / Sand Sub- Catchment.
- Sub-catchment conclusion.

The direct impacts on the different economic sectors in respect of the Crocodile East and Sabie/Sand sub-catchments are reflected in Appendix A and B.

2 APPROACH AND METHODOLOGY

This study addresses the secondary sub-catchment area X2 referred to as the Crocodile East Sub-Catchment and the portion of the secondary sub-catchment area X3 which excludes the Kruger National Park and is referred to as the Sabie/Sand Sub-Catchment (WRC Report No. 298/6.2/94 Vol. VI First Edition 1994). The two sub-catchments are again divided into economic zones (EZs), i.e. the Crocodile East is divided into seven EZs and the Sabie/Sand into three EZs.

2.1 ECONOMIC BASELINE

The economic baseline provides the current impacts of water usage (before any water allocation reductions) in the respective sub-systems on variables such as GDP, employment, and income received by low income households.

2.1.1 Macro Economic Impact Model (MEIM)

To achieve the stated objectives the study will apply a Macro Economic Impact Model (MEIM). The model, as is currently constructed, is in the form of a dynamic computerised water entitlement model which can be used to identify and quantify the following indicators:

- Economic benefits.
- Maximum possible water reduction.
- Capitalised impact.

Despite the fact that farm sizes in the area are far from being definitive, the model includes the facility to analyse three different farm sizes, viz., small, medium and commercial. This feature provides a facility for determining whether there are impacts that are specific to different scales of farming operations.

As a first step the macro economy of the Crocodile East catchment was established and then sub-divided into its sub-catchments. Production and employment data was used for the catchment and its sub-catchments. A Macro Economic Impact Model was constructed for the catchment and the identified sub-catchments. The model is water driven and gives the direct and indirect / induced results for the following sectors: Irrigation agriculture, commercial forestry and industry. For agriculture the model can accommodate up to ten individual products and for forestry it makes provision for pine and gum sub-species.

The following impacts are estimated by the Macro Economic Impact Model:

- Gross Domestic Product.
- Low Income Households and Total Households.
- Employment Creation.

A group of economic multipliers was then developed for comparing different water use activities in terms of Gross Domestic Product (GDP/m^3), employment creation (number/Mm^3) and the low-income households.

2.1.1.1 Model Structure

The water impact model comprises various sub-models which are used in determining the values of the above economic variables. These are described in detail below.

The primary impetus drivers of the MEIM are:

- The volume of water allocated to the various water users in each sub-catchment.
- The level of water assurance given to each water user in each sub-catchment.
- Hectares under irrigation.
- Production.
- Economic Data in the form of a Social Accounting Matrix.
- Economic Multipliers.

2.1.1.2 Multipliers Incorporated into the MEIM

By using a Social Accounting Matrix (SAM) applicable to the study area, multipliers have been calculated. The multipliers that were used in this study to determine the economic impacts for the MEIM are as follows:

- Economic growth (i.e. the impact on GDP).
- Employment creation (i.e. the impact on labour requirements).
- Income distribution (i.e. the impact on low-income households).

An example of the agriculture sector multipliers used in this study is as follows:

- Direct effect: Refers to effects occurring directly in the agriculture sector.
- Indirect effects: Refer to those effects occurring in the different economic sectors that link backward to agriculture due to the supply of intermediate inputs, i.e. fertilisers, seeds, etc.
- Induced effects: Refers to the chain reaction triggered by the salaries and profits (less retained earnings) that are ploughed back into the economy in the form of private consumption expenditure.

2.1.2 Macro-Economic Impacts

2.1.2.1 Gross Domestic Product (GDP)

These impacts describe the positive effects of water usage in various economic activities on the GDP of the local area. In line with the described multipliers, the total impacts on GDP can further be categorised into direct, indirect and induced effects. The results in this study will however present the direct and total macro-economic impact as a means to assist in reflecting the total economic picture.

2.1.2.2 Employment

These impacts describe the employment created in the local area as a result of water usage in various economic activities, such as irrigation agriculture, water use in the mining sector etc. As the case with impacts on GDP, total impacts of wage usage on employment can also be divided into direct, indirect and induced effects.

2.1.2.3 Total and Low Income Households

Besides the GDP and employment impacts, water use will also have a positive effect on the income earned by low income households in the study area.

2.1.3 Economic Sectors

The following are the major economic sectors in the two sub-systems:

- Mining.
- Irrigation.
- Agriculture.
- Commercial forestry; and
- Manufacturing.

2.1.3.1 Agriculture Irrigation

a) Different Crops

The major economic driver in the two sub-systems under study is irrigation agriculture where a number of different crops are being irrigated. The following main crops have been identified:

- Bananas.
- Citrus.
- Avocados.
- Macadamias.
- Papaya.
- Sugar Cane.
- Brassicas.
- Maize and Wheat.
- Cucurbits, and
- Pastures.

b) Water Use and Hectares

The amount of water available and allocated to the various irrigated crops as well as the allocated hectares play a major role towards the significance of irrigation agriculture in these sub-systems. The more hectares, coupled with adequate or high water volumes available for irrigation, the higher will be the impact of any crop in terms of contribution to the GDP, employment and to income towards total and low income households.

c) Computer Based Budgets (Combud)

The inputs towards the irrigation sector consist of Computer Based Budgets (Combud) that were applied to a farm model. Figure 2.1 shows the structure of how the Net Farm Income is calculated. The Combud compiled by the Department of Agriculture were used as base documents to develop the 2006/2007 production budgets. They were updated and adapted for the different production areas in terms of yield, production prices and input costs. The Combud provided data up to Gross Margin on a hectare basis, after which the fixed costs are subtracted to get Net Farm Income per hectare and in the end the Net Income or Profits per hectare.

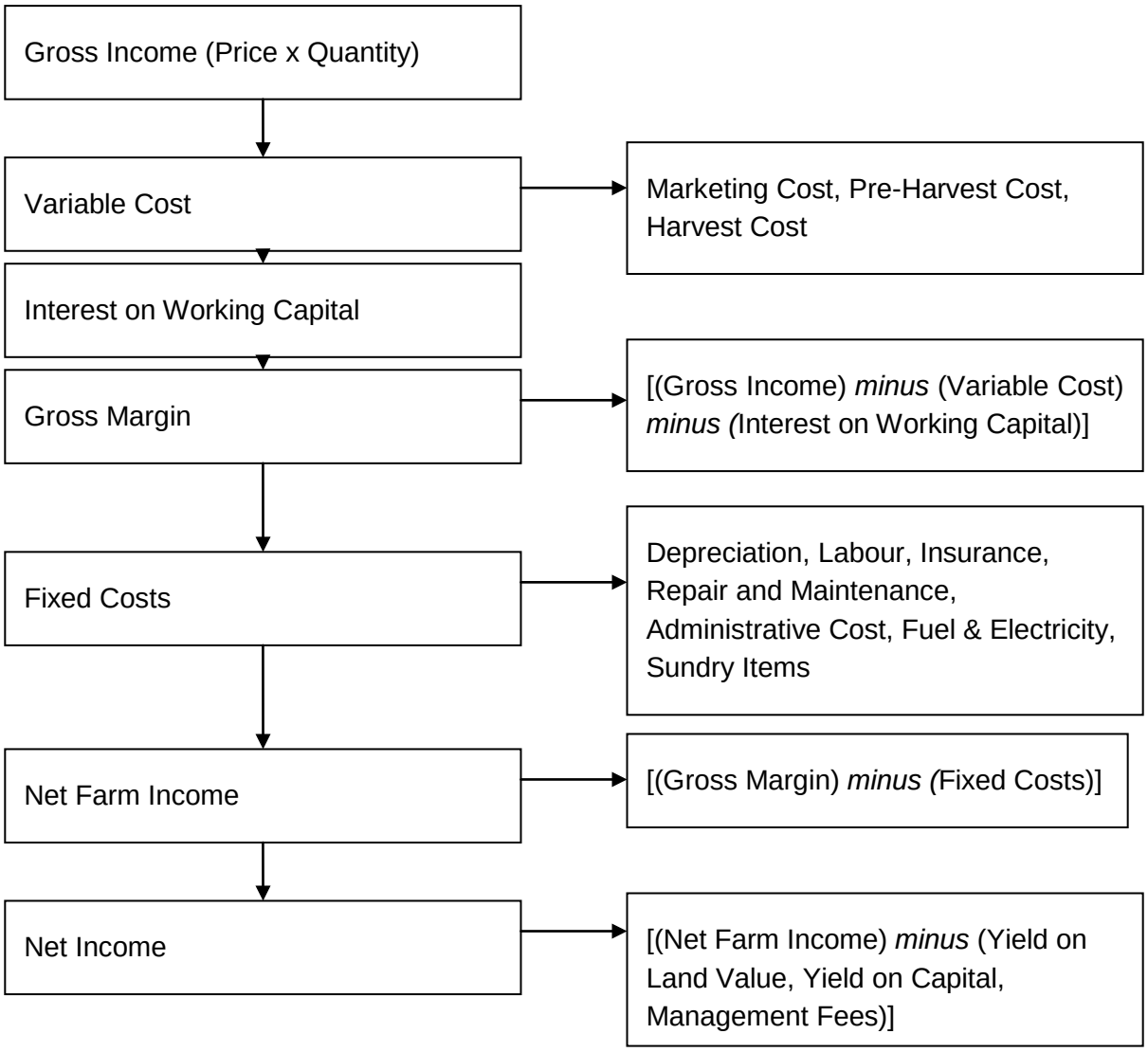

Figure 2.1 Irrigation Budget Structure

For the use of the macro economic impacts determination these costs in the budget are allocated to structures in such a way that it is allocated to the different sectors of the economy. These will be applied to determine the direct, and indirect and induced effects.

Table 2.1 Structure of Production Costs

Total costs (Intermediate inputs and labour requirements).
Agriculture.
Mining.
Manufacturing (Fuel, Fertilizer, Pharmaceuticals and Other).
Electricity.
Water.
Construction.
Trade and accommodation.
Transport and communication.
Financial and business services.
Community services.
Salaries and wages: (Skilled, Semi-Skilled and Unskilled).

2.1.3.2 Forestry

Commercial plantation forestry is an important economic activity in the area, with all the economic zones having sizeable hectares of both gum and pine tree plantations. Plantation forestry is concentrated in the rural areas where unemployment is high and alternative economic activities and employment opportunities are scarce.

2.1.3.2.1 Area and Water Reduction

The economic impact from commercial forestry will be calculated using the area under plantations together with the annual average volume growth per hectare. The water used by commercial forestry is based on the run-off reduction by the plantations and will be based on the 'Scott Method'.

2.1.3.2.2 Budgets

To determine the forestry income and production costs Combud was used. In determining the number of hectares and the water usage for the Crocodile East and Sabie / Sand Catchments, the "Estimation of Stream flow Reductions Resulting from Commercial Afforestation in South Africa" as well as the "Surface Water Resources of South Africa" was used.

2.1.3.3 Mining

All the mining activities investigated in this study are located in the Crocodile East sub-catchment. Mining operations in general decant large quantities of water from both surface and underground water sources. At the same time these same mining operations also discharge large quantities of water back into the water system. This is underground seepage water which fills the mines and which is then pumped from the mines to the surface and discharged in the existing surface water systems.

Mining activities are mainly dominated by manganese production in various forms (magnetite, manganese-dioxide, manganese-metal, manganese sulphate and manganese-oxide) with gold production in two of the economic zones. At least four of the seven economic zones have some mining activities. Talc production and aggregate sand quarrying is also present in the area.

a) Turnover and Employment

The annual turnover per mine together with the work force is used in the MEIM model to calculate macroeconomic impacts of the sector in each economic zone.

b) Gold

There are four gold mines operating in the area, one in the Machadodorp area (Elands River EZ), one in the Barberton area, one in the Kaapmuiden area (both in the Kaap River EZ) and the fourth, the Makonjwaan mine (presently an open pit mine), situated 76 km from Nelspruit on the road to Malelane (Middle Crocodile EZ). Three of these mines are underground mining operations.

c) Manganese

Manganese mining entails surface works, opencast and underground operations. Manganese, in different forms, is produced by three mines located in the Malelane (Lower Crocodile EZ) and two in the Nelspruit (Middle Crocodile EZ) areas.

d) Other

There are several other mining activities spread over the area such as crushers for the production of aggregate sand from open cast mines, clay, for the production of bricks, from open cast mining in the Malelane area and talc from underground mining in the Barberton area. All these mining activities make use of a dry process in the production of the various commodities and have therefore not been taken into account in this study.

2.1.3.4 Industry

The three main industries in the area outside of urban areas are paper and pulp production, sawmills, sugar milling and the ferrochrome smelter in Machadodorp. Pulp and paper production is located in the Elands EZ, with the Ngodwana Mill as one of the largest mills in the Southern Hemisphere. Sawmills operate in all of the economic zones, varying considerably in size, depending on their location in terms of the Ngodwana mill. There is one TSB sugar mill in the area at Malelane (Lower Crocodile EZ). A soft drink bottling plant (Coca-Cola Company) is also present in Nelspruit. Both the paper and pulp and sugar industries are large water users.

3 CROCODILE EAST SUB-CATCHMENT

3.1 OVERVIEW

The Crocodile East Sub-Catchment lies entirely in the Mpumalanga Province. Approximately 1.6 million people live in the water management area, with the majority living in the rural areas. There are five main towns: Nelspruit/White River, Malelane, Komatipoort and Barberton. The Crocodile East Sub-catchment in relation to the Inkomati WMA and its extent is shown in Map 3.1 below. The map indicates the outline of the WMA and its major sub-catchments.

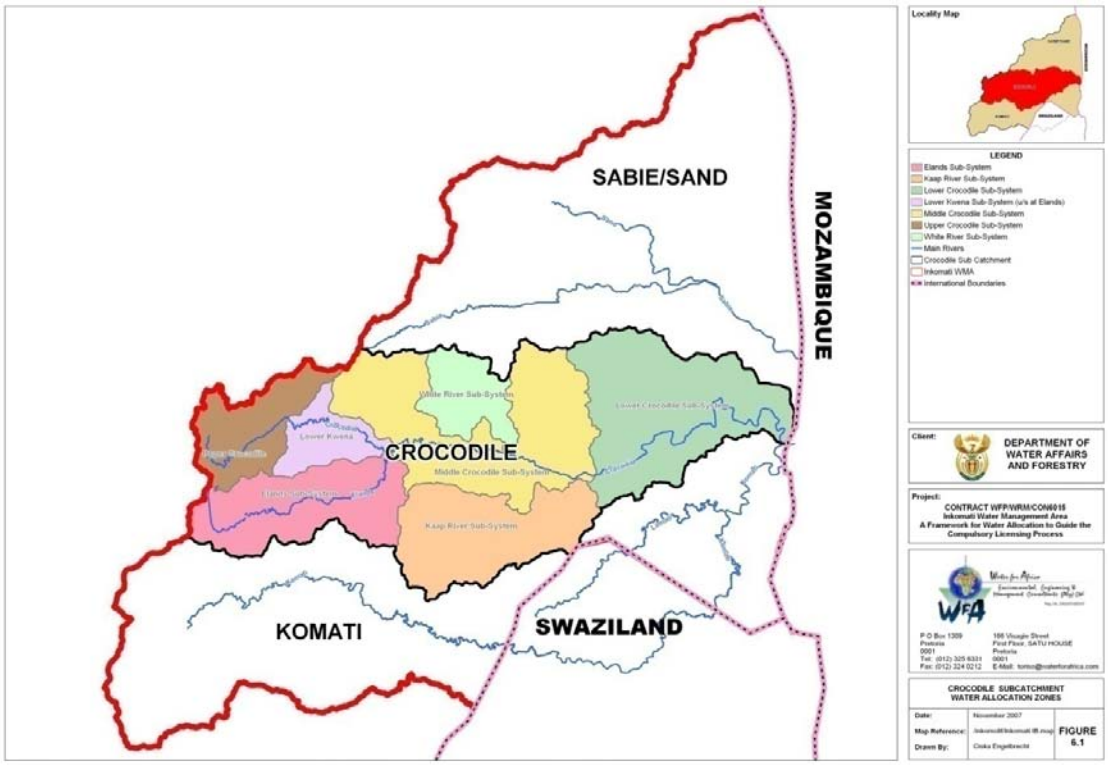

Figure 3.1 Crocodile East Sub-Catchment

The main river in the Crocodile East sub-catchment is the Crocodile River which flows through the entire area from the west to the east where it borders the south end of the Kruger National Park before joining the Komati to form the Rio Inkomati in Mozambique.

For analysis purposes, the Crocodile East sub-catchment is further divided into seven economic zones namely the:

- Upper Crocodile EZ.
- Lower Kwena EZ.
- Elands EZ.
- White EZ.
- Middle Crocodile EZ.
- Kaap River EZ, and the
- Lower Crocodile EZ.

3.2 DATA AND DATA SOURCES

Relevant data from the studies; "An Assessment of the Current Water Allocation Status and potential for Establishing Viable Water Using Enterprises in the Olifants and Inkomati WMA" Contract (WRM/CON 2006) by Conningarth Economists (regarding multipliers, values and economic baselines); Genesis 2005 - published by Genesis Analytics (Pty) Ltd., Version 2.5 (regarding forestry, paper and pulp production and employment) and Statistics South Africa as published in their quarterly journals (in terms of GDP, employment and population figures sub-divided into the main economic sub-sectors) was used together with data obtained from DWAF's validation team in respect of water volumes and hectares cultivated and direct contact with role players in the study area.

Data of the third quarter of 2007 for the Mpumalanga province was used as base for this project. The data was firstly sub-divided to establish a macro economic base for the total sub-catchment. This was done by developing a number of coefficients using different drivers depending on the specific activities. Coefficients were developed using population numbers both rural and urban, mining data, dry-land farming activities and the number of labourers according to magisterial district data.

3.2.1 Irrigation

The following table shows the overall water usage and cultivated area in hectares in the seven economic zones of the Crocodile East sub-catchment. The Lower Crocodile is the most cultivated zone with 21 000 hectares under irrigation as well as the largest water user. On the other hand, the Upper Crocodile is the least cultivated as well as the EZ using the least water. A total of 53 485 crop hectares are irrigated in this sub-system.

Table 3.1 Water Allocation for Irrigation Agriculture Crocodile East Sub-Catchment

Economic Zone	Water Use Mm^3	Area (Ha)
Upper Crocodile	4.09	782
Lower Kwena	9.29	1 454
Elands River	5.77	1 426
White River	30.50	6 319
Middle Crocodile	111.62	13 120
Kaap River	81.40	9 377
Lower Crocodile	242.98	21 007
Total	**485.65**	**53 485**

The following table presents the number of irrigated hectares for the different crops in the different EZs identified. Although agriculture is a dynamic industry and the area per crop varies from time to time and from zone to zone, for purposes of this exercise they were assumed to be constant. The most cultivated crops are sugar cane and citrus.

Table 3.2 Crop Distribution of Hectares in the Crocodile East Sub-Catchment (2007)

Crop/Zone	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile	Total Crocodile East
	Hectares							
Bananas	-	-	-	-	103	1,023	-	1 126
Citrus	6	441	278	1 027	4 502	1 334	4 750	12 338
Avocados	-	-	-	-	1 133	589	-	1 722
Macadamias	-	132	-	-	2,356	1 114	-	3 602
Papaya	-	-	-	-	-	-	-	-
Sugar cane	-	-	-	367	4 128	4 756	16 197	25 448
Brassicas	9	117	300	1 971	449	139	30	3 015
Maize and Wheat	531	379	548	-	-	283	-	1 741
Cucurbits	8	117	300	1,969	449	139	30	3 012
Pastures	228	268	-	985	-	-	-	1 481
Total crop	**782**	**1 454**	**1 426**	**6 319**	**13 120**	**9 377**	**21 007**	**53 485**

3.2.2 Forestry

The two irrigated forestry plantations in the Crocodile East sub-catchment are pine and gum. As indicated in the table below, pine plantations (152 283 hectares) are by far more irrigated than gum plantations (24 790). On the other hand, the Middle Crocodile dominates forestry plantation in this sub-catchment.

Table 3.3 Forestry Distribution of Hectares in the Crocodile East Sub-Catchment (2007)

Forestry	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile	Total Crocodile East
	Hectares							
Pine	3 828	11 637	24 500	28 405	51 220	32 539	153	152 283
Gum	623	1 894	3 988	4 624	8 338	5 297	25	24 790
Total Forestry	**4 451**	**13 532**	**28 488**	**33 029**	**59 558**	**37 836**	**178**	**177 073**

3.2.3 Mining

a) Gold

All the mining activities considered in this study are located in the Crocodile East Sub-Catchment. Mining operation in general decant large quantities of water taken from both surface and underground sources. At the same time these same mining operations also discharge large quantities of water back in the water system. This is underground seepage water filling the mines and which is then pumped from the mines to the surface and discharged in the existing surface water systems.

b) Manganese

Manganese mining in the area entails surface works, opencast and underground operations. Manganese, in different forms, is produced by three mines located in the Malelane and Nelspruit areas.

c) Other

There are several other mining activities spread over the area such as crushers for the production of aggregate sand from open cast mines, clay, for the production of bricks, from open cast mining in the Malelane area and talc from underground mining in the Barberton area. All these mining activities make use of a dry process in the production of the various commodities and have therefore not been taken into account in this study.

Table 3.4 Mining Activities in the Crocodile-East Catchment

Economic Zone	Annual Turnover	Labour Force	Water Use
	Rand mil	Number	Mm^3
Kaap River	646.45	2 173	1.15
Middle Crocodile	969.05	1 218	0.99
Lower Crocodile	39.48	70	0.07
Total	**1 654.98**	**3 461**	**2.21**

The table above shows the various economic zones mining activities. It represents the manganese as well as the gold production in the catchment. There are no substantial mining activities in the Sabie / Sand Catchment.

3.2.4 Industry

The three main industries in the area are paper and pulp production, sugar milling and the ferrochrome smelter in Machadodorp. Both the paper and pulp and sugar industries are large water users.

Table 3.5 Industrial Activities in the Crocodile-East Catchment\

Economic Zone	Water Use	Annual Financial Turnover	Direct Labour
	Mm^3	R Million	Number
Upper Crocodile	0.08	16	103
Lower Kwena	0.26	49	312
Elands River	7.32	3 827	2 669
White River	0.63	119	762
Middle Crocodile	1.18	284	1 424
Kaap River	0.40	75	480
Lower Crocodile	0.75	510	750
Total	**10.61**	**4 878**	**6 500**

The main industrial activities are in the Elands River EZ with the paper, pulp and saw mills present. In the Middle Crocodile sub-catchment the Malelane Sugar Mill is situated as well as the Coca-Cola Company.

Table 3.6 Industrial Activities in the Sabie / Sand Catchment

Economic Zone	Water Use	Annual Financial Turnover	Direct Labour
	Mm^3	R Million	Number
Sabie River	0.90	516	3 311
Maritsane / Inyaka	0.45	259	1 663
Sand River	0.15	88	563
Total	**1.51**	**863**	**5 537**

The Sabie River and the Maritsane / Inyaka economic zones as reflected in the table above show the highest value in the water usage, annual financial turnover and direct labour. It is due to the pulp, paper and saw mills in the catchment.

3.3 RESULTS - BASELINE AND MULTIPLIERS

As described in the previous section the direct GDP and employment are economic impacts within the project area, while some of the other multiplier impacts might occur outside of the project area. In presenting the results it was decided to present the total macroeconomic impact to assist in reflecting the total economic picture. The model is now available to test the impact of certain water allocation proposals.

3.4 IRRIGATION AGRICULTURE

3.4.1 Sectoral Contribution to Gross Domestic Product (GDP)

The following table reflects the total multiplier effect of each activity in the different EZs. The individual crops are shown as well as the weighted multiplier for the irrigation agriculture.

Table 3.7 The Total Multipliers of the Gross Domestic Product of Crops in the Crocodile Sub-Catchment for Irrigation Agriculture (R/m^3)

Crocodile East Catchment	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile
Sectors	**R/m^3**						
Bananas	-	-	-	-	-	4.91	-
Citrus, mangoes and litchis	8.46	7.29	6.41	6.41	-	7.67	5.61
Avocados	-	-	-	-	-	9.81	-
Macadamias	-	7.05	-	-	-	9.10	-
Papaya	-	-	-	-	-	-	-
Sugar Cane	-	-	-	1.59	-	1.59	1.41
Brassicas	24.42	24.42	17.08	17.08	-	24.42	21.52
Maize and Wheat	4.80	3.99	3.99	-	-	5.37	-
Cucurbits	20.55	20.55	16.36	16.36	-	22.52	19.00
Pastures	1.45	1.22	-	1.78	-	-	-
Irrigation Agriculture (Weighted)	3.00	5.27	8.20	7.76	4.78	3.75	2.19

The highest irrigation multiplier is for brassicas in all the seven economic zones expressed as GDP/water volumes.

The table below shows the results in GDP for the Crocodile East sub-catchment area.

Table 3.8 Total Results and Sectoral Gross Domestic Product of Crops in the Crocodile Sub-Catchment for Irrigation Agriculture (R Million, 2007 constant prices)

Crops	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile	Total Crocodile East
	R Mil							
Bananas	-	-	-	-	4.84	48.03	-	52.87
Citrus	0.32	23.39	14.74	54.47	238.76	70.75	251.91	654.34
Avocados	-	-	-	-	68.12	35.41	-	103.53
Macadamias	-	6.39	-	-	114.01	53.91	-	174.30
Papaya	-	-	-	-	-	-	-	-
Sugar cane	-	-	-	6.32	71.06	81.88	278.84	438.10
Brassicas	0.44	5.71	14.65	96.27	21.93	6.79	1.47	147.26

Crops	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile	Total Crocodile East
	R Mil							
Maize and Wheat	7.75	5.53	8.00	-	-	4.13	-	25.42
Cucurbits	0.26	3.85	9.86	64.73	14.76	4.57	0.99	99.02
Pastures	3.48	4.09	-	15.03	-	-	-	22.60
Total	**12.25**	**48.96**	**47.26**	**236.82**	**533.48**	**305.46**	**533.20**	**1 717.43**

The highest GDP creation will be in the Middle and Lower Crocodile economic zones, where citrus reflects the highest GDP when compared to other irrigated crops.

3.4.2 Sectoral Contribution to Employment

The following table reflect the total multiplier effect of each activity in the different EZs. The individual crops are shown as well as the weighted multiplier for the irrigation agriculture.

Table 3.9 Total Employment Multipliers of Crops in the Crocodile Sub-Catchment for Irrigation Agriculture (No/Mm^3)

Crops	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile
	No/Mm^3						
Bananas	-	-	-	-	66.53	75.98	-
Citrus	171.39	147.81	129.94	129.94	129.94	155.52	113.60
Avocados	-	-	-	-	78.26	87.58	-
Macadamias	-	68.66	-	-	59.92	88.53	-
Papaya	-	-	-	-	-	-	-
Sugar cane	-	-	-	26.94	26.94	26.94	23.92
Brassicas	234.11	234.11	163.71	163.71	163.71	234.11	206.26
Maize and Wheat	17.96	14.92	14.92	-	-	20.08	-
Cucurbits	95.04	95.04	75.65	75.65	75.65	104.15	87.89
Pastures	4.01	3.37	-	4.95	-	-	-
Irrigation Agriculture (Weighted)	12.36	69.00	89.28	81.14	72.71	55.41	40.57

The highest irrigation multiplier is for brassicas in all the seven economic zones.

The table below shows the total employment results for the Crocodile East sub-catchment. Overall, the results indicate that citrus is the crop which provides the most employment across all the seven economic zones, with pastures providing the least employment.

Table 3.10 Results of the Total Employment for Irrigation Agriculture (Numbers 2007)

Crops	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile	Total Crocodile East
	Numbers							
Bananas	-	-	-	-	75	744	-	**819**
Citrus	6	474	299	1 104	4 838	1 434	5 104	**13 259**
Avocados	-	-	-	-	608	316	-	**924**
Macadamias	-	62	-	-	1 110	525	-	**1 696**
Papaya	-	-	-	-	-	-	-	**-**
Sugar cane	-	-	-	107	1 207	1 390	4 734	**7 438**
Brassicas	4	55	140	923	210	65	14	**1 412**
Maize and	29	21	30	-	-	15	-	**95**

Crops	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile	Total Crocodile East
	Numbers							
Wheat								
Cucurbits	1	18	46	299	68	21	5	**458**
Pastures	10	11	-	42	-	-	-	**63**
Total Irrigation Agriculture	**51**	**641**	**515**	**2 475**	**8 116**	**4 510**	**9 857**	**26 164**

3.4.3 Sectoral Contribution to Total Income

The following table reflect the total multiplier effect of each activity in the different EZs. The individual crops are shown as well as the weighted multiplier for the irrigation agriculture.

Table 3.11 Multipliers for Calculating the Impact on Total Income Households Domestic Product for Irrigation Agriculture (R/m^3)

Crop/Zone	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile
	R/Mm^3						
Bananas	-	-	-	-	-	4.88	-
Citrus	9.58	8.26	7.26	7.26	7.26	8.69	6.35
Avocados	-	-	-	-	-	11.26	-
Macadamias	-	4.55	-	-	-	5.87	-
Papaya	-	-	-	-	-	-	-
Sugar cane	-	-	-	1.75	-	1.75	1.56
Brassicas	23.16	23.16	16.19	16.19	16.19	23.16	20.40
Maize and Wheat	4.12	3.42	3.42	-	-	4.61	-
Cucurbits	18.30	18.30	14.57	14.57	14.57	20.05	16.92
Pastures	1.02	0.85	-	1.25	-	-	-
Irrigation Agriculture (weighted)	2.47	5.07	8.02	7.48	2.73	3.78	2.45

The highest multipliers for GDP creation are citrus and brassicas expressed in water use.

The table below shows the results in Total Income Households for the Crocodile East Sub-Catchment.

Table 3.12 Household Income of Irrigation Agriculture Directed at Total Income Households (R Million, 2007 constant prices)

Crops	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile	Total Crocodile East
	R Mil							
Bananas	-	-	-	-	-	47.78	-	47.78
Citrus	0.36	26.49	16.70	61.70	270.47	80.14	285.36	741.23
Avocados	-	-	-	-	-	40.67	-	40.67
Macadamias	-	4.12	-	-	-	34.80	-	38.93
Papaya	-	-	-	-	-	-	-	-
Sugar cane	-	-	-	6.99	-	90.56	308.41	405.96
Brassicas	0.42	5.42	13.89	91.29	20.80	6.44	1.39	139.64
Maize and Wheat	6.65	4.75	6.87	-	-	3.55	-	21.81
Cucurbits	0.23	3.43	8.78	57.65	13.15	4.07	0.88	88.18
Pastures	2.45	2.88	-	10.57	-	-	-	15.90

Crops	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile	Total Crocodile East
	R Mil							
Total Irrigation Agriculture	10.11	47.09	46.25	228.19	304.41	308.01	596.05	1 540.10

The highest irrigation crop that will benefit the total income household is citrus, especially in the Lower Crocodile EZ.

3.4.4 Forestry

3.4.4.1 Sectoral Contribution to Gross Domestic Product (GDP)

The table below shows the total (direct, indirect and induced) impacts of forestry activities towards the GDP of crocodile East sub-system. Highest contribution is from Middle Crocodile EZ, with R657 million being the total contribution of forestry to GDP from all the seven EZs.

Table 3.13 Total Multipliers and Results for the Forestry Contribution to Gross Domestic Product

	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile	Total Crocodile East
Multipliers (R/m^3)	4.33	4.33	4.33	4.33	4.33	4.33	4.33	**N/A**
Results (R Mil)	16.51	50.19	105.67	122.51	220.92	140.35	0.66	**656.82**

3.4.4.2 Sectoral Contribution to Employment

The largest contribution from plantations of the total employment is in the Middle Crocodile EZ, providing 2 648 employment opportunities. A total of 7 873 employment opportunities are created in the plantation activities in this Catchment.

Table 3.14 Total Multiplier and Result of Employment for Forestry in the Crocodile-East Sub-Catchment

Forestry	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile	Total Crocodile East
Multipliers (R/Numbers)	51.94	51.94	51.94	51.94	51.94	51.94	51.94	N/A
Results (Numbers)	198	602	1 267	1 469	2 648	1 682	8	7 873

3.4.4.3 Sectoral Contribution to Total Income

The table below shows the amount of income which will be received by total income households (TIH) emanating for forestry activities.

Table 3.15 Household Income Multiplier and Results for Forestry Directed at Total Income Households (TIH)

Zone	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile	Total Crocodile East
Multipliers (R/m^3)	7.69	4.20	3.30	3.19	2.88	3.10	132.43	**N/A**
Results (R Mil)	29.30	48.67	80.57	90.26	146.85	100.51	20.18	**516.34**

3.4.5 Mining

3.4.5.1 Sectoral Contribution to Gross Domestic Product (GDP)

The following table shows total multipliers to GDP as well as the actual GDP figures generated by mining activities across the seven EZs. Mining activities in the Kaap River EZ provides the highest GDP (in 2007 values) of R 726 million. A total GDP of R 1.859 billion is generated in the whole sub-system.

Table 3.16 Total Multipliers and Results for Economic Zones Gross Domestic Product for Mining

Zone	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile	Total Crocodile East
Multiplier (R/m^3)	-	-	-	-	1 105.35	632.12	616.08	**N/A**-
GDP(R mill)	-	-	-	-	1 088.77	726.32	44.36	**1 859.45**

3.4.5.2 Sectoral Contribution to Employment

Employment impacts of the mining sector are presented in the table below. The highest employment of where the mining activities takes place is created in the Kaap River EZ, while the least employment is created in the Lower crocodile EZ. A total of 6 752 employment opportunities are provided by mines in e whole Catchment.

Table 3.17 Total Multipliers and Results for Employment of Mining (No/Mm^3)

Sectors	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile	Total Crocodile East
Multiplier (No/Mm^3)	-	-	-	-	3 193.03	3 010.04	2 062.69	**N/A**-
Employment (numbers)	-	-	-	-	3 145	3 459	149	**6 752**

3.4.5.3 Sectoral Contribution to Income

The following table reflects the results of the income received by total income households (TIH) in the Crocodile East Sub-catchment as a result of mining activities. TIH benefits most from mining activities being done in the Kaap River EZ as compared to other zones.

Table 3.18 Total Multipliers and Results for Mining Directed at Total Income Households

Zone	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile	Total Crocodile East
Multiplier (R/m^3)	-	-	-	-	357.41	204.39	199.21	**N/A**
TIH(R mill)	-	-	-	-	352.05	234.85	14.34	**601**

3.4.6 Industry

3.4.6.1 Sectoral Contribution to Gross Domestic Product (GDP)

The contribution of industrial activities towards GDP is depicted in the table below. Highest GDP multipliers are recorded in Kaap River EZ. Nevertheless, in value terms, Elands River EZ generates the highest GDP (R4.0 billion), while Upper Crocodile generates the lowest GDP value. In total, industrial activities contributes close to R5.1 billion towards this Catchment's GDP.

Table 3.19 Total GDP Multipliers and Results for Industry in the Crocodile East Sub-Catchment

Sectors	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile	Total Crocodile East
Multiplier (R/m^3)	196.02	196.02	542.26	196.02	3 471.72	196.02	704.40	**N/A**
GDP (R million)	16.60	50.46	3 967.31	123.15	293.95	77.63	528.30	**5 057.40**

3.4.6.2 Sectoral Contribution to Employment

Compared to other sectors (irrigation agriculture, mining and forestry), the contribution of industry activities is largest in employment creation. As presented in the table below, a total of 25 057 employment opportunities are provided in the various industrial activities alluded to before. At disaggregated EZ level, Elands River zone provides more employment opportunities in industrial activities compared to other zones.

Table 3.20 Total Employment Multipliers (No/Mm^3) and Results for Industry in the Crocodile East Sub-Catchment

Sectors	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile	Total Crocodile East
Multiplier (No/Mm^3)	1 932.28	1 932.28	2 354.47	1 932.28	29 551.44	1 932.28	3 584.62	**N/A**
Employment (numbers)	164	497	17 226	1 214	2 502	765	2 688	**25 057**

3.4.6.3 Sectoral Contribution to Income

Income available to low income households from industrial activities is shown in the table below.

Table 3.21 Total Household Income Multipliers (R/m^3) and Results of Total Income Households (R Million, 2007 constant prices)

Zone	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile	Total Crocodile East
Multiplier (R/m^3)	69.82	69.82	193.13	69.82	1 236.50	69.82	250.88	**N/A**
TIH(R mill)	5.91	17.97	1 413.01	43.86	104.70	27.65	188.16	**1 801**

Industries in Elands River EZ provides the largest income benefit to total income households and a total income of R1.8 billion directed to total households is generated in this sub-Catchment from industrial activities.

4 SABIE / SAND SUB-CATCHMENTS

The Sabie / Sand Sub-Catchment falls in the Mpumalanga Province except for part of the catchment this falls in the Limpopo Province. Approximately 0.7 million people live in the catchment area, with the majority living in the rural areas. There are few urban areas, only two relatively important towns, namely Sabie and Graskop and the extended Bosbokrand which can be considered as semi urban. The Sabie / Sand sub-catchment in relation to the Sabie / Sand Sub-Catchment and its extent is shown in Map 4.1 below. The map indicates the outline of the WMA and its major Sub-catchments.

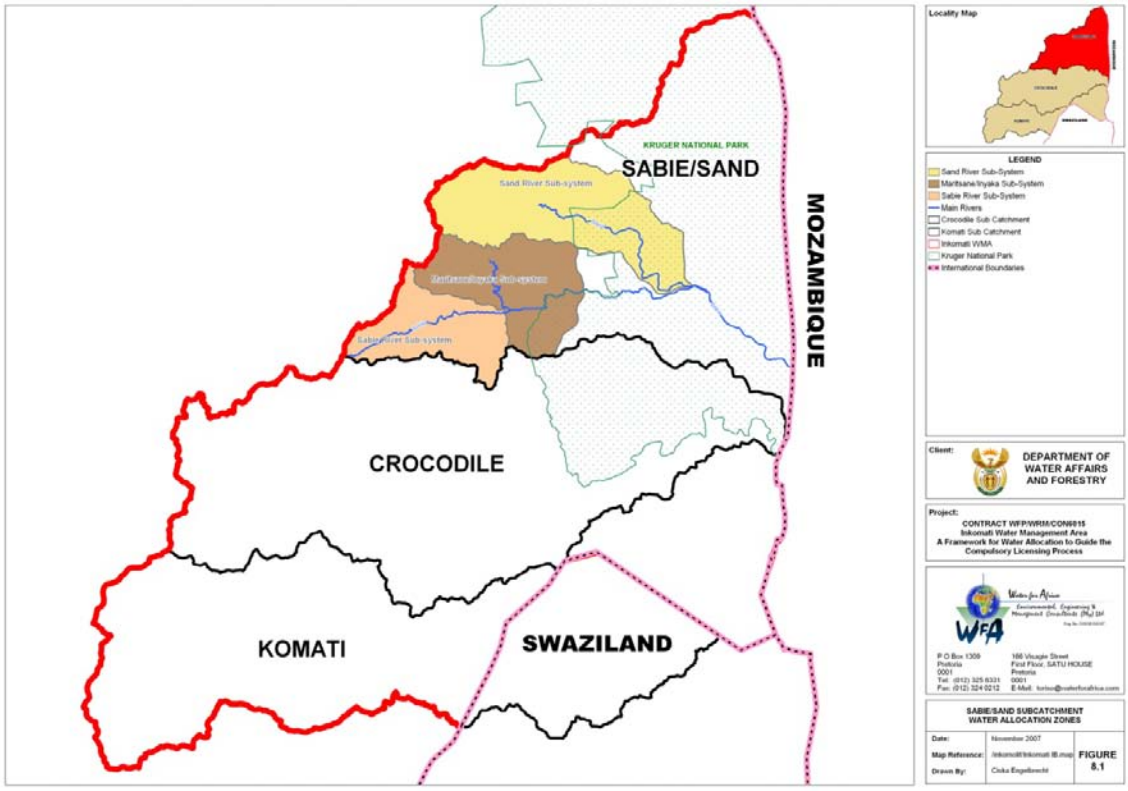

Figure 4.1 Sabie / Sand Sub-Catchment

The main rivers in the Sabie / Sand sub-catchment are the Sabie and Sand Rivers which flow through the entire area from the west to the east, with the confluence on the border of the Kruger National Park. The Sabie River then runs through the Kruger National Park and until it join the Komati in Mozambique to form the Rio Inkomati in Mozambique.

There are two main river systems in the Sabie / Sand sub-catchment. Both river systems are highly regulated:

- The Sabie River which flows through the southern part of the area from west to east until it is joined by the Sand River on the Kruger National Park border and eventually flows into Mozambique.
- The Sand River to the north of the area joining the Sabie River on the border of the Kruger National Park.

The area is sub-divided into three economic zones, namely the Sabie River, Maritsane / Inyaka and Sand River, with each zone having a number of economic activities. These activities include

irrigation agriculture, commercial forestry, manufacturing and electricity supply. The area's mining activities is limited to minor sand quarrying.

4.1 DATA AND DATA SOURCES

Relevant data from the studies; "An Assessment of the Current Water Allocation Status and potential for Establishing Viable Water Using Enterprises in the Olifants and Inkomati WMA" Contract (WRM/CON 2006) by Conningarth Economists (regarding multipliers, values and economic baselines); Genesis 2005 - published by Genesis Analytics (Pty) Ltd., Version 2.5 (regarding forestry, paper and pulp production and employment) and Statistics South Africa as published in their quarterly journals (in terms of GDP, employment and population figures sub-divided into the main economic sub-sectors) was used together with data obtained from DWAF's validation team in respect of water volumes and hectares cultivated and direct contact with role players in the study area.

Data of the third quarter of 2007 for the Mpumalanga province was used as base for this project. The data was firstly sub-divided to establish a macro economic base for the total sub-catchment. This was done by developing a number of coefficients using different drivers depending on the specific activities. Coefficients were developed using population numbers both rural and urban, mining data, dry-land farming activities and the number of labourers according to magisterial district data.

4.1.1 Irrigation

The following table shows the overall water usage and cultivated area in hectares in the three economic zones of the Sabie / Sand sub-catchment. The Sabie River is the most cultivated zone with 9 447 hectares under irrigation as well as the biggest water user. On the other hand, the Sand River is the least cultivated as well as the zone using the least water. A total of 15 865 crop hectares are irrigated in this sub-system.

Table 4.1 Water Allocation for Irrigation Agriculture Sabie / Sand Sub-Catchment

Zone	Water Use Mm^3	Area Hectares
Sabie River	83.9	9 447
Maritsane/Inyaka	44.3	4 536
Sand River	12.6	1 882
Total	**140.8**	**15 865**

The following table shows the number of irrigated hectares for the different crops in the different economic zones identified. The most cultivated crops are bananas and avocados.

Table 4.2 Crop Distribution of Hectares in the Sabie / Sand Sub-Catchment

Crop/Zone	Sabie River	Maritsane / Inyaka	Sand River	Total Sabie / Sand
	Hectares			
Bananas	1 498	792	180	**2 470**
Citrus	1 046	927	126	**2 099**
Avocados	1 948	382	113	**2 442**
Macadamias	1 099	109	-	**1 208**
Papaya	849	-	-	**849**
Sugar cane	-	-	-	**-**
Brassicas	325	26	1 130	**1 481**
Maize & Wheat	556	35	-	**591**

Crop/Zone	Sabie River	Maritsane / Inyaka	Sand River	Total Sabie / Sand
	Hectares			
Cucurbits	251	21	673	**945**
Pastures	148	247	-	**394**
Total	**7 719**	**2 539**	**2 221**	**12 479**

4.1.2 Forestry

The two irrigated forestry plantations in the Sabie / Sand sub-catchment are pine and gum. As indicated in the table below, pine plantations (68 108 hectares) are by far the most irrigated than gum plantations (11 087 hectares). On the other hand, Sabie River EZ dominates forestry plantation in this sub-catchment.

Table 4.3 Forestry Distribution of Hectares in the Sabie / Sand Sub-system

Type	Sabie River	Maritsane / Inyaka	Sand River	Total Sabie / Sand
	Hectares			
Pine	**40 726**	**20 457**	**6 924**	68 108
Gum	**6 630**	**3 330**	**1 127**	11 087
Total	47 356	23 788	8 051	79 195

4.1.3 Mining

There are no mining activities in the Sabie / Sand Sub-Catchment other than small opencast production of aggregate sand.

4.1.4 Industry

The only industries present in the Sabie / Sand sub-catchment providing employment are the sawmills.

4.2 RESULTS - BASELINE AND MULTIPLIERS

As pointed out before, the direct GDP and employment are economic impacts within the project area, while some of the other multiplier impacts might occur outside of the project area. In presenting the results it was decided to present the total macro-economic impact to assist in reflecting the total economic picture. The model is now available to test the impact of certain water allocation proposals.

4.2.1 Irrigation

4.2.1.1 Product Contribution to Gross Domestic Product (GDP)

The following table reflect the total multiplier effect of each activity in the different economic zones. The individual crops are shown as well as the weighted multiplier for the irrigation agriculture.

Table 4.4 The Total Multipliers of the Gross Domestic Product of Crops in the Sabie / Sand Sub-Catchment for Irrigation Agriculture (R/m^3)

Sabie / Sand Sub-Catchment	Sabie River	Maritsane / Inyaka	Sand River
Crops	**R/m^3**		
Bananas	5.29	5.53	1.82
Citrus	5.98	6.24	2.06
Avocados	6.78	7.08	2.33

Sabie / Sand Sub-Catchment	Sabie River	Maritsane / Inyaka	Sand River
Crops	**R/m^3**		
Macadamias	5.46	5.70	-…
Papaya	12.82	-	-
Sugar cane	-	-	-
Brassicas	29.30	17.98	48.16
Maize & Wheat	8.76	5.37	-
Cucurbits	19.72	12.10	32.42
Pastures	9.16	5.62	-
Irrigation agriculture (weighted)	7.21	6.15	7.88

The highest irrigation multiplier is for brassicas in all the three economic zones.

The table below shows the results in GDP for the Sabie / Sand sub-catchment.

Table 4.5 Total Results and Sectoral Gross Domestic Product of Crops in the Sabie / Sand Sub-Catchment for Irrigation Agriculture (R Million, 2007 constant)

Sabie / Sand Sub-Catchment	Sabie River	Maritsane / Inyaka	Sand River	Total Sabie / Sand
Crops	**R Million**			
Bananas	70.35	37.18	8.43	116
Citrus	55.47	49.17	6.67	111
Avocados	117.11	22.95	6.78	147
Macadamias	53.17	5.28	-	58
Papaya	96.54	-	-	97
Sugar cane	-	-	-	-
Brassicas	15.86	1.28	55.19	72
Maize and Wheat	8.11	0.51	-	9
Cucurbits	8.25	0.69	22.13	31
Pastures	2.25	3.76	-	6
Total Irrigation Agriculture	427.11	120.83	99.19	647

The highest GDP creation will be in Sabie River EZ, while avocados create the highest GDP when compared to other irrigated crops.

4.2.1.2 Sectoral Contribution to Employment

The following table shows the total employment multiplier effect of each activity in the different EZs. The individual crops are shown as well as the weighted multiplier for the irrigation agriculture.

Table 4.6 Total Employment Multipliers of Crops in the Sabie / Sand Sub-Catchment for Irrigation Agriculture (No/Mm^3)

Sabie / Sand Sub-Catchment	Sabie River	Maritsane / Inyaka	Sand River
Crops	**No/Mm^3**		
Bananas	59.43	62.07	20.47
Citrus	68.16	71.19	23.47
Avocados	68.25	71.28	23.50
Macadamias	53.09	55.45	-
Papaya	112.38	-	-
Sugar cane	-	-	-
Brassicas	280.88	172.34	461.66
Maize and Wheat	32.76	20.10	-

Sabie / Sand Sub-Catchment	Sabie River	Maritsane / Inyaka	Sand River
Crops	**No/Mm^3**		
Cucurbits	372.52	228.57	612.27
Pastures	25.42	15.60	-
Irrigation agriculture (weighted)	72.73	66.02	94.15

The highest employment multiplier is for brassicas in all the three economic zones.

The table below shows the total employment results for the Sabie / Sand sub-catchment. Overall, the results indicate that avocados are the crop which provides more employment when compared to other crops, with pastures providing the least employment opportunities.

Table 4.7 Results of the Total Employment for Irrigation Agriculture (Numbers 2007)

Sabie / Sand Sub-Catchment	Sabie River	Maritsane / Inyaka	Sand River	Total
Crops	**Numbers**			
Bananas	790	417	95	1 302
Citrus	632	561	76	1 269
Avocados	1 179	231	68	1 479
Macadamias	518	51	0	569
Papaya	846	0	0	846
Sugar cane	0	0	0	0
Brassicas	152	12	529	693
Maize and Wheat	30	2	0	32
Cucurbits	156	13	418	587
Pastures	6	10	0	17
Total Irrigation Agriculture	4 310	1 298	1 186	6 794

4.2.1.3 Sectoral Contribution to Income

The table below shows the Total Income Households multipliers for the Sabie / Sand sub-catchment. As indicated, brassicas has the highest multiplier.

Table 4.8 Multipliers for Calculating the Impact on Total Income Households Domestic Product for Irrigation Agriculture (R/m^3)

Sabie / Sand Sub-Catchment	Sabie River	Maritsane / Inyaka	Sand River
Crops	**R/m^3**		
Bananas	5.26	5.50	1.81
Citrus	6.77	7.07	2.33
Avocados	7.78	8.13	2.68
Macadamias	3.52	3.68	-
Papaya	13.14	-	-
Sugar cane	-	-	-
Brassicas	27.78	17.05	45.67
Maize and Wheat	7.52	4.61	-
Cucurbits	17.56	10.78	28.87
Pastures	6.44	3.95	-
Irrigation Agriculture (weighted)	7.28	6.48	7.60

Table 4.9 Household Income of Irrigation Agriculture Directed at Total Income Households (R Million, 2007 constant prices)

Crops / Zone	Sabie River	Maritsane / Inyaka	Sand River	Total
	R Million			
Bananas	69.98	36.99	8.39	115
Citrus	62.83	55.70	7.55	126
Avocados	134.50	26.36	7.79	169
Macadamias	34.33	3.41	-	38
Papaya	99.00	-	-	99
Sugar cane	-	-	-	-
Brassicas	15.04	1.21	52.34	69
Maize and Wheat	6.96	0.44	-	7
Cucurbits	7.35	0.61	19.70	28
Pastures	1.58	2.65	-	4
Total	**431.57**	**127.38**	**95.76**	**655**

The results from the above table indicate that the irrigation crop that will benefit the total income households the most are avocadoes.

4.2.2 Forestry

4.2.2.1 Sectoral Contribution to Gross Domestic Product (GDP)

The table below shows the total (direct, indirect and induced) impacts of forestry activities on the GDP of Sabie / Sand sub-catchment. Highest contribution is from Sabie River EZ, with R294 million being the total contribution of forestry to GDP from all the three EZs.

Table 4.10 Multipliers and Results for the Forestry Contribution to GDP

Zone	Sabie River	Maritsane / Inyaka	Sand River	Total
Multipliers (R/m^3)	3.79	3.79	3.79	N/A
GDP (R Million)	**175.66**	**88.24**	**29.86**	**294**

4.2.2.2 Sectoral Contribution to Employment

The largest contribution from plantations in terms of direct employment is in the Sabie River EZ, providing 2 106 employment opportunities. A total of 2 196 total jobs are created in the plantation activities in this sub-system.

Table 4.11 Total Employment Multipliers and Results for Forestry in the Sabie / Sand Sub-Catchment

Forestry	Sabie River	Maritsane / Inyaka	Sand River	Total
Multipliers (No/Mm^3)	45.48	45.48	45.48	N/A
Employment (numbers)	2 106	45	45	2 196

4.2.3 Sectoral Contribution to Income

The table below shows the amount of income which will be received by total income households (TIH) emanating for forestry activities.

Table 4.12 Household Income Results for Forestry Directed at Total Income Households (TIH) [R million, 2007]

Zone	Sabie River	Maritsane / Inyaka	Sand River	Total
Multipliers (R/m^3)	2.61	3.03	4.70	N/A
Results TIH (R Million)	120.82	70.54	36.98	228

4.2.4 Industry

4.2.4.1 Sectoral Contribution to Gross Domestic Product (GDP)

The contribution of industrial activities towards GDP is depicted in the table below. Highest GDP values are generated the Sabie River EZ (R 535 million). In total, industrial activities contributes R895 million towards this Catchment's GDP.

Table 4.13 Total GDP Multipliers and Results for Industry in the Sabie / Sand Sub-Catchment

Zone	Sabie River	Maritsane / Inyaka	Sand River	Total Sabie / Sand
Multiplier (R/m^3)	594.01	594.01	594.01	N/A
GDP(R million)	535.08	268.78	90.97	895

4.2.4.2 Sectoral Contribution to Employment

Compared to other sectors (irrigation agriculture, mining and forestry), the contribution of industry activities is largest in employment creation. As presented in the table below, a total of 16 985 employment opportunities are provided in the various industrial activities taking place in this catchment.

Table 4.14 Total Employment Multipliers (No/Mm^3) and Results for Industry in the Crocodile East Sub-Catchment

Zone	Sabie River	Maritsane / Inyaka	Sand River	Total Sabie / Sand
Multiplier (No/Mm^3)	5 855.40	5 855.40	5 855.40	N/A
Employment (numbers)	5 274	5 855	5 855	16 985

4.2.4.3 Sectoral Contribution to Income

Income available to low income households from industrial activities is shown in the table below.

Table 4.15 Total Household Income Multipliers (R/m^3) and Results of Total Income Households (R Million, 2007 constant prices)

Zone	Sabie River	Maritsane / Inyaka	Sand River	Total Sabie / Sand
Multiplier (R/m^3)	211.57	211.57	211.57	N/A
TIH(R million)	190.58	95.73	32.40	319

5 CROCODILE EAST AND SABIE / SAND SUB-CATCHMENTS CONCLUSION

This report identified and quantified the economic and commodity benefits which were derived from the water use in the Crocodile and Sabie / Sand Sub-Catchments of the WMA. It reflects the current situation in the two sub-catchments. The primary sectors that were identified are irrigation agriculture, forestry and mining. The secondary industries analysed were the raw water user industries i.e. paper, pulp and saw mills.

This report specifically studied the Crocodile-East and the Sabie / Sand Catchments which were also divided in economic zones respectively. Inputs such as water use, annual turnover and direct labour force were used to determine results by applying the MEIM model. Results obtained from the model were the multiplier effect as well as the values for the different high water user sectors.

This comprehensive assessment will assist DWAF in making informed decisions regarding the authorisation of future water use and to determine the magnitude of the impacts of the present and proposed developments.

6 APPENDIX A: DIRECT IMPACTS FOR THE CROCODILE EAST AND THE SABIE-SUB-CATCHMENTS

6.1 DIRECT IMPACTS FOR THE CROCODILE EAST SUB-CATCHMENT

Table 6.1 Direct Results for Gross Domestic Product all Sectors (R Million, 2007 constant prices)

Crocodile East Catchment	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile
Sectors	**R/m^3**						
Bananas	-	-	-	-	1.64	1.88	-
Citrus, mangoes and litchis	2.55	2.20	1.93	1.93	1.93	2.31	1.69
Avocados	-	-	-	-	2.76	3.09	-
Macadamias	-	4.23	-	-	3.69	5.45	-
Papaya	-	-	-	-	-	-	-
Sugar Cane	-	-	-	0.54	0.54	0.54	0.48
Brassicas	10.46	10.46	7.31	7.31	7.31	10.46	9.21
Maize & Wheat	2.30	1.91	1.91	-	-	2.57	-
Cucurbits	9.47	9.47	7.54	7.54	7.54	10.38	8.76
Pastures	0.82	0.69	-	1.01	-	-	-
Irrigation Agriculture (Weighted)	1.49	2.16	3.31	3.22	1.83	1.45	0.71
Forestry	2.29	2.29	2.29	2.29	2.29	2.29	2.29
Mining	-	-	-	-	529.29	302.69	295.01
Industry	68.01	-	-	-	-	-	-

Table 6.2 Results of the Direct Employment for all Sectors (Numbers 2007)

Crocodile East Catchment	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile	Total
Sectors	**Numbers**							
Bananas	-	-	-	-	56	558	-	614
Citrus, mangoes and litchis	5	370	233	861	3 773	1 118	3 981	10 341
Avocados	-	-	-	-	311	162	-	473
Macadamias	-	47	-	-	845	399	-	1 291
Papaya	-	-	-	-	-	-	-	-
Sugar Cane	-	-	-	81	909	1 047	3 567	5 604
Brassicas	3	35	88	581	132	41	9	889
Maize & Wheat	4	3	4	-	-	2	-	14
Cucurbits	0	5	13	85	19	6	1	130
Pastures	1	1	-	3	-	-	-	5
Total Irrigation Agriculture	13	460	339	1 611	6 046	3 334	7 559	19 362
Forestry	251	763	1 607	1 863	3 360	2 135	10	9 990
Mining	-	-	-	-	1 218	2 173	70	3 461
Industry	103	312	2 669	762	1 424	480	750	6 500
Total	367	1 536	4 615	4 236	12 048	8 122	8 389	39 313

Table 6.3 Household Income Directed at Low Income Households for all sectors (R Million, 2007 constant prices)

Crocodile East Catchment	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile	Total
Sectors	**R Million**							
Bananas	-	-	-	-	1.25	12.37	-	14
Citrus, mangoes and litchis	0.09	6.87	4.33	15.99	70.11	20.77	73.97	192
Avocados	-	-	-	-	21.46	11.16	-	33
Macadamias	-	1.12	-	-	19.90	9.41	-	30
Papaya	-	-	-	-	-	-	-	-
Sugar Cane	-	-	-	1.92	21.55	24.82	84.54	133
Brassicas	0.11	1.48	3.80	24.94	5.68	1.76	0.38	38
Maize & Wheat	1.81	1.29	1.87	-	-	0.97	-	6
Cucurbits	0.06	0.93	2.40	15.73	3.59	1.11	0.24	24
Pastures	0.66	0.78	-	2.87	-	-	-	4
Total Irrigation Agriculture	2.75	12.47	12.39	61.45	143.53	82.38	159.13	474
Forestry	0.39	1.18	2.49	2.88	5.20	3.30	0.02	15.45
Mining	3.92	11.91	25.08	29.08	52.44	33.31	0.16	156
Industry	4.31	13.09	27.57	31.96	57.63	36.61	0.17	171
Total	11.36	38.66	67.53	125.37	258.80	155.60	159.48	816.81

6.2 DIRECT IMPACTS FOR THE SABIE / SAND SUB-CATCHMENT

Table 6.4 Direct Forestry Gross Domestic Product for all Sectors (R Million, 2007 constant prices)

Sabie & Sand Catchment	Sabie River	Maritsane / Inyaka	Sand River	Total
Sectors	**R Million**			
Bananas	26.91	14.22	3.22	44
Citrus, mangoes and litchis	16.71	14.81	2.01	34
Avocados	36.91	7.23	2.14	46
Macadamias	31.85	3.16	-	35
Papaya	37.13	-	-	37
Sugar Cane	-	-	-	-
Brassicas	6.79	0.55	23.63	31
Maize & Wheat	3.89	0.25	-	4
Cucurbits	3.80	0.32	10.20	14
Pastures	1.28	2.13	-	3
Total Irrigation Agriculture	165.26	42.67	41.20	249
Forestry	92.91	46.67	15.80	155
Mining	-	-	-	-
Industry	185.63	93.25	31.56	310
Total	443.81	182.59	88.55	714.95

Table 6.5 Results of the Direct Employment for all Sectors (Numbers 2007)

Sabie & Sand Catchment	Sabie River	Maritsane / Inyaka	Sand River	Total
Sectors	**Numbers**			
Bananas	517.23	273.37	61.98	853
Citrus, mangoes and litchis	385.07	341.38	46.28	773
Avocados	668.82	131.09	38.72	839
Macadamias	393.88	39.10	-	433
Papaya	473.75	-	-	474
Sugar Cane	-	-	-	-
Brassicas	95.77	7.73	333.23	437
Maize & Wheat	4.51	0.28	-	5
Cucurbits	128.48	10.74	344.55	484
Pastures	0.49	0.82	-	1
Total Irrigation Agriculture	2 668.00	804.52	824.75	4 297
Forestry	2 671.63	57.70	57.70	2 787
Mining	-	-	-	-
Industry	3 311.11	3 675.82	3 675.82	10 663
Total	8 650.75	4 538.04	4 558.27	17 747

Table 6.6 Household Income Directed at Low Income Households for all Sectors (R Million, 2007 constant prices)

Sabie / Sand Catchment	Sabie River	Maritsane / Inyaka	Sand River	Total
Sectors	**R Million**			
Bananas	18.12	9.58	2.17	30
Citrus, mangoes and litchis	16.29	14.44	1.96	33
Avocados	36.89	7.23	2.14	46
Macadamias	9.28	0.92	-	10
Papaya	27.10	-	-	27
Sugar Cane	-	-	-	-
Brassicas	4.11	0.33	14.30	19
Maize & Wheat	1.90	0.12	-	2
Cucurbits	2.00	0.17	5.38	8
Pastures	0.43	0.72	-	1
Total Irrigation Agriculture	116.13	33.51	25.94	176
Forestry	4.13	2.08	0.70	7
Mining	41.69	20.94	7.09	70
Industry	45.83	23.02	7.79	77
Total	207.78	79.55	41.52	329

7 THE DIRECT MULTIPLIERS IN THE CROCODILE AND THE SABIE / SAND SUB-CATCHMENT

7.1 DIRECT MULTIPLIERS FOR THE CROCODILE SUB-CATCHMENT

Table 7.1 Direct Multipliers of the Crops Gross Domestic Product for all Sectors (R Million, 2007 constant prices)

Crocodile East Catchment	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile
Sectors	**R/m^3**						
Bananas	-	-	-	-	1.64	1.88	-
Citrus, mangoes and litchis	2.55	2.20	1.93	1.93	1.93	2.31	1.69
Avocados	-	-	-	-	2.76	3.09	-
Macadamias	-	4.23	-	-	3.69	5.45	-
Papaya	-	-	-	-	-	-	-
Sugar Cane	-	-	-	0.54	0.54	0.54	0.48
Brassicas	10.46	10.46	7.31	7.31	7.31	10.46	9.21
Maize & Wheat	2.30	1.91	1.91	-	-	2.57	-
Cucurbits	9.47	9.47	7.54	7.54	7.54	10.38	8.76
Pastures	0.82	0.69	-	1.01	-	-	-
Irrigation Agriculture (Weighted)	1.49	2.16	3.31	3.22	1.83	1.45	0.71
Forestry	2.29	2.29	2.29	2.29	2.29	2.29	2.29
Mining	-	-	-	-	529.29	302.69	295.01
Industry	68.01	68.01	188.12	68.01	86.45	68.01	244.38

Table 7.2 Multipliers of the Direct Employment for all Sectors (Numbers 2007)

Crocodile East Catchment	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile
Sectors	**No/Mm^3**						
Bananas	-	-	-	-	49.88	56.97	-
Citrus, mangoes and litchis	133.68	115.29	101.35	101.35	101.35	121.30	88.60
Avocados	-	-	-	-	40.06	44.83	-
Macadamias	-	52.25	-	-	45.61	67.38	-
Papaya	-	-	-	-	-	-	-
Sugar Cane	-	-	-	20.30	20.30	20.30	18.02
Brassicas	147.44	147.44	103.11	103.11	103.11	147.44	129.91
Maize & Wheat	2.67	2.22	2.22	-	-	2.98	-
Cucurbits	26.92	26.92	21.43	21.43	21.43	29.50	24.89
Pastures	0.32	0.27	-	0.39	-	-	-
Irrigation Agriculture (Weighted)	3.20	49.59	58.77	52.81	54.17	40.96	31.11
Forestry	65.91	65.91	65.91	65.91	65.91	65.91	65.91
Mining	-	-	-	-	1 236.55	1 891.18	972.22
Industry	1 213.02	1 213.02	364.80	1 213.02	1 206.72	1 213.02	1 000.00

Table 7.3 Multipliers of the Household Income Directed at Low Income Households for all Sectors (R Million, 2007 constant prices)

Crocodile East Catchment	Upper Crocodile	Lower Kwena	Elands River	White River	Middle Crocodile	Kaap River	Lower Crocodile
Sectors	**R/m^3**						
Bananas	-	-	-	-	1.11	1.26	-
Citrus, mangoes and litchis	2.48	2.14	1.88	1.88	1.88	2.25	1.65
Avocados	-	-	-	-	2.76	3.09	-
Macadamias	-	1.23	-	-	1.07	1.59	-
Papaya	-	-	-	-	-	-	-
Sugar Cane	-	-	-	0.48	0.48	0.48	0.43
Brassicas	6.33	6.33	4.43	4.43	4.43	6.33	5.58
Maize & Wheat	1.12	0.93	0.93	-	-	1.26	-
Cucurbits	4.99	4.99	3.97	3.97	3.97	5.47	4.62
Pastures	0.28	0.23	-	0.34	-	-	-
Irrigation Agriculture (Weighted)	0.67	1.34	2.15	2.01	1.29	1.01	0.65
Forestry	1.13	1.13	1.13	1.13	1.13	1.13	1.13
Mining	-	-	-	-	151.52	86.65	84.45
Industry	21.84	21.84	60.42	21.84	27.76	21.84	78.49

7.2 DIRECT MULTIPLIERS FOR THE SABIE / SAND SUB-CATCHMENT

Table 7.4 Direct Multipliers of the Gross Domestic Product for all Sectors (R Million, 2007 constant prices)

Sabie & Sand Catchment	Sabie River	Maritsane-Inyaka	Sand River
Sectors	**R/m^3**		
Bananas	2.02	2.11	0.70
Citrus, mangoes and litchis	1.80	1.88	0.62
Avocados	2.14	2.23	0.74
Macadamias	3.27	3.41	-
Papaya	4.93	-	-
Sugar Cane	-	-	-
Brassicas	12.55	7.70	20.62
Maize & Wheat	4.20	2.57	-
Cucurbits	9.09	5.58	14.94
Pastures	5.19	3.18	-
Irrigation Agriculture (Weighted)	2.79	2.17	3.27
Forestry	2.01	2.01	2.01
Mining	-	-	-
Industry	206.08	206.08	206.08

Table 7.5 Direct Multipliers of the Direct Employment for all Sectors (Numbers 2007)

Sabie & Sand Catchment	Sabie River	Maritsane-Inyaka	Sand River
Sectors	**No/Mm^3**		
Bananas	38.91	40.64	13.40
Citrus, mangoes and litchis	41.51	43.35	14.29
Avocados	38.71	40.43	13.33
Macadamias	40.41	42.21	-

Sabie & Sand Catchment	Sabie River	Maritsane-Inyaka	Sand River
Sectors	**No/Mm^3**		
Papaya	62.90	-	-
Sugar Cane	-	-	-
Brassicas	176.90	108.55	290.76
Maize & Wheat	4.87	2.99	-
Cucurbits	307.13	188.45	504.80
Pastures	2.00	1.23	-
Irrigation Agriculture (Weighted)	45.02	40.91	65.48
Forestry	57.70	57.70	57.70
Mining	-	-	-
Industry	3 675.82	3 675.82	3 675.82

Table 7.6 Direct Multipliers of the Household Income Directed at Low Income Households for all Sectors (R Million, 2007 constant prices)

Sabie & Sand Catchment	Sabie River	Maritsane-Inyaka	Sand River
Sectors	**R/m^3**		
Bananas	1.36	1.42	0.47
Citrus, mangoes and litchis	1.76	1.83	0.60
Avocados	2.14	2.23	0.74
Macadamias	0.95	0.99	-
Papaya	3.60	-	-
Sugar Cane	-	-	-
Brassicas	7.59	4.66	12.48
Maize & Wheat	2.05	1.26	-
Cucurbits	4.79	2.94	7.88
Pastures	1.75	1.07	-
Irrigation Agriculture (Weighted)	1.96	1.70	2.06
Forestry	0.99	0.99	0.99
Mining	-	-	-
Industry	66.19	66.19	66.19