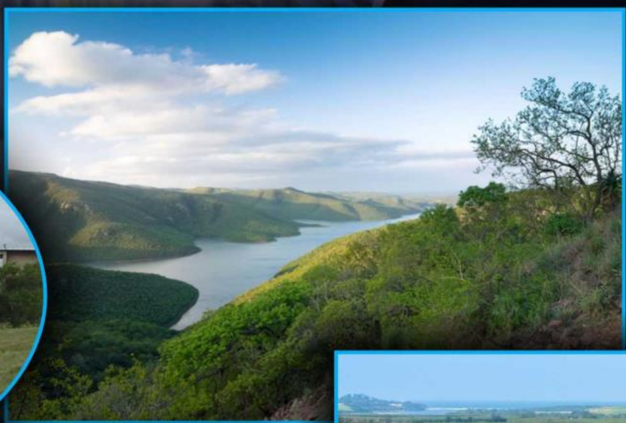
WEM/WMA3/4/00/CON/CLA/0423

water and sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

# Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments

## ECONOMIC & USER WATER QUALITY CONSEQUENCES REPORT



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Department of Water and Sanitation

**Chief Directorate: Water Ecosystem Management**

PROJECT NUMBER**:** WP 11387

# Economic & User Water Quality Consequences Report

# CLASSIFICATION OF SIGNIFICANT WATER RESOURCES AND DETERMINATION OF RESOURCE QUALITY OBJECTIVES FOR WATER RESOURCES IN THE USUTU TO MHLATHUZE CATCHMENTS

**JULY 2023**



**REFERENCE**

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| 14 | WEM/WMA3/4/00/CON/CLA/0123, | Classification of Significant Water Resources and |

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| 16 | WEM/WMA3/4/00/CON/CLA/0423 | Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Economic & User water quality Consequences Report** |
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| 18 | WEM/WMA3/4/00/CON/CLA/0623, volume 1 | Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Resource Quality Objectives Report, Volume 1: Rivers** |
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# APPROVAL

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***Approved for the PSP by:***

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# EXECUTIVE SUMMARY

## BACKGROUND

Chapter 3 of the National Water Act, 1998 (NWA) (Act 36 of 1998), deals with the protection of water resources. Section 12 of the NWA requires the Minister to develop a system to classify water resources. In response to this, the Water Resource Classification System (WRCS) was gazetted on 17 September 2010 and published in the Government Gazette no. 33541 as Regulation 810. The WRCS is a step-wise process, whereby water resources are categorised according to specific classes that represent a management vision of a particular catchment. This vision takes into account, the current state of the water resource, the ecological, social, and economic aspects that are dependent on the resource. Once significant water resources have been classified through the WRCS, Resource Quality Objectives (RQOs) have to be determined to give effect to the class.

The Chief Directorate: Water Ecosystems Management (CD: WEM) of the Department of Water and Sanitation (DWS), initiated a study to determine the Water Resource Classes and RQOs for all significant water resources in the Usutu to Mhlathuze Catchment. The Usutu to Mhlathuze Catchments are amongst many water-stressed catchments in South Africa. These catchment areas are important for conservation, and contain a number of protected areas such as natural heritage sites, cultural and historic sites, as well as other conservation areas that need protection.

## STUDY AREA

The study area is the Usutu to Mhlathuze Catchment, which has been divided into six drainage areas, as well as secondary catchment areas:

- W1 catchment (main river: Mhlathuze).
- W2 catchment (main river: Umfolozi).
- W3 catchment (main river: Mkuze).
- W4 catchment (main river: Pongola) - part of this catchment area falls within Eswatini.
- W5 catchment (main river: Usutu) - much of this catchment falls within Eswatini.
- W7 catchment (Kosi Bay and Lake Sibaya).

## PURPOSE OF THIS REPORT

The purpose of this report is to evaluate and document the economic and user (non-ecological) water quality consequences of the various operational scenarios on the affected water resources of the study area. Note that this assessment is therefore focused on the rivers where EWR sites are located (user water quality and economics), and on estuaries identified for assessment through this process (economics).

## SCENARIOS

The scenarios are documented in the scenario report (DWS, 2022a), and have been presented to stakeholders for comment and input. The Table below summarises the scenarios that were applicable to economics and user water quality.

## Description of river flow related scenarios (DWS, 2022)

| IUA[1] | Scenario | | | Type |
|---|---|---|---|---|
| | # | Abbrev. | Description | |
| W11 | 1 | CC | Climate Change. | Both, including MA1 |
| | 2 | -20%MAR[2] | Reduction of present day MAR by 20%. | Matigulu Estuary |
| | 3 | -30%MAR | Reduction of present day MAR by 30%. | Matigulu Estuary |
| | 4 | +15%MAR | Increase of present day MAR by 15%. | Matigulu Estuary |
| W12-a | 1 | CC | Climate Change. | Rivers |
| W12-b | 1 | CC | Climate Change. | Rivers, including NS1 |
| W12-c | 1 | CC | Climate Change. | Both |
| | 2 | +15%MAR | Increase of present day MAR by 15%. | uMhlathuze Estuary |
| | 3 | 2030 | 2030 year projected water requirements on the system (including increased transfer from Thukela to Goedertrouw). | uMhlathuze Estuary |
| | 4 | 2040 | 2040 year projected water requirements on the system (including increased transfer from Thukela to Goedertrouw). | uMhlathuze Estuary |
| W12-d | 1 | CC | Climate Change. | Both |
| | 2 | EWR | Present Day including EWR releases from Lake Nhlabane as obtained from Mhlathuze Water Availability Assessment Study (MWAAS - DWAF, 2009). | iNhlabane Estuary |
| | 3 | Rest | Restoration Scenario 1 to allow for mouth breaching each year. | iNhlabane Estuary |
| | 4 | Rest/Int | Restoration and interventions Scenario 2. | iNhlabane Estuary |
| W12-e | 1 | CC | Climate Change. | Rivers and Lake Msingazi |
| W13 | 1 | CC | Climate Change. | Both |
| | 2 | -15%MAR | Reduction of present day MAR by 15% (SIYAYA). | Mlalazi and Siyaya estuaries |
| | 3 | +15%MAR | Increase of present day MAR by 15% (SIYAYA). | Mlalazi and Siyaya estuaries |
| | 4 | WWTW | Present day including the upgrade of the Mtunzini Waste Water Treatment Works (WWTW) increased to a 1.5 Ml/d plant (Mlalazi). | Mlalazi and Siyaya estuaries |
| | 5 | Sc1 | Present day including additional demand of 10% on present day MAR supplied by Eshowe Dam with an increased capacity of 15 million $m^3$ (Mlalazi). | Mlalazi and Siyaya estuaries |
| | 6 | Sc2 | Present day reduced by 10% through abstraction from lower reaches of river (Mlalazi). | Mlalazi and Siyaya estuaries |
| | 7 | Sc3 | Present day reduced by 20% through abstraction from lower reaches of river (Mlalazi). | Mlalazi and Siyaya estuaries |
| | 8 | Sc4 | Scenario 3 including additional demand of 10% on present day MAR supplied by Eshowe Dam with an | Mlalazi and Siyaya estuaries |

| IUA[1] | Scenario | | | Type |
|---|---|---|---|---|
| | # | Abbrev. | Description | |
| | | | increased capacity of 20 million m$^3$ (Mlalazi). | |
| | 9 | Sc5 | Restoration/Intervention Scenario 1: Mlalazi Estuary= REC; Siyaya Estuary= PES. | Mlalazi and Siyaya estuaries |
| | 10 | Sc6 | Restoration/Intervention Scenario 2: Mlalazi Estuary= REC; Siyaya Estuary= REC. | Mlalazi and Siyaya estuaries |
| W21 | 1 | CC | Climate Change. | Rivers, including. WM1 |
| | 2 | HFY-noEWR | Historic Firm Yield (HFY) abstracted from upstream dams, no EWR. | Rivers, including. WM1 |
| | 3 | HFYEWR | HFY abstracted from upstream dams, with EWR. | Rivers, including. WM1 |
| | 4 | KLPEWR | Raised Klipfontein HFY abstracted from upstream dams, with EWR. | Rivers, including. WM1 |
| W22 | 1 | CC | Climate Change. | Rivers, including BM1 |
| W23 | 1 | CC | Climate Change. | Rivers |
| W31-a | 1 | CC | Climate Change. | Rivers |
| W31-b | 1 | CC | Climate Change. | Rivers, including MK1 |
| | 2 | 2040 | Present Day with increased upstream domestic use. | Rivers, including MK1 |
| | 3 | IRR | Present Day with increased return flows due to increased irrigation supplied from Pongolapoort Dam. | Rivers, including MK1 |
| W32-a | 1 | CC | Climate Change. | Rivers |
| W32-b | 1 | CC | Climate Change. | Rivers |
| W41 | 1 | CC | Climate Change. | Rivers |
| W42-a | 1 | CC | Climate Change. | Rivers, including UP1 |
| | 2 | 2040 | Present Day with increased upstream domestic use (upgraded Frischgewaad Water Treatment Works - WTW). | Rivers, including UP1 |
| W42-b | 1 | CC | Climate Change. | Rivers |
| W44 | 1 | CC | Climate Change. | Rivers |
| W45 | 1 | CC | Climate Change. | Rivers and Pongola Floodplain |
| W51-a | 1 | CC | Climate Change. | Rivers |
| W51-b | 1 | CC | Climate Change. | Rivers |
| W52 | 1 | CC | Climate Change. | Both, including AS1 and NG1 |

| IUA[1] | Scenario | | | Type |
|---|---|---|---|---|
| | # | Abbrev. | Description | |
| | 2 | 2040 | Present Day with increased upstream domestic use. | Rivers, including AS1 and NG1 |
| | 3 | EWR | Present Day with EWR included. | Rivers, including AS1 and NG1 |
| | 4 | noEWR | Present Day with no EWR. | Rivers, including AS1 and NG1 |
| W55 | 1 | CC | Climate Change. | Rivers, including Pans and Chrissiesmeer |
| W57 | 1 | CC | Climate Change. | Rivers, including Ndumo Pans |
| W70-a | 1 | CC | Climate Change. | Both, including Kosi Lakes and Estuary |
| W70-Muzi Swamps | 1 | CC | Climate Change. | Muzi Swamps |
| W-70b | 1 | CC | Climate Change. | Both, including Lake Sibaya, uMgobezeleni Estuary |
| St Lucia | 1 | CC | Climate Change. | St Lucia, W2 and W3 feeder streams. W32-Mkuze Floodplain/Swamp |

1 Integrated Unit of Analysis 2 Mean Annual Runoff

## RESULTS: ECONOMICS

By using the scenarios determined and estimated in the different fields of expertise, the economic results expressed in direct Gross Domestic Product (GDP) and direct employment for the rivers and estuaries had the minimal impact on irrigation agriculture and commercial forestry where quantitative analysis (numbers) was calculated.

Assessing the Urban and Industries where scenarios were also identified, using a qualitative (non-numerical) analysis, the findings were that if water was increased, security from water as a driver made it possible to expand economic activities, thus increase GDP, employment opportunities and contribution to low-income households.

In scenarios such as climate change where water reduction is the result, decrease in domestic supply, restricts economic sustainability that threatens the standard of living of communities, especially the low-income households.

## RESULTS: USER WATER QUALITY

Impacts on user water quality under operational scenarios were evaluated according to the methods outlined in the DWS (2016a) document on operationalising Resource Directed Measures, and focuses on EWR sites and river reaches potentially affected by scenarios.

The following information was gathered for identified water quality priority areas, and tested at a Technical Task Group meeting in November 2022:

- Water quality role players/users and their locations within Resource Units (RUs) and Integrated Unit of Analysis (IUAs).
- Driving users/role players in terms of water quality.
- Water quality variables that drive water quality state or requirements.

For the consequences step, the RUs and Sub-Quaternary catchments (SQs) which may be affected by the scenarios needed to be identified. Although all riverine Ecological Water Requirements (EWR) sites will be affected by scenarios, i.e. they are positioned downstream of the implementation areas, there are few scenarios that could potentially have a significant enough impact to require evaluation. Of those identified, the Scenario Climate Change (Sc CC) was often marginally ‘worse’ than the other scenarios, which all met ecological requirements (DWS, 2023).

As the ecosystem is the most stringent ‘user’ in terms of water quality in the Water Quality (WQ) priority areas identified, it follows that if there is no discernible impact on the ecology, none would be expected for non-ecological water quality under implementation of the operational scenarios.

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# TERMINOLOGY AND ACRONYMS

| | |
|---|---|
| Sc CC | Climate Change Scenario |
| CD: WEM | Chief Directorate: Water Ecosystems Management |
| CID | Conningarth Infrastructure Database |
| CRR | Critical Risk Rating |
| DWA | Department of Water Affairs |
| DWAF | Department of Water Affairs and Forestry |
| DWS | Department of Water and Sanitation |
| EC | Ecological Category |
| EFZ | Estuary Functional Zone |
| EWR | Ecological Water Requirements |
| GDP | Gross Domestic Product |
| GOS | Gross Operating Surplus |
| HFY | Historic Firm Yield |
| IUA | Integrated Unit of Analysis |
| IWRM | Integrated Water Resource Management |
| KZN | KwaZulu-Natal |
| MAR | Mean Annual Run-off |
| NWA | National Water Act |
| PAI | Physico-chemical driver Assessment Index |
| PD | Present Day |
| PES/EIS | Present Ecological State / Ecological Importance and Sensitivity |
| RBM | Richards Bay Minerals |
| RDM | Resource Directed Measures |
| RQO | Resource Quality Objectives |
| RU | Resource Unit |
| SAM | Social Accounting Matrix |
| Sc | Scenario |
| Sc CC | Scenario Climate Change |
| SQ | Sub-Quaternary reach |
| STW | Sewage Treatment Works |
| TTG | Technical Task Group |
| WIM | Water Impact Model |
| WQ | Water Quality |
| WRC-DSS | Water Resource Class Decision Support System |
| WRCS | Water Resource Classification System |
| WTW | Water Treatment Works |
| WWTW | Waste Water Treatment Works |
| ZAC | Zululand Anthracite Collieries |

# SPELLING

There are multiple references to the spelling of various Rivers, Lakes, Dams and Estuaries, depending on the source of information. For the purposes of this report, the following Table presents the selected spelling of indicated water resources and places.

| Selected Spelling for this Study | Alternate spellings |
|---|---|
| Usutu River | Usuthu River |
| Mhlathuze River | Mhlatuze, uMhlatuze River |
| Pongola (river, Town & Pongolapoort Dam) | Phongola, Phongolo |
| Lake Sibaya | Lake Sibiya, Lake Sibhayi, Lake Sibhaya |
| Eswatini | eSwatini |
| Umfolozi River | Mfolozi River |
| Amatigulu River | Amatikulu, Matigulu River |
| Goedertrouw Dam | Lake Phobane |
| Mfuli River | Mefule River, Mfule |
| aMatigulu/iNyoni Estuary | |
| Sibiya Estuary | |
| Mlalazi Estuary | |
| uMhlathuze /Richards Bay Estuary | |
| iNhlabane Estuary | |
| uMfolozi/uMsunduze Estuary | |
| St Lucia Estuary | |
| uMgobezeleni Estuary | |
| Kosi Estuary | |
| Hluhluwe Game Reserve | |
| iMfolozi Game Reserve | |
| Ithala Game Reserve | |
| Ndumo Game Reserve | |
| Tembe Elephant Reserve | |
| iSimangaliso Wetland Park | |
| Kosi Bay and Coastal Forest Area | |
| uMkhuze Game Reserve | |

# GLOSSARY

| | |
|---|---|
| *Ecological Water Requirements (EWR)* | The flow patterns (magnitude, timing and duration) and water quality needed to maintain a riverine ecosystem in a particular condition. This term is used to refer to both the quantity and quality components. |
| *Integrated Unit of Analysis (IUAs)* | An IUA is a homogeneous area that can be managed as an entity. It is the basic unit of assessment for the Classification of water resources, and is defined by areas that can be managed together in terms of water resource operations, quality, socio-economics and ecosystem services. |
| *Resource Quality Objectives (RQOs)* | RQOs are numeric or descriptive goals or objectives that can be monitored for compliance to the Water Resource Classification, for each part of each water resource. “The purpose of setting RQOs is to establish clear goals relating to the quality of the relevant water resources” (NWA, 1998). |
| *Socio Economic Parameters* | Broad concept of expressing the social economic welfare of a community through indicators such as gross domestic product, employment creation and household income distribution. |
| *Scenario* | Scenarios, in the context of water resource management and planning, are plausible definitions (settings) of factors (variables) that influence the water balance and water quality in a catchment and the system as a whole. Each scenario represents an alternative future condition, generally reflecting a change to the present condition. |
| *Sub-quaternary (SQ) reaches* | A finer subdivision of the quaternary catchments (the catchment areas of tributaries of main stem rivers in quaternary catchments), to a sub-quaternary reach. |
| *Target Ecological Category (TEC)* | This is the ecological category toward which a water resource will be managed once the Classification process has been completed and the Reserve has been finalised. The draft TECs are therefore related to the draft Classes and selected scenario. |
| *Water Resource Class* | The Water Resource Class (hereafter referred to as Class) is representative of those attributes that the DWS (as the custodian) and society require of different water resources. The decision-making toward a Class requires a wide range of trade-offs to be assessed and evaluated at a number of scales. Final outcome of the process is a set of desired characteristics for use and ecological condition of the water resources in a given catchment. The WRCS defines three management classes, Class I, II, and III, based on extent of use and alteration of ecological condition from the predevelopment condition. |

# 1 INTRODUCTION

## 1.1 BACKGROUND

Chapter 3 of the National Water Act, 1998 (NWA) (Act 36 of 1998), deals with the protection of water resources. Section 12 of the NWA requires the Minister develop a system to classify water resources. In response to this, the Water Resource Classification System (WRCS) was gazetted on 17 September 2010 and published in Government Gazette 33541 as Regulation 810. The WRCS is a stepwise process whereby water resources are categorised according to specific classes that represent a management vision of a particular catchment. This vision takes into account the current state of the water resource, the ecological, social and economic aspects that are dependent on the resource. Once significant water resources have been classified through the WRCS, Resource Quality Objectives (RQOs) must be determined to give effect to the class. The implementation of the WRCS therefore assesses the costs and benefits associated with utilisation versus protection of a water resource. Section 13 of the NWA requires that Water Resource Classes and RQOs be determined for all significant water resources.

Thus, the Chief Directorate: Water Ecosystems Management (CD: WEM) of the Department of Water and Sanitation (DWS) initiated a study for determining the Water Resource Classes and RQOs for all significant water resources in the Usutu to Mhlathuze Catchment. The Usutu to Mhlathuze Catchments are amongst many water-stressed catchments in South Africa. These catchment areas are important for conservation and contain a number of protected areas, natural heritage sites, cultural and historic sites as well as other conservation areas that need protection. There are five RAMSAR[1] sites within the catchment, which includes the world heritage site, St Lucia. The others are Sibaya, Kosi Bay, Ndumo Game Reserve and Turtle Beaches.

## 1.2 STUDY AREA

The study area is the Usutu to Mhlathuze Catchment that has been divided into six drainage areas and secondary catchment areas as follows (refer to the locality map provided as **Figure 1.1**):

- W1 catchment (main river: Mhlathuze).
- W2 catchment (main river: Umfolozi).
- W3 catchment (main river: Mkuze).
- W4 catchment (main river: Pongola) - part of this catchment area falls within Eswatini.
- W5 catchment (main river: Usutu) - much of this catchment falls within Eswatini.
- W7 catchment (Kosi Bay estuary and Lake Sibaya).

Note that all assessments within Eswatini are excluded apart from the hydrological modelling required to assess any downstream rivers in South Africa that either run through Eswatini or originate (source) in Eswatini.

River Ecological Water Requirements (EWR) sites are shown on **Figure 1.1**.

[1] A Ramsar site is a wetland site designated to be of international importance under the Ramsar Convention, also known as "The Convention on Wetlands", an intergovernmental environmental treaty established in 1971 by UNESCO in the Iranian city of Ramsar, which came into force in 1975.

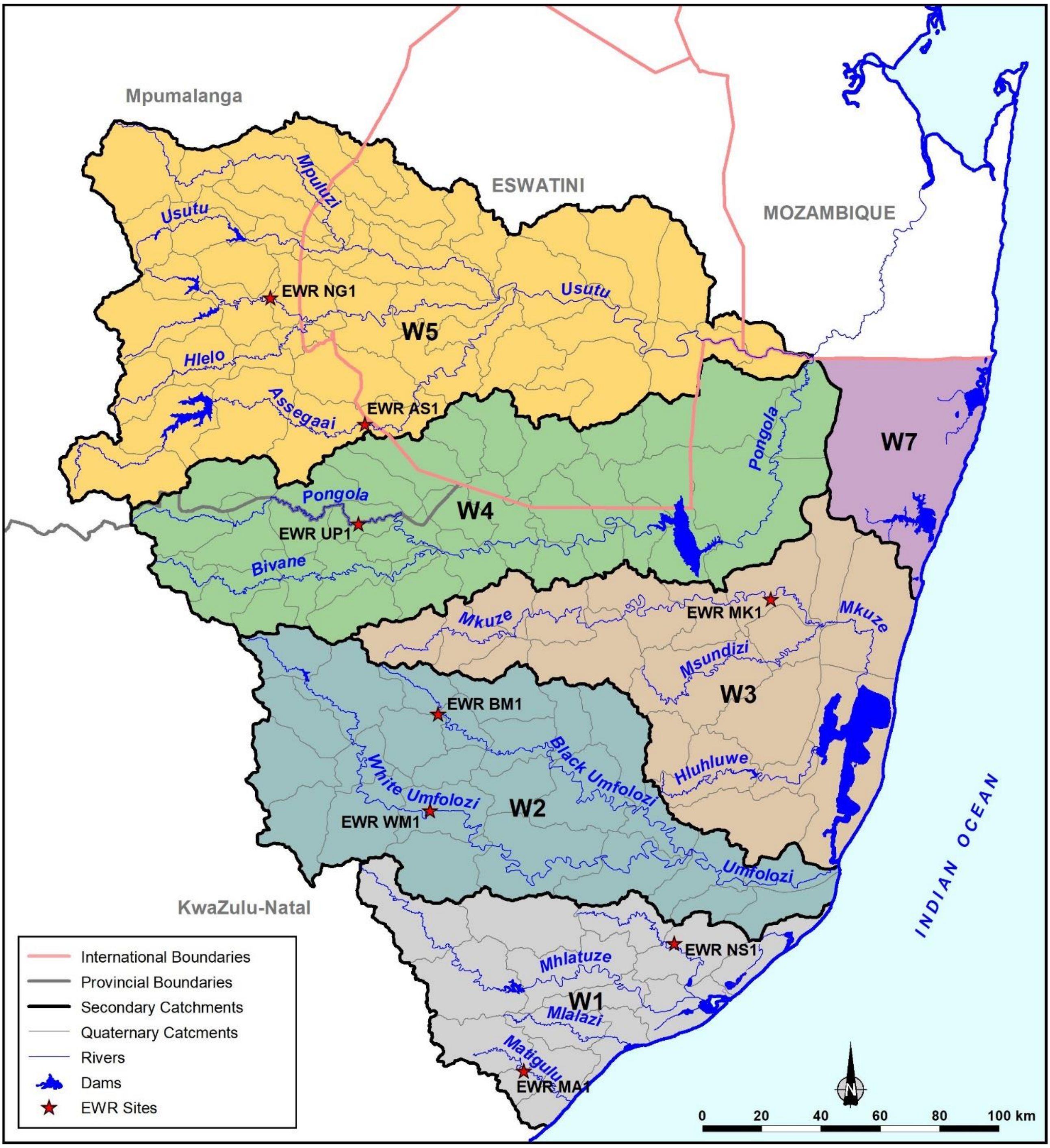



**Figure 1.1 Locality Map of the Study Area showing EWR sites**

## 1.3 PURPOSE OF THIS REPORT

The purpose of this report is to evaluate and document consequences of the various operational scenarios on the economic and user (non-ecological) water quality of the affected water resources of the study area. Note that this assessment is therefore focused on the rivers where EWR sites are located (user water quality and economics), and on estuaries identified for assessment through this process (economics).

Scenarios are shown as a scenario matrix in **Chapter 2**. The results form part of Task 4: Identify and Evaluate scenarios within Integrated Water Resource Management (IWRM) (**Figure 1.2**).

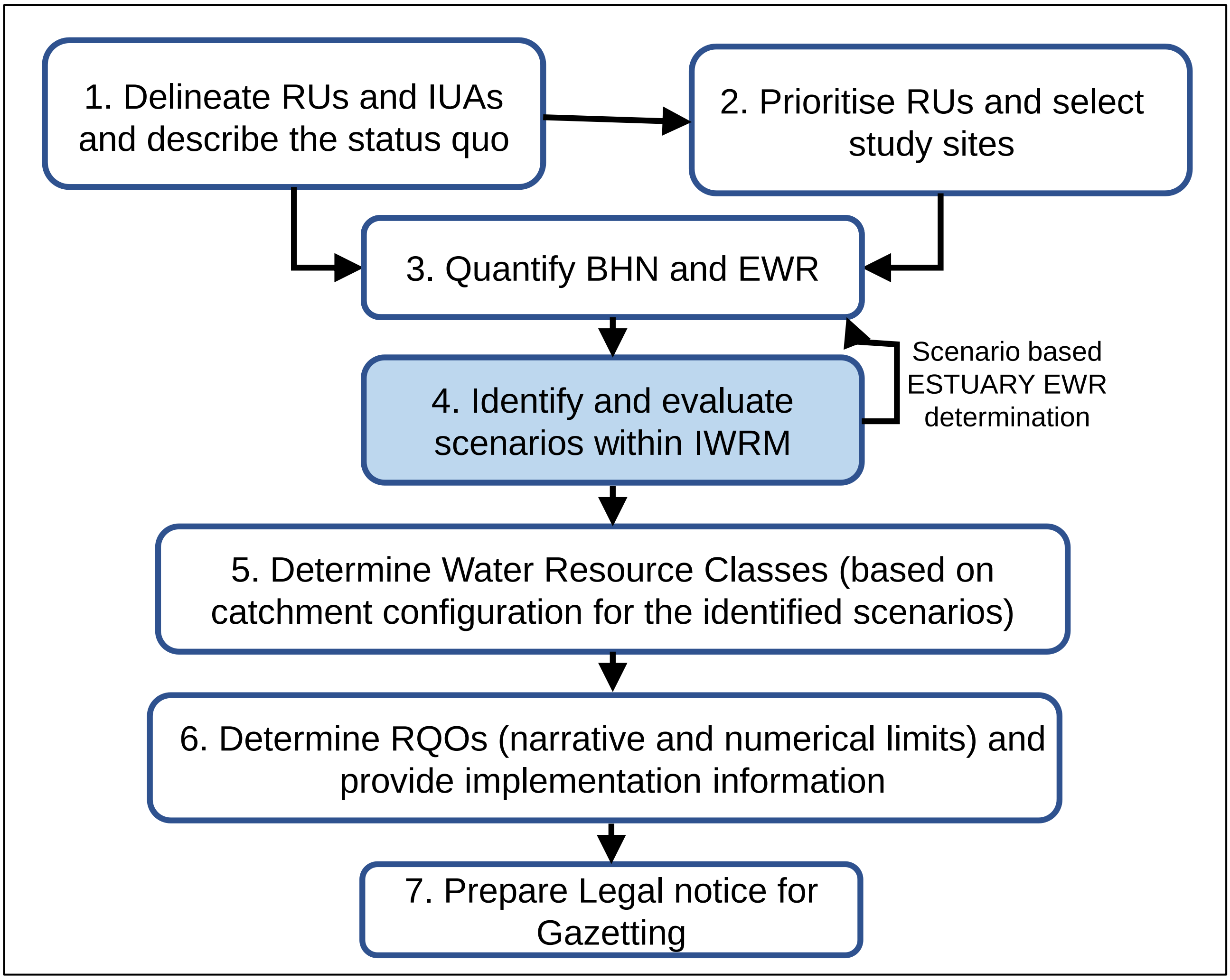



**Figure 1.2 Project Plan for the Usutu-Mhlathuze Classification study**

## 1.4 REPORT OUTLINE

The report outline is as follows:

- **Chapter 1** provides general background information on the study area and the Project Plan.
- **Chapter 2** provides a summary of the different scenarios assessed.
- **Chapter 3** outlines the general approach and methodology to determining economic consequences of operational scenarios on selected rivers and estuaries.
- **Chapter 4** outlines the consequences of operational scenarios on non-ecological or user water quality of rivers potentially affected by scenarios.
- **Chapter 5** outlines the main conclusions from the assessments.
- **Chapter 6** lists the references used in the report.

# 2 SCENARIO DESCRIPTION

Scenarios, in the context of water resource management and planning are plausible definitions (settings) of all the factors (variables) that influence the water balance and water quality in a catchment and the system as a whole. The scale (resolution) of the analysis requires the aggregation of land-use effects, and therefore individual and localised small-scale developments will not significantly influence the classification of a water resource. However significant small-scale impacts on priority water resources should be managed by setting the RQOs at the specific point to protect the said water resource, especially in the case of sensitive aquatic resources.

Possible variables that make up scenarios have been identified for the Usutu-Mhlathuze Catchments. These variables have been combined into different scenarios which are described in (DWS, 2022a). The variables and scenarios are illustrated in matrices that show scenario naming and which variables are applicable to each scenario. The operational scenarios are based on flow related aspects and not on non-flow related aspects. Mitigation measures to address non-flow related aspects will be identified and will be addressed as part of the RQO identification process.

The range of scenarios and associated variables were presented and discussed with the DWS and stakeholders, and a final (representative) range selected for the purposes of modelling and scenario assessment. The detailed descriptions of the scenarios and their resulting flows are included in the Scenario description report produced as part of this study (DWS, 2022a). A summary table of the final scenarios that were assessed from a rivers, estuary or both (rivers and estuary) perspective is included in **Table 2.1**. EWR sites are indicated where present in the Integrated Unit of Analysis (IUA).

### Table 2.1 Description of river flow related scenarios (DWS, 2022)

| IUA[1] | Scenario | | | Type |
|---|---|---|---|---|
| | # | Abbrev. | Description | |
| W11 | 1 | CC | Climate Change. | Both, including MA1 |
| | 2 | -20%MAR[2] | Reduction of present day MAR by 20%. | Matigulu Estuary |
| | 3 | -30%MAR | Reduction of present day MAR by 30%. | Matigulu Estuary |
| | 4 | +15%MAR | Increase of present day MAR by 15%. | Matigulu Estuary |
| | 5 | | Present with non-flow restoration interventions including active restoration of the riparian area undertaken in conjunction with a reduction in harvesting and grazing pressures on the macrophytes. Fishing pressure (especially illegal gill netting) is reduced and recreational activities such as boating are controlled. Recreational activities in the lower reaches are curbed through zonation and improved compliance. | Matigulu Estuary |
| W12-a | 1 | CC | Climate Change. | Rivers |
| W12-b | 1 | CC | Climate Change. | Rivers, including NS1 |
| W12-c | 1 | CC | Climate Change. | Both |
| | 2 | +15%MAR | Increase of present day MAR by 15%. | uMhlathuze Estuary |
| | 3 | 2030 | 2030 year projected water requirements on the system (including increased transfer from Thukela to Goedertrouw). | uMhlathuze Estuary |
| | 4 | 2040 | 2040 year projected water requirements on the system (including increased transfer from Thukela to Goedertrouw). | uMhlathuze Estuary |
| W12-d | 1 | CC | Climate Change. | Both |
| | 2 | EWR | Present Day including EWR releases from Lake Nhlabane as obtained from Mhlathuze Water Availability Assessment Study (MWAAS - DWAF, 2009). | iNhlabane Estuary |
| | 3 | Rest | Restoration Scenario 1 to allow for mouth breaching each year. | iNhlabane Estuary |
| | 4 | Rest/Int | Restoration and interventions Scenario 2. | iNhlabane Estuary |
| W12-e | 1 | CC | Climate Change. | Rivers and Lake Msingazi |
| W13 | 1 | CC | Climate Change. | Both |
| | 2 | -15%MAR | Reduction of present day MAR by 15% (SIYAYA). | Mlalazi and Siyaya estuaries |
| | 3 | +15%MAR | Increase of present day MAR by 15% (SIYAYA). | Mlalazi and Siyaya estuaries |
| | 4 | WWTW | Present day including the upgrade of the Mtunzini Waste Water Treatment Works (WWTW) increased to a 1.5 Ml/d plant (Mlalazi). | Mlalazi and Siyaya estuaries |

| IUA[1] | Scenario | | | Type |
|---|---|---|---|---|
| | # | Abbrev. | Description | |
| | 5 | Sc1 | Present day including additional demand of 10% on present day MAR supplied by Eshowe Dam with an increased capacity of 15 million $m^3$ (Mlalazi). | Mlalazi and Siyaya estuaries |
| | 6 | Sc2 | Present day reduced by 10% through abstraction from lower reaches of river (Mlalazi). | Mlalazi and Siyaya estuaries |
| | 7 | Sc3 | Present day reduced by 20% through abstraction from lower reaches of river (Mlalazi). | Mlalazi and Siyaya estuaries |
| | 8 | Sc4 | Scenario 3 including additional demand of 10% on present day MAR supplied by Eshowe Dam with an increased capacity of 20 million $m^3$ (Mlalazi). | Mlalazi and Siyaya estuaries |
| | 9 | Sc5 | Restoration/Intervention Scenario 1: Mlalazi Estuary= REC; Siyaya Estuary= PES. | Mlalazi and Siyaya estuaries |
| | 10 | Sc6 | Restoration/Intervention Scenario 2: Mlalazi Estuary= REC; Siyaya Estuary= REC. | Mlalazi and Siyaya estuaries |
| W21 | 1 | CC | Climate Change. | Rivers, including. WM1 |
| | 2 | HFY-noEWR | Historic Firm Yield (HFY) abstracted from upstream dams, no EWR. | Rivers, including. WM1 |
| | 3 | HFYEWR | HFY abstracted from upstream dams, with EWR. | Rivers, including. WM1 |
| | 4 | KLPEWR | Raised Klipfontein HFY abstracted from upstream dams, with EWR. | Rivers, including. WM1 |
| W22 | 1 | CC | Climate Change. | Rivers, including BM1 |
| W23 | 1 | CC | Climate Change. | Rivers |
| W31-a | 1 | CC | Climate Change. | Rivers |
| W31-b | 1 | CC | Climate Change. | Rivers, including MK1 |
| | 2 | 2040 | Present Day with increased upstream domestic use. | Rivers, including MK1 |
| | 3 | IRR | Present Day with increased return flows due to increased irrigation supplied from Pongolapoort Dam. | Rivers, including MK1 |
| W32-a | 1 | CC | Climate Change. | Rivers |
| W32-b | 1 | CC | Climate Change. | Rivers |
| W41 | 1 | CC | Climate Change. | Rivers |
| W42-a | 1 | CC | Climate Change. | Rivers, including UP1 |
| | 2 | 2040 | Present Day with increased upstream domestic use (upgraded Frischgewaad Water Treatment Works - WTW). | Rivers, including UP1 |
| W42-b | 1 | CC | Climate Change. | Rivers |
| W44 | 1 | CC | Climate Change. | Rivers |

| IUA[1] | Scenario | | | Type |
|---|---|---|---|---|
| | # | Abbrev. | Description | |
| W45 | 1 | CC | Climate Change. | Rivers and Pongola Floodplain |
| W51-a | 1 | CC | Climate Change. | Rivers |
| W51-b | 1 | CC | Climate Change. | Rivers |
| W52 | 1 | CC | Climate Change. | Both, including AS1 and NG1 |
| | 2 | 2040 | Present Day with increased upstream domestic use. | Rivers, including AS1 and NG1 |
| | 3 | EWR | Present Day with EWR included. | Rivers, including AS1 and NG1 |
| | 4 | noEWR | Present Day with no EWR. | Rivers, including AS1 and NG1 |
| W55 | 1 | CC | Climate Change. | Rivers, including Pans and Chrissiesmeer |
| W57 | 1 | CC | Climate Change. | Rivers, including Ndumo Pans |
| W70-a | 1 | CC | Climate Change. | Both, including Kosi Lakes and Estuary |
| W70-Muzi Swamps | 1 | CC | Climate Change. | Muzi Swamps |
| W-70b | 1 | CC | Climate Change. | Both, including Lake Sibaya, uMgobezeleni Estuary |
| St Lucia | 1 | CC | Climate Change. | St Lucia, W2 and W3 feeder streams. W32-Mkuze Floodplain/Swamp |

1 Integrated Unit of Analysis 2 Mean Annual Runoff

# 3 ECONOMICS

## 3.1 BACKGROUND

The current economic activities in the Usutu to Mhlathuze catchment range from sub-catchments with minimal economic activity to extensive economic active areas. The approach was to establish the economic baseline used to measure the anticipated impact of a specific scenario on the current activities in the various sub-catchments.

Socio-economic indicators are calculated to present the baseline and to estimate the projected change by any change in water availability. The following socio-economic indicators are used in the baseline and impact analysis presenting the dependency on the available water:

- Gross Domestic Product (GDP) - A country’s or catchment’s GDP, is the total monetary or market value of all the goods and services produced within that country's or catchment’s borders during a specified period. In this case the GDP represents the value as produced by the water dependent activities in the specific catchment.
- Current number of employees in the identified catchment.
- Household Income dependent on the available water.

The water dependent activities identified are divided in the rural and urban activities although there is often a link between these rural and urban areas. The rural area activities are the irrigation farming consisting of sugar cane, citrus, other fruit types, vegetable production and commercial forestry plantations which all reduces the available Mean Annual Runoff (MAR) of the surrounding rivers and estuaries. The urban links are the sugar mills, saw mils and paper mills dependent on the products produced. The tourist activities also depend on the quality/quantity of the water in the rivers and the attractiveness of the estuaries, in this part of the KwaZulu-Natal Province.

## 3.2 APPROACH

The catchment has been divided into six drainage areas and secondary catchment areas (**Figure 1.1**) and further divided to Integrated Units of Analysis (IUAs) (DWS, 2022b). It formed the basis of areas where the economic baseline and subsequent scenario assessment and consequences of these scenarios on the economy would focus. The economic baseline determines what are produced from irrigation, forestry and the other water related industries. The average production income was then determined by applying a budget-based methodology. The quantified impact of scenarios per IUA or other relevant zones are provided as output of the socio-economic impact model applying the baseline.

### 3.2.1 Sub-catchments and IUAs

The following section describes the economic profile of the sub-catchments and highlights IUAs with specific importance from an economic perspective (DWS, 2022b).

***W1 Catchment (Main River: Mhlathuze)***

This catchment is the most economic active sub-catchment in the study area and was delineated into seven IUAs.

IUA W11 (Matigulu) represents the area north of the Tugela River with extensive dryland sugar cane along the coast but in the interior, big areas of irrigated sugar cane and citrus orchards and some commercial plantations are present. The Amatikulu sugar mill is in this IUA, but also receives sugar cane from areas situated in other IUAs.

IUA W12-a (Upper Mhlathuze) consists mostly of commercial forestry. IUA W12-c (Lower Mhlathuze) consists of large economic activities such as citrus, sub-tropical fruits (e.g., bananas, litchis, mangos, and paw-paws), and irrigated sugar cane, sand mining. Eco-tourism activities also occur here. The other IUAs such as W12-b (Mfule, Mhlatuzane, Nseleni Tributary systems) and W13 (Mlalazi) have a large production of irrigated and dryland sugar cane respectively. Large commercial activities can also be found in IUA W12-e (Lake Msingazi). In the Richards Bay and Empangeni areas large commercial activities are found including various saw mills, sugar mill, pulp production and an aluminium smelter and port which is mostly used for coal exports.

***W2 Catchment (Main River: Umfolozi)***

In the W2 catchment, the White and Black Umfolozi rivers drains a very large part of the interior of KZN. Upstream from the town Mtubatuba some farming irrigation is present producing maize and vegetables. Large forest plantation areas are also present with several medium sized operational saw mills. A sugar mill in Mtubatuba receives irrigated cane from IUA W23. Two major and famous areas form part of W2, namely the Hluhluwe–Umfolozi game park and the World Heritage/RAMSAR site, St Lucia Lake area. The catchment is a very popular tourist destination. The Black Umfolozi flows into the St Lucia Estuary. Between Mtubatuba and the Hluhluwe–Umfolozi Game Park a coal mine is operational, and currently additional coal mine applications have been received.

***W3 catchment (Main River: Mkuze)***

The Mkuze is the main river of the sub-catchment which is divided into four IUAs. IUA W31-a (Upper Mkuze) is mostly dominated by subsistence agriculture. The Mkuze Game Reserve is situated in IUA W31-b (Lower Mkuze) represents the lower part of the river with situated in that IUA. A large, irrigated sugar cane production area has developed in this IUA and water is sourced from the Pongola Dam.

IUA W32-a (Upper Hluhluwe) is situated upstream of Hluhluwe Dam and falls largely within the Hluhluwe Game Reserve. IUA W32-b (Nyalazi and Mzinene) covers the areas of the Nyalazi and Mzinene tributaries and enters downstream of the Hluhluwe Dam. Formal and subsistence agriculture exists below the dam, but very little irrigation takes place, and consists of mostly vegetable and queen pineapple production.

***W4 Catchment (Main River: Pongola – excluding Eswatini)***

The catchment consists of five IUAs and irrigation agriculture, commercial forestry, mining, sugar, saw and paper mills as well as tourism can be found in these areas. In IUA W41 (Bivane) commercial agriculture and forestry plantations are present. IUA W42-b (Middle Pongola) represents the area that is downstream of the Pongola and Bivane River confluence, upstream of the irrigation water canals which support the Pongola sugar cane production. The Pongola Sugar Mill is also situated in this catchment. Small areas of irrigation, mostly vegetable and maize, are found in IUA W45 (Lower Pongola – Floodplain)

***W5 Catchment (Main River: Usutu) - much of this catchment falls within Eswatini***

The main stem of the river flows through Eswatini but four IUAs have been identified and forms part of the study, namely IUA W51 (Upstream from major dams), IUA W52 (Downstream of major dams and Hlelo), IUA W55 (Mpuluzi and Lusushwana) and the Lower Usuthu - IUA W57. Land use in IUA W51 over the different sub-catchments is very similar and dominated by commercial forestry.

***W7 Catchment (Kosi Bay estuary and Lake Sibaya)***

Two IUAs fall within this catchment, IUA W70-a (Kosi) and IUA 70-b (Sibaya). Some subsistence agriculture is present along with commercial forestry, especially above Lake Sibaya.

### 3.2.2 Baseline modelling

The economic activities that rely on the water resources from the catchments were estimated and analysed in terms of a baseline as well as the provided scenarios. The scenarios were measured against the baseline to establish the measure of impact of the various scenarios. This provided additional data input from work undertaken by other members of the research team with respect to the various river systems and the associated impact of the various scenarios.

The baseline input data entails parameters such as water use per economic activity, where users have a higher or lower intensity of water use in terms of economic output, and the annual turnover expressed in terms of the base year prices etc. Variables such as a price and employment impact will be determined depending on the nature of the economic activity.

The economic baseline provides the impacts of water usage when the full water allocation is available in the respective catchments for variables such as Gross GDP, employment, and income received by low-income households.

A broad schematic representation of the structure of the different sectors of the economy is shown in **Figure 3.1** below.

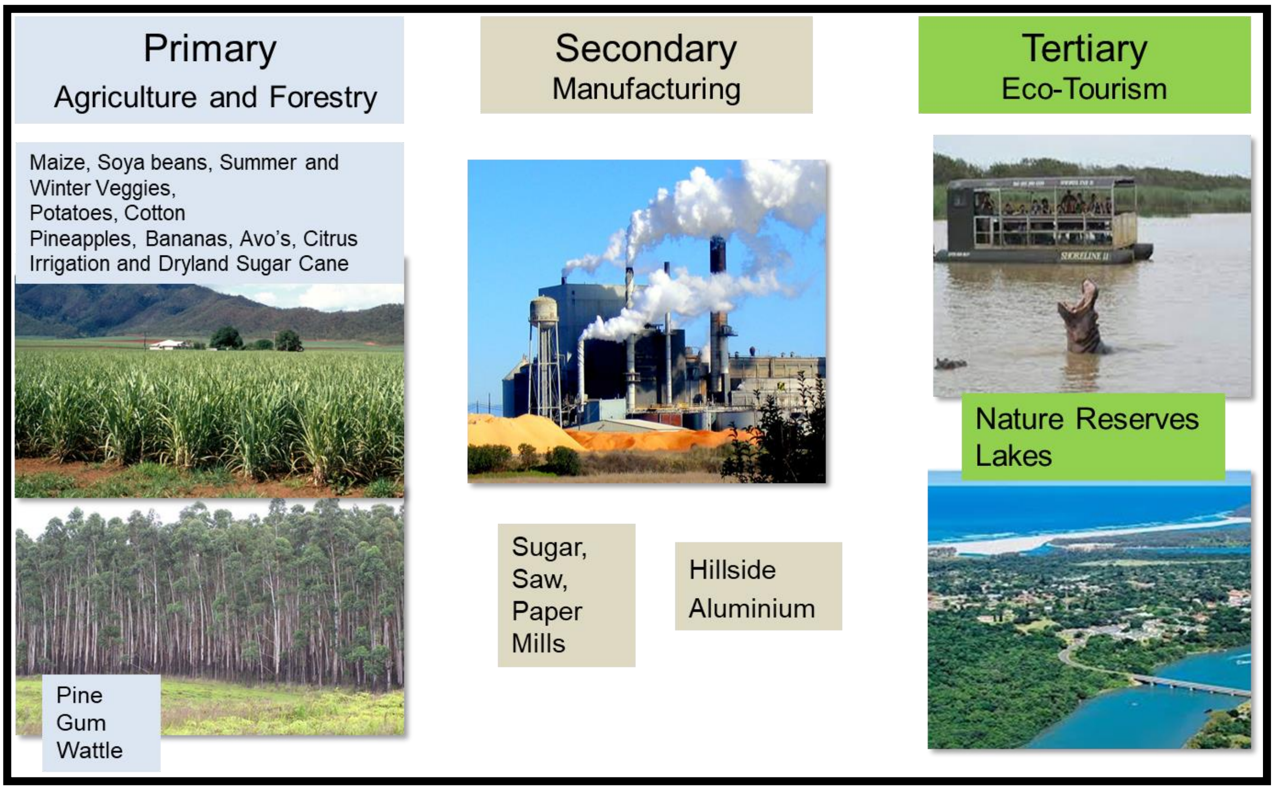



**Figure 3.1 Economic Sector Process**

The important factors in the economic status quo are the dependence of some of the major secondary industries in the catchment on the primary production sector:

- Commercial Forestry:
    - Sawmills.
    - Pulp and paper factories; and
- Sugar cane – sugar mills.

To calculate the macro-economy indicators of each of the IUAs in the project area the approach was to identify and establish the detailed water users in terms of volume used. The main inputs required for the irrigation agriculture and forestry model is the water volumes and number of hectares. Dry land sugar cane was not included as not recognised as a water flow reduction crop such as commercial forestry (Schulze *et al*., 2000; Talanda *et al*., 2007), although two of the sugar mills do mill large quantities of rain fed cane and of which sugar mills are large water users, where the primary production feed into the secondary production sector (all types of sugar cane to sugar mills).

To accomplish this economic baseline, an econometric model has been constructed with the multipliers synthesised from the representative KwaZulu–Natal Provincial Social Accounting Matrix (KZN Provincial SAM) for the Usutu to Mhlathuze catchment, as basis. The econometric model called the Water Impact Model (WIM) was used for the primary sectors namely irrigation agriculture and commercial forestry. Mining, various mills, heavy industries, and eco-tourism sectors used a turnover approach, which is multiplied with the various multipliers to determine the economic results.

The output of the model provides direct, indirect, and induced results for all the identified economic sectors. For irrigation agriculture the model can accommodate up to twenty different products and for forestry it provides for pine, gum, and wattle sub-species. Examples of the direct, indirect, and induced effects explained by means of the agricultural sector are:

- Direct effects: Refers to effects occurring directly in the agriculture sector such as the hectares cultivated impacts.
- 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 reinvests back into the economy in the form of private consumption expenditure.

The following parameters are used to determine the impacts estimated by the model:

- Gross Domestic Product (GDP): The impact on GDP reflects the magnitude of the values added to the regional and wider economy from activities using the water. Value added is made up of three elements, namely:
    - Remuneration of employees (payments to households),
    - Gross Operating Surplus (GOS) which includes profit and depreciation, and
    - Net indirect taxes (taxes and subsidies).
- Payments to Households, specifically low-income households, and total households.
- Employment creation.

Direct employment and payment to low-income households are the two macro-economic parameters, providing an indication of the socio-economic contribution of the natural resource to the local community.

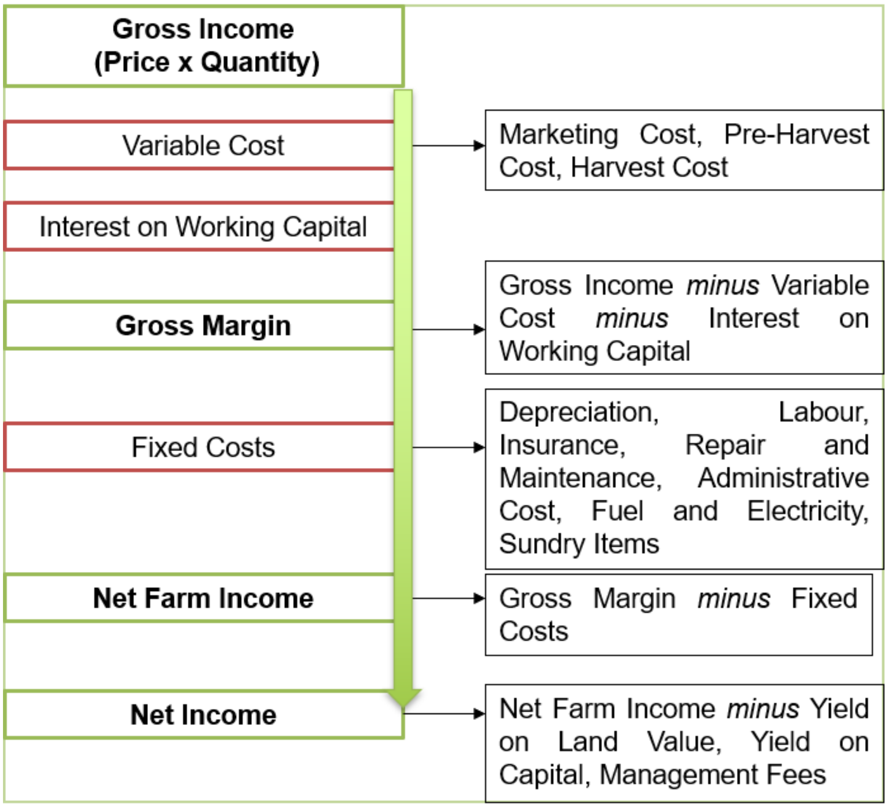
**Irrigation Crop Budgets:** The main inputs required for the irrigation agriculture and forestry model is the water volumes and number of hectares. Dry land sugar cane production is included in the comprehensive economic profile for the catchment but it was excluded from the scenario analysis as it does not specifically deals with the change in water volume to be curtailed.

Invasive species that reduce run-off water were also excluded as no economic and financial data were available for including in the analyses.

**Irrigation Crops:** Crops were identified, and the actual hectares irrigated established. The expected yield per hectare was multiplied with the average price per ton to determine the estimated annual hectare turnover. This was then multiplied with the number of hectares (ha). Note that the same cost factors were applied to commercial and subsistence farmers

- Average turnover per hectare = crop yield (ton/ha) x price (Rand/ha)
- Economic zone turnover = Average turnover (Rand/ha) x Number of hectares

**Figure 3.2** shows the income and costs detail components of the Irrigation Enterprise Budget.




*Note: Detailed pre-harvest costs include ploughing, fertilizers, and pesticides etc.*

**Figure 3.2 Irrigation Enterprise Budget**

The Enterprise Budgets originally compiled by the Department of Agriculture were used as base documents to develop production budgets. They were updated and adapted for crops in terms of yield, production prices and input costs. The Enterprise budget provided data up to the Gross

Margin stage on a hectare basis, after which the fixed costs were subtracted to get Net Farm Income per hectare and in the end, the Net Income or Profits per hectare.

***Commercial Forestry Plantations Budgets***

A very similar approach was followed with the Forestry budgets, using an adapted original budget obtained from the industry. It was adapted to make provision for the three different types of forestry, namely gum, pine and wattle, taking into consideration different hectare yield in the different IUA catchments and accompanied costs.

### 3.2.3 Macro-Economic Impacts

For determining the macro-economic impacts of these cost items in the budgets, the cost items were allocated to structures in such a way that they were applied to the different sectors of the economy. These were applied to determine the direct, and indirect and induced effects.

Data pertaining to main drivers of water volume and number of hectares applied to the specific crop budgets is then synthesised until the direct, indirect, and induced impacts of the different indicators are determined.

The KZN SAM compiled by Conningarth Economists was converted into a user-friendly macro-economic impact model that can be used to calculate the economic impact of interventions by way of programmes and projects on the economy of the relevant IUA.

It is also important to highlight the fact that the macro-economic impact model is robust enough to cater for varying degrees of input data qualities and availability. For instance, if the impacts are required at IUA level, the model lends itself to adjusting relevant national coefficients to portray the situation at lower levels realistically.

***The Social Accounting Matrix***

A Social Accounting Matrix (SAM) also represents a mathematical matrix depicting the linkages that exist in financial terms between all the major role players in the economy, i.e., business sectors, households, and government. It is very similar to an input/output table in the sense that it also reflects the inter-sectoral linkages that are present in an economy. The development of the SAM also provides a logical framework within the context of the National Accounts in which the activities of especially households are accentuated and prominently distinguished. The households are indeed the basic economic unit where significant decisions are made that affect economic variables, such as consumption, expenditure and personal savings. Combining households into homogenic groups in the SAM, makes it possible to study how the economic welfare of these groups are affected by changes in the economy.

To summarise, the SAM serves a dual purpose. Firstly, it reflects the magnitude of financial linkages that exist between the major stakeholders in an economy. Secondly, it becomes a powerful econometric tool that can be used to conduct various economic analyses such as calculating the impact of investment projects on the economy.

By applying the general tenets of the general equilibrium economic model to the SAM structure, the so-called direct, indirect, and induced effects emanating from the various levels of value adding at all levels are quantified i.e., primary manufacturing, commercial services etc.

For example, the direct impact that occurs in the manufacturing industry is measured through changes in production/turnover, payment of remuneration to employees and profit generation. The indirect impacts refer to impacts on industries that provide raw material inputs to the production process, for example the paper and wood industry and other backward linkages. The induced effect or income effect refers to a further round of economic activity that takes place in the economy because of additional consumer spending because of the additional salaries and wages that are earned throughout the catchment economy. The impact analysis is based on, and expressed as the standard economic aggregates (GDP, employment, and household income).

For each of the macro-economic impact indicators, economic multiplier factors are generated by the SAM. The multiplier factors of the KZN SAM were used to calculate the macro-economic impacts of the different activities in a IUA by multiplying the specific multiplier factor with the production value for each sector, then adding the sectoral impacts to get the total impact.

***Contribution of Social Accounting Matrix as modelling tool***

The Water Impact Model (WIM) presented in **Figure 3.3** below is based on the multiplier factors as generated by the KZN SAM. The model shows the detail for the different irrigated crops but was also slightly adapted to accommodate the forestry sector.

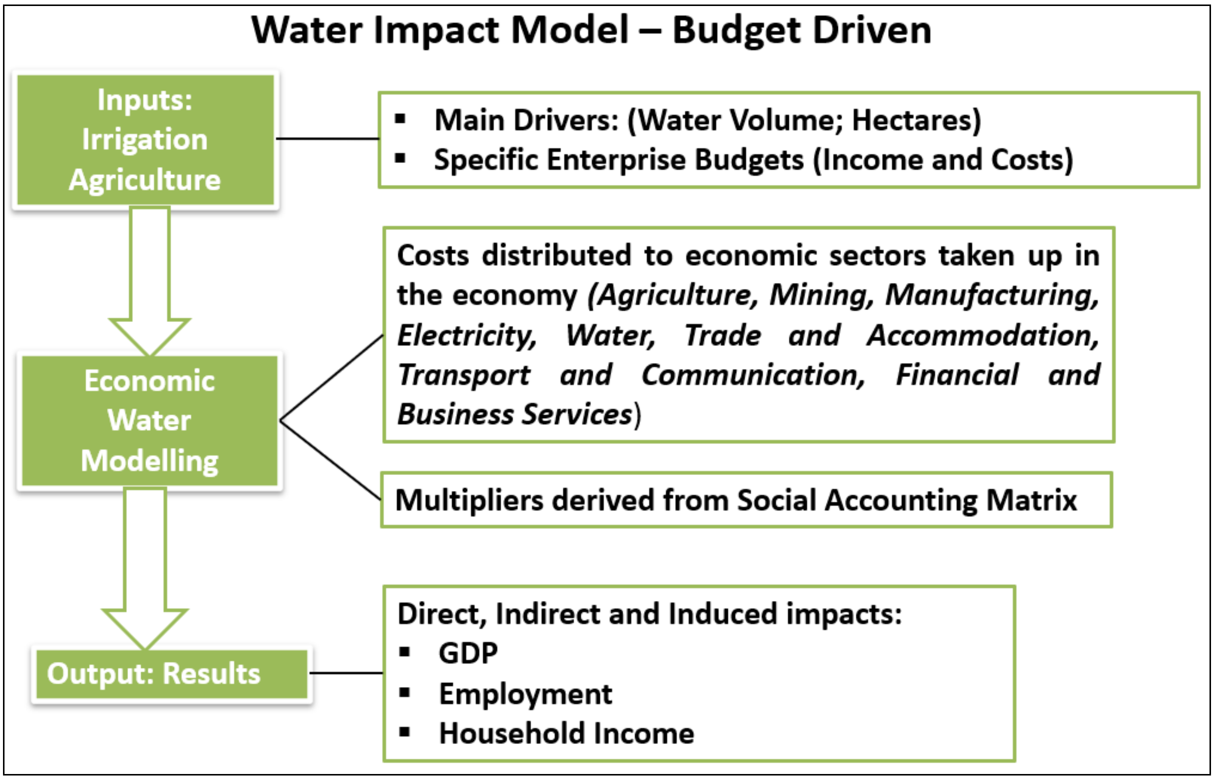



**Figure 3.3 Socio-economic Model for baseline and scenario modelling**

The results are presented as “Direct”, “Indirect” and “Induced” impacts, the difference which is explained in the following sections.

**Direct Impacts**

The direct impacts refer to the effect of the activities that take place in the IUA. It refers to the income and expenditure that is associated with the everyday operation of each of the components of the relevant activity. For instance, if the manufacturing component, a sugar mill, is taken as an example, the direct impacts refer to the total production/turnover of the manufacturing activities; the intermediate goods bought by the manufacturers; the salaries and wages paid by the manufacturers; and the profits generated by the manufacturers.

**Indirect Impacts**

The indirect impacts refer to economic activities that arise in the sectors that provide inputs to the production activities and other backward linked industries. For example, if the irrigation sector uses steel, the indirect impacts refer to the activity (paying of salaries and wages; and profit generation) that occurs in the steel sector as well as the sectors that provide materials to the steel sector.

**Induced Impacts**

Induced impacts refer, *inter alia*, to the economic impacts that result from the payment of salaries and wages to people who are (directly) employed at the various consecutive stages of beneficiation of the different activities and industries. In addition, the induced impact also includes the salaries and wages paid by businesses operating in the sectors indirectly linked to these industries through the supply of inputs. These additional salaries and wages lead to an increased demand for various consumable goods that need to be supplied by other sectors of the economy that then need to increase their production in tandem with the demand for their products and services.

**Figure 3.4** below indicates the value chain through the direct, indirect, and induced impacts which stimulates the different areas of the economy when production occurs.

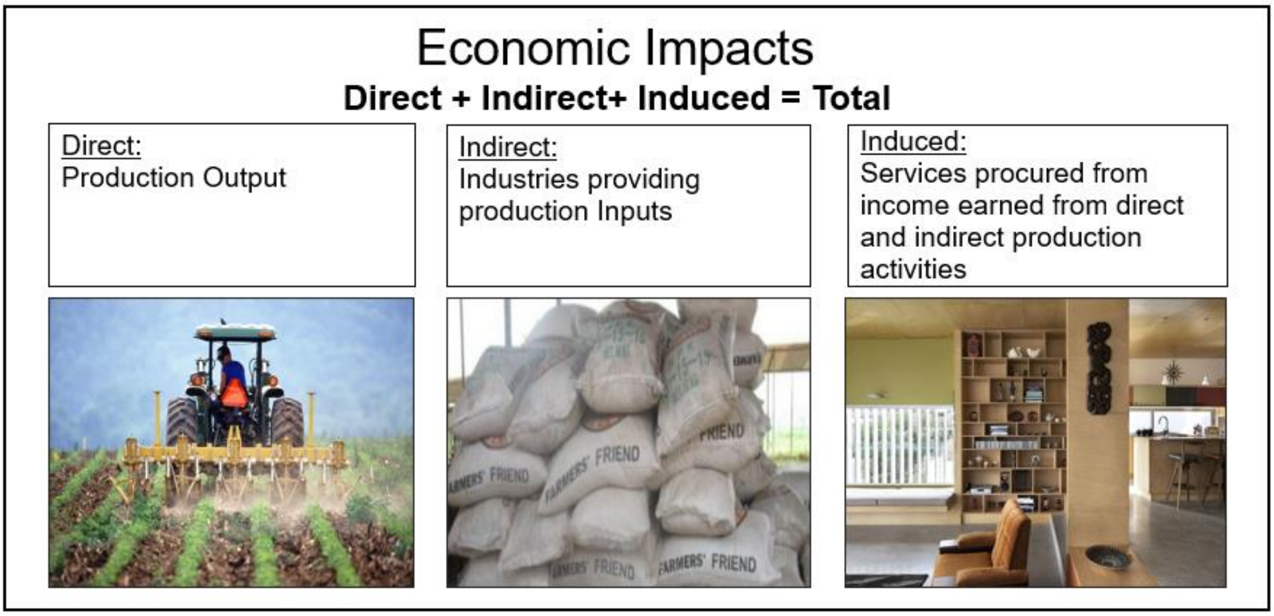



**Figure 3.4 Economic value chain**

The economic tools were applied to the baseline and scenario modelling. The approach to calculate the macro-economy indicators of each of the Usutu to Mhlathuze catchments was to identify and establish the detailed water users in terms of volume used.

### 3.2.4 Scenario modelling

The Present Day (PD) MAR includes the water allocated to irrigation production and the runoff reduction by commercial forestry, as dryland sugar cane production is not classified as a water run-off reducer (Schulze *et al*., 2000; Talanda *et al*., 2007). As a possible impact is a decrease in land use as water is curtailed, the consequences are only calculated in those water use sectors.

The reduction of water use by the industries and other water users is not a practical option and thus not determined, but it can be accepted that a curtailed volume of product will impact negatively on the product related industries.

For preparation of the scenarios, number of hectares was multiplied per water use, per crop, to calculate the water volume. From the production budgets also applied in the comprehensive baseline analysis, the turnover was converted to direct GDP and labour multipliers of which economic impacts could be determined. Based on further calculations, Direct GDP and direct labour multipliers was expressed as GDP/water, and labour/water use.

The economic impact for all the scenarios was also provided where water was curtailed (Present flow minus Scenario flow). In the extended scenarios, scenarios where additional water was made available, no quantitative impact was provided as it will only be qualitative impacts. The water usage consists of a combination of rainfall, water directly from the river and other sources.

To determine the application of the curtailment, the hectares of the crops that have the shortest life cycle were the first to be eliminated as the least capital infrastructure was applied,

It was also possible to curtail the water per irrigation and commercial forestry separately. For the scenario analysis, the dryland agriculture, and specifically sugar cane was omitted, as no specific curtailment could take place in this regard. In the case of commercial forestry, trees will be removed. As it does play an important role in the catchment economy and value chains, it was only considered when the comprehensive baseline in the sub-catchments was calculated.

The ranking for curtailment if crops were cultivated in the catchment is provided in **Table 3.1**.

**Table 3.1 Curtailment preference ranking**

| Irrigation Agriculture | | Commercial Forestry | |
|---|---|---|---|
| 1 | Cotton | 1 | Wattle |
| 2 | Maize | 2 | Gum |
| 3 | Soya beans | 3 | Pine |
| 4 | Summer Vegetables | | |
| 5 | Winter Vegetables | | |
| 6 | Potatoes | | |
| 7 | Irrigation Sugar Cane | | |
| 8 | Pineapples | | |
| 9 | Bananas | | |
| 10 | Avocadoes | | |
| 11 | Citrus (Grapefruit) | | |

This means that if there are summer vegetables and citrus currently being cultivated, the water of the summer vegetables will be the first crop to be curtailed, and if there is more water curtailment, the citrus crop will follow. It can be assumed that the oldest plant or the youngest trees will be reduced first, and those trees that are producing fruit with an optimal yield, will be kept.

### 3.3 DATA AND DATA SOURCES

The main input data required for the economic impacts, is shown in **Table 3.2**. As discussed in the approach, land use and financial turnovers are key components for the modelling process.

**Table 3.2 Agricultural land use of the Usutu to Mhlathuze catchment in hectares**

| Agriculture | W1 | W2 | W3 | W4 | W5 | W7 | Catchment |
|---|---|---|---|---|---|---|---|
| | Mhlathuze | Umfolozi | Mkuze | Pongola | Usutu | Kosi Bay and Lake Sibaya | Total |
| Maize | - | 1 764 | 1 121 | 2 468 | 640 | - | **5 993** |
| Pineapples | - | - | 633 | - | - | - | **633** |
| Soya beans | - | - | - | 436 | - | - | **436** |
| Summer Vegetables | 157 | 195 | - | 1 297 | - | - | **1 649** |
| Winter Vegetables | 292 | 113 | 263 | 558 | 71 | - | **1 297** |
| Potatoes | - | - | - | 499 | - | - | **499** |
| Bananas | 322 | - | - | - | - | - | **322** |
| Avocadoes | 20 | 257 | - | - | - | - | **277** |
| Citrus (Grapefruit) | 2 584 | - | 369 | - | - | - | **2 953** |
| Irrigation Sugar Cane | 12 733 | 10 155 | 3 324 | 11 605 | - | - | **37 817** |
| Cotton | - | - | - | 1 296 | - | - | **1 296** |
| Dryland Sugar Cane | 68 250 | 5 429 | 1 535 | - | - | - | **75 214** |
| **Total** | **84 358** | **17 913** | **7 245** | **18 159** | **711** | **-** | **128 386** |

The largest agricultural land use in the total catchment is in the Mhlathuze, with dryland sugar cane being the dominant crop. In the parts of Umfolozi, Mkuze as well as Pongola, irrigation sugar cane is the highest crops cultivated compared to the rest of the crops. This indicates at a hectare analysis level, how important sugar cane is in this catchment, and with any change to water allocation or economic change, farming practices will be influenced.

**Table 3.3 Commercial forestry land use in the Usutu to Mhlathuze catchment in hectares**

| Commercial Forestry | W1 | W2 | W3 | W4 | W5 | W7 | Catchment |
|---|---|---|---|---|---|---|---|
| | Mhlathuze | Umfolozi | Mkuze | Pongola | Usutu | Kosi Bay and Lake Sibaya | Total |
| Gum | 52 862 | 14 079 | 9 676 | 20 770 | 37 232 | 9 629 | **144 247** |
| Pine | 17 601 | 18 623 | 17 939 | 26 150 | 126 259 | 14 775 | **221 347** |
| Wattle | 5 347 | 19 663 | 12 284 | 29 103 | 29 064 | 6 828 | **102 288** |
| **Total** | **75 810** | **52 364** | **39 898** | **76 022** | **192 555** | **31 232** | **467 881** |

In **Table 3.3** above, the Usutu catchment has the highest afforestation / commercial forestry land use in the study area with 41% (192 555/467 881 ha) and pine forestry has the largest land use with 47% (221 347/467 881 ha). Pine has a hardwood quality and after moving through the saw mills, furniture or musical instruments are products made.

The **Table 3.4** below shows the different water dependant sectors. The production values are key drivers for the economic modelling process where it is ultimately converted to GDP, employment and income allocated to households' impacts.

**Table 3.4 Estimated annual production turnover of water dependant sectors in the Usutu to Mhlathuze catchment (2022 Prices, Rand millions)**

| Water Dependant Sectors | W1 | W2 | W3 | W4 | W5 | W7 | Catchment |
|---|---|---|---|---|---|---|---|
| | Mhlathuze | Umfolozi | Mkuze | Pongola | Usutu | Kosi Bay and Lake Sibaya | Total |
| | R Million | R Million | R Million | R Million | R Million | R Million | R Million |
| Irrigation Agriculture | 3 032 | 527 | 509 | 959 | 50 | - | **5 077** |
| Commercial Forestry | 650 | 438 | 333 | 635 | 1 605 | 262 | **3 923** |
| Saw Mills | 453 | 284 | - | - | 3 384 | - | **4 122** |
| Paper Mills | 2 353 | - | - | - | 706 | - | **3 059** |
| Heavy Industry | 4 409 | - | - | - | - | - | **4 409** |
| Mining | 836 | 64 | 27 | 23 | 86 | 0 | **1 036** |
| Sugar Mills | 7 076 | 4 839 | - | 5 559 | - | - | **17 474** |
| Eco-Tourism | 1 727 | 103 | 584 | 64 | 318 | 35 | **2 832** |
| Total | **20 536** | **6 255** | **1 453** | **7 242** | **6 149** | **297** | **41 931** |

**Table 3.4** gives an indication of the production of the agriculture and commercial forestry sector. As sugar cane and the tree species are refined into products, it moves through the sugar and saw and paper mills in the value chain to the end-user. With the different nature reserves and estuaries in the Mhlathuze catchment, the turnover is also the largest of all the secondary catchments.

Data that was not sourced in specific publications was retrieved from the Conningarth Database and adapted and updated for the relevant sectors and IUAs.

The Agriculture, Commercial Forestry hectare and water data is based on the following hydrology reports:

- Hydrological Analysis Report - Water Availability Assessment Study for the Usutu Catchment DWS (2016b).
- Pongola - Umfolozi: Water Requirements Report - Development, Updating and Review of Strategies to Reconcile Water Availability and Requirement in the East Planning Area Comprising Water Supply Systems for Mbombela, Richards Bay, Mgeni and All Other Towns and Clusters of Villages. DWS (2023a) and ongoing.
- Scenario Description Report - Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments. DWS (2023b) and ongoing.

The Enterprise Budgets compiled by the Department of Agriculture was updated to 2021/22 production year. The Abstract of Agricultural Statistics of the Department of Agriculture, Land Reform and Rural Development 2021/2022 was used for updating of various crops data.

Sugar Mill data was updated with SA Canegrowers data. Saw Mill data was based on South African Forestry data and G:ENISIS report. Paper Mills data was sourced and adapted from Mondi and other representative sources. Heavy Industries data for the Richards Bay area was determined using the Conningarth Industrial Database (CID) and refined for the UIAs. Mining was also determined using the CID and refined for the UIAs. The Eco-Tourism information was compiled from Tourism KwaZulu-Natal Statistics Reports, own calculations as well as the CID. Google Earth observations were also used as a cross checking method for supporting the logistics of the different production areas and companies.

**Sources for economic tools**

The newly updated KwaZulu-Natal Socio-Accounting Matrix developed by Conningarth Economists served as basis to calculate the multipliers. The economic tools and modelling systems were developed by Conningarth Economists based on standard economic principles.

## 3.4 STATUS QUO IMPACTS/BASELINE

The following tables will show a comprehensive economic profile expressed in multiple economic indicators. The results will be presented per secondary catchment area and the primary, secondary, and tertiary sectors are quantified.

### 3.4.1 W1 catchment (Main River: Mhlathuze)

**Table 3.5** provides the economic impacts on primary water users expressed in GDP, Employment and Household Income distribution.

**Table 3.5 Economic profile of the W1 catchment (Main River: Mhlathuze)**

| Impacts | Agri-culture | Commercial Forestry | Saw Mills | Paper Mill | Sugar Mill | Mining and Heavy Industries | Eco-Tourism | Total |
|---|---|---|---|---|---|---|---|---|
| **Gross Domestic Product (Rand Million)** | | | | | | | | |
| Direct | 1 111.3 | 159.0 | 115.4 | 451.6 | 2 420.5 | 1 472.9 | 315.0 | **6 045.7** |
| Indirect and induced | 304.0 | 246.2 | 132.9 | 647.1 | 2 010.3 | 1 640.8 | 684.9 | **5 666.1** |
| **Total** | **1 415.3** | **405.2** | **248.3** | **1 098.6** | **4 430.9** | **3 113.6** | **999.9** | **11 711.8** |
| **% Direct/Total** | ***78.5%*** | ***39.2%*** | ***46.5%*** | ***41.1%*** | ***54.6%*** | ***47.3%*** | ***31.5%*** | ***51.6%*** |
| **Employment Numbers)** | | | | | | | | |
| Direct | 15 399 | 5 150 | 197 | 956 | 2 978 | 1 625 | 1 129 | **27 433** |
| Indirect and induced | 1 047 | 126 | 507 | 2 336 | 7 467 | 5 014 | 2 284 | **18 781** |
| **Total** | **16 445** | **5 276** | **704** | **3 292** | **10 445** | **6 639** | **3 413** | **46 214** |
| **% Direct/Total** | ***93.6%*** | ***97.6%*** | ***28.0%*** | ***29%*** | ***28.5%*** | ***24.5%*** | ***33.1%*** | ***59.4%*** |
| **Household Income (Rand Million)** | | | | | | | | |
| Low-Income | 160.0 | 5.3 | 23.0 | 116.2 | 354.2 | 226.5 | 96.9 | **982.1** |
| Medium and High Income | 281.7 | 14.1 | 81.2 | 483.9 | 1 361.2 | 992.7 | 398.6 | **3 613.4** |
| **Total** | **441.7** | **19.3** | **104.1** | **600.1** | **1 715.4** | **1 219.2** | **495.5** | **4 595.5** |
| **% Low/Total** | ***36.2%*** | ***27.3%*** | ***22.1%*** | ***19.4%*** | ***20.6%*** | ***18.6%*** | ***19.6%*** | ***21.4%*** |

With the breakdown between all the different impacts and sectors in the economic active Mhlathuze catchment, the largest sectors are the Sugar Mills, and the Heavy Industry and Mining sectors.

The major heavy sector area is in the Lower Mhlathuze area and includes the towns of Empangeni and Richards Bay. There is also trade, private and public services that are dependent on water resources. The shipping and port activities are once again dependent on the supply from the primary and secondary sectors for exports to their specific markets.

Due to the diverse catchment that includes also mills and a healthy eco-tourism sector it is important that the water distribution needs to be carefully managed to reach the full potential in all economic sectors.

### 3.4.2 W2 catchment (Main River: Umfolozi)

**Table 3.6** provides the economic impacts on primary water users expressed in GDP, Employment and Household Income distribution.

**Table 3.6 Economic profile of the W2 catchment (Main River: Umfolozi)**

| Impacts | Agriculture | Commercial Forestry | Saw Mills | Paper Mill | Sugar Mill | Mining and Heavy Industries | Eco-Tourism | Total |
|---|---|---|---|---|---|---|---|---|
| **Gross Domestic Product (Rand Million)** | | | | | | | | |
| Direct | 149.8 | 107.9 | 72.4 | - | 1 655.3 | 25.8 | 18.8 | **2 029.9** |
| Indirect and induced | 137.9 | 19.0 | 83.4 | - | 1 374.7 | 25.6 | 40.9 | **1 681.6** |
| **Total** | **287.7** | **126.9** | **155.8** | **-** | **3 030.0** | **51.4** | **59.7** | **3 711.4** |
| **% Direct/Total** | ***52.1%*** | ***85.0%*** | ***46.5%*** | ***-*** | ***54.6%*** | ***50.1%*** | ***31.5%*** | ***54.7%*** |
| **Employment (Numbers)** | | | | | | | | |
| Direct | 3 240 | 3 330 | 124 | - | 2 036 | 17 | 67 | **8 814** |
| Indirect and induced | 406 | 85 | 318 | - | 5 106 | 71 | 136 | **6 123** |
| **Total** | **3 646** | **3 415** | **442** | **-** | **7 143** | **88** | **204** | **14 937** |
| **% Direct/Total** | ***88.9%*** | ***97.5%*** | ***28.0%*** | ***-*** | ***28.5%*** | ***19.2%*** | ***33.1%*** | ***59.0%*** |
| **Household Income (Rand Million)** | | | | | | | | |
| Low-Income | 61.9 | 3.5 | 14.4 | - | 242.2 | 4.6 | 5.8 | **332.4** |
| Medium and High Income | 122.4 | 9.5 | 50.9 | - | 930.9 | 20.6 | 23.8 | **1 158.1** |
| **Total** | **184.3** | **13.1** | **65.3** | **-** | **1 173.1** | **25.2** | **29.6** | **1 490.5** |
| **% Low/Total** | ***33.6%*** | ***27.1%*** | ***22.1%*** | ***-*** | ***20.6%*** | ***18.1%*** | ***19.6%*** | ***22.3%*** |

The largest economic impacts in the Umfolozi catchment on GDP, employment and household income is the Agricultural sector, with 52% direct GDP. Although the direct GDP of forestry is much higher, it indicates that the value added of the indirect and induced effects is much higher in the agricultural sector due to irrigation sugar cane production. It also provides the highest low- to total household income ratio of 33.6%.

Sugar cane not only contributed to the primary sector, but also is an input to the secondary sector for the sugar mills. Although not specifically estimated in the study, as the focus was on the main water dependant sectors, the products from sugar cane such as molasses and sugar, is once again inputs to other products or production processes.

The eco-tourism sector provides an estimated 204 total employment opportunities which is dependent on the rivers, specifically the St Lucia Estuary and the Umfolozi/Hluhluwe game reserve.

### 3.4.3 W3 (Main River: Mkuze)

**Table 3.7** provides the economic impacts on primary water users expressed in GPD, Employment and Household Income distribution.

**Table 3.7 Economic profile of W3 (Main River: Mkuze)**

| Impacts | Agriculture | Commercial Forestry | Saw Mills | Paper Mill | Sugar Mill | Mining and Heavy Industries | Eco-Tourism | Total |
|---|---|---|---|---|---|---|---|---|
| **Gross Domestic Product (Rand Million)** | | | | | | | | |
| Direct | 188.3 | 84.7 | - | - | - | 10.8 | 106.6 | **390.5** |
| Indirect and induced | 142.6 | 129.4 | - | - | - | 10.8 | 231.8 | **514.6** |
| **Total** | **330.9** | **214.2** | **-** | **-** | **-** | **21.6** | **338.4** | **905.1** |
| **% Direct/Total** | ***56.9%*** | ***39.6%*** | **-** | **-** | **-** | ***50.1%*** | ***31.5%*** | ***43.1%*** |
| **Employment (Numbers)** | | | | | | | | |
| Direct | 1 961 | 2 575 | - | - | - | 7 | 382 | **4 926** |
| Indirect and induced | 516 | 65 | - | - | - | 30 | 773 | **1 384** |
| **Total** | **2 478** | **2 640** | **-** | **-** | **-** | **37** | **1 155** | **6 310** |
| **% Direct/Total** | ***79.2%*** | ***97.6%*** | **-** | **-** | **-** | ***19.2%*** | ***33.1%*** | ***78.1%*** |
| **Household Income (Rand Million)** | | | | | | | | |
| Low-Income | 55.5 | 2.7 | - | - | - | 1.9 | 32.8 | **92.9** |
| Medium and High Income | 115.3 | 7.5 | - | - | - | 8.6 | 134.9 | **266.4** |
| **Total** | **170.8** | **10.2** | **-** | **-** | **-** | **10.6** | **167.7** | **359.2** |
| **% Low/Total** | ***32.5%*** | ***26.5%*** | **-** | **-** | **-** | ***18.1%*** | ***19.6%*** | ***25.9%*** |

The Mkuze catchment is dominated by agriculture, commercial forestry and eco-tourism that totals more than 50% in total jobs compared to the other sectors. These eco-tourism attractions, of which healthy rivers complement its popularity, provide impetus for tourist spending.

The irrigation production area relies on two water dependent areas. The first area is the area around the Hluhluwe River where the production of Queen Pineapples and other agriculture crops take place. The second area is irrigated sugar cane production which uses water that is transferred from the Pongola Dam. The Mkuze River is one of the main feeders into St Lucia.

### 3.4.4 W4 (Main River: Pongola (excluding Swaziland))

**Table 3.8** provides the economic impacts on primary water users expressed in GPD, Employment and Household Income distribution.

**Table 3.8 Economic profile of W4 (Main River: Pongola, excluding Eswatini)**

| Impacts | Agriculture | Commercial Forestry | Saw Mills | Paper Mill | Sugar Mill | Mining and Heavy Industries | Eco-Tourism | Total |
|---|---|---|---|---|---|---|---|---|
| **Gross Domestic Product (Rand Million)** | | | | | | | | |
| Direct | 295.7 | 156.0 | - | - | 1 901.8 | 9.2 | 11.7 | **2 374.4** |
| Indirect and induced | 262.3 | 241.3 | - | - | 1 579.5 | 9.2 | 25.5 | **2 117.8** |
| **Total** | **558.0** | **397.3** | **-** | **-** | **3 481.2** | **18.4** | **37.2** | **4 492.2** |
| **% Direct/Total** | ***53.0%*** | ***39.3%*** | ***-*** | ***-*** | ***54.6%*** | ***50.1%*** | ***31.5%*** | ***52.9%*** |
| **Employment (Numbers)** | | | | | | | | |
| Direct | 3 955 | 4 826 | - | - | 2 340 | 6 | 42 | **11 169** |
| Indirect and induced | 875 | 123 | - | - | 5 867 | 25 | 85 | **6 975** |
| **Total** | **4 829** | **4 950** | **-** | **-** | **8 206** | **32** | **127** | **18 144** |
| **% Direct/Total** | ***81.9%*** | ***97.5%*** | ***-*** | ***-*** | ***28.5%*** | ***19.2%*** | ***33.1%*** | ***61.6%*** |
| **Household Income (Rand Million)** | | | | | | | | |
| Low-Income | 113.7 | 5.2 | - | - | 278.3 | 1.6 | 3.6 | **402.3** |
| Medium and High Income | 224.9 | 13.8 | - | - | 1 069.5 | 7.4 | 14.8 | **1 330.4** |
| **Total** | **338.6** | **18.9** | **-** | **-** | **1 347.8** | **9.0** | **18.4** | **1 732.7** |
| **% Low/Total** | ***33.6%*** | ***27.2%*** | ***-*** | ***-*** | ***20.6%*** | ***18.1%*** | ***19.6%*** | ***23.2%*** |

The Pongola River is the water resource driver for sugar cane, vegetables, and maize irrigation in this secondary catchment. Thus, the agriculture sector reflects 50% of all economic impacts or more of the primary water dependant sectors. The sugar mill provides most of the job opportunities in the catchment that emphasise the importance of the sugar cane to sugar mill value chain in the catchment.

### 3.4.5 W5 (Main River: Usutu, excluding Swaziland)

**Table 3.9** provides the economic impacts on primary water users expressed in GDP, Employment and Household Income distribution.

**Table 3.9 Economic profile of W5 (Main River: Usutu, excluding Eswatini)**

| Impacts | Agriculture | Commercial Forestry | Saw Mills | Paper Mill | Sugar Mill | Mining and Heavy Industries | Eco-Tourism | Total |
|---|---|---|---|---|---|---|---|---|
| **Gross Domestic Product (Rand Million)** | | | | | | | | |
| Direct | 17.5 | 436.6 | 862.1 | 135.5 | - | 34.4 | 58.1 | **1 544.1** |
| Indirect and induced | 13.1 | 651.9 | 992.3 | 194.1 | - | 34.2 | 126.3 | **2 011.9** |
| **Total** | **30.7** | **1 088.5** | **1 854.3** | **329.6** | **-** | **68.6** | **184.4** | **3 556.0** |
| **% Direct/Total** | ***57.2%*** | ***40.1%*** | ***46.5%*** | ***41%*** | ***-*** | ***50.1%*** | ***31.5%*** | ***43.4%*** |
| **Employment (Numbers)** | | | | | | | | |
| Direct | 166 | 12 860 | 1 473 | 287 | - | 23 | 208 | **15 016** |
| Indirect and induced | 48 | 311 | 3 783 | 701 | - | 95 | 421 | **5 359** |
| **Total** | **214** | **13 171** | **5 256** | **988** | **-** | **118** | **629** | **20 375** |
| **% Direct/Total** | ***77.4%*** | ***97.6%*** | ***28.0%*** | ***29%*** | ***-*** | ***19.2%*** | ***33.1%*** | ***73.7%*** |
| **Household Income (Rand Million)** | | | | | | | | |
| Low-Income | 5.6 | 13.0 | 171.6 | 34.9 | - | 6.1 | 17.9 | **249.0** |
| Medium and High Income | 11.2 | 38.6 | 606.0 | 145.2 | - | 27.5 | 73.5 | **902.0** |
| **Total** | **16.8** | **51.6** | **777.6** | **180.0** | **-** | **33.6** | **91.4** | **1 151.0** |
| **% Low/Total** | ***33.2%*** | ***25.2%*** | ***22.1%*** | ***19%*** | ***-*** | ***18.1%*** | ***19.6%*** | ***21.6%*** |

In the Usutu catchment commercial forestry in the primary sector and saw mills in the secondary sector represent the forestry to mill value chain that contribute to most of the GDP, employment creation and household income.

### 3.4.6 W7 (Kosi Estuary and Sibaya Lake)

**Table 3.10** provides the economic impacts on primary water users expressed in GDP, Employment and Household Income distribution.

**Table 3.10 Economic profile of W7 (Kosi Estuary and Sibaya Lake)**

| Impacts | Agriculture | Commercial Forestry | Saw Mills | Paper Mill | Sugar Mill | Mining and Heavy Industries | Eco-Tourism | Total |
|---|---|---|---|---|---|---|---|---|
| | **Gross Domestic Product (Rand Million)** | | | | | | | |
| Direct | - | 67.5 | - | - | - | 0.015 | 6.4 | **74.0** |
| Indirect and induced | - | 102.7 | - | - | - | 0.014 | 14.0 | **116.6** |
| **Total** | **-** | **170.2** | **-** | **-** | **-** | **0.029** | **20.4** | **190.6** |
| **% Direct/Total** | ***-*** | ***39.7%*** | ***-*** | ***-*** | ***-*** | ***50.1%*** | ***31.5%*** | ***38.8%*** |
| | **Employment (Numbers)** | | | | | | | |
| Direct | - | 2 056 | - | - | - | 0.02 | 23 | **2 079** |
| Indirect and induced | - | 51 | - | - | - | 0.08 | 47 | **97** |
| **Total** | **-** | **2 107** | **-** | **-** | **-** | **0.10** | **70** | **2 176** |
| **% Direct/Total** | ***-*** | ***97.6%*** | ***-*** | ***-*** | ***-*** | ***19.2%*** | ***33.1%*** | ***95.5%*** |
| | **Household Income (Rand Million)** | | | | | | | |
| Low-Income | - | 2.1 | - | - | - | 0.005 | 2.0 | **4.1** |
| Medium and High Income | - | 6.0 | - | - | - | 0.023 | 8.1 | **14.1** |
| **Total** | **-** | **8.1** | **-** | **-** | **-** | **0.028** | **10.1** | **18.2** |
| **% Low/Total** | ***-*** | ***26.2%*** | ***-*** | ***-*** | ***-*** | ***18.1%*** | ***19.6%*** | ***22.5%*** |

*Note: The mining and quarrying sector represents a very small amount of quarrying that is taking place. The labour number represents a temporary worker.*

In this secondary catchment, no irrigation agriculture is present, however commercial forestry plantations are present and in the eco-tourism sector, the two water resources, the Kosi Estuary and Sibiya Lake provides the economic contributions.

### 3.4.7 Socio-Economic Baseline summary results

The socio-economic impacts that follow (**Table 3.11**) provide the total impacts of the different sectors in the secondary catchments on the GDP. The tables also identify the ratio between the direct and total impacts of each sector. The total reflects what the direct impacts of the total catchment are compared to the total impacts of the total catchment.

**Table 3.11 Gross domestic impacts in the Usutu to Mhlathuze catchment (Rand Millions)**

| Sector | W1 | W2 | W3 | W4 | W5 | W7 | Catchment | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mhlathuze | Umfolozi | Mkuze | Pongola | Usutu | Kosi Bay and Lake Sibaya | Total | Direct | Direct/ Total |
| | R Million | R Million | R Million | R Million | R Million | R Million | R Million | R Million | |
| Agriculture | R 1 415 | R 288 | R 331 | R 558 | R 31 | - | **R 2 623** | R 1 763 | 67.2% |
| Commercial Forestry | R 405 | R 127 | R 214 | R 397 | R 1 088 | R 170 | **R 2 402** | R 1 012 | 42.1% |
| Saw Mills | R 248 | R 156 | - | - | R 1 854 | - | **R 2 258** | R 1 050 | 46.5% |
| Paper Mills | R 1 099 | - | - | - | R 330 | - | **R 1 428** | R 587 | 41.1% |
| Heavy Industry | R 2 444 | - | - | - | - | - | **R 2 444** | R 1 137 | 46.5% |
| Mining | R 669 | R 51 | R 22 | R 18 | R 69 | R 0 | **R 829** | R 416 | 50.1% |
| Sugar Mills | R 4 431 | R 3 030 | - | R 3 481 | - | - | **R 10 942** | R 5 978 | 54.6% |
| Eco-Tourism | R 1 000 | R 60 | R 338 | R 37 | R 184 | R 20 | **R 1 640** | R 517 | 31.5% |
| **Total** | **R 11 712** | **R 3 711** | **R 905** | **R 4 492** | **R 3 556** | **R 191** | **R 24 567** | **R 12 459** | **50.7%** |

The two most economic active secondary catchments are the Mhlathuze with value added contributions in all the different sectors and the Usutu catchment with most being industries. The direct to total impact ratio for the total catchment is 50.7%. The direct impacts compared to the total impacts on Agriculture is 67.2%, almost 17% higher than the total catchments' direct to total GDP ratio of 50.7% (R12 459 million/R24 567 million). The GDP that consists of payments to employees, gross operating surplus and net taxes is mostly applicable to farming where the direct impact takes place. The other sectors direct/total ratios are less, but not necessarily less important as it contributes to the indirect and induced impacts of the economy.

**Table 3.12 Employment impacts of the Usutu to Mhlathuze catchment (Numbers)**

| Sector | W1 | W2 | W3 | W4 | W5 | W7 | Catchment | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mhlathuze | Umfolozi | Mkuze | Pongola | Usutu | Kosi Bay and Lake Sibaya | Total | Direct | Direct/ Total |
| | Number | Number | Number | Number | Number | Number | Number | Number | |
| Agriculture | 16 445 | 3 646 | 2 478 | 4 829 | 214 | - | **27 612** | 24 720 | 89.5% |
| Commercial Forestry | 5 276 | 3 415 | 2 640 | 4 950 | 13 171 | 2 107 | **31 558** | 30 796 | 97.6% |
| Saw Mills | 704 | 442 | - | - | 5 256 | - | **6 401** | 1 794 | 28.0% |
| Paper Mills | 3 292 | - | - | - | 988 | - | **4 280** | 1 243 | 29.0% |
| Heavy Industry | 5 491 | - | - | - | - | - | **5 491** | 1 404 | 25.6% |
| Mining | 1 148 | 88 | 37 | 32 | 118 | 0 | **1 422** | 273 | 19.2% |
| Sugar Mills | 10 445 | 7 143 | - | 8 206 | - | - | **25 794** | 7 354 | 28.5% |
| Eco-Tourism | 3 413 | 204 | 1 155 | 127 | 629 | 70 | **5 598** | 1 851 | 33.1% |
| **Total** | **46 214** | **14 937** | **6 310** | **18 144** | **20 375** | **2 176** | **108 156** | **69 436** | **64.2%** |

The total employment impacts (**Table 3.12**) on the Mhlathuze catchment consist of 48.6% (26 381/54 252) compared to the other sub-catchments. The eco-tourism sector provides 33.1% (1 851/5 598) of employees' jobs at lodges and nature reserves as direct employees. This is also a labour-intensive industry and provides income not only to the urban areas but also to smaller communities in the catchment area.

**Table 3.13 Household income impacts of the Usutu to Mhlathuze catchment (Rand Millions)**

| Sector | W1 | W2 | W3 | W4 | W5 | W7 | Catchment | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mhlathuze | Umfolozi | Mkuze | Pongola | Usutu | Kosi Bay and Lake Sibaya | Total | Low | Low/ Total |
| | R million | R million | R million | R million | R million | R million | R million | R million | |
| Agriculture | R 441.7 | R 184.3 | R170.8 | R 338.6 | R 16.8 | - | **R 1 152.2** | R 397 | 34.4% |
| Commercial Forestry | R 19.3 | R 13.1 | R10.2 | R 18.9 | R 51.6 | R 8.1 | **R 121.3** | R 32 | 26.2% |
| Saw Mills | R 104.1 | R 65.3 | - | - | R 777.6 | - | **R 947.1** | R 209 | 22.1% |
| Paper Mills | R 600.1 | - | - | - | R 180.0 | - | **R 780.2** | R151 | 19.4% |
| Heavy Industry | R 891.8 | - | - | - | - | - | **R 891.8** | R 167 | 18.8% |
| Mining | R 327.5 | R 25.2 | R10.6 | R 9.0 | R 33.6 | R 0.0 | **R 405.8** | R 73 | 18.1% |
| Sugar Mills | R 1 715.4 | R 1 173.1 | - | R 1 347.8 | - | - | **R 4 236.2** | R 875 | 20.6% |
| Eco-Tourism | R 495.5 | R29.6 | R167.7 | R 18.4 | R 91.4 | R 10.1 | **R 812.7** | R 159 | 19.6% |
| Total | **R 4 595.5** | **R1 490.5** | **R 359.2** | **R 1 732.7** | **R 1 151.0** | **R 18.2** | **R 9 347.2** | **R 2 063** | **22.1%** |

The total households consist of the low, medium, and high-income groups of which 49.2% (R4 595.5 million/R9 347.2 million) are earning an income in the Mhlathuze secondary catchment (**Table 3.13**). The ratio between low and the total households is 22.1%. This implies that economic activities in the catchment provides a household income for low-income households 22.1% (R 2 063 million).

## 3.5 SCENARIO IMPACTS

The economic consequences are expressed as quantitative (numbers) and qualitative (non-numerical) analysis. The quantitative analysis is applied to scenarios that have an economic impact due to water changes on irrigation agriculture, commercial forestry and physical numbers that were calculated. By calculating water use per hectare and then the number of hectares curtailed, an estimation of the employment and GDP loss can be determined. Although it is a difficult process to mitigate and apply, it is easier to remove hectares than remove a portion of an aluminium smelter or a portion of an urban communities' water. The possible impact of water changes in the industries and urban community sectors were analysed on a qualitative level where the impacts of scenarios relating to a reduction or increase of water is described.

### 3.5.1 Quantitative Analysis: Irrigation agriculture and commercial forestry

The following tables show the scenarios and associated consequences relating to impact on direct GDP and labour.

The colour scheme used in **Table 3.14** to **Table 3.16** shows the severity of the curtailment of the economic impacts and is outlined below:

- Dark green indicates the least curtailment when comparing the rest of the specific indicators in the specific table.

- Yellow shows the mid-range comparing the rest of the specific indicators in the specific table.
- Dark red shows the highest curtailment comparing the rest of the specific indicators in the specific table.

The scenarios resulting from the present flow situation is expressed as direct GDP and labour (employment) indicators.

**Table 3.14 Irrigation agriculture quantitative economic analysis of the river scenarios**

| Catchment / River | Scenario | Baseline Impact | | Scenario Impact | | Percentage Change (Curtailment) | |
|---|---|---|---|---|---|---|---|
| | | Direct GDP | Direct Labour | Direct GDP | Direct Labour | Direct GDP | Direct Labour |
| | | Rand Millions | Numbers | Rand Millions | Numbers | % | % |
| White Umfolozi | Sc 1 - WM1_CC Natural inflow files scaled for **climate change** | 73.01 | 1 714 | 71.71 | 1 690 | 1.78% | 1.42% |
| Mkuze | Sc 1 - MK1_CC: Natural inflow scaled for **climate change** | 137.63 | 1 872 | 136.74 | 1 856 | 0.65% | 0.89% |
| Mkuze | Sc 2 - MK1_2040: PD scenario **with increased upstream domestic use** | 137.63 | 1 872 | 137.55 | 1 871 | 0.06% | 0.08% |
| Pongola | Sc 1 - UP1_CC: Natural inflow scaled for climate change scenario | 148.50 | 4 119 | 148.34 | 4 116 | 0.11% | 0.07% |
| Pongola | Sc 2 - UP1_2040: PD scenario with **increased upstream domestic use** (upgraded Frischgewaad WTW) | 148.50 | 4 119 | 148.49 | 4 119 | 0.01% | 0.00% |
| Assegaai | Sc 1 - AS1_CC: Natural inflow scaled for **climate change** scenario | 109.52 | 3 070 | 109.52 | 3 070 | 0.00% | 0.00% |
| Assegaai | Sc 2 - AS1_2040: PD scenario with **increased upstream domestic use** | 109.52 | 3 070 | 106.97 | 3 022 | 2.33% | 1.56% |
| Ngwempisi | Sc 1 - NG1_CC: Natural inflow scaled for **climate change** scenario | 276.64 | 8 168 | 276.37 | 8 163 | 0.10% | 0.06% |
| Ngwempisi | Sc 2 - NG1_2040: PD scenario with **increased upstream domestic use** | 276.64 | 8 168 | 276.64 | 8 168 | 0.00% | 0.00% |
| Ngwempisi | Sc 3 - NG1_EWR: **PD scenario with EWR as provided included** (Yield of Jericho drops) | 276.64 | 8 168 | 276.56 | 8 166 | 0.03% | 0.02% |

As the present water situation (MAR) has already made provision for irrigation, the curtailment effect was in context of labour, where lay-off of farm workers will take place or in the context of the GDP indicator, where the GOS will possibly decrease, and labour remuneration and net taxes will not be that substantial.

The relatively highest curtailment calculated was Sc 2 - AS1 2040 of which 3 070 – 3 022 = 48 possible job opportunities can be lost. The highest climate change scenario of curtailment in the river scenarios was in the White Mfolozi catchment (Sc 1 - WM1 CC) where the GDP is reduced by 1.8% (about R1 million) and direct employment by 0.4% (24 jobs).

**Table 3.15 Irrigation agriculture and commercial forestry quantitative economic analysis of the Estuary scenarios – Water curtailed**

| Catchment / River | Scenario | Baseline Impact | | Scenario Impact | | Percentage Change (Curtailment) | |
|---|---|---|---|---|---|---|---|
| | | Direct GDP | Direct Labour | Direct GDP | Direct Labour | Direct GDP | Direct Labour |
| | | Rand Millions | Numbers | Rand Millions | Numbers | % | % |
| Amatigulu | Sc 1 - MA1 CC: Natural inflow scaled for **climate change** | 23.1 | 404 | 20.0 | 380 | 13.4% | 6.1% |
| Nseleni | Sc 1 - NS1 CC: Natural inflow scaled for **climate change** | 187.4 | 3 112 | 164.6 | 2 919 | 12.2% | 6.2% |
| Mlalazi | Sc 1 CC: **Climate Change** | 8.2 | 251 | 8.2 | 250 | 0.8% | 0.4% |

The estuary scenarios that resulted in curtailment of irrigation and commercial forestry were the climate change scenarios of Amatigulu (Sc 1 - MA1 CC) and Nseleni (Sc 1 - NS1 CC) rivers of which the scenarios were identified at the point of the inflow to the estuary. The GDP was reduced by about 13.4% and 12.2% respectively. The relatively high curtailment percentage change of Amatigulu is due to citrus curtailment which has a high value crop and is cultivated upstream of the estuary. Wattle was the first ranking tree species to be curtailed as it is the closest to an alien tree crop and removed first with the forestry water changes. Sc 1 - NS1 CC resulted in a high reduction of available water for irrigation agriculture where all the vegetables had to be curtailed and then a portion of the sugar cane according to the ranking table.

In an estuary scenario where the water volume was extended for irrigation agriculture, a proxy was developed with the increased water available.

**Table 3.16 Irrigation agriculture and forestry quantitative economic analysis of the Estuary scenarios – Water extended**

| Catchment / River | Scenario | Baseline Impact | | Scenario Impact | | Percentage Change (Extended) | |
|---|---|---|---|---|---|---|---|
| | | Direct GDP | Direct Labour | Direct GDP | Direct Labour | Direct GDP | Direct Labour |
| | | Rand Millions | Numbers | Rand Millions | Numbers | % | % |
| Mhlathuze | Sc 4: 2040 year projected water requirements on the system (including increased transfer from Thukela to Goedertrouw) | 87.0 | 2 130 | 88.1 | 2 146 | 1.3% | 0.8% |

If it was economically feasible to expand irrigation, using irrigation sugar cane, as it is the main crop already cultivated in the area, the direct GDP increases to 1.3% (about R1.1 million) and direct employment to 0.8% (16 job opportunities).

If this scenario was not economically feasible with the available water as driver, but more water was available for the long term, the farmers have more security to carry on with current farming practices. There is then no need to invest in other irrigation systems or consider other crops to cultivate in order to use the water optimally and efficiently, but with a huge cost that is part of the future to produce sugar cane.

### 3.5.2 Qualitative Analysis: Urban and Industries

**Table 3.17** and **Table 3.18** provide qualitative descriptions of what the curtailment or water augmentation will have on the future of the rivers and estuaries.

## Table 3.17 Urban and industry qualitative economic analysis of the river scenarios

| Catchment / River | Scenario | Urban or Industries Actions | Qualitative scenario impact |
|---|---|---|---|
| Black Umfolozi | Natural inflow files scaled for **climate change** scenario | No impact | No economic change. |
| White Umfolozi | Natural inflow files scaled for **climate change** scenario | Urban water reduction | Economic growth might be restricted as expansion in supply of water for housing will be reduced, and light industries such as shopping malls will not be considered to expand due to water limitations. |
| White Umfolozi | HFY abstracted from upstream dams, **no EWR** | No impact | No economic change. |
| White Umfolozi | HFY (12.9) abstracted from upstream dams, with EWR on (**yield is not affected by EWR**) | No impact | No economic change. |
| White Umfolozi | Raised Klipfontein HFY (14.3) abstracted from upstream dams, with EWR on (**yield is not affected by EWR**) | No impact | No economic change. |
| Mkuze | Natural inflow files scaled for **climate change** scenario | Urban water reduction | Economic growth might be restricted as expansion in supply of water for housing will be reduced, and light industries such as shopping malls will not be considered to expand due to water limitations. |
| Mkuze | PD scenario with **increased upstream domestic use** | Urban water increased | As water supply is increased, towns able to expand on housing as light industries will come as demand for services, thus job opportunities and GDP contributions is possible. |
| Mkuze | PD scenario with increased return flows due to increased irrigation supplied from Pongolapoort Dam | No impact | If more water is available, farmers can have the opportunity of expansion if all economic conditions with arable land are suitable. However, it is not applicable for the Mkuze River. The Mkuze River water is reserved for the St. Lucia Lake and irrigation farmers received their water from the Pongolapoort Dam. |
| Pongola | Natural inflow files scaled for **climate change scenario** | Urban water reduction | Economic growth might be restricted as expansion in supply of water for housing will be reduced, and light industries such as shopping malls will not be considered to expand due to water limitations. |
| Pongola | PD scenario with increased upstream domestic use (upgraded Frischgewaad WTW) | Urban water increased | As water treatment works is upgraded, improve water quality provides better reticulation to homes, improve ease of living. |
| Assegaai | Natural inflow files scaled for **climate change scenario** | Eskom (Heyshope yield) water reduced | Will have an influence on Eskom's water use if demand for water is increased. |
| Assegaai | PD scenario with increased upstream domestic use | Urban water increased | As water supply is increased, towns can expand on housing as light industries will come as demand for services, thus job opportunities and GDP contributions is possible. |
| Assegaai | PD scenario with EWR as provided included (**no impact on yield of Heyshope**) | No impact | No economic change. |
| Assegaai | PD scenario with **no EWR** | No impact | No economic change. |
| Ngwempisi | Natural inflow files scaled for **climate change** scenario | Urban water reduction | Economic growth might be restricted as expansion in supply of water for housing will be reduced, and light industries such as shopping malls will not be considered to expand due to water limitations. |
| Ngwempisi | PD scenario with **increased upstream domestic use** | Urban water increased | As water supply is increased, towns are able to expand on housing as light industries will come as demand for services, thus job opportunities and GDP contributions is possible. |
| Ngwempisi | PD scenario with EWR as provided included (**Yield of** | No current impact | Can have a problem with water supply to users if demand increase. |

| Catchment / River | Scenario | Urban or Industries Actions | Qualitative scenario impact |
|---|---|---|---|
| | **Jericho drops** from 58 to 49) | | |

From the river scenarios in **Table 3.17** where the water will be available for domestic use, security for future developments is provided if the funding is available. If this is not the situation, it does however provide water security for continuous use to accommodate gradual demand in population, and other urbanisation factors.

Where water is reduced, economic growth and sustainability of the communities and industries is at risk.

### Table 3.18 Urban and Industry qualitative economic analysis of the estuary scenarios

| Catchment / River | Description | Urban or Industries Actions | Qualitative scenario impact |
|---|---|---|---|
| Amatigulu | Natural inflow files scaled for climate change scenario | No changes | No economic change. |
| Amatigulu | Reduction of present-day MAR by 10% | No impact | No economic change. |
| Amatigulu | Reduction of present-day MAR by 20% | No Impact | No economic change. |
| Amatigulu | Reduction of present-day MAR by 30% | No Impact | No economic change. |
| Amatigulu | Increase of present-day MAR by 15% | No Impact | No economic change. |
| Nseleni | Natural inflow files scaled for climate change scenario | No Impact | No economic change. |
| Mlalazi | Climate Change | No Impact | No economic change. |
| Mlalazi | Increase of present-day MAR by 15% | No Impact | No economic change. |
| Mlalazi | Reduction of present-day MAR by 15% | No Impact | No economic change. |
| Mlalazi | Climate Change | No Impact | No economic change. |
| Mlalazi | Present day including the upgrade of the Mtunzini WWTW increased to a 1.5 Ml/d plant | No Impact | No economic change. |
| Mlalazi | Present day including additional demand of 10% on present day MAR supplied by Eshowe Dam with an increased capacity of 15 million m3. | No Impact | No economic change. |
| Mlalazi | Present day reduced by 10% through abstraction from lower reaches of river | No Impact | No economic change. |
| Mlalazi | Present day reduced by 20% through abstraction from lower reaches of river | No Impact | No economic change. |
| Mlalazi | Scenario 3 including additional demand of 10% on present day MAR supplied by Eshowe Dam with an increased capacity of 20 million m3. | No Impact | No economic change. |
| Mhlathuze | Climate Change | Urban water reduction | Economic growth might be restricted as expansion in supply of water for housing will be reduced, and light industries such as shopping malls will not be considered to expand due to water limitations. |
| Mhlathuze | Increase of present-day MAR by 15% | No Impact | No economic change. |
| Mhlathuze | Increase of present-day MAR by 10% | No Impact | No economic change. |
| Mhlathuze | 2030 year projected water requirements on the system (including increased transfer from Thukela to Goedertrouw) | No Impact | No economic change. |

| Catchment / River | Description | Urban or Industries Actions | Qualitative scenario impact |
|---|---|---|---|
| Mhlathuze | 2040 year projected water requirements on the system (including increased transfer from Thukela to Goedertrouw) | Urban water increased | As water supply is increased, towns can expand on housing as light industries will come as demand for services, thus job opportunities and GDP contributions is possible. |
| Nhlabane | Climate Change | No Impact | No economic change. |
| Nhlabane | Present Day including EWR releases from Lake Nhlabane as obtained from MWAAS (DWAF, 2009) | No Impact | No economic change. |
| Nhlabane | Restoration Scenario | No Impact | No economic change. |

It must be noted in **Table 3.18** that water acts as the driver in the analysis and is taking into account possible changes in economic conditions. Thus, if this is the only factor to consider, when water volumes are increased, the urban and industrial water can be more sustained for the economic opportunities in the future.

However, availability of water will not necessarily generate economic growth but without the availability of water no economic growth can take place.

The scenarios that cause reduction in water volumes will decrease the economic sustainability that will therefor put pressure on the water use of the current water systems.

# 4 USER WATER QUALITY

## 4.1 APPROACH

As this assessment focuses primarily on water quality as related to users other than ecology, it is linked to water quality (WQ) priority river stretches, potentially impacted by operational river scenarios. This component therefore forms part of the consequences assessment for rivers. Note that impacts on user water quality are not included in the Water Resource Class Decision Support System (WRC-DSS), that is the multi-criteria analysis approach used for determining integrated scenario consequences and Water Resource Classes. Water quality would be double-accounted if included as an additional separate component in the WRC-DSS, as it is already incorporated as follows:

- Part of ECOLOGICAL consequences (as ecological water quality);
- a service identified in ECOSYSTEM SERVICES; and
- in the ECONOMICS consequences assessment in terms of water treatment costs (where applicable).

The approach to the User Water Quality tasks is encapsulated in DWS (2016a), which is a document containing all water quality tools and standardized inputs and outputs currently used for the operationalizing of Resource Directed Measures (RDM). It is understood that water quality consists of the following two broad components:

- **Ecological**, i.e. as part of the EWR or Reserve process. A standard process is followed for scenario evaluation[2]. Ecological Specifications or EcoSpecs are the output of the Reserve process.
- **Users**, i.e. water quality related to users or role players other than ecology, for example: Domestic Use, Agriculture - Stock Watering, Agriculture – Irrigation, Industrial - Category 3 and Recreation - Intermediate Contact. UserSpecs are defined[3].

All eight EWR sites (**Figure 1.1**) are affected by the supplied river operational scenarios.

## 4.2 OVERVIEW AND DATA COLLECTION

### 4.2.1 User data collection

During Steps 1 and 2 and associated sub-steps of the Integrated framework (DWS, 2016a), and Steps 4 and 6 of the Project Plan for the Usutu-Mhlathuze Classification study **(Figure 1.2)**, data is gathered on the following to inform the water quality process for both ecological and user water quality:

- Identify water quality users or role players and associated uses, and water quality issues/problems that may impact on use (Step 1.2.3 and Step 2.3 and 2.5, respectively for rivers and estuaries, of the integrated framework).

[2] The Physico-chemical driver Assessment Index (PAI) model (DWAF, 2008) was used to assess changes in ecological water quality for EWR sites potentially affected by scenarios, and results presented as an integrated water quality category for each identified scenario.

[3] Ecosystems are often also defined as ‘users’, but it should be remembered that aquatic systems also serve as resource base.

- Identify pollution priority areas, or water quality hotspots (Step 1.2.3 of the integrated framework). Priority protection areas, e.g. springs where drinking water is collected, may also be identified.
- Identify driving variables responsible for water quality state (Step 1.2.3 of the integrated framework).
- Gather information on users, issues and driving variables from stakeholders at Technical Task Group (TTG) and information meetings and prepare water quality users spreadsheet (Step 2.1.3 of the integrated framework). *The river water quality TTG meeting for the Usutu-Mhlathuze study was held in Richards Bay on 3 November 2022. Information was also gathered at a subsequent online meeting on 1 December 2022 with the KZN regional DWS office and Geert Grobler of DWS Head Office.*
- Test information with stakeholders (this information feeds into Integrated Step 6, the selection of RQOs for water quality) (Step 2.1.3 of the integrated framework). *This step was undertaken at the TTG meeting in November 2022.*
- Catchment water quality (status quo) and processes (Step 2.1.6 of the integrated framework).

The output of these two steps is a spreadsheet or tables containing the following information for identified WQ priority areas:

- Study area delineated into SQ catchments, clustered into Resource Units (RUs), and within the framework of Integrated Units of Analysis (IUAs).
- Water quality priority areas.
- Water quality role players/users and their locations within Sub-Quaternary (SQ) reaches, RUs and IUAs.
- Driving users/role players in terms of water quality.
- Water quality variables that drive water quality state or requirements.

These spreadsheets appear as preliminary information at the end of Step 2 as more information may become available as the study progresses. Spreadsheets are finalized by Steps 4 and 6 of the Project Plan or Integrated Framework, i.e. consequences of scenarios and preparation of RQOs. The spreadsheets for the Usutu-Mhlathuze study are shown in **Section 4.3.2**.

### 4.2.2 Consequences of operational scenarios

The objective of Step 4.6 of the Integrated Framework (DWS, 2016a) is to determine the consequences of operational scenarios on identified non-ecological users or role players.

The bullets below describe the actions required by this step.

- **Set WQ requirements for non-ecological water quality users**

The significant step here is to (1) link the condition of the resource to user water quality targets (e.g. as per industrial or agricultural water quality guidelines), and (2) determine or confirm water quality requirements for identified priority user driving variables. Priority users are therefore those driving water quality state.

- **Assess changes in water quality state under scenarios**

The change in water quality state has to be determined under each scenario for impacted areas or users.

- **Determine consequences by linking expected changes in water quality state to requirements of priority driving variables**

Changes in water quality state under each scenario will be linked to changes in driving variables resulting in the changed overall state. These changes are evaluated against the requirements of identified users or role players.

The user water quality approach for assessing consequences to scenarios is represented in **Figure 4.1**.

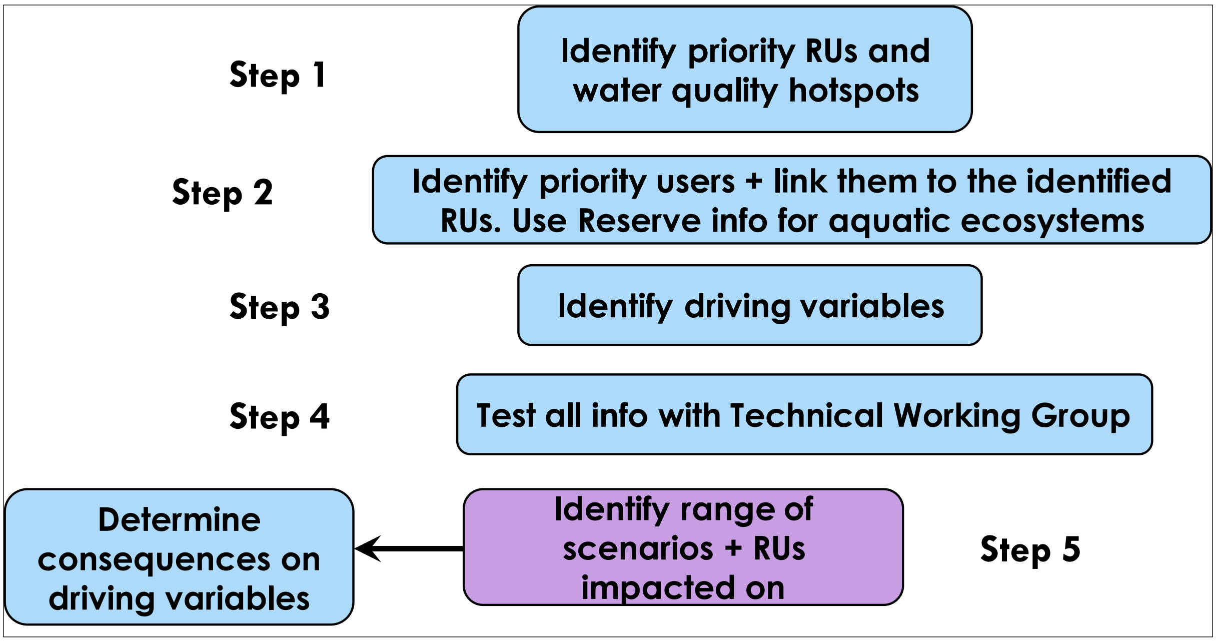



**Figure 4.1 Diagrammatic representation of the User Water Quality process for evaluating consequences of operational scenarios**

## 4.3 RESULTS

### 4.3.1 Water quality overview

*The following overview is modified from the Status Quo report for the study, i.e. DWS (2022b).*
The study catchments are still largely rural, with the impacts of coal mining (present and past) and mine decant still present in certain areas. Water quality issues appear to be localised due to problems such as non-compliant Waste Water Treatment Works (WWTW) and Sewage Treatment Works (STWs), or industrial complexes, although non-point sources of pollution such as increasing salinity levels are widespread and difficult to manage. The drivers of water quality state in aquatic systems in the study area are largely the following:

- In its review of the Pongola to Mtamvuna WMA, DWS (2020) identified coal mining operations and associated consequences, particularly where the mines have been closed, in various parts of the study area, e.g. the Mfolozi catchment, the Mkuze catchment, the and the area around Richards Bay. Acid mine drainage from abandoned and operational coal mines in the Vryheid and Paulpietersburg areas have specifically impacted on the headwaters of the Pongola, Mkuze and Mfolozi rivers, and
- The Richards Bay Coal Terminal is the centre of operations for SA's aluminium industry, making SA the second-largest exporter of steam coal in the world (source: https://municipalities.co.za/provinces/view/4/kwazulu-natal).

- The growth of the Richards Bay urban/industrial complex; both in terms of water demand and waste discharge (DWS, 2020).
- Irrigation return-flows and rising salinity levels. The sugar cane plantations along the coastal belt are critical to the GDP of the area, together with the sub-tropical fruit grown in the area. Farmers inland concentrate on vegetable, dairy and stock farming (source: https://municipalities.co.za/provinces/view/4/kwazulu-natal).
- Areas of poor land management have resulted in high sedimentation levels in river systems.
- Extensive forestry in the areas around Vryheid, Eshowe, Richmond, Harding and Ngome (source: https://municipalities.co.za/provinces/view/4/kwazulu-natal).
- Cholera and other diseases have been reported in some rural areas due to poor sanitation and using run-of-river for domestic use (DWS, 2020).
- Most of the municipal WWTW are only partially functional and therefore contribute to some form of pollution within the river catchments. Some of the challenges observed include, but are not limited to, the following (K Naidoo, DWS KZN, *pers. comm*.):
    - Burst pipes/manhole overflows.
    - Pumpstation failure.
    - Non-functional components of the works.
    - Inadequate disinfection leading to discharge of poor-quality effluent.
    - Nutrient enrichment downstream of WWTW discharge and irrigation schemes. Toxic algal blooms and game fatalities have been reported in the upper reaches of Pongolapoort Dam. Filamentous algal growth has been seen in the Assegaai River downstream of Piet Retief, and algal blooms in the Klipfontein Dam near Vryheid on the upper Umfolozi River (DWS, 2020).

Green Drop (2022) reports the following for KwaZulu-Natal:

- 14 Water Services Authorities and 147 systems audited.
- 68.7% Technical Site Assessment score.
- 60.3% Critical Risk Rating (CRR) – medium risk.
- 3 Green Drop certifications.
- 20 Critical State systems – 14 of these fall within the study area, with Zululand District Municipality showing the lowest Green Drop score of 14%.

### 4.3.2 Summarized water quality information

Priority role players and water quality variables driving riverine state were identified and are shown on **Tables 4.1** to **4.6**. Ratings shown on the table are modified from the PES/EIS (Present Ecological State / Ecological Importance and Sensitivity) (DWS, 2014) database (physico-chemical metric) modified during the Classification study and reviewed during the TTG meeting of November 2022 and follow-up DWS online meeting of 1 December 2022. Impacts are rated as follows:

0: No impact
1: Little impact
2: Moderate impact
3: Large impact
4: Serious impact
5: Critical impact

Impact ratings above a 3, i.e. a Large impact, are used to identify water quality hotspots or pollution areas. These hotspots are refined throughout the study using additional information gathered and stakeholder input, and are shown in **Tables 4.1** to **4.6**. Water quality issues linked to the hotspots and driving variables are also listed on the table and shown per SQ reach. SQ locations within the RU and IUA are indicated.

## Table 4.1 Summarized water quality information for WQ priority areas in W1

| IUA | RU | SQ reach | River name | Impact rating | WQ role players | WQ driving variables | WQ notes |
|---|---|---|---|---|---|---|---|
| W11 | W11-2 | W11A-03612 | Matigulu | EWR MA1 | Ecosystem | All | All RQOs as EWR site |
| W12-b | W12-8 | W12G-03229 | Nseleni | EWR NS1 | Ecosystem | All | All RQOs as EWR site |
| | W12-8 | W12H-03401 | Okula | 3.0 | Dryland cultivation; erosion | Turbidity | Tronox KZN sands |
| W12-c | W12-6 | W12E-03475 | Mhlathuze | 3.0 | Dryland cultivation | Turbidity | |
| | W12-9 | W12F-03611 | Mzingwenya | 3.0 | Urban impacts | Nutrients, toxics, *E. coli* / coliforms | Short urban stream running next to Uzimgwenya township. Gobandlovu on the other bank at the top end of the Estuary Functional Zone (EFZ) |
| W12-e | W12-10 | W12J-03392 | Mpisini | 3.0 | Smelter | Toxics | Richards Bay Minerals (RBM) smelter |

## Table 4.2 Summarized water quality information for WQ priority areas in W2

| IUA | RU | SQ reach | River name | Impact rating | WQ role players | WQ driving variables | WQ notes |
|---|---|---|---|---|---|---|---|
| W21 | W21-1 | W21A-02527 | White Mfolozi | 3.0 | WWTW | Nutrients, salts, *E. coli* / coliforms | Stilwater Hotel with package plant that is non-compliant; discharges into the river. Reach is long; instream point downstream (d/s) discharge at bottom of reach |
| | W21-1 | W21B-02539 | iShoba | 4.0 | Hlobane Mine; erosion | Toxics, salts, nutrients, turbidity, sulphate | Highest salts and sulphates in W2 |
| | W21-1 | W21B-02546 | White Mfolozi | 3.0 | WWTW | Nutrients, salts, *E. coli* / coliforms | WWTW discharges into White Mfolozi u/s dam. High nutrients into Klipfontein Dam |
| | W21-4 | W21D-02676 | Mvunyane | 3.0 | Urban impacts, incl. WWTW; erosion | Toxics, salts, nutrients, turbidity, *E. coli* / coliforms | Mondlo WWTW discharges into small tributary (Ugoqo) and into dam. 1.5 km from dam. |
| | W21-4 | W21D-02788 | Vumankala | 3.0 | Erosion | Turbidity | |
| | W21-4 | W21D-02832 | Jojosi | 3.0 | Erosion; over-grazing | Turbidity | |
| | W21-4 | W21D-02848 | Jojosi | 3.0 | Erosion; over-grazing | Turbidity | |
| | W21-4 | W21E-02963 | Nondweni | 3.5 | Erosion; over-grazing | Turbidity | |
| | W21-4 | W21E-02912 | Nondweni | 3.0 | Erosion; over-grazing | Turbidity | |
| | W21-4 | W21E-02873 | Nondweni | 3.0 | Erosion; over-grazing | Turbidity | Recommendations for data collection, e.g. turbidity/TSS |
| | W21-5 | W21H-02897 | White Mfolozi | EWR WM1 | Ecosystem | All | All RQOs as EWR site |
| | W21-7 | W21K-02976 | Mbilane | 3.0 | Ulundi WWTW; urban impacts | Nutrients, salts, toxics | WWTW discharge point into W21K-02981 |
| | W21-7 | W21K-03019 | Nhlungwane | 3.0 | Erosion; over-grazing; anthracite mine | Turbidity, salts, toxics | Zululand Anthracite Collieries (ZAC) |
| | W21-7 | W21K-02981 | White Mfolozi | 3.0 | Domestic use; commercial forestry; | | uAfrimat quarry upstream oxidation ponds |

| IUA | RU | SQ reach | River name | Impact rating | WQ role players | WQ driving variables | WQ notes |
|---|---|---|---|---|---|---|---|
| | | | | | irrigation | | |
| W22 | W22-1 | W22A-02610 | Black Mfolozi | EWR BM1 | Ecosystem | All | All RQOs as EWR site. High sulphates from coal mining + elevated nutrients due to extensive rural settlements |
| | W22-2 | W22C-02688 | Black Mfolozi | EWR BM2 | Ecosystem | All | All RQOs as EWR site |
| W23 | W22-5 | W22J-02942 | Mvalo | 3.5 | Coal mining impact; over-grazing | Nutrients, salts, toxics, turbidity | ZAC; border of the Hluhluwe-Imfolozi Game Reserve |
| | W23-1 | W23A-03058 | Mbukwini | 3.0 | Mining | Toxics, salts | Tendele mine - number of mining sites. Not being mined as no access to extended mining area. Not closed; on care and maintenance. License valid until 2025. |
| | W23-1 | W23A-03083 | Mfolozi | 3.0 | Erosion; over-grazing; mining | Turbidity, toxics, salts | Extension of Tendele mine - straddles both SQ reaches |
| | W23-3 | W23B-03231 | Msunduzi | 4.0 | Cultivation; fertilizers/ biocides | Nutrients, salts, toxics | |
| | W23-3 | W23C-03180 | Msunduzi | 4.0 | Cultivation; fertilizers/ biocides | Nutrients, salts, toxics | |
| | W23-3 | W23D-03108 | Mfolozi | 4.0 | Cultivation; fertilizers/ biocides; sugar mill discharge point; urban impacts | Nutrients, salts, toxics, *E. coli* / coliforms | Three WWTWs in larger area. Mtubatuba, St Lucia oxidation ponds, KwaMsane WWTW |

## Table 4.3 Summarized water quality information for WQ priority areas in W3

| IUA | RU | SQ reach | River name | Impact rating | WQ role players | WQ driving variables | WQ notes |
|---|---|---|---|---|---|---|---|
| W31-a | W31-1 | W31A-02494 | Nkongolwana | 4.0 | Mining; cultivation; erosion | Toxics, salts, nutrients, turbidity | |
| | W31-1 | W31B-02477 | Mkuze | 3.0 | Erosion | Turbidity | |
| W31-b | W31-4 | W31J-02469 | Mkuze | 3.0 | WWTW | Nutrients, salts, toxics, *E. coli* / coliforms | Mkuze WWTW medium risk |
| | W31-5 | W31J-02480 | Mkuze | EWR MK1 | Ecosystem | All | All RQOs as EWR site |

## Table 4.4 Summarized water quality information for WQ priority areas in W4

| IUA | RU | SQ reach | River name | Impact rating | WQ role players | WQ driving variables | WQ notes |
|---|---|---|---|---|---|---|---|
| W42-a | W42-1 | W42B-02331 | Bazangoma | 3.0 | Cultivation | Nutrients, salts, toxics, pH, sulphate | Makateeskop - tributary to Bazangoma. Coal discard dumps |
| | W42-2 | W42D-02327 | Gode | 3.0 | Urban impacts; cultivation | Nutrients, salts, toxics, *E. coli* / coliforms | eDumbe (Paulpietersburg) oxidation ponds |
| | W42-2 | W42E-02221 | Phongolo | EWR UP1 | Ecosystem | All | All RQOs as EWR site |
| W45 | W43-1 | W43F-02099 | Ngwavuma | 3.0 | Erosion; extensive cultivation | Turbidity, toxics, nutrients, salts | |
| W44 | W44-1 | W44B-02248 | Manzawakho | 3.5 | Erosion; feedlots; WWTW; extensive cultivation | Turbidity, toxics, nutrients, salts, *E. coli* / coliforms | Pongola WWTW |
| | W44-1 | W44B-02351 | Phongolo | 4.0 | Mill discharges; extensive cultivation | Toxics, nutrients, salts | |
| | W44-1 | W44C-02338 | Phongolo | 4.0 | Extensive cultivation | Toxics, nutrients, salts | |
| | W44-1 | W44D-02304 | Phongolo | 3.0 | Extensive cultivation | Toxics, nutrients, salts | |
| W45 | W45-1 | W45A-02368 | Phongolo | 4.0 | WWTW; extensive cultivation | Toxics, nutrients, salts, *E. coli*/coliforms | |
| | W45-1 | W45B-02105 | Phongolo | 3.0 | Extensive cultivation; erosion; settlements | Toxics, nutrients, salts, turbidity, *E. coli* / coliforms | Extensive rural and subsistence farming in Pongola floodplain/Makitini Flats |

## Table 4.5 Summarized water quality information for WQ priority areas in W5

| IUA | RU | SQ reach | River name | Impact rating | WQ role players | WQ driving variables | WQ notes |
|---|---|---|---|---|---|---|---|
| W52 | W51-3 | W51D-02044 | Assegaai | 3.0 | Urban impacts | Nutrients, salts, toxics, *E. coli* / coliforms | |
| | W51-3 | W51E-02049 | Mhkondvo | EWR AS1 | Ecosystem | All | All RQOs as EWR site |
| | W51-4 | W51F-01986 | Blesbokspruit | 3.0 | Cultivation; wood-processing | Toxics, nutrients, salts | Wood-processing plant |
| | W51-4 | W51F-02019 | Blesbokspruit | 4.0 | Wood treatment + tannery effluents; settlements | Toxics, nutrients, salts, *E. coli* / coliforms | Tannery effluent draining into the Farroloop and into the Blesbokspruit |
| | W53-3 | W53C-01679 | Thole | 3.0 | Urban impacts; WWTW; cultivation | Toxics, nutrients, salts, *E. coli* / coliforms | |
| W55 | W55-1 | W55C-01395 | Mpuluzi | 3.0 | Erosion (sand-mining); WWTW | Turbidity, toxics, nutrients, salts | |

## Table 4.6 Summarized water quality information for WQ priority areas in W7

| IUA | RU | SQ reach | River name | Impact rating | WQ role players | WQ driving variables | WQ notes |
|---|---|---|---|---|---|---|---|
| W70-a | W70-1 | W70A-02079 | Swamanzi | 3.0 | Urban impacts; cultivation | Toxics, nutrients, salts, *E. coli* / coliforms | Manguzi oxidation ponds, KZN Wildlife lodge near Kosi Bay, Manguzi landfill site |
| W70-b | W70-3 | W70A-02301 | W70-3 | 3.0 | Effluent discharge points; cultivation | Toxics, nutrients, salt *E. coli* / coliforms | Mseleni Hospital oxidation ponds |

### 4.3.3 Scenario consequences

For the consequences step, the RUs and SQs which may be affected by the scenarios needed to be identified. Although all riverine EWR sites will be affected by scenarios, i.e. they are positioned downstream of the implementation areas, there are few scenarios that could potentially have a significant enough impact to require evaluation. Of those identified, the Scenario Climate Change (Sc CC) was often marginally ‘worse’ than the other scenarios, which all met ecological requirements (DWS, 2023a).

As the ecosystem is the most stringent ‘user’ in terms of water quality in the WQ priority areas identified, it follows that if there is no discernible impact on the ecology, none would be expected for non-ecological water quality under implementation of the operational scenarios.

# 5 CONCLUSIONS

## 5.1 ECONOMICS

South Africa is a water stressed country and the Usutu to Mhlathuze catchments are no exception. Thus, management of the water systems is crucial in preserving water, including good water quality as well. Unfortunately, in certain rivers or catchments, the natural state deviates from the present day measurements with such a large range that to make water improvements, investigation into the areas where sources of deterioration are present need to be identified.

The Usutu to Mhlathuze catchment have sub-catchments with active economic land use, and the scenarios suggested that in certain rivers and estuaries water needs to be curtailed so it can be returned to the natural state. In context with the production output of the various water dependant economic sectors, slight adjustments need to be made where water was curtailed with quantitative analysis of the agriculture and commercial forestry sectors in the primary sector of the economy. With the urban and industry sectors, reducing water to the natural state, results in more difficult practical implications than those produced per hectare and maize, sugar cane, vegetables or citrus are crops that might be removed if those scenarios are chosen and applied.

If that might ultimately be the decision, the economic consequences will result in contraction to the economy. It might only be felt directly on a sugar cane farm with reduction of the farmer’s profit that is part of the direct GDP, but will probably result in job cuts as a result and reduced income to the low-income households will have not only an economic, but also socio-economic consequence. In **Table 5.1** the number of employment opportunities dependant on availability of water in the catchment is presented.

**Table 5.1 Number of employment opportunities dependant on water availability in the Usutu to Mhlathuze catchment**

| Sector | W1 | W2 | W3 | W4 | W5 | W7 | Catchment | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mhlathuze | Umfolozi | Mkuze | Pongola | Usutu | Kosi Bay and Lake Sibaya | Total | Direct | Direct/Total |
| Agriculture | 16 445 | 3 646 | 2 478 | 4 829 | 214 | - | **27 612** | 24 720 | 89.5% |
| Commercial Forestry | 5 276 | 3 415 | 2 640 | 4 950 | 13 171 | 2 107 | **31 558** | 30 796 | 97.6% |
| Saw Mills | 704 | 442 | - | - | 5 256 | - | **6 401** | 1 794 | 28.0% |
| Paper Mills | 3 292 | - | - | - | 988 | - | **4 280** | 1 243 | 29.0% |
| Heavy Industry | 5 491 | - | - | - | - | - | **5 491** | 1 404 | 25.6% |
| Mining | 1 148 | 88 | 37 | 32 | 118 | 0 | **1 422** | 273 | 19.2% |
| Sugar Mills | 10 445 | 7 143 | - | 8 206 | - | - | **25 794** | 7 354 | 28.5% |
| Eco-Tourism | 3 413 | 2 | 1 155 | 127 | 629 | 70 | **5 598** | 1 851 | 33.1% |
| **Total** | **46 214** | **14 937** | **6 310** | **18 144** | **20 375** | **2 176** | **108 156** | **69 436** | **64.2%** |

**Table 5.1** shows that over 100 000 total job opportunities or more depend on the availability of the current water assurance of supply. The total irrigated sugar production is used in the calculations which include the production by subsistence farmers.

Where there are in certain scenarios an excess of water of either, climate change, domestic use of upgrading of a weir or dam wall, if there isn't any government or private sector drive for utilising the allocated water available, it provides security for the various sectors or community to continue as is, without any forced financial investment to optimise the water use, to keep on producing or having a good standard of living.

## 5.2 USER WATER QUALITY

Results from the river ecological consequences report (DWS, 2023b) have direct links to potential impacts on non-ecological water quality, if ecosystem requirements for water quality state are the driving 'user' of the resource. A number of other users or priority role-players were identified, e.g. urban use (excluding drinking water as treatment is undertaken at WTWs), cultivation/irrigation and mining. The most sensitive user, and that requiring the highest fitness for use, is the aquatic ecosystem. Considering that requirement, and the negligible impact of operational scenarios on the EWR sites representing the river systems, it follows that the impact on user water quality under the proposed river operational scenarios, is expected to be negligible.

Note that the information provided in this report will be used toward the development of water quality RQOs, where objectives linked to the most stringent 'user' requirements will be developed.

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# 7 APPENDIX A: COMMENTS AND RESPONSE REGISTER

| No. | Section | Comment | From | Addressed? |
|---|---|---|---|---|
| 1. | Report | Editorial changes | All | Addressed as required |
| 2. | General | The Economic report states that *"The Usutu to Mhlathuze catchment have sub-catchments with active economic land use, and the scenarios suggested that in certain rivers and estuaries water needs to be curtailed so it can be returned to the natural state"*. With respect to those scenarios that require an increase in the MAR, this may not be an easy task especially if this would require curtailment of allocated water. What other actions over and above the curtailment of water use could be implemented that could bring about the required MAR increase that has been defined as part of the scenarios and how feasible would this be? | R. Pillay | A number of non flow-related interventions have been considered as it is understood that curtailment would probably have significant impacts and be difficult to implement. |
| 3. | General | I think the report addresses the main water quality issues of concern in the study area. Even though negligible impact is anticipated in terms of user water quality, the chosen RQOs should monitor the long-term trends in terms of water quality changes in the catchment. Nutrient enrichment is increasing in the catchment and proper monitoring system should be recommended. | S. Mthembu | Agreed. The RQO report will unpack more water quality detail and association objectives, particularly nutrient enrichment. |
| 4. | General | The current classification study scenario planning does not include reconciliation options (2 off channel storage dams, one for Ulundi and one at Matubatuba and a possible dam on the Nseleni River), however the raising of Klipfontein Dam is included. What is extremely worrying is that the total **MAR** for the estuary is recommended, by this study. Something that is not feasible. Well, in any case the draft reports are not specific in how this will be achieved. My take on it is that the only way to take the estuary to a **B** is to expropriate the whole catchment or built massive dams that will capture extreme events (run-off's) and fill-up once in 20 years. The above needs to be addressed in these 2 or other reports. | K. Bester | The recent reports submitted are on the consequences of scenarios for the various sectors. The scenarios are only evaluated at specific pre-selected sites which have historical information that is used to determine the impacts. The Recon strategy options mentioned do not affect the specific sites. Raising Klipfontein does impact the site on the White Mfolozi which is why it was included. The impacts of the scenarios on the Estuaries are included in the Volume 2 estuary report which was submitted as draft on 28 June 2023. That is still to be circulated amongst PSC members. Nothing has yet been recommended and no classes have yet been tabled in reports submitted to date, which may be why the commenter feels that this has not yet been addressed. The comment is noted and will be incorporated into the future reports. |
| 5. | Table 2.1<br>Pg 2-2 | Let us not forget that this table, scenarios, and the associated consequences would need to change once the estuaries scenario amendments have been concluded. | N. Jafta | Table updated with additional scenarios evaluated for Matigulu and Umlalazi estuaries |
| 6. | Sec 3.2<br>Pg 3-1 | References for the methods are lacking. Or are these approaches being unpacked in this report for the first time? | N. Jafta | Included more content for clarity. |
| 7. | Sec 3.2.2<br>Pg 3-4 | It is strange to quantify forestry but not dryland sugarcane because they are both not directly irrigated but rely on rain, interflow and groundwater.<br>There are WRC projects, and others, that have embarked on quantifying water consumption of dryland sugarcane, similar to forestry. | N. Jafta | Text adjusted to state that dry land sugar cane is not recognised as a water flow reduction crop such as commercial forestry. |

| No. | Section | Comment | From | Addressed? |
|---|---|---|---|---|
| | | Unless the approach is to focus on the activities that are regulated by NWA, or you indicate that you have identified that dryland sugarcane does not utilise runoff, etc. | | |
| 8. | Section 3.2.4 Pg 3-9 | Comment 7: Dryland sugarcane also has this impact. Thus, if consumption by sugarcane is not accounted for then the present MAR might be an over-representation than what is actually available. | N. Jafta | Nobody has an answer. Dryland sugar cane has not been classified as a water run-off reducer. |
| 9. | | What kind of curtailment is expected from commercial forestry? Is it removal of trees? | N. Jafta | Text has been updated to indicate the removal of trees for curtailment. |
| 10. | Table 3.4 | What does heavy industry represent? | N. Jafta | Heavy industry is the type of business that involves large-scale undertakings, big equipment, large areas of land, high cost, and high barriers to entry. It contrasts with light industry, or production that is small-scale can be completed in factories or small facilities, costs less, and has lower barriers to entry. |
| 11. | Table 3.12 Pg 3-18 | Is this supposed to be Rands or numbers? | N. Jafta | Numbers, table was replaced and moved to GDP table. |
| 12. | Section 3.5.1 Pg 3-20 | Table 3.14: How are these values calculated? Is it = (the difference between baseline and scenario impact / baseline) x 100?<br>If so, some of the values might not be correct. | N. Jafta | Correct. Decimals used for clearer visibility and text adjusted where required. |
| 13. | Table 3.16 Pg 3-20 | Does GDP increase or decrease? | N. Jafta | It is an increase, however, the scenario numbers had to be recalculated to adjust for more water available, as it was not a curtailment scenario. The % change stayed the same (in absolute terms) |
| 14. | Table 3.17 Pg 3-18 | Mkhuze: PD scenario with increased return flows due to increased irrigation supplied from Pongolapoort Dam - Could this not be quantified into GDP and employment increases under agriculture? | N Jafta | Perhaps, but not applicable for Mkuze River. The Mkuze River water is reserved for the St. Lucia Lake and irrigation farmers received their water from the Pongolapoort Dam. Text adjusted. |
| 15. | Sec.4.3.1 Pg 4-3 | May you indicate which area this is. Is it the Richards Bay area as per the next sentence or is it northern of the Usuthu-Mhlathuze? Which leads me to think of the Usuthu part. | N. Jafta | Text clarified to be more specific where the main coal mining issues exist. |
| 16. | Sec 4.3.3 Pg 4-4 | Does this mean there is still no need even for areas where people rely on water directly from water resources? How does that get covered or catered for?<br><br>Also, at which point does the Mkhuze irrigation scenario get accounted for? | N. Jafta | If RQOs to drinking water standards are to be included for rivers, a policy decision would need to be taken by the DWS. This is not covered under user water quality, as it is the responsibility of local municipalities to supply water of the required standards for human use. The method does however make provision for protection of priority water source areas, e.g. drinking water from spring when no other water, or water of sufficient quality, is available. Note that this information was not forthcoming during any of the meetings (other than some input from Ms Govender of DUT), which is considered a gap in the water quality assessment and will be reported as such in the RQO report. Note that ecological requirements are generally more stringent than drinking water standards, according to current SA ecosystem guidelines (DWAF, 1996).<br><br>Economics team has responded as it is part of an irrigation scenario. The Mkuze sugar cane irrigation production is produced from applying |

| No. | Section | Comment | From | Addressed? |
|---|---|---|---|---|
| | | | | Pongolapoort and is included in the total analysis in the project. |
| 17. | Table 2.1 Pg 2-2 | How about uMfolozi/even Msunduzi floodplains, which are the major feeders/sustainers of the St Lucia estuary? | B. Madikizela | Feeder streams are included in IUA St Lucia. |
| 18. | Section 3.2.2 Pg 3-5 | This refers to authorised activities, licensed, how about invasive species (eucalyptus, etc.) outside known hectares? | B. Madikizela | Text adjusted. Invasive species that reduce run-off water were also excluded as no economic and financial data are available for including in the analysis. |
| 19. | | Same as above, these hectares refer to commercial farmers, how about Sokhulu subsistence farmers and others? | B. Madikizela | Text adjusted. The same cost factors are applied to commercial and subsistence farmers. |
| 20. | | How about ploughing, fertilizers, pesticides, etc.? | B. Madikizela | Text adjusted. Pre-harvest costs include ploughing etc. costs. |
| 21. | Table 3.1 Pg 3-9 | What happened to amadumbe, one of the most popular crops in Sokhulu and other communities? | B. Madikizela | It is incorporated in the vegetable metric. |
| 22. | Table 3.10 Pg 3-17 | Please explain the 50.1% under mining column | | Represents a very small amount of quarrying that's taking place. The labour amount represents only a temporary worker. |
| 23. | | | | |
| 24. | Sec 4.2.1 Pg 4-2 | I have not heard local communities voice throughout these interim reports? Can this be explained in the document as to why? | B. Madikizela | The stakeholder database covers all the communities potentially impacted on, or who could provide information to, the study. Unfortunately meetings are never well represented by community leaders. The method is designed to cover user water quality as pertains to communities, e.g. by identifying priority protection areas such as springs that serve as drinking water sources, but results are dependent on information received. RQOs are then set to offer the appropriate protection where required. |
| 25. | Figure 4.1 Pg 4-3 | Who are the Priority users? Is there legal definition or gazetted definition in a report to support this? Are communities a priority or not? | B. Madikizela | Priority users in this context refer to those driving water quality states, which could be a community, either due to their impact on water quality, or their requirement for protection of a water source. Text has been adjusted to define the term priority users in this context. |
| 26. | Table 5.1 | NB: This is a conservative estimation because subsistence farmers are excluded in the calculations, so the situation is worse than this! | B. Madikizela | The comment is addressed and figures recalculated. The contribution of subsistence farmers is included. |
| 27. | Sec 6 | Are these reports published (peer review) or only known to some South African-experts? | B. Madikizela | Many of these reports are DWS documents so externally reviewed. It should be noted that DWAF (2008) is widely used and was externally reviewed (coordinated by the author), but was never reviewed and completed by DWS. Although the method is valid and regularly tested, the document needs extensive revision, e.g. all references to TEACHA must be removed and Dallas and Rivers-Moore's temperature indices and methods should be included. |