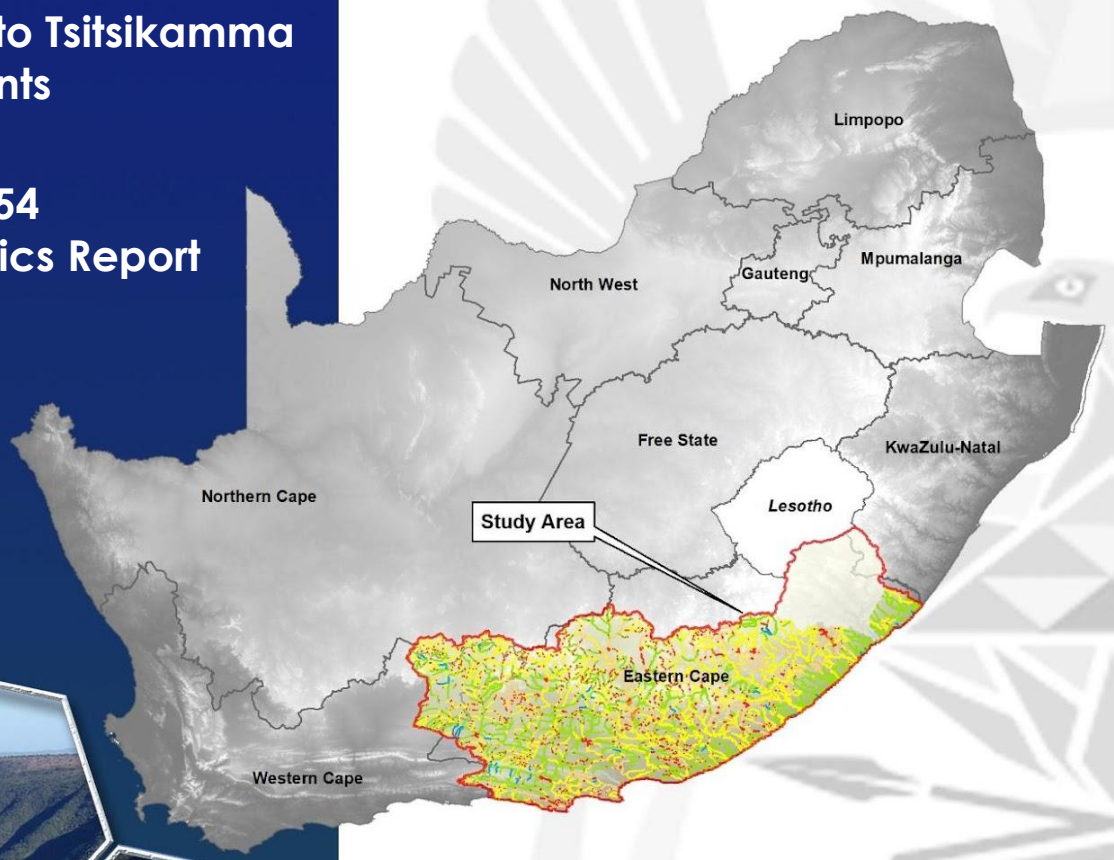
DEPARTMENT OF WATER AND SANITATION

Determination of Water Resource Classes, Reserve and the Resource Quality Objectives in the Keiskamma and Fish to Tsitsikamma Catchments

WP11354
Socio-Economics Report



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LIST OF ACRONYMS

BHN	Basic Human Needs
CD: WEM	Chief Directorate: Water Ecosystems Management
CRA	Comparative Risk Assessment
CERA	Comparative Ecological Risk Assessment
DWS	Department of Water and Sanitation
EI	Ecological Infrastructure
ES	Ecological Sensitivity
EWR	Ecological Water Requirements
IEM	Integrated Economic Model
GDP	Gross Domestic Product
GVA	Gross Value Added
IUA	Integrated Unit of Analysis
MEA	Millenium Ecosystem Assessment
NMBM	Nelson Mandela Bay Municipality
NWA	National Water Act
QSAM	Quasi-Social Accounting Matrix
RDM	Resource Directed Measures
RQO	Resource Quality Objectives
SA	South Africa
SANBI	South African National Biodiversity Institute
SEZ	Socio-Economic Zones
SWSA	Strategic Water Source Areas
WMA	Water Management Area
WR2012	Water Resources 2012
WRC	Water Research Commission
WRCS	Water Resources Classification System

EXECUTIVE SUMMARY

The Department of Water and Sanitation, through the Chief Directorate: Water Ecosystems Management (CD: WEM), has initiated a study for the determination of Water Resource Classes, Reserve and associated Resource Quality Objectives for the identified significant water resources in the Keiskamma and Fish to Tsitsikamma catchments. The water resource components included for this study are rivers, wetlands, groundwater and estuaries. The Reserve determination include both the water quantity and quality of the Ecological Water Requirements (EWR) and Basic Human Needs (BHN). This will ensure the availability of water required to protect aquatic systems and that the essential needs of individuals that are directly dependent on these water resources.

The Keiskamma and Fish to Tsitsikamma catchments (study area) within the Mzimvubu to Tsitsikamma Water Management Area (WMA7) are amongst many waters stressed catchments in South Africa (high water use from surface and groundwater, primarily for agricultural and domestic, ultimately impacting on the availability of water resources for the protection of the aquatic ecosystems. Industrial practices and domestic water use are on the rise in some of these catchments, especially around the major towns and cities. Water transfers into the study area from adjacent WMAs and within the study area and numerous storage dams changes the flow patterns, impacting on the aquatic biota. Furthermore, the study is also important from a conservation perspective, including protected areas, natural heritage, cultural and historical sites that require protection.

The determination of the Water Resource Classes is necessary to facilitate a balance between protection and use of water resources. In determining the class, it is important to recognise that different water resources will require different levels of protection which requires the consideration of the social and economic needs. The Water Resource Classification System (WRCS) is applied taking account of the local conditions, socio-economic imperatives and system dynamics within the context of the catchment. The process also requires a wide range of complex trade-offs to be assessed and evaluated at a number of scales.

The purpose of this report is to provide a consolidated summary of all the socio-economic aspects related to the study area, which includes the socio-economic condition, community well-being and ecosystem services and attributes. It additionally describes the linkages between the socio-economic and ecological value and condition of water resources as they currently stand in the Keiskamma and Fish to Tsitsikamma catchment.

Furthermore, the report highlights the approach that will be taken to ascertain the economic consequences and potential trade-offs from each scenario during the scenario / consequences phase (Step 4 of the integrated framework as developed by the DWS).

The majority of the study area falls within the Eastern Cape province, with small portions in two Local Municipalities of the Western Cape (Beaufort West and George LM) and one local municipality from Northern Cape (i.e., one ward in Ubuntu LM). The population of the catchment was 5.87 million in 2021 (2011 Stats SA census adjustments) and the population is predominately Xhosa speaking. According to Stats SA Census 2022, the Eastern Cape had the second highest percentage of households with no access to piped water, at 19.5% and nationally it was at 8.7%.

The catchment is mainly rural with a few urban areas in East London, Gqeberha (Port Elizabeth), and Makhanda (Grahamstown). According to Stats SA 2023, the Eastern Cape had the highest unemployment rate, at 41.9% and nationally it was at 32.1%. The province also had the second highest agricultural households, at 26.2% and nationally it was at 13.8%. Subsistence agriculture is mainly livestock, poultry, food crops and vegetable production (Stats SA, 2024).

The Eastern Cape province contributed a GDP of approximately R368.9 billion in the fourth quarter of 2023, which is a contribution of 7.8% to the total national GDP (ECSECC, 2023Q4). The economy is mainly supported by the tertiary sector (wholesale and retail trade, tourism and communications), followed by the sectors of manufacturing (large proportion by the automotive sub-sector), agriculture and agro-processing. In 2023 fourth quarter, the tertiary sector accounted for 81.6% of the provincial gross value added (GVA) and the secondary sector 16.6% (largely the automotive manufacturing sector), followed by the primary sector (agriculture and to lesser extent mining) accounting for less than 2% (ECSECC, 2023Q4).

As a highly rural catchment, ecosystem services have been demonstrated to provide significant contributions to socio-economic wellbeing to both formal and informal economy beneficiaries within the catchment.

Ecosystem services linked to the socio-economics of the Keiskamma and Fish to Tsitsikamma were identified to include the following:

1. Fresh water provisioning;
2. Water quantity regulating;
3. Food, raw materials and wild collected products provisioning;
4. Erosion regulation;
5. Water quality regulation: purification and waste management;
6. Spiritual, landscape and amenity services;
7. Tourism and recreational services; and
8. Biodiversity support.

Predominant ecological infrastructure identified to supply these services included estuaries; national parks (i.e., Addo Elephant and Camdeboo, and Mount Zebra); the water source infrastructure itself; represented mainly by surface waters of rivers and streams; groundwater and wetlands and grasslands.

The primary ecosystem service in the Keiskamma and Fish to Tsitsikamma catchment is water provisioning, which is fundamental to the effective functioning of the key economic sectors of the region, including agriculture, households, and the government sector.

Although it is understood that economic productivity of key sectors is not fully reliant on ecosystem services, it is acknowledged that a proportion of the output be attributed directly to the services provided by ecological infrastructure within the catchment. This is especially true for the water provisioning services provided in a strategic water source area such as the Keiskamma and Fish to Tsitsikamma.

Findings show that the agriculture and agricultural manufacturing sectors contribute significantly to the formal water economy through their purchases of both raw and treated water. This provides some indication of the level of reliance of these industries on water provisioning, although care should be taken in interpreting these results, as the contribution to the water economy, in financial terms, does not directly link to the volume of water required by each sector. Households, for instance, represent the largest purchasers of water in monetary terms, even though the agricultural sector consumes a larger portion of volume. This raises interesting challenges for the overall valuation of these ecosystem services.

Careful consideration should be given to the impact a change in ecosystem services may have on the livelihoods of these communities, as this catchment is mainly rural. This will be further expanded upon as scenarios come into focus.

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1 INTRODUCTION

1.1 Background

The National Water Act, 1998 (No. 36 of 1998) (NWA) is founded on the principle that National Government has overall responsibility for and authority over water resource management for the benefit of the public without affecting the functioning of water resource systems. To achieve this objective, Chapter 3 of the NWA provides for the protection of water resources through the implementation of Resource Directed Measures (RDM). These measures include Water Resource Classification, determination of the Reserve and setting the associated Resource Quality Objectives (RQOs). These measures collectively aim to ensure that a balance is reached between the need to protect and sustain water resources, while allowing economic development.

The provision of water required for the maintenance of the natural functionality of the ecosystem and provision of Basic Human Needs (BHN) is the only right to water in the National Water Act (No. 36 of 1998) (NWA). The other water users from a strategic use who are second in line to other water users are subject to formal gazetted General Authorization and water use authorization as per Section 21 of the NWA.

The Department of Water and Sanitation, through the Chief Directorate: Water Ecosystems Management (CD: WEM), has initiated a study for the determination of Water Resource Classes, Reserve and associated Resource Quality Objectives for the identified significant water resources in the Keiskamma and Fish to Tsitsikamma catchments. The water resource components included for this study are rivers, wetlands, groundwater and estuaries. The Reserve determination include both the water quantity and quality of the Ecological Water Requirements (EWR) and Basic Human Needs (BHN). This will ensure the availability of water required to protect aquatic systems and that the essential needs of individuals that are directly dependent on these water resources.

1.2 Purpose of this study

The Keiskamma and Fish to Tsitsikamma catchments within the Mzimvubu to Tsitsikamma Water Management Area (WMA7) are amongst many waters stressed catchments in South Africa. These areas are important for conservation and have recognisable protected areas, natural heritage, cultural and historical sites that require protection. However, water use from surface as well as groundwater for agricultural and domestic purposes are high, especially in the more arid catchments, impacting on the availability of water resources for the protection of the aquatic ecosystems. Industrial practices and domestic water use are on the rise in some of these catchments, especially around the major towns and cities. Water transfers into the study area from adjacent WMAs and within the study area and numerous storage dams changes the flow patterns, impacting on the aquatic biota.

Thus, the main purpose of the study is to determine appropriate Water Resource Classes, the Reserve and associated RQOs for all significant water resources in the study area to facilitate sustainable use of the water resources while maintaining ecological integrity.

The aim is to:

- implement the Water Resource Classification System (WRCS) (Regulation 810, 2010) to determine the Water Resource Classes,
- follow the integrated framework (DWS, 2017),
- undertake the 7-step process to determine and set RQOs, and
- determine the Reserve for the water resources of the study area.

This will ultimately assist the DWS in the management of the water resources in the study area and making informed decisions regarding the authorisation of future water use and the magnitude of the impacts of proposed developments.

1.3 Purpose of this report

The purpose of this report is to provide a consolidated summary of all the socio-economic aspects related to the study area, which includes the socio-economic condition, community well-being and ecosystem services and attributes. It additionally describes the linkages between the socio-economic and ecological value and condition of water resources as they currently stand in the Keiskamma and Fish to Tsitsikamma catchment.

Furthermore, the report highlights the approach that will be taken to ascertain the economic consequences and potential trade-offs from each scenario during the scenario / consequences phase (Step 4 of the integrated framework as developed by the DWS).

2 APPROACH AND METHODOLOGY

The socio-economic assessment for the study area requires the definition, understanding and classification of social, economic and ecological components. This is done through a stepwise process whereby the primary characteristics within each component are identified and changes thereof are analysed against various scenarios. The socio-economic components form part of steps 1, 2 and 5 of the water resource classification process. There are several tasks related to the socio-economic aspects and the flow of tasks is depicted in **Figure 2-1**.

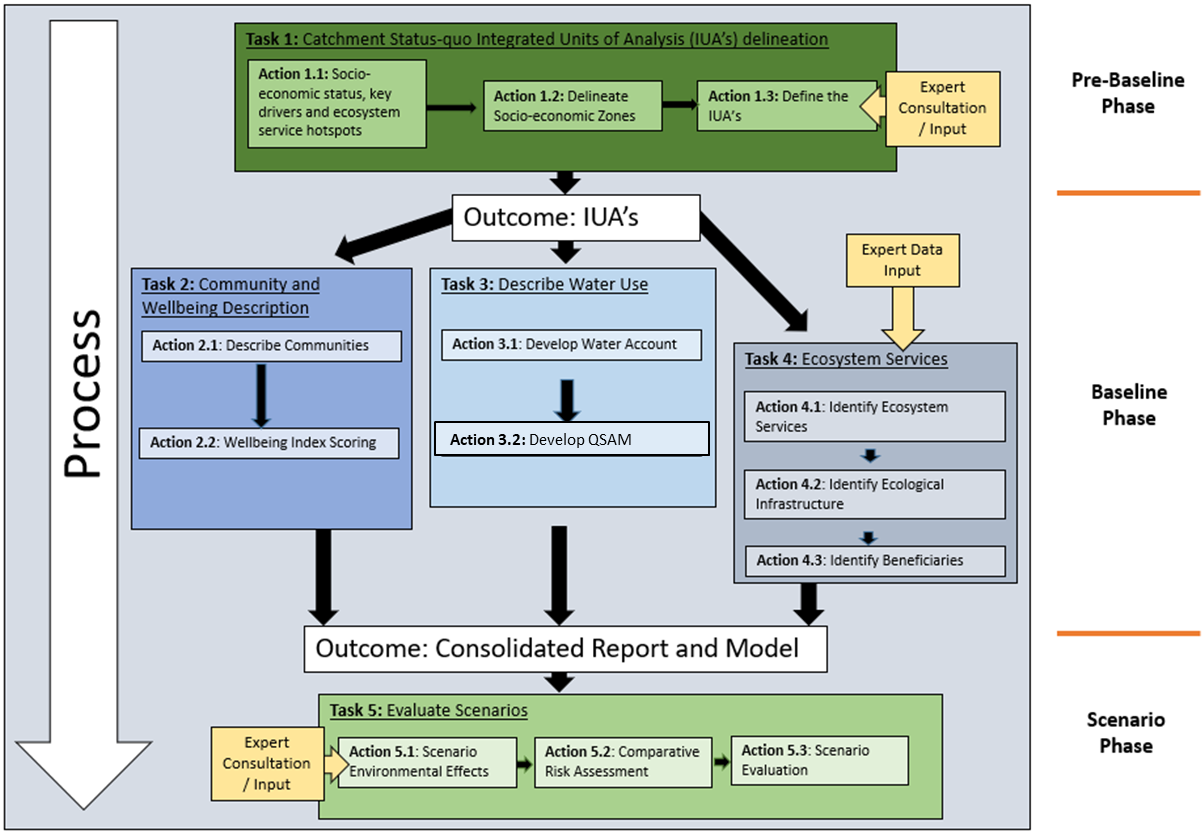

Figure 2-1: Socio-Economic Guidelines Showing the Flow of Tasks for Completion of the Socio-Economic Aspects within the WRCS Process (Adapted from Naidoo et al. 2017)

2.1 WRCS Step 1 and socio-economic tasks

The approach of the two socio-economic tasks that relate to Step 1 of the WRCS process to delineate IUAs and describe status quo are described here.

Task 1: Catchment Status Quo Integrated Unit of Analysis (IUAs) delineation

Socio-Economic Zones (SEZ) are assessed at a high level. SEZs represent areas with relatively homogenous socio-economic characteristics and dependencies to services provided by associated aquatic ecosystems. The following is assessed:

- Land assessment and identifying ecological infrastructure hotspots (i.e. wetlands, rivers, dams and protected areas)
- Social assessment or condition (i.e. population demographics including population density, education level, employment and access to and use of water)
- Economic assessment (identifying economic drivers, key economic sectors such as agriculture, industries, and urban and tourism areas)

Task 2 Describe communities and their wellbeing

This task aim is to describe the wellbeing of communities within each of the delineated IUAs and particularly in respect of their reliance on ecological infrastructure.

2.2 WRCS Step 2 and Socio-economic tasks

In terms of the water resource classification process, Step 2 requires that the quantification of the relationships that link the change in the configuration of scenarios to a resulting change in economic value and social wellbeing, be defined. This includes rationalisation of those values, by selecting a subset on which efforts can be concentrated for evaluating catchment configuration scenarios and, determination of the scoring system to be used to evaluate the catchment scenarios in later steps of the process. The linkage step covers Tasks 3 and 4 in Figure 2-1 and the detailed rationale and approach for this step is discussed in the sections that follow.

2.2.1 Rationale

As natural features in the landscape, ecosystems provide environmental, social and economic benefits to communities. The value of ecosystems in providing these free ecosystem services to a range of formal and informal beneficiaries has been vigorously demonstrated and there is ever growing recognition of their importance to human well-being at multiple scales (Perrings 2006, Freeman 2003, Pearce et. al. 2005, Dasgupta 2008 and 2010, Mäler 1991, MEA 2005, 2007, TEEB 2010, WAVES 2013).

Impacts or changes to ecosystems (or Ecological Infrastructure) alters the ability to supply valuable services to beneficiaries. Ecological infrastructure refers here to functioning ecosystems that deliver valuable services to people such as fresh water, water and climate regulation, cultural services and soil formation (SANBI 2012). Ecological infrastructure is the nature-based equivalent of built or hard infrastructure which includes features such as wetlands, rivers and other watercourses, forests and entire catchments.

The classification of the cause-and-effect relationships (or linkages) between ecological infrastructure and beneficiaries of ecosystem services is vital to appropriately manage natural resources in a sustainable manner. Informed appropriate natural resource management

maximises natural benefits and opportunities towards contributing to optimal socio-ecological and economic well-being. The classification of these linkages requires an understanding of the role that ecological infrastructure and the presence of beneficiaries (at a landscape, local and regional scale) play in the delivery of ecosystem services (See **Appendix B** for the Decision Analysis Framework).

An established approach to defining these linkages is through the use of Ecosystem Services Frameworks as formalised and refined through initiatives such as the Millennium Ecosystem Assessment (MEA 2005, MEA 2010), The Economics of Ecosystems and Biodiversity (TEEB 2013) and the Final Ecosystem Goods and Services Classification System (Landers and Nahlik 2013). This approach is refined through the use of complimentary economic tools and methodologies such as environmental economic accounting (specifically water resource accounting) and quasi-input-output modelling.

The aim of this linkage step is to demonstrate the linkages between the socio-economic and ecological value and condition of water resources as they currently stand in the Keiskamma and Fish to Tsitsikamma catchment.

Demonstrating these linkages required the application and integration of the numerous socio-ecological, and econometric methodologies. This integration required the development of Ecosystem Services Classification and Modelling and Quasi-Social Accounting Matrix (QSAM) for the Keiskamma and Fish to Tsitsikamma catchment. The results were the development of an Integrated Economic Model (IEM) for the Keiskamma and Fish to Tsitsikamma catchment towards demonstrating socio-economic and ecological linkages.

The identification of linkages through the development of the IEM is a precursor to quantifying these linkages, which will be conducted in Step 4 (scenario evaluation) of the WRCS 7 step process.

2.2.2 Approach for linkage task

The linkage step will be used to inform the evaluation of scenarios in step 4 of the WRCS process. This linkage step aimed to develop the IEM and demonstrate linkages between the ecological and the socio-economic baseline in the Keiskamma and Fish to Tsitsikamma catchment. The broad approach taken to develop the IEM is provided in **Figure 2-2**. Key inputs, components and outputs of the process include the following:

1. The drivers of change, which in this report represents the current baseline scenario. This component will eventually represent various scenarios which will drive changes in the relationships defined at this point.
2. The ecological responses to change in development scenario, which in this case are quantified change to hydrological (flows) and ecological (condition) indicators.
3. The classification of socio, ecological and economic characteristics within the target catchment linked to the effects of varying response inputs. The classification process was done through the use of three modular tools (described below), which through the IEM linked ecological responses to changing scenarios with a socio-economic response.

a. The ecosystem services valuation model aims to link the presence and condition of ecological infrastructure with key beneficiaries through the use of ecosystem services frameworks;

b. The Water/water Quality Account module (optional part of IEM and which will be addressed as part of the socio-economic consequences included in the evaluation of scenarios involving water quality issues) aims to define the use of water through physical flows and financial transactions. This allows analysis on how economic changes impact the environment and conversely how changes in water availability/quality impact the economy. This module will be considered within the socio-economics consequences report (subsequent deliverable); and

c. The Quasi Social Accounting Matrix (QSAM) module aims to quantify the size of the Keiskamma and Fish to Tsitsikamma economy. The QSAM combines the suppliers and consumers of economic products into a single matrix (table of interacting economic sectors) in order to determine the magnitude of the macro-economic indicators of the Keiskamma and Fish to Tsitsikamma economy.

4. The socio-economic response to change in development scenario, which in this case is presented through key economic indicators such as GVA, jobs and value of ecosystem services. In the linkage step the socio-economic response represents the current status-quo of the catchment. The socio-economic consequences and trade-offs will be assessed during the scenario phase (WRCS Step 4). In this step the ecosystem services at risk will be identified and evaluated by means of a Comparative Ecological Risk Assessment (CERA).

Towards ensuring a robust and defendable output, this approach uses well established methodologies that have been formalised through the literature. At this point of the WRCS 7 step process the methodologies are used to establish the IEM architecture and populate the modules using the best available data obtained at a desktop level. The IEM will be updated as additional primary data becomes available.

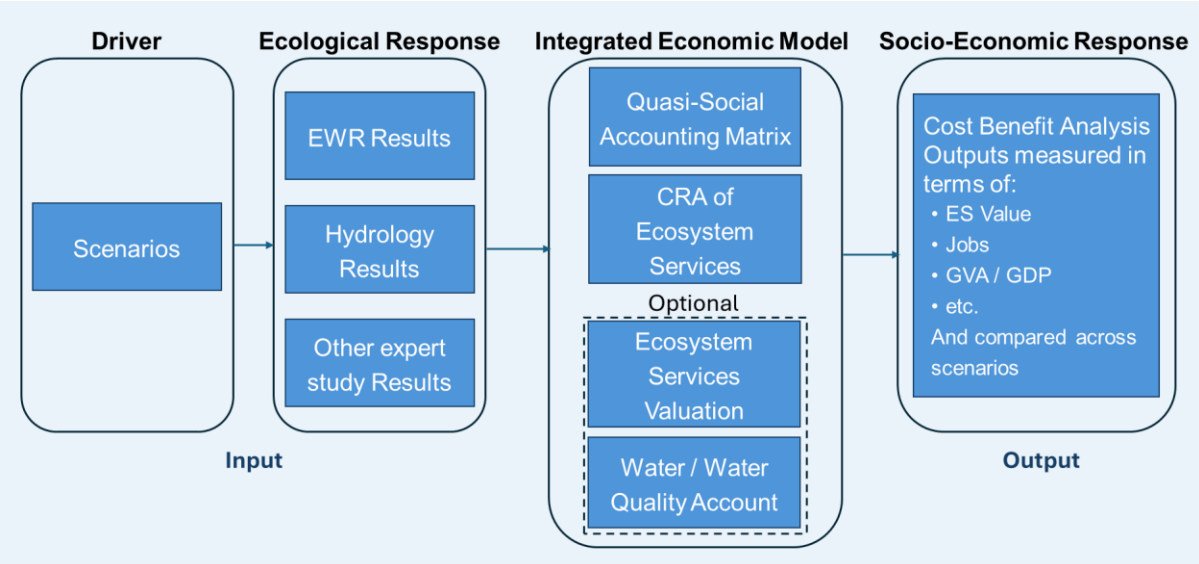

Figure 2-2: Approach to the development of the Integrated Economic Model that Demonstrates the Socio-Economic Linkages in the Keiskamma and Fish to Tsitsikamma Catchment (Arrows indicate flow of data from input to output)

2.2.2.1 Ecosystem Services Framework Selection

Since the inception of the Millennium Ecosystem Assessment in 2005, several frameworks have been developed to better categorize and disaggregate the benefits that people receive from ecosystem services, enabling a full evaluation of their economic value. These include the framework created by the International Panel on Biodiversity and Ecosystem Services (IPBES, 2019), The Economics of Ecosystems and Biodiversity (TEEB, 2010), and the Common International Classification of Ecosystem Services (CICES, 2013). (Frameworks are described in **Table 2-1**). While each of these frameworks attempts to build upon one another, they essentially follow a similar logic, where ecosystem services and the benefits derived therefrom by beneficiaries are classified into three broad categories, namely: provisioning services, where human derive direct material benefit in the form of nutrition, energy sources, and raw materials (including biochemical and genetic materials); regulation, where direct and indirect benefits are derived in the form of regular flows of biotic and abiotic components of ecosystems which allow for the regular, effective functioning of ecosystems; and cultural services, where an intangible benefit is received in terms of intellectual, spiritual and symbolic significance attached to certain aspects of the ecosystem and environmental infrastructure. A fourth category is added in some cases to distinguish between regulating or supporting services in a specific delineated ecosystem, and the global system as a whole. This may include the maintenance of options (IPBES); genetic diversity, biodiversity, and habitat (MA, TEEB, IPBES); and largescale planetary processes, such as nutrient cycling and soil formation (MA) and evolutionary or biological processes (IPBES). These frameworks contain essentially the same services and processes, differing only slightly in where or how these processes are classified.

Two key distinctions are explicitly defined by the IPBES, which are tacitly implied within the other frameworks. These relate to the manner in which benefits to people are derived from ecosystem services, and the role played by social and cultural factors in the valuation of these benefits. Firstly, regarding the benefits derived from ecosystems, the IPBES framework explicitly considers and distinguishes between the conversion of ecosystem services to benefits in terms of “nature’s contributions to people” or the role that ecosystem services play in relation to the human institutional and physical systems, and the neutral processes whereby human systems derive benefits from natural systems without the need for any conversion or additional effort, defined as “nature’s gifts to people”. The second distinction of the IPBES framework relates to the manner in which it explicitly emphasises the importance of relational value of the benefits derived by different social and cultural groups from ecosystem services. Both these distinctions, while valuable, can be seen as implicit within the preceding frameworks of the MA, TEEB, and CICES.

In the economic valuation of benefits derived from ecosystem services, specialists must consider the benefits received from the natural systems in relation to the value they represent in the social, cultural and economic systems in which they occur. It is understood by the former classifications, that it is the interplay between the human and natural systems in which the value of benefits to humans can be defined. There is value in the explicit acknowledgement of the interactive role played by the various social, economic and cultural systems with the

ecosystems under review irrespective of the specific classification utilised. The ecosystem services that were considered in this analysis are as per TEEB Framework (TEEB 2013).

Table 2-1: Review and comparison of popular Ecosystem Service Frameworks commonly utilised in classifying natural benefits

Ecosystem Services Typology as per MEA (2005)	Ecosystem Services Typology as per TEEB (2010)	Ecosystem Services Typology as per CICES (Haines-Young & Potschin, 2013)	Natures Contribution to People (NCP) as per IPBES (IPBES 2018; Diaz et al 2018, Kadykalo et al 2019)
Focus on framing Ecosystem Services	Focus on framing Ecosystem Services	Focus on framing Ecosystem Services in hierarchical system	Focus on framing the benefits. This drives the consideration of variation in benefits between groups of beneficiaries.

Provisioning Services
• Food
• Fresh Water
• Fiber
• Fuel wood
• Genetic resources
• Biochemicals
	Provisioning Services
	• Food
	• Fresh water
	• Raw materials
	• Genetic resources
	• Medicinal resources
	• Ornamental resources
		Provisioning
		• Nutrition
		  ◦ biomass
		  ◦ water
		• Materials
		  ◦ biomass, fibre
		  ◦ water
		• Energy
		  ◦ biomass based energy sources
		  ◦ mechanical energy
			Material NCP (includes non-material elements)
			• Energy
			• Food and feed
			• Materials, companionship and labour
			• Medicinal, biochemical and genetic resources

Regulating Services
• Climate Regulation
• Disease Regulation
• Water Regulation
• Water Purification
	Regulating Services
	• Air quality regulation
	• Climate regulation
	• Moderation of extreme events
	• Regulation of water flows
	• Waste treatment
	• Erosion prevention
	• Maintenance of soil fertility
	• Pollination
	• Biological control
		Regulation and Maintenance
		• Mediation of wastes, toxics, and other nuisances
		  ◦ mediation by biota
		  ◦ mediation by ecosystems
		• Mediation of flows
		  ◦ Mass
		  ◦ Liquids
		  ◦ gaseous/airflows
		• Maintenance of physical, chemical and biological conditions
		  ◦ lifecycle maintenance, habitat and gene pool protection
			Regulating NCP
			• Habitat creation and maintenance
			• Pollination and dispersal of seeds and other propagules
			• Regulation of air quality
			• Regulation of climate
			• Regulation of ocean acidification
			• Regulation of freshwater quantity, location and timing
			• Regulation of freshwater and coastal water quality
			8. Formation, protection and decontamination of soils and sediments
			9. Regulation of hazards and extreme events

Ecosystem Services Typology as per MEA (2005)	Ecosystem Services Typology as per TEEB (2010)	Ecosystem Services Typology as per CICES (Haines-Young & Potschin, 2013)	Natures Contribution to People (NCP) as per IPBES (IPBES 2018; Diaz et al 2018, Kadykalo et al 2019)
		◦ pest and disease control ◦ soil formation and composition ◦ water conditions ◦ atmospheric composition and climate regulation	10. Regulation of detrimental organisms and biological processes
Cultural Services • Aesthetic values • Spiritual/ religious values • Educational • Recreation and ecotourism • Inspirational • Sense of place • Cultural heritage	**Cultural and Amenity Services** • Recreation, mental and physical health • Tourism • Aesthetic appreciation • Spiritual experience and sense of place	**Cultural Services** • Physical and intellectual interactions with ecosystems and land-/seascapes ◦ Physical and experiential interactions ◦ Intellectual and representational interactions • Spiritual, symbolic and other interactions with ecosystems and land-/seascapes ◦ Spiritual and/or emblematic ◦ Other cultural outputs	**Non-Material NCP (includes material elements)** 15. Learning and inspiration 16. Physical and psychological experiences 17. Supporting identities
Supporting Services • Nutrient Cycling • Soil Formation • Primary Production • Habitat • Biodiversity	**Habitat Services** • Habitat for species • Maintenance of genetic diversity		**Material, Non-material and Regulating NCP** 18. Maintenance of options **Nature (Intrinsic) e.g.:** • Genetic Diversity, Species diversity • Evolutionary and ecological processes • Gaia, Mother Earth • Animal welfare / rights

2.2.2.2 Ecosystem Services Valuation Module

The Ecosystem Services Valuation Module functions to standardise the identification, quantification, and prioritisation of services towards assessing the value of ecosystem services present within the catchment. The four components, as presented in the Decision Analysis Framework, form the focus of the module. The Socio-Economic Comparison Tool (SEcT) (Naidoo et al. 2017) is used as the platform from which to frame relationships between various components. Although inputs draw largely from data collected (and presented) in the status-quo report (DWS, 2022 Report No: WEM/WMA7/00/CON/RDM/0322), additional data inputs were identified and included where necessary. Key data that are used as inputs into the module include the following:

1. The presence of Ecological Infrastructure (EI) segregated into type, extent and condition per IUA;
2. The socio-economic wellbeing of communities within the catchment represented by demographic breakdowns and spatial indicators of land use per IUA as well as indicators of vulnerability and wellbeing;
3. Classification of beneficiaries per IUA into representative beneficiary categories present within standard Social Accounting Matrix (SAM). These were further segregated into formal and informal recipients of ecosystem services.

Utilising the data inputs, ecosystem services will be prioritised against the risk of impact on socio-economic wellbeing through impact to ecological infrastructure. The process involves undertaking a Comparative Risk Assessment (CRA) per IUA, looking at the likelihood and consequences of impact to beneficiaries. The resulting output is a prioritised list of Ecosystem Services that are spatially aggregated across the study area.

2.2.2.3 Quasi Social Accounting Matrix (QSAM)

A Social Accounting Matrix (SAM) is a well-established macro-economic modelling tool, which has been used in several WRCS studies in the past. A SAM quantifies all transactions between sectors and actors in the economy, in a specific calendar year. The sectors and actors include primary (predominantly agriculture, forestry and mining), secondary (predominantly manufacturing) and tertiary (all service sectors) sectors, as well as consumption by households and trade outside of the economy.

The underlying data used to construct a SAM is official economic data provided by Statistics SA. The SAM can be restructured into a modelling tool though which the impact of water resource management scenarios can be evaluated.

The first step is to construct the Input-Output table. An input-output table is a representation of national or regional economic accounts that records how industries produce and trade between themselves (i.e., flows of goods and services). The flows for input are recorded in the columns of the Input-Output table and the outputs are included in the rows of the table. These flows are recorded in a matrix, simultaneously by origin and destination (OECD 2006). An input-output analysis is the standard method for measuring the propagation effects of changes in final demand for a product in an industry or sector (Surugiu 2009).

The input-output table is then extended into a quasi-social accounting matrix (Q-SAM) by incorporating labour and capital production factors and contributions to government. The Q-

SAM is a square matrix of transactions between the rows (incomes) and columns (expenditures) of the matrix representing the various sector accounts. In the square format of a SAM the total receipts must equal total payments for each of its accounts (van Seventer & Davies, 2019). The Q-SAM can be restructured into a modelling tool through which the impact of various scenarios on the sectors of the economy can be determined. It may be used to evaluate the socio-economic impact of exogenous changes to the national economy.

A Keiskamma and Fish to Tsitsikamma Quasi-Social Accounting Matrix (QSAM) was developed with the aim to quantify the size of the Keiskamma and Fish to Tsitsikamma economy. The QSAM module was initially developed from the Supply and Use tables published by Statistics South Africa (Stats SA) in March 2022 for the year 2019 and subsequently updated with the Supply and Use tables published by Stats SA in June 2024 for the year 2021. The QSAM may be used to evaluate the socio-economic impact of exogenous changes to the Keiskamma and Fish to Tsitsikamma catchment economy.

The macro-economic indicators estimated in the QSAM model for the catchment are Gross Value Added (GVA) and Compensation to Employees as described in **Table 2-2** below.

Table 2-2: Macro-economic indicators estimated in the economic model

Indicator	Unit	Description
Gross Value Added (GVA)	Rand Millions	Economic productivity metric measuring the contribution of Keiskamma and Fish to Tsitsikamma to the economy
Compensation to Employees	Rand Millions	Component of the Gross Domestic Product (GDP) measuring the change in total salaries paid

The QSAM model also estimates economic multipliers from the Leontief inverse matrix. Multipliers indicate the increase in final income arising from the expenditures within economic sectors.

The methodology followed to build the QSAM for the Keiskamma and Fish to Tsitsikamma catchment is illustrated in **Figure 2-3.**

The major economic sectors of the Keiskamma and Fish to Tsitsikamma catchment were identified using information sourced from the socio-economic profiles and spatial economic overviews of the district municipalities that fall within the catchment. Stats SA Census 2011 data was used to determine the total number employed per sector (formal and informal) and together with the Stats SA quarterly employment statistics information the total average salaries per sector were calculated. The Keiskamma and Fish to Tsitsikamma GVA was determined per sector based on the national QSAM GVA to compensation of employees' proportion. These values were used to construct the Keiskamma and Fish to Tsitsikamma QSAM. Finally, the multipliers were derived from the QSAM.

The aim of the QSAM is to combine the suppliers and consumers of economic products in a single matrix (table of interacting economic sectors) in order to determine the magnitude of the macro-economic indicators.

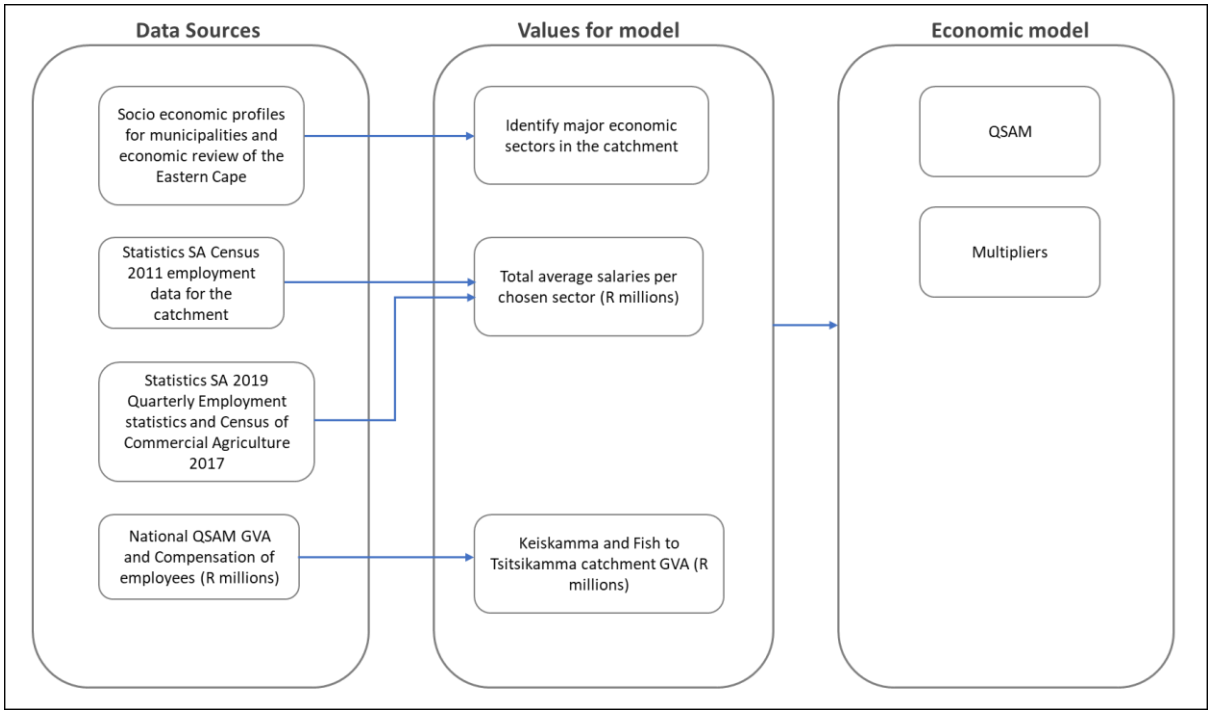

Figure 2-3: Schematic representation of the methodology used for the economic model development

2.3 WRCS Step 4 Socio-economic approach

This section provides an explanation of the approach that will be used during the assessment of the ecological consequences as part of Step 4 scenario phase of the study that is still to be completed.

In this step, through the use of ecosystem service valuation the natural benefits provided by ecosystems will be quantified in socio-economic terms. This socio-economic yard stick will allow for a comparison of trade-offs to development, towards understanding the costs of environmental damage and restoration to the economy. Furthermore, by understanding the flow of services from the environment to beneficiaries, decision makers will be empowered to identify opportunities towards maximising of the natural benefits received. The opportunities may include the improvement in functionality of a system or even provide support services or infrastructure necessary for sustainable utilisation by beneficiaries.

2.3.1 Comparative Ecological Risk Assessment (CERA) methodology

The assessment of development scenarios in this step will provide insights into the impact of the development scenarios on the ecological value, water resources availability, corresponding socio-economics and associated quality objectives. The ecosystem services valuation approach will be utilised towards evaluating trade-offs against varying water management scenarios. The approach will identify ecosystem services at risk, and value these to support informed allocation of management class per IUA.

The process involves undertaking a Comparative Risk Assessment (CRA) per IUA looking at the likelihood and consequences of impact to beneficiaries. The resulting output is a prioritised list of Ecosystem Services that are spatially aggregated across the WMA.

The CRA process involves defining the following linkages in the chain of causality:

- **Environmental hazard:** The environmental hazard is the environmental stressor which drives change. The hazard is identified as the input which initiates the chain of causality and is determined through the changes initiated through varying scenarios. Examples in this case include decreased surface water flow through over abstraction from rivers. Note the environmental hazard would vary between ecological infrastructure and across scenarios.
- **Environmental effect statement:** The environmental effect statement describes the physical impacts that the environmental hazard has on specific ecological infrastructure. In line with the example above, this would describe that decreased surface water flow would modify natural flows processes and restrict primary productivity within the channel and riparian areas.
- **Risk rating of ecosystem services.** The risk to the flow of ecosystem services is assessed in terms of the likelihood and consequences of impact by the identified environmental effect on the specific ecological infrastructure providing the service. The process is further detailed below:

Ecosystem risk is the function of the likelihood and consequence of a scenario to which EI is exposed.

Thus: ***Risk = f (likelihood, consequence)*** *of environmental effect on EI.*

For each scenario-EI-ES combination, two questions will be asked:

Firstly, ‘What is the likelihood that this ecosystem service, provided by the specific ecological infrastructure, will be affected under this scenario? This speaks to impacts that the scenario would have on the ability to provide the ecosystem service.

Secondly, ‘What would be the consequences of this scenario in this ecological infrastructure to the delivery of this ecosystem service?’ This speaks to the socio-economic consequences and therefore links directly to the relevant beneficiaries within the IUA.

The likelihood of an impact is the change in possibility that a specific scenario will have an impact on the EI and therefore the benefits received. The likelihood rating framework can be seen in

Table 2-3. The consequence of the scenario is the change in the service from the environmental effect of the scenario on the exposed EI. A consequence rating framework can be seen in **Table 2-4**. Likelihood and consequence categories are chosen for each ES. It is important that the certainty is recorded to ensure transparency of the level of confidence in categories chosen. Risks are then automatically ranked according to risk levels. A description of each risk is given (Risk Statement) which includes the underlying chain of causality between environmental effect and its consequence to ensure transparency of the ranking process (**Table 2-5**).

Table 2-3: Qualitative and quantitative classes of likelihood of impacts (environmental effect, or resultant change in the flow of an ecosystem service) of a scenario having an ecological consequence to a service from EI. Adapted from the classification adopted by the IPCC (2007)

Likelihood rating	Assessed probability of occurrence	Description
Almost certain	> 90%	Extremely or very likely, or virtually certain. Is expected to occur.
Likely	> 66%	Will probably occur
Possible	> 50%	Might occur; more likely than not
Unlikely	< 50%	May occur
Very unlikely	< 10%	Could occur
Extremely unlikely	< 5%	May occur only in exceptional circumstances

Table 2-4: Qualitative measures of consequence to ecosystem services arising from impacts linked to scenarios. Adapted from the classification adopted by the IPCC (2007)

Consequence rating	Level of consequence	Environmental effect
Severe	1	Substantial permanent loss of environmental service, requiring mitigation or offset.
Major	2	Major effect on the EI or service, that will require several years to recover, and substantial mitigation.
Moderate	3	Serious effect on the EI or service, that will take a few years to recover, but with no or little mitigation.
Minor	4	Discernible effect on the EI or service, but with rapid recovery, not requiring mitigation.
Insignificant	5	A negligible effect on the EI or service.

Table 2-5: Levels of risk, assessed as the product of likelihood and consequence in the event of an environmental effect on EI. Adapted from the classification adopted by the IPCC (2007)

Likelihood Rating	Consequence Rating				
	Insignificant	**Minor**	**Moderate**	**Major**	**Severe**
Almost certain	Low	Medium	High	Extreme	Extreme
Likely	Low	Medium	High	Extreme	Extreme
Possible	Low	Medium	High	High	Extreme
Unlikely	Low	Low	Medium	High	Extreme
Very unlikely	Low	Low	Low	High	Extreme
Extremely unlikely	Low	Low	Low	Medium	High

The output of the CRA process is an aggregated risk assessment for each of the scenario-EI-ES combinations for each IUA. Not all of these combinations are valuable and the results are used to prioritise the key ecosystem services at risk per scenario across all IUA's.

The output is thus a prioritised list of risks, with diagnostic and causal descriptions for each priority risk. High and extreme risks are classed as priority risks. These risks and their relative weight (High risk=3, Extreme risk=4) are summed for each scenario to allow for a comparison of cumulative risks between scenarios. The beneficiaries of the identified ES will be at the greatest risk due to a specific scenario.

Post CRA process, ecosystem services that have been highlighted through the CRA process to be of special concern will be evaluated. The evaluation step looks at the magnitude of an impact, both on the demand and the EWR, and assesses it against the potential benefits of the various scenarios. The relative risks will be evaluated at a desktop level and together with specialists at the scenario trade-off workshops.

2.3.2 Economic Trade-off Analysis Methodology

The QSAM model that was developed (see **Section 2.2.3**) will be used to evaluate the socio-economic impact of exogenous changes to the national and Keiskamma and Fish to Tsitsikamma economy resulting from the implementation of the water management scenarios. The data inputs into the QSAM include the change in water flows for each scenario and will measure the impact and economic consequences of these changes.Various macro-economic indicators are estimated in QSAM models (see **Section 2.2.3**), and the indicator for Gross Value Added (GVA) will be used as a measure of the potential economic trade-offs for each IUA and scenario.

3 STATUS QUO OF THE STUDY AREA

3.1 Overview

The study area forms part of the Mzimvubu to Tsitsikamma Water Management Area (WMA7). The water resources of the Mzimvubu River (T31 – T36) are not included as part of the study area for the purposes of this study

The study area is mainly rural with some major towns (i.e., Gqeberha (Port Elizabeth), East London, Makhanda (Grahamstown) and Mthatha. Economic activity is concentrated in the south-western portion of the study area, within the Gqeberha/Kariega area , as this area is regarded as the economic hub of the Eastern Cape Province, contributing more than 40% of the Gross Geographic Product of the whole Province (DWS,2011) The proximity of extensive commercial agriculture contributes to growth in the Nelson Mandela Bay Metropolitan Municipality (NMBM), providing permanent and seasonal jobs, as well as value-added activities for communities, both within and on the fringe of the NMBM.

3.2 Socio-economics

3.2.1 Demographics and socio-economic profile

The majority of the study area falls within the Eastern Cape province, with small portions in two Local Municipalities of the Western Cape (Beaufort West and George LM) and one local municipality from Northern Cape (i.e., one ward in Ubuntu LM). The population of the catchment was 5.87 million in 2021 (2011 Stats SA census adjustments) and the population is predominately Xhosa speaking. According to Stats SA Census 2022, the Eastern Cape had the second highest percentage of households with no access to piped water, at 19.5% and nationally it was at 8.7%.

The catchment is mainly rural with a few urban areas in East London, Gqeberha (Port Elizabeth), and Makhanda (Grahamstown). According to Stats SA 2023, the Eastern Cape had the highest unemployment rate, at 41.9% and nationally it was at 32.1%. The province also had the second highest agricultural households, at 26.2% and nationally it was at 13.8%. Subsistence agriculture is mainly livestock, poultry, food crops and vegetable production (Stats SA, 2024).

3.2.2 Economic sectors

The Eastern Cape province contributed a GDP of approximately R368.9 billion in the fourth quarter of 2023, which is a contribution of 7.8% to the total national GDP (ECSECC, 2023Q4). The largest contributors to the national GDP were Gauteng (35%) and KwaZulu-Natal (16%). The economy of the Eastern Cape is mainly supported by the tertiary sector (wholesale and retail trade, tourism and communications), followed by the sectors of manufacturing (large proportion by the automotive sub-sector), agriculture and agro-processing. In 2023 fourth quarter, the tertiary sector accounted for 81.6% of the provincial gross value added (GVA) and the secondary sector 16.6% (largely the automotive manufacturing sector), followed by the primary sector (agriculture and to lesser extent mining) accounting for less than 2% (ECSECC, 2023Q4).

In the Eastern Cape, the Sarah Baartman district municipality region (Kouga, Kou-Kamma, Dr Beyers Naude, Sundays River Valley, Blue Crane Route, Makana and Ndlambe local municipalities) has the largest contribution to the national commercial agriculture income at 3.9% (Stats SA, 2020). The Eastern Cape accounts for 12.3% in terms of land use area of the national commercial agricultural land.

The GDP of Keiskamma and Fish to Tsitsikamma contributed an estimated R280 billion based on 2016 ECSECC municipal economic data (**Table 3-1**). In the Keiskamma and Fish to Tsitsikamma catchment the largest contribution to GVA is from the government sector which represents 26% of the Keiskamma and Fish to Tsitsikamma economy. Financial services, trade and industry and manufacturing sectors contributed 20%, 19% and 12% respectively to the Keiskamma and Fish to Tsitsikamma GDP. Agriculture plays a minor role in the catchment and its GVA contributes 1.5% to the Keiskamma and Fish to Tsitsikamma economy.

Table 3-1: The Keiskamma and Fish to Tsitsikamma GDP per sector (preliminary based on data from ECSECC, 2016)

Economic Sectors	GVA contribution (R billions) based on 2016 GDP data	Percentage contribution
Agriculture	4	1.5%
Mining	0.4	0.1%
Manufacturing	34	12%
Electricity	6	2%
Construction	12	4%
Trade	52	19%
Transport	25	9%
Finance	55	20%
Community services	73	26%
Other	20	7%
Total GDP	279	

3.3 Ecosystem services

3.3.1 Ecological infrastructure

Key water resources include various large wetland systems, rivers, dams and impoundments. Large rivers within the study area include the Great Kei, Sunday, Great Fish, Keiskamma, Buffalo, Tsitsikamma, Mthatha and Mbashe Rivers, as well as their many tributaries. The major dams and impoundments include *inter alia* the uMtata, Darlington, Grassridge, Impofu, Kouga and Bridledrift dams.

The catchment houses large extents of protected landscapes including Addo Elephant and Camdeboo National Park in the N region and Mount Zebra National Park in the Q region, and numerous nature reserves (**Appendix A, Figure 8-2**).

3.3.2 Ecosystem service sensitivity

Ecosystem Service Sensitivity areas are identified at a high level through two general ways:

- Knowledge of benefits received through ecological infrastructure.
- Inferring the flow of ecosystem services through the spatial relationship of potential beneficiaries and ecological infrastructure.

General categories of ecosystem services are utilised to define sensitivity and include provisioning, regulating and cultural services. Additionally, due to the nature of the catchment classification process, the water provisioning service is highlighted to be included in the sensitivity analysis.

Key ecosystem services in the catchment are preliminarily identified as the following:

- Water Provisioning Services provided by the network of rivers, dams and impoundments and Strategic Water Source Areas (SWSA).
- Cultural services as indicated by the distribution of protected areas, tourism and community demographics.

Refer to **Appendix A, Figure 8-3** for the ecosystem service sensitivity areas in the study area.

4 STATUS QUO PER IUA

The Keiskamma and Fish to Tsitsikamma catchment is divided into 19 Integrated Units of Analysis (IUAs) (illustrated in Figure 4-1). The IUAs which are similar from a broad socio-economic, water resource component and catchment boundary perspective and can be managed as an entity, forming a logical unit for which management and operational scenarios can be considered and evaluated (DWS, 2022, Report No: WEM/WMA7/00/CON/RDM/0322).

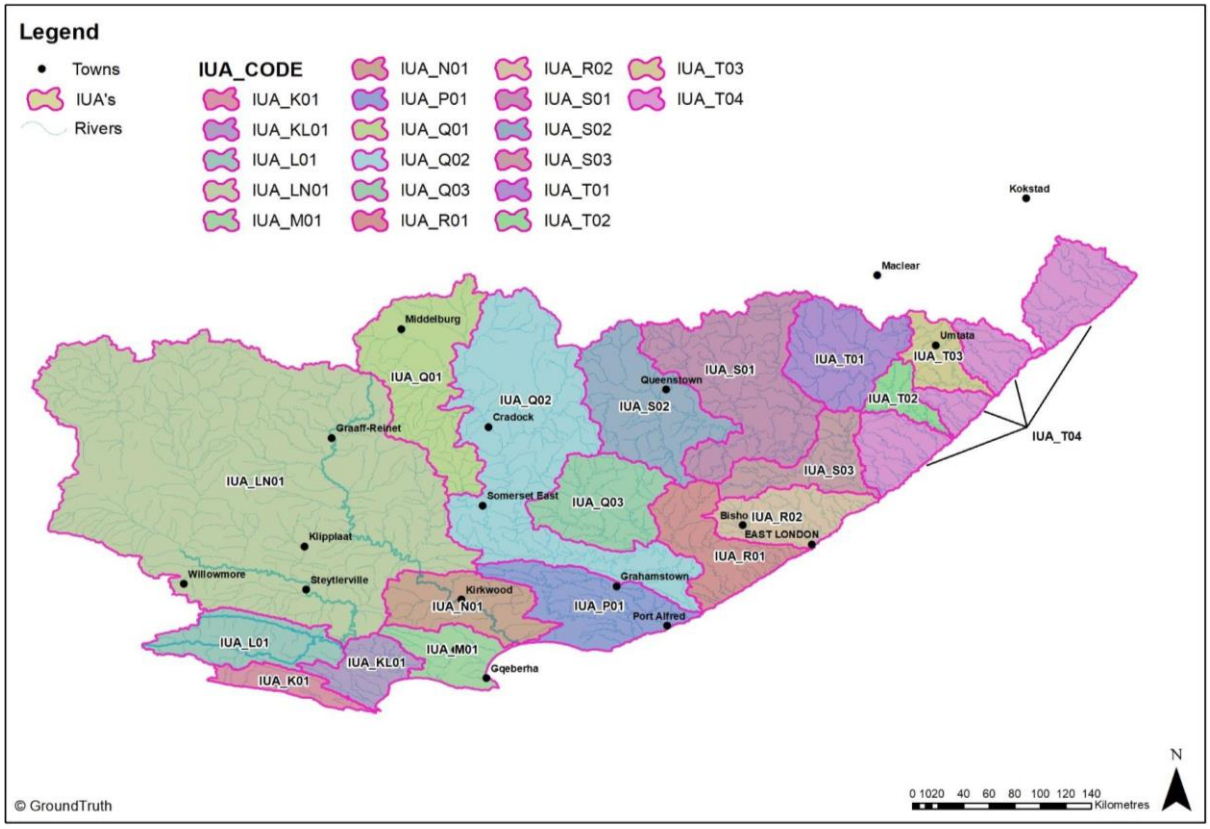

Figure 4-1: Delineated 19 IUAs throughout the study area

4.1 Status quo from a socio-economic perspective

A summary of the socio-economic profiles per IUA of the study area are provided in Table 4-1. The table describes the socio-economic profile in each IUA in terms of the demographics (population size, employment rate and access to water services) and economic aspects including the main towns and the key economic sectors and activities within each IUA.

Table 4-1: Socio-economic profiles per IUA

IUA	Status quo socio-economic profile
1: IUA_K01 Tsitsikamma and headwaters of Krommer to Kromme dam	This IUA falls within Koukamma LM (wards 4, 5, 6) and Kouga LM (ward 1). The population in 2021 was 23 669 with employment rate at 52%. Approximately 31% of the population rely on water resources (mainly groundwater) to access basic water services. No large cities in this IUA. Main small towns include Kareedouw, Clarkson, Woodlands, Stormsriver and Oyster Bay. The key economic activities include tourism, forestry and agriculture (dairy, sheep and fruit).
2: IUA_KL01 Kromme from Kromme Dam to estuary and Gamtoos	This IUA falls within Kouga LM (ward 2-15) a. and Koukamma LM (ward 4). The population in 2021 was 117 009, with employment rate at 47%. Only 6% of the population rely on water resources to access basic water services. The main towns in this IUA are St Francis Bay, Humansdorp, Jeffreys Bay, Patensie, Hankey and Loueriehеuwel. The economy of the area is largely centred on tourism and there are also agricultural activities including dairy and beef farming, field crops and citrus. Forestry activities in the Hankey area.
3: IUA_L01 Kouga to Kouga Dam, Baviaanskloof	This IUA falls within Koukamma (ward 1-3), Dr Beyers Naude (ward 1) and George (ward 24) local municipalities. The population in 2021 was 36 787, with employment rate at 59%. Approximately 35% of the population rely on water resources (mainly ground water) to access basic water services. The main towns are Joubertina and Twee Riviers (Koukamma LM) and Haarlem (George LM). The main economic activity is tourism and agriculture. Agriculture includes livestock farming (goats and sheep) and there is a well-established deciduous fruit growing area in the Langkloof valley
4: IUA_M01 M primary catchment	This IUA falls within the entire Nelson Mandela Bay MM and Sundays River Valley LM (ward 7, 8). The population in 2021 was 1 331 897, with employment rate at 37%. Only 2% of the population rely on water resources to access basic water service. This IUA has the city of Gqeberha (Port Elizabeth) and smaller towns of Kariega (Uitenhage), Despatch and Colchester. The main economic sectors in Nelson Mandela Bay metro are tourism, agriculture (sheep, angora goats, dairy and oranges) and the manufacturing sector, in particular the automotive manufacturing subsector which contributes over 54% of the Eastern Cape GVA from manufacturing. The IUA includes the Coega Industrial Zone (IDZ) with the saltworks. The metro also has two seaports, Port Elizabeth Harbour and Ngqura.
5: IUA_LN01 Groot to Kouga confluence, Upper Sundays to Darlington Dam	This IUA falls within the large portion of Dr Beyers Naude LM (ward 1), Blue Crane Route LM (ward 4 & 6), Beaufort West LM (ward 1 & 2) and Ubuntu LM (ward 3). The population in 2021 was 122 678, with employment rate at 40%. Approximately 23% of the population rely on water resources (mainly groundwater) to access basic water services. The main towns include Murraysburg (Beaufort West), Willowmore, Steytlerville, Aberdeen, Graaff-Reinet, Nieu-Bethesda, and Jansenville (Dr Beyers Naude). The IUA has nature reserves including the Riverdale Game reserve and Camdeboo National Park.

IUA	Status quo socio-economic profile
	The main economic activities are tourism and agriculture. Agriculture includes goat and sheep farming.
6: IUA_N01 Sundays downstream Darlington Dam	This IUA falls within the Sundays River Valley LM (ward 1-6) and Blue Crane Route LM (ward 6). The population in 2021 was 43 549, with employment rate at 41%. Approximately 12% of the population rely on water resources (mainly groundwater) to access basic water services. The main towns in the IUA are Kirkwood and Addo. The economy is this IUA is driven by agriculture (citrus, cattle and goats), urban commercial trade and some tourism.
7: IUA_P01 P primary catchment	This IUA falls within the Makana LM (ward 2-10; 12; 14), Blue Crane Route LM (ward 6), and Ndlambe LM (ward 10). The population in 2021 was 163 885, with employment rate at 36%. Approximately 11% of the population rely on water resources (mainly ground water and rainwater) to access basic water services. Makana includes the city of Makhanda (Grahamstown) and smaller towns of Alicedale, Sidbury and Riebeek East. Towns in Ndlambe include Port Alfred, Kenton on sea, Seafield and Alexandria. The IUA also includes the town of Paterson (Sundays River Valley). Economic activities include agriculture (dairy, beef, coffee and pineapples), tourism (University town of Makhanda with large number of natural heritage sites) and urban industrial trade. The IUA includes a large area of game farms.
8: IUA_Q01 Fish	This IUA falls within the Inxuba Yethu LM (ward 6-9), and Blue Crane Route LM (ward 4). The population in 2021 was 38 825, with employment rate at 43%. Approximately 36% of the population rely on water resources (mainly groundwater) to access basic water services. The main town is Middelburg. Economic sectors include trade and community services, finance, agriculture, and construction.
9: IUA_Q02 Great Fish	This IUA falls within the Blue Crane Route LM (ward 2-3; 5-6), Inxuba Yethemba LM (ward 1-6), Enoch Mgijima LM (ward 2-5), Ngushwa LM (ward 9-10) Makana LM (ward 1; 11), Walter Sisulu (ward 2), and Ndlambe LM (ward 6). The population in 2021 was 41 684, with employment rate of 31%. Approximately 11% of the population rely on water resources (mainly groundwater) to access basic water services. The main towns within the IUA include Steynsburg, Hofmeyer, Tarkastad, Cradock, Cookhouse, Somerset East and Peddie. Economic activity in the IUA includes commercial agriculture (irrigated field crops, and livestock farming), trade (wholesale, retail and catering) and community services sector activity
10: IUA_Q03 Koonap and Kat	This IUA falls within Raymond Mhlaba LM (ward 1-8; 20; 21), Blue Crane Route LM (ward 1), and Nxuba LM (ward 4). The population in 2021 was 64 090, with employment rate of 26%. Approximately 17% of the population rely on water resource (mainly groundwater and rainwater) to access basic water services. The main towns include Adelaide, Bedford, Fort Beaufort and Seymore. Subsistence farming is the main activity within the rural areas of this IUA. Other economic activity includes commercial agriculture.

IUA	Status quo socio-economic profile
11: IUA_R01 Keiskamma	This IUA falls within the Raymond Mlhaba LM (ward 12-19), Amahlathi LM (ward 1-3; 10-11) and Buffalo City MM (ward 31-33). The population in 2021 was 200 403, with employment rate of 18%. Approximately 23% of the population rely on water resources (mainly rainwater and surface water) to access basic water services. The towns in the IUA include Hamburg, Dimbiza, Hogsback and Alice. Key economic activity within this IUA includes agriculture and tourism. Agriculture includes commercial (irrigated crops) and large areas of subsistence farming.
12: IUA_R02 Buffalo/ Nahoon	This IUA falls within Buffalo City MM (ward 1-50), Great Kei LM (ward 1-6), and Amahlathi LM (ward 8, 9) The population in 2021 was 852 204, with employment rate at 36%. Only 4% of the population rely on water resources to access basic water services. The IUA includes the city of East London and towns of Zwelitsha, Phakamisa, Qonce (King Williams town), Bisho, Mdantsane and Gonubie. The main towns within the Great Kei municipality in this IUA include Morgan's Bay, Kei Mouth and Amatola Coastal. Key economic activities within the IUA include tourism, community services, agriculture and manufacturing. There is forestry activity in the Qonce area. The Buffalo City metro has a well-established manufacturing industry, and the automotive industry plays a large role. East London has South Africa's only commercial river port at the Buffalo River mouth
13: IUA_S01 Upper Great Kei	This IUA falls within Emalahleni LM (ward 1-17), Intsika Yethu LM (ward 3-21), Amahlathi LM (ward 4-6, 13), and Sakhisizwe (ward 6-9),). The population in 2021 was 308 136 with employment rate at 16%. 40% of the population rely on water resources (rivers and groundwater) to access water services. The main towns are Dordrecht, Indwe and Lady Frere (Emalahleni LM) and Cofimvaba and Tsomo (Intsika Yethu LM). A large portion of the IUA is rural and supported mainly by subsistence farming. The main market crop being sorghum and there is a developing wool production market. There is some commercial agriculture more in the northern areas of the IUA. Other economic sector activity is in the community services and trade sectors.
14: IUA_S02 Black Kei	This IUA falls within the Enoch Mgijima LM (ward 1-27), and Amahlathi LM (ward 4). The population in 2021 was 28 004, with employment rate at 28%. Approximately 12% of the population rely on water resource (mainly groundwater) to access basic water services. The main towns being Komani (Queenstown), Sterkstroom and Whittlesea. Economic activities include commercial agriculture and some subsistence farming. The IUA has a large rural area.
15: IUA_S03 Lower Great Kei	This IUA falls within the Mquma LM (ward 1-21), Amahlathi LM (ward 14- 18), and Great Kei LM (ward 7). The population in 2021 was 182 201, with employment rate at 22%. Approximately 33% of the population rely on water resources (mainly rivers) to access basic water services. The main towns include Stutterheim, Komga, Gcuwa (Butterworth) and Ngqamakhwe. The main economic activities include agriculture (crops and livestock), plantation forestry and other sectors including community services, wholesale and retail trade and manufacturing.

IUA	Status quo socio-economic profile
16: IUA_T01 Upper Mbashe, Upper Mthatha	This IUA falls within the entire Engcobo LM, Intsika Yethu LM (ward 11,12, 18), Mbashe LM (ward 5,31), King Sabata Dalindyebo LM (ward 34), and Sakhisizwe LM (ward 1). The population in 2021 was 248 996, with employment rate at 14%. Approximately 56 % of the population rely on water resources (mainly rivers) to access basic water services. The main towns are Ngcobo and Elliot. The area is largely rural with many rural towns. Commercial agriculture in the IUA lies in the northern part in the Sakhisizwe municipality and is mainly crop farming and some livestock farming. Other economic activity is from forestry plantations in the Sakhisizwe and Engcobo municipalities. A large portion of this IUA is supported by subsistence farming.
17: IUA_T02 Lower Mbashe	This IUA falls within the Mbashe LM (ward 6-8; 13-16, 21, 24) and King Sabata Dalindyebo LM (ward 18-21, 31-32). The population in 2021 was 175 700, with employment rate at 10%. Approximately 60% of the population rely on water resources (mainly rivers) to access basic water services. The IUA is mainly a rural area with rural towns and is supported by subsistence farming.
18: IUA_T03 Lower Mthatha	The IUA falls within the King Sabata Dalindyebo LM (ward 7-9, 27-29) , Nyandeni LM (ward 9-14, 22-23, 26, 29), and Mhlontlo LM (ward 2, 4-5). The population in 2021 was 505 096, with employment rate at 24%. 33% of the population rely on water resources (mainly rivers) to access basic water services. The main towns in the IUA are Mthata and Mqanduli. The main economic sectors are trade and finance. In terms of agriculture the IUA is supported by subsistence agriculture.
19: IUA_T04 Pondoland coastal	The IUA falls within the Mbashe LM (ward 1-3, 10-12, 18-20, 22-23, 25-30); Mnquma LM (ward 22-28), Port St John LM (ward 10-12, 14-15, 19-20), Nyandeni LM (ward 2, 4, 6-8, 15-21, 24,25,27), Nguquza Hill LM (ward 2,4-7, 10-31), and Mbizana LM. The population in 2021 was 1 044 914 with employment rate of 12%. Approximately 57% of the population rely on water resources (mainly rivers) to access basic water services. The main towns within these respective municipalities are Elliotdale, rural towns, Ngqeleni, Libode, Port St Johns, Bizana and Lusikisiki. The main economic activity is from tourism (mainly along the coast), agriculture and some forestry (near Lusikisiki). Agriculture includes commercial agriculture (maize, soya, sugar beans and other) and subsistence farming in large areas.

4.2 Status quo of ecosystem services

The catchment has various ecological infrastructure with associated ecosystem services and beneficiaries of these services and these vary within the different IUAs. A status quo summary of the ecosystem services, the main beneficiaries of these services and the impact within each IUA is provided in **Table 4-2**.

Table 4-2: Summary of status quo ecosystem services, beneficiaries and impact in the Keiskamma and Fish to Tsitsikamma catchments

IUA	Ecosystem services, beneficiaries and impact	
1: IUA_K01 Tsitsikamma and headwaters of Krommer to Kromme dam	**Key Ecosystem Service:**	**Key Ecological Infrastructure:**
	Provisioning: • Water • Food • Raw materials	• Rivers • Wetlands • Ground and surface SWSA
	Regulation: ● Water regulation ● Water quantity ● Erosion control / soil stability ● Biological control	● Rivers ● Wetland ● Estuaries
	Cultural: ● Ecotourism & recreation ● Landscape & amenity values	● Estuaries and coastline ● Tsitsikamma nature reserve and other small nature reserves
	Beneficiaries	● Significance to households that rely on ground water for water provisioning; ● Significant commercial agriculture (dairy, sheep and fruit) in associated towns and their surroundings; and ● Significant tourism industry in associated towns and communities.
	Impacts	● Commercial farming near the coastline, forestry and high reliance on water resources from the municipality; and ● Tourism; and households.
2: IUA_KL01 Kromme from Kromme Dam to estuary and Gamtoos	**Key Ecosystem Service:**	**Key Ecological Infrastructure:**
	Provisioning: • Water • Food • Raw materials	● Impofu dam ● Rivers ● Wetlands ● Ground and surface SWSA
	Regulation: ● Water regulation ● Water quantity ● Erosion control / soil stability ● Biological control ● Climate regulation	● Rivers ● Wetlands ● Estuaries ● Forestry
	Cultural: ● Ecotourism & recreation ● Landscape & amenity values	● Estuaries and coastline ● Gamtoos river mouth nature reserve and other small nature reserves
	Beneficiaries	● Significance to households that rely on ground water and Impofu dam for water provisioning. ● Significant commercial agriculture (dairy and beef farming, field crops and citrus). associated in Humansdorp and Louerieheuwel ● Significant tourism industry in associated towns and communities

IUA	Ecosystem services, beneficiaries and impact	
	Impacts	• Commercial agriculture; tourism; and households
3: IUA_L01 Kouga to Kouga Dam, Baviaanskloof	**Key Ecosystem Service:**	**Key Ecological Infrastructure:**
	Provisioning: • Water • Food • Raw materials	• Rivers • Wetlands
	Regulation: • Water regulation • Water quantity • Erosion control / soil stability • Biological control	• Rivers • Wetlands
	Cultural: • Ecotourism & recreation • Landscape & amenity values	• Baviaanskloof Nature Reserve
	Beneficiaries	• Significance to households that rely on ground water for water provisioning; • Significant commercial agriculture (goats and sheep and fruit) in Twee Rivers, Krakeel River and their surrounding areas; and • Tourism industry in Baviaanskloof Nature Reserve area.
	Impacts	• Commercial agriculture; tourism; and households
4: IUA_M01 M primary catchment	**Key Ecosystem Service:**	**Key Ecological Infrastructure:**
	Provisioning: • Water • Food	• Rivers • Wetlands • Ground and surface SWSA
	Regulation: • Water regulation • Water quantity • Erosion control / soil stability • Biological control • Climate change regulation	• Rivers • Wetlands • Estuary • Forestry
	Cultural: • Ecotourism & recreation • Landscape & amenity values	• Estuaries and coastline • Groendal Nature reserve and other small nature reserves
	Beneficiaries	• Significant commercial agriculture (sheep, angora goats, dairy and oranges). associated with towns and their surroundings • Significant tourism industry in associated towns and communities
	Impacts	• Commercial agriculture; tourism; manufacturing, and households
5: IUA_LN01 Groot to Kouga confluence, Upper	**Key Ecosystem Service:**	**Key Ecological Infrastructure:**
	Provisioning: • Water	• Rivers • Wetlands

IUA	Ecosystem services, beneficiaries and impact	
Sundays to Darlington Dam	• Food • Raw materials	• Ground water • Darlington and Nqweba dam
	Regulation: • Water regulation • Water quantity • Erosion control / soil stability • Biological control	• Rivers • Wetlands
	Cultural: • Ecotourism & recreation • Landscape & amenity values	• Camdeboo national park • Karoo and Noorsveld nature reserves
	Beneficiaries	• Significance to households that rely on ground water for water provisioning; • Significant commercial agriculture (goat and sheep farming) in associated towns and their surroundings; and • Significant tourism industry in associated towns and communities.
	Impacts	• Commercial agriculture; tourism; and households
6: IUA_N01 Sundays downstream Darlington Dam	**Key Ecosystem Service:**	**Key Ecological Infrastructure:**
	Provisioning: • Water • Food • Raw materials	• Rivers • Wetlands • Ground water
	Regulation: • Water regulation • Water quantity • Erosion control / soil stability • Biological control	• Rivers • Wetlands
	Cultural: • Ecotourism & recreation • Landscape & amenity values	• Addo Elephant national park • Congas kraal nature reserve • Coastline
	Beneficiaries	• Significance to households that rely on ground water for water provisioning. • Significant commercial agriculture (citrus, cattle and goats), in associated towns and their surroundings • Tourism industry in associated towns and communities
	Impacts	• Commercial agriculture; tourism; and households
7: IUA_P01 P primary catchment	**Key Ecosystem Service:**	**Key Ecological Infrastructure:**
	Provisioning: • Water • Food • Raw materials	• Rivers • Wetlands • Ground water
	Regulation: • Water regulation • Water quantity • Erosion control/ soil stability • Biological control • Climate change	• Rivers • Wetlands • Estuaries • Forestry

IUA	Ecosystem services, beneficiaries and impact	
	Cultural: ● Ecotourism & recreation ● Landscape & amenity values	● Estuaries and coastline ● Indalo nature reserve and other small nature reserves
	Beneficiaries	● Significance to households that rely on ground water for water provisioning; ● Significant commercial agriculture (dairy, beef, coffee and pineapples) in associated towns and their surroundings; and ● Tourism industry in associated towns and Communities.
	Impacts	● Commercial agriculture (including forestry); tourism industry; manufacturing, and households.
8: IUA_Q01 Fish	**Key Ecosystem Service:**	**Key Ecological Infrastructure:**
	Provisioning: • Water • Food • Raw materials	● Rivers ● Wetlands ● Ground water
	Regulation: ● Water regulation ● Water quantity ● Erosion control/ soil stability ● Biological control	● Rivers ● Wetlands
	Cultural: ● Ecotourism & recreation ● Landscape & amenity values	● Mount Zebra National Park ● Renosterberg Nature Reserve and other small nature reserves
	Beneficiaries	● Significance to households that rely on ground water for water provisioning; ● commercial agriculture in associated towns and their surroundings; and ● Tourism industry in associated towns and communities.
	Impacts	● Commercial agriculture; tourism; and households.
9: IUA_Q02 Great Fish	**Key Ecosystem Service:**	**Key Ecological Infrastructure:**
	Provisioning: • Water • Food • Raw materials	● Rivers ● Wetlands ● Ground water ● Grassridge dam
	Regulation: ● Water regulation ● Water quantity ● Erosion control/ soil stability ● Biological control	● Rivers ● Wetlands
	Cultural: ● Landscape & amenity values	● Commandodrift Nature Reserve
	Beneficiaries	● Significance to households that rely on ground water for water provisioning; and

IUA	Ecosystem services, beneficiaries and impact		
		● Significant commercial agriculture (irrigated field crops, and livestock farming) in associated towns and their surroundings.	
	Impacts	● Commercial agriculture; and households.	
10: IUA_Q03 Koonap and Kat	**Key Ecosystem Service:**		**Key Ecological Infrastructure:**
	Provisioning: • Water • Food • Raw materials		● Rivers ● Wetlands ● Ground water
	Regulation: ● water regulation ● Water quantity ● Erosion control/ soil stability ● Biological control ● Climate change		● Rivers ● Wetlands ● Forestry
	Cultural: ● Landscape & amenity values		● Molweni nature reserve
	Beneficiaries	● Significance to households that rely on ground water for water provisioning. ● Subsistence and commercial agriculture in associated towns and their surroundings	
	Impacts	● Commercial agriculture (including forestry); and households	
11: IUA_R01 Keiskamma	**Key Ecosystem Service:**		**Key Ecological Infrastructure:**
	Provisioning: • Water • Food • Raw materials		● Rivers ● Wetlands ● Ground water
	Regulation: ● Water regulation ● Water quantity ● Erosion control / soil stability ● Biological control		● Rivers ● Wetlands
	Cultural: ● Ecotourism & recreation ● Landscape & amenity values		● Estuary and coastline
	Beneficiaries	● Significance to households that rely on water resource for water provisioning; ● Subsistence and commercial agriculture (irrigated crops) associated with towns and their surroundings; and ● Major Significance to the tourism industry and catchment associated towns and Communities.	
	Impacts	● Commercial agriculture; tourism; households.	
12: IUA_R02 Buffalo/ Nahoon	**Key Ecosystem Service:**		**Key Ecological Infrastructure:**
	Provisioning:		

IUA	Ecosystem services, beneficiaries and impact	
	• Water • Food • Raw materials	• Rivers • Wetlands • Ground water • Bridle Drift dam
	Regulation: • Water regulation • Water quantity • Erosion control / soil stability • Biological control • Climate change	• Rivers • Wetlands • Forestry
	Cultural: • Ecotourism & recreation • Landscape & amenity values	• Amathole marine protected area • Coastline • Nahoon nature reserve and other small reserves
	Beneficiaries	• Significance to households that rely on ground water for water provisioning; • Subsistence and commercial agriculture in associated towns and their surroundings; and • Tourism industry in associated towns and communities.
	Impacts	• Commercial agriculture (including forestry); manufacturing; tourism; and households.
13: IUA_S01 Upper Great Kei	**Key Ecosystem Service:**	**Key Ecological Infrastructure:**
	Provisioning: • Water • Food • Raw materials	• Rivers • Wetlands • Ground water SWSA • Lubisi, Ncora and Indwe dam
	Regulation: • Water regulation • Water quantity • Erosion control / soil stability • Biological control	• Rivers • Wetlands • Forestry
	Beneficiaries	• Significance to households that rely on ground water for water provisioning; and • Significant subsistence agriculture in associated towns and their surroundings.
	Impacts	• Households, and forestry
14: IUA_S02 Black Kei	**Key Ecosystem Service:**	**Key Ecological Infrastructure:**
	Provisioning: • Water • Food • Raw materials	• Rivers • Wetlands • Ground water
	Regulation: • Water regulation • Water quantity • Erosion control / soil stability • Biological control	• Rivers • Wetlands

IUA	Ecosystem services, beneficiaries and impact	
	Cultural: ● Landscape & amenity values	
	Beneficiaries	● Significance to households that rely on ground water for water provisioning. ● Subsistence and commercial agriculture in associated towns and their surroundings
	Impacts	● Commercial agriculture; and households
15: IUA_S03 Lower Great Kei	**Key Ecosystem Service:**	**Key Ecological Infrastructure:**
	Provisioning: ● Water ● Food ● Raw materials	● Rivers ● Wetlands ● Ground water SWSA ● Wrigglewade dam
	Regulation: ● Water regulation ● Water quantity ● Erosion control / soil stability ● Biological control ● Climate change	● Rivers ● Wetlands ● Forestry
	Cultural: ● Ecotourism & recreation ● Landscape & amenity values	● Coastline ● Qacu nature reserve and other small nature reserves
	Beneficiaries	● Significance to households that rely on ground water for water provisioning; ● Commercial and subsistence agriculture in associated towns and their surroundings; and ● Tourism industry in associated towns and communities.
	Impacts	● Commercial agriculture (including forestry); tourism; and households.
16: IUA_T01 Upper Mbashe, Upper Mthatha	**Key Ecosystem Service**	**Key Ecological Infrastructure:**
	Provisioning: ● Water ● Food ● Raw materials	● Rivers ● Wetlands ● Ground water
	Regulation: ● Water regulation ● Water quantity ● Erosion control / soil stability ● Biological control ● Climate change	● Rivers ● Wetlands ● Forestry
	Beneficiaries	● Significance to households that rely on surface water for water provisioning; and ● Significant subsistence agriculture in associated towns and their surroundings.
	Impacts	● Households and forestry
17: IUA_T02	**Key Ecosystem Service:**	**Key Ecological Infrastructure:**

IUA	Ecosystem services, beneficiaries and impact	
Lower Mbashe	**Provisioning**: ● Water ● Food ● Raw materials	● Rivers ● Wetlands ● Ground water
	Regulation: ● Water regulation ● Water quantity ● Erosion control / soil stability ● Biological control	● Rivers ● Wetlands
	Cultural: ● Ecotourism & recreation ● Landscape & amenity values	● Coastline ● Dwesa-Cwebe marine protect area
	Beneficiaries	● Significance to households that rely on rivers for water provisioning. ● Subsistence farming in associated towns and their surroundings ● Tourism industry in associated towns and communities
	Impacts	● Subsistence agriculture; tourism; households
18: IUA_T03 Lower Mthatha	**Key Ecosystem Service**	**Key Ecological Infrastructure:**
	Provisioning: ● Water ● Food	● Umtata dam ● Rivers ● Estuary ● Ground and surface SWSA ● Wetlands
	Regulating: ● Water quantity ● Water quality ● Erosion control Biological control	● Rivers ● Wetlands
	Cultural: ● Ecotourism ● Aesthetic appreciation and cultural inspiration	● Estuary ● Coastline
	Beneficiaries	● Significance to rural communities as some households rely on rivers for water provisioning; ● Hydropower in the catchment; ● Subsistence agriculture (Livestock) associated with the town of Mthata and surroundings; and ● Tourism industry in associated towns and communities.
	Impacts	● Agriculture; Manufacturing; Electricity; Tourism; Households.
19: IUA_T04 Pondoland coastal	**Key Ecosystem Service**	**Key Ecological Infrastructure:**
	Provisioning: ● Water ● Food ● Raw materials	● Rivers ● Wetlands ● Ground-surface water SWSA

IUA	Ecosystem services, beneficiaries and impact	
	Regulation: ● Water regulation ● Water quantity ● Erosion control / soil stability ● Biological control	● Rivers ● Wetlands ● Forestry
	Cultural: ● Ecotourism & recreation ● Landscape & amenity values	● Pondoland protected area ● Dwesa-Cwebe protected area ● Coastlines
	Beneficiaries	● Significance to households that rely on rivers for water provisioning; ● Significant subsistence agriculture in associated towns and their surroundings; and ● Tourism industry in associated towns and communities.
	Impacts	● Tourism; households, and forestry.

4.3 Status quo of groundwater aspects

Table 4-3 summarises the groundwater status for each IUA, highlighting areas where groundwater is the primary source of water use (DWS, 2024, Report No. WEM/WMA7/00/CON/RDM/0922; DWS, 2022, Report No: WEM/WMA7/00/CON/RDM/0322). These IUAs mostly include small towns reliant on groundwater to supplement surface water resources. Additionally, parts of certain IUAs are designated for future development (Scenario 2 and/or Scenario 3) to reduce pressure on surface water supplies (see DWS, 2024, Report No: WEM/WMA7/00/CON/RDM/2324). The table also presents where groundwater-stressed areas are identified where usage exceeds recharge.

Table 4-3: Summary of the groundwater status within each IUA

IUA No.		IUA description	GW Aquifer types	Current GW use	BHN (million m^3/a)	Stressed areas	SWSA	GW driving the water use	Planned GW developments (Sc 2 and/or 3)
1	IUA_K01	Tsitsikamma and headwaters of Kromme to Kromme Dam	The aquifer is of a fractured type, mainly associated with the fractured Table Mountain Group Aquifer.	9.4Mm^3/annum. Large percentage of total groundwater use is for irrigation (78%)	0.0477	Moderately to highly stressed	Yes	High	-
2	IUA_KL01	Kromme from Kromme Dam to estuary and Gamtoos	The aquifer is of a fractured type, mainly associated with the fractured Table Mountain Group Aquifer.	Large percentage of total groundwater use is for irrigation (57%) and 26% for municipal use. Groundwater qualities are good to marginal.	0.0146	Moderately stressed in certain areas	Yes	High	Groundwater development for Kouga LM There will be potentially short term groundwater development, medium term de-salination and further groundwater development to provide domestic demands for Algoa area. Coega-kop aquifer and other ad hoc groundwater exploitation near Kromme Dam (Churchill).

IUA No.		IUA description	GW Aquifer types	Current GW use	BHN (million m^3/a)	Stressed areas	SWSA	GW driving the water use	Planned GW developments (Sc 2 and/or 3)
3	IUA_L01	Kouga to Kouga Dam, Baviaanskloof	The aquifer is of a fractured type, mainly associated with the fractured Table Mountain Group Aquifer.	6.0Mm^3/annum, of which 90% is for irrigation.	0.0346	Mildly stressed in certain areas. However, there is high GW use impacts on baseflows in the rivers	Yes	High	Kouga LM additional groundwater development to augment and supplement existing surface water allocations from Churchill & Kouga Dams. (2.2 million m^3/a)
4	IUA_M01	M primary catchment	The aquifer is of a fractured type, mainly associated with the fractured Table Mountain Group and Uitenhage Group. A small part of the IUA is also of an intergranular type, associated with Quaternary sands.	8.4Mm^3/annum, of which 51% is for irrigation, 29% is for municipal use and 12% is for industrial use.	0.0968	Mildly stressed in certain areas.	Yes	High	Groundwater development Groundwater development at Swartkops (0.4 million m^3/a)

IUA No.		IUA description	GW Aquifer types	Current GW use	BHN (million m^3/a)	Stressed areas	SWSA	GW driving the water use	Planned GW developments (Sc 2 and/or 3)
5	IUA_LN01	Groot to Kouga confluence, Upper Sundays to Darlington Dam	The aquifer is of a fractured type, mainly associated with the fractured Upper Cape Supergroup (Bokkeveld and Witteberg Groups) and Lower Karoo Supergroup.	65% of groundwater use is for irrigation and, 31% for domestic. A number of towns in this area is solely dependant on groundwater with no other sources available.	0.1523	Mildly to moderately stressed in certain areas.	Yes	High	Groundwater development (Groot) (0.2 MCM/a) Groundwater development (Sundays) (0.82 MCM/a)
6	IUA_N01	Sundays downstream Darlington Dam	The aquifer is mainly of a fractured type associated with the fractured Lower Karoo Supergroup and Uitenhage Group. A smaller part of the area is also of an intergranular type associated with Quaternary sand and alluvium.	Minimal groundwater use for irrigation, industrial and domestic.	0.0161	No stressed areas	No	Low	-

IUA No.		IUA description	GW Aquifer types	Current GW use	BHN (million m^3/a)	Stressed areas	SWSA	GW driving the water use	Planned GW developments (Sc 2 and/or 3)
7	IUA_P01	P primary catchment	The aquifer is mainly of a fractured type associated with the upper Cape Supergroup (Bokkeveld and Witteberg Groups) and Lower Karoo Supergroup. A smaller part of the area is also of an intergranular type associated with Quaternary sand and alluvium.	70% of the total groundwater use is for municipal and 15% for irrigation.	0.1034	No stressed areas	Yes	High	-
8	IUA_Q01	Upper Fish	The aquifer is mainly of a fractured type associated with the Karoo Supergroup. Intergranular and fractured aquifers, owing to the presence of dolerite sills and dykes also exist, as well as localised intergranular aquifers	57% of the total groundwater use is for irrigation purposes and 30% for domestic	0.1545	Mildly to highly stressed in certain areas.	No	High	Groundwater development (Fish) (0.7 MCM/a)

IUA No.		IUA description	GW Aquifer types	Current GW use	BHN (million m^3/a)	Stressed areas	SWSA	GW driving the water use	Planned GW developments (Sc 2 and/or 3)
			associated with alluvial deposits.						
9	IUA_Q02	Great Fish	The aquifer is mainly of a fractured type associated with the Karoo Supergroup. Intergranular and fractured aquifers, owing to the presence of dolerite sills and dykes also exist.	Water use, mainly for irrigation in those areas not linked to the transfer scheme.	0.0530	Mildly to highly stressed in certain areas.	Yes	Moderate	Groundwater development (Fish) (0.7 MCM/a)

IUA No.		IUA description	GW Aquifer types	Current GW use	BHN (million m^3/a)	Stressed areas	SWSA	GW driving the water use	Planned GW developments (Sc 2 and/or 3)
10	IUA_Q03	Koonap and Kat	The aquifer is mainly of a fractured type associated with the Karoo Supergroup. Intergranular and fractured aquifers, owing to the presence of dolerite sills and dykes also exist.	GW use limited	0.0115	No stressed areas	Yes	Low	Groundwater development (Kat) (0.7 MCM/a)
11	IUA_R01	Keiskamma	The aquifer is mainly of a fractured type associated with the Karoo Supergroup. Intergranular and fractured aquifers, owing to the presence of dolerite sills and dykes also exist.	GW use limited	0.0425	No stressed areas	No	Low	-

IUA No.		IUA description	GW Aquifer types	Current GW use	BHN (million m^3/a)	Stressed areas	SWSA	GW driving the water use	Planned GW developments (Sc 2 and/or 3)
12	IUA_R02	Buffalo/ Nahoon	The aquifer is mainly of a fractured type associated with the Karoo Supergroup. Intergranular and fractured aquifers, owing to the presence of dolerite sills and dykes also exist.	GW use limited	0.0490	Mildly stressed in certain areas.	No	Low	Groundwater (Amathola) (3.3 million m^3/a Water reuse / Aquifer storage Recovery (ARS). This is TBC (water balance suggests that the first intervention would be needed in around 2027). Dependant on effectiveness of WC/WDM and AIP removal, this could be around 2030. This recommends for both future scenarios (medium and long term) AIP removal – TBC, approximate areas of AIPs flagged by Region. Total use appears uncertain. 2015 estimates of AIP impacts around 8.4 million m^3/a. Location needs to be confirmed.

IUA No.		IUA description	GW Aquifer types	Current GW use	BHN (million m^3/a)	Stressed areas	SWSA	GW driving the water use	Planned GW developments (Sc 2 and/or 3)
13	IUA_S01	Upper Great Kei	The aquifer is of an intergranular and fractured type associated with the Karoo Supergroup, as well as the presence of dolerite sills and dykes.	Mostly for domestic/ rural water supply.	0.2238	No stressed areas.	Yes	High	Groundwater development (0.1 MCM/a)
14	IUA_S02	Black Kei	The aquifer is of an intergranular and fractured type associated with the Karoo Supergroup, as well as the presence of dolerite sills and dykes.	GW use limited	0.1111	Mildly to moderately stressed in certain areas.	No	Low	-
15	IUA_S03	Lower Great Kei	The aquifer is of an intergranular and fractured type associated with the Karoo Supergroup, as well as the presence of dolerite sills and dykes. The IUA is	GW use limited	0.0271	Moderately stressed in certain areas.	Yes	Low	Kubu: Groundwater development (2 MCM/a) Groundwater development in Butterworth & Idutwa

IUA No.		IUA description	GW Aquifer types	Current GW use	BHN (million m^3/a)	Stressed areas	SWSA	GW driving the water use	Planned GW developments (Sc 2 and/or 3)
16	IUA_T01	Upper Mbashe, Upper Mthatha	The aquifer is of an intergranular and fractured type associated with the Karoo Supergroup, as well as the presence of dolerite sills and dykes.	GW use limited	0.1574	Mildly to highly stressed in certain areas.	Yes	Low	-
17	IUA_T02	Lower Mbashe	The aquifer is of an intergranular and fractured type associated with the Karoo Supergroup, as well as the presence of dolerite sills and dykes.	GW use limited	0.0268	Mildly stressed in certain areas.	No	Low	-
18	IUA_T03	Lower Mthatha	The aquifer is of an intergranular and fractured type associated with the Karoo Supergroup, as well as the presence of dolerite sills and dykes.	GW use limited	0.0666	Moderately stressed in certain areas.	No	Low	Groundwater development proposed in Mthatha to alleviate stress on surface water resources

IUA No.		IUA description	GW Aquifer types	Current GW use	BHN (million m^3/a)	Stressed areas	SWSA	GW driving the water use	Planned GW developments (Sc 2 and/or 3)
19	IUA_T04	Pondoland coastal	The aquifer is of an intergranular and fractured type associated with the Karoo Supergroup, as well as the presence of dolerite sills and dykes.	GW use limited	0.1197	No stressed areas	Yes	Low	-

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5 LINKING SOCIO-ECONOMIC AND ECOLOGICAL VALUE AND CONDITION OF WATER RESOURCES

5.1 Ecosystem services per IUA

The Keiskamma and Fish to Tsitsikamma catchment IUAs broadly represent variation between socio-economic drivers, well-being and characteristics of beneficiaries of ecosystem services across the catchment. Based on this variation, and variation in distribution of ecological infrastructure, each IUA benefits to varying degrees from the flow and direct use of ecosystem services. Variation between beneficiaries is further subdivided into formal and informal users.

Formal beneficiaries are defined here as beneficiaries whose use of consumptive ecosystem services (provisioning services) are regulated through formal structures (i.e., require a water use license or municipality to extract or use water). The formal beneficiaries in the catchment include municipalities, agricultural, manufacturing, mining, government services, electricity and water, real estate and business and urban households. Informal beneficiaries include beneficiaries of services that are not formally regulated and are attributed to the subsistence use of resources in relatively undeveloped regions and on traditional land. These informal beneficiaries are associated with rural communities of whom livelihoods are closely associated with benefits from natural ecosystems.

The consequences on ecosystem services flow of management may vary between each beneficiary type. The rural populations are especially vulnerable to changes in ecosystem service delivery. The spatial distribution of these beneficiaries in relation to ecological infrastructure was assessed to reveal the spatial orientation of ecosystem service flow and type.

Key ecosystem services identified and prioritised across the Keiskamma and Fish to Tsitsikamma catchment include:

1. Fresh Water Provisioning;
2. Water Quantity Regulation;
3. Food, Raw Materials and Wild Collected Products Provisioning;
4. Erosion Regulation;
5. Water Quality Regulation: Purification and Waste Management;
6. Spiritual, Landscape and Amenity Services;
7. Tourism and Recreational Services; and
8. Biodiversity Support.

5.1.2 Fresh Water Provisioning

Key Ecological infrastructure:	Rivers, Streams, Dams and Aquifers
Beneficiaries:	Agriculture, Households, Manufacturing, Mining, Government Services, Forestry,
Use:	Direct use value

Water provisioning is a predominant ecosystem service provided to beneficiaries within the Keiskamma and Fish to Tsitsikamma catchment. There are a range of formal and informal beneficiaries of the fresh-water provisioning service.

There are several large and small dams within the catchment and these provide mainly for irrigation, but also for local domestic and rural water use purposes. Commercial agriculture is a large consumer of water in the catchment and the sector is predominantly situated on the coastline (i.e., region P, K and M). While annual crop cultivation relies primarily on seasonal rains, irrigated agriculture is largely dependent on water abstraction from dams, rivers and streams. The estimated total area that is under irrigation is just under 133,000ha. The rest of the agricultural land within the catchment falls under dryland, grazing or subsistence agriculture (this may be informally irrigated). Irrigation represents one of the main water users within the catchment with approximately 797 million m^3 /a (based on WR2012 and consumption rates) water being supplied through various irrigation schemes. Irrigated agriculture is situated within all of the IUA's, apart from IUA 17, 18 and 19.

Subsistence agriculture, while it is likely to consist mainly of annual crops, may contain a mixture of dryland and irrigated crops. The irrigation supplied to these crops is likely informal, which requires the manual transfer of water from streams or rivers to the fields. The catchment has a notable subsistence agriculture area, with large areas covering the eastern region of the catchment.

The Keiskamma and Fish to Tsitsikamma catchment is home to a population of approximately 6 million people which represent the beneficiaries that use water. Households can be subdivided into those with formal water distribution infrastructure (i.e., piped tap water) and those without. The distribution of households with operational piped tap water is largely concentrated around cities and towns.

The catchment is mainly rural with a few large urban areas in East London, Gqeberha, and Makhanda. A significant proportion of the rural population has limited or no access to piped water, needing to rely on informal sources of water, often directly from the ecological infrastructure of rivers and streams. This may be due to either formal water distribution infrastructure in bad condition or requiring maintenance or perhaps a lack of this infrastructure therefore driving communities to source water from alternative sources. Impacted infrastructure could include silted dams, non-compliant WWTWs (48 plants in critical state according to 2021 Green Drop assessment) or inefficient distribution infrastructure. For those people that rely on sourcing their water directly from rivers and streams (i.e., predominately in region T), the condition and flow in these source channels are vitally important.

There are two key industrial hubs within the Keiskamma and Fish to Tsitsikamma catchment located in the Buffalo City Metropolitan Municipality and the Nelson Mandela Bay Metropolitan Municipality areas. Two of South Africa's Special Economic Zones (SEZ) are located here, East London Industrial Development Zone (supported by the Port of East London) and the Coega Industrial Development Zone (at the Port of Ngqura in Gqeberha). Both areas have well-established manufacturing industries, with the automotive industry playing a significantly large role. The wide range of heavy, and light manufacturing and commercial activities taking place, all require a constant, uninterrupted supply of water, which is generally supplied through formal municipal water distribution systems. Due to the large size of the agricultural industry in the catchment, it is likely that agriculture related manufacturing also represents a large proportion of water allocation as required for production.

The mining operations within the catchment are predominantly quarrying, mineral and sand mining. It should be noted that sand mining may pose a threat to estuary condition and this particularly affects IUA 18 (IUA_T03).

The largest water transfer into the catchment is the water transferred into the catchment from the Gariep Dam to the upper reaches of the Great Fish River. This water is used mainly for irrigation and some domestic use by towns. Water is also transferred within the catchment to the Algoa System to provide water for domestic use.

Changes to allocation of water within the system may affect different beneficiaries in a variety of ways. Greater allocation of water to commercial or industrial activities, may have a significant impact on some informal water users, although most of these rely on smaller tributaries above the main water courses. Similarly, the state of formal water distribution infrastructure will influence the flow of these water provisioning benefits to their final intended beneficiaries.

5.1.3 Water quantity regulation (Flow Regulation)

The eco-classification process plays an important role in integrating various parameters of flow, geomorphology, water chemistry and others and recommending ecological classification scenarios are various EWR sites in the WMA. From the resource economics perspective, our challenge is to interpret the consequences and likelihoods of these scenarios on beneficiaries.

Key ecological infrastructure:	Wetlands, Surface & Groundwater Strategic Water Source Areas (SWSAs)
Beneficiaries:	Households, Agriculture, Industry
Use:	Indirect use value

Water quantity regulation is an ecosystem service provided by ecosystems within the Keiskamma and Fish to Tsitsikamma catchment. The catchment contains several Strategic Water Source Areas which represent sourcing areas for water that supplies not only the basin but also adjacent basins with valuable fresh water.

The service is linked to the ability of the catchment to capture precipitation through various processes. Healthy, intact soils are vital for effective infiltration, with the escarpment,

grasslands, woodlands and forests being the primary ecological infrastructure associated with this ecosystem service.

The bulk of precipitation is captured throughout the wet season in the summer months by the surface Strategic Water Source Areas (SWSA's). Strategic Water Source Areas (SWSA's) are defined as areas that supply a disproportionate amount of mean annual runoff to a geographical region of interest. The geographic region of interest is in fact South Africa making the SWSA's present in the catchment highly crucial water source areas at a national scale. These SWSA's represent key ecological infrastructure in this regulating service. Other ecological infrastructure associated with water quantity regulation includes wetlands and aquifers that are found downstream of the SWSA's.

Domestic users require a constant supply of water throughout the year. This is mostly facilitated by municipal infrastructure. However, there is a large proportion of households in the catchment that rely on rivers and streams for their daily water needs. The ecosystem service of water flow regulation is particularly important for these users (ie., region T), who would be unable to continue their way of life if the rivers and streams they rely on were to run dry, even if only for a short period during the year. As suggested in the previous section, upgrading or investment into water distribution infrastructure may mitigate these risks. Many households are also situated along riverbanks, and by mitigating the potential effects of flooding, water regulation ensures their protection.

The commercial agricultural activity of dryland crop cultivation in the Keiskamma and Fish to Tsitsikamma catchment relies primarily on seasonal rains. Irrigated agriculture, however, often relies on direct abstraction from rivers and streams, both playing a role in regulating water flow, and relying on a steady supply. A change in water allocation towards water transfers could affect these beneficiaries negatively.

The cascading effect of a healthy river system supports provisioning and regulating services in the entire system. Particular consideration is through the interactions with estuaries through facilitating the spawning cycle of a number of fish species which rely on the nutrients in the outflow of the river into the sea.

A key concept to note here are the water requirements associated with effective functioning of aquatic ecosystems within the catchment known as the Ecological Water Requirements (EWR). The EWR represents a base flow that is necessary for ecosystem functioning. The management and maintenance of the EWR is vital to ensure long term sustainable development of the catchment and its natural resources. This consideration is key when determining the upper limits of development and water extraction scenarios and therefore limit specific types of development activities across varying ecosystems and catchments.

5.1.4 Erosion Regulation

Key ecological infrastructure:	**Grasslands, Wetlands, Forests, Rivers, Estuaries**
Beneficiaries:	Commercial and subsistence agriculture (multiple indirect beneficiaries)
Use:	Indirect use value

Erosion control is an intermediary service and is therefore integral to other final ecosystem goods and services and is linked to water quantity regulation services. “Vegetation cover prevents soil erosion and ensures soil productivity through natural biological processes such as nitrogen fixation” (FAO, 2020), and is thus linked to the food provisioning services discussed above.

The main ecological infrastructure associated with soil stability and erosion control is healthy terrestrial systems, wetlands and indigenous forests. This is particularly true of areas with significant slopes and undulating or extreme topography. Soil stability is of vital importance throughout the catchment, with some IUAs being of particular significance for the prevention of erosion to protect food and water security. Any regions within the catchment with potentially erosive soils will be considered in the risk assessment to follow during the scenario evaluation step.

This may be in IUAs that exhibit high levels of subsistence agriculture, which is often where the highest prevalence of erosion is found. While commercial farmers possess the knowledge and resources to mitigate for the dangers of soil erosion, this is not always the case for subsistence farmers. Many of these communities also inhabit slopes, where the danger of erosion is exaggerated.

As is clear from the above, subsistence farmers are the primary beneficiaries of the regulating service of erosion control, due to their reliance on healthy, intact soil to grow their food. Commercial agriculture also derives indirect use value from this service, as stable soils form the basis of their productive capacity.

Changes to water allocation is unlikely to have a major effect on the beneficiaries of this ecosystem service, although effective erosion control may in fact have a net benefit on the overall quantity of water for allocation, due to the water capturing quality of healthy vegetated slopes.

5.1.5 Water Quality Regulation: Purification and Waste Management

Key ecological infrastructure:	Wetlands, Aquifers, Rivers
Beneficiaries:	Government Services, Households, Manufacturing, Agriculture, Mining (Multiple indirect beneficiaries)
Use:	Direct/indirect use value

Ecological infrastructure associated with water purification and waste management are primarily wetlands, but also includes rivers and streams. Wetlands act as natural water filters. By slowing the flow of water they allow particulate matter to settle, while many of the aquatic plants found in wetlands are even capable of extracting chemical pollutants from the water. Natural watercourses of streams and rivers also play a role in purifying water, as vortices and eddies further purify and oxygenate water.

It may be said that the main beneficiaries of natural water purification services are regional and local water boards, who would otherwise have to invest considerable funds into the man-made infrastructure necessary for water purification. This benefit is also carried forward to private and commercial water users, through lower water tariffs and naturally pure water. Treated wastewater released by municipalities into the environment is also further purified by natural systems.

Low income and rural communities are once again one of the primary beneficiaries, as they rely on the water they collect from rivers and streams being clean. While formal beneficiaries often have the means to improve water quality, informal beneficiaries do not always have the means to identify alternative sources of water, and may need to divert valuable resources to water purification before consumption is possible.

Industry, particularly industries which produce significant amounts of contaminated effluent also benefit greatly from the purification services provided by the natural environment. While polluting industries are required to treat their effluent before releasing it back into watercourses, further purification by natural systems ensures that water users downstream is of a higher quality than it otherwise may be, externalising some of the costs of purification for these industries.

Key ecosystems providing water quality regulation services to beneficiaries are those positioned downstream of land uses that are known to impact water quality negatively. This being ecosystems that receive contaminated water resources from upstream impacts, typically more industrialised land uses, and provide regulated or treated water to downstream beneficiaries. For this reason, we do not expect water quality ecosystem services to have significant value high in the escarpment (as the water is not contaminated at that point), but rather see this service adding value to beneficiaries in the central regions of the catchment prior to supplying the less developed regions of the catchment.

The ecological infrastructure of primary importance for the quality regulation of water in the Keiskamma and Fish to Tsitsikamma catchment include the wetland systems.

If wetlands dry up due to insufficient flow, their ability to perform the purification services may be impaired. It is thus important that any changes to water allocation consider the health of these systems in their design.

5.1.6 Food, Raw Materials and Wild Collected Products Provisioning

Key ecological infrastructure:	**Grasslands, Rivers, Wetlands, Dams; Estuaries**
Beneficiaries:	Rural households, subsistence agriculture, agricultural sector (livestock grazers)
Use:	Direct use value

With both commercial and subsistence agriculture being widespread throughout the Keiskamma and Fish to Tsitsikamma Basin, the ability of the land to provide food provisioning services is of major importance to the region. Fertile soil, along with sufficient water, as discussed above, provides the ideal conditions for food cultivation. Grasslands also provide grazing for cattle, which is of particular importance to subsistence farmers.

There are several commercially productive areas in the Keiskamma and Fish to Tsitsikamma catchment. Commercial agriculture derives the highest quantifiable benefit from the ability of the land to provide the necessary conditions for a range of crops to be cultivated, and is one of the main economic driver in a number of municipalities throughout the region. It should be noted, however that only a portion of the value in agriculture can be linked to this ecosystem service, as significant additional inputs are required for the cultivation of commercial crops.

Subsistence agriculture, although less easily quantifiable, is arguably even more important as it is the primary source of nutrition for rural populations, which comprise a large number of the people in region. This is likely largely comprised of staple crop and vegetable cultivation, as well as widespread grazing of cattle and goats.

The benefits of food production also extend beyond only the agricultural industry itself and subsistence farmers. Significant economic value is also added in secondary processing of agricultural products, providing an income for a large number of households and industries throughout the region, and facilitating further economic development.

With regards to more rural communities, it is likely that wild collected food also contributes to their food security, while wood collected from the wild is often a primary source of fuel. Other wild harvested medicinal products and foodstuffs from the surrounding environment may also be traded in the informal economy.

It is not expected that changes to water allocation policies would affect beneficiaries of wild harvested food and materials considerably. Reduced water flow may however affect harvesting of fish in rivers and have greater impacts on ecosystems associated with river mouth estuaries. Changes to flow regime would impact on processes such as sedimentation and flood events, the period for which the mouth is open (impacting salinity gradients and

access by species) and inputs to marine systems from inland. Impacts on these processes would greatly impact the provisioning services supported by the estuarine system.

5.1.7 Spiritual, Landscape and Amenity Services

Key ecological infrastructure:	**Ecological Infrastructure within Traditional homelands, the Drakensberg escarpment, protected areas and the coastline**
Beneficiaries:	Households, real estate activities
Use:	Direct use value

A significant portion of the Keiskamma and Fish to Tsitsikamma catchment is home to rural communities for whom the region is inextricably linked to their cultural identity and sense of place. This indirect non-use, or existence, value is present with much of the history and traditional knowledge of the Xhosa people being linked to the greater region, while also holding historical value for other groups of South Africans as well.

Areas with clusters of rural settlements and land tenure patterns are expected to hold significant existence value for the local communities. It is likely that the people in these communities have been tied to those areas of land for many generations, and that many of their spiritual beliefs and cultural practices are linked to features of the landscape.

The inhabitants of these communities are likely also more heavily reliant on the other life-sustaining ecosystem services discussed above, as they are generally quite isolated, and thus have largely not been connected to infrastructure such as piped water, waste removal, and other services associated with economic development. These communities thus hardly engage in the formal economy, and may not even be particularly active in the informal economy. Areas of significant historical importance such as Isandlwana may also be considered as having particular cultural value.

Amenity value is also considered here, with places of particular natural beauty which drive increased property values and are attractive to developmental activities such as real estate development. IUA's exhibiting value in this regard include those close to nature reserves or scenic areas and those with coastal properties (i.e., Addo Elephant, Tsitsikamma, Garden Route, Mountain Zebra)

Primary Catchment L includes a portion of the Cape Floral Region which is a World Heritage Site. This results in key policies attributed to this region governing the protection of cultural and natural heritage.

5.1.8 Tourism and Recreational Services

Key ecological infrastructure:	**Escarpment, rivers, wetlands, dams, protected areas, estuaries, and the coastline**
Beneficiaries:	Local populations, Tourists, Hotels & Restaurants
Use:	Direct use value

Tourism has been identified as a key economic driver in many parts of the Keiskamma and Fish to Tsitsikamma catchment. This cultural ecosystem service "includes both benefits to visitors and income opportunities for nature tourism service providers" (FAO, 2020). This direct use value is associated with a wide range of ecological infrastructure, including natural pristine landscapes, comprised of mountains, rivers, wetlands, and coastal areas, particularly those which host a diversity of plant and animal life.

Three specific categories of tourism are identified, namely business, historic and eco-tourism. The business tourism, although it will reflect on the size of the tourism industry is not necessarily linked to ecosystems. Business tourism industry is expected to centre around major economic hubs such as Buffalo City and Nelson Mandela Bay. Historical tourism, including memorials or museums or other historic sites, is not necessarily linked to ecosystems, however the undeveloped nature of these landscapes likely causes historical tourism to overlap with ecotourism. The eco-tourism industry is directly related to the presence of healthy ecosystems and undeveloped ecological infrastructure such as those found in the Protected Areas (government and private) and along the coast.

The Keiskamma and Fish to Tsitsikamma catchment includes several national parks, nature reserves (provincial and private), protected areas and heritage sites which all contribute towards attracting tourists to the region. The National Parks include Addo Elephant in IUA 6 (IUA_N01), Tsitsikamma and Garden Route in IUA 1 (IUA_K01), and Mountain Zebra in IUA 9 (IUA_Q02) and are a significant asset, drawing a tourists, both domestically and from around the world. Provincial Nature Reserves include Mkambati in IUA 19 (IUA_T04), Hluleka, Dwesa-Cwebe in IUA 17 (IUA_T02), Hamburg in IUA 11 (IUA_R01), Great Fish in IUA 9 (IUA_Q02), Mpofu, Groendal in IUA 4 (IUA_M01), Baviaanskloof in IUA 3 (IUA_L01), Formosa IUA 1 (IUA_K01), and Doubledrift. The Private Nature Reserves include for example Black Eagle Nature Reserve.

Aquatic recreational activities such as boating, river rafting, kayaking, fishing, and diving (mostly the estuary areas) also attract tourists and holiday makers to both inland and coastal aquatic systems within the greater catchment.

Beneficiaries deriving value from this service include those visiting and, possibly more importantly, the local communities in which these attractions are situated. A number of local municipalities have aspirations to further develop their tourism industry as a way of boosting economic activity.

Tourists and holiday makers derive pleasure from engaging in activities such as hiking, game viewing, bird watching in the many protected areas throughout the region. It is widely accepted

that spending time in nature provides significant psychological and emotional benefits, as well as the obvious physical benefits gained from the more active pastimes.

Communities around tourism hotspots are the primary local beneficiaries of the value created by these areas. These include local hoteliers, tour operators and tour guides, as well as curio manufacturers, and the support staff employed by the tourism industry, particularly in hotels and restaurants.

Changes to water allocation my affect some of these beneficiaries. If river flow is reduced this could lead to a reduction in the potential for aquatic activities along the major water courses, although dams would likely be unaffected. An important consideration is the impact of reduced flow on the ecological integrity of the estuary, and thus its value to visitors.

5.1.9 Biodiversity Support

Key ecological infrastructure:	**Undeveloped biodiversity corridors, ecosystem margins**
Beneficiaries:	Agriculture, households, (Multiple indirect beneficiaries)
Use:	Indirect non-use value

Support of biodiversity, including biological control, is another important, but often overlooked service provided by healthy ecosystems, and intrinsically linked to many of the other services discussed. Biodiversity has far-reaching benefits to human-natural systems, such as maintaining a balance between parasites, pests, and their predators; maintaining healthy populations of pollinators; and fostering the necessary conditions for many of the food species, particularly fish species, which form a key part of human nourishment.

In this respect, key biodiversity hotspots include the protected areas in various IUAs. The estuaries within the catchment, represent significant features that play an integral role in the regulation and support of biotic processes. The nutrient rich water flowing into the sea supports and drives lifecycles of a number of commercially valuable aquatic species (fish, crab, eel and prawns).

The beneficiaries of this service are widespread and diverse. Agriculture benefits through the natural control of pests and parasites, saving costs on pesticides and animal dips. Healthy populations of pollinators also increase crop yields. Households benefit through the reduced prevalence of disease, and it follows that healthcare systems also benefit from a healthier population.

Reduction of flow may have significant effects on the ability of certain areas of the catchment to provide biodiversity support services. An important consideration is the impact of reduced flow on the ecological integrity of the estuaries, and thus their value to the propagation of fish species.

5.2 Ecosystem services and linkages to socio-economics

5.2.1 Consolidated Beneficiaries

Beneficiaries, as per those identified through the QSAM, of prioritised ecosystem services were consolidated per ecosystem service (**Table 5-1**). The value of the ecosystem services to each beneficiary varies depending on the size of the sector, the magnitude of environmental contribution received and the dependency of the sector on the benefit.

Table 5-1: Ecosystem Service linkages with QSAM beneficiaries in the Keiskamma and Fish to Tsitsikamma catchment

Intermediate Ecosystem Service	Final Ecosystem, Services	General Sector	QSAM Beneficiary Class
Water Quality Regulation Water Quantity Regulation Erosion and Soil Regulation	Food Provisioning	Informal Households	Non-observed, informal, non-profit, households
		Agriculture	Agriculture
	Fresh Water (Water quantity) Provisioning	Households	Non-observed, informal, non-profit, households
			Households
		Agriculture	Agriculture (Irrigation)
		Forestry	Forestry
		Manufacturing	Food
			Beverages and tobacco
			Tanning and dressing of leather
			Paper
			Other chemical products, man-made fibres
			Rubber
			Plastic
			Glass
			Basic iron and steel, casting of metals
			Basic precious and non-ferrous metals
			Machinery and equipment
			Electrical machinery and apparatus
			Radio, television, communication equipment and apparatus
			Motor vehicles, trailers, parts
			Other transport equipment
			Furniture
			Manufacturing n.e.c, recycling
		Mining	Other mining and quarrying
		Government Services	Electricity, gas, steam and hot water supply

Intermediate Ecosystem Service	Final Ecosystem, Services	General Sector	QSAM Beneficiary Class
			Collection, purification and distribution of water
			Sewerage and refuse disposal
	Raw Materials Provisioning	Informal Households	Non-observed, informal, non-profit, households,
	Medicinal resources Provisioning	Informal Households	Non-observed, informal, non-profit, households,
	Landscape & amenity values	Households	Non-observed, informal, non-profit, households,
			Households
			Real estate activities
	Ecotourism & recreation	Accommodation	Hotels and restaurants
		Recreation/Activities	Recreational, cultural and sporting activities

5.2.2 Demonstrating linkages between the socio-economic and ecological value and condition of water resources

The Keiskamma and Fish to Tsitsikamma catchment is characteristic of a range of ecological infrastructure which provide a range of natural benefits to a range of formal and informal beneficiaries. Through the development of the IEM, several key linkages and insights have been revealed.

The Keiskamma and Fish to Tsitsikamma catchment contributes an estimated R279 billion (preliminary based on data from ECSECC, 2016) to the economy of South Africa. This economy is relatively small representing only 5.8% of the national GDP of R4.9 trillion (Stats SA 2018). The largest sectors include the government sector, agriculture, hotels, restaurants and real estate, and manufacturing activities which represent 26%, 20%, 19% and 12% contribution to the catchment total GVA respectively.

The links of economic sectors to ecosystem services are predominantly through the provisioning and regulation of much needed fresh water, but also through the cultural services, including tourism and recreation, and landscape amenity values. Although the value added by the sectors in their entirety cannot be directly attributed to ecosystem services, the support these services provide through enabling or opportunity benefits, is significant. The natural contributions can therefore be linked as a proportion of the total size of the sectors. The value of ecosystem services, as a proportion of the total size of a specific sector will vary between sectors depending on their reliance on the service. The value contribution, for example to the irrigated agriculture sector (as a highly water reliant sector) will be significantly larger than that of the glass manufacturing, for instance (whose reliance on water for production is not as high as agriculture).

Where the management of water is concerned, the agricultural (specifically irrigated agriculture), agricultural manufacturing, households, and government sectors were highlighted as key contributors to the water economy in the Keiskamma and Fish to Tsitsikamma catchment. These contributions indicate linkages between the requirement of fresh water provisioning services on the sectors themselves and therefore indicate linkages between production and natural benefits. An important note is that these contributions to the water economy do not, directly translate to the quantity of water utilised by a sector, as each sector faces a different tariff for the water they purchase. Tourism, as a formal sector that is prominent in the catchment, although not a significant water consumer, is directly underpinned by cultural services provided by ecosystems present. Water provisioning services includes natural water and treated water.

The agricultural sector is comprised of dryland, irrigated and livestock agriculture of which the latter two are directly reliant on water provisioning services. This reliance on raw water is largely due to irrigation demand, which is observed to represent a significant proportion of the agricultural industry in the Keiskamma and Fish to Tsitsikamma catchment. The agriculture sector, by total GVA, is the largest sector within the catchment that relies heavily on water provisioning services. The sector contributes R 4 billion to the Keiskamma and Fish to Tsitsikamma total GVA.

Tourism is a key economic driver in the catchment and is represented here by the Hotel and restaurant and the Recreational, cultural and sporting activities sectors. The linkages with cultural ecosystem services provided by key ecological infrastructure have direct linkages to the presence of ecological features associated with tourism and recreational activities, such as twelve estuaries, national parks (i.e., Addo Elephant and Camdeboo, and Mount Zebra) and other nature reserves (both government and private). This sector is part of the total Trade sector which makes a large contribution of R52 billion to catchment GVA.

The catchment has a highly rural character, and the economy is relatively small from a formal economic perspective. There is an important informal economy. These beneficiaries reside specifically within the rural and traditionally owned land. These beneficiaries are characteristic of rural communities with generally reduced wellbeing from the perspective of reduced access to services, infrastructure development, employment and education. As a result, subsistence-based livelihoods are prevalent within these communities having intimate relationships with the natural systems represented by direct linkages to a broader range of ecosystem services. The benefits are realised predominantly through provisioning of food, collection of raw materials, medicine and fresh water, regulation of water and soils and cultural and spiritual services provided by the traditionally significant landscape. The dynamic relationship observed here is twofold: Firstly, the value of these natural benefits to communities who rely directly on them, coupled with limited access to alternatives translates very differently to Rands and Cents compared to economic production. For instance, the value of drinking water (which is necessary for survival) vs the value of irrigation water (which is necessary for production). Secondly, the cause-and-effect relationships economic development and social wellbeing need to be carefully balanced when implementing management scenarios that influence these beneficiaries. For instance, although increased water allocation to industry may create jobs (economic wellbeing), this could translate in reduced condition of ecosystems and therefore impact on these vulnerable communities (reduced social-wellbeing). Conversely, water

management that increases flow (reduced extraction) would likely benefit these vulnerable communities through increased ecosystem services flow.

The linkages between ecosystems and socio-economics of the catchment demonstrated here provide valuable insights into the dynamic relationship between ecosystems and beneficiaries of the services they provide.

6 WAY FORWARD

The next step in the WRCS process is the assessment of the development scenarios and this will provide insights into the impact of the development scenarios on the ecological value, water resources availability, corresponding socio-economics and associated quality objectives. During this assessment the economic consequences and potential trade-offs from each scenario will be evaluated. Additionally, the ecosystem services at risk will be identified and assessed using the CERA approach. The methodology and approach for the above is described in Section 2.3.

7 REFERENCES

Census 2011 Statistical Release. 2012. Statistics South Africa. Pretoria.

Dasgupta, P., 2008. The place of nature in economic development. Biejer Discussion Paper Series No 216. Available: http://www.beijer.kva.se/PDF/1965944_Disc%20216_new.pdf.

Dasgupta, P., 2010. The Place of Nature in Economic Development. Handbook of Development Economics. Volume 5, Pages 4039-5061 (2010). Chapter 74. Pages 4977-5046. Edited by Dani Rodrik and Mark Rosenzweig. ISBN: 978-0-444-52944-2.

Department of Water Affairs, South Africa. 2011. Algoa Reconciliation Strategy. Prepared by E van der Berg and Dr MJ Shand of Aurecon, as part of the Water Reconciliation Strategy Study for the Algoa Water Supply Area. DWA Report No. WMA 15/M00/00/1409/04.

Department of Water and Sanitation (DWS). 2017. Development of Procedures to Operationalise Resource Directed Measures. Main Report. Prepared by: Rivers for Africa eFlows Consulting (Pty) Ltd. Report no RDM/WE/00/CON/ORDM/0117.

DWS, 2021. Determination of Water Resource Classes, Reserve and RQOs in the Keiskamma and Fish to Tsitsikamma catchment: Inception Report. Draft - Version 01. Report No: WEM/WMA7/00/CON/RDM/0121Dosskey, Michael, G., Vidon, P., Gurwick, N.P., Allan, C.J., Duval, T.P. and Lowrance, R. 2010. The Role of Riparian Vegetation in Protecting and Improving Chemical Water Quality in Streams. Journal of the American Water Resources Association (JAWRA) 46(2):261-277. DOI: 10.1111/j.1752-1688.2010.00419.

DWS, 2022. Determination of Water Resource Classes, Reserve and RQOs in the Keiskamma and Fish to Tsitsikamma catchment: Status quo and delineation of Integrated Units of Analysis Report. Report No: WEM/WMA7/00/CON/RDM/0322.

DWS, 2024. Determination of Water Resource Classes, Reserve and RQOs in the Keiskamma and Fish to Tsitsikamma catchment: Basic Human Needs Report. Report No: WEM/WMA7/00/CON/RDM/0922.

Díaz S, Pascual U., Stenseke M., Martín-López B., Watson R., Molnar Z., Hill R., Chan K., Baste I., Brauman K., Polasky S., Church A., Lonsdale M., Larigauderie A., Leadley P., van Oudenhoven A., van der Plaat F., Schroter M., Lavorel S., Aumeeruddy-Thomas Y., Bukvareva E., Davies K., Demissew S., Erpul G., Failler P., Guerra C., Hewitt C., Keune H., Lindley S., & Shirayama Y., 2018. Assessing nature's contributions to people. *Science* 359: 270–272.

Eastern Cape Socio Economic Consultative Council, ECSECC, 2020. Economic review of the eastern Cape gross domestic product (GDP) Quarter 4 2020. ISBN 978-1-77593-103-4. https://www.ecsecc.org/datarepository/documents/ecsecc-gdp-report2020q4_6I5B1.pdf.

Eastern Cape Socio Economic Consultative Council, ECSECC, 2023. Economic review of the eastern Cape gross domestic product (GDP) Quarter 4-2023. ISBN 978-1-77593-155-3. https://www.ecsecc.org/datarepository/documents/q4-gdp-report_VPKiy.pdf.

Food and Agriculture Organization of the United Nations (FAO), 2020. Official Website: Ecosystem Services and Biodiversity. Accessed 4 August 2020. Available at: http://www.fao.org/ecosystem-services-biodiversity.

Freeman A.M., 2003. The measurement of environmental and resource values: theory and methods, RFF Press.

Haines-Young, R. & Potschin, M., 2013. Common International Classification of Ecosystem Services (CICES): Consultation on Version 4, August-December 2012. EEA Framework Contract No EEA/IEA/09/003.

IPBES, 2018. Summary for policymakers of the regional assessment report on biodiversity and ecosystem services for Europe and Central Asia of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. In: Fischer M., Rounsevell M., Torre-Marin Rando A., Mader A., Church A., Elbakidze M., Elias V., Hahn T., Harrison P., Hauck J., Martín-López B., Ring I., Sandström C., Sousa Pinto I., Visconti P., Zimmermann V., Christie M. (eds). IPBES Secretariat, Bonn, Germany.

Kadykalo, A.N., López-Rodriguez, María D., Ainscough, J., Droste, N., Ryu, H., Ávila-Flores, G., Le Clec'h, S., Muñoz, Marcia C., Nilsson, L., Rana, S., Sarkar, Priyanka, Sevecke, Katharina J. & Harmáčková, Zuzana V., 2019. Disentangling 'ecosystem services' and 'nature's contributions to people', Ecosystems and People, 15:1, 269-287, DOI: 10.1080/26395916.2019.1669713.

Landers, D., & Nahlik, A., 2013. Final ecosystem goods and services classification system (FEGS-CS). EPA/600/R-13/ORD-004914. Washington, DC: U.S. Environmental Protection Agency.

Mäler, K.G., 1991. The production function approach. In: Vincent, J.R. Crawford, E.W. and Hoehn, J.P. (Eds.). Valuing Environmental Benefits in Developing Countries. Special Report 29. Michigan State University, East Lansing, pp. 11–32.

MEA (Millennium Ecosystem Assessment), 2005. Ecosystems and human well-being: current state and trends, Volume 1. Edited by R. Hassan, R. Scholes and N. Ash. World Resources Institute. Island Press, Washington.

MEA (Millennium Ecosystem Assessment), 2005. Ecosystems and Human Well-Being: Synthesis. Washington DC: Island Press.

MEA (Millennium Ecosystem Assessment). 2007. Overview of the Millennium Ecosystem Assessment. http://www.millenniumassessment.org/en/About.aspx.

Naidoo, N., Mülders, J., Maila, D., Harris, K. and Crafford, J., 2017. Review of Socio-Economic Guidelines for Water Resource Classification and Development of an Improved Decision Support Tool. WRC Report K5/2465.

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD), 2006. Input output analysis in an increasingly globalised world: Applications of OECD's harmonized international tables. STI/Working Paper 2006/7. OECD.

Perrings, C., 2006. Ecological Economics after the Millennium Assessment. International Journal of Ecological Economics & Statistics (IJEES). Fall 2006, Vol. 6, No.F06; Int. J. Ecol. Econ. Stat.; 8-22.

Statistics South Africa, Stats SA 2016. Community Survey 2016, Agricultural households. Report No. 03-01-05 (2016). Statistics South Africa. Pretoria: Statistics South Africa.

Statistics South Africa, Stats SA 2020. Census of commercial agriculture, Report No. 11-02-01 (2017).

Statistics South Africa, Stats SA 2024. Census 2022 Agricultural Households, Report No. 03-11-01 (2022).

Surugiu, C., 2009. The Economic Impact of Tourism. an Input-Output Analysis. Romanian Journal of Economics, Vol. 29, Issue 2/2009, pp. 142-161, Available online: http://www.revecon.ro/articles/2009-2/2009-2-8.pdf.

TEEB (The Economics of Ecosystems and Biodiversity), 2010. The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations. Edited by Pushpam Kumar. Earthscan, London and Washington.

TEEB, 2013. The Economics of Ecosystems and Biodiversity for Water and Wetlands. IEEP, London and Brussels; Ramsar Secretariat, Gland.

Van Seventer, D. & Davies, R. 2019. A 2016 social accounting matrix for South Africa with an occupationally disaggregated labour market representation. UNU-WIDER

WAVES. Wealth accounting and the valuation of ecosystem services. Washington: Wealth accounting and the valuation of ecosystem services, 2013. Available from: http://www.wavespartnership.org/waves/.

8 APPENDICES

8.1 Appendix A:

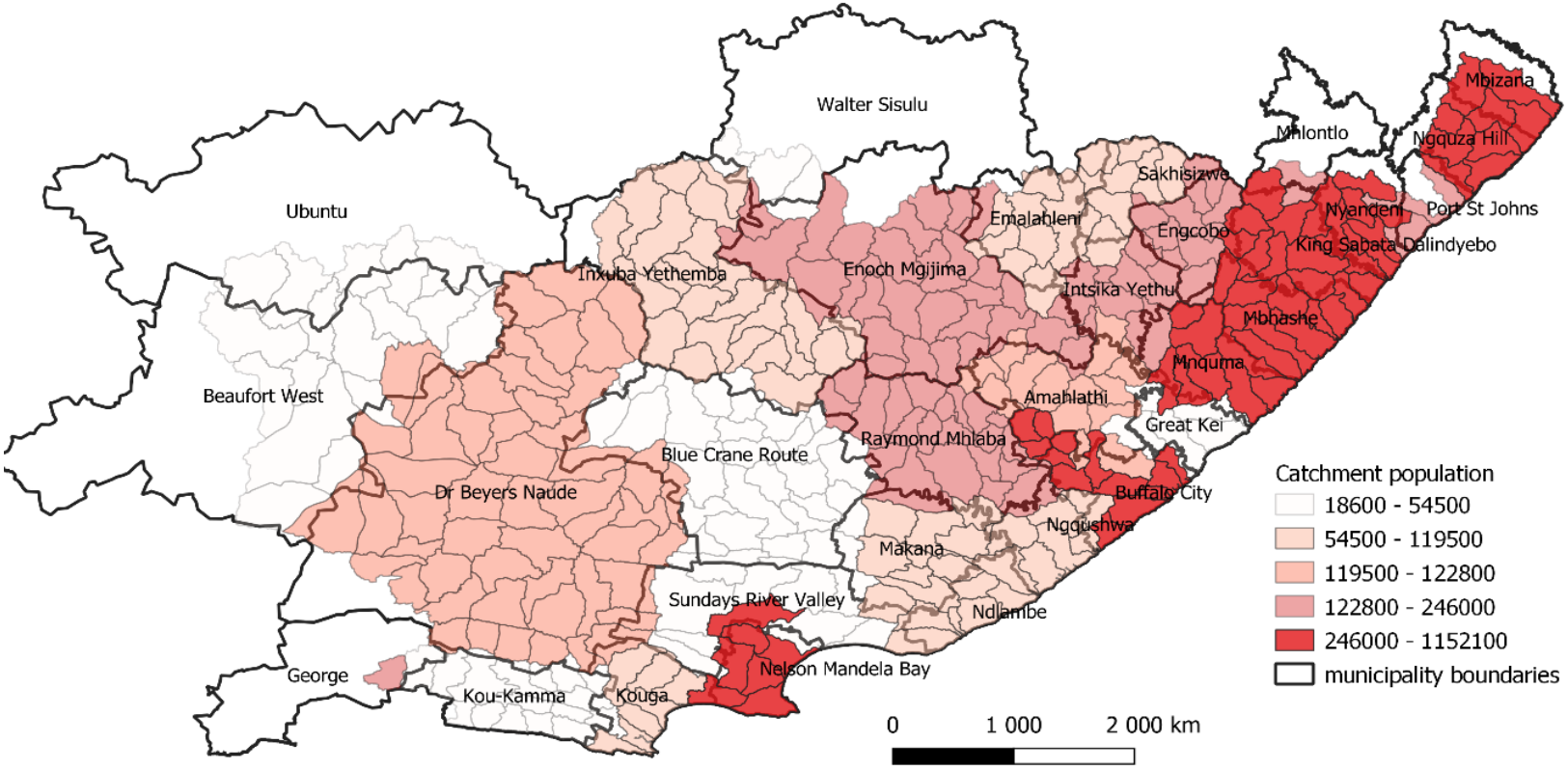

Figure 8-1: Population density of the study area

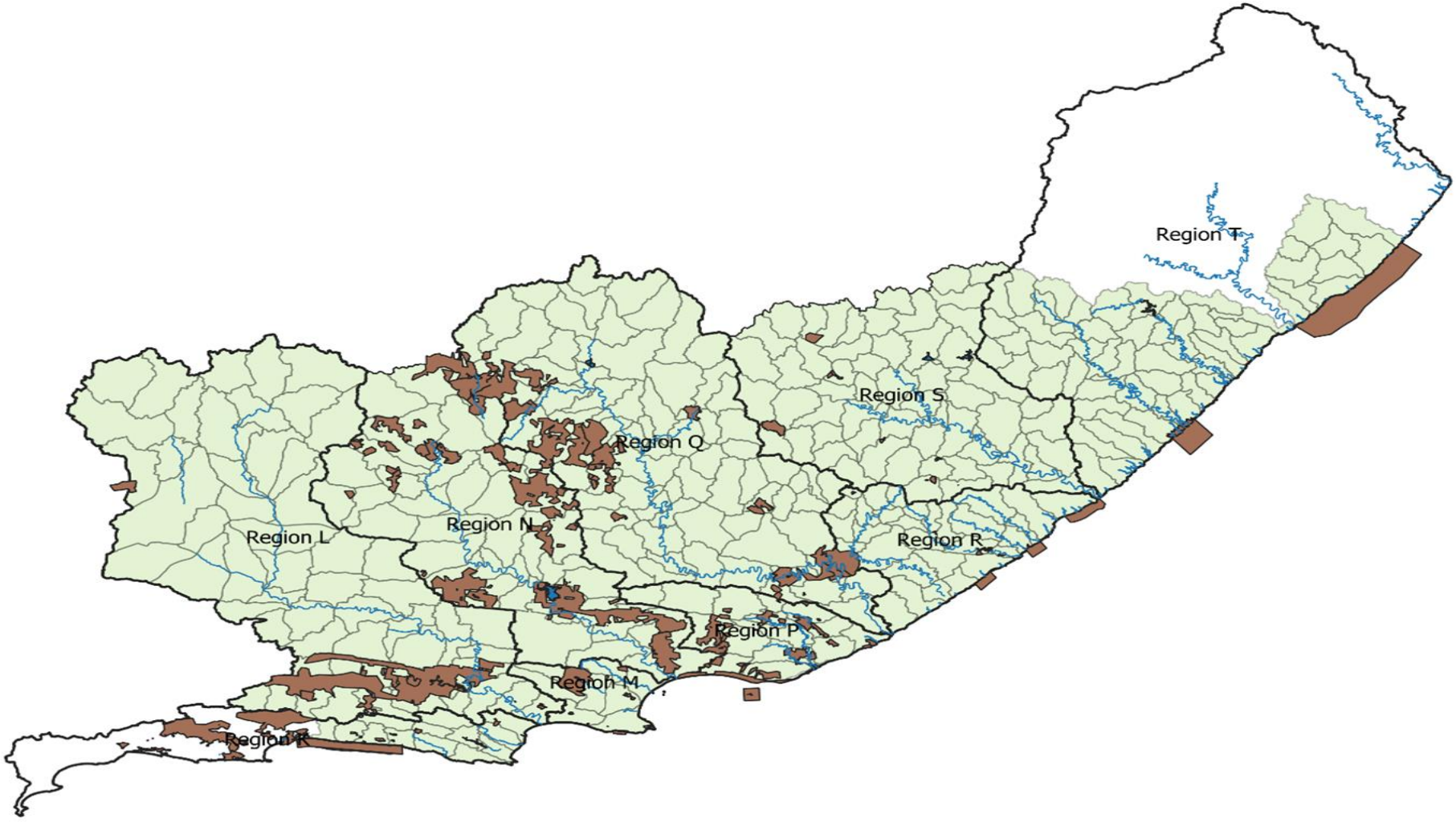

Figure 8-2: Locality of ecological infrastructure within the Fish to Tsitsikamma catchment

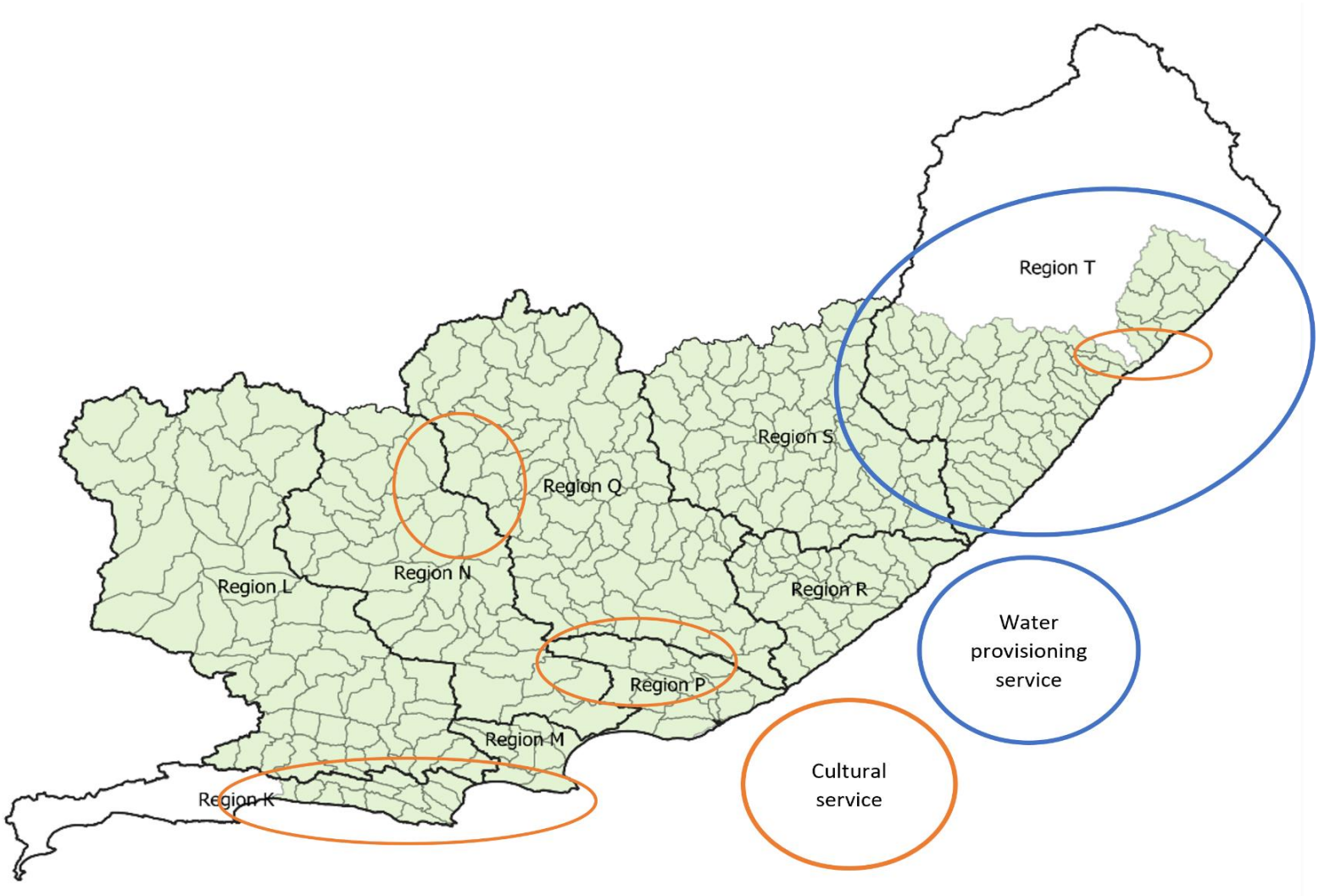

Figure 8-3: Ecosystem Service Sensitivity Areas in the Fish-Tsitsikamma Catchment

8.2 Appendix B

The Decision Analysis Framework

Demonstrating the linkages between ecological value and condition of the water resources and the socio-economic classification, utilised an ecosystem services approach which is framed by the Decision Analysis Framework. The Framework allows for the assessment of the implications of different catchment configuration scenarios at an IUA level on economic prosperity, social wellbeing and ecological condition.

This Framework is based on the interaction of four components (as have been defined and described in the socio-economic section of the Upper Orange River catchment status-quo report) (**Figure 8-4**):

i) Ecological infrastructure (EI)
ii) Ecosystem services
iii) Human wellbeing, and
iv) Economic production.

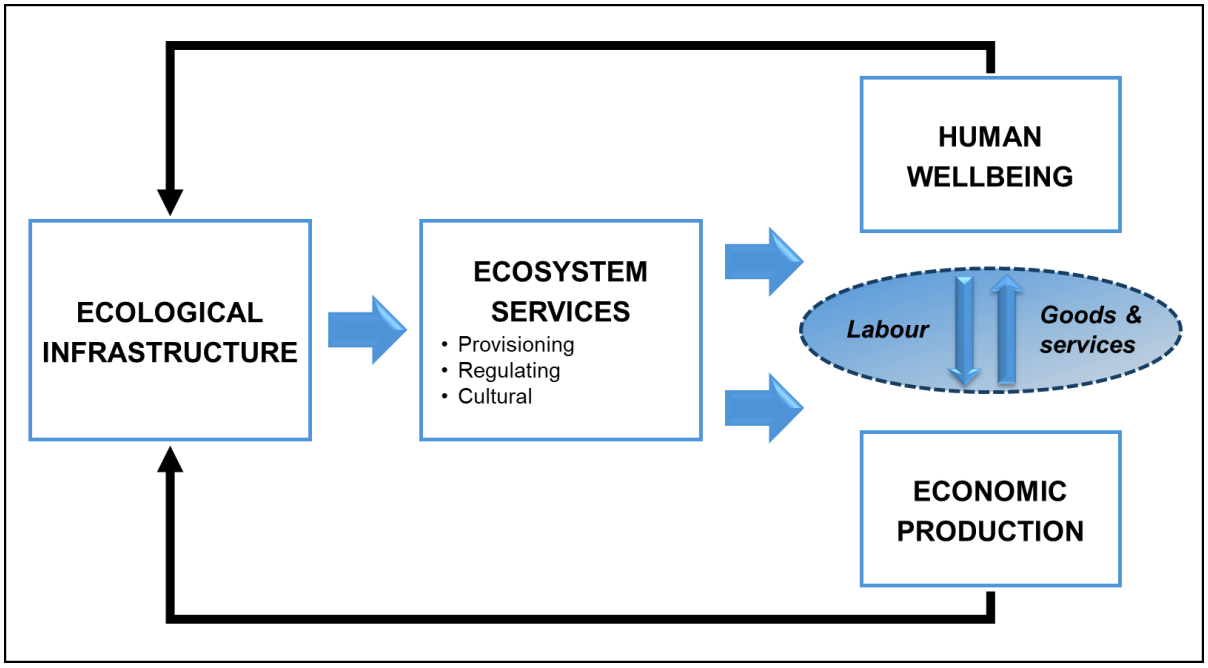

Figure 8-4: Schematic representation of the Decision Analysis Framework used to inform the assessment of the implications of different catchment configuration scenarios

Ecological infrastructure refers to naturally functioning ecosystems that deliver valuable ecosystem services to people, such as fresh water, climate regulation, soil formation and disaster risk reduction. In the case of catchment management, ecological infrastructure could include aquifers, wetlands and sub-catchments. The supply of ecosystem services is dependent on the type, condition and extent of the EI. EI in a good ecological condition would theoretically provide a robust flow of ecosystem services while EI in an impacted condition would deliver a less robust set of ecosystem services. The supply of ecosystem services is further dependent on the presence of beneficiaries, communities or economic sectors, in the landscape.

Figure 8-4 illustrates how aquatic ecosystem services are provided directly and indirectly to communities which influence human wellbeing and to the economy through providing natural

services. Economic production, however, may have a negative impact on ecological infrastructure through activities such as over abstraction or pollution, which in turn has an impact on the delivery of ecosystem services. The same relationship exists with communities and ecological infrastructure, but to a lesser extent. The relationship between human wellbeing and economic production can be described in economic terms, with households providing labour into economic sectors, which provide goods and services in return.

The Decision Support Framework represents a significant simplification of the assessment process, although still complex, and requires transdisciplinary collaboration.