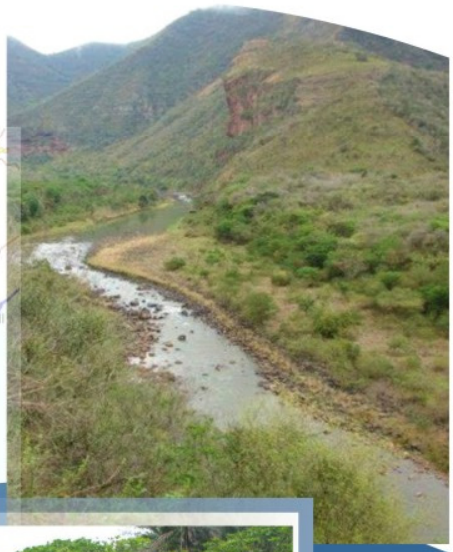
REPORT NUMBER: RDM/WMA11/00/CON/CLA/0213

CLASSIFICATION OF WATER RESOURCES AND DETERMINATION OF THE COMPREHENSIVE RESERVE AND RESOURCE QUALITY OBJECTIVES IN THE MVOTI TO UMZIMKULU WATER MANAGEMENT AREA

PROJECT NUMBER: WP 10679

RIVER RESOURCE UNITS AND EWR SITE REPORT



JULY 2013

water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

CLASSIFICATION OF WATER RESOURCES AND DETERMINATION OF THE COMPREHENSIVE RESERVE AND RESOURCE QUALITY OBJECTIVES IN THE MVOTI TO UMZIMKULU WATER MANAGEMENT AREA

RIVER RESOURCE UNITS AND EWR SITES

Report Number: RDM/WMA11/00/CON/CLA/0213

JULY 2013

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DEPARTMENT OF WATER AFFAIRS
CHIEF DIRECTORATE: RESOURCE DIRECTED MEASURES

CLASSIFICATION OF WATER RESOURCES AND DETERMINATION OF THE COMPREHENSIVE RESERVE AND RESOURCE QUALITY OBJECTIVES IN THE MVOTI TO UMZIMKULU WATER MANAGEMENT AREA

RESOURCE UNITS AND EWR SITES

Approved for RFA by:

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REPORT SCHEDULE

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Second draft	September 2013

EXECUTIVE SUMMARY

INTRODUCTION

The Chief Directorate: Resource Directed Measures (CD: RDM) of the Department of Water Affairs (DWA) initiated a study during 2012 for the provision of professional services to undertake the Comprehensive Reserve, classify all significant water resources and determine the Resource Quality Objectives (RQOs) in the Mvoti to Umzimkulu WMA.

This report documents the determination of the Ecological Reserve and focuses on step 2 of the Reserve process, i.e. delineation of the river Resource Units. This step is incorporated into step 1 and 3 of the Integrated steps (Water Resources Classification System (WRCS), the Reserve and the Resource Quality Objectives). The key river biophysical nodes, i.e. EWR sites selected are also provided and discussed.

RESOURCE UNITS (RU)

Resource Units are required as it may not be appropriate to set the same numerical Reserve for the headwaters of a river as for the lowland reaches. Different sections of a river frequently have different natural flow patterns, react differently to stress according to their sensitivity, and require individual specifications of the Reserve appropriate for that reach. The approach adopted was to consider both Natural Resource Units (NRU) and Management Resource Units (MRU) and to take account of the following aspects:

- EcoRegion classification of the river system;
- Geomorphological zonation in which channel gradient has been found to be a dominant factor;
- Land cover;
- Management and operation of the river system;
- Water quality considerations; and
- Local knowledge.
- Present Ecological State

The MRUs selected are summarised below:

Table 1: MRU summary table

MRU	RATIONALE
Mtamvuna River	
MRU Mtamvuna A	Coincides with area dominated by farming, grazing and low density settlements.
MRU Mtamvuna B	Area with improved PES and river with gorge nature
MRU Mtamvuna C	Subsistence farming, grazing, rural settlements, sedimentation
Mkomazi River	
MRU Mkomazi A	The MRU coincides with land use (largely natural with forestry and a mostly B PES.
MRU Mkomazi B	This area has more land use with a slightly lower PES (C and B/C). The logical break is the next MRU where a steep and inaccessible gorge with a better PES starts.
MRU Mkomazi C	A gorge area in good ecological condition with limited access
MRU Mkomazi D	Downstream of the gorge the PES changes with concurrent landuse changes such as irrigation and mostly settlements with grazing. This warrants an MRU which is different from the gorge.
Lovu River	

MRU Lovu A	This land use is dominated by forestry and the logical end of the MRU is the Richmond Dam and Richmond town.
MRU Lovu B	Downstream of the town there is extensive sugar cane with some forestry. The PES is similar for this whole stretch (C/D).
MRU Lovu C	The MRU is distinct from the upstream stretch as the intensive forestry is replaced by rural settlements with associated subsistence and agriculture.
MRU Lovu D	This area is different from upstream due to the change in topography and the resulting limited use of the river compared to upstream. The PES also improves in this section.
uMngeni River	
MRU uMngeni A	Upstream of Midmar Dam. Formal agriculture and forestry with no major water resource operation of infrastructure
MRU uMngeni B	Operation from Midmar Dam with quality impacts of Howick results in this being a logical MRU
MRU uMngeni C	Operation from Albert Falls Dam with a consistent release results in this MRU.
MRU uMngeni D	Nagle Dam is small, spills often, and the flow is more diverse that the consistent flow upstream. This therefore forms a separate MRU.
Karkloof River	
MRU Karkloof A	The land use is used to delineate the NRU A into two MRUs. This MRU is dominated by forestry.
MRU Karkloof B	Upstream of the waterfall with landuse dominated by agriculture.
MRU Karkloof C	The waterfall and break between the two NRUs also forms a definitive break in terms of landuse (private nature reserve) and warrants an MRU.
uMnsunduze	
uMnsunduze A	Impacts upstream of Pietermaritzburg is different than those associated with the urban areas where water quality problems become severe. This area is therefore an MRU on its own, ends at a dam, is of the same PES and coincides virtually with NRU A.
MRU uMnsunduze B	Pietermaritzburg area requires an MRU on its own due to very specific impacts associated with urbanisation.
uMnsunduze C	The section downstream of PMB is in some way protected by the river falling within a gorge. The water quality issues from upstream however is still prevalent. The landuse is different (forestry and some formal agriculture).
MRU uMnsunduze D	Landuse changes to high density rural settlements. The water quality improves somewhat with the dilution that tributary inflows contribute. This section therefore forms its own MRU.
Mvoti River and Heinespruit	
MRU Heine A	The Heinespruit is too short to warrant more than one MRU.
MRU Mvoti A	The area is dominated by forestry, irrigation and a large section of the river is a wetland. The logical break is the confluence of the Heinespruit as it forms a separate MRU.
MRU Mvoti B	This MRU is based on a change in land cover and the changed nature of the river within a gorge.
MRU Mvoti C	This section of the river again illustrates changed landuse and ends at the point where sand mining dominates the river.
MRU Mvoti D	This MRU is dominated by sand mining and is separate from the upstream river as it would require intensive non-flow related mitigation measures.

EWR SITES

Well established criteria and processes (Louw *et al.*, 1999) were adopted to select EWR sites for further analysis. A table with the EWR sites and summarised criteria is provided below.

Table 2: EWR site summary

EWR site name	SQ	River	Level	EcoRegion (Level II)	Geomorphic Zone	Altitude (m)	MRU	Quat
Mv_I_EWR 1	U40B-	Heinesspruit	Intermediate	16.02	Lower	929	MRU Heynes A	U40B

	03770				Foothills			
Mv_I_EWR 2	U40H-04064	Mvoti	Intermediate	17.03	Lower Foothills	203	MRU Mvoti C	U40H
Mg_I_EWR 2	U20E-04243	Mgeni	Intermediate	16.03	Upper Foothills	725	MRU Mgeni B	U20E
Mg_I_EWR 5	U20L-04435	Mgeni	Intermediate	17.03	Upper Foothills	177	MRU Mgeni D	U20L
Mk_I_EWR1	U10E-04380	Mkomazi	Intermediate	16.03	Lower Foothills	916	MRU Mkomazi B	U20F
Mk_I_EWR2	U20J-4679	Mkomazi	Intermediate	16.02	Upper Foothills	537	MRU Mkomazi C	U20J
Mk_I_EWR3	U20M-04746	Mkomazi	Intermediate	17.01	Lower Foothills	50	MRU Mkomazi D	U10M
Mg_R_EWR1	U20A-04253	Mgeni	Rapid	16.01	Lower Foothills	1081	MRU Mgeni A	U20A
Mg_R_EWR3	U20E-04170	Karkloof	Rapid	16.03	Upper Foothills	738	MRU Karkloof C	U20E
Mg_R_EWR4	U20J-04364	uMnsunduze	Rapid	16.03	Lower Foothills	602	MRU Duze C	U20J
Lo_R_EWR1	U70C-04859	Lovu	Rapid	17.01	Lower Foothills	44	MRU Lovu D	U70D
Mt_R_EWR1	T40E-5601	Umtamvuna	Rapid	17.01	Lower Foothills	277	MRU Mtam B	T40E

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ABBREVIATIONS

DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
EWR	Ecological Water Requirements
IUA	Integrated Units of Analysis
MC	Management Classes
MRU	Management Resource Units
NRU	Natural Resource Units
PES	Present Ecological State
RQO	Resource Quality Objectives
RU	Resource Unit
SQ	Subquaternary
WMA	Water Management Area

1 INTRODUCTION

1.1 BACKGROUND

There is an urgency to ensure that water resources in the Mvoti to Umzimkulu Water Management Area (WMA) are able to sustain their level of uses and be maintained at their desired states. The determination of the Management Classes (MC) of the significant water resources in Mvoti to Umzimkulu WMA will ensure that the desired condition of the water resources, and conversely, the degree to which they can be utilised is maintained and adequately managed within the economic, social and ecological goals of the water users (DWA, 2011). The Chief Directorate: Resource Directed Measures (CD: RDM) of the Department of Water Affairs (DWA) initiated a study during 2012 for the provision of professional services to undertake the Comprehensive Reserve, classify all significant water resources and determine the Resource Quality Objectives (RQOs) in the Mvoti to Umzimkulu WMA.

1.2 STUDY AREA

The Mvoti to Umzimkulu WMA encompasses a total catchment area of approximately 27,000 km^2 and occurs largely within Kwazulu-Natal. A small portion of the Mtamvuna River and the upper and lower segments of the Umzimkulu River straddle the Eastern Cape, close to the Mzimvubu and Keiskamma WMA in the south (DWA, 2011).

The WMA extends from the town of Zinkwazi, in the north to Port Edward and on the south along the KwaZulu-Natal coastline and envelopes the inland towns of Underberg and Greytown up until the Drakensberg escarpment. The WMA spans across the primary catchment “U” and incorporates the secondary drainage areas of T40 (Mtamvuna River in Port Shepstone) and T52 (Umzimkulu River). Ninety quaternary catchments constitute the water management area and the major rivers draining this WMA include the Mvoti, UMngeni, Mkomazi, Umzimkulu and Mtamvuna (DWA, 2011).

Two large river systems, the Umzimkulu and Mkomazi rise in the Drakensberg. Two medium-sized river systems the UMngeni and Mvoti rise in the Natal Midlands and have been largely modified by human activities, mainly intensive agriculture, forestry and urban settlements. Several smaller river systems (e.g. Mzumbe, Mdloti, Tongaat, Fafa, and Lovu Rivers) also exist within the WMA (DWAF, 2004). Several parallel rivers arise in the escarpment and discharges into the Indian Ocean and the water courses in the study area display a prominent southeasterly flow direction (DWA, 2011).

The WMA is very rugged and very steep slopes characterise the river valleys in the inland areas for all rivers and moderate slopes are found but comprise only 3% of the area of the WMA (DWAF, 2004).

1.3 PURPOSE OF THIS REPORT

The purpose of this report is:

- To provide the information used to define the river Resource Units (RUs).
- To provide the delineation of the RUs in the study areas.
- To provide information on the key river biophysical nodes, i.e. the Rapid and Intermediate Reserve level EWR sites.

Note that this report only focusses on river Resource Units. The term Resource Units are also used within the wetland Reserve approaches as well as the groundwater component of the Reserve, but in a different context. Groundwater RUs are describe in DWA (2013a).

1.4 STRUCTURE OF THIS REPORT

The report structure is as follows:

- Chapter 1: Introduction
  This chapter.
- Chapter 2: River reach demarcation and delineation
  Describes the approach to determining Resource Units and the selection of EWR sites.
- Chapter 3 - 9: Resource Units: River name
  Describes the Natural Resource Units (NRU) and Management Resource Units (MRU) as well as the EWR sites for each of the rivers selected as hotspots and where EWR sites are to be selected.

2 RIVER REACH DEMARCATION AND DELINEATION

2.1 APPROACH

If an Ecological Reserve determination is required for a whole catchment, it is necessary to delineate the catchment into Resource Units (RUs). These are each significantly different to warrant their own specification of the Reserve, and the geographic boundaries of each must be clearly delineated. (DWAF, 1999, volume 3).

Resource Units are required as it may not be appropriate to set the same numerical Reserve for the headwaters of a river as for the lowland reaches. These sections of a river frequently have different natural flow patterns, react differently to stress according to their sensitivity, and require individual specifications of the Reserve appropriate for that reach.

2.1.1 Natural Resource Units

Based on the above approach, the breakdown of a catchment into RUs for the purpose of determining the Reserve for rivers is therefore done primarily on a biophysical basis within the catchment and called Natural Resource Units (NRU). EcoRegions and geomorph zones are the major criteria that are considered.

2.1.2 Management Resource Units

Management requirements (DWAF, 1999, volume 3) also play a role in the delineation. An example could be where large dams and/or transfer schemes occur. Furthermore, the type of disturbance/impact on a river plays a role to select homogenous river reaches from a biophysical basis under present circumstances. These are called Management Resource Units (MRU).

The delineation process considers all of the above issues. Overlaying all the data does not necessarily result in a logical and clear delineation and therefore expert judgement, a consultative process and local knowledge are required for the final delineation. The practicalities of dealing with numerous reaches within one study must also be considered to determine a logical and practical suite of MRUs.

MRUs can be further delineated in even smaller assessment units and the approach for this is described in DWAF, 2008.

The Ecological Water Requirements (EWRs) are determined for each MRU by means of the following (Louw & Hughes, 2002):

- An EWR site is selected within the MRU and represents a critical site within the relevant river section. Results generated at the EWR site will then be relevant for the MRU as a whole.
- If no EWR site can be selected within the MRU, extrapolated results from an adjacent MRU with an EWR site are used. The reasons for an EWR site not being selected within the MRU can be the following:
  - The characteristics of the river within the MRU do not meet the criteria for EWR sites.
  - Due to the number of MRUs within the study area, it is not practical and/or cost-effective to address EWR sites within each MRU.

2.2 RESOURCE UNIT CONSIDERATIONS

2.2.1 EcoRegions (Level II)

The EcoRegion typing approach developed in the USA (Omernik, 1987) was applied and tested at a preliminary level in South Africa. EcoRegional classification or typing will allow the grouping of rivers according to similarities based on a top-down approach. The purpose of this approach is to simplify and contextualise assessments and statements on Ecological Water Requirements. One of the advantages of such a system is the extrapolation of information from data rich rivers to data poor rivers within the same hierarchical typing context.

The first effort used available information to delineate EcoRegion boundaries at a very broad scale (i.e. Level I) for South Africa. Attributes such as physiography, climate, rainfall, geology and potential natural vegetation were evaluated in this process and 18 Level I EcoRegions were identified (Kleynhans *et al*., 2005). The next Level II (Kleynhans *et al*., 2007), used the same attributes but in more detail. Physiography can for example, be explored in more detail by considering terrain morphological classes, slopes, relief, altitude, etc.

2.2.2 Geomorphological zonation

Rowntree and Wadeson (1999) have developed a zonal classification system for Southern African rivers modified from Noble and Hemens (1978). In their classification an attempt was made to give each zone a geomorphological definition in terms of distinctive channel morphological units and reach types. After working in a number of different rivers around the country it has become clear that channel gradient is a good indicator of channel characteristics and that probable or expected difference can be identified from an analysis of gradients (Table 2.1).

Table 2.1 Geomorphological Zonation of River Channels (adapted from Rowntree and Wadeson, 1999)

Longitudinal zone	Characteristic channel features	
	Zone	Description
Mountain headwater stream	A	A very steep gradient stream dominated by vertical flow over bedrock with waterfalls and plunge pools. Normally first or second order. Reach types include bedrock fall and cascades.
Mountain stream	B	Steep gradient stream dominated by bedrock and boulders, locally cobble or coarse gravels in pools. Reach types include cascades, bedrock fall, step-pool, Approximate equal distribution of 'vertical' and 'horizontal' flow components.
Transitional	C	Moderately steep stream dominated by bedrock or boulder. Reach types include plain-bed, pool-rapid or pool riffle. Confined or semi-confined valley floor with limited flood plain development.
Upper Foothills	D	Moderately steep, cobble-bed or mixed bedrock-cobble bed channel, with plain-bed, pool-riffle or pool-rapid reach types. Length of pools and riffles/rapids similar. Narrow flood plain of sand, gravel or cobble often present.
Lower Foothills	E	Lower gradient mixed bed alluvial channel with sand and gravel dominating the bed, locally may be bedrock controlled. Reach types typically include pool- riffle or pool-rapid, sand bars common in pools. Pools of significantly greater extent than rapids or riffles. Flood plain often present.
Lowland river	F	Low gradient alluvial fine bed channel, typically regime reach type. May be confined, but fully developed meandering pattern within a distinct flood plain develops in unconfined reaches where there is an increased silt content in bed or banks.

2.2.3 Land cover

The land cover is provided as part of the PESEIS project (DWA 2013), but in this case was updated by extensive Google Earth viewing and groundtruthing.

2.2.4 System operation

After identifying Natural Resource Units, which are based largely on natural hydrology, EcoRegions and geomorphological zonation, Management Resource Units (MRUs) must be defined. The overriding aspects in terms of identifying MRUs are the land cover (a surrogate for land use) and the closely related management and operation of the water resources within the study area. Management Resource Units therefore have to consider the different operational structures, management and constraints regarding Reserve implementation. Mostly qualitative information is required to describe the operation and this is usually available at the onset of the Reserve study based on various previous studies.

2.2.5 Local knowledge

Any expert information that could contribute to the assessments are considered and used.

2.2.6 Present Ecological State (PES)

The PES is also considered in the MRU delineation as it provides an indication of the response of the river to the operation of the system, landuse and land cover. PES is determined following the procedures in Kleynhans and Louw (2007). PES has been provided at subquaternary reaches (DWA 2013) and reviewed within this study (DWA 2013a).

2.3 RESOURCE UNITS AND INTEGRATED UNITS OF ANALYSIS (IUA)

IUAs have been selected for this study area (DWA 2013a). IUAs are homogenous catchments or linear river reaches that can be managed as an entity. IUAs normally represent a catchment and therefore differ from RU which are linear. Furthermore, an IUA can consist of many different ecological types of rivers (as this does not play a role in IUA selection). IUAs are therefore NOT the same or similar to RUs which are linear stretches of river that each are significantly different to warrant their own specification of the Reserve. (DWAF, 1999, volume 3). RUs are therefore nested within IUAs.

2.4 RIVERS SELECTED IN THE MVOTI TO UMZIMKULU WMA FOR RU DELINEATION

Hotspots were defined in DWA 2013a. Hotspots used in this context is defined as areas that warrant detailed investigations. Logically, these are the rivers in which key biophysical nodes or EWR sites are to be selected. EWR assessments at these sites will follow a Rapid III, Intermediate or Comprehensive level of EWR assessment which implies that results should have confidence which is higher than desktop level. All other biophysical nodes in the WMA will therefore be assessed at Desktop level.

The rivers selected for detailed EWR assessment and that therefore requires RU delineation are from south to north:

- Mtamvuna River
- Mkomazi River
- Lovu River
- uMngeni River and the Karkloof and uMnsunduze Tributaries
- Mvoti River and the Heinespruit tributary

The results of the assessment for each of these rivers are described in the above sequence in the following chapters.

2.5 CRITERIA FOR EWR SITE SELECTION

EWR sites (previously called IFR sites) are selected through a multi-disciplinary process consisting of evaluating an aerial video (if available) or Google Earth images of the river to identify a range of possible sites, and groundtruthing to make a final selection from the various options. An EWR site consists of a length of river which includes one or various cross-sections for both hydraulic and ecological purposes (modified from Louw *et al*., 1999). The EWR site is nested within an RU.

EWRs are determined at each of the EWR sites, and it is therefore vital that:

- The sites are selected to provide as much information as possible about the variety of conditions in a river reach.
- The specialists that need to use these sites to set flow requirements for their discipline can relate to the habitat the sites represented.
- The persons involved in selecting the sites understand and are experienced in the use of sites in EWR studies.

The selection of EWR sites is guided by a number of considerations, including (modified from Louw *et al* 1999):

- The locality of hotspots.

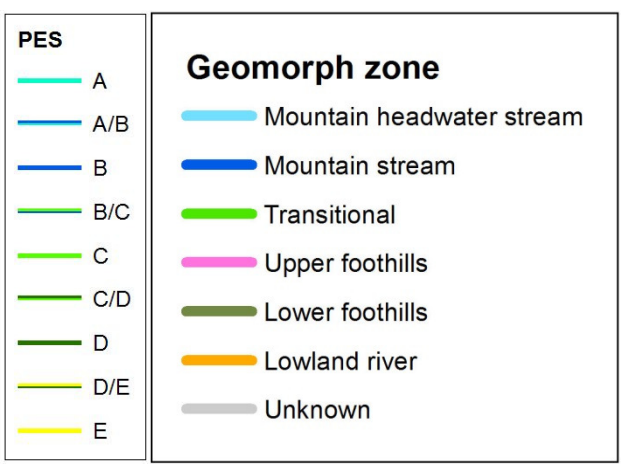
- The locality of gauging weirs with good quality hydrological data.
- The locality of the proposed and existing developments.
- The locality and characteristics of tributaries.
- The habitat integrity or PES of the different river reaches.
- The boundaries of Level II EcoRegions within the study area.
- The reaches where people depend directly on a healthy river ecosystem.
- The suitability of the sites for follow-up monitoring.
- The locality of geomorphologically representative sites.
- The habitat diversity for aquatic organisms, marginal and riparian vegetation.
- **The suitability of the sites for accurate hydraulic modelling throughout the range of possible flows, especially low flows.**
- **Accessibility of the sites.**
- **An area or site that could be critical for ecosystem functioning. These are often represented by riffle units, where low flow conditions or the cessation of flow constitutes a break in the functioning of the river, and consequently, the biota dependant on this habitat and/or perennial flow are adversely affected. Pools are not considered critical habitats in perennial system since they are still able to function or at least maintain life during periods of no flow.**

The criteria in bold are the most important and therefore the overriding criteria.

3 RESOURCE UNITS: MTAMVUNA RIVER

The PES and geomorphic zone legends for standard colours are provided below and not repeated on maps further in this document. The purpose of different colours in all other maps (NRU, EcoRegions, MRU, Landuse) ONLY illustrate the delineation changes from eg one landuse to another). The colours are not specific to eg any type of landuse.

Table 3.1 Generic PES and geomorph zone legends and standard colours



3.1 NATURAL RESOURCE UNITS

The subquaternary reaches (representing hydrological zones), EcoRegions and geomorphic zones of the Mtamvuna are described in the Fig 3.1. The Natural Resource Units (NRU) are derived from the EcoRegions and the geomorphic zones.

The study area falls within three EcoRegions (level 2), i.e. 16.03, 17.01 and 17.04 and is dominated by the Upper and Lower Foothills geomorphic zone. Each of the EcoRegions are dominated by a different geomorphic zone and the EcoRegions are used as the NRUs. The NRUs are described as NRU Umtamvuna A, B and C and the delineation information are provided in Table 3.2.

3.2 MANAGEMENT RESOURCE UNITS

The river is divided into Management Resource Units (MRUs) as illustrated in Figure 3.2. The description of the MRUs and the rationale for selection is provided below and in Table 3.3.

System operation & Land use:
The storage regulation in this IUA is low with no noticeable dams located in the area. There is no surface water developments planned in the IUA. The land use activities include extensive forestry in the upper reaches and some cultivation in the lower reaches. There are large areas of dryland sugar cane in the catchment but the reduction in runoff due to this has little impact on the available yield because of its location along the coast. Irrigation in the catchment is insignificant. The IUA is predominantly rural with a large number of scattered rural and informal settlements supplied from regional water abstractions.

Present Ecological State:

The PES of the SQ reaches are dominated by B and B/C SQs. T40B falls in a C PES with flow and non-flow related impacts, consisting of extensive forestry occurring in the upper reaches, with a timber mill and rural settlements in the lower reaches. The reaches in T40C ranges between B and B/C PES, with the primary land use activities being subsistence farming, grazing and low density rural settlements. The good state of the B PES is often the result of protection provided by gorges. The primary impacts are non-flow related activities including small scale subsistence farming, rural settlements and limited forestry in the most upper reaches.

There are no obvious delineation on land use based on land use and water resource use. Most of the land use impact on the river as non-flow related impacts. The PES is relatively homogenous (mostly B/C). The one section that stands out is the reach dominated by a gorge (B PES) with limited access and limited landuse. The implication of this section being a MRU means that the river is delineated into 3 MRUs.

3.3 EWR SITE SELECTION

Considering the criteria for site selection, the most suitable position for an EWR section is in the B PES section in the gorge. As this section is in the best condition, it would provide good indicators for EWR determination. However, the gorge is inaccessible and the next best option is in the B/C section further downstream. A Rapid Reserve determination will be undertaken in this section and an EWR site was selected in the vicinity of this section.

The criteria and process as indicated in Louw *et al* (1999) was followed, and one EWR site was selected. Site details are provided in Appendix A and the site locality and characterised are illustrated in Fig 3.3.

Table 3.2 Mtamvuna: Description and rationale for the Natural Resource Units

NRU	EcoRegion Level 2	Geomorphic zone	Rationale	Delineation
NRU Umtamvuna A	16.03 (100%)	Upper foothills: 59% Lower Foothills:41%	The break is formed by the change in EcoRegion Level II.	From the confluence of the Mafadobo and the Goze River (i.e. start of the Umtamvuna River to the end of EcoRegion 16.03. Start: -30.696042; 29.695066 End: -30.724565; 29.805718
NRU Umtamvuna B	17.01 (100%)	Upper foothills:23% Lower Foothills: 77%	The downstream break is formed by the change in EcoRegion Level II which coincides with a break in geomorphic zones	To the end of 17.01. End: -30.724989; 29.805736
NRU Umtamvuna C	17.04 (100%)	Upper foothills: 62% Lower Foothills: 33% Other: 5%	The downstream break is upstream of the Estuary	To the estuary. End: -30.884894; 30.109871

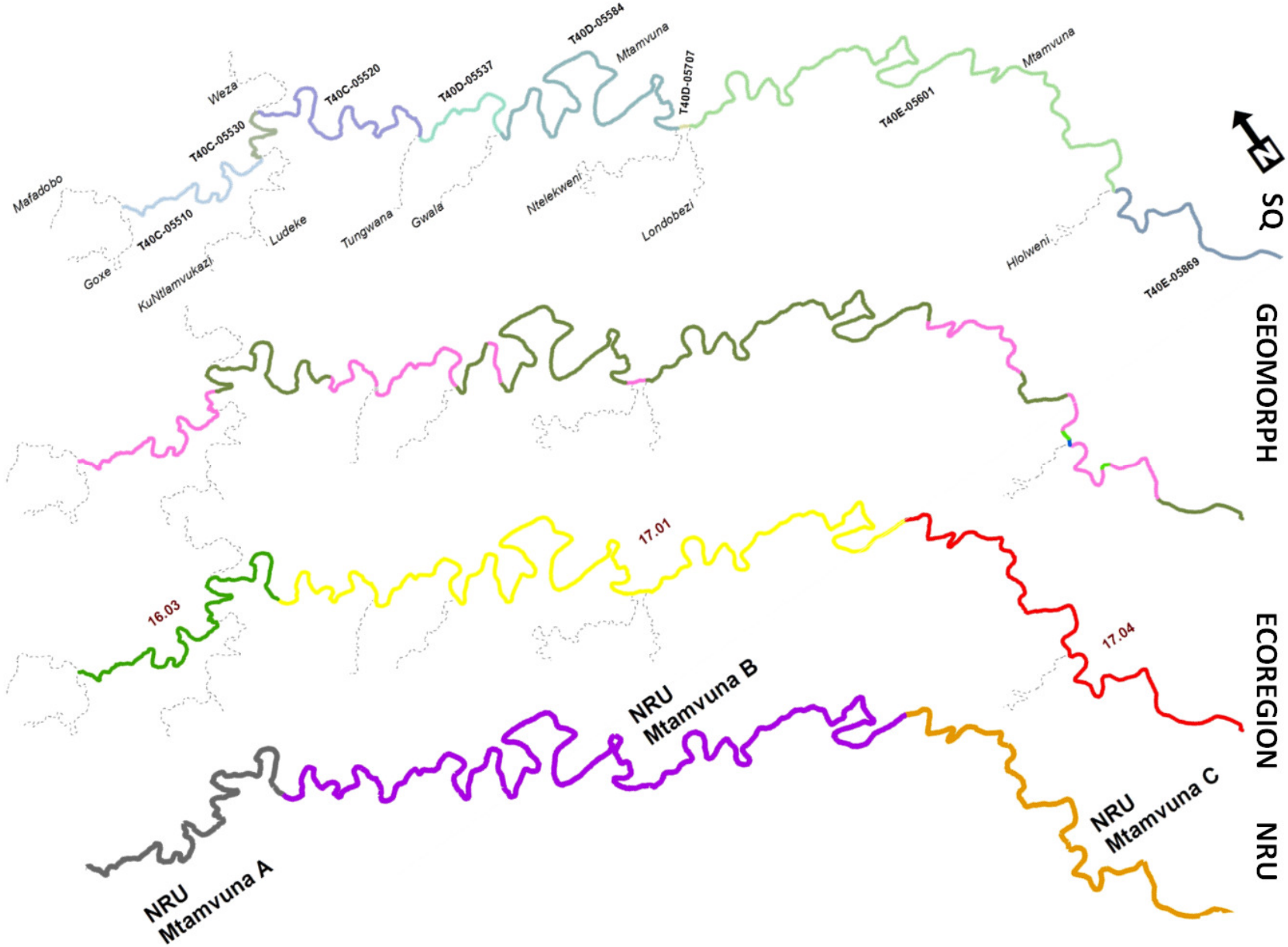

Weza
T40C-05520
T40D-05537
T40D-05584
Mtamvuna
T40D-05707
T40E-05601
Mtamvuna
T40C-05530
Mafadobo
T40C-05510
Goxe
KuNtlamvukazi
Ludeke
Tungwana
Gwala
Ntelekweni
Londobezi
Hloiweni
T40E-05869
SQ
GEOMORPH
16.03
17.01
17.04
ECOREGION
NRU
NRU
Mtamvuna B
NRU
Mtamvuna C
NRU
Mtamvuna A

Figure 3.1 Mtamvuna River: EcoRegions, geomorphological zones and Natural Resource Units

Table 3.3 Mtamvuna: Description and rationale of the Management Resource Units

MRU	EcoRegion Level 2	Geomorphic zone	Land cover	Rationale	Delineation	Quat
MRU Mtamvuna A	16.03: 65% 17.01: 35%	Upper foothills: 60% Lower Foothills:40%	Coincides with the area dominated by farming, grazing and low density settlements.	There are no obvious reasons in terms of changes in land use or operation of the system. Landuse is mostly non-flow related. The PES is mostly B/C and C. The PES improves downstream where the river goes into a gorge .	Start: -30.696042; 29.695066, End: -30.755177; 29.871599	T40A, T40C
MRU Mtamvuna B	17.01: 92% 17.04: 8%	Upper foothills: 18% Lower Foothills:81%	Gorge with subsistence farming in accessible areas	The PES improves downstream where the river goes into a gorge - PES dominated by a B and B/C. The gorge nature of the river and PES provides motivation for a separate MRU.	End: 30.909127; 30.131191	T40C T40D T40E
MRU Mtamvuna C		Mountain stream: 1% Transitional: 5% Upper foothills: 62% Lower Foothills:33%	Subsistence grazing, rural settlements, sediments.	The change from a gorge into a more accessible area allows for more intensive landuse and a different MRU.	End: -31.082522; 30.193976	T40E

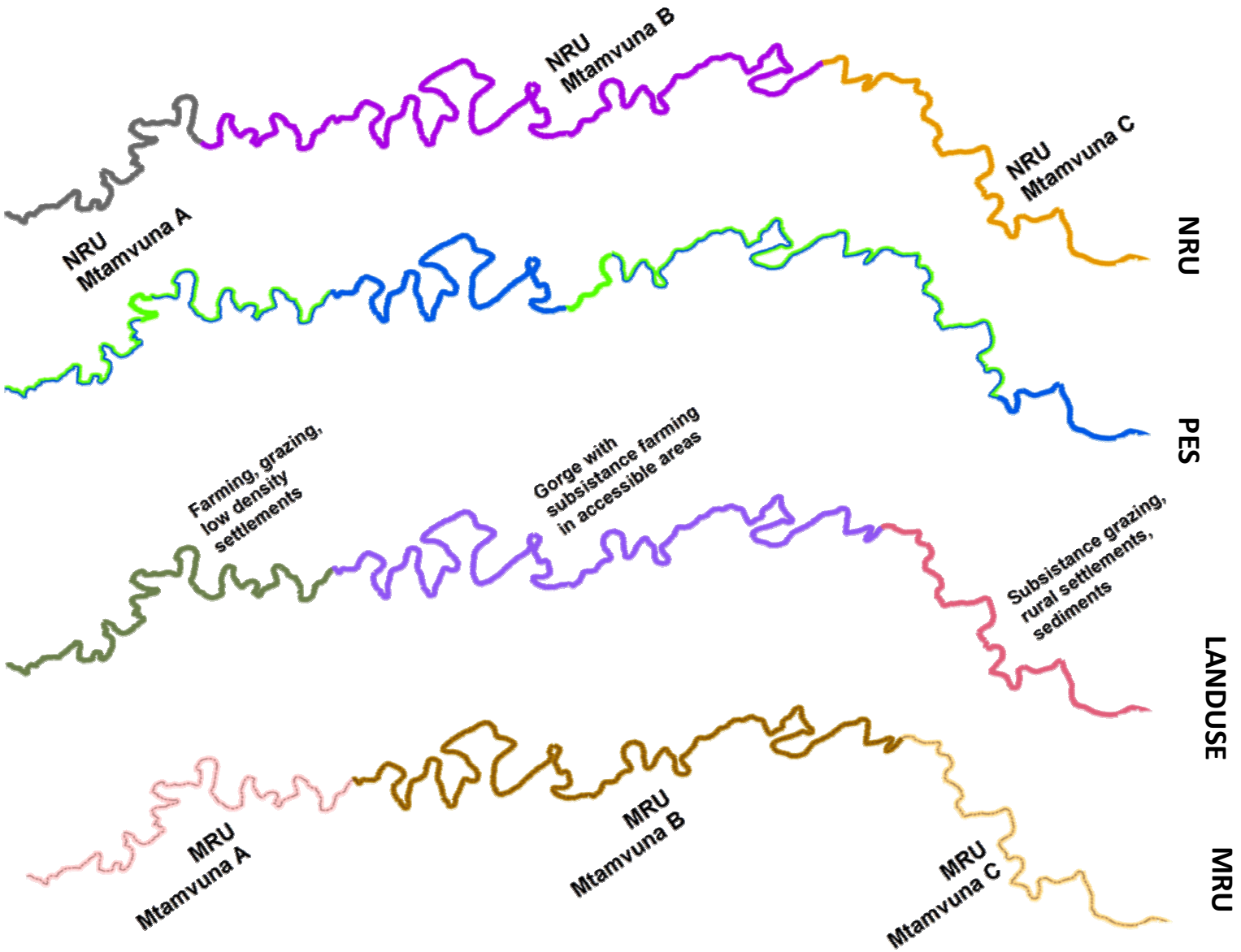

NRU
Mtamvuna A
NRU
Mtamvuna B
NRU
Mtamvuna C
NRU
PES
Farming, grazing,
low density
settlements
Gorge with
subsistance farming
in accessible areas
Subsistance grazing,
rural settlements,
sediments
LANDUSE
MRU
Mtamvuna A
MRU
Mtamvuna B
MRU
Mtamvuna C
MRU

Figure 3.2 Mtamvuna River: PES, operation, landuse and Management Resource Units

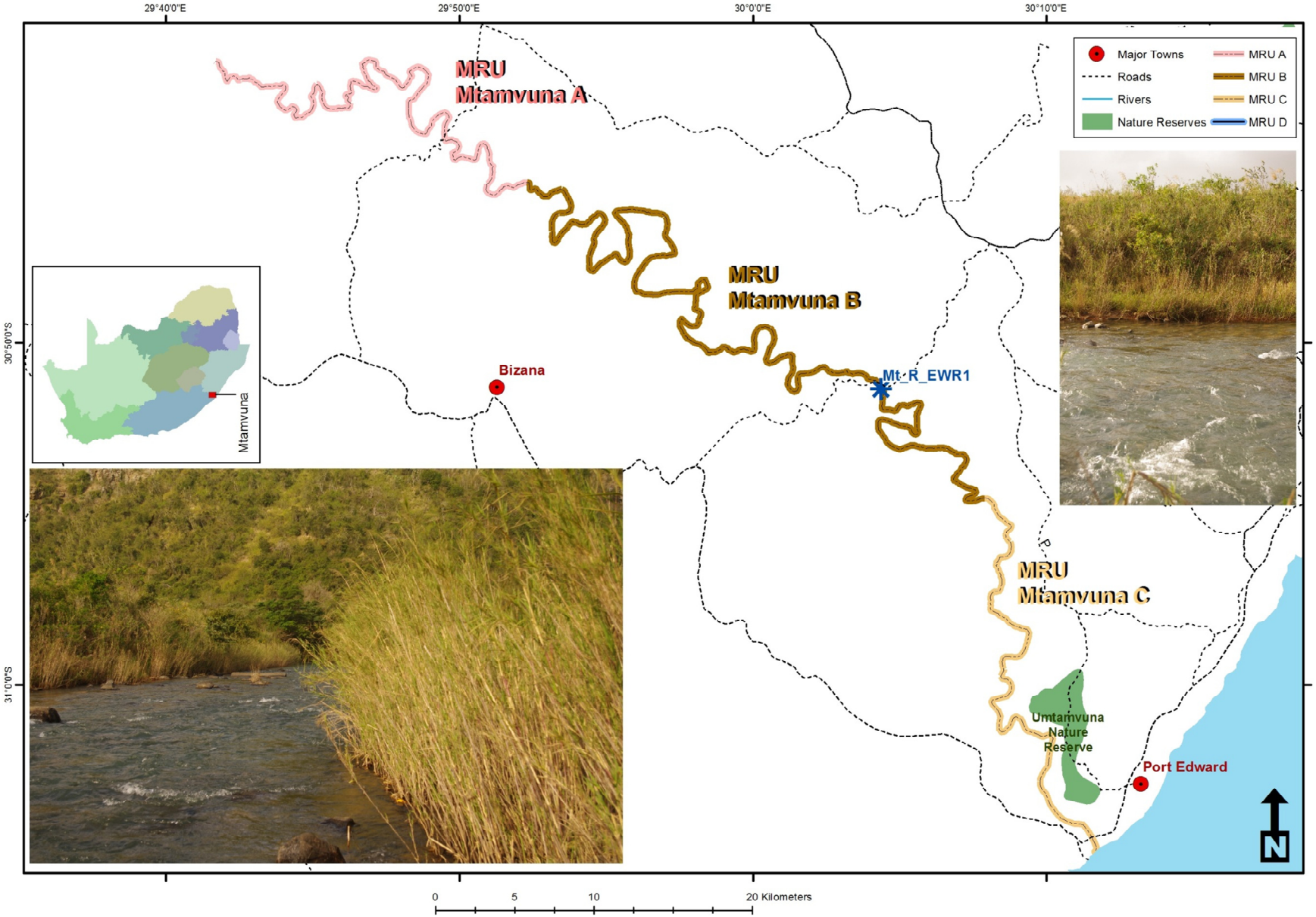


Figure 3.3 Mt_R_EWR1 (Mtamvuna River) locality and photographs

4 RESOURCE UNITS: MKOMAZI RIVER

4.1 NATURAL RESOURCE UNITS

The subquaternary reaches (representing hydrological zones), EcoRegions and geomorphic zones of the Mkomazi are described in the Fig 4.1. The Natural Resource Units (NRU) are derived from the EcoRegions and the geomorphic zones.

The study area falls within three EcoRegions (level 1) and seven EcoRegions (level 2), i.e. 15.06, 15.07, 16.01, 16.02, 16.03, and 17.03 and is dominated by the Upper and Lower Foothills geomorphic zone. Each of the EcoRegions are dominated by a specific geomorphic zone and the EcoRegions are used as the NRUs (apart from 15.06 which is very short). The NRUs are described as NRU Mkomazi A, B, C, D, E and F and the delineation information are provided in Table 4.1 and Fig 4.1.

4.2 MANAGEMENT RESOURCE UNITS

The river is divided into Management Resource Units (MRUs) as illustrated in Figure 4.2. The description of the MRUs and the rationale for selection is provided in Table 4.2.

System operation & Land use:

The only dams in the area include a number of small farm dams in tributaries and a few Instream dams. The middle to upper reach of the river is mainly a mountainous area, where nature reserves are located. There are some agriculture and community water use forestry, cultivation, irrigation, grazing, and community water use from low density rural settlements. The land use activities in the middle sections include forestry, cultivation, irrigation, some sugar cane, cattle farming, and community water use from low density rural settlements. In the gorge section down to the coast, the land use activities are predominantly community water use from low density rural settlements. At the coast, there is an abstraction for Sappi Saiccor.

Present Ecological State:

In the upper sections, the river is in a good PES due to protection of nature reserves. Small patches of afforestation and other alien vegetation, small dams and trout farms, tourism, and rural community use in the form of subsistence farming (cattle trampling, erosion, roads, and agricultural lands) are the only impacts. Downstream of the mountain zone, the river is mostly in a C and B/C state with the gorge section in a B. Impacts down the reach are similar and associated with forestry and rural settlements with informal agriculture.

Rationale:

The landuse and PES are linked and in this case are used as the main drivers for selecting the MRUs. Further information is provided in Table 4.2.

4.3 EWR SITE SELECTION

These EWR sites were selected during 1998 and due to the valuable information available at the sites, these were maintained as sites during this EWR study. The criteria to select sites Louw *et al* (1999) were in place and these sites should conform to the requirements. IFR 1 (Lundy's Hill) now called Mk_I_EWR1 is placed in MRU Mkomazi B where the PES improves from a C to a B/C. IFR 2 (Hela Hela) now called Mk_I_EWR2 is at the start of the gorge section which is in a good ecological state (PES - B). IFR 4 now called Mk_I_EWR3 represents the downstream area and is in the long section which is in a B/C PES. Site details are provided in Appendix A and the site locality and characterised are illustrated in Fig 4.3.

Table 4.1 Mkomazi: Description and rationale for the Natural Resource Units

NRU	EcoRegion Level 2	Geomorphic zone	Rationale	Delineation
NRU Mkomazi A	15.07: 100%	Source: 14% Mountain stream: 21% Transitional: 26 Upper Foothills: 39%	Includes very small portion of EcoRegion 15.06 (less than 1%. Rest of section made up of EcoRegion 15.07 and consists of a mixture of mostly Mountain Stream, Transitional, Upper Foothills	Start: -29.476124; 29.321892, End: -29.576418; 29.527026,
NRU Mkomazi B	16.01: 100%	Transitional: 2% Upper Foothills: 40% Lower Foothills: 58%	Coincides with EcoRegion 16.01 and consists of a mixture of mostly Upper and Lower Foothills	End: -29.722434; 29.840035 -
NRU Mkomazi C	16.03: 100%	Upper Foothills: 39% Lower Foothills: 61%	Coincides with EcoRegion 16.03 and consists of a mixture of mostly Lower Foothills with some Upper Foothills.	End: -29.852419; 30.002059
NRU Mkomazi D	16.02: 100%	Upper Foothills: 57% Lower Foothills: 43%	Coincides with EcoRegion 16.02 and consists of a mixture of mostly Upper and Lower Foothills	End: -30.075807; 30.377498
NRU Mkomazi E	17.03: 100%	Upper Foothills: 2% Lower Foothills: 98%	Coincides with EcoRegion 17.03 and is dominated by Lower Foothills.	End: -30.131736; 30.601380
NRU Mkomazi F	17.01: 100%	Lower Foothills: 100%	Coincides with EcoRegion 17.01 and consists Lower Foothills only.	End: -30.201051, 30.802388

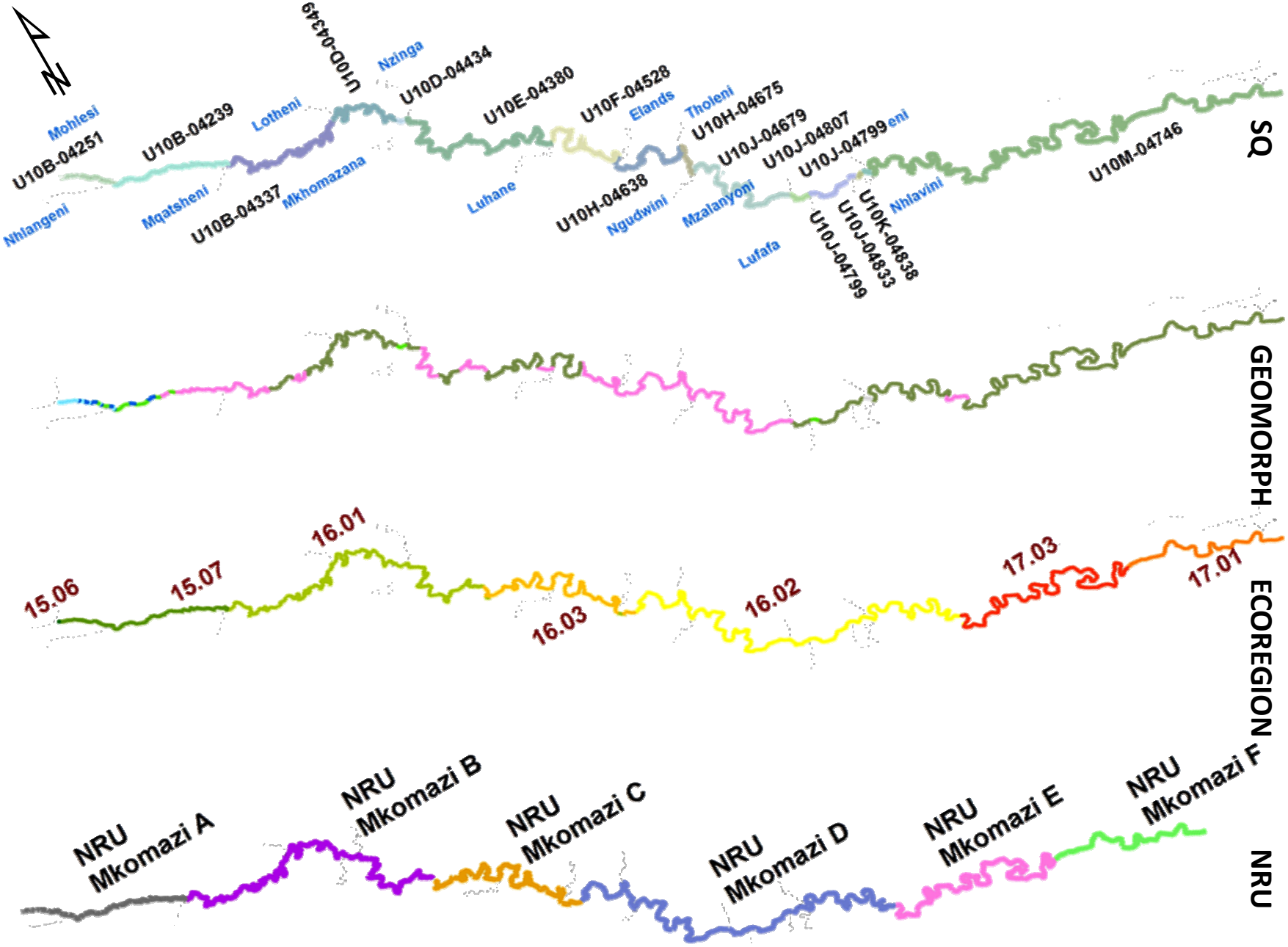

N
Mohlesi
U10B-04251
U10B-04239
Lotheni
U10D-04349
Nzinga
U10D-04434
U10E-04380
U10F-04528
Elands
Tholeni
U10H-04675
U10J-04679
U10J-04807
U10J-04799
eni
U10M-04746
SQ
Nhlangeni
Mqatsheni
U10B-04337
Mkhomazana
Luhane
U10H-04638
Ngudwini
Mzalanyoni
Lufafa
U10J-04799
U10J-04833
U10K-04838
Nhlavini
15.06
15.07
16.01
16.03
16.02
17.03
17.01
GEOMORPH
ECOREGION
NRU Mkomazi A
NRU Mkomazi B
NRU Mkomazi C
NRU Mkomazi D
NRU Mkomazi E
NRU Mkomazi F
NRU

Figure 4.1 Mkomazi River: EcoRegions, geomorphological zones and Natural Resource Units

Table 4.2 Mkomazi: Description and rationale of the Management Resource Units

MRU	EcoRegion Level 2	Geomorphic zone	Land cover	Rationale	Delineation	Quat
MRU Mkomazi A	15.07: 44% 16.01: 57%	Source: 6% Mountain stream: 9% Transitional 11% Upper foothills 37% Lower foothills 36%	Natural areas (Reserves), forestry and subsistence farming	The MRU coincides with land use (largely natural with forestry and a mostly B PES.	Start: -29.476124; 29.321891 End: -29.595497; 29.711858	U20B
MRU Mkomazi B	16:01: 38% 16.02: 17% 16.03: 45%	Transitional 2% Upper Foothills: 51% Lower Foothills 47%	Forestry, rural settlements	This area has more land use with a slightly lower PES (C and B/C). The logical break is the next MRU where a steep and inaccessible gorge with a better PES starts.	End: -29.89070; 30.06052	U20E U20F U20G U20H
MRU Mkomazi C	16.02: 100%	Upper Foothills 100%	Gorge	A gorge area in good ecological condition with limited access	End: -29.979919; 30.136763	U20J U20H
MRU Mkomazi D	16.02: 34% 17.01: 21% 17.03: 43%	Upper Foothills 5% Lower foothills 93% Other: 2%	Dense rural settlements, grazing	Downstream of the gorge the PES changes with concurrent landuse changes such as irrigation and mostly settlements with grazing. This warrants an MRU which is different from the gorge.	End: -30.201290; 30.802966	U20J U20L U20M

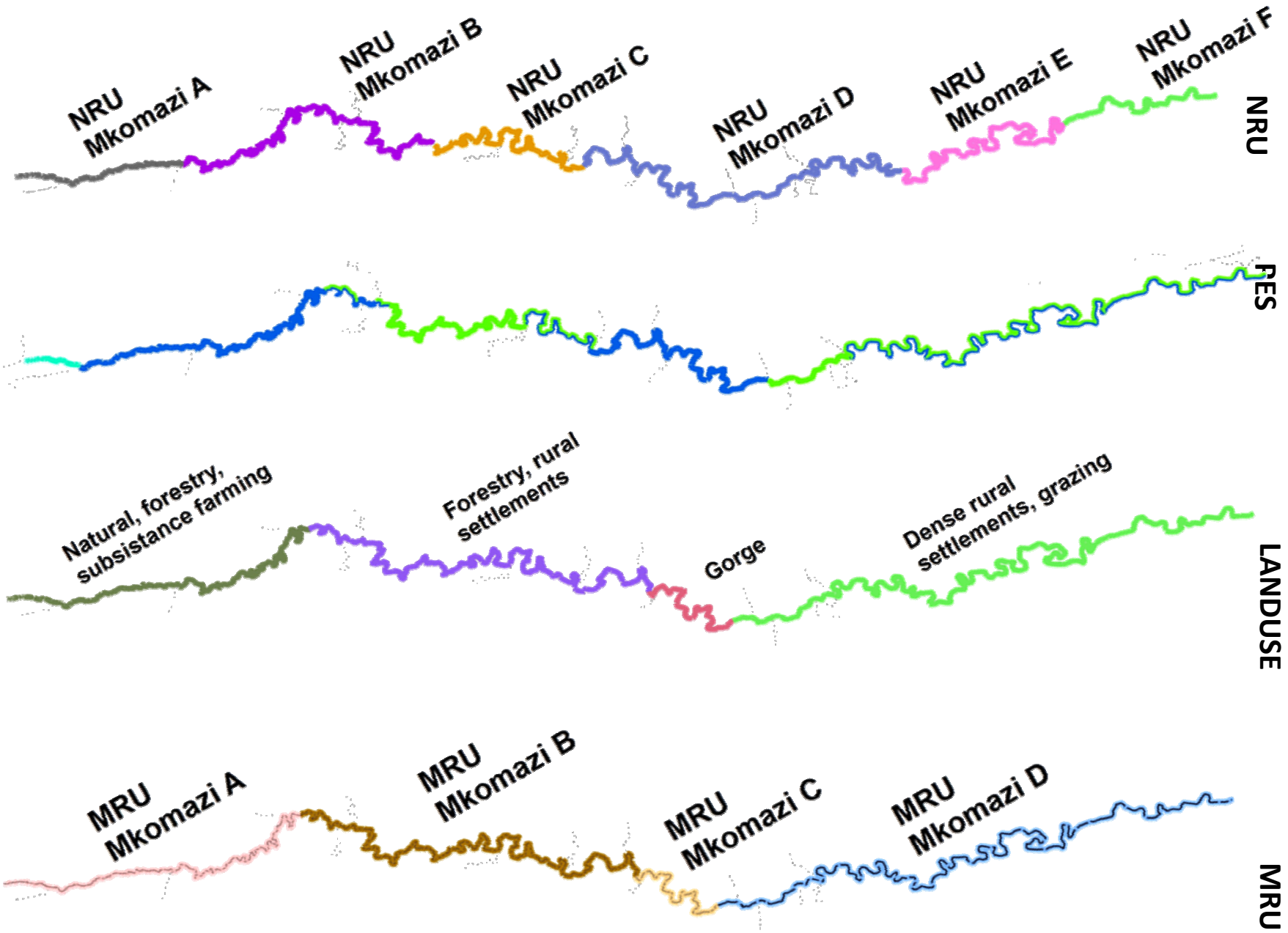

NRU Mkomazi A
NRU Mkomazi B
NRU Mkomazi C
NRU Mkomazi D
NRU Mkomazi E
NRU Mkomazi F
NRU
RES
Natural, forestry, subsistance farming
Forestry, rural settlements
Gorge
Dense rural settlements, grazing
LANDUSE
MRU Mkomazi A
MRU Mkomazi B
MRU Mkomazi C
MRU Mkomazi D
MRU

Figure 4.2 Mkomazi River: PES, operation, landuse and Management Resource Units

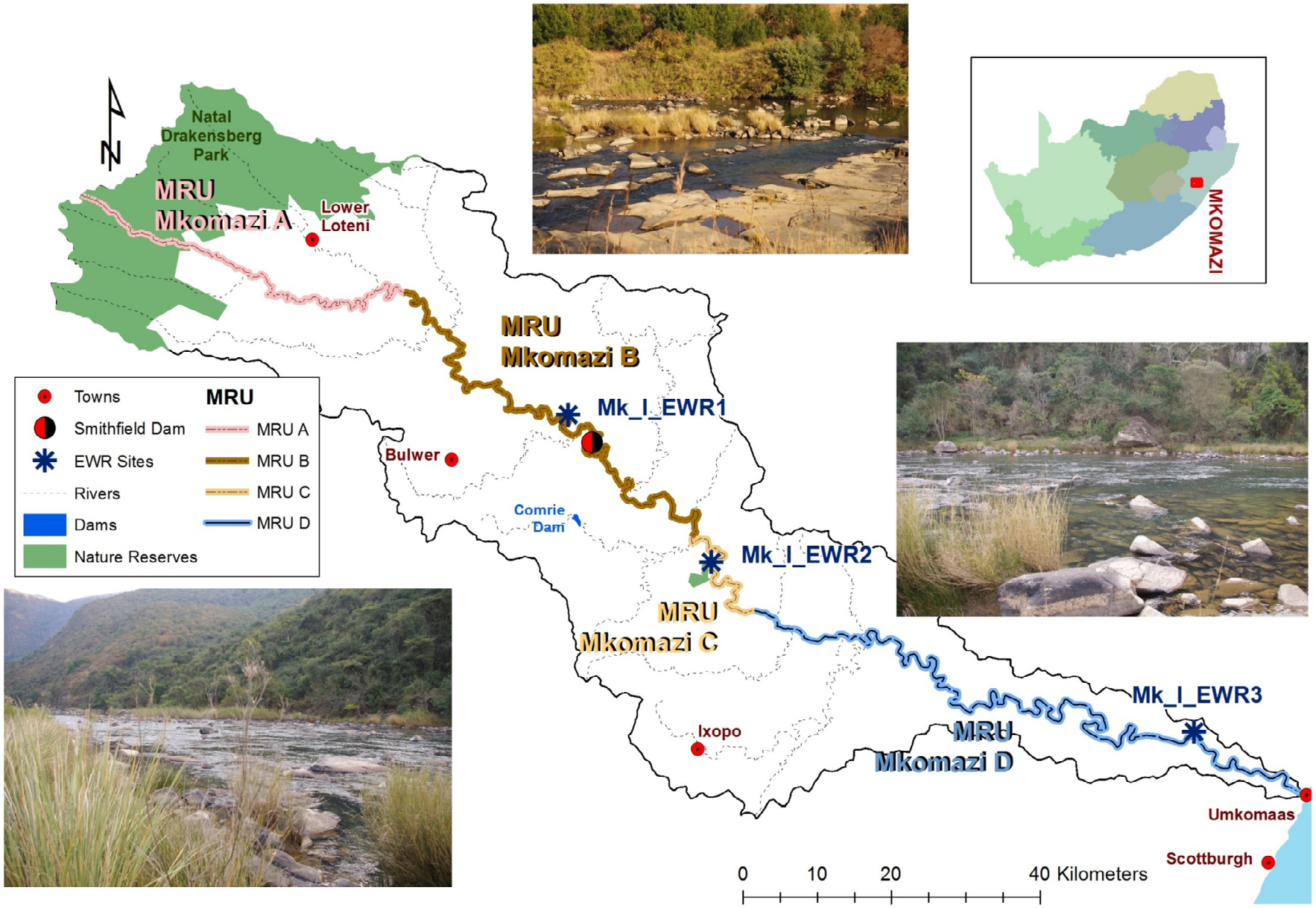


Figure 4.3 Mk_I_EWR1, Mk_I_EWR2 and Mk_I_EWR3 (Mkomazi) locality and photographs

5 RESOURCE UNITS: LOVU RIVER

5.1 NATURAL RESOURCE UNITS

The subquaternary reaches (representing hydrological zones), EcoRegions and geomorphic zones of the Lovu are described in the Fig 5.1. The Natural Resource Units (NRU) are derived from the EcoRegions and the geomorphic zones.

The study area falls within four EcoRegions (level 2), i.e. 16.01, 16.03, 17.01 and 17.03 and is dominated by the Upper Foothills geomorphic zone. As the geomorphic zones do not provide any motivation for a break in NRU, the EcoRegions are broadly used as the NRUs. The NRUs are described as NRU Lovu A, B, C and D and the delineation information are provided in Table 5.1.

5.2 MANAGEMENT RESOURCE UNITS

The river is divided into Management Resource Units (MRUs) as illustrated in Figure 5.2. The description of the MRUs and the rationale for selection is provided in Table 5.2.

System operation & Land use:
There are extensive forestry and sugar cane plantations located in the middle to upper with Richmond town and adjacent township also located in the upper reach. The Lovu Dam is situated upstream of Richmond. The middle to lower reaches is occupied by scattered rural villages. Discharges from the Richmond and township area enter the river systems affecting both the flow and especially the water quality of the river.

Present Ecological State:
The upper Lovu is situated in areas mainly covered with plantation forestry (C and B/C PES). Further downstream there are large areas of forestry. Sugar cane, rural development (towns/townships), and dams, have increased impacts on these rivers, especially the water quality (C/D PES). Further downstream, the condition improves to a B/C as the deeper valleys of the Lovu prevent the people from impacting too much on the rivers but water quality impacts prevail.

5.3 EWR SITE SELECTION

Site details are provided in Appendix A and the site locality and characterics are illustrated in Fig 5.3.

One Rapid III EWR site was selected in this river and to be useful for estuary EWR assessment, it should be selected as far downstream as possible. The logical place would be to select the site within the downstream area where the river improves to a PES of a B/C. Lo_R_EWR1 was therefore selected in this reach.

Table 5.1 Lovu: Description and rationale for the Natural Resource Units

NRU	EcoRegion Level 2	Geomorphic zone	Rationale	Delineation
NRU Lovu A	16.01: 100%	Mountain headwater: 5% Mountain: 16% Transitional: 32% Upper Foothills: 44% Lower Foothills: 3%	Coincides with EcoRegion 16.01 and consists of a mixture of mostly Upper and Transitional Foothills	Start: -29.873576; 30.158592 End: -29.863248; 30.236379
NRU Lovu B	16.03: 70% 17.01: 30%	Transitional: 2% Upper Foothills: 66% Lower Foothills: 32%	Coincides with EcoRegion 16.03 and the first portion of 17.01 and consists of a mixture of mostly Upper and Lower Foothills	End: -30.002553; 30.48244
NRU Lovu C	17.01: 12% 17.03: 88%	Transitional: 4% Upper Foothills: 96%	Coincides with EcoRegion 17.03 with small portions of 17.01 interspersed within 17.03. The geomorphic zones consist of mostly Upper Foothills	End: -30.060853; 30.611696
NRU Lovu D	17.01: 100%	Upper Foothills: 56% Lower Foothills: 29% Lowland: 15%	Coincides with EcoRegion 17.01 and consists of a mixture of mostly Upper and Lower Foothills, including a small portion of Lowland.	End: -30.113121; 30.852810

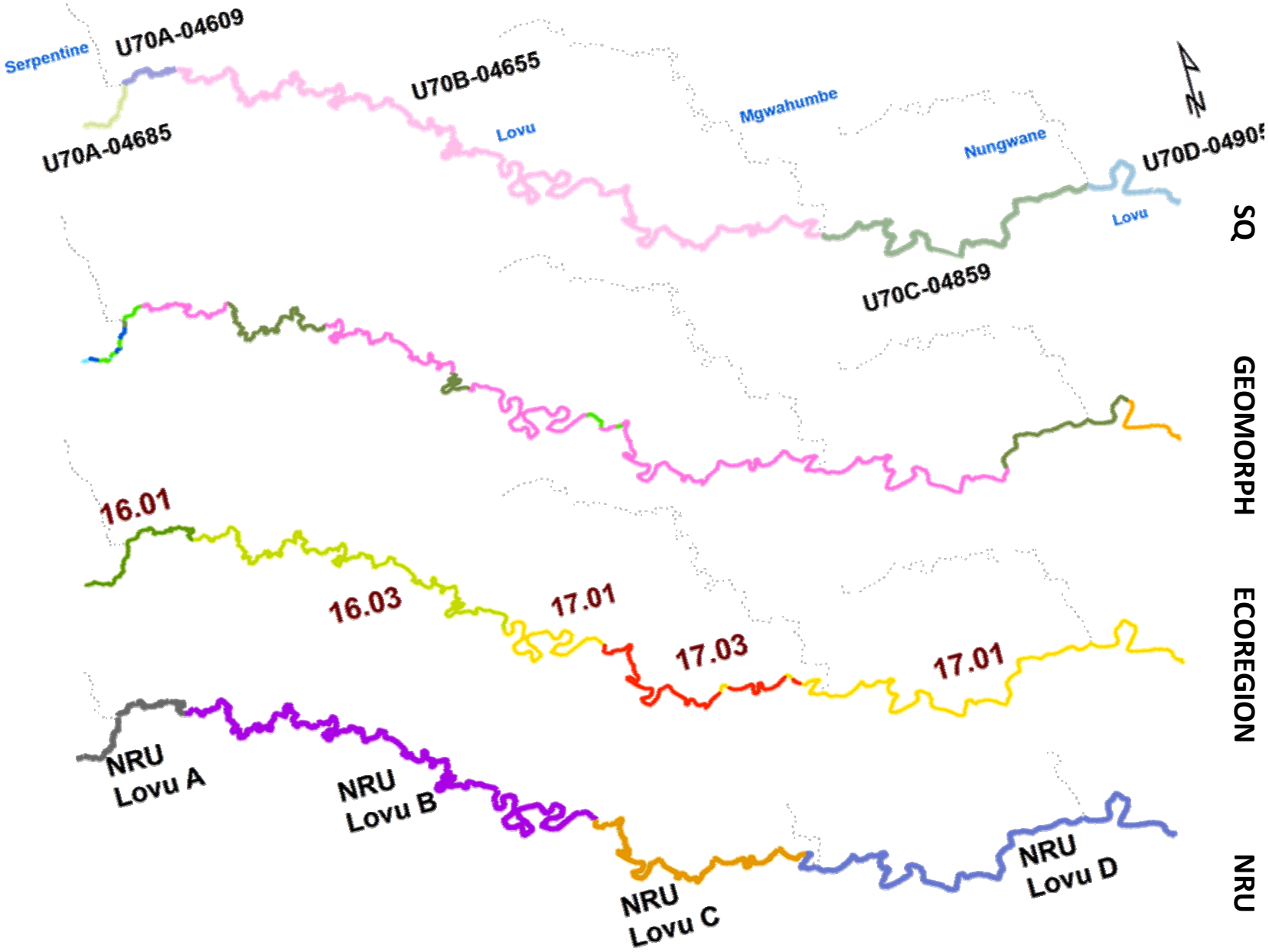

Serpentine
U70A-04609
U70A-04685
U70B-04655
Lovu
Mgwahumbe
Nungwane
U70D-0490
Lovu
U70C-04859
SQ
GEOMORPH
16.01
16.03
17.01
17.03
17.01
ECOREGION
NRU
Lovu A
NRU
Lovu B
NRU
Lovu C
NRU
Lovu D
NRU

Figure 5.1 Lovu River: EcoRegions, geomorphological zones and Natural Resource Units

Table 5.2 Lovu: Description and rationale of the Management Resource Units

MRU	EcoRegion Level 2	Geomorphic zone	Land cover	Rationale	Delineation	Quat
MRU Lovu A	16.01: 100%	Mountain headwater: 5% Mountain: 15% Transitional: 32% Upper Foothills: 44% Lower Foothills: 4%	Forestry	This land use is dominated by forestry and the logical end of the MRU is the Richmond Dam and Richmond town.	Start: -29.873576; 30.158592 End: -29.863248; 30.236379	U70A
MRU Lovu B	16.03: 67% 17.01: 28% 17.03: 5%	Transitional: 3% Upper Foothills: 66% Lower Foothills: 30%	Sugar cane, forestry (small)	Downstream of the town there is extensive sugar cane with some forestry. The PES is similar for this whole stretch (C/D).	End: -30.014011; 30.496317	U70B
MRU Lovu C	17.01: 47% 17.03: 53%	Upper Foothills: 100%	Some rural settlements, grazing, subsistence agriculture.	The MRU is distinct from the upstream stretch as the intensive forestry is replaced by rural settlements with associated subsistence and agriculture.	End: -30.088913; 30.682215	U70C
MRU Lovu D	17.01: 100%	Upper Foothills: 32% Lower Foothills: 45% Lowland: 23%	Limited access (topography) and therefore limited use.	This area is different from upstream due to the change in topography and the resulting limited use of the river compared to upstream. The PES also improves in this section.	End: -30.111869; 0.8522378	U70C U70D

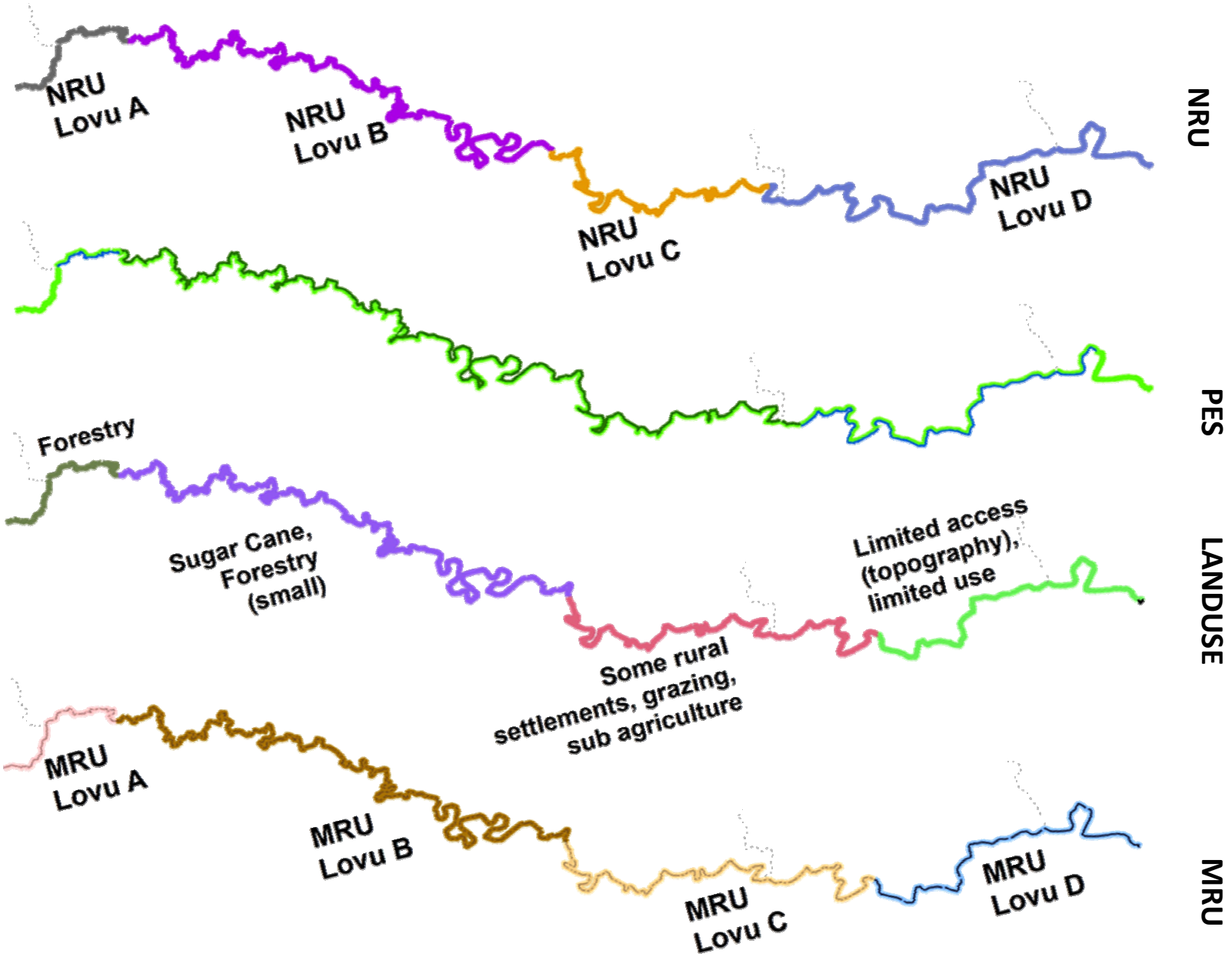


Figure 5.2 Lovu River: PES, operation, landuse and Management Resource Units

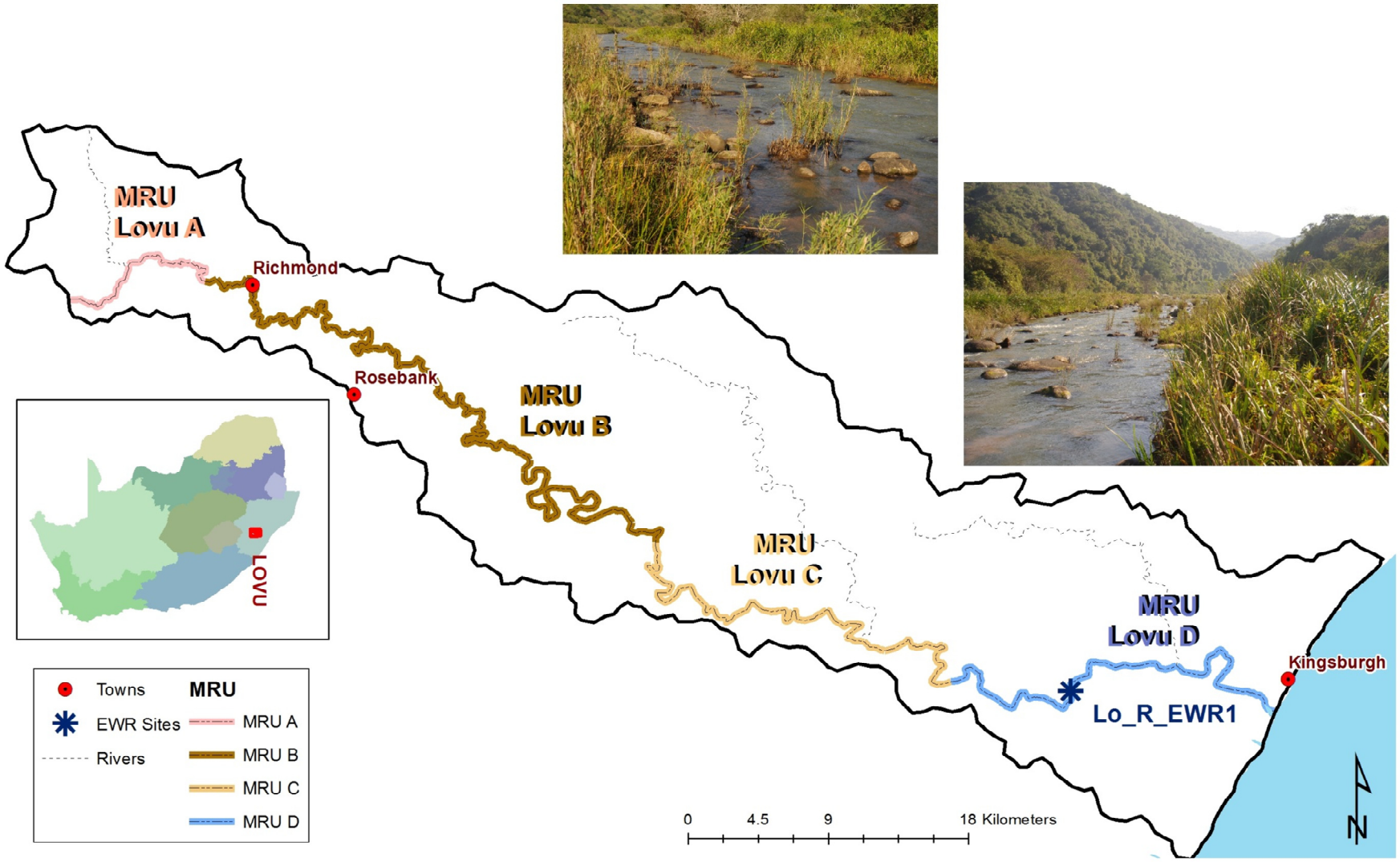


Figure 5.3 Lo_R_EWR1 (Lovu River) locality and photographs

6 RESOURCE UNITS: uMNGENI RIVER

6.1 NATURAL RESOURCE UNITS

The subquaternary reaches (representing hydrological zones), EcoRegions and geomorphic zones of the uMngeni are described in the Fig 6.1. The Natural Resource Units (NRU) are derived from the EcoRegions and the geomorphic zones.

The study area falls within six EcoRegions (level 2), i.e. 15.07, 16.01, 16.03, 17.03, 17.01 and 17.02. The geomorphic zone is generally a mixture being dominated by Upper and Lower Foothills. As there are no distinct geomorphic zone boundaries that could indicate change in NRU, the dominant EcoRegion Level 2s are taken as the NRUs. The NRUs are described as NRU uMngeni A, B, C, D, and E and the delineation information are provided in Table 6.1.

6.2 MANAGEMENT RESOURCE UNITS

The river is divided into Management Resource Units (MRUs) as illustrated in Figure 6.2. The description of the MRUs and the rationale for selection is provided in Table 6.2.

System operation & Land use:
The main uMngeni River is essentially operated in terms of water resources through a range of large dams. The different operating rules of these dams results in different land use between the dams and are described as follows:

- Upstream of Midmar Dam: The landuse is forestry and agriculture. Small farm dams occur in the main river and the tributaries.
- Midmar to Albert Falls Dam: Howick town occurs downstream of Midmar Dam with resulting water quality problems. Midmar Dam releases a compensation flow of approximately 0.9m^3/s and the downstream flow therefore consists of this compensation release, spills, return flows and tributary inflows. The main land use activities in the IUA include extensive forestry, cultivation (sugar cane and other cash crops) and irrigation.
- Albert Falls to Nagle Dam: A high constant flow is released from Albert Falls Dam. The area consist of many chicken farms and formal agriculture. The lower section upstream of Nagle dam is in a rural area with settlements where access allows.
- Nagle to Inanda Dam: The uMnsunduze River with its poor water quality comes into this section. The section is dominated by rural settlements and agriculture.

The dams therefore form the breaks for the operational and land use delineation.

Present Ecological State:
Upstream of Midmar Dam, the stretch is mostly in a C and B/C PES with impacts related to forestry and agriculture. Downstream of Midmar Dam, flow is one of the major issues that result in the PES, which at a desktop level is probably higher (C and B/C) than it should be. Downstream of Albert Falls Dam, the river is in a B/C due to the protection of steep river valleys. Downstream of the uMnsunduze River, the water quality becomes poor with a resulting drop in PES.

Rationale:
The large dams in the system form logical breaks for the Management Resource Units. Each MRU apart from the river reaches above Midmar Dam is therefore controlled (in terms of flow) by the upstream dams. The river downstream of Inanda Dam does not form part of the river MRUs as this section will be managed according to estuary requirements.

6.3 EWR SITE SELECTION

A site is located in each of the MRUs apart from the MRU uMngeni C (downstream of Albert Falls Dam). The indications are that the socio-economic consequences would be high if the consistent flow from Albert Falls Dam has to change to accommodate a more seasonal distribution. This would be required for the EWR releases. It was therefore decided to focus on the other MRUs for the selection of EWR sites. Over and above the normal site selection criteria (Louw *et al* 1999), the following were key in selecting the EWR sites.

- **MRU uMngeni A:** An existing site used for a Rapid EWR assessment was used due to the information available for this site.
- **MRU uMngeni C:** Access was a major problem as well as many instream small dams resulting in inundation. An area on Karkloof SPA was selected as the river is locally in a reasonable condition given that the area is within a private nature reserve.
- **MRU uMngeni D:** Access was a major problem in this reach and the site selection was governed by access combined suitable instream habitat.

Site details are provided in Appendix A and the site locality and characterised are illustrated in Fig 6.3.

Table 6.1 uMngeni: Description and rationale for the Natural Resource Units

NRU	EcoRegion Level 2	Geomorphic zone	Rationale	Delineation
NRU uMngeni A	15.07: 100%	Mountain headwater: 7% Mountain: 20% Transitional: 11% Upper Foothills: 28% Lower Foothills: 34%	Coincides with EcoRegion 15.07. The geomorphic zones are varied, but dominated by Upper and Lower Foothills.	Start: -29.457427; 29.814275 End: -29.471557; 29.881634
NRU uMngeni B	16.01: 100%	Mountain: 3% Transitional: 6% Upper Foothills: 37% Lower Foothills: 47%	Coincides with EcoRegion 16.01. Dominant geomorphic zones are Upper and Lower Foothills.	End: -29.494428; 30.251207
NRU uMngeni C	16.03: 70% 17.01: 30%	Mountain: 4% Transitional: 2% Upper Foothills: 33% Lower Foothills: 61%	Coincides with EcoRegion 16.03 with a small portions of 17.01 included. Dominant geomorphic zones are Upper and Lower Foothills.	End: -29.476797; 30.482954
NRU uMngeni D	17.01: 100%	Upper Foothills: 42% Lower Foothills: 58%	Coincides with EcoRegion 17.03. Dominant geomorphic zones are Upper and Lower Foothills.	End: -29.544118; 30.539907
NRU uMngeni E	17.03: 80% 17.01: 20%	Upper Foothills: 25% Lower Foothills: 75%	Coincides with EcoRegion 17.01 with small portions of 17.02 included. The geomorphic zones consist of mostly Lower Foothills	End: -29.809971; 31.038595

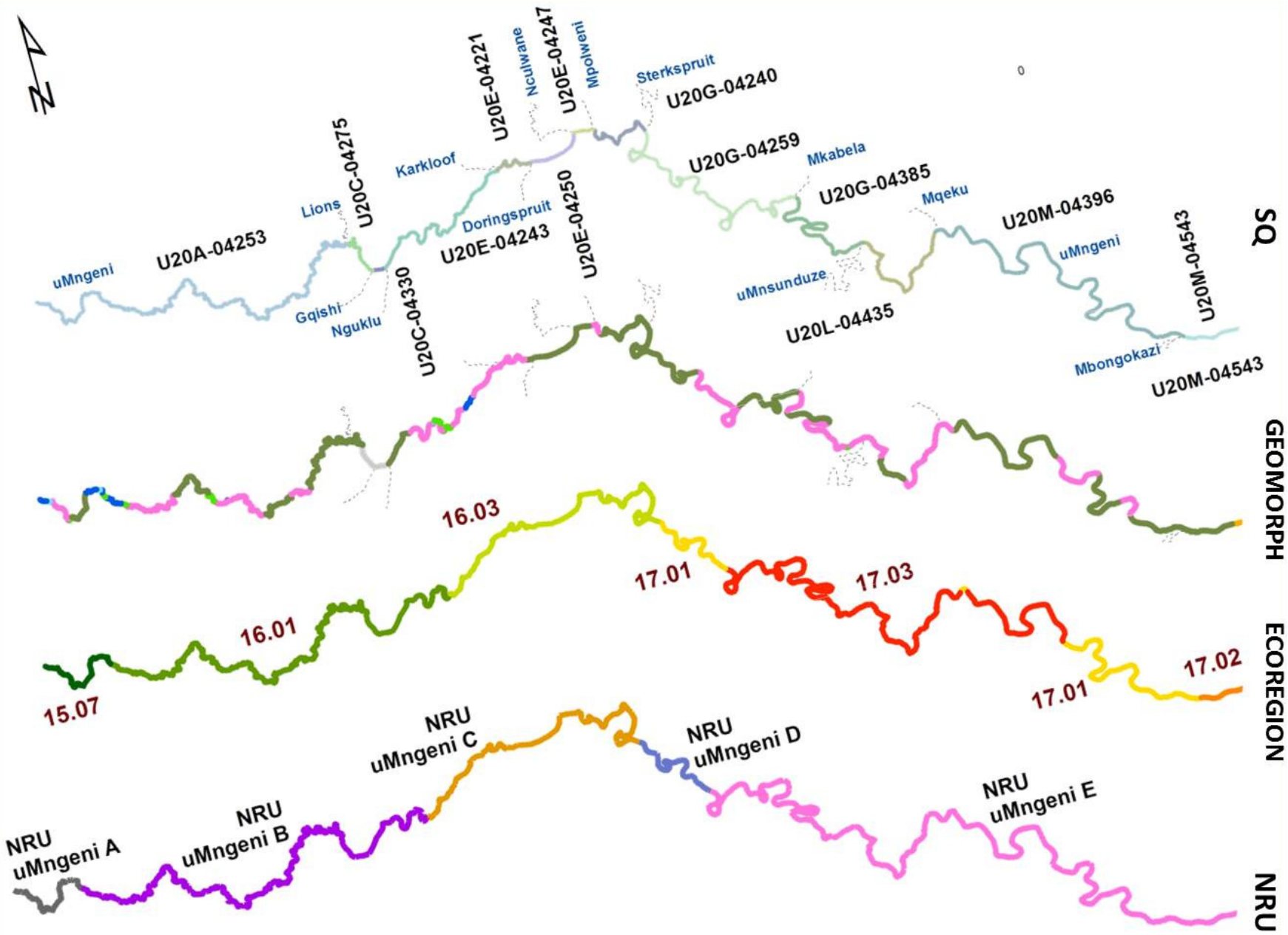

N
0
U20A-04253
U20C-04275
U20C-04330
U20E-04221
U20E-04247
U20E-04243
U20E-04250
U20G-04240
U20G-04259
U20G-04385
U20L-04435
U20M-04396
U20M-04543
U20M-04543
uMngeni
Lions
Gqishi
Nguklu
Karkloof
Doringspruit
Nculwane
Mpolweni
Sterkspruit
Mkabela
Mqeku
uMnsunduze
uMngeni
Mbongokazi
SQ
GEOMORPH
ECOREGION
NRU
15.07
16.01
16.03
17.01
17.03
17.01
17.02
NRU uMngeni A
NRU uMngeni B
NRU uMngeni C
NRU uMngeni D
NRU uMngeni E

Figure 6.1 uMngeni River: EcoRegions, geomorphological zones and Natural Resource Units

Table 6.2 uMngeni: Description and rationale of the Management Resource Units

MRU	EcoRegion Level 2	Geomorphic zone	Land cover	Rationale	Delineation	Quat
MRU uMngeni A	15.07: 18% 16.01: 82%	Mountain headwater: 1% Mountain: 7% Transitional: 5% Upper Foothills: 33% Lower Foothills: 46%	Formal agriculture and forestry.	Upstream of Midmar Dam. Formal agriculture and forestry with no major water resource operation of infrastructure	Source to Midmar Dam Start: -29.4574267; 29.814276 End: -29.516264; 30.181104	U20A, U20C
MRU uMngeni B	16.01: 37% 16.03: 63%	Mountain: 5% Transitional: 8% Upper Foothills: 53% Lower Foothills: 34%	Forestry, irrigation, urbanisation, compensation flow from Midmar Dam	Operation from Midmar Dam with quality impacts of Howick results in this being a logical MRU	Midmar Dam wall to Albert Falls End: -29.428938; 30.410045	U20E
MRU uMngeni C	16.03: 33% 17.01: 25% 17.03: 42%	Upper Foothills: 30% Lower Foothills: 70%	High consistent flows from Albert Falls Dam.	Operation from Albert Falls Dam with a consistent release results in this MRU.	Albert Falls Dam wall to Nagle Dam wall End: -29.594094; 30.643315	U20G
MRU uMngeni D	17.01: 33% 17.02: 5% 17.03: 62%	Transitional: 1% Upper Foothills: 43% Lower Foothills: 55% Lowland 1%	Rural settlements, subsistence agriculture, water quality issues from the uMnsunduze.	Nagle Dam is small, spills often, and the flow is more diverse that the consistent flow upstream. This therefore forms a separate MRU.	Nagle Dam wall to Inanda Dam. End: -29.809971; 31.038595	U20G, U20L

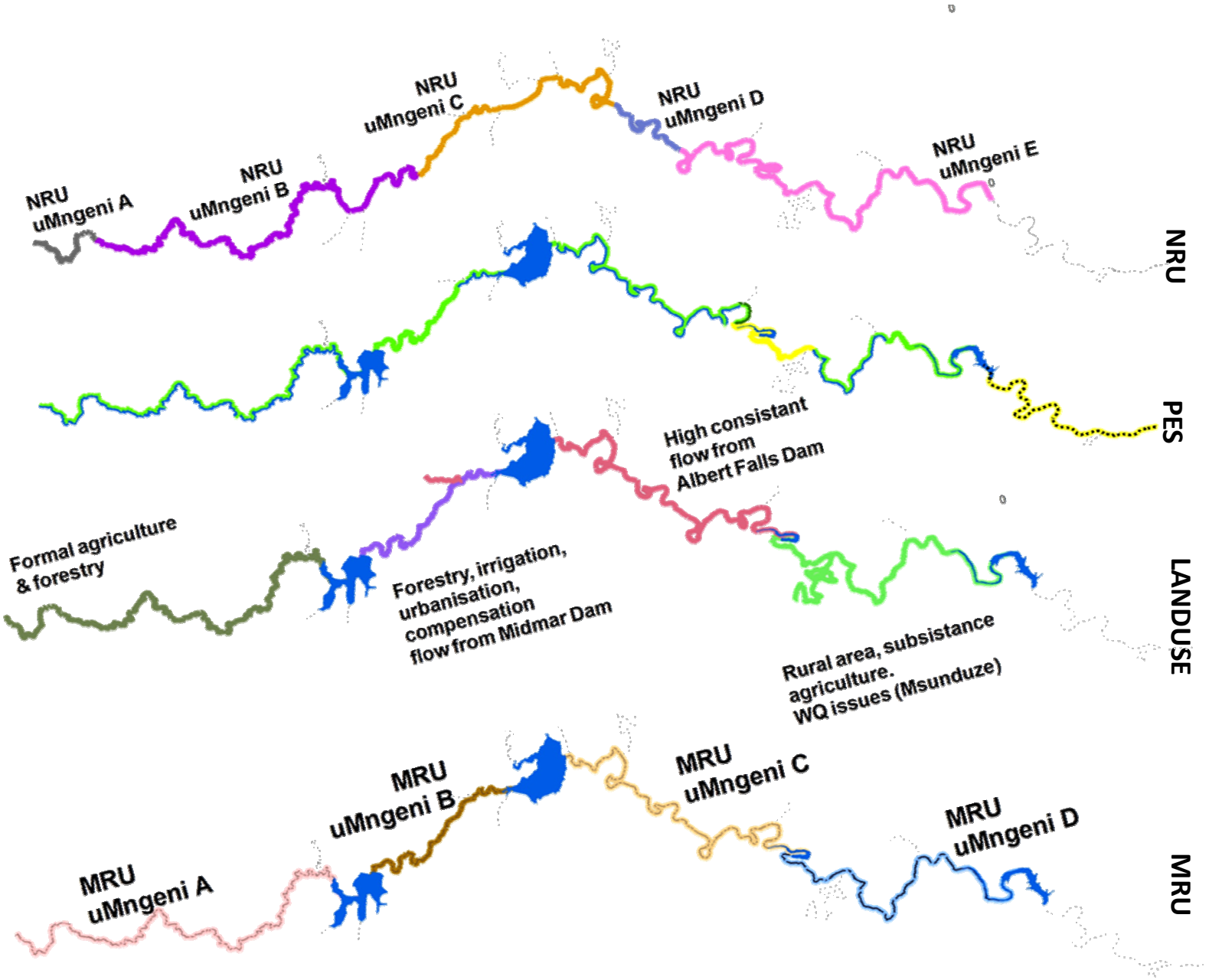

NRU uMngeni A
NRU uMngeni B
NRU uMngeni C
NRU uMngeni D
NRU uMngeni E
NRU
PES
High consistant flow from Albert Falls Dam
Formal agriculture & forestry
Forestry, irrigation, urbanisation, compensation flow from Midmar Dam
Rural area, subsistance agriculture. WQ issues (Msunduze)
LANDUSE
MRU uMngeni A
MRU uMngeni B
MRU uMngeni C
MRU uMngeni D
MRU

Figure 6.2 UMngeni River: PES, operation, landuse and Management Resource Units

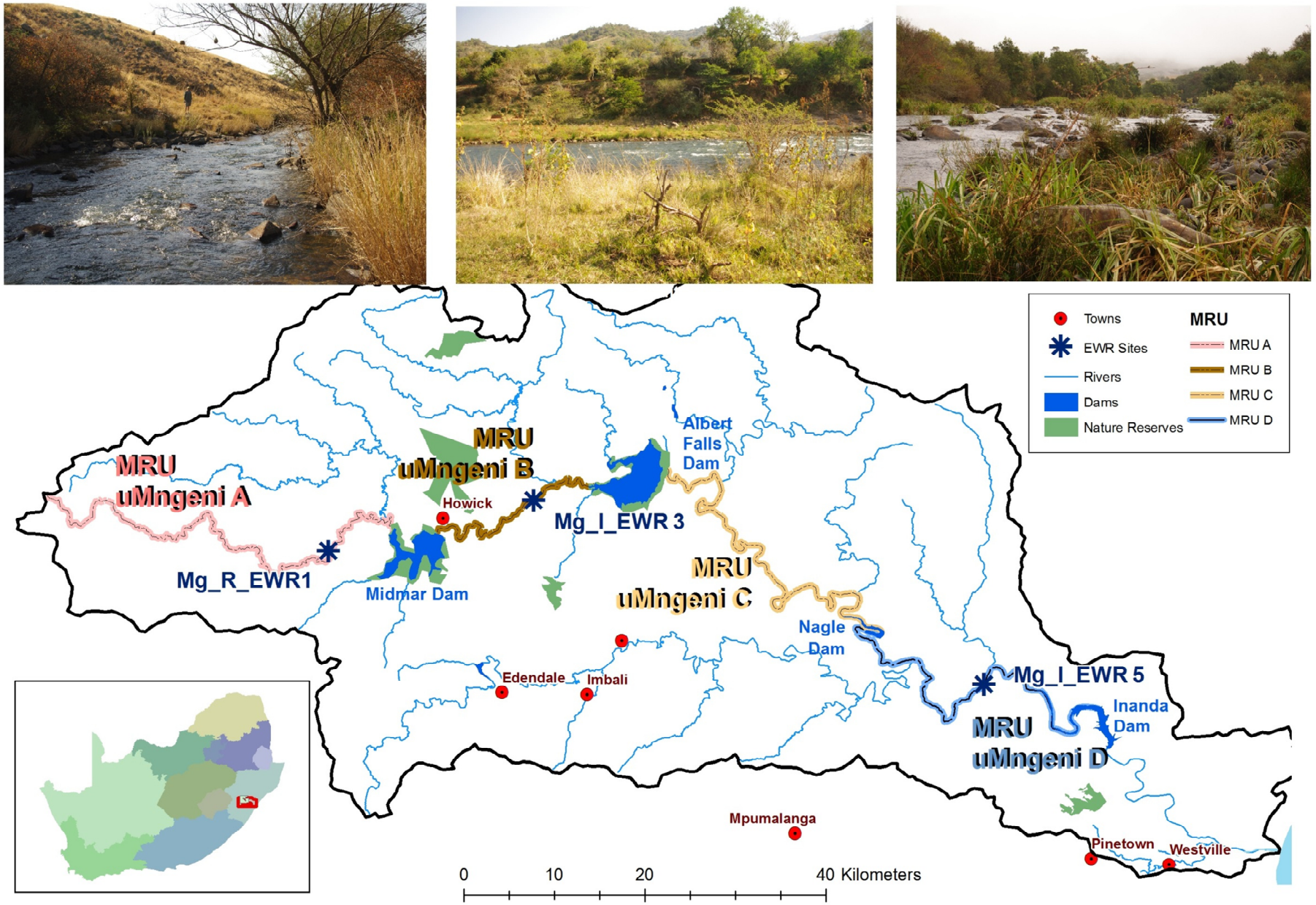


Figure 6.3 Mg_R_EWR1, MG_I_EWR2 and MG_I_EWR5 (uMngeni River) locality and photographs

7 RESOURCE UNITS: KARKLOOF RIVER

7.1 NATURAL RESOURCE UNITS

The subquaternary reaches (representing hydrological zones), EcoRegions and geomorphic zones of the Karkloof are described in the Fig 7.1. The Natural Resource Units (NRU) are derived from the EcoRegions and the geomorphic zones.

The study area falls within two EcoRegions (level 2), i.e. 16.01 and 16.03 and is dominated by the Upper and Lower Foothills geomorphic zone. The 16.01 EcoRegion is dominated by Upper and Lower Foothills and the 16.03 one with Upper Foothills. The Karkloof Water fall forms a distinct break between the two EcoRegions and the exact break has been used to as the break for the NRUs. The NRUs are described as NRU Karkloof A and B and the delineation information are provided in Table 7.1.

7.2 MANAGEMENT RESOURCE UNITS

The river is divided into Management Resource Units (MRUs) as illustrated in Figure 7.2. The description of the MRUs and the rationale for selection is provided in Table 7.2.

System operation & Land use:
The upper Karkloof is dominated by commercial forestry with agriculture (irrigation) in the lower section towards the Karkloof Waterfall. Downstream of the waterfall, the river falls within a private nature reserve and although protected, barriers and inundation of small dams built prior to the existence of the Reserve are a serious problem.

Present Ecological State:
The larger part of the upper area within forestry is in a C PES. Further downstream it is a B/C to the Mgeni River. The improved condition is related to the inaccessibility as well as the protection of the private reserve and the waterfall.

7.3 EWR SITE SELECTION

An EWR site should be placed in the B/C section and downstream of the waterfall. The waterfall forms a natural barrier and the flow requirements upstream of the barrier might not be relevant for the section lower down. A site was therefore selected in MRU Karkloof C. Site details are provided in Appendix A and the site locality and characterised are illustrated in Fig 7.3.

Table 7.1 Karkloof: Description and rationale for the Natural Resource Units

NRU	EcoRegion Level 2	Geomorphic zone	Rationale	Delineation
NRU Karkloof A	16.01: 100%	Mountain headwater: 1% Mountain: 2% Transitional: 15% Upper Foothills: 34% Lower Foothills: 48%	Upstream of the waterfall and in one EcoRegion. Dominated by Upper and Lower Foothills.	Start: -29.252479; 30.20552 End: -29.395734; 30.279855
NRU Karkloof B	16.01:13% 16.03: 87%	Mountain headwater: 4% Mountain: 9% Transitional: 27% Upper Foothills: 60%	A natural break is formed by the Karkloof Waterfall which coincides almost with the break between EcoRegions. The natural barrier therefore delineates NRU B.	End: -29.446005; 30.321495

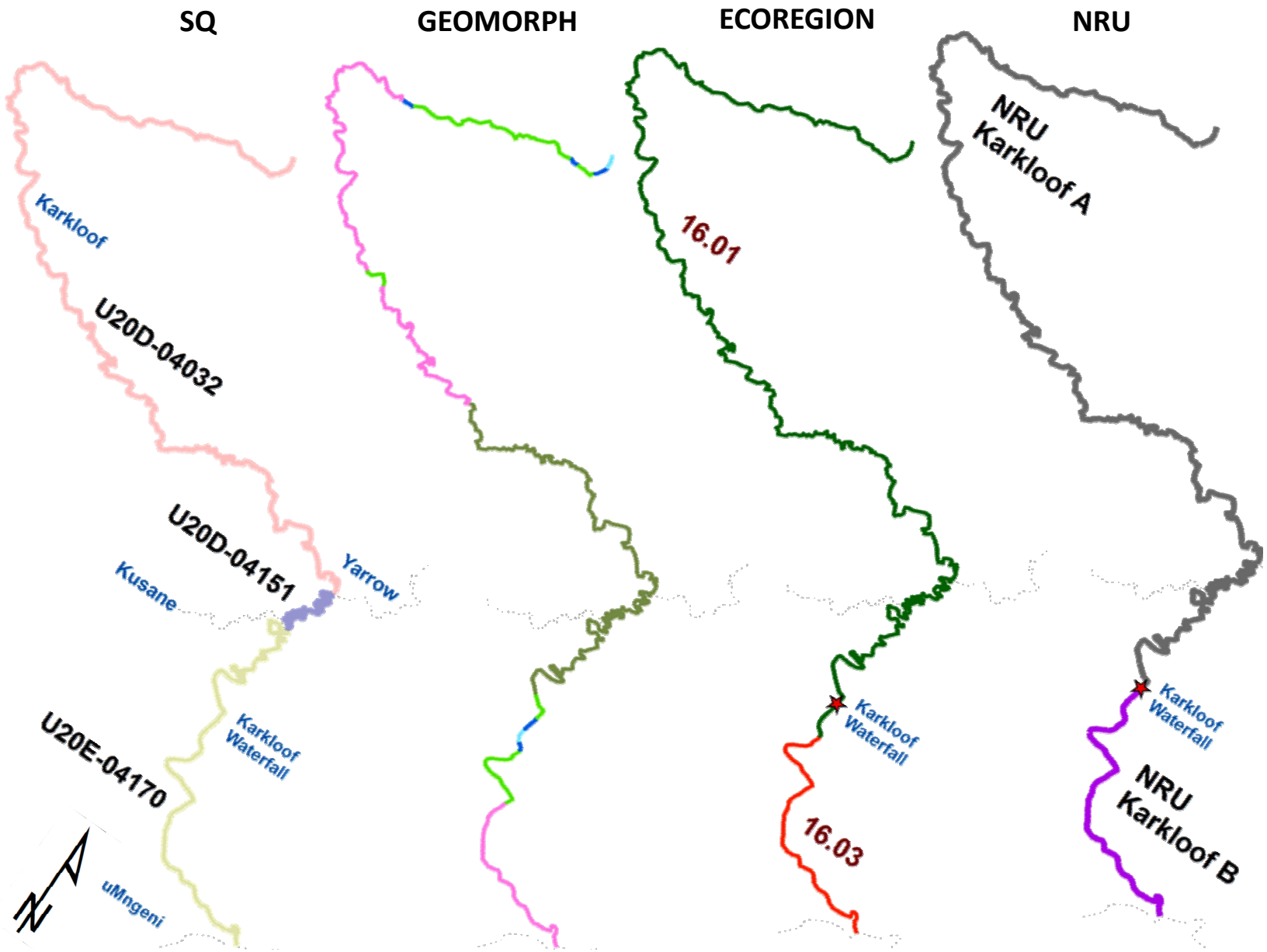


Figure 7.1 Karkloof River: EcoRegions, geomorphological zones and Natural Resource Units

Table 7.2 Karkloof: Description and rationale of the Management Resource Units

MRU	EcoRegion Level 2	Geomorphic zone	Land cover	Rationale	Delineation	Quat
MRU Karkloof A	16.01: 100%	Mountain headwater: 1% Mountain: 5% Transitional: 26% Upper Foothills: 68%	Dominated by commercial forestry	The land use is used to delineate the NRU A into two MRUs. This MRU is dominated by forestry.	Start: -29.252479; 30.205519 End: -29.333798; 30.212245	U20D
MRU Karkloof B	16.01:100%	Transitional: 3% Lower Foothills: 97%	Forestry mixed with irrigation and commercial farming	Upstream of the waterfall with landuse dominated by agriculture.	End: -29.395734; 30.279855	U20E U20D
MRU Karkloof C	16.01:13% 16.01:87%	Mountain headwater: 4% Mountain: 8% Transitional: 28% Upper Foothills: 60%	Private Nature Reserve (Karkloof Spa)	The waterfall and break between the two NRUs also forms a definitive break in terms of landuse (private nature reserve) and warrants an MRU.	End: -29.446005; 30.321495	U20E

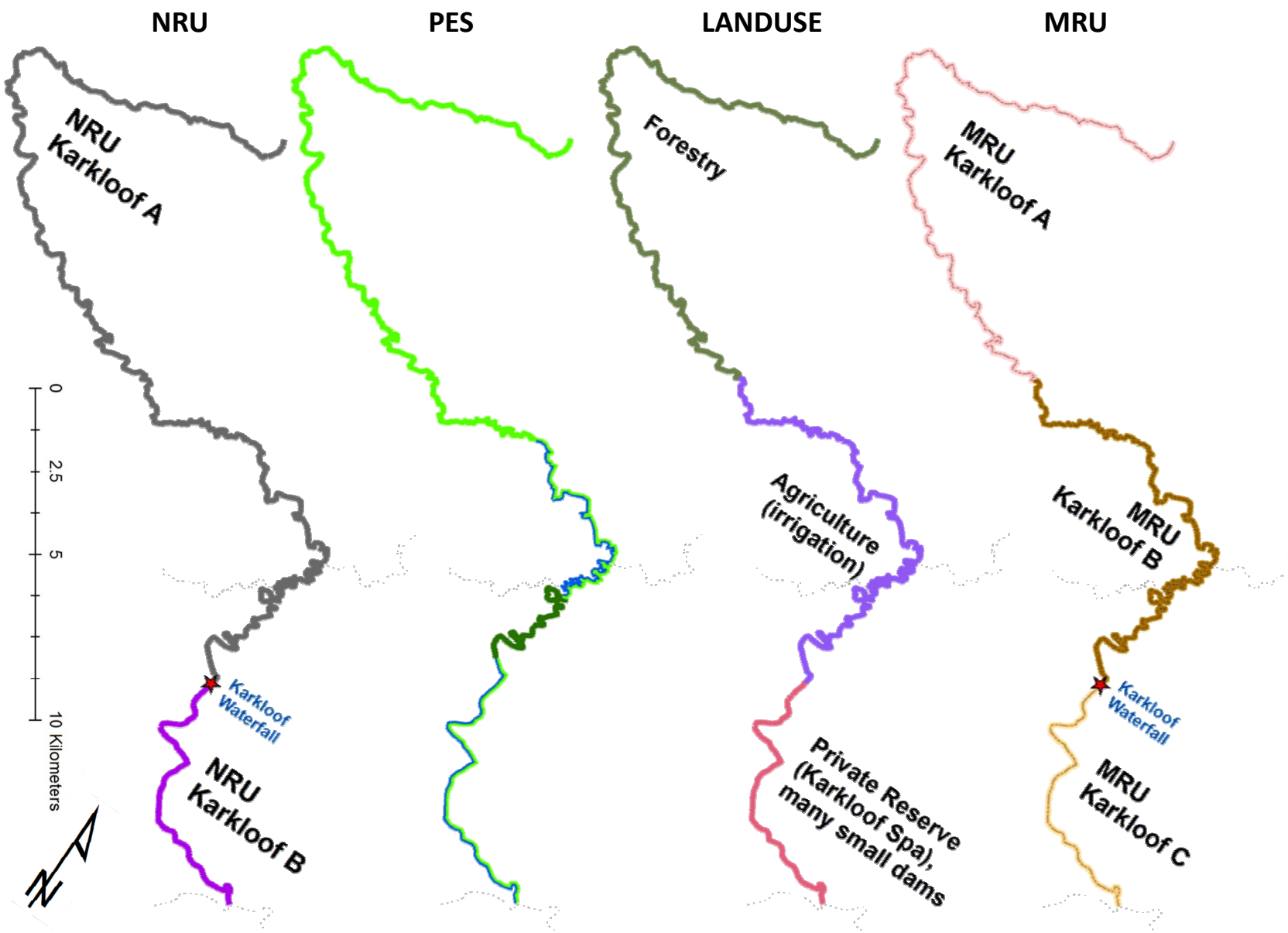

NRU
PES
LANDUSE
MRU
NRU Karkloof A
NRU Karkloof B
Karkloof Waterfall
Forestry
Agriculture (irrigation)
Private Reserve (Karkloof Spa), many small dams
MRU Karkloof A
MRU Karkloof B
MRU Karkloof C
Karkloof Waterfall
0
2.5
5
10 Kilometers
N

Figure 7.2 Karkloof River: PES, operation, landuse and Management Resource Units

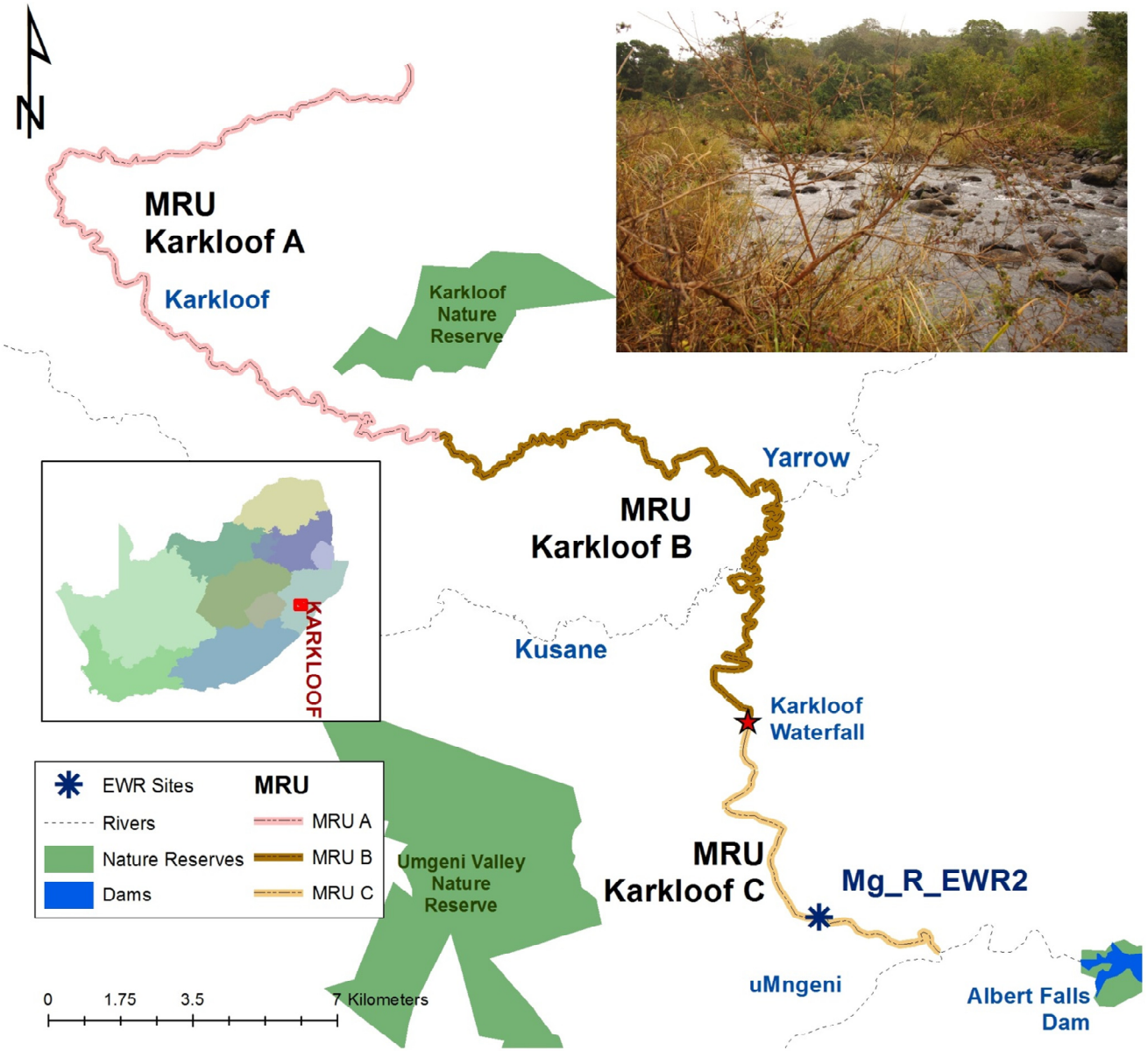


Figure 7.3 Mg_R_EWR3 (Karkloof River) locality and photographs

8 RESOURCE UNITS: uMNSUNDUZE RIVER

8.1 NATURAL RESOURCE UNITS

The subquaternary reaches (representing hydrological zones), EcoRegions and geomorphic zones of the Mkomazi are described in the Fig 8.1. The Natural Resource Units (NRU) are derived from the EcoRegions and the geomorphic zones.

The study area falls within three EcoRegions (level 2), i.e. 16.01. 16.03 and 17.03 and is dominated by the Upper Foothills geomorphic zone. Each of the EcoRegions are dominated by a different geomorphic zone combination and the EcoRegions are used as the NRUs. The NRUs are described as NRU Duze A, B and C and the delineation information are provided in Table 8.1 and Figure 8.1.

8.2 MANAGEMENT RESOURCE UNITS

The river is divided into Management Resource Units (MRUs) as illustrated in Figure 8.2. The description of the MRUs and the rationale for selection is provided in Table 8.2.

System operation & Land use:
Henley Dam is located in the upper reaches, which is a relatively small dam when compared to the dams located in the Mgeni System, and there are also a number of small farm and instream dams.

A large portion of the IUA is occupied by the greater Pietermaritzburg urban area and there are also a large number of semi-urban and rural settlements. Discharges from the Darvill WWTW (Pietermaritzburg area) enter the uMnsunduze River and affect the flow and especially the water quality of the river. Umgeni Water is currently investigating the potential of re-using effluent from the Darvill WWTW, which could have a future impact on the uMnsunduze River. The main land use activities include extensive forestry and dry land sugar cane.

Present Ecological State:
Upstream of Henley Dam the PES is a C, with non-flow related impacts (poor water quality, rural settlements, sedimentation, overgrazing, agriculture and alien vegetation). Downstream of Henley Dam through Pietermaritzburg the PES ranges from C to D to E. The E PES is due to poor water quality, canalisation, inundation, instream barriers and high intensity urbanisation. Downstream of the E, the river is impacted by poor water quality, rural settlements, informal agriculture, clearing of vegetation, overgrazing and some erosion.

8.3 EWR SITE SELECTION

Ideally, the EWR site should be far downstream of the system in the C PES section as representing the best condition site and excluding the major water quality impacts. However, access was problematic. It was therefore decided to select the site just downstream of Pietermarizburg at an existing river health site. Site details are provided in Appendix A and the site locality and characterised are illustrated in Fig 4.3.

Table 8.1 uMnsunduze: Description and rationale for the Natural Resource Units

NRU	EcoRegion Level 2	Geomorphic zone	Rationale	Delineation
NRU uMnsunduzi A	16.01:95% 16.03:6%	Mountain headwater: 1% Mountain: 5% Transitional: 7% Upper Foothills: 87%	Coincides with 16.01 and includes a very small section of 16.03. Dominated by Upper Foothills.	Start: -29.775117; 30.134547 End: -29.630565; 30.244625
NRU uMnsunduzi B	16.03:100%	Mountain: 1% Transitional: 4% Upper Foothills: 75% Lower Foothills: 20%	Coincides with 16.03. Dominated by Upper Foothills.	End: -29.614166; 30.579247
NRU uMnsunduzi C	17.01 (yellow):4% 17.03:96%	Upper Foothills: 26% Lower Foothills: 74%	Coincides with 17.0 and includes a very small portion of 16.01. Dominated by Lower Foothills.	End: -29.62042; 30.676473

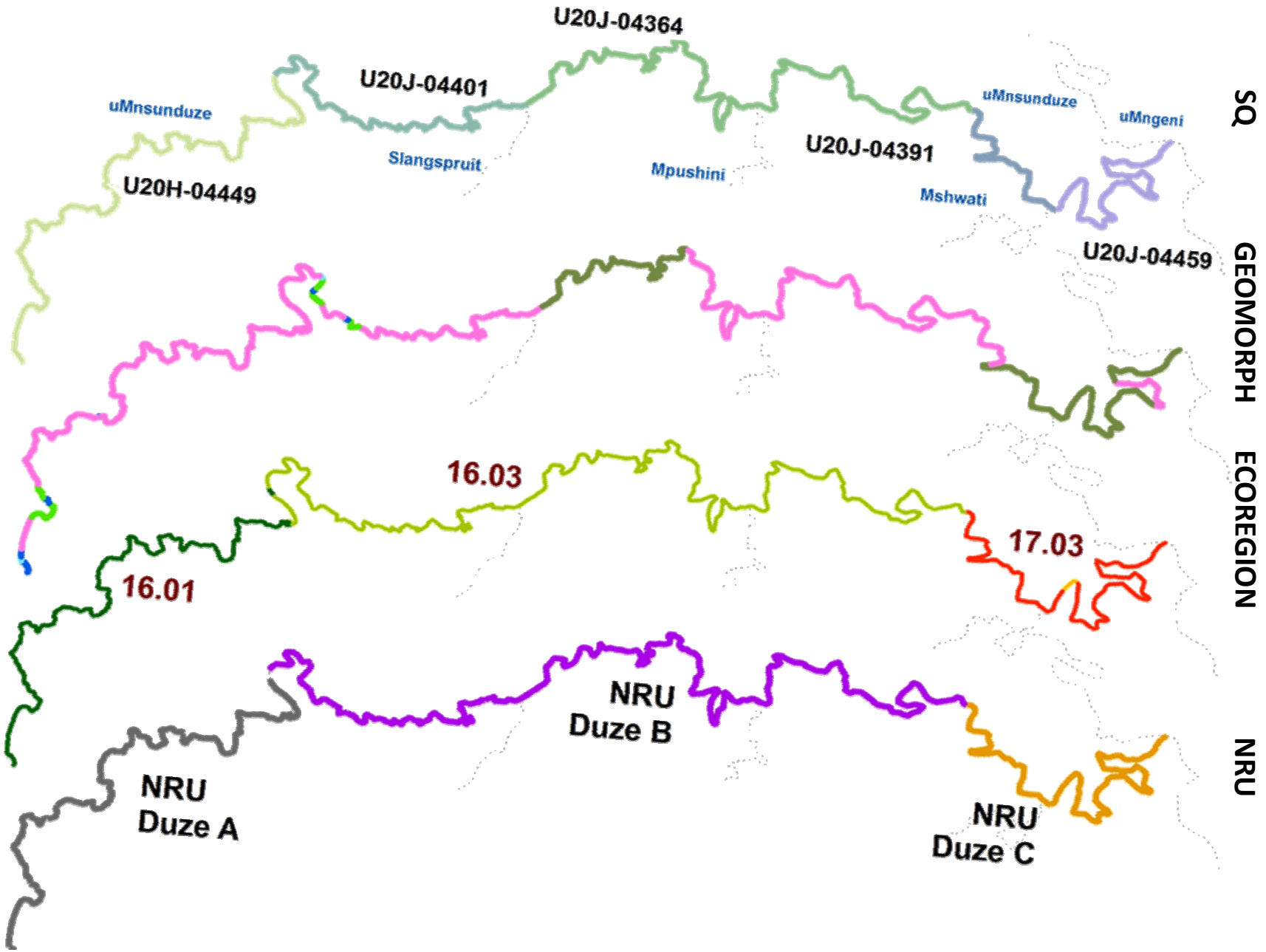

U20J-04364
U20J-04401
uMnsunduze
Slangspruit
U20H-04449
Mpushini
U20J-04391
uMnsunduze
uMngeni
Mshwati
U20J-04459
16.03
16.01
17.03
NRU
Duze B
NRU
Duze A
NRU
Duze C
SQ
GEOMORPH
ECOREGION
NRU

Figure 8.1 uMnsunduze River: EcoRegions, geomorphological zones and Natural Resource Units

Table 8.2 uMnsunduze: Description and rationale of the Management Resource Units

MRU	EcoRegion Level 2	Geomorphic zone	Land cover	Rationale	Delineation	Quat
MRU uMnsunduze A	16.01: 83% 16.03: 17%	Mountain headwater: 1% Mountain: 5% Transitional: 10% Upper Foothills: 84%	Low density settlements, sedimentation, chicken farms, erosion.	Impacts upstream of Pietermaritzburg is different than those associated with the urban areas where water quality problems become severe. This area is therefore an MRU on its own, ends at a dam, is of the same PES and coincides virtually with NRU A.	Start: -29.7751167; 30.134547 End: -29.63384; 30.26395	U20H
MRU uMnsunduze B	16.03: 100%	Transitional: 4% Upper Foothills: 52% Lower Foothills: 44%	Mostly Pietermaritzburg	Pietermaritzburg area requires an MRU on its own due to very specific impacts associated with urbanisation.	End: -29.621746; 30.263201	U20J
MRU uMnsunduze C	16.03: 100%	Upper Foothills: 100%	Forestry, gorge, some formal agriculture.	The section downstream of PMB is in some way protected by the river falling within a gorge. The water quality issues from upstream however is still prevalent. The landuse is different (forestry and some formal agriculture).	End: -29.606138; 30.552621	U20J
MRU uMnsunduze D	16.03: 10% 17.01: 3% 17.03: 87%	Upper Foothills 33% Lower Foothills 67%	High density rural settlements.	Landuse changes to high density rural settlements. The water quality improves somewhat with the dilution that tributary inflows contribute. This section therefore forms its own MRU.	End: -29.620421; 30.676473	U20J

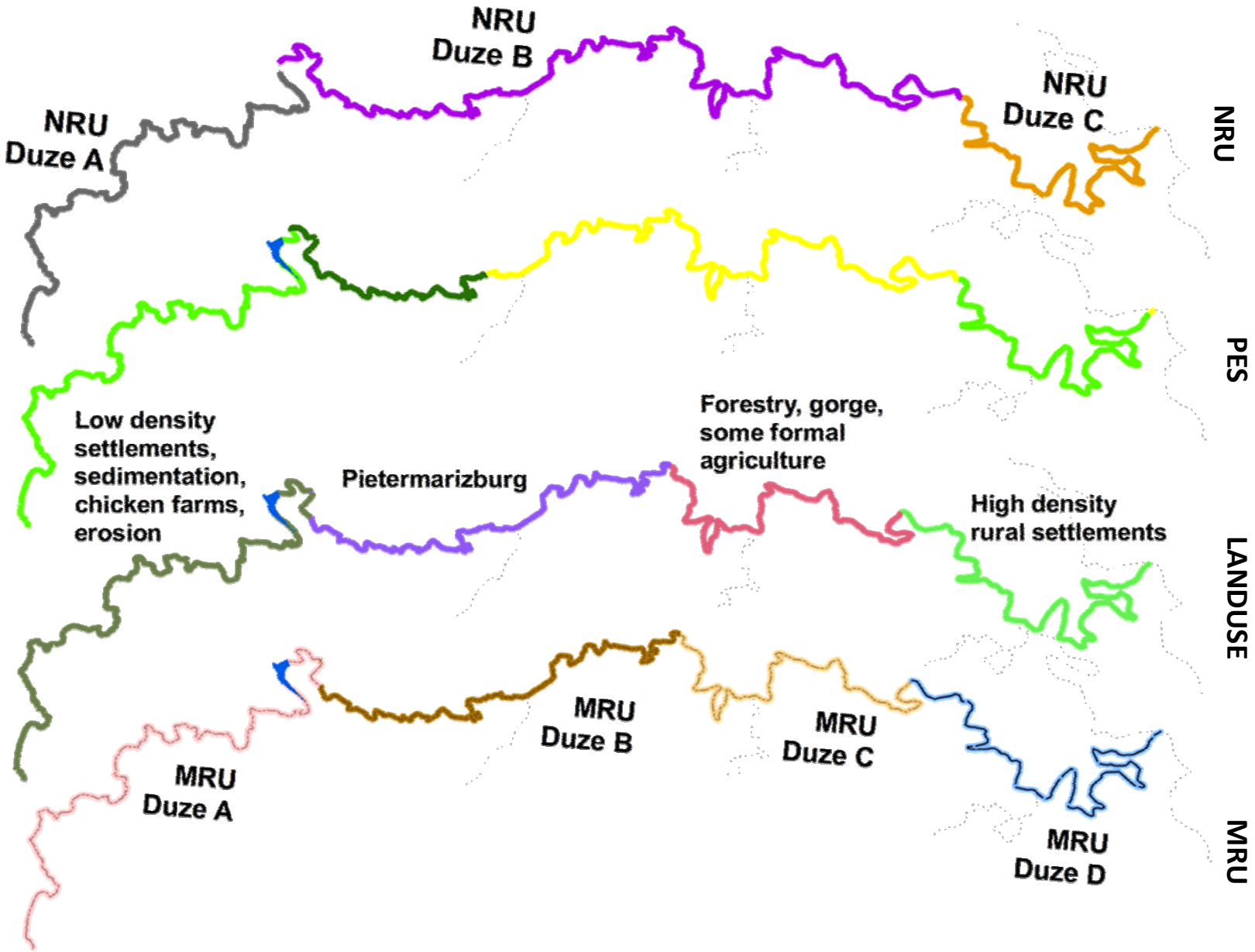

NRU
Duze A
NRU
Duze B
NRU
Duze C
NRU
Low density
settlements,
sedimentation,
chicken farms,
erosion
Pietermarizburg
Forestry, gorge,
some formal
agriculture
High density
rural settlements
PES
LANDUSE
MRU
Duze A
MRU
Duze B
MRU
Duze C
MRU
Duze D
MRU

Figure 8.2 uMnsunduze River: PES, operation, landuse and Management Resource Units

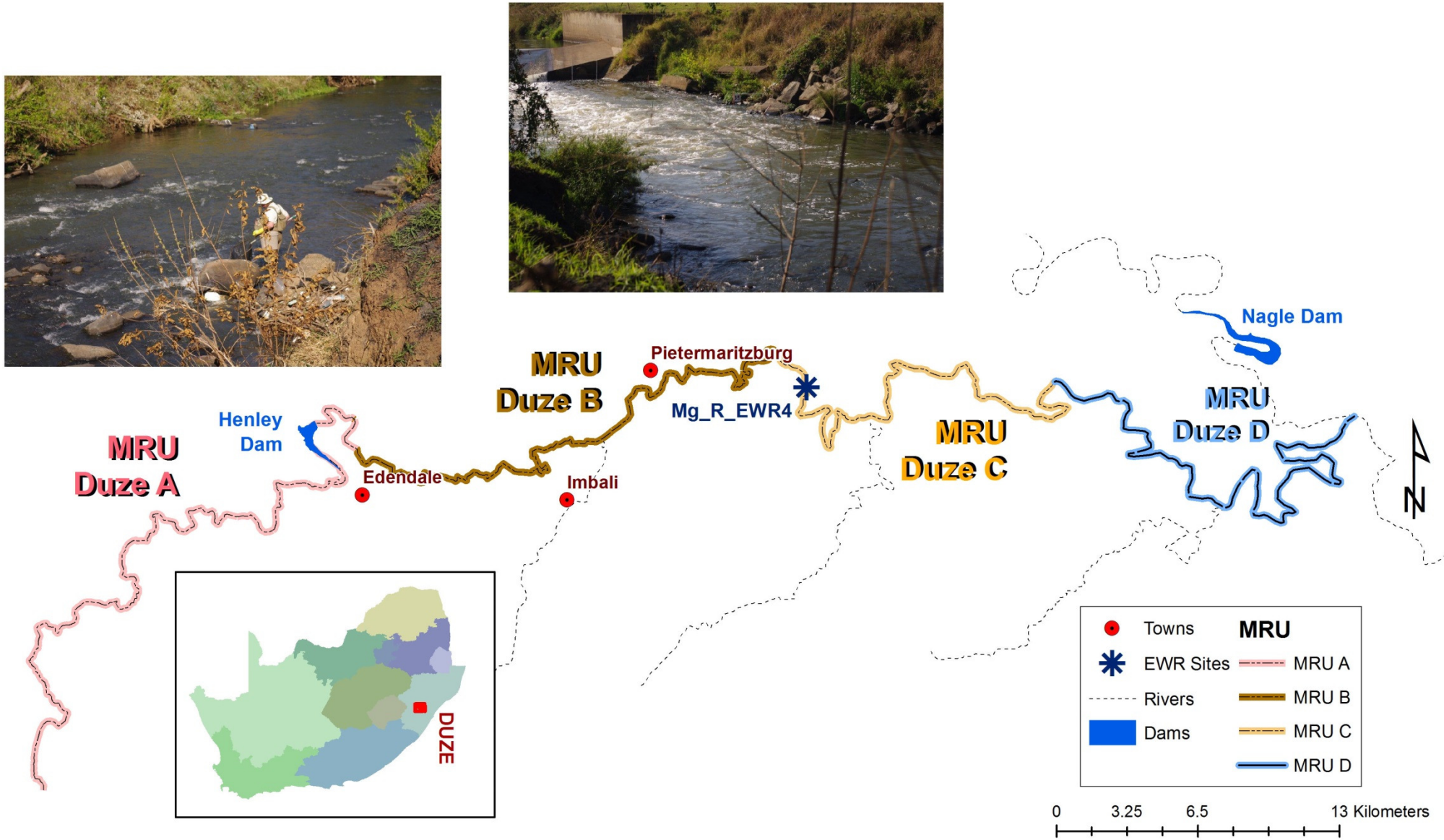


Figure 8.3 Mg_R_EWR4 (uMnsunduze River) locality and photographs

9 RESOURCE UNITS: MVOTI RIVER

9.1 NATURAL RESOURCE UNITS

The subquaternary reaches (representing hydrological zones), EcoRegions and geomorphic zones of the Mvoti are described in the Fig 9.1. The Natural Resource Units (NRU) are derived from the EcoRegions and the geomorphic zones.

The study area falls within eight EcoRegions (level 2). The Heinespruit has 3 EcoRegions (level 2). The first two are combined to form NRU Heine A and the downstream NRU follow the 16.03 EcoRegion to the Mvoti border. The Mvoti forms 5 Level 2 EcoRegions and these become the NRUs. The Mvoti River is dominated by the Upper and Lower Foothills geomorphic zone. The NRUs in the Mvoti River are described as NRU Mvoti A, B, C, D and E and the delineation information are provided in Table 9.1 and Figure 9.1.

9.2 MANAGEMENT RESOURCE UNITS

The river is divided into Management Resource Units (MRUs) as illustrated in Figure 9.2. The description of the MRUs and the rationale for selection is provided in Table 9.2.

System operation & Land use:
Greytown is located close to the Heinespruit and the discharges from the towns WWTW enter the river system, affecting both the flow and water quality of the river system. The main land use activities in the upper Mvoti include extensive forestry and a significant amount of sugar cane plantations and irrigation (sugar cane, maize etc.) also occur. There are also a few low density settlements and rural settlements located in the lower reaches. Further downstream to the IsiThunda Dam site, the main landuse is forestry and sugar cane. In the lower reaches, there are a vast amount of low density and rural settlements located throughout.

Present Ecological State:
The Heinespruit is in a C with the major impact being based on water quality. Apart from the lower section, most of the Mvoti is in a B/C PES with a small section protected within a gorge in a B PES. The impacts in the upper area is commercial forestry and irrigation. Further downstream, the impacts are mostly rural with some sugarcane in the lower edges. The last section of the river is damaged by extensive sand mining and the PES for some sections, specifically where IFR 4 is situated, is probably now in an E PES.

9.3 EWR SITE SELECTION

Site details are provided in Appendix A and the site locality and characterised are illustrated in Fig 9.3. The Heinespruit required a Rapid III EWR site to address water quality and quantity issues from the upstream sewage inflows from Greytown. A site was therefore selected downstream of Greytown.

Based on the hotspot identification, it was decided to select two EWR sites on the Mvoti River. To accommodate the proposed dam (IsiThunda), it was initially decided to use the IFR 3 and 4 sites. IFR 3 was selected for use during this study, however IFR 4 was destroyed (and so was most of the downstream river) by sand mining.

Table 9.1 Mvoti: Description and rationale for the Natural Resource Units

NRU	EcoRegion Level 2	Geomorphic zone	Rationale	Delineation
NRU Heine A	14.07: 26% 16.01: 74%	Mountain headwater: 7% Mountain: 28% Transitional: 17% Upper Foothills: 48%	Coincides with two EcoRegions and a variety of geomorphic zones occur..	Start: -29.032054; 30.507337 End: -29.084747; 30.577948
NRU Heine B	16.03: 100%	Upper Foothills: 42% Lower Foothills: 48%	Coincides with the lower EcoRegion and ends at the confluence with the Mvoti River.	End: -29.134999; 30.643716
NRU Mvoti A	16.01: 100%	Mountain headwater: 1% Mountain: 9% Transitional: 18% Upper Foothills: 56% Lower Foothills: 16%	Coincides with the EcoRegion 16.01 and a variety of geomorphic zones occur.	Start: -29.242644; 30.323102 End: -29.184561; 30.509626
NRU Mvoti B	16.03: 100%	Transitional: 7% Upper Foothills: 23% Lower Foothills: 70%	The river becomes more wetland in nature and includes the Mvoti Vlei. This NRU coincides with 16.03 and is dominated by Upper Foothills.	End: -29.183656; 30.725374
NRU Mvoti C	17.01: 100%	Upper Foothills: 93% Lower Foothills: 7%	Coincides with 17.01 and is mostly within the Upper Foothills geomorphic zone.	End: -29.245928; 30.989031
NRU Mvoti D	17.03: 100%	Upper Foothills: 32% Lower Foothills: 68%	Coincides with 17.03 EcoRegions and is mostly Lower Foothills.	End: -29.306270; 31.106624
NRU Mvoti E	17.01: 89% 17.02: 11%	Lower Foothills: 70%	Coincides with EcoRegion 17.01 and 17.02 and is mostly Lower Foothills.	End: -29.384647, 31.33799

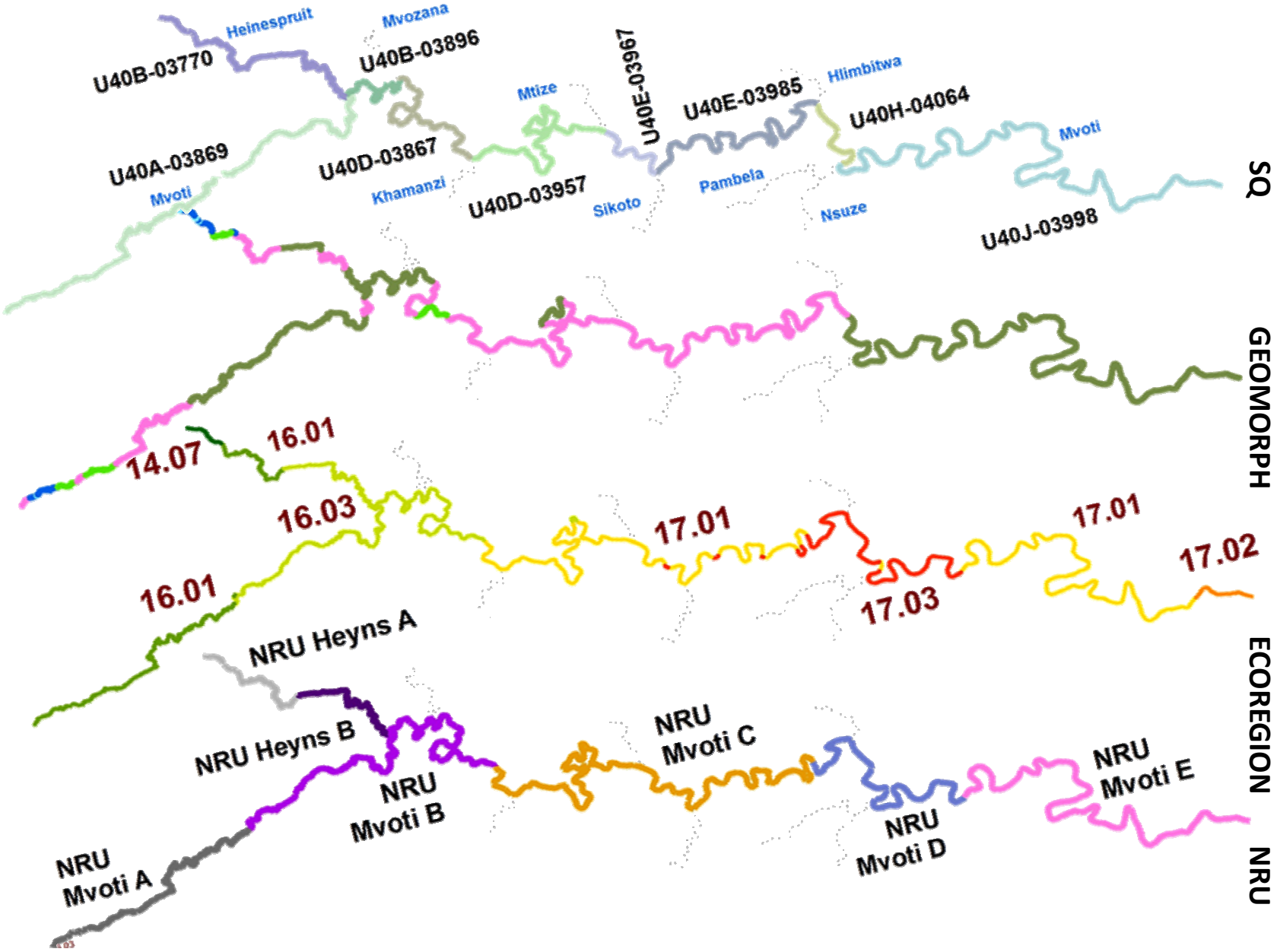

Heinespruit
Mvozana
U40B-03770
U40B-03896
U40A-03869
Mvoti
U40D-03867
Mtize
Khamanzi
U40D-03957
U40E-03967
Sikoto
U40E-03985
Hlimbitwa
Pambela
U40H-04064
Mvoti
Nsuze
U40J-03998
SQ
GEOMORPH
ECOREGION
NRU
14.07
16.01
16.03
16.01
17.01
17.03
17.01
17.02
NRU Heyns A
NRU Heyns B
NRU Mvoti A
NRU Mvoti B
NRU Mvoti C
NRU Mvoti D
NRU Mvoti E

Figure 9.1 Mvoti River: EcoRegions, geomorphological zones and Natural Resource Units

Table 9.2 Mvoti River: Description and rationale of the Management Resource Units

MRU	EcoRegion Level 2	Geomorphic zone	Land cover	Rationale	Delineation	Quat
MRU Heine A	14.07: 13% 16.01: 36% 16.03: 51%	Mountain headwater: 3% Mountain: 14% Transitional: 8% Upper Foothills: 45% Lower Foothills: 30%	Forestry and irrigation	The Heinespruit is to short to warrant more than one MRU.	Start: -29.032054; 30.507337 End: -29.134998; 30.643716	U40B
MRU Mvoti A	16.01: 54% 16.03: 46%	Mountain: 5% Transitional: 10% Upper Foothills: 34% Lower Foothills: 51%	Forestry and irrigation	The area is dominated by forestry, irrigation and a large section of the river is a wetland. The logical break is the confluence of the Heinespruit as it forms a separate MRU.	Start: -29.242643; 30.323102 End: -29.134999; 30.643716	U40A U40B
MRU Mvoti B	16.03: 26% 17.01: 61% 17.03: 13%	Transitional: 4% Upper Foothills: 79% Lower Foothills: 17%	Gorge, sedimentation, rural settlements.	This MRU is based on a change in land cover and the changed nature of the river within a gorge.	End: -29.254241; 31.032116	U40B U40D U40E
MRU Mvoti C	17.01: 38% 17.03: 62%	Lower Foothills: 100%	Rural settlements, sedimentation, sugarcane.	This section of the river again illustrates changed landuse and ends at the point where sand mining dominates the river.	End: -29.295510; 31.1589753	U40E U40J
MRU Mvoti D	17.01: 86% 17.02: 14%	Lower Foothills: 100%	Intensive sand mining and sugarcane.	This MRU is dominated by sand mining and is separate from the upstream river as it would require intensive non-flow related mitigation measures.	End: -29.384647; 31.337986	U40J

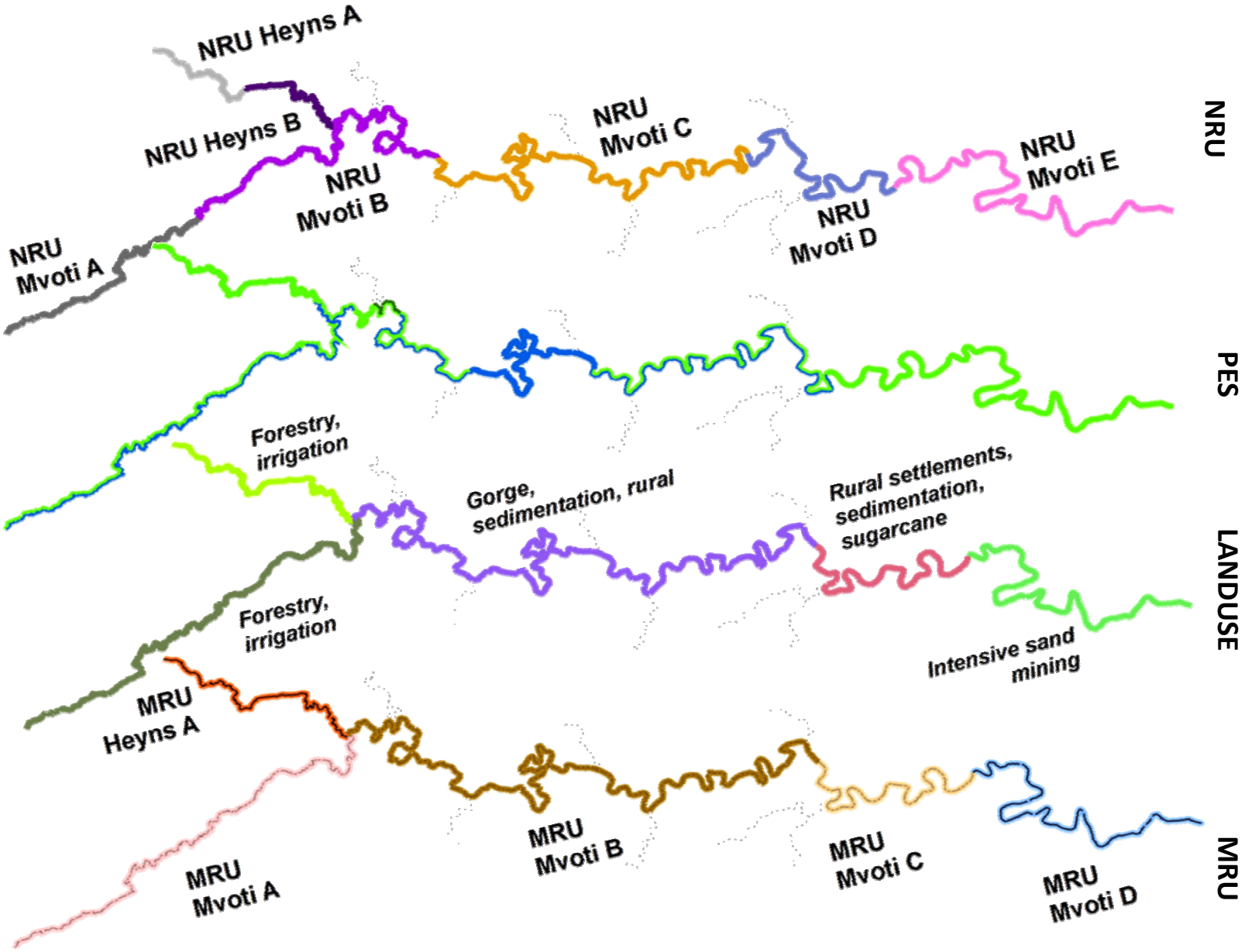

NRU Heyns A
NRU Heyns B
NRU Mvoti A
NRU Mvoti B
NRU Mvoti C
NRU Mvoti D
NRU Mvoti E
NRU
Forestry, irrigation
Gorge, sedimentation, rural
Rural settlements, sedimentation, sugarcane
Intensive sand mining
Forestry, irrigation
PES
LANDUSE
MRU Heyns A
MRU Mvoti A
MRU Mvoti B
MRU Mvoti C
MRU Mvoti D
MRU

Figure 9.2 Mvoti River: PES, operation, landuse and Management Resource Units

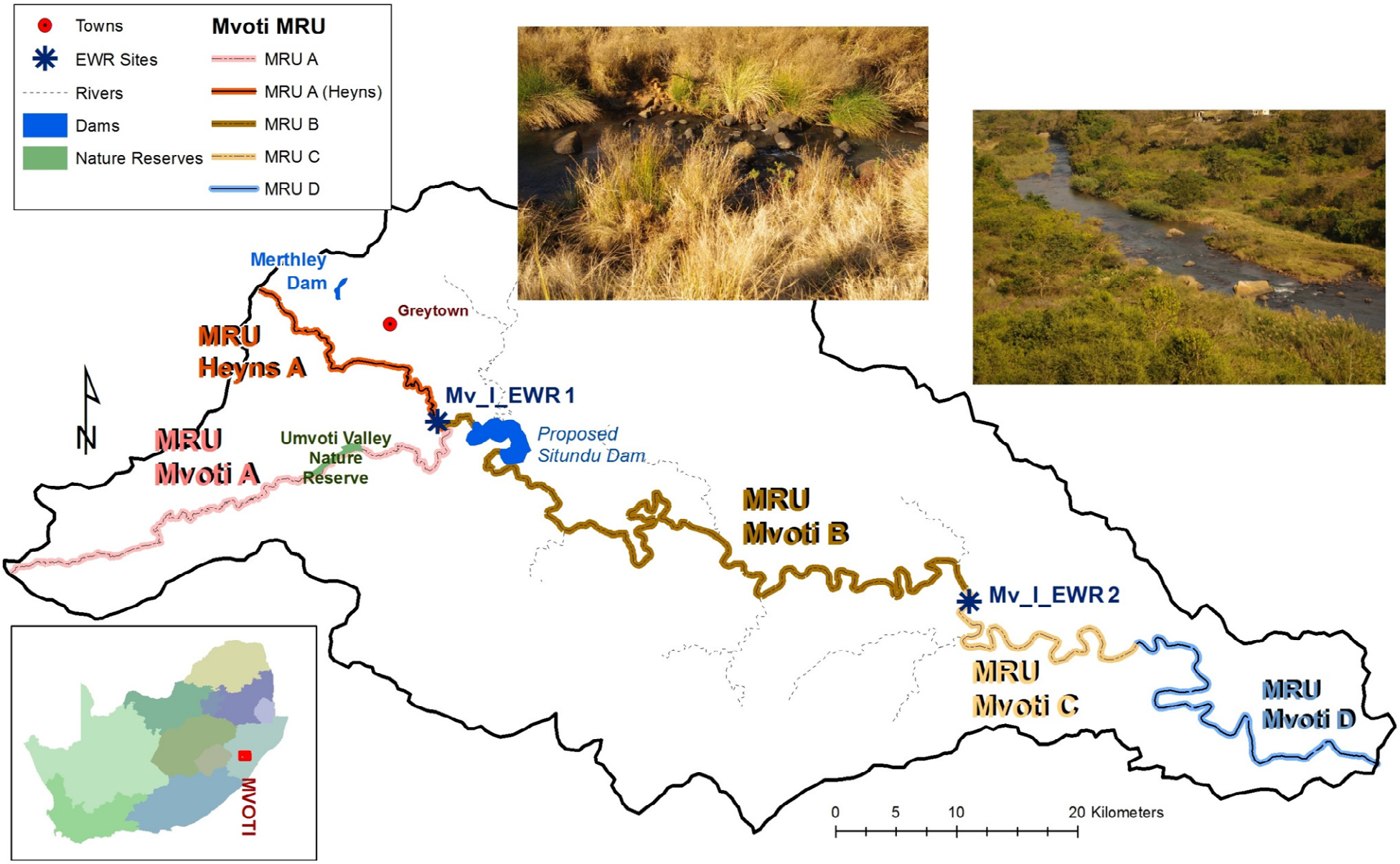


Figure 9.3 Mv_R_EWR1 (Heinesspruit) and MV_I_EWR2 (Mvoti River) locality and photographs

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11 APPENDIX A: EWR SITES

EWR site	River	SQ	Old name	RHP site	Decimal deg S	Decimal deg E	Level
Mv_I_EWR 1	Heinsespruit	U40B-03770	New site	None	-29.13054	30.64002	Intermediate
Mv_I_EWR 2	Mvoti	U40H-04064	IFR3	U4MVOT-DSHLI	-29.26398	31.03513	Intermediate
Mg_I_EWR 2	Mgeni	U20E-04243	New site	U2MGEN-MORTO	-29.46184	30.29832	Intermediate
Mg_I_EWR 5	Mgeni	U20L-04435	New site	U2MGEN-USUMC	-29.64521	30.74556	Intermediate
Mk_I_EWR1	Mkomazi	U10E-04380	IFR1 Lundy's Hill	U1MKOM-LUNDY	-29.74338	29.91165	Intermediate
Mk_I_EWR2	Mkomazi	U20J-4679	IFR 2 Hela Hela	None	-29.921	30.08448	Intermediate
Mk_I_EWR3	Mkomazi	U20M-04746	IFR 4	U1MKO-USCRA	-30.132	30.66245	Intermediate
Mg_R_EWR1	Mgeni	U20A-04253	Mgeni 1	U2MGEN-PETRU	-29.5125	30.09417	Rapid
Mg_R_EWR3	Karkloof	U20E-04170	New site	U2KARK-USMGN	-29.4385	30.29522	Rapid
Mg_R_EWR4	uMnsunduze	U20J-04364	New site	U2DUZI-MOTOX	-29.60801	30.450406	Rapid
Lo_R_EWR1	Lovu	U70C-04859	New site	None	-30.09997	30.73603	Rapid
Mt_R_EWR1	Umtamvuna	T40E-5601	EWR1	None	-30.85608	30.07268	Rapid

EWR site	River	EcoRegion (Level II)	Geomorphic Zone	Altitude (m)	MRU	Quat	Farm names	Hydrological gauge
Mv_I_EWR 1	Heinesspruit	16.02	Lower Foothills	929	MRU Heines A	U40B	Mispah1306/36?	None
Mv_I_EWR 2	Mvoti	17.03	Lower Foothills	203	MRU Mvoti C	U40H	Farm 16568	U4H005, U4H007
Mg_I_EWR 2	Mgeni	16.03	Upper Foothills	725	MRU Mgeni B	U20E	Leo-Smith 17142	U2H001
Mg_I_EWR 5	Mgeni	17.03	Upper Foothills	177	MRU Mgeni D	U20L	Stanco	U2H002, U2H015
Mk_I_EWR1	Mkomazi	16.03	Lower Foothills	916	MRU Mkomazi B	U20F	Lundy's Hill	U1H005
Mk_I_EWR2	Mkomazi	16.02	Upper Foothills	537	MRU Mkomazi C	U20J	Farm 8420	U1H002
Mk_I_EWR3	Mkomazi	17.01	Lower Foothills	50	MRU Mkomazi D	U10M		U1H009
Mg_R_EWR1	Mgeni	16.01	Lower Foothills	1081	MRU Mgeni A	U20A	Petrus Stroom	U2H013
Mg_R_EWR3	Karkloof	16.03	Upper Foothills	738	MRU Karkloof C	U20E	Ezulwini	None
Mg_R_EWR4	uMnsunduze	16.03	Lower Foothills	602	MRU Duze C	U20J	Hamstead Park	U2H041
Lo_R_EWR1	Lovu	17.01	Lower Foothills	44	MRU Lovu D	U70D		None
Mt_R_EWR1	Umtamvuna	17.01	Lower Foothills	277	MRU Mtam B	T40E		None

12 APPENDIX B: REPORT COMMENTS

PAGE &/ OR SECTION	REPORT STATEMENT	COMMENTS	CHANGES MADE?	AUTHOR COMMENT
25 September 2013: Comments from Adaora Onkonkwo and Nancy Motebe				
		Why Groundwater RUs not reflected in the RUs Report, as was done for the Status Quo Report.	Yes	In the introduction it is made clear that this is the river resource unit report linked to step 2 in the Ecological Reserve process. It has now been explicitly made clear in various sections and in the title of the report that this only refer to river. Also note that groundwater RUs is different concept from the river RUs as spelt out in the 1999 documents. Also as the groundwater RUs are already in the status quo report, it will not be repeated in other reports, but it can be referred to (as has also been done in this report now.)
25 September 2013: Comments from Tovho Nyamande				
		Take out reference to WMA 11 (DWA has new WMA demarcation – now 9 WMAs)	Yes	
Fig 3.1		Include Table of colour description for Geomorph zones.	Yes	The geomorph zone legend was included. I have now however moved it to the beginning of the chapter and explained explicitly how the colour coding works for all the river delineations. (Page 3.1)
Fig 9.2		Colour combination in the legend is bit confusing, is there a better way of indicating with things like stars?	Yes	If your comment was understood correctly, the above comment addressed this as well.
25 September 2013: Comments from Mmaphefo Thwala				
		Add DWA logo on the front page	Yes	The formal front (colour) page has the logo on and has now been included in the report
Pages ii, iii		Name the tables	Done	
Page iii		Specify which 'well established criteria and processes were adopted' to select EWR sites	Done	
Page ix:		Remove blank page	Done	

PAGE &/ OR SECTION	REPORT STATEMENT	COMMENTS	CHANGES MADE?	AUTHOR COMMENT
Page 1-2:		chapter 3 not listed		
Page 2-1		The use of 'therefore' in section 2.1.1 sounds like the sentence is a continuation of the previous paragraph – rephrase	Done	
Page 2-3 section 2.3:		Edit the second last sentence so it reads: "IUAs are therefore NOT the same or similar to RUs which are linear...."	Done	
Page 3-1 section 3.2 paragraph 4, 3rd sentence:		relatively	Done	
Page 3-2:		"...and one EWR site was selected"	Done	
Figure 3.1 page 3-2		Provide a legend for the figure and do the same for all the figures	Yes	The geomorph zone legend was included. I have now however moved it to the beginning of the chapter and explained explicitly how the colour coding works for all the river delineations. (Page 3.1)
Page 4-1 section 4.2, last paragraph:		The word "and" repeated, remove the second one	Done	
Page 5-1 section 5.3, first sentence:		"....locality and characteristics are..."	Done	
Page 6-1 section 6.1		"....six EcoRegion leve 2s..." this applies to all sections	Done	
Page 8-1 section 8.3		"ds" – write the word downstream in full	Done	
25 September 2013: Comments from Geert Grobler				
		Page for signatures: remove "and Forestry" on the DWA name.	Done	
Page iii:		MRU Heine A: spelling error 'too'	Done	
Page 6-3, Table 6.1:		NRU D looks more like it coincides with unlabelled 17.01?	Yes	Made the correct changes
		NRU E looks more like it coincides with 17.03?	Yes	Addressed
		Where is NRU F?	Yes	There is no NRU F
Figure 6.1:		Where is NRU F? Also label the small section of 17.01 not labelled.	Yes	

PAGE &/ OR SECTION	REPORT STATEMENT	COMMENTS	CHANGES MADE?	AUTHOR COMMENT
Table 8.1:		NRU C: The Ecoregion numbers don't correlate with the next figure. Should it be 16.03 & 17.03?	Yes	Correct changes made
Section 9.1, second paragraph:		spelling mistake: 'Two'?	Done	
Section 9.2, second paragraph, first sentence:		edit so that it reads as follows: "Greytown is located close to Heinespruit....."	Done	
Section 9.2, second paragraph, second sentence		: edit so it reads as follows: "....a significant amount of sugarcane....."	Done	
Section 9.2, third paragraph, last sentence:		'situated'.	Done	
Section 9.3, second paragraph:		remove the words "most like".	Done	