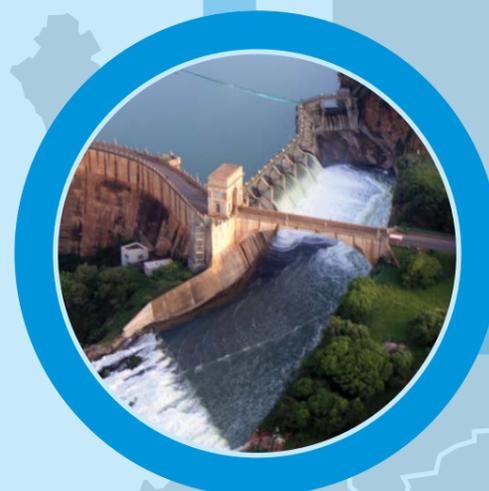


WATER RESOURCES OF SOUTH AFRICA, 2012 STUDY (WR2012)

Volume 3: Book of Maps

AK Bailey & WV Pitman



WATER RESOURCES OF SOUTH AFRICA, 2012 STUDY (WR2012)

BOOK OF MAPS

Report to the
Water Research Commission

by

AK Bailey and WV Pitman
Royal HaskoningDHV (Pty) Ltd

WRC REPORT NO. TT 685/16

AUGUST 2016



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This report forms part of a series of nine reports. The other reports are:

1. WR2012 Executive Summary (WRC Report No. TT 683/16);
2. WR2012 User Guide (WRC Report No. TT 684/16);
3. **WR2012 Book of Maps (WRC Report No. TT 685/16 – this report);**
4. WR2012 Calibration Accuracy (WRC Report No. TT 686/16);
5. WR2012 SAMI Groundwater module: Verification Studies, Default Parameters and Calibration Guide (WRC Report No. TT 687/16);
6. WR2012 SALMOD: Salinity Modelling of the Upper Vaal, Middle Vaal and Lower Vaal sub-Water Management Areas (new Vaal Water Management Area) (WRC Report No. TT 688/16);
7. WRSM/Pitman User Manual (WRC Report No. TT 689/16);
8. WRSM/Pitman Theory Manual (WRC Report No. TT 690/16), and
9. WRSM/Pitman Programmer's Code Manual (WRC Report No. TT 691/16).

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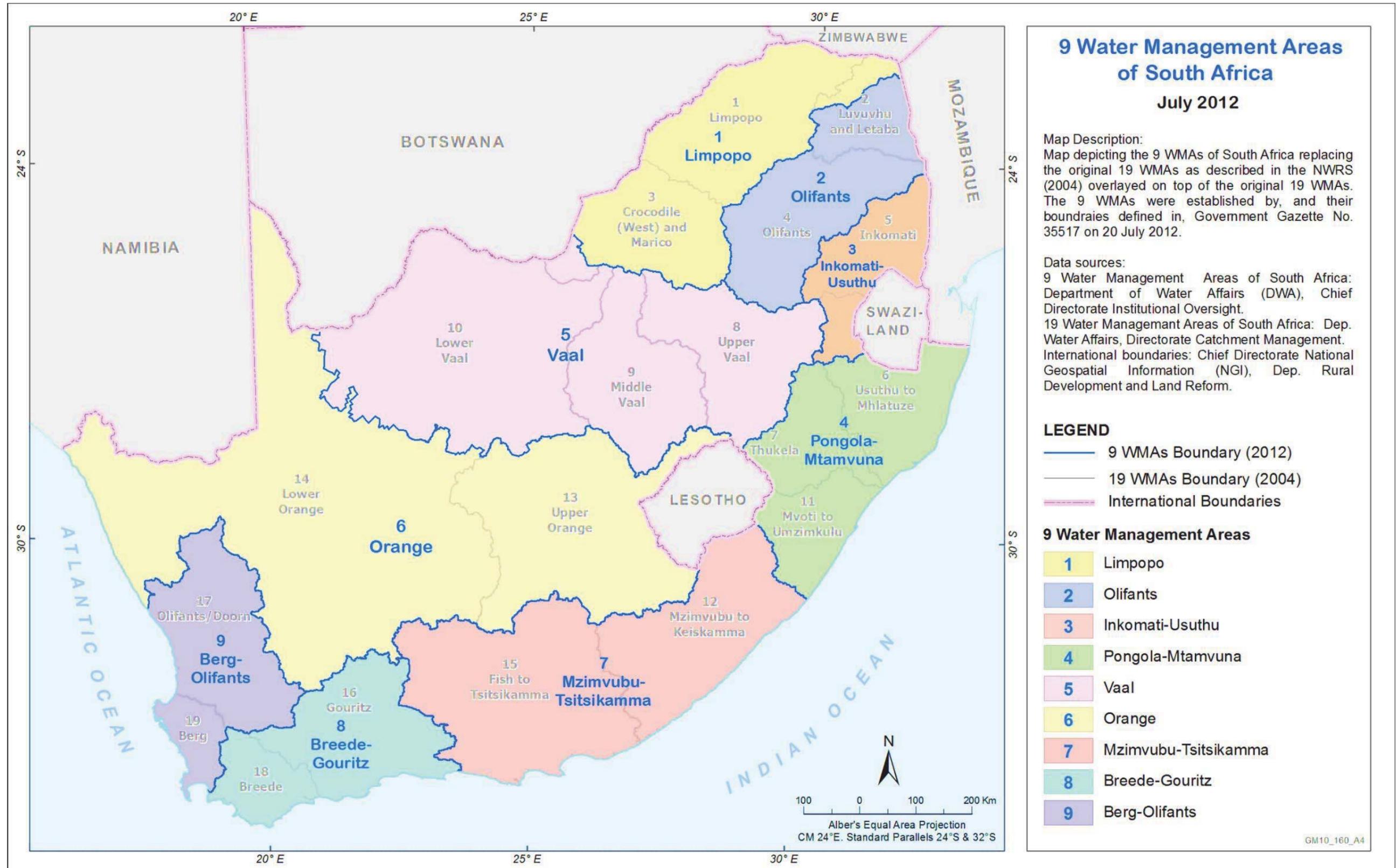
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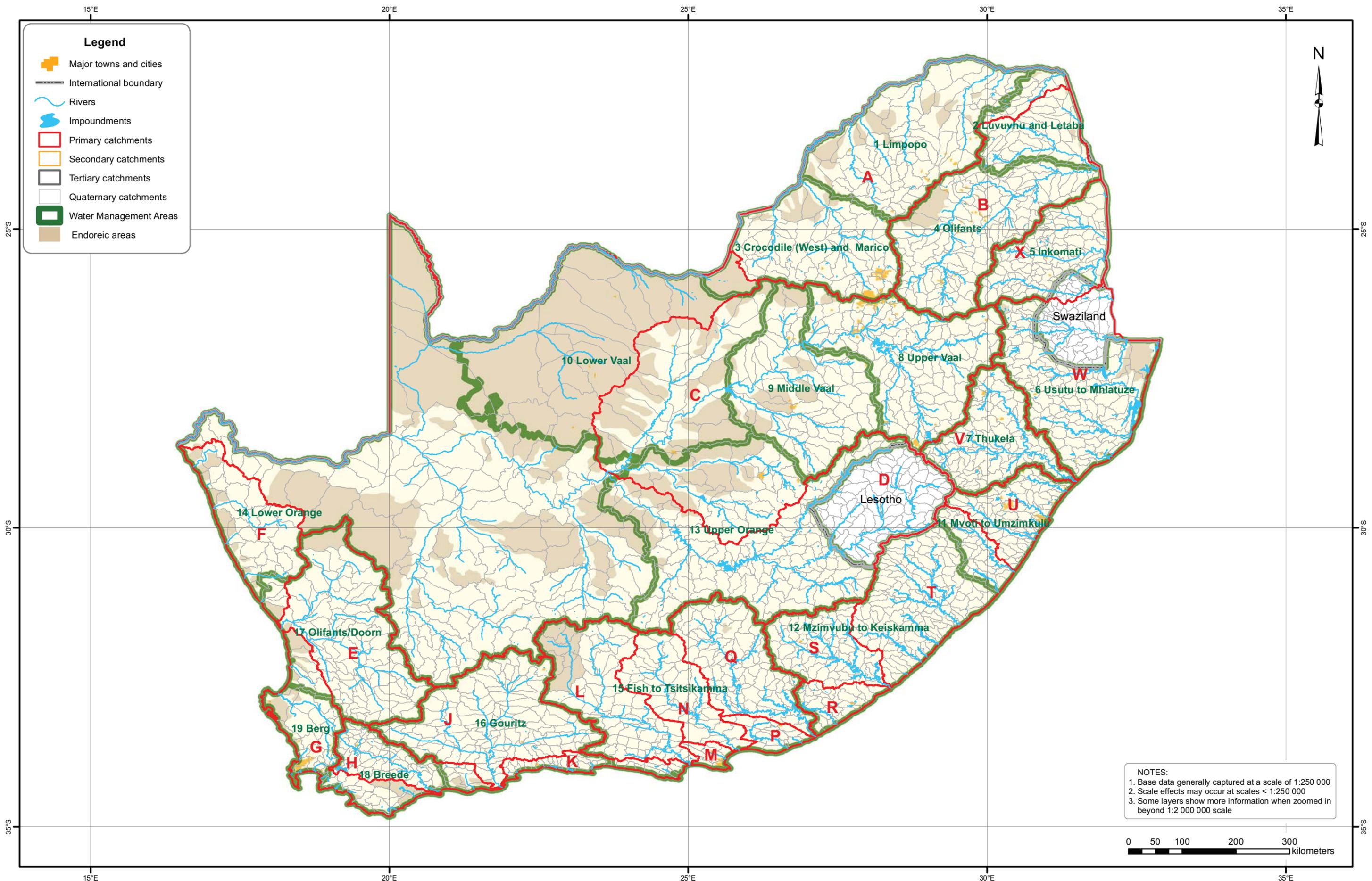
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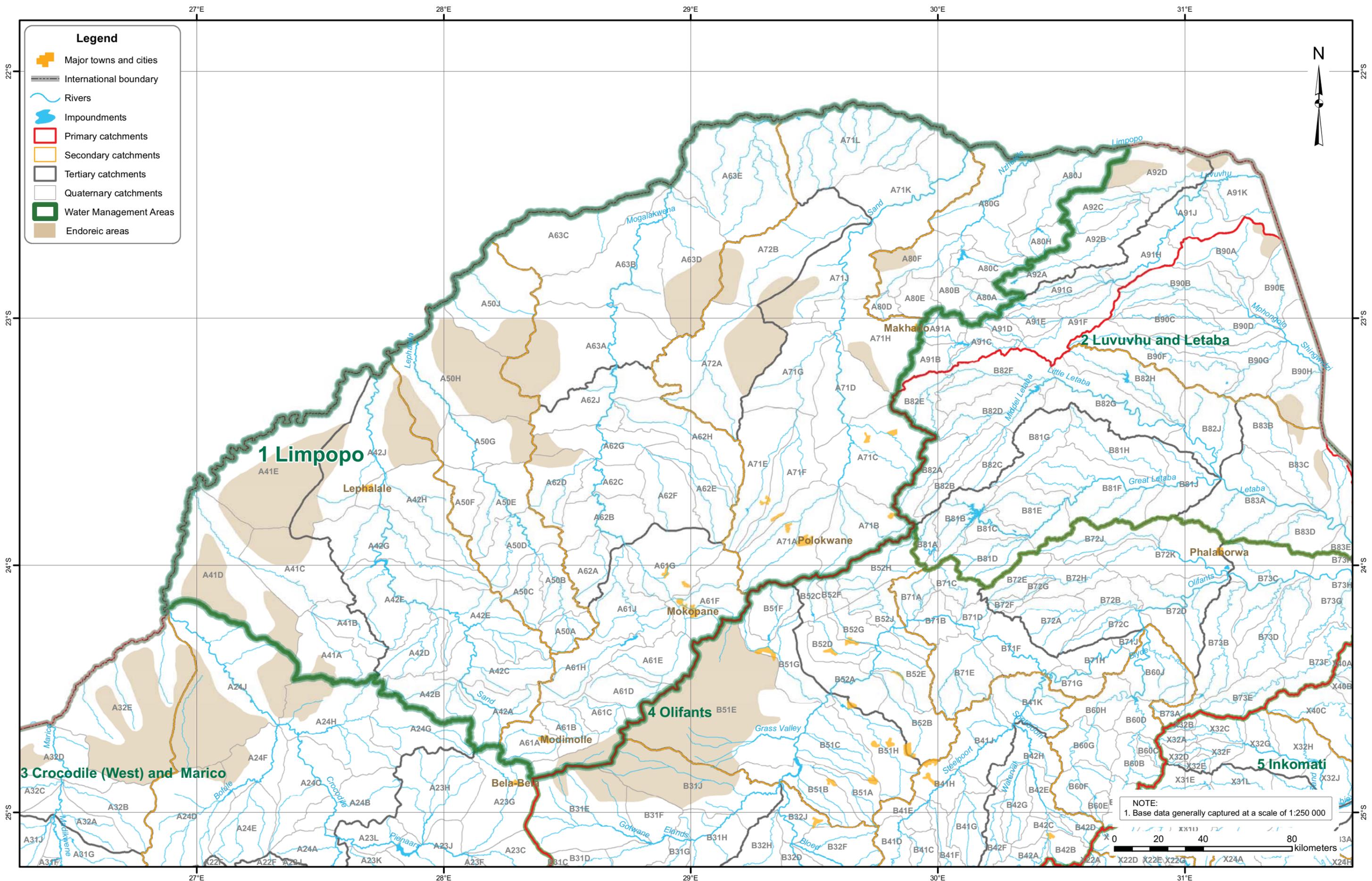
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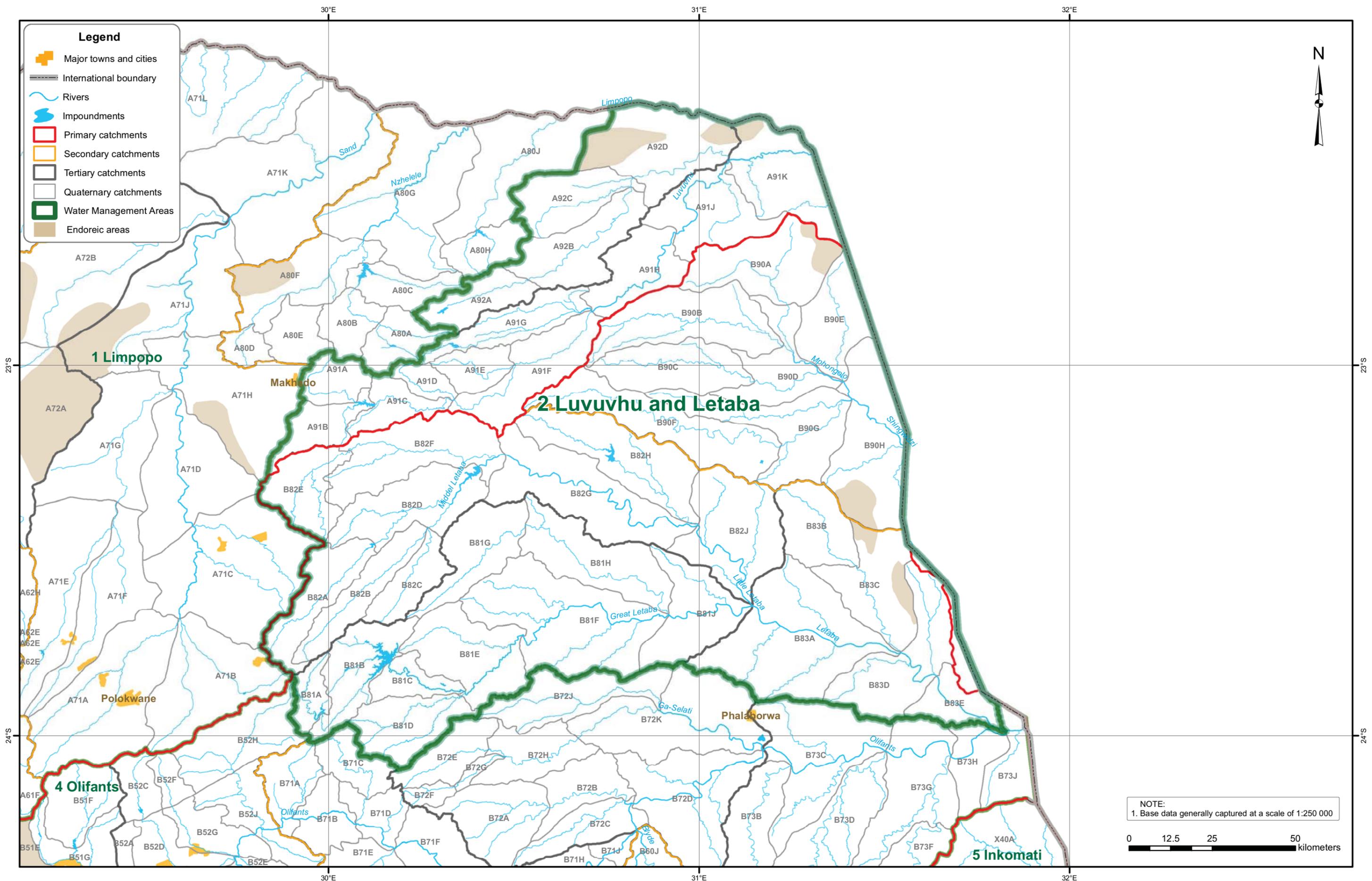
Note: As the new 9 Water Management Areas (WMAs) were instituted during the course of the study and therefore not included in the scope of work, the old 19 WMAs have been shown.

The new 9 WMAs are shown in the map below.









NOTE:
1. Base data generally captured at a scale of 1:250 000



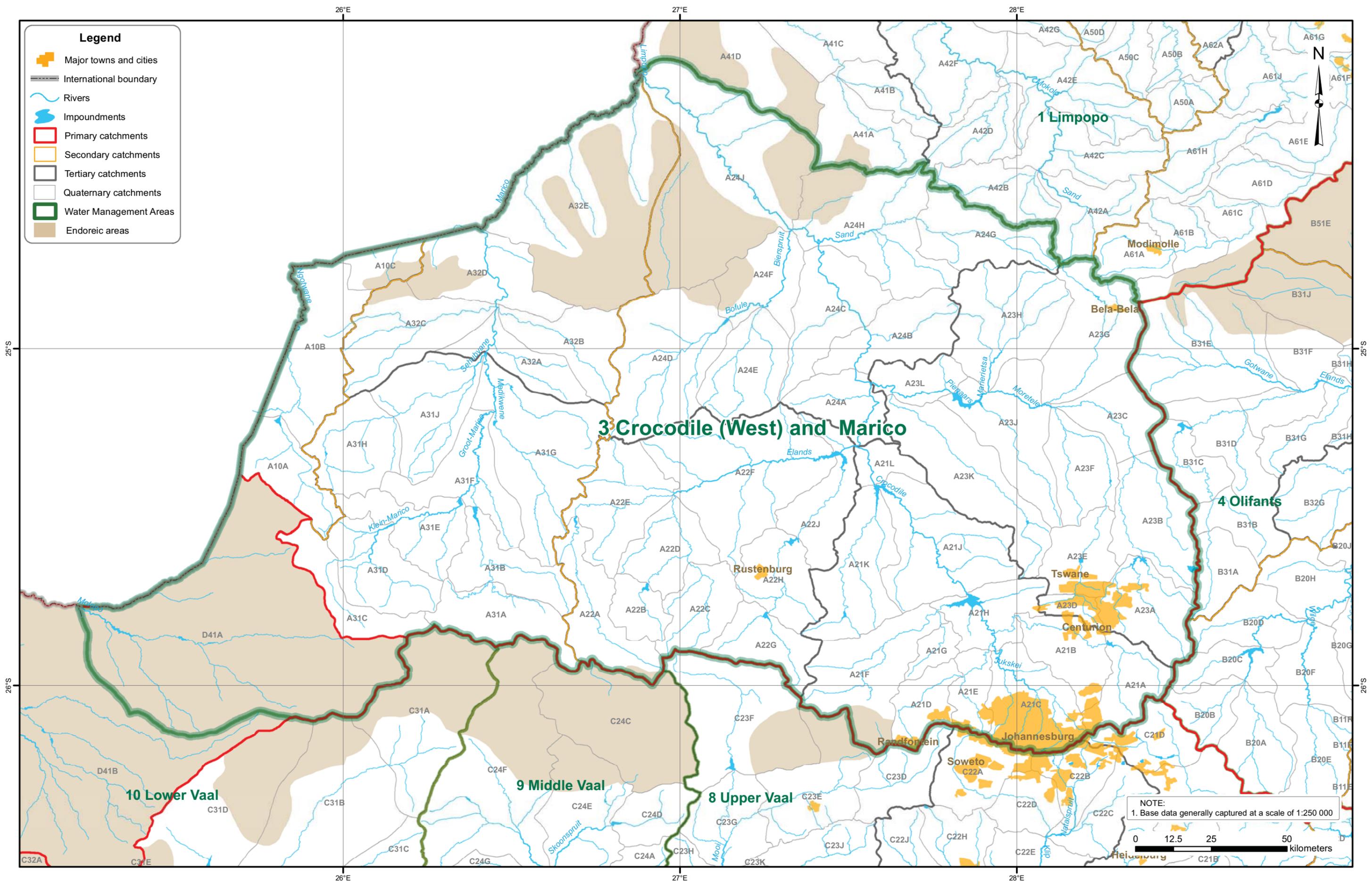


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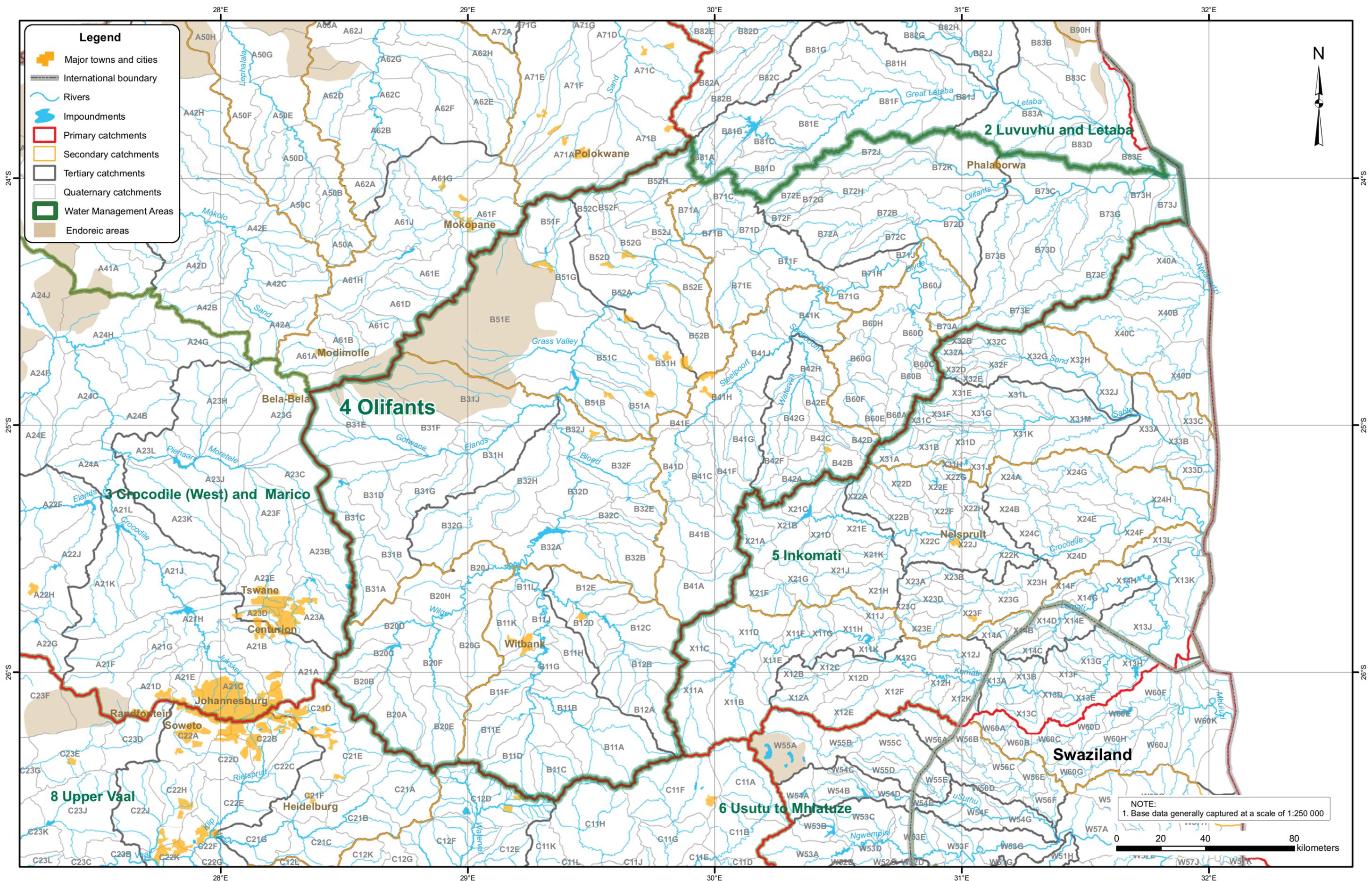
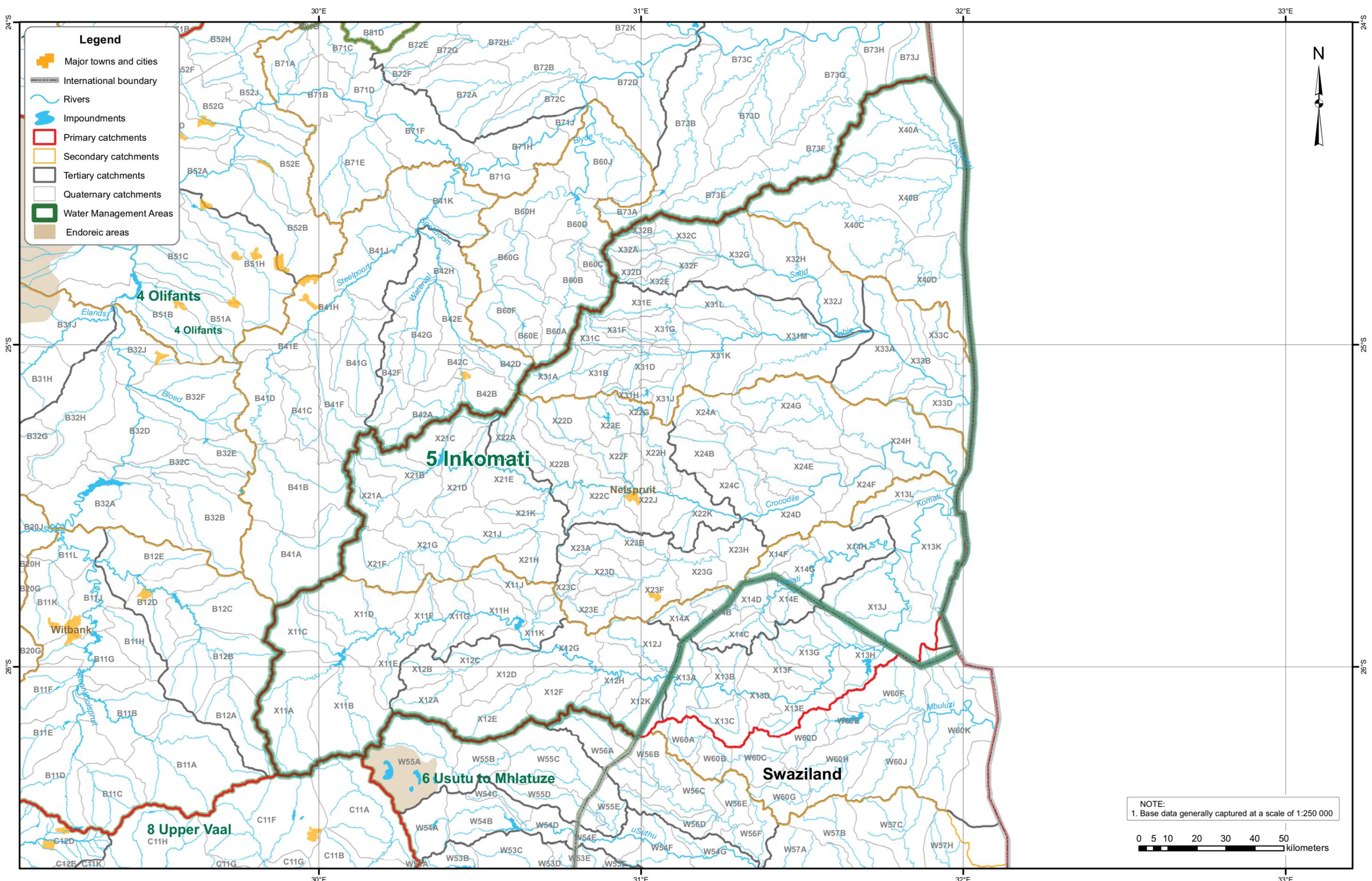
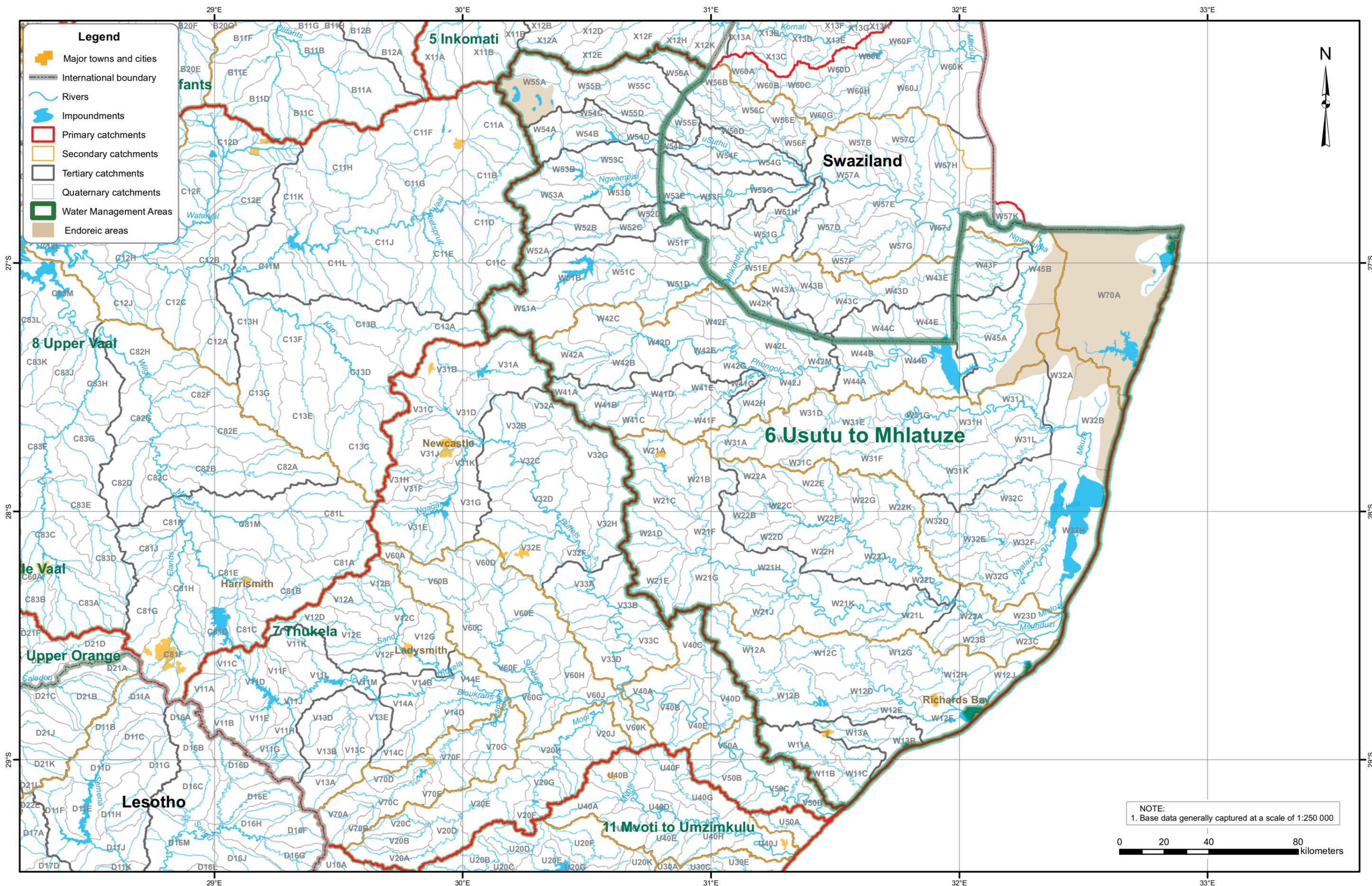


Figure 0.4 :Base Map: Olifants WMA





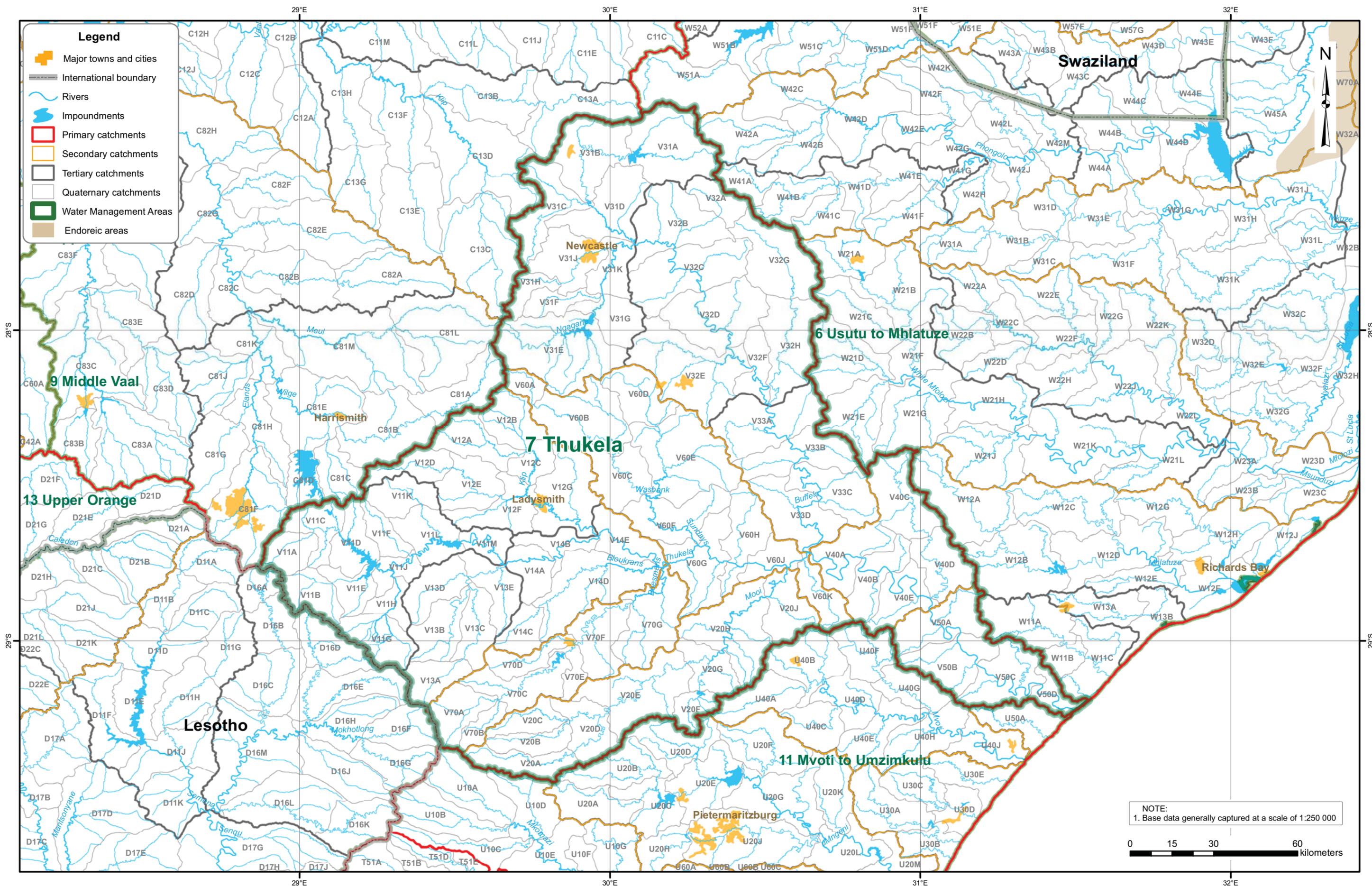
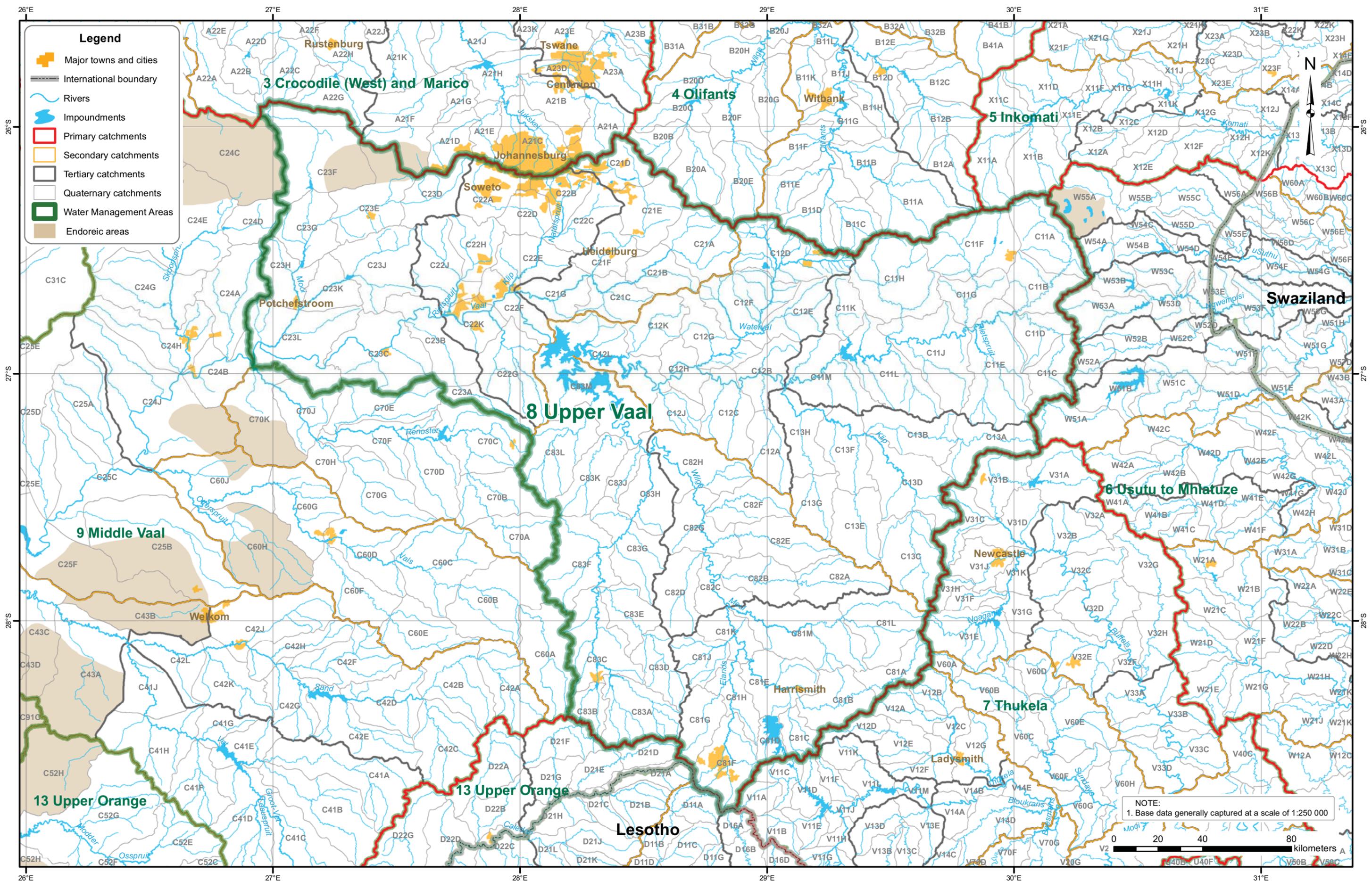
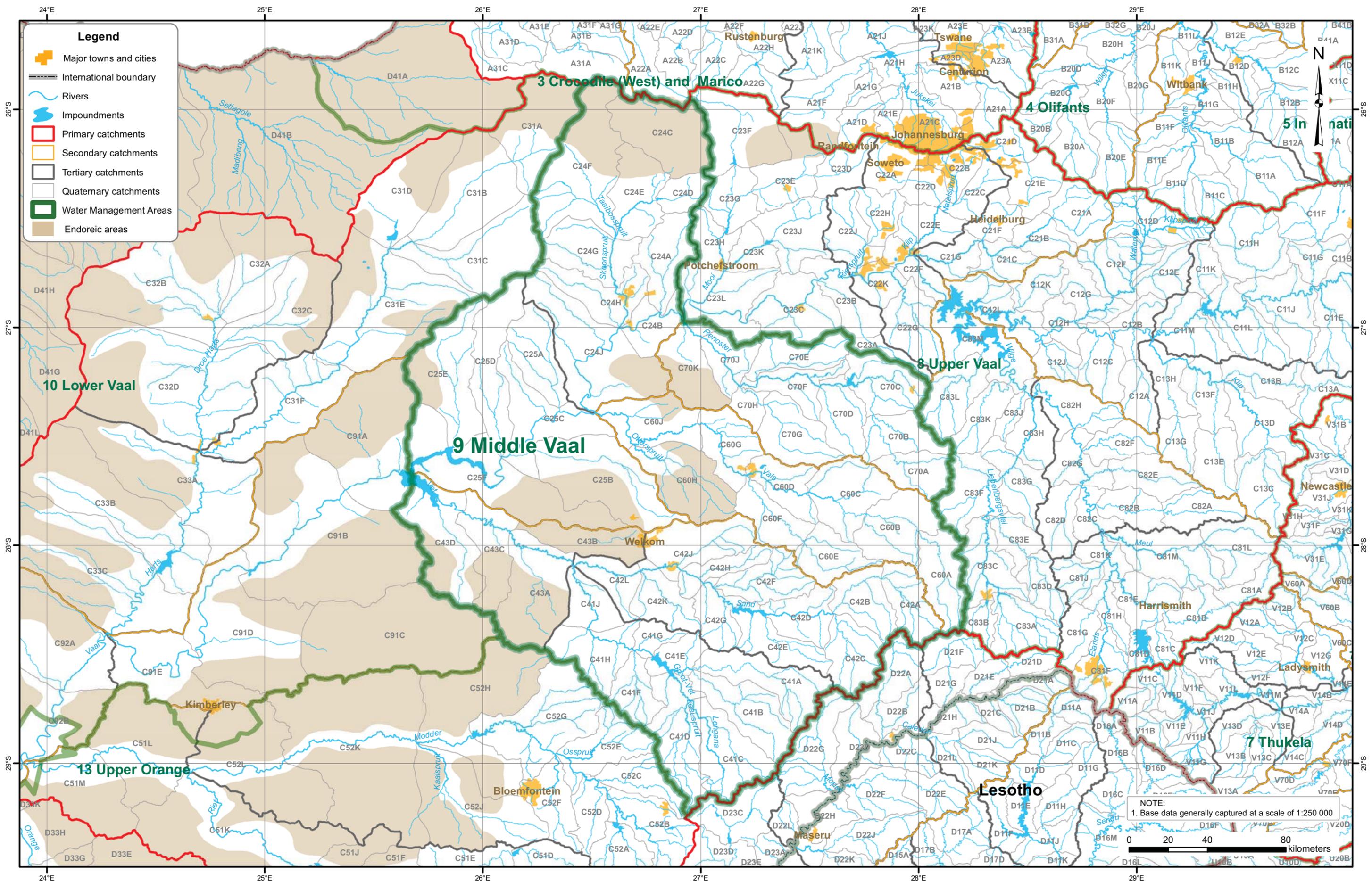
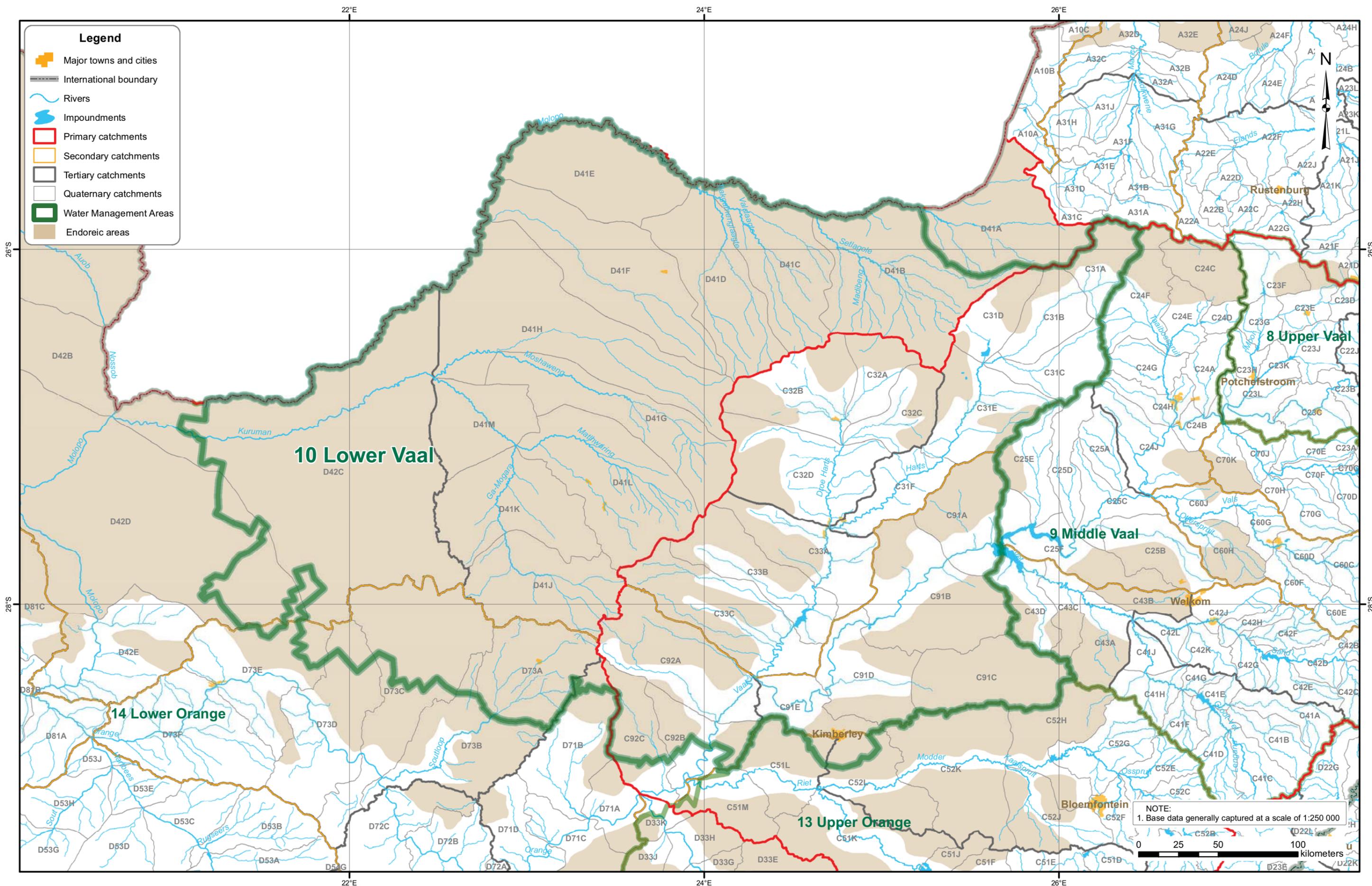


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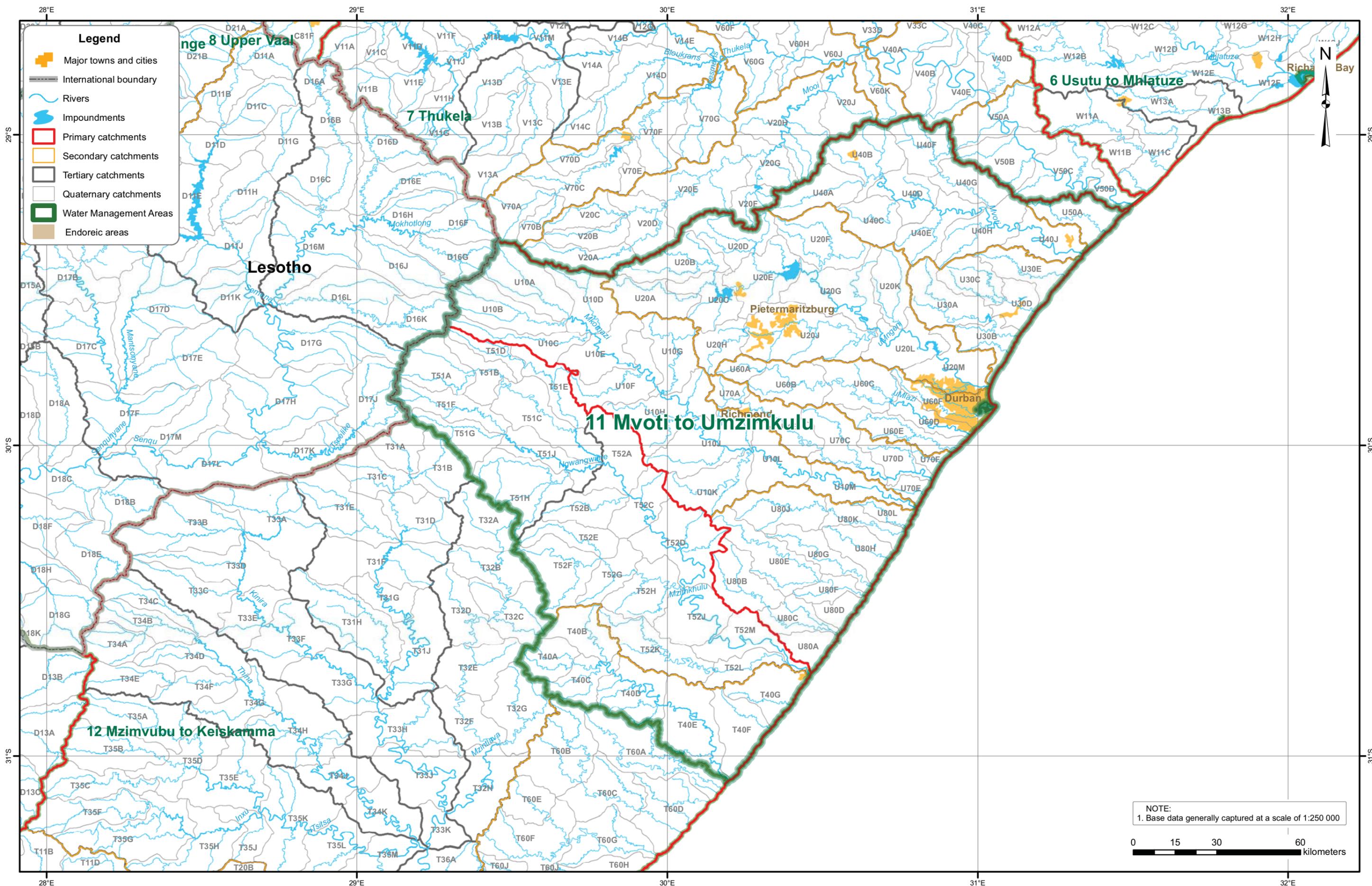


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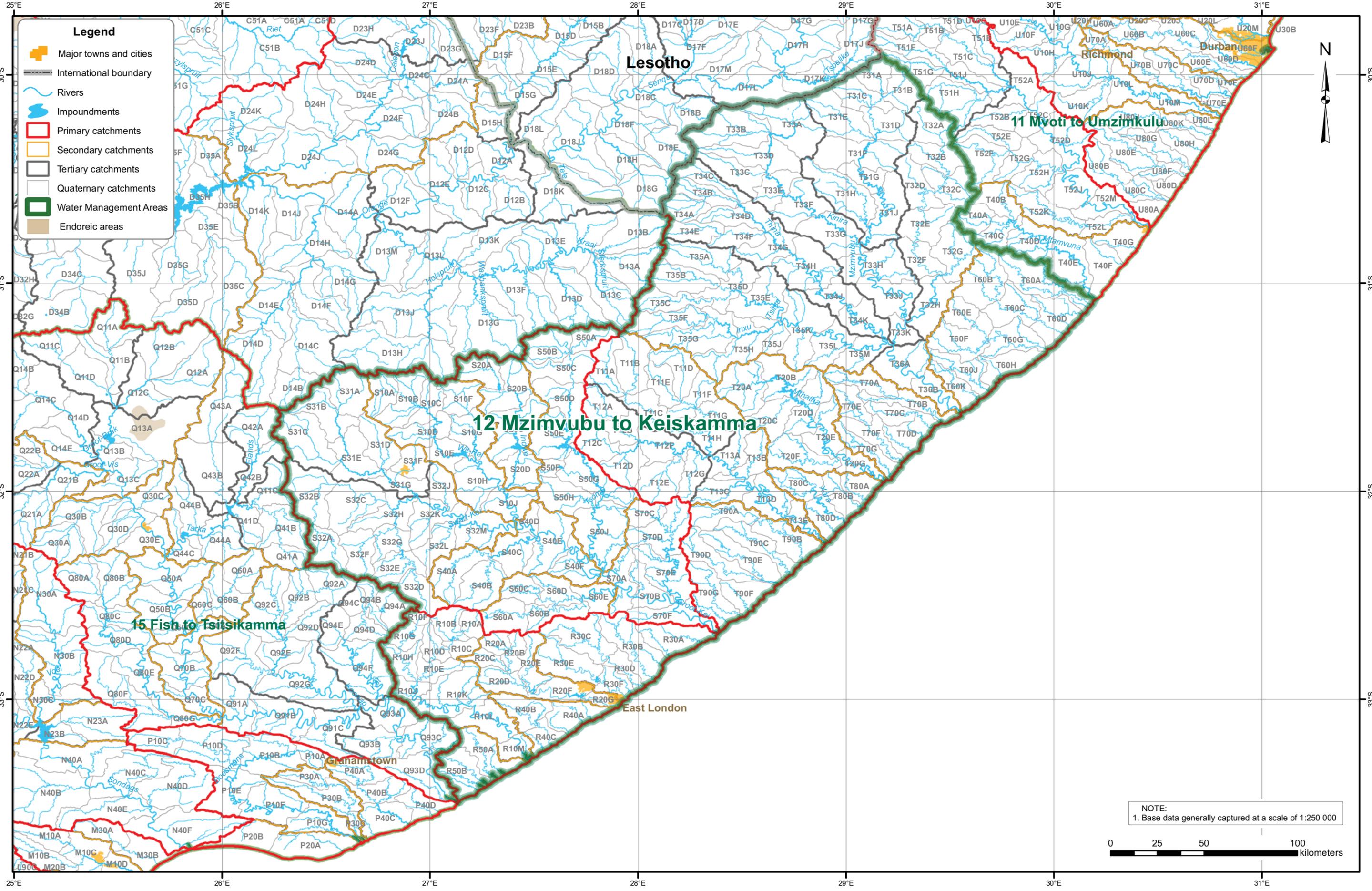


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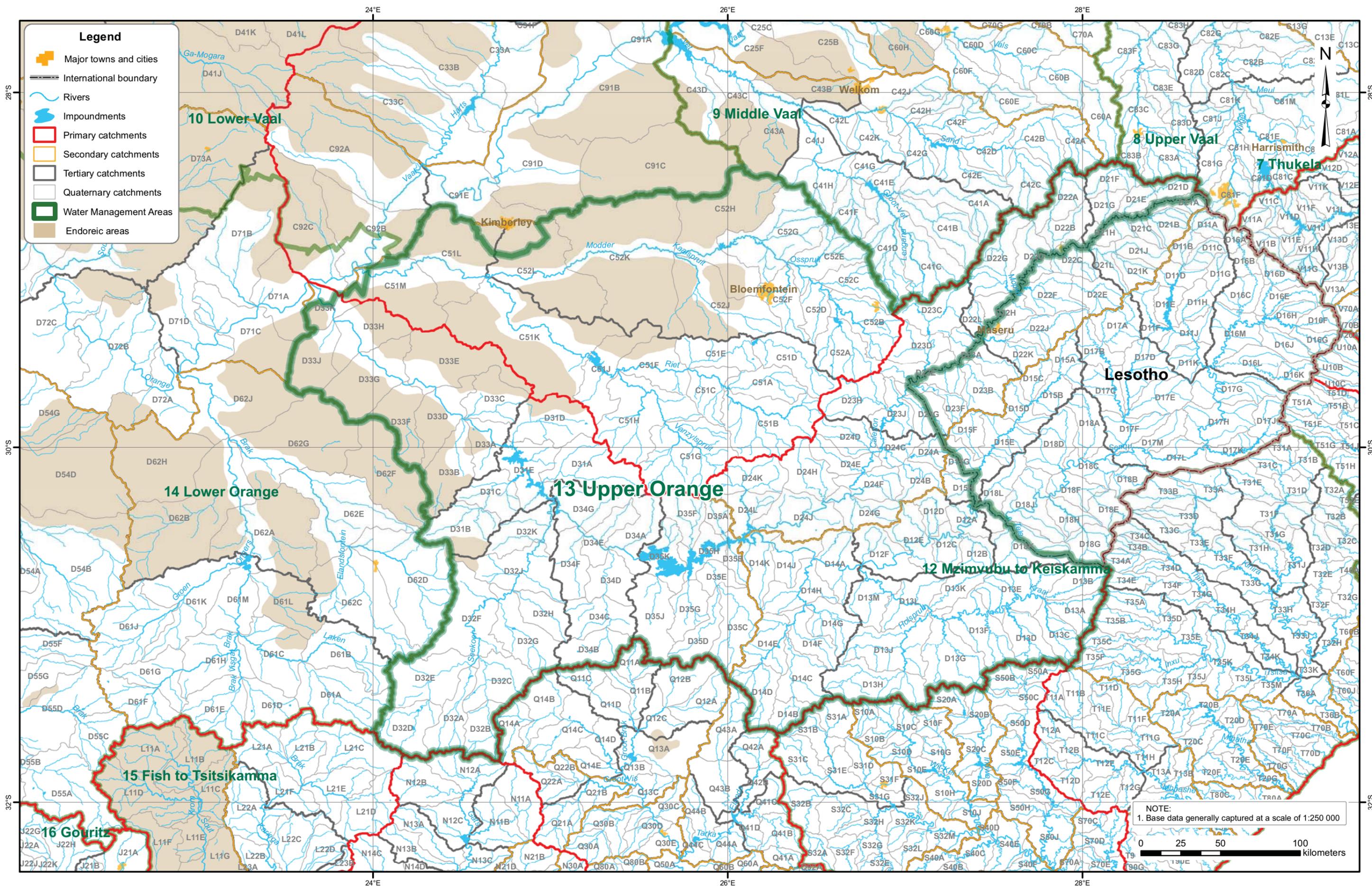
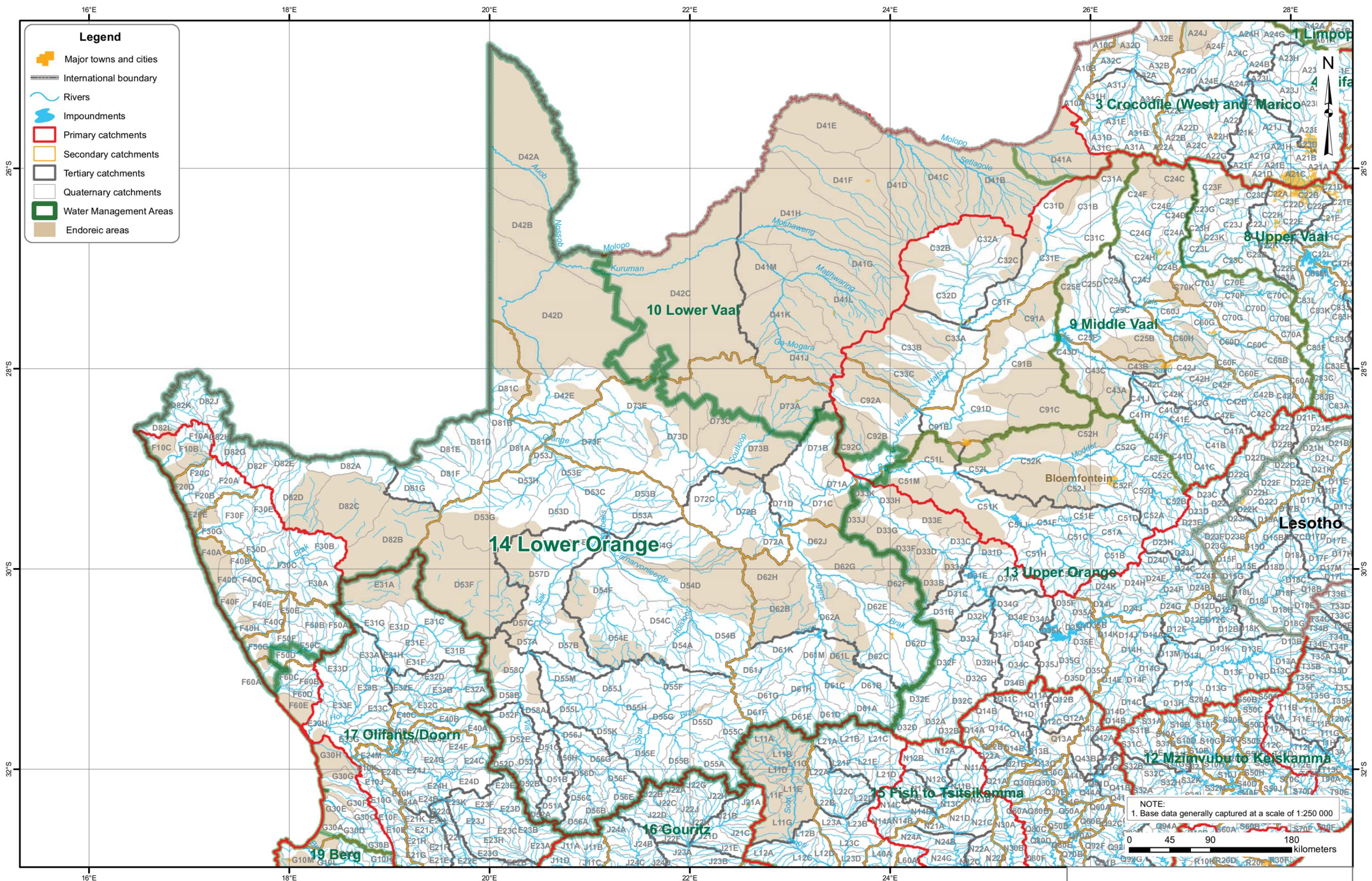
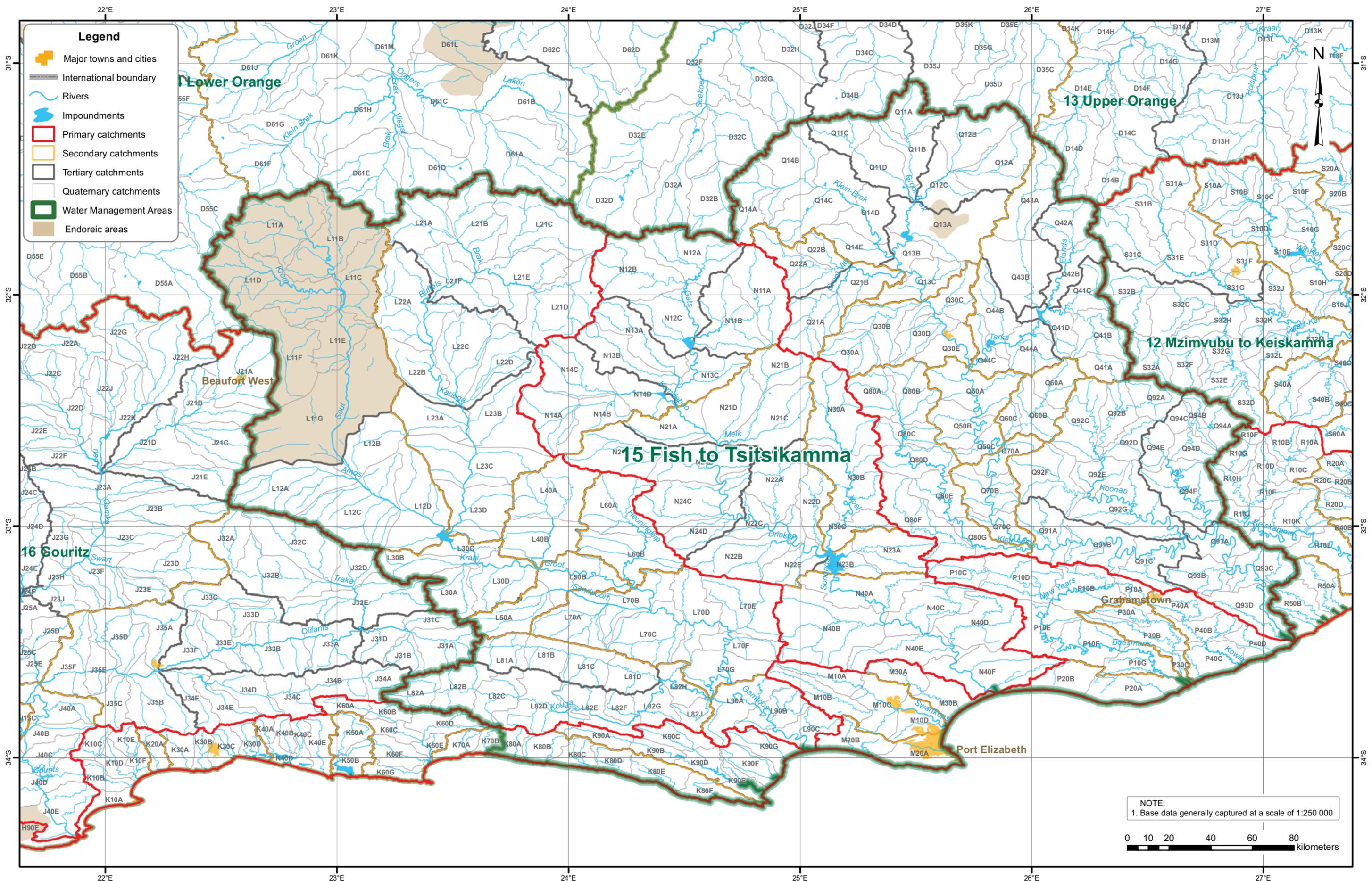


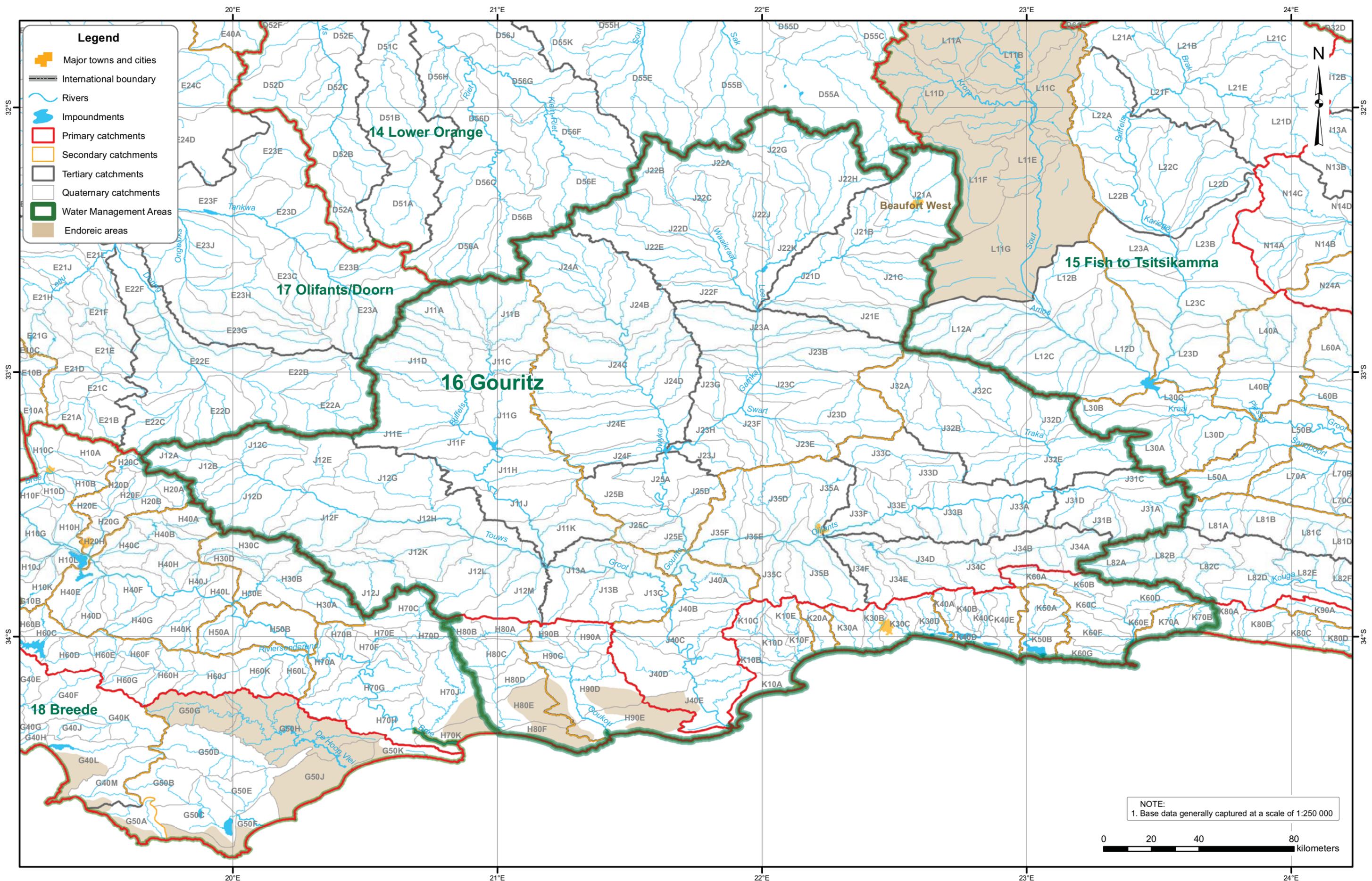
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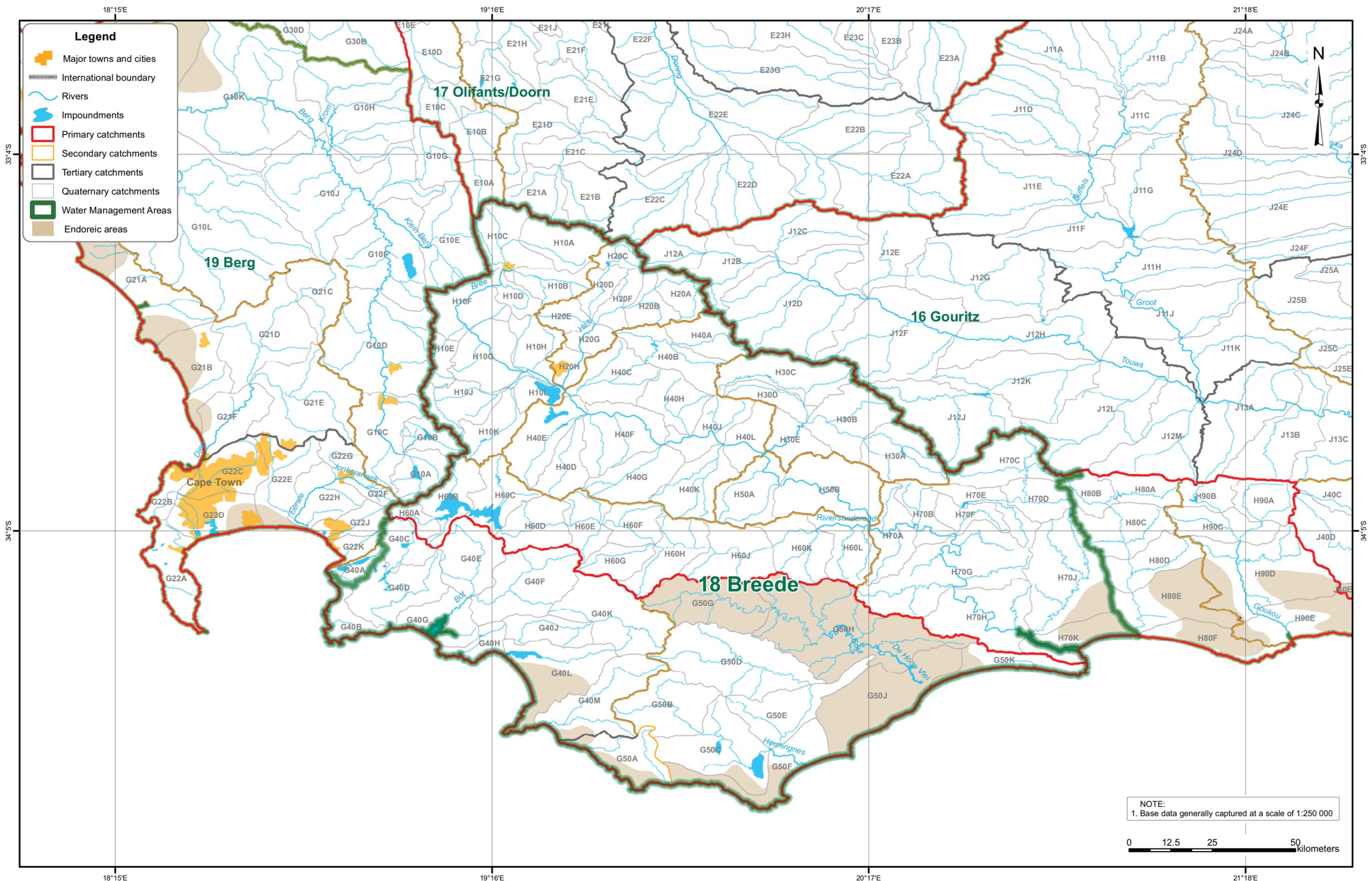


NOTE:
 1. Base data generally captured at a scale of 1:250 000

0 10 20 40 60 80 kilometers







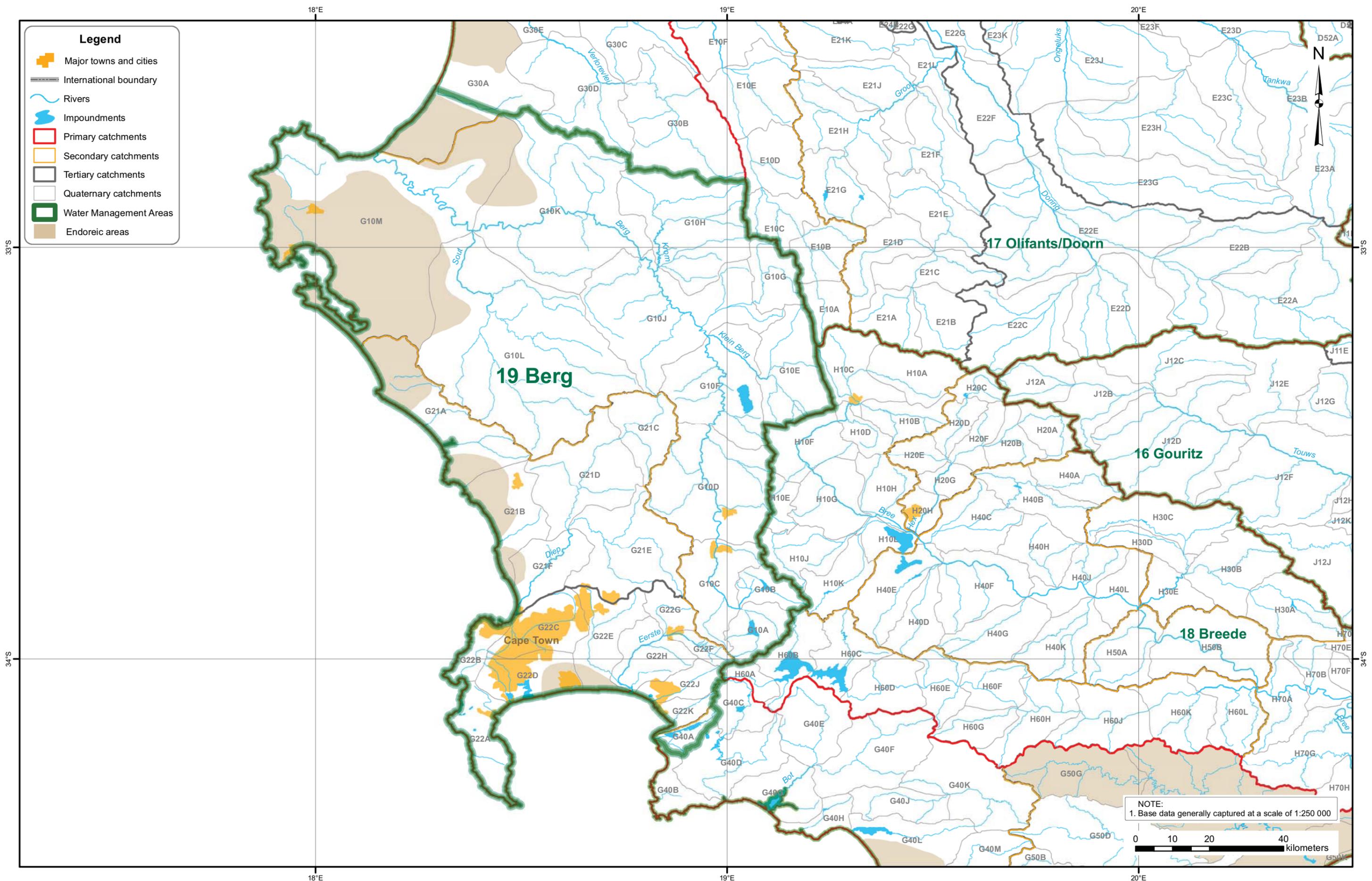
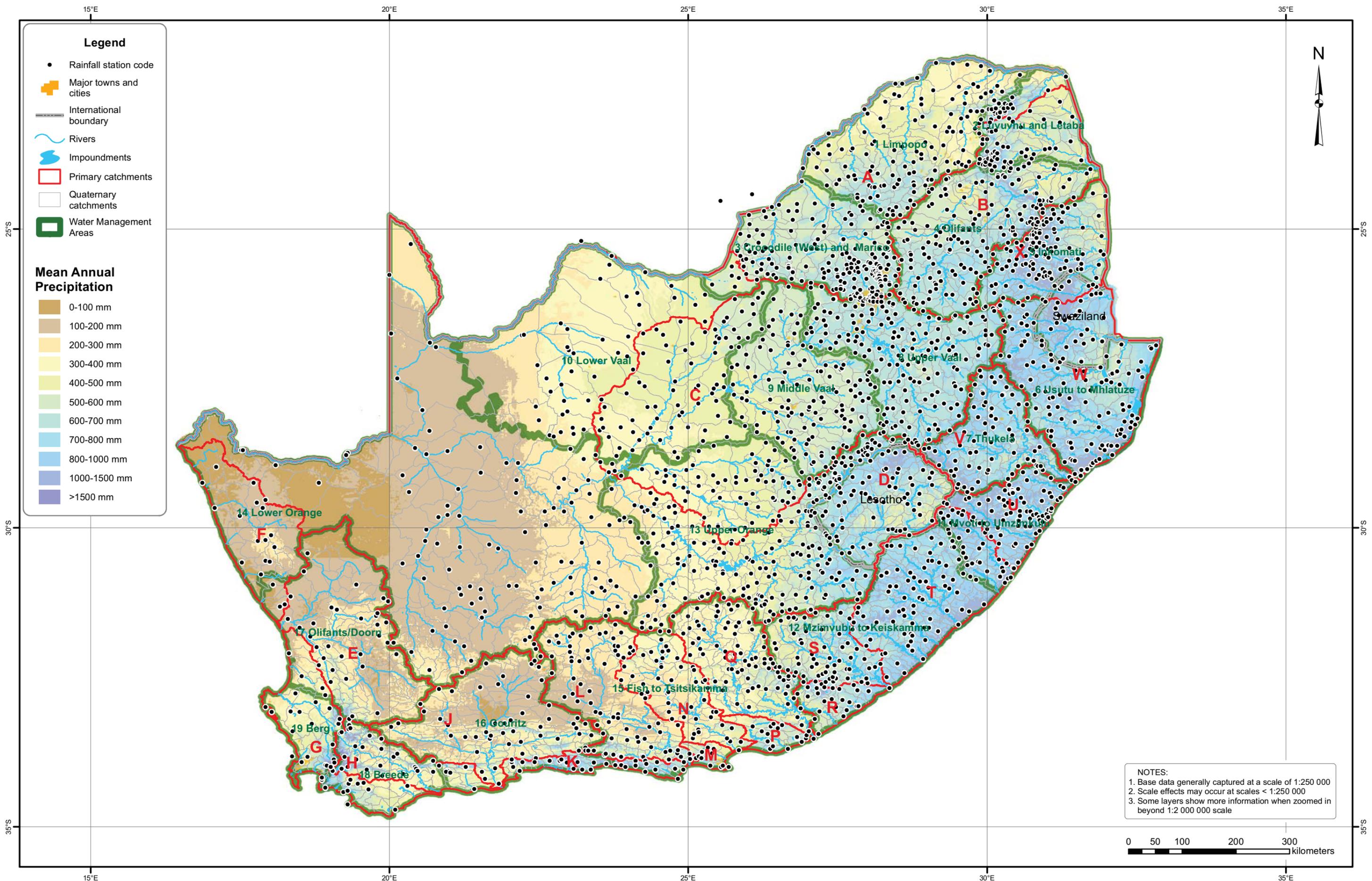


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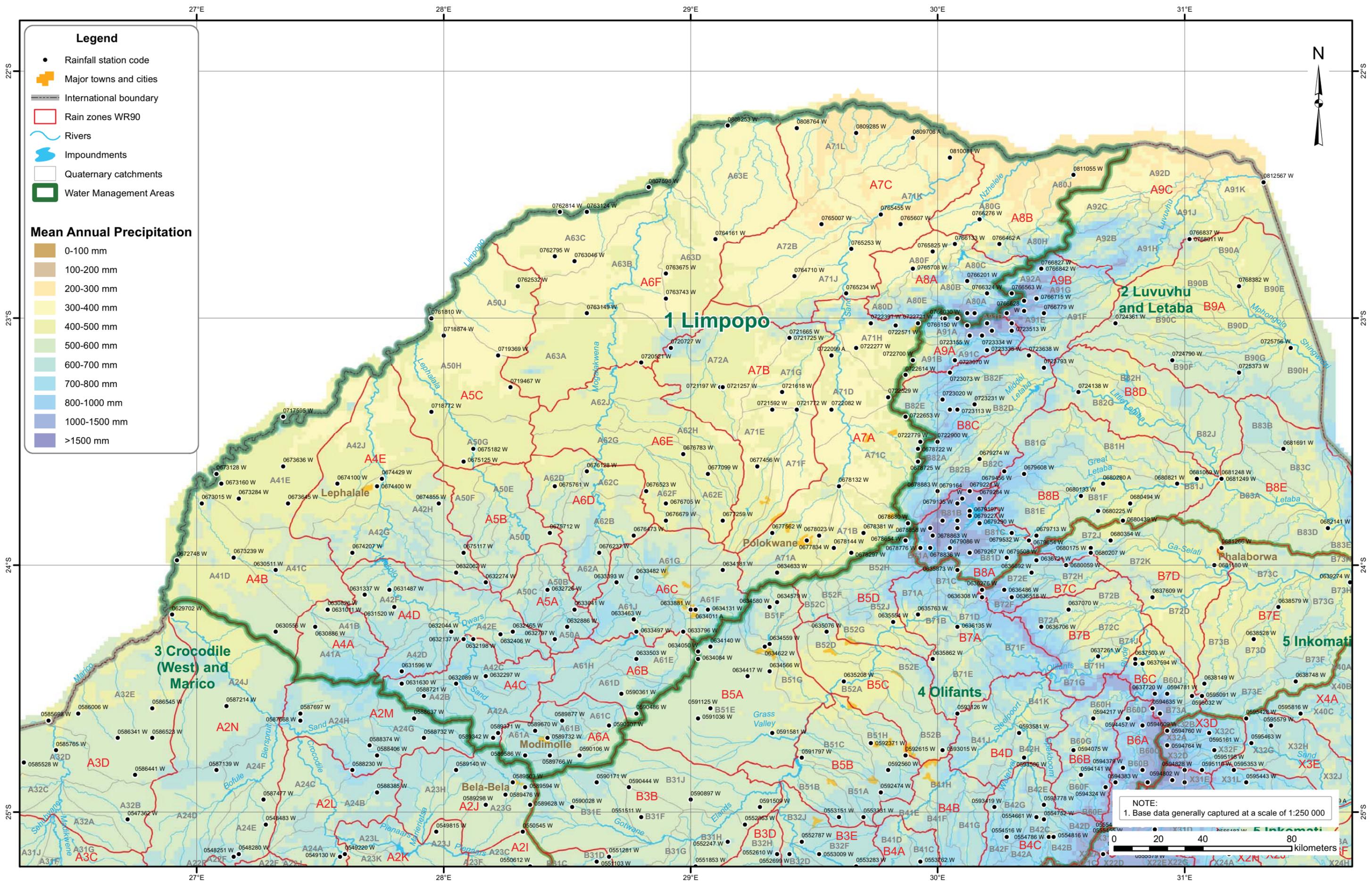
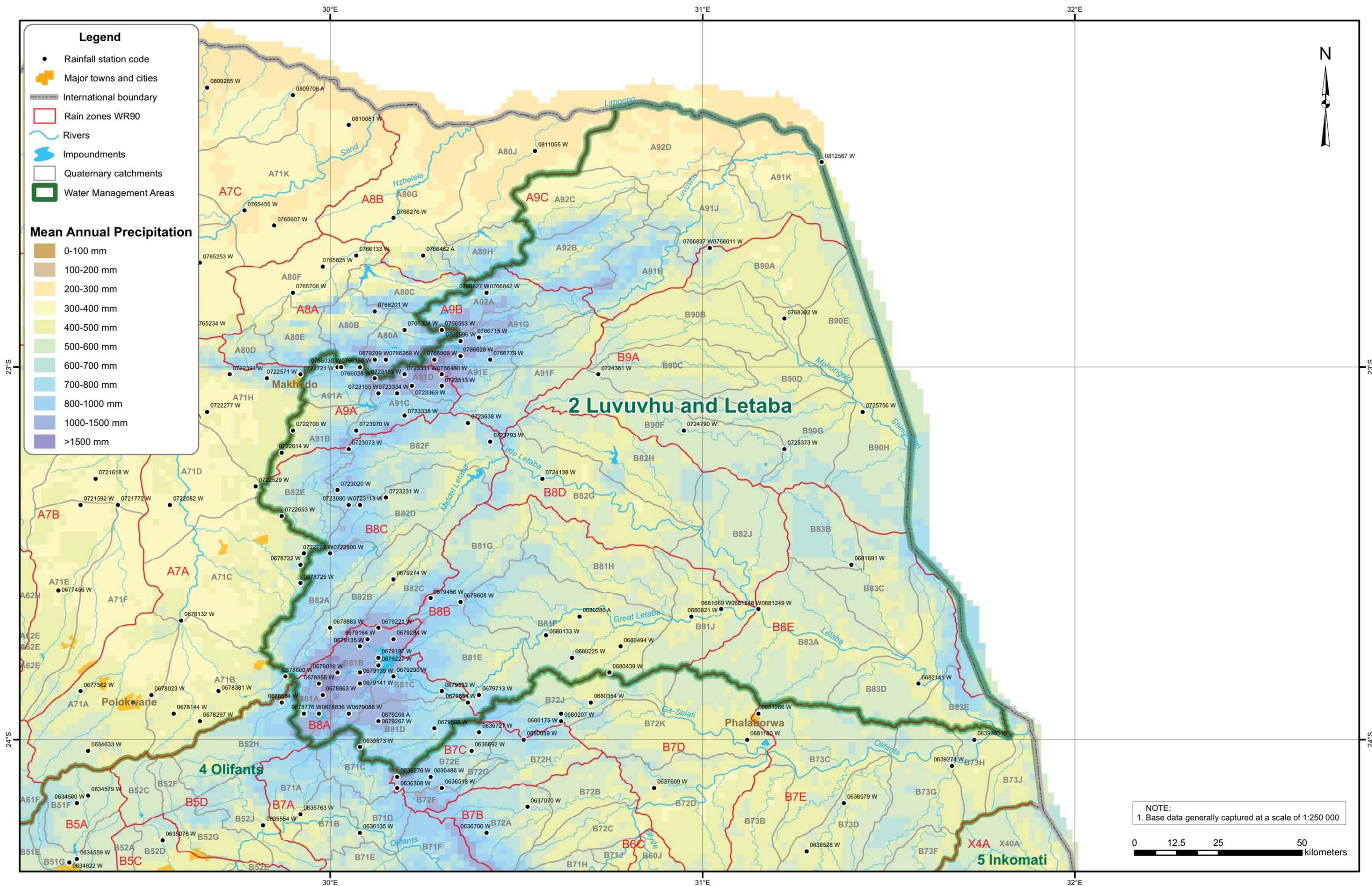
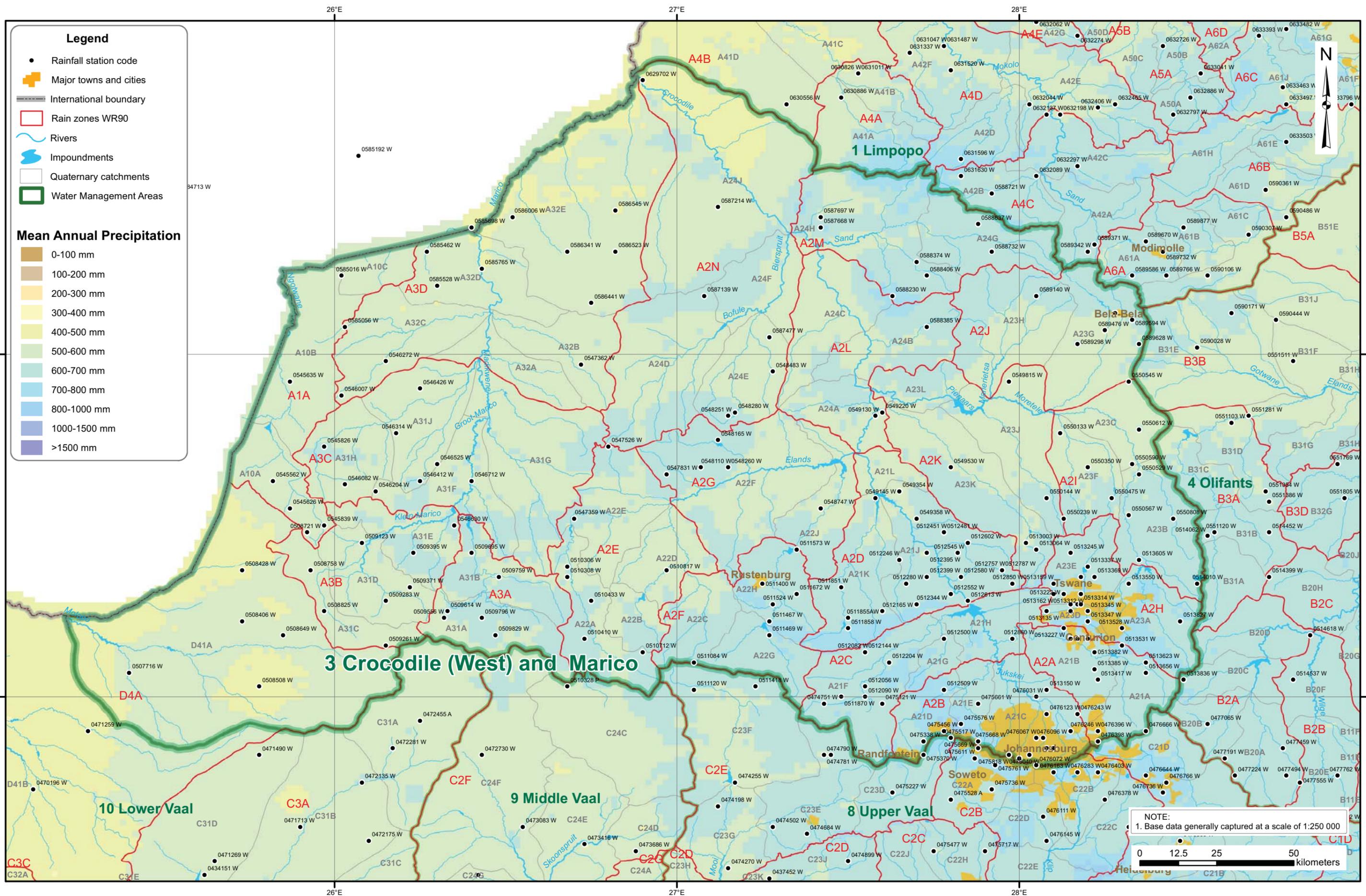


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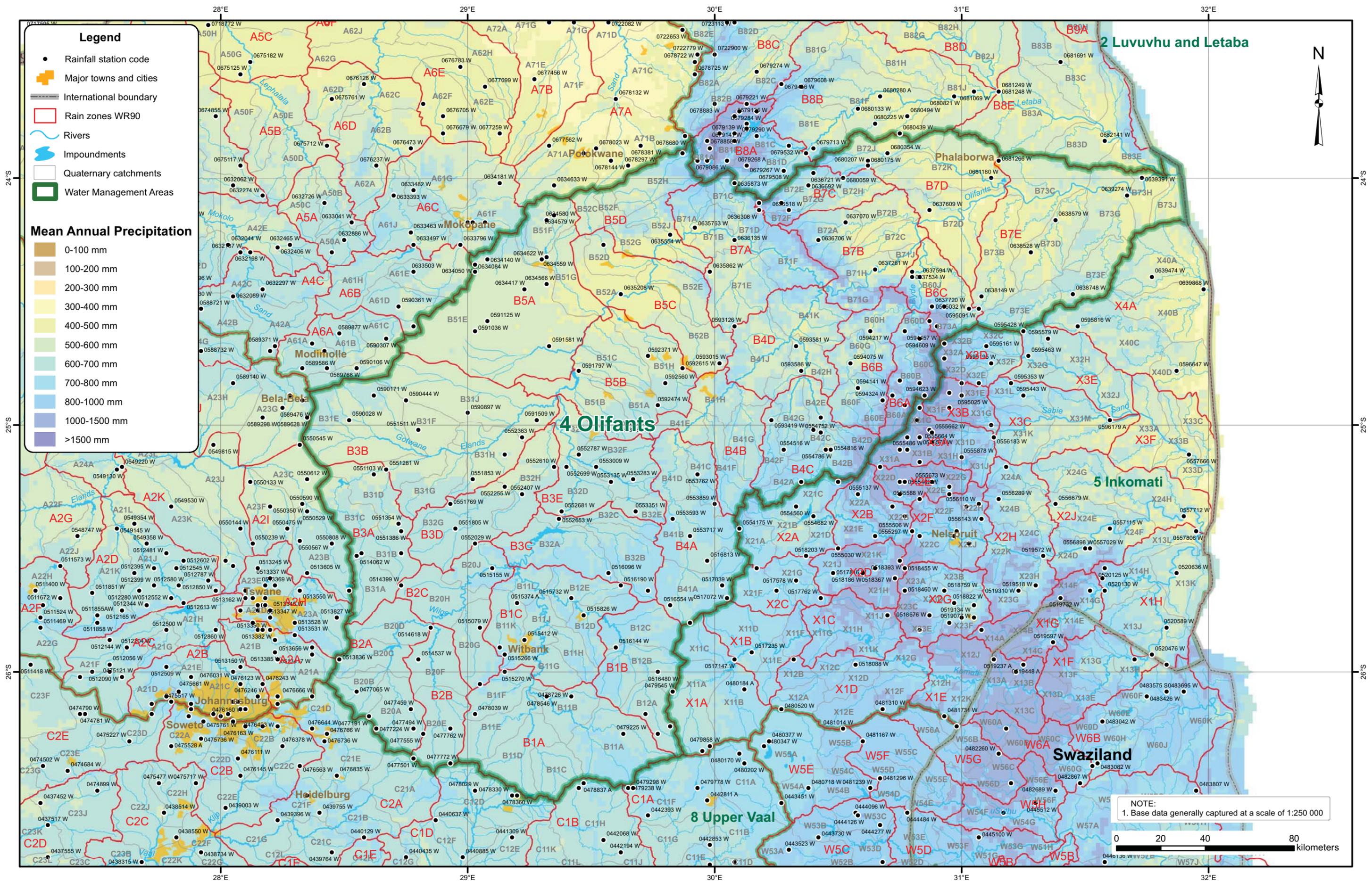


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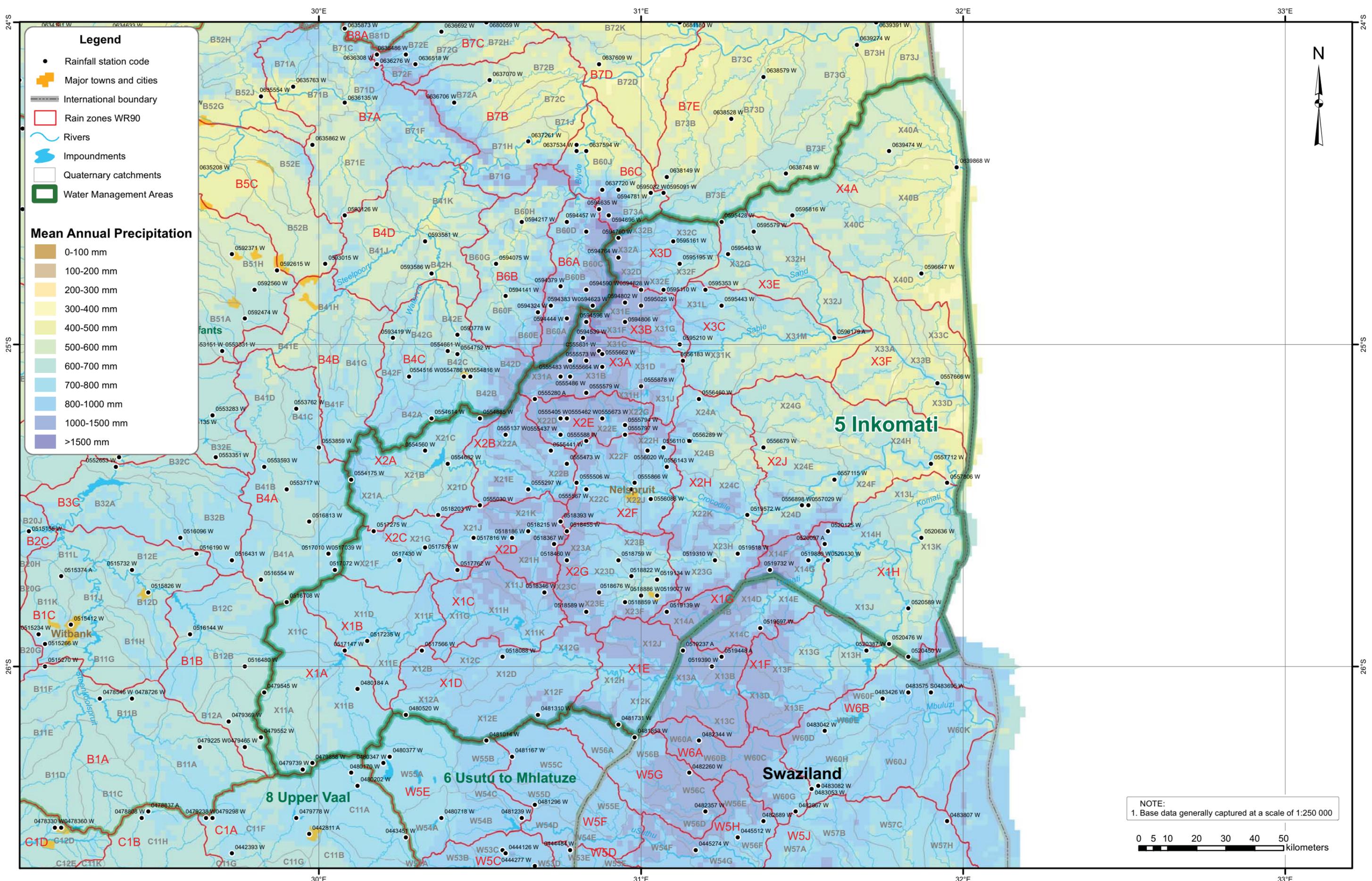


NOTE:
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0 12.5 25 50 kilometers



**Figure 1.4 : Rainfall : Olifants WMA
(now part of new 2. Olifants WMA)**



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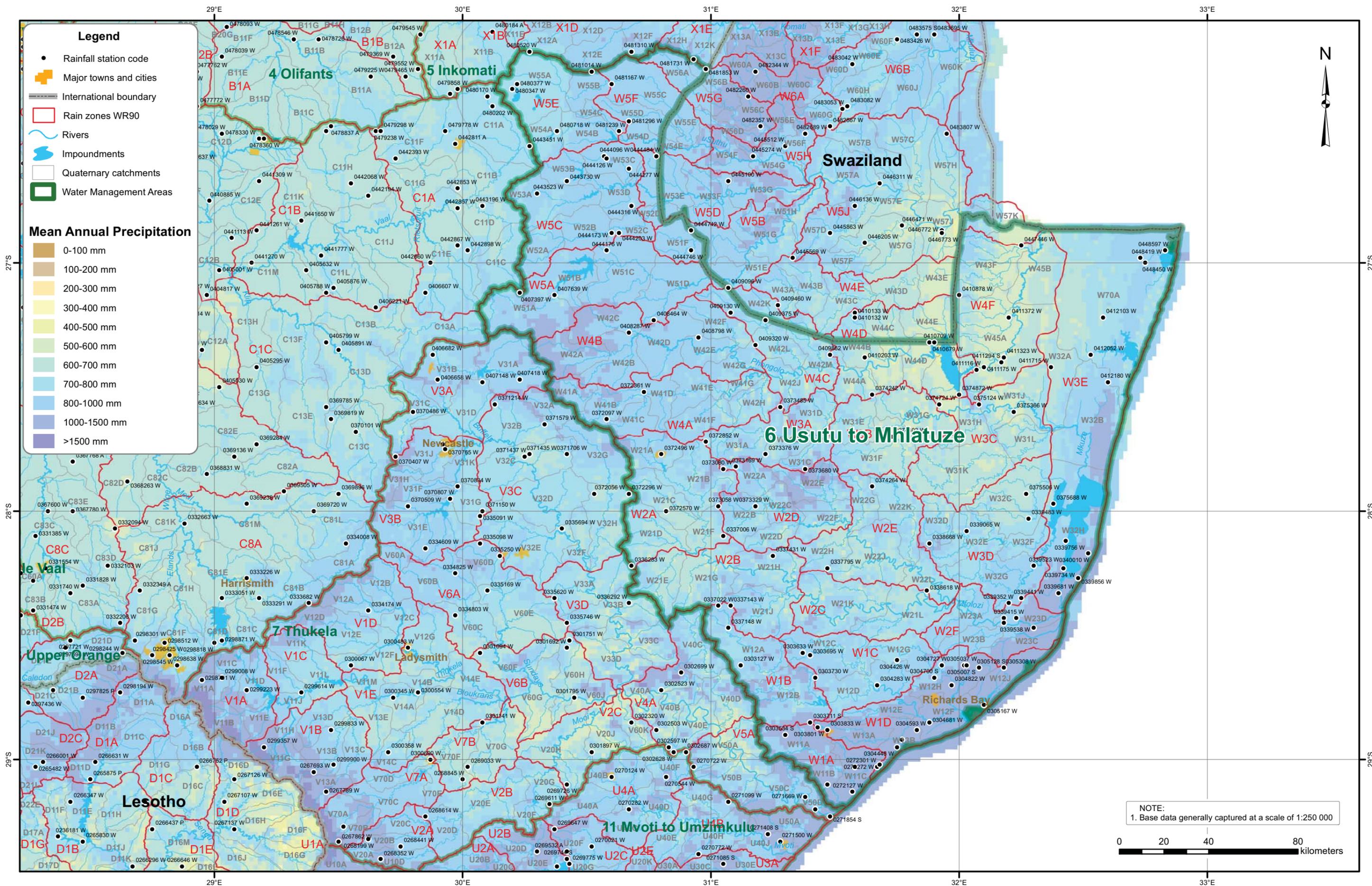
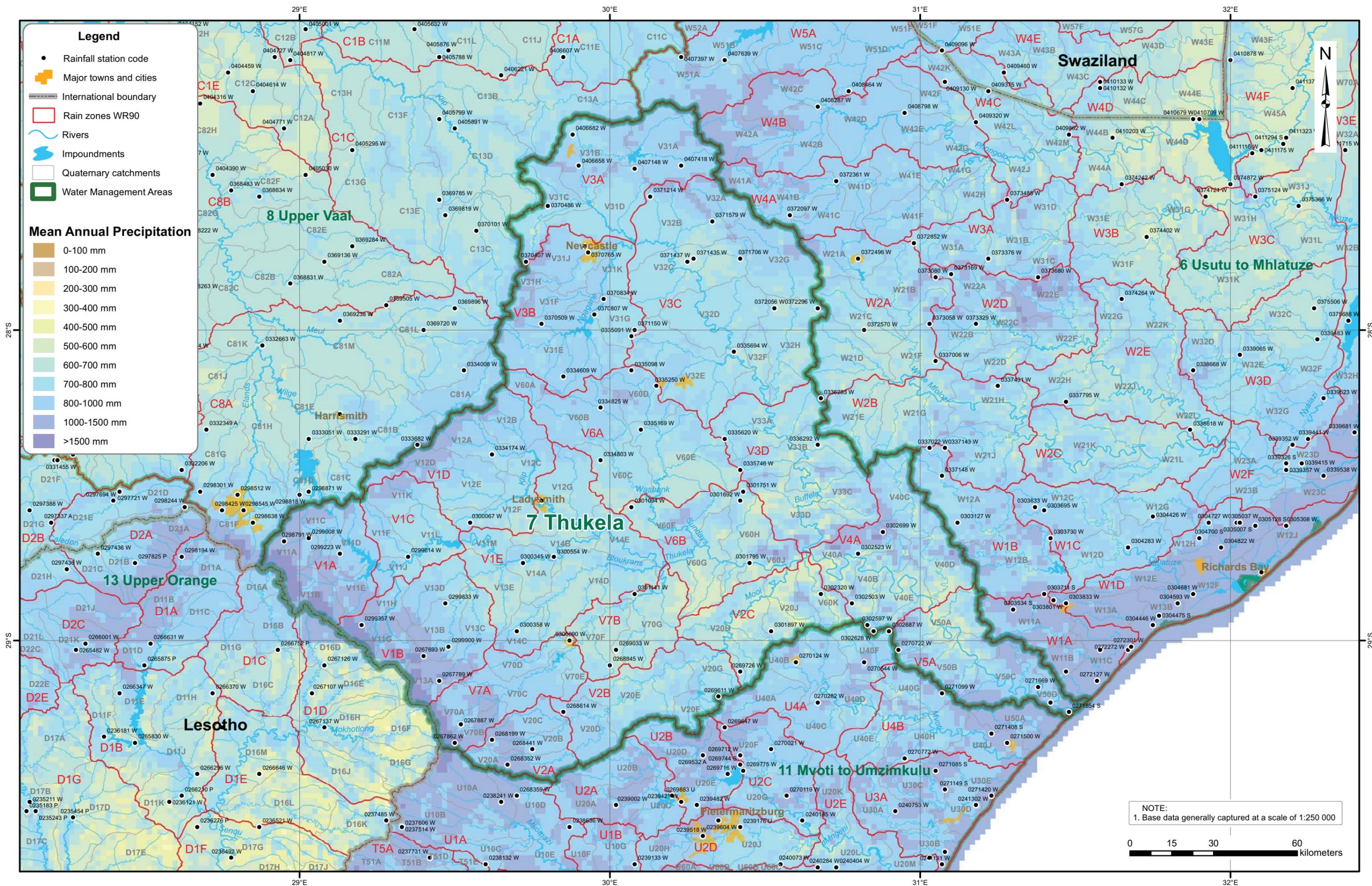
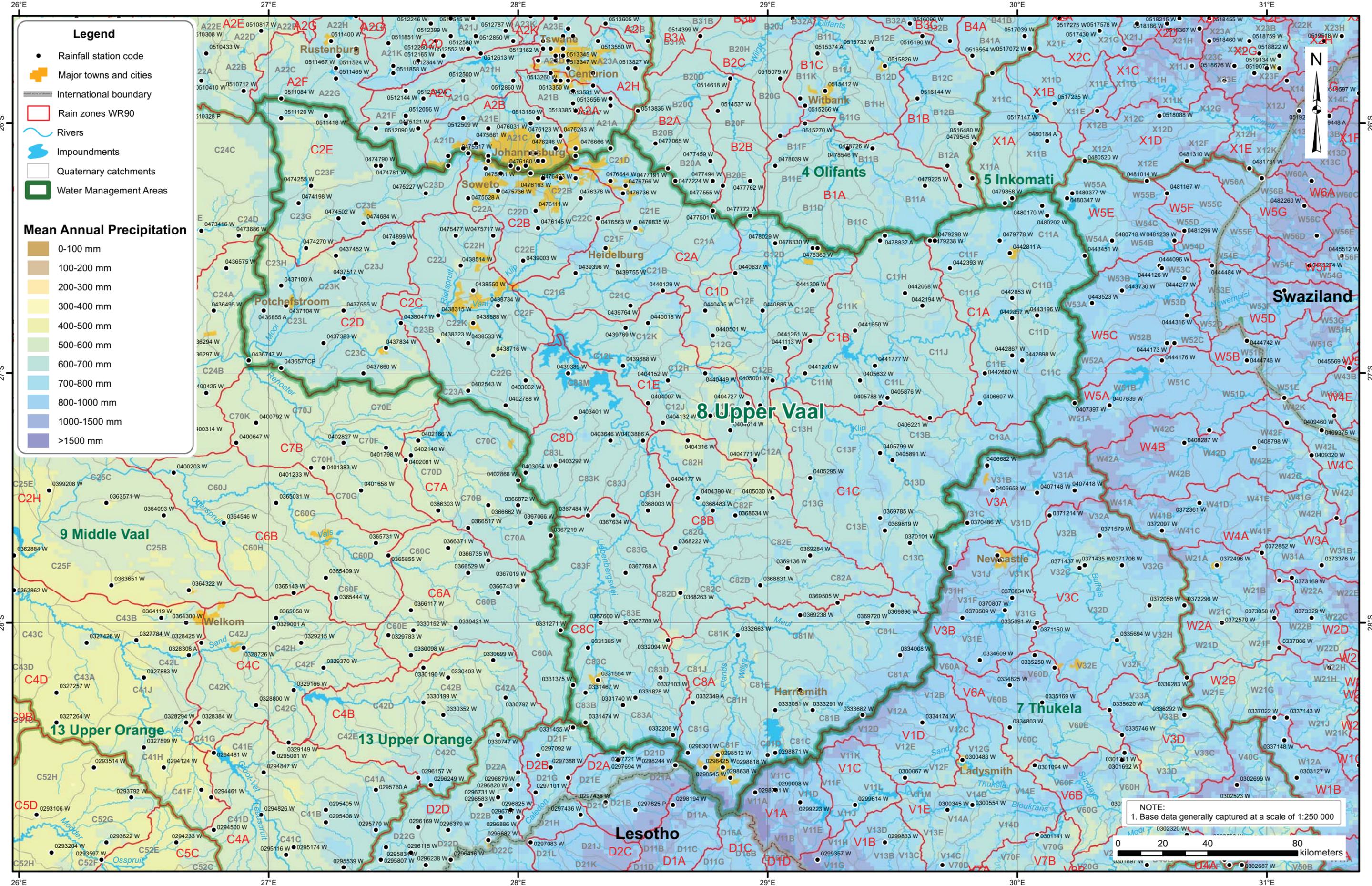


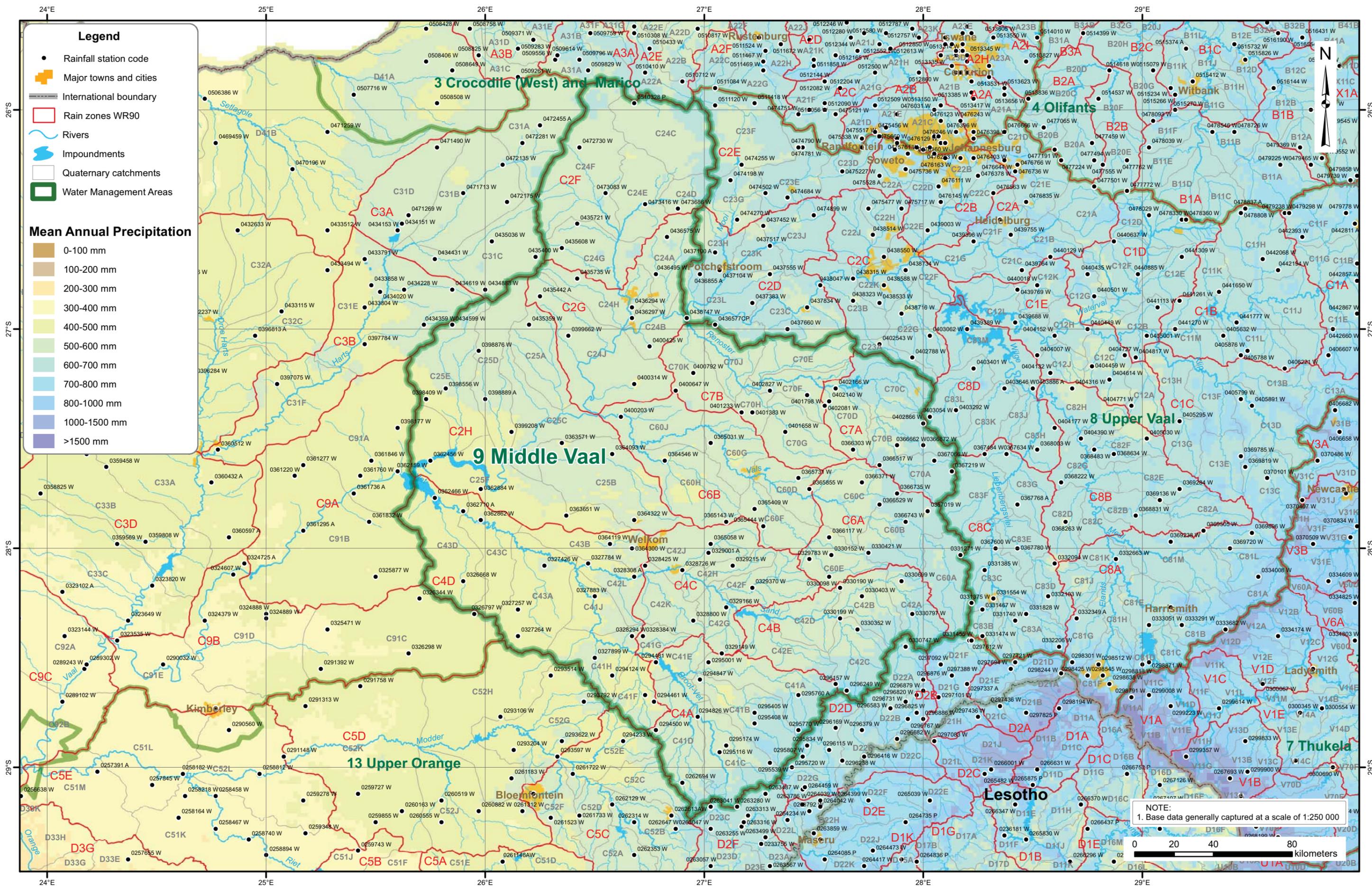
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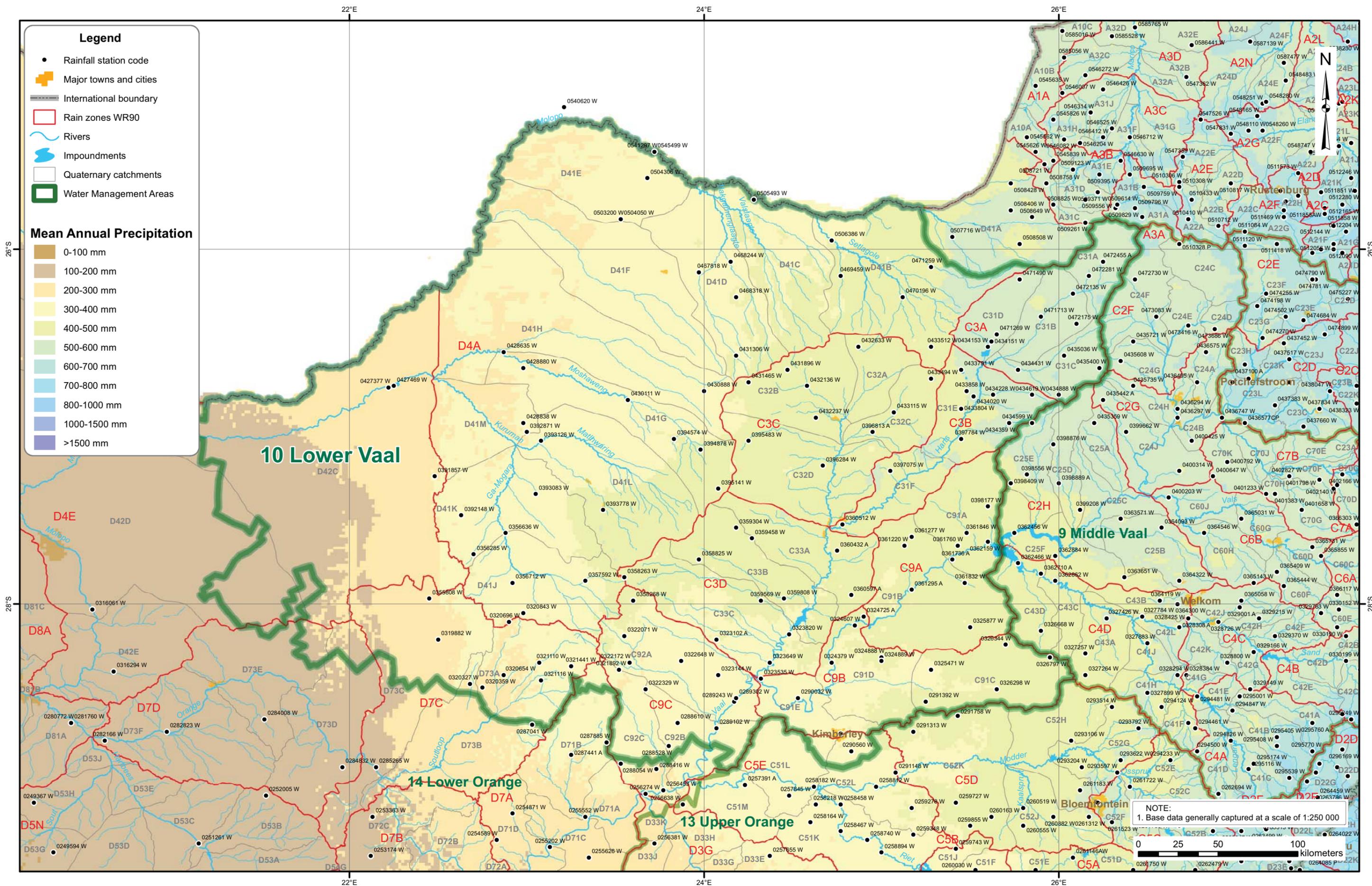
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**Figure 1.10 : Rainfall: Lower Vaal WMA
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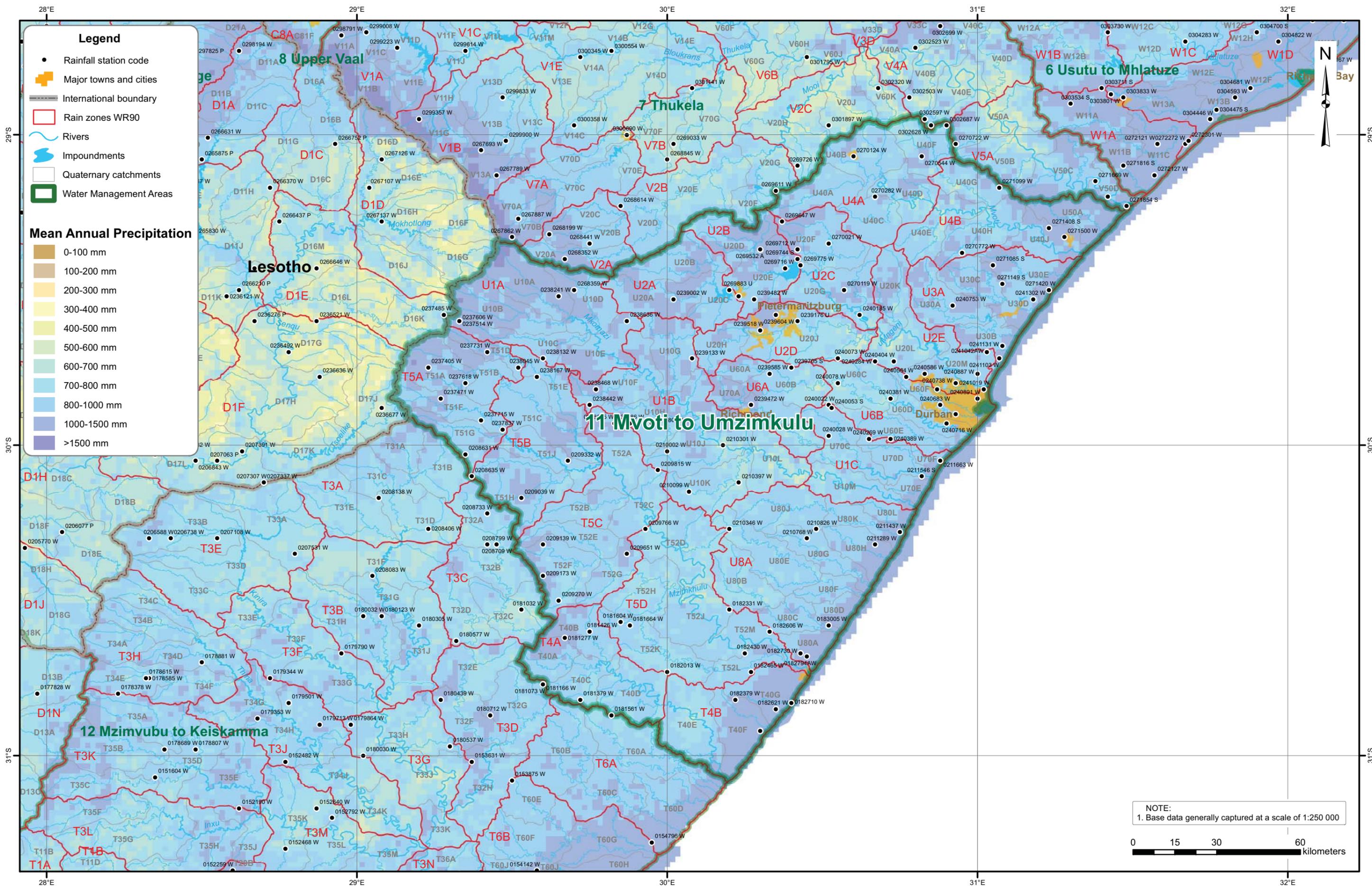
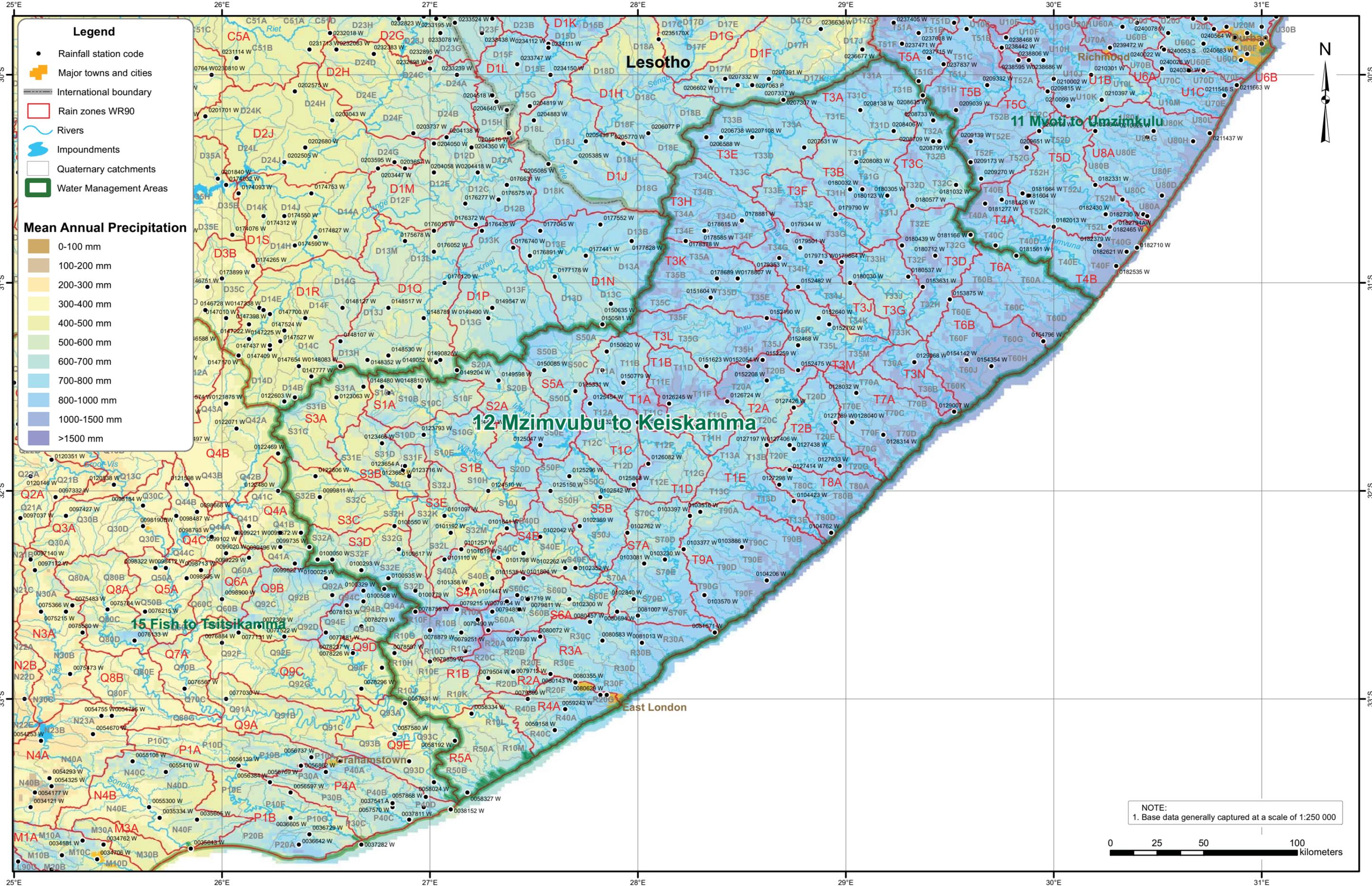
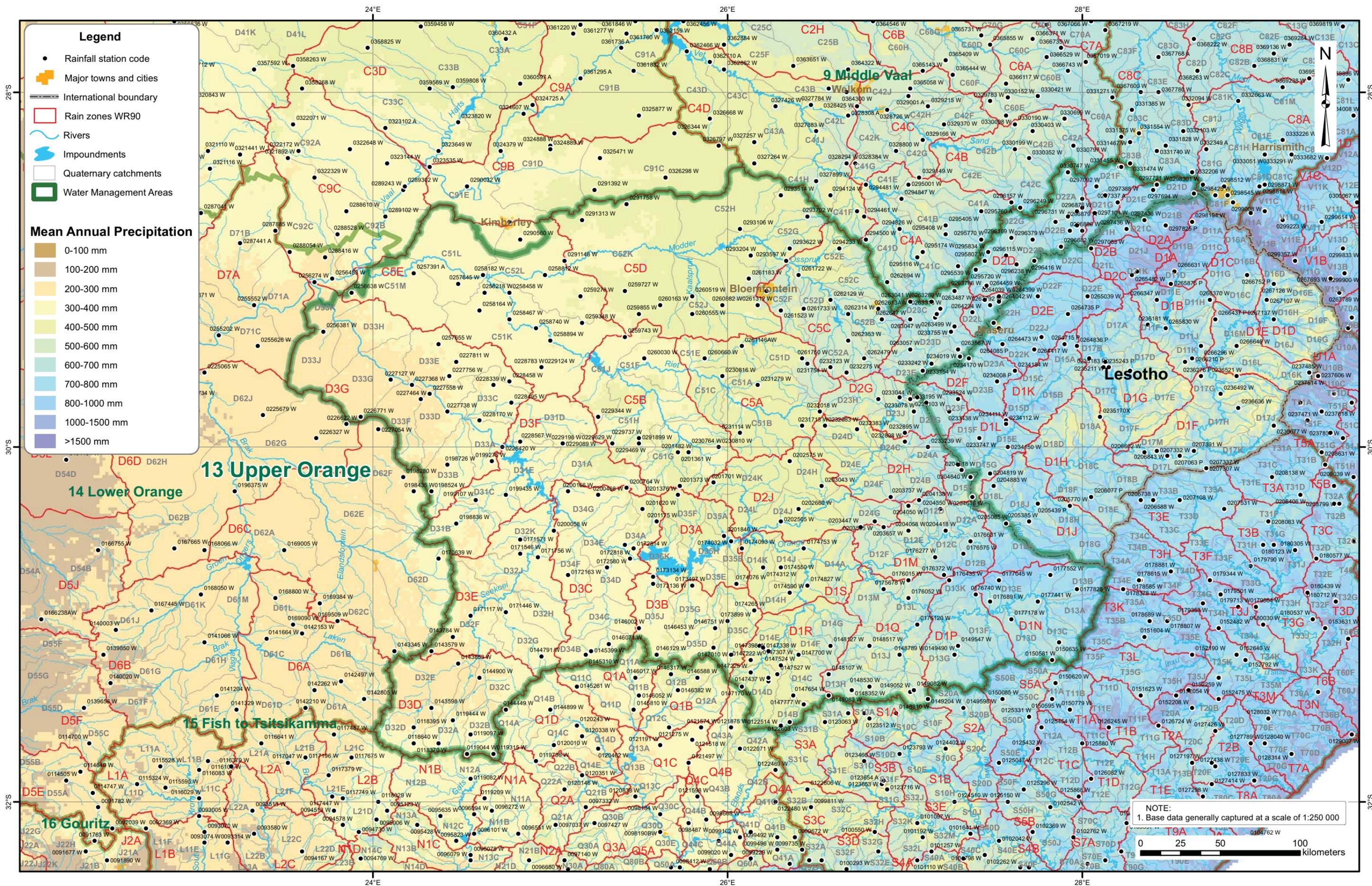


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**Figure 1.13 : Rainfall: Upper Orange WMA
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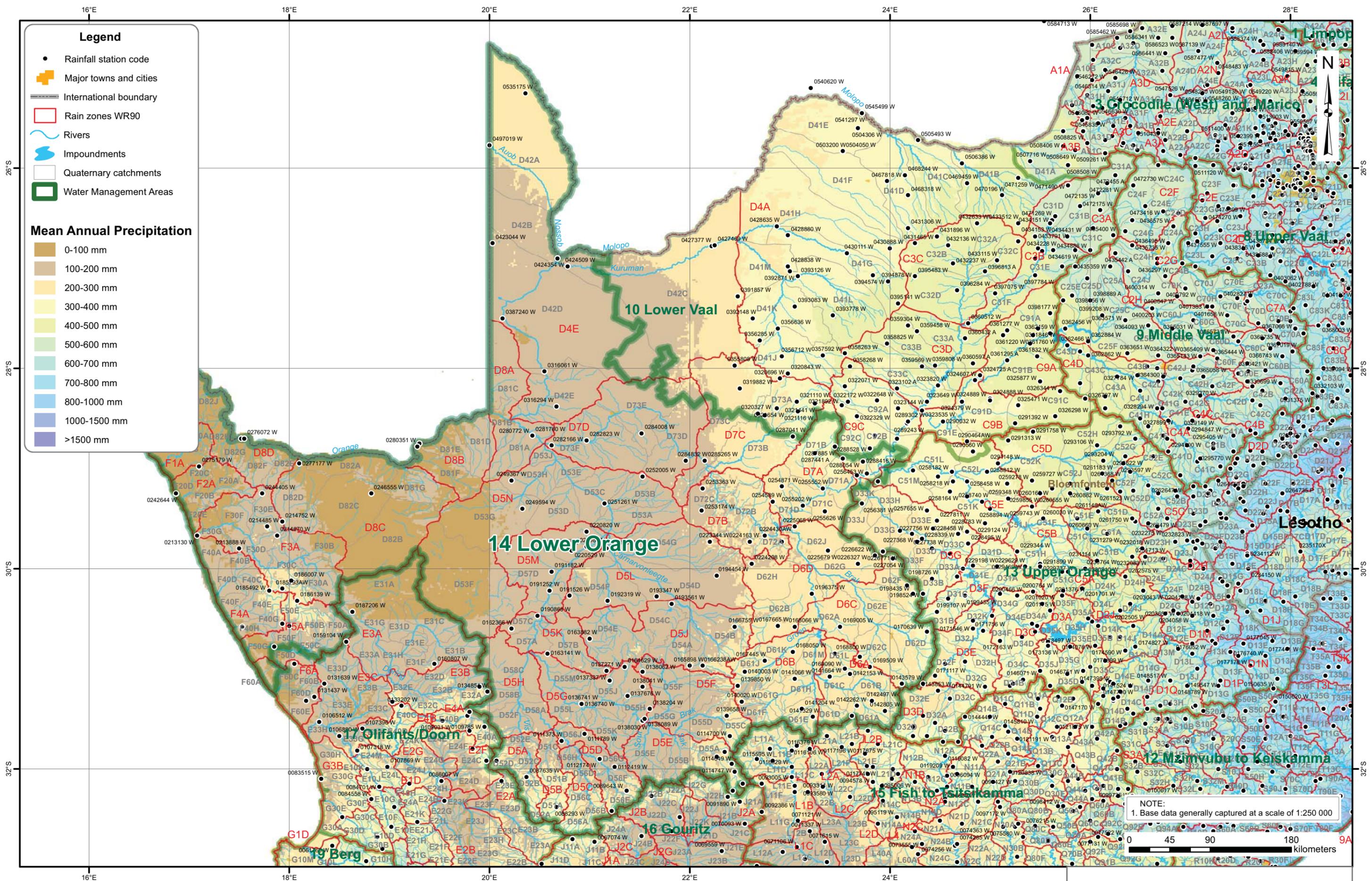


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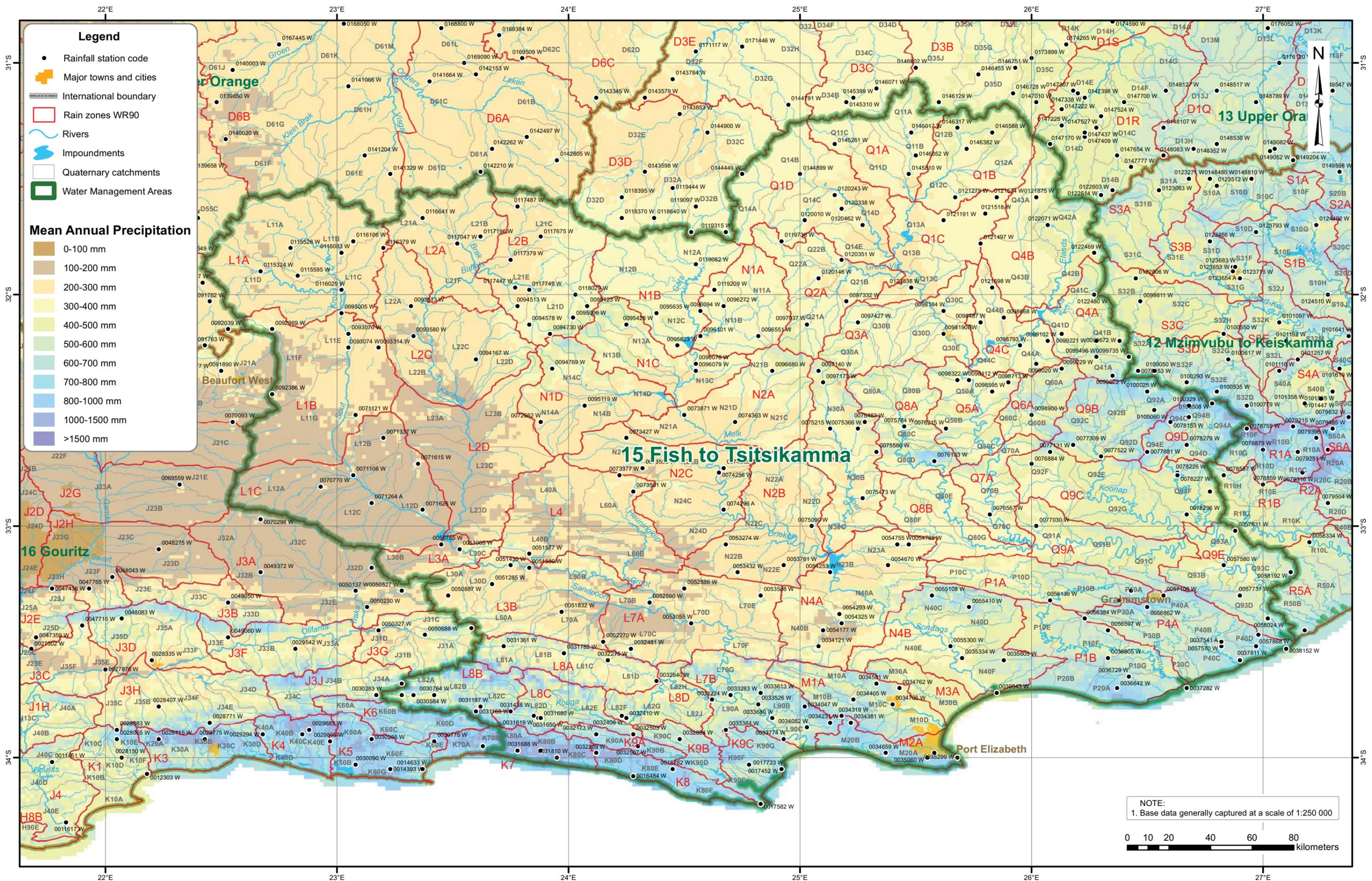
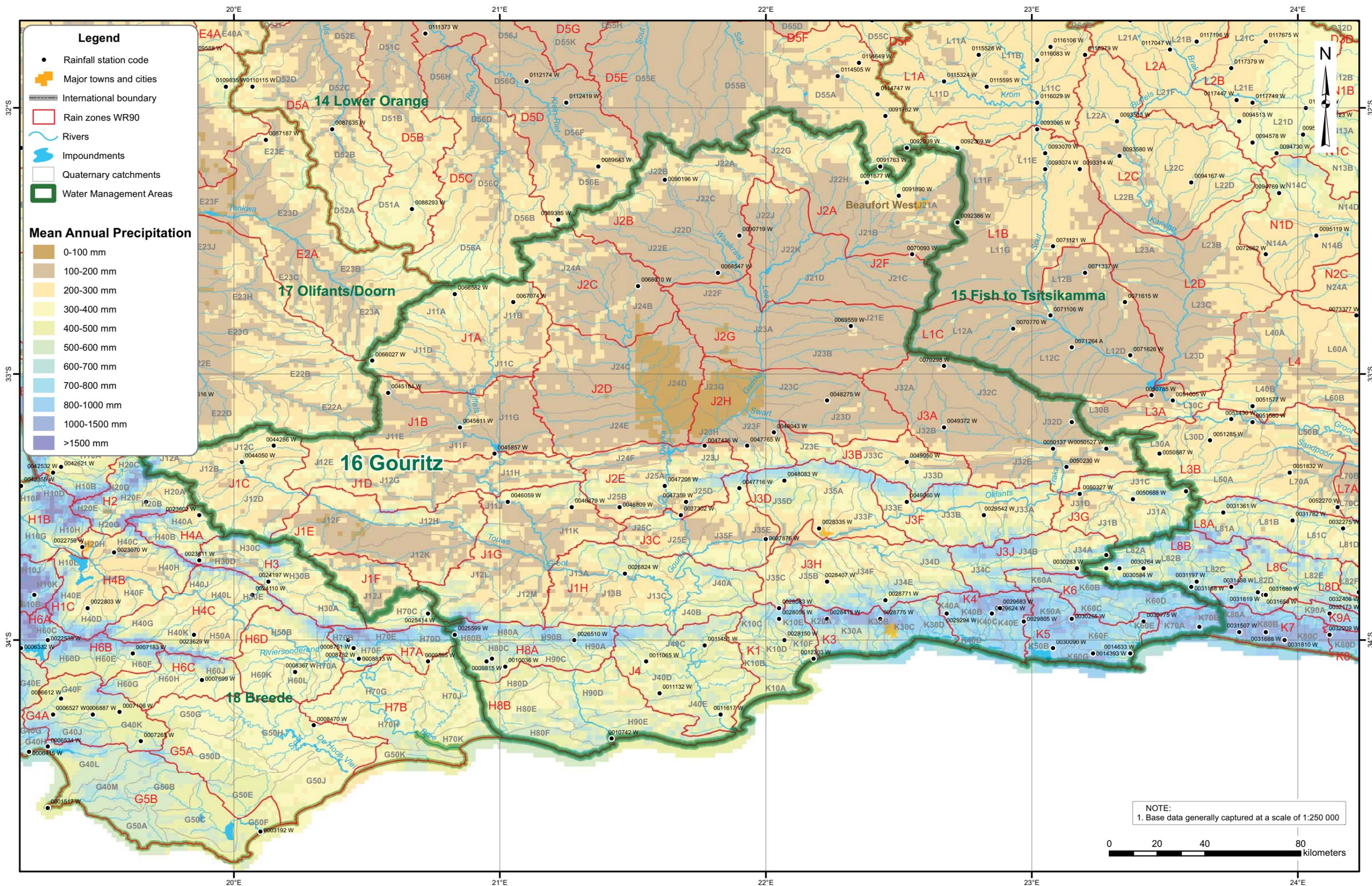
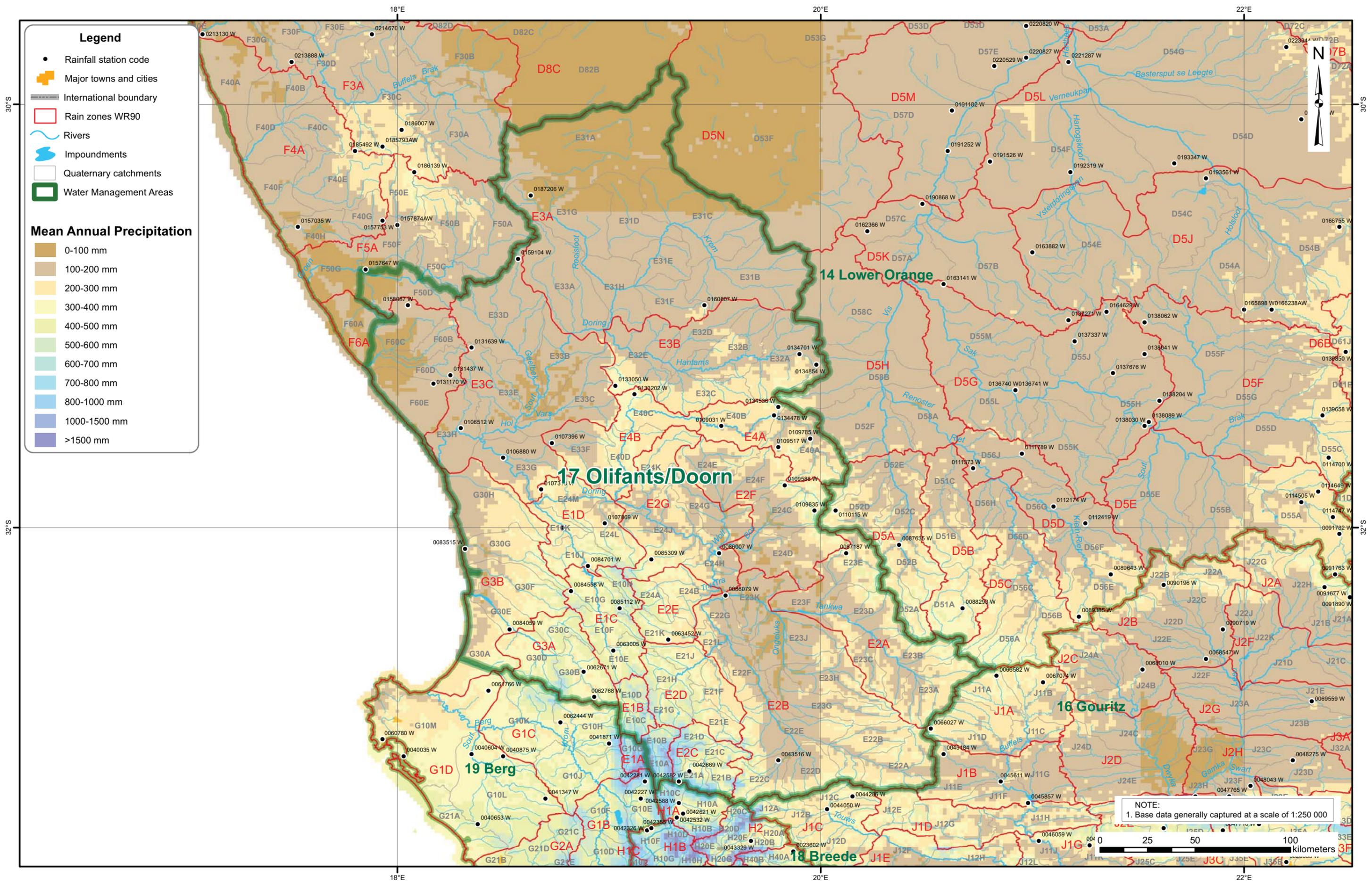


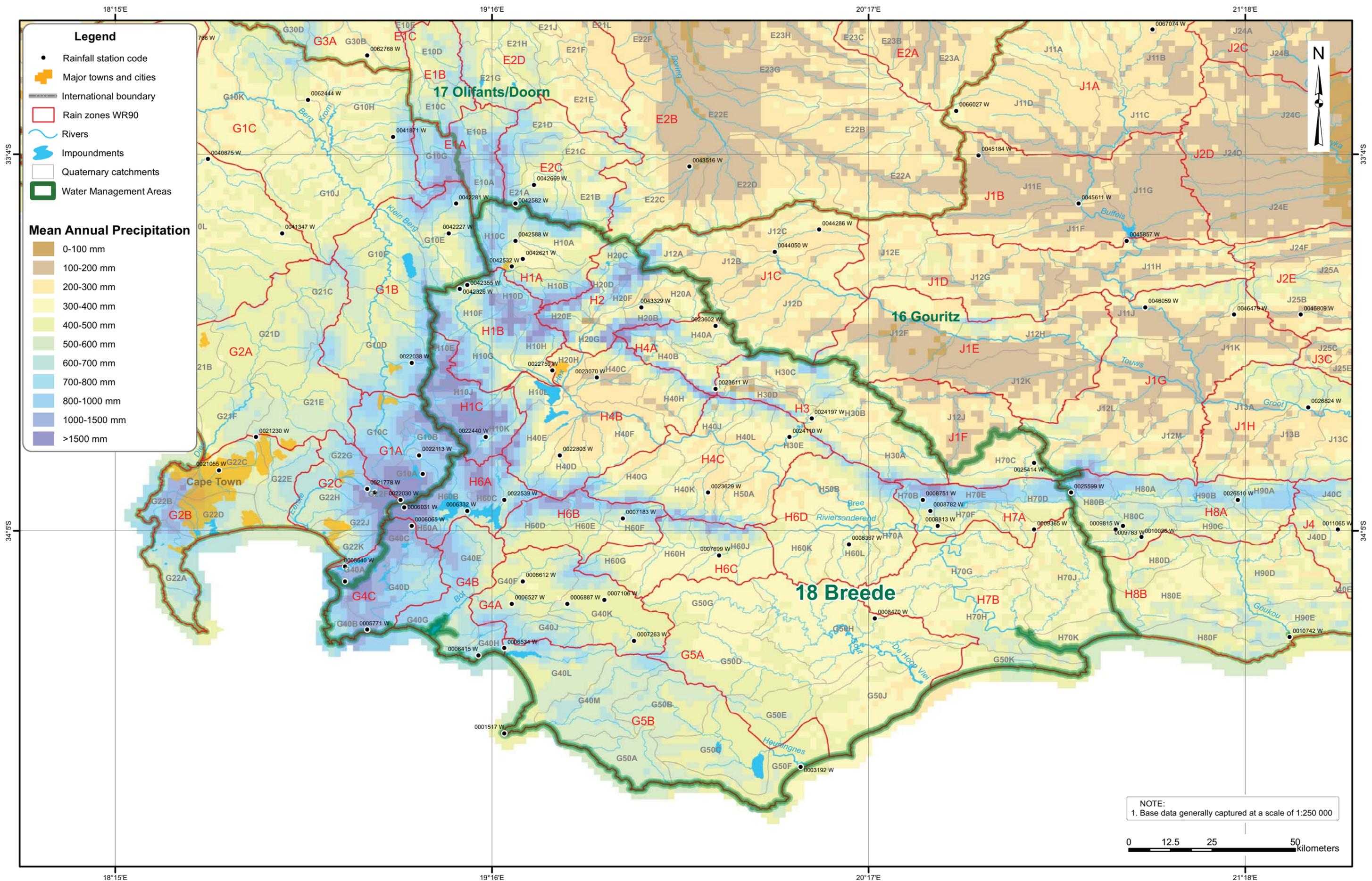
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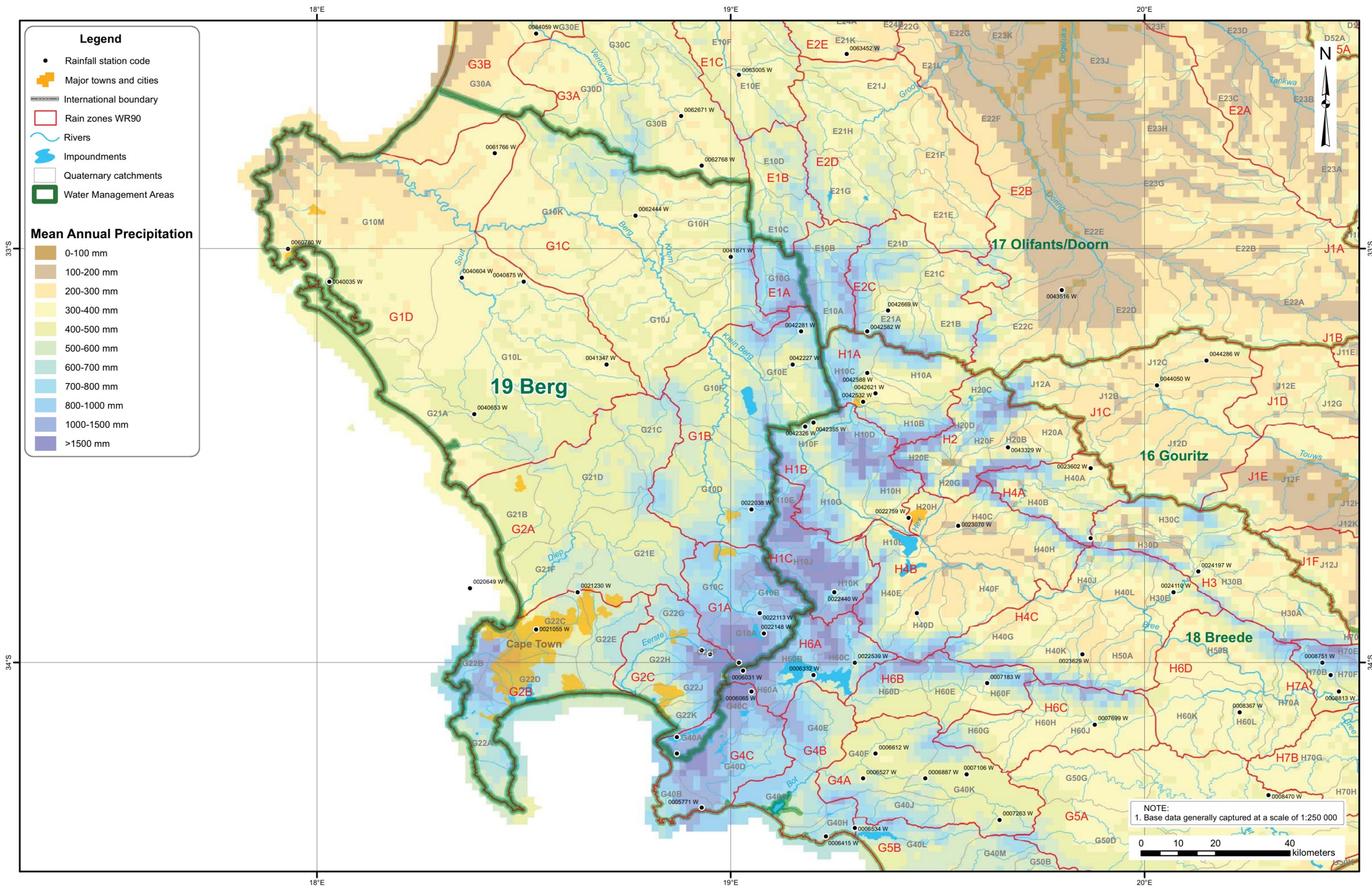
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**Figure 1.18 : Rainfall : Breede WMA
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NOTE:
1. Base data generally captured at a scale of 1:250 000

0 12.5 25 50 kilometers



**Figure 1.19 : Rainfall: Berg WMA
(now part of new 9. Berg - Olifants WMA)**

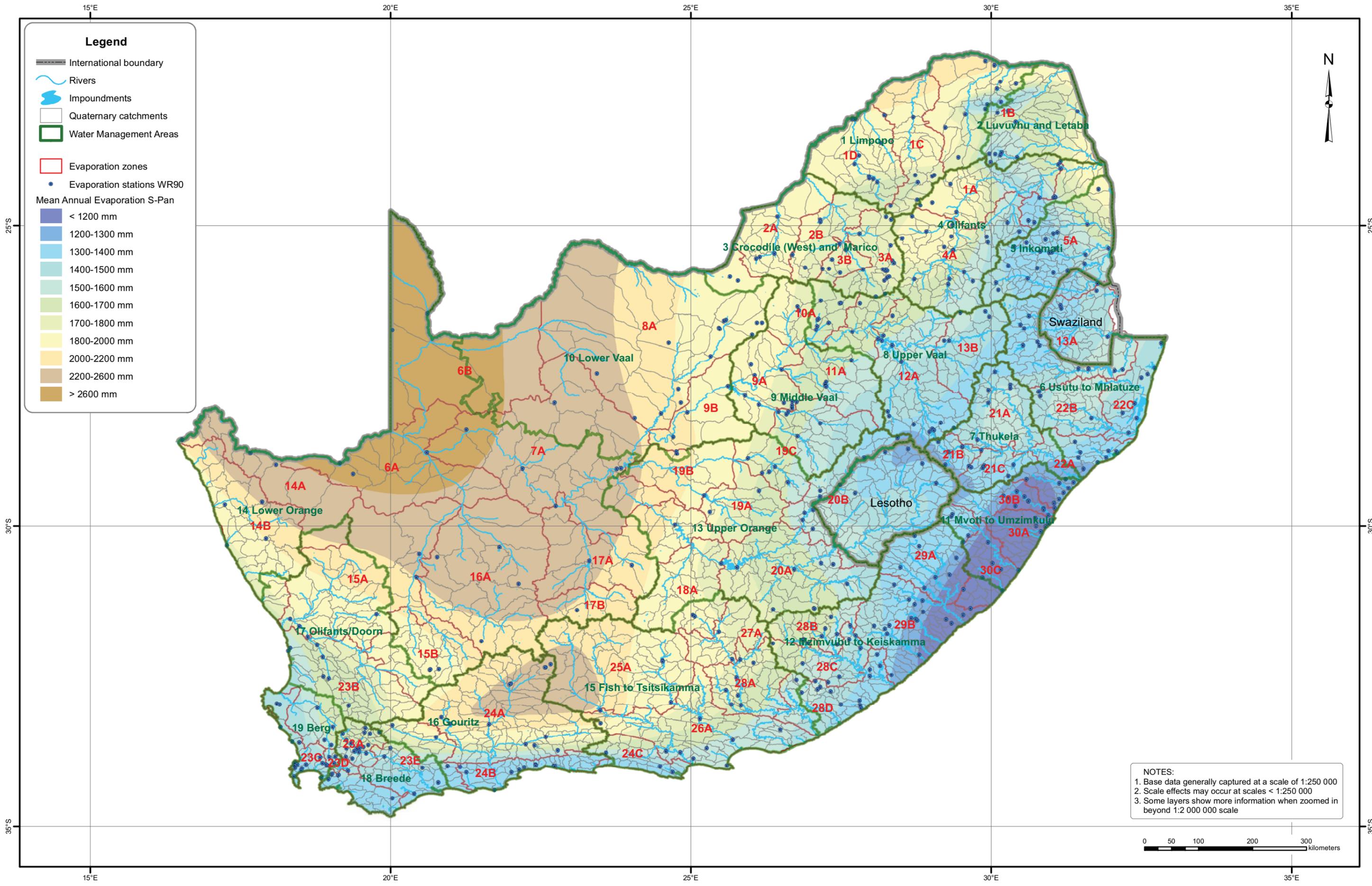


Figure 2a : Evaporation (WR90 S-pan)

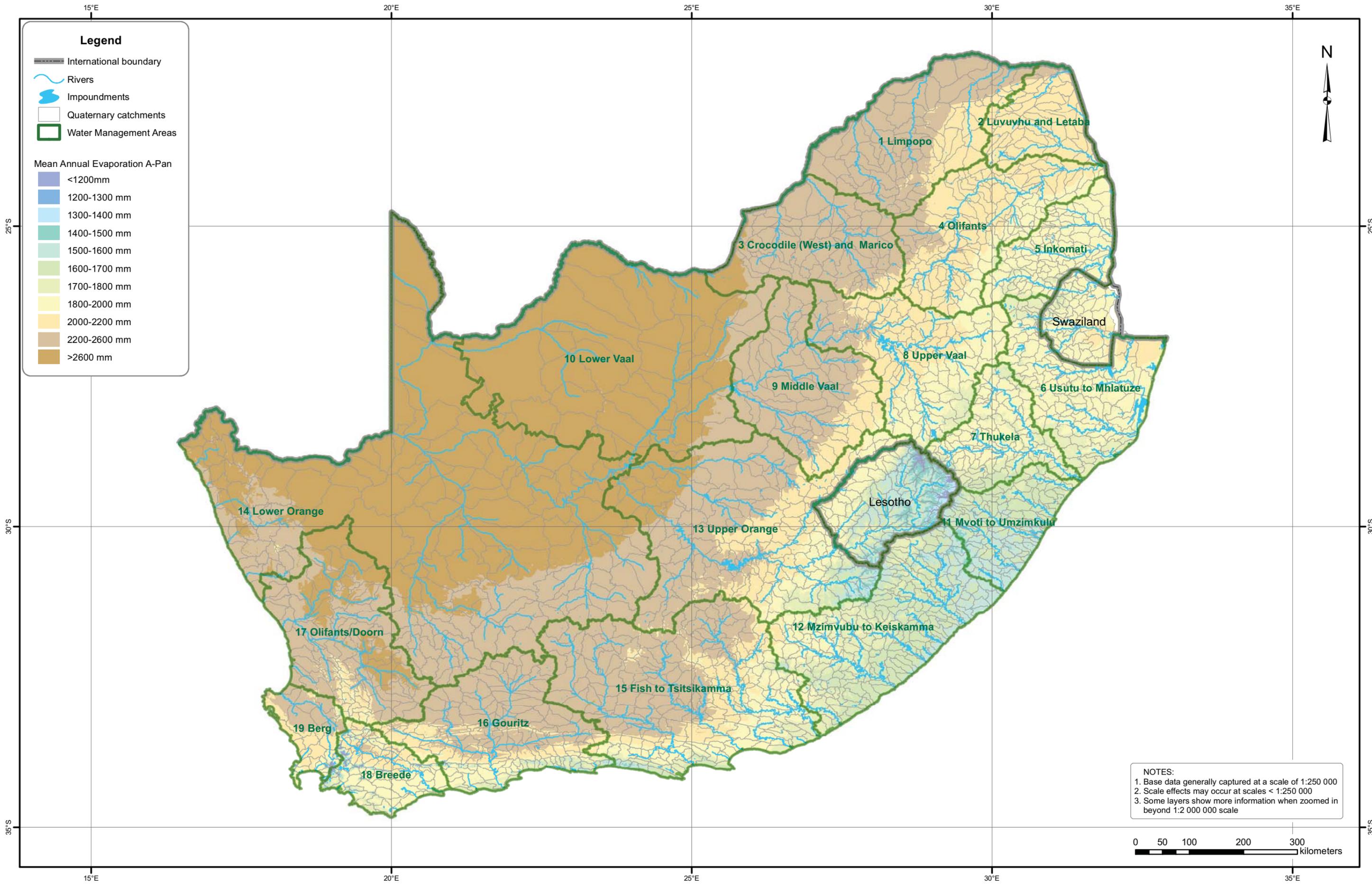


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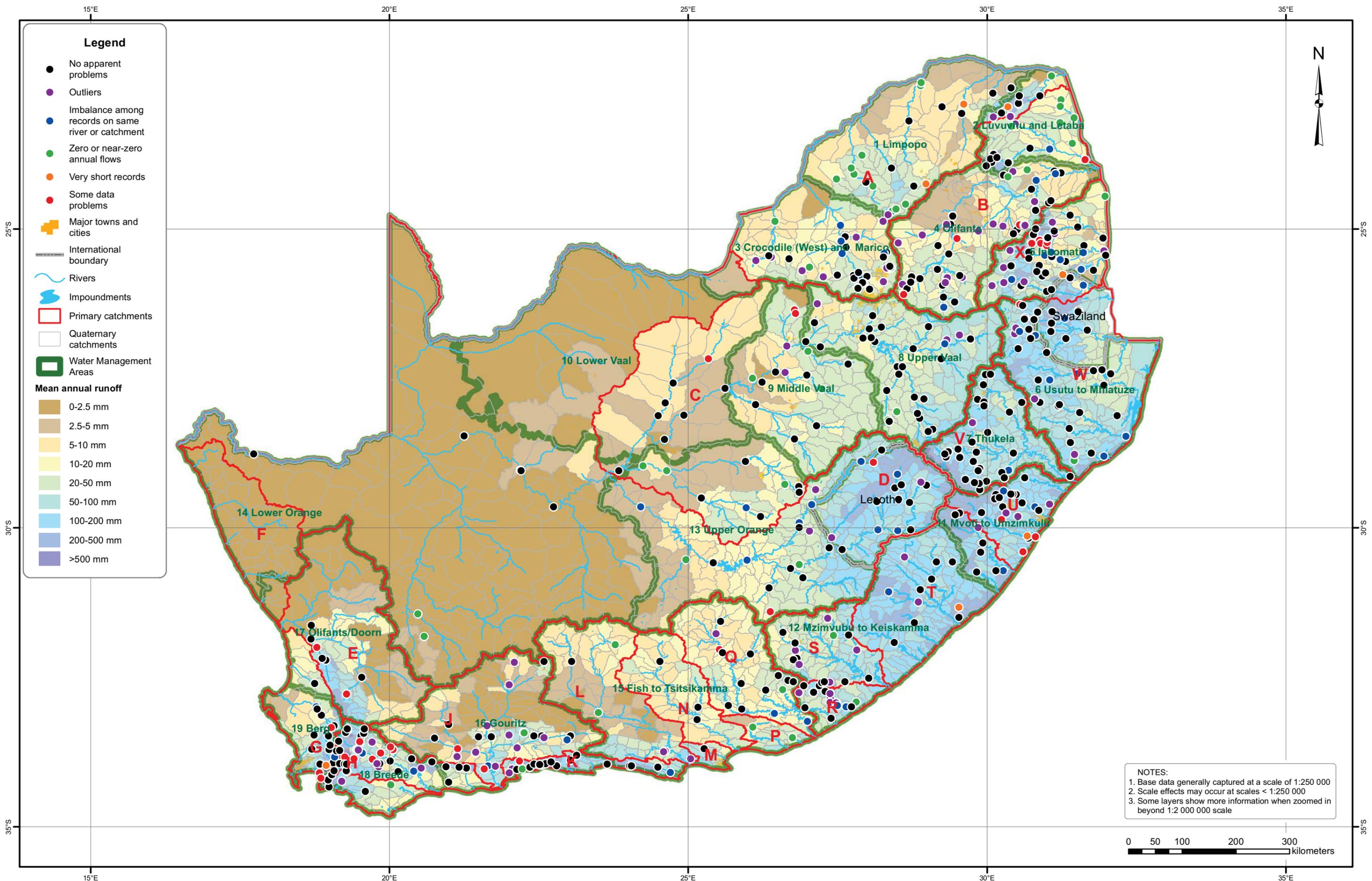
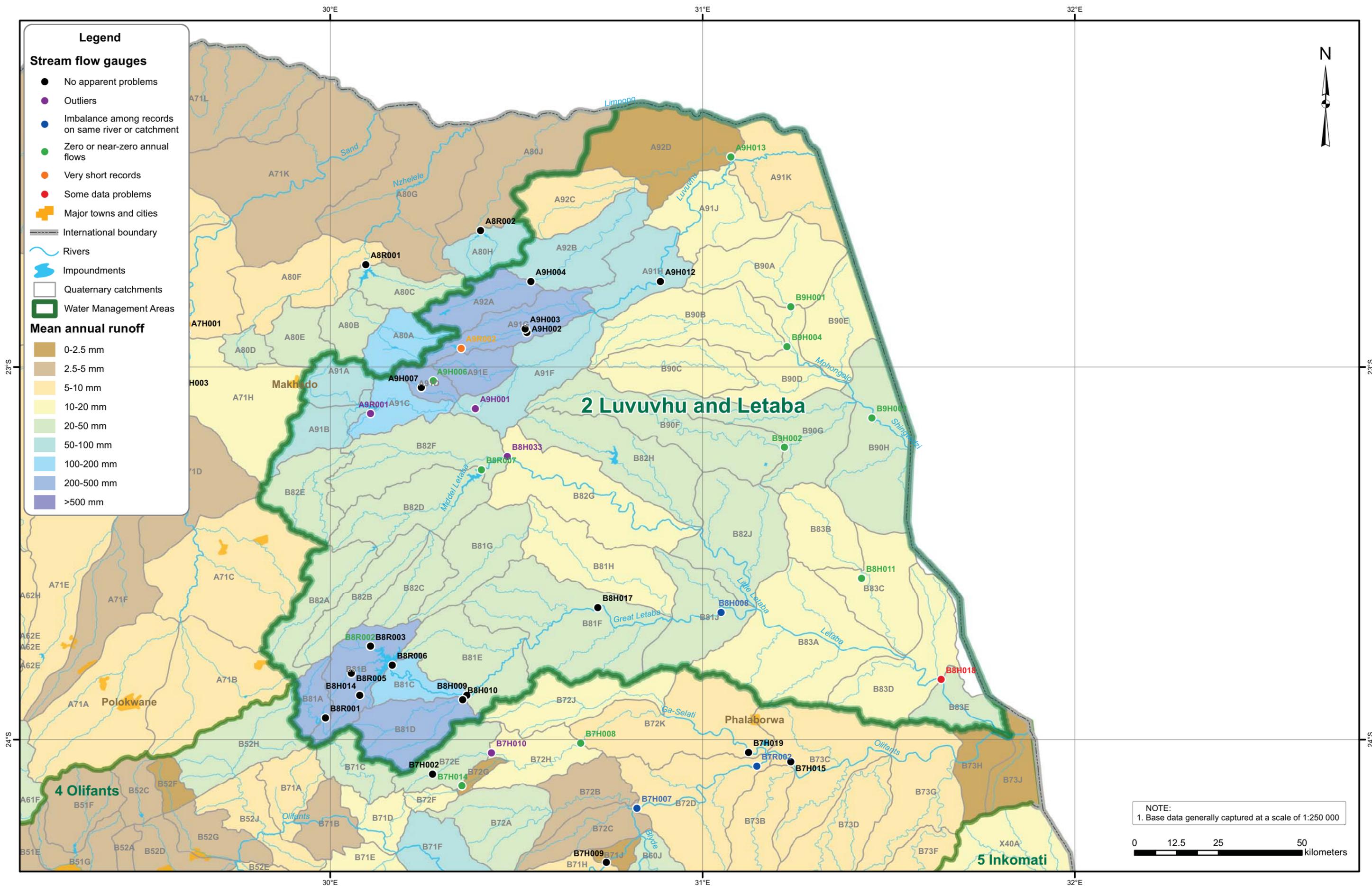
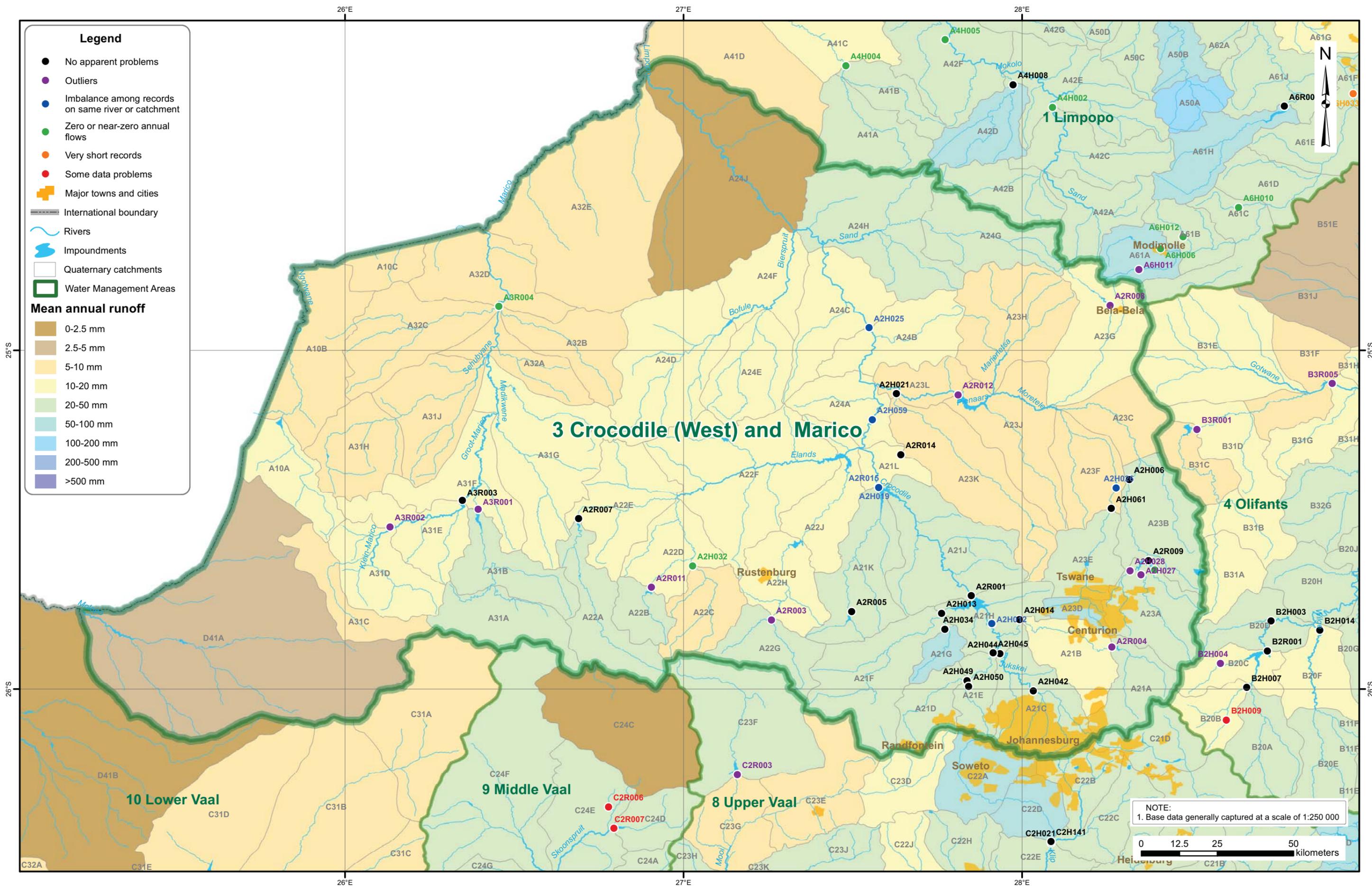


Figure 3 : Runoff



**Figure 3.2 : Runoff: Luvuvhu and Letaba WMA
(now part of new 2. Olifants WMA)**



**Figure 3.3 : Runoff: Crocodile (West) and Marico WMA
(now part of new 1. Limpopo WMA)**

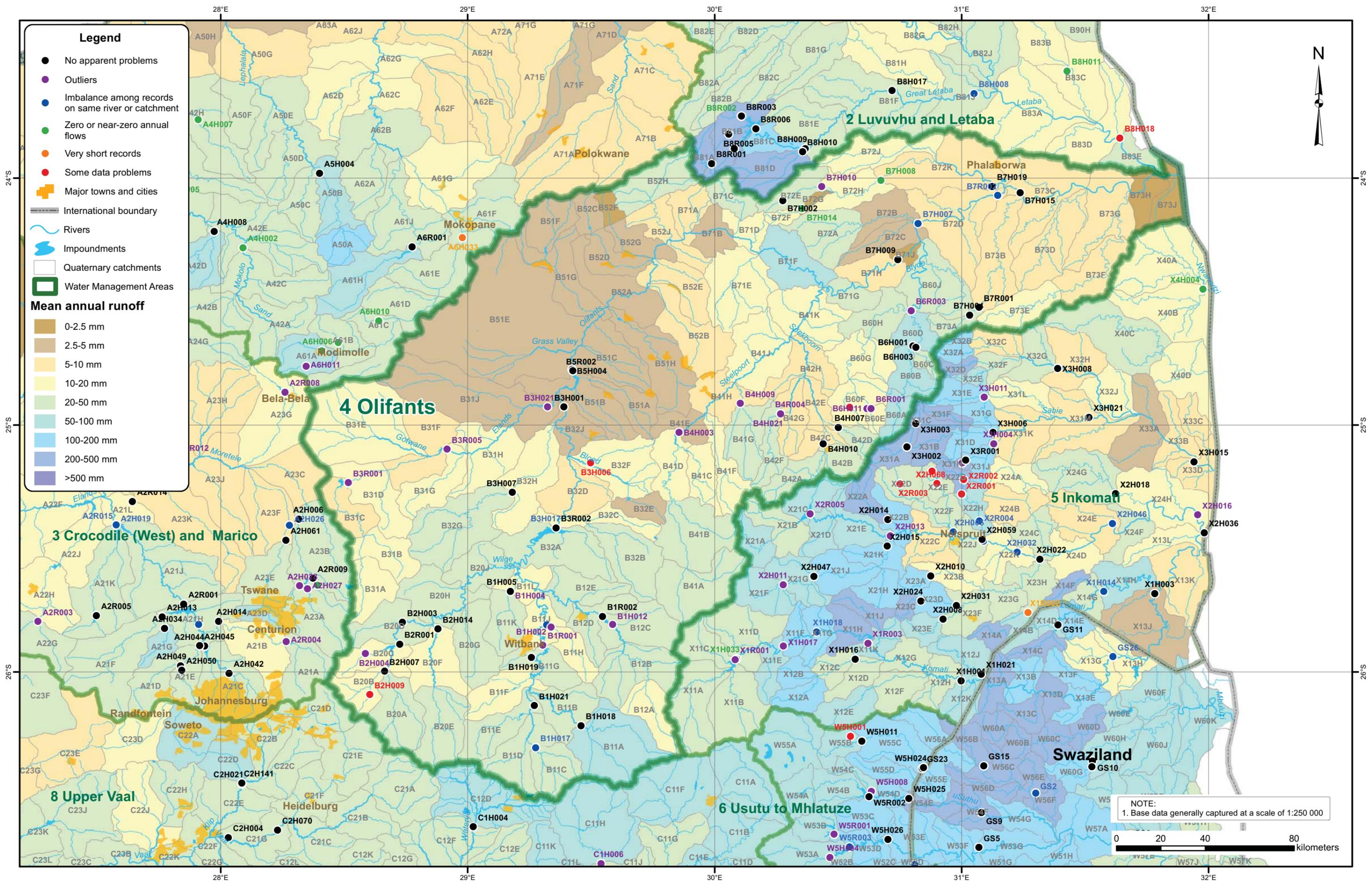
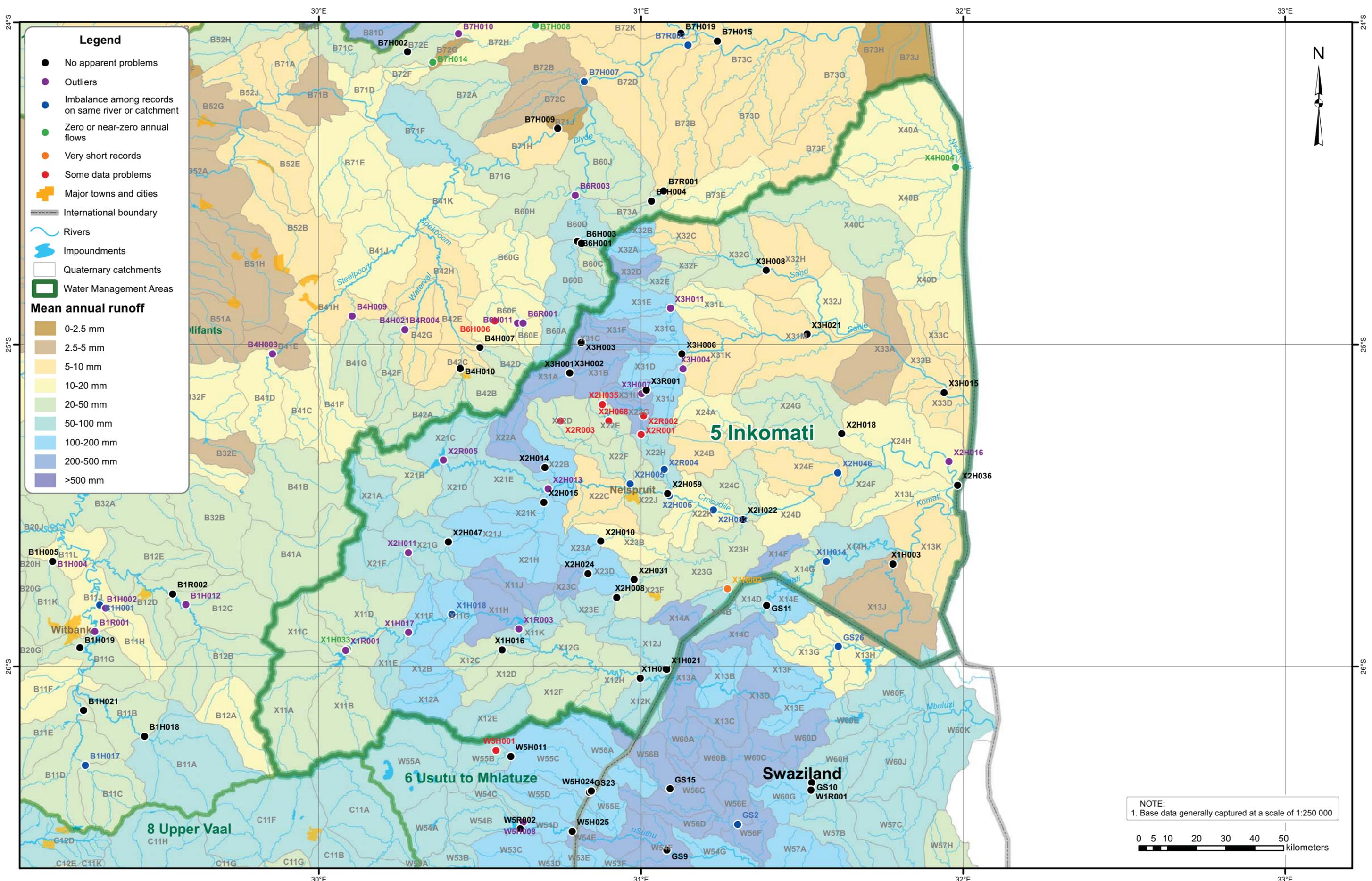


Figure 3.4 : Runoff: Olifants WMA (now part of new 2. Olifants WMA)



**Figure 3.5 : Runoff: Inkomati WMA
(now part of new 3. Inkomati-Usuthu WMA)**

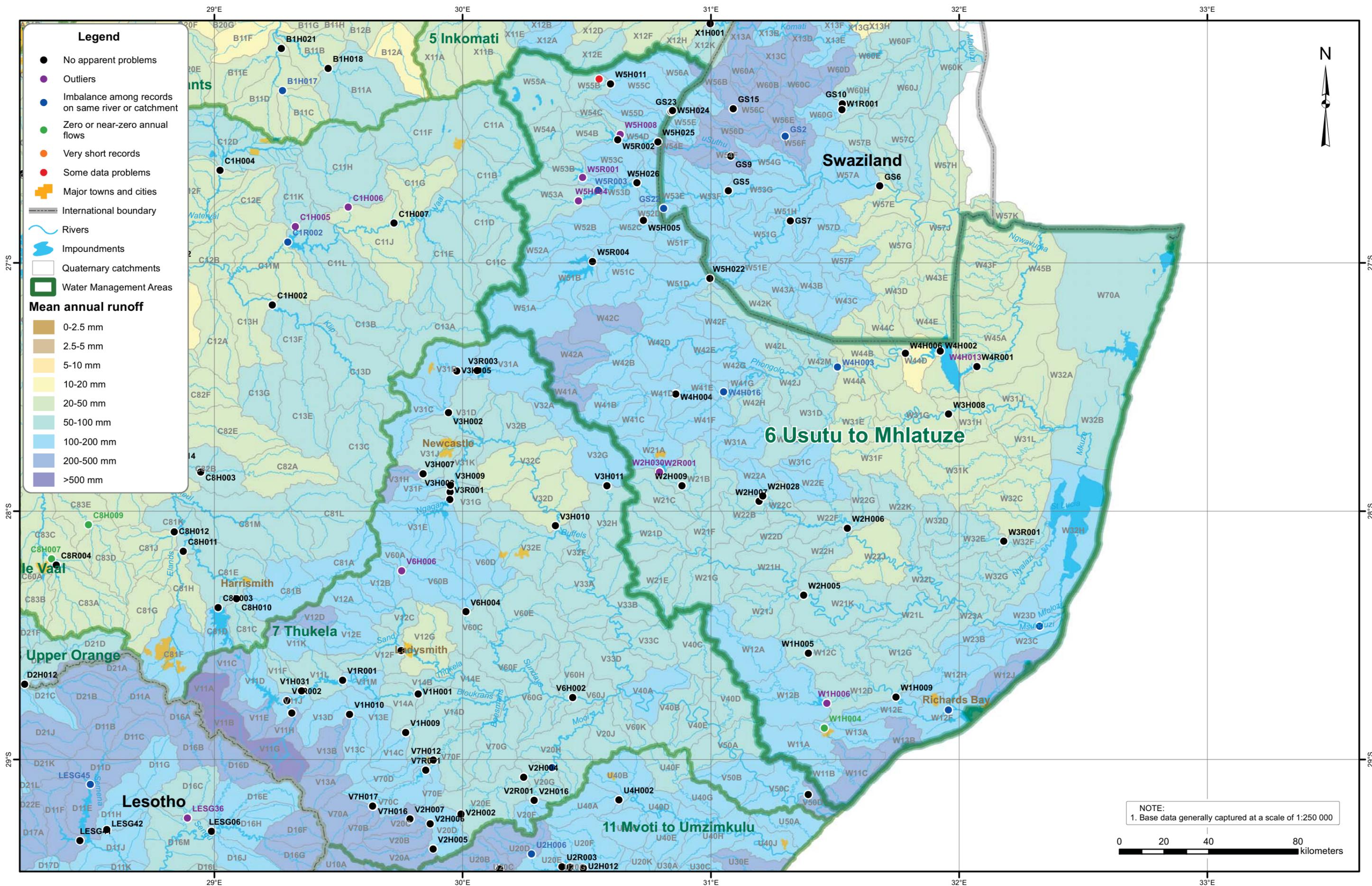
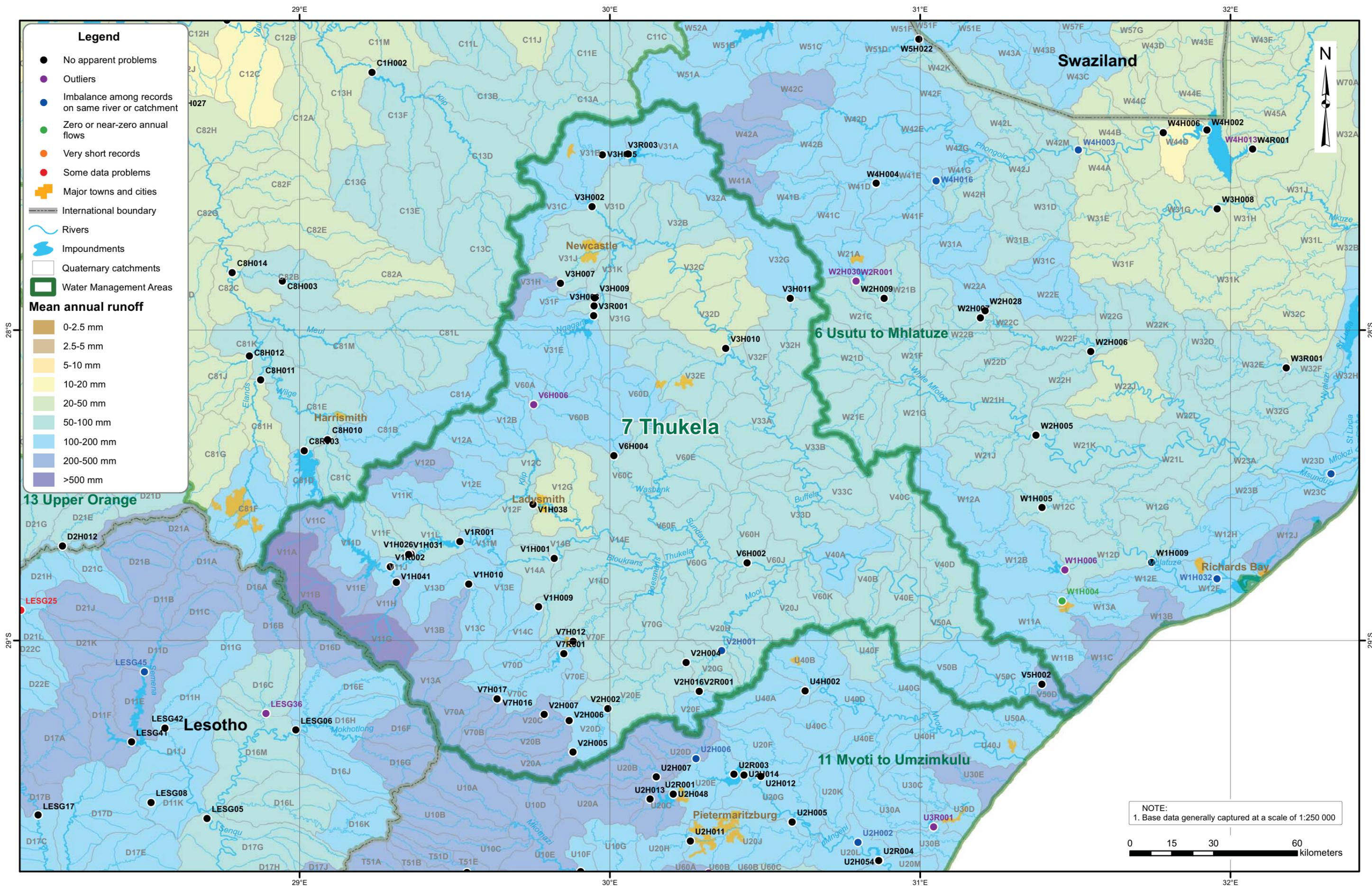
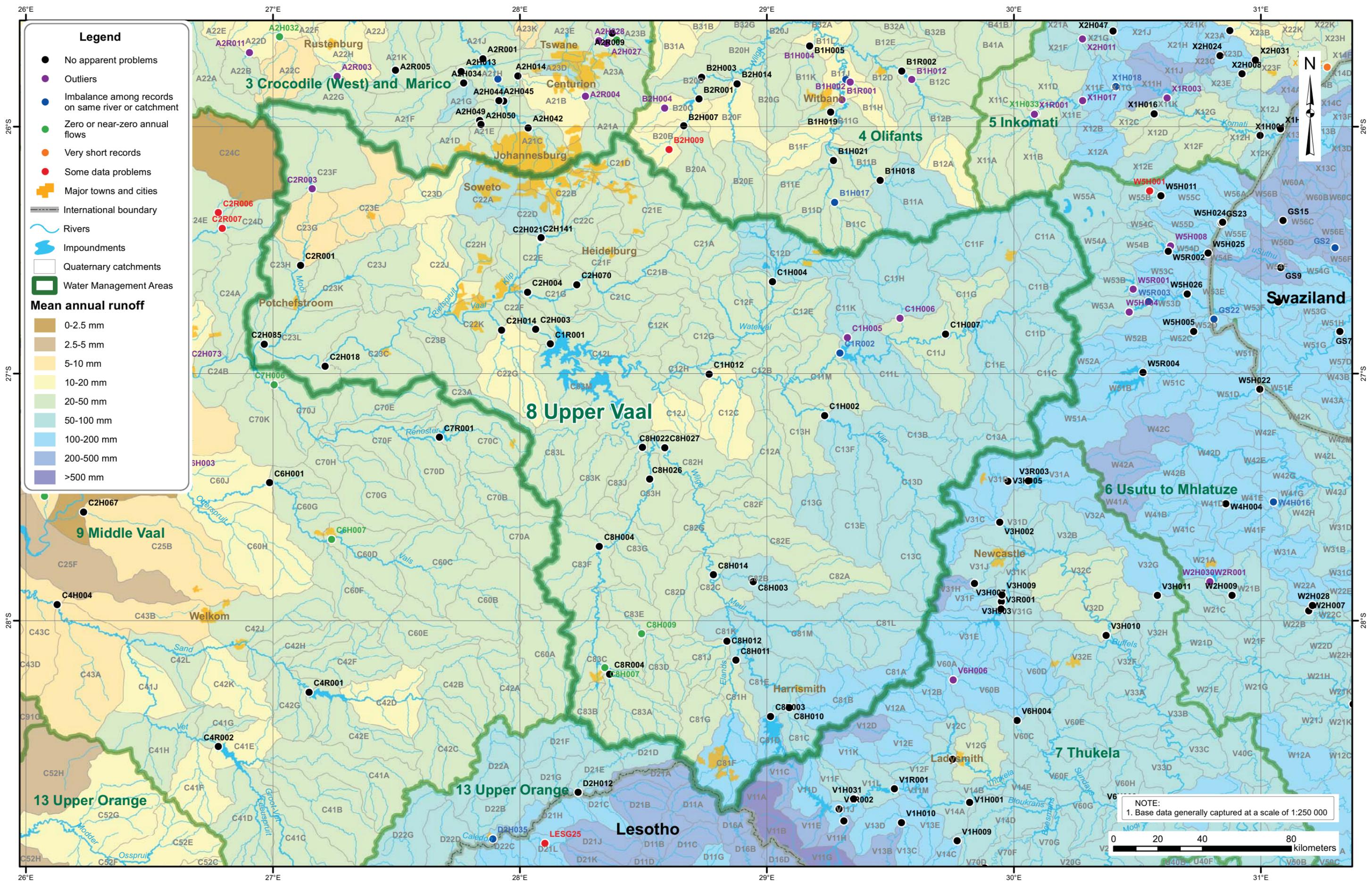


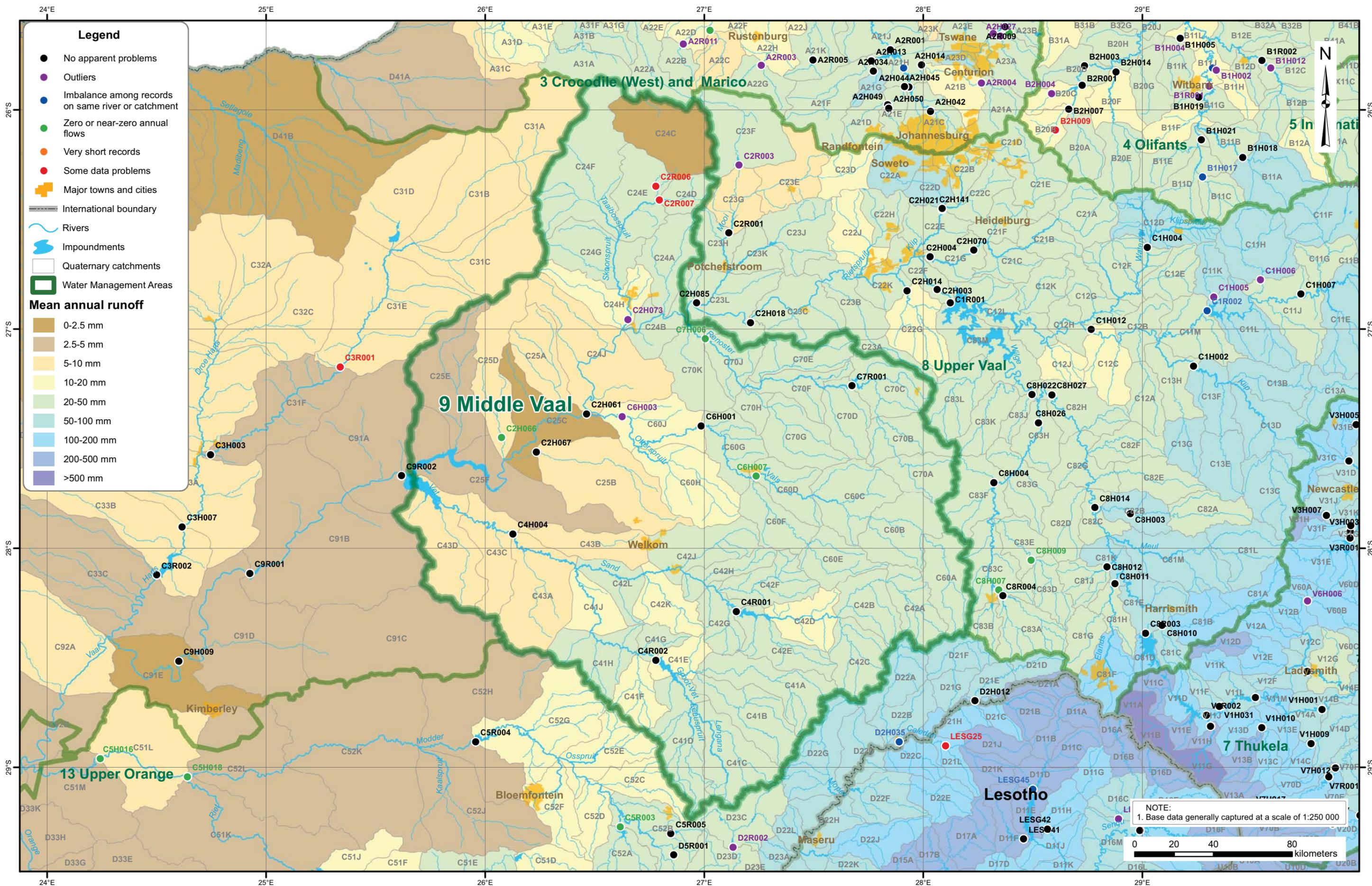
Figure 3.6 : Runoff : Usutu to Mhlatusze WMA (now part of new 3. Inkomati-Usuthu WMA)

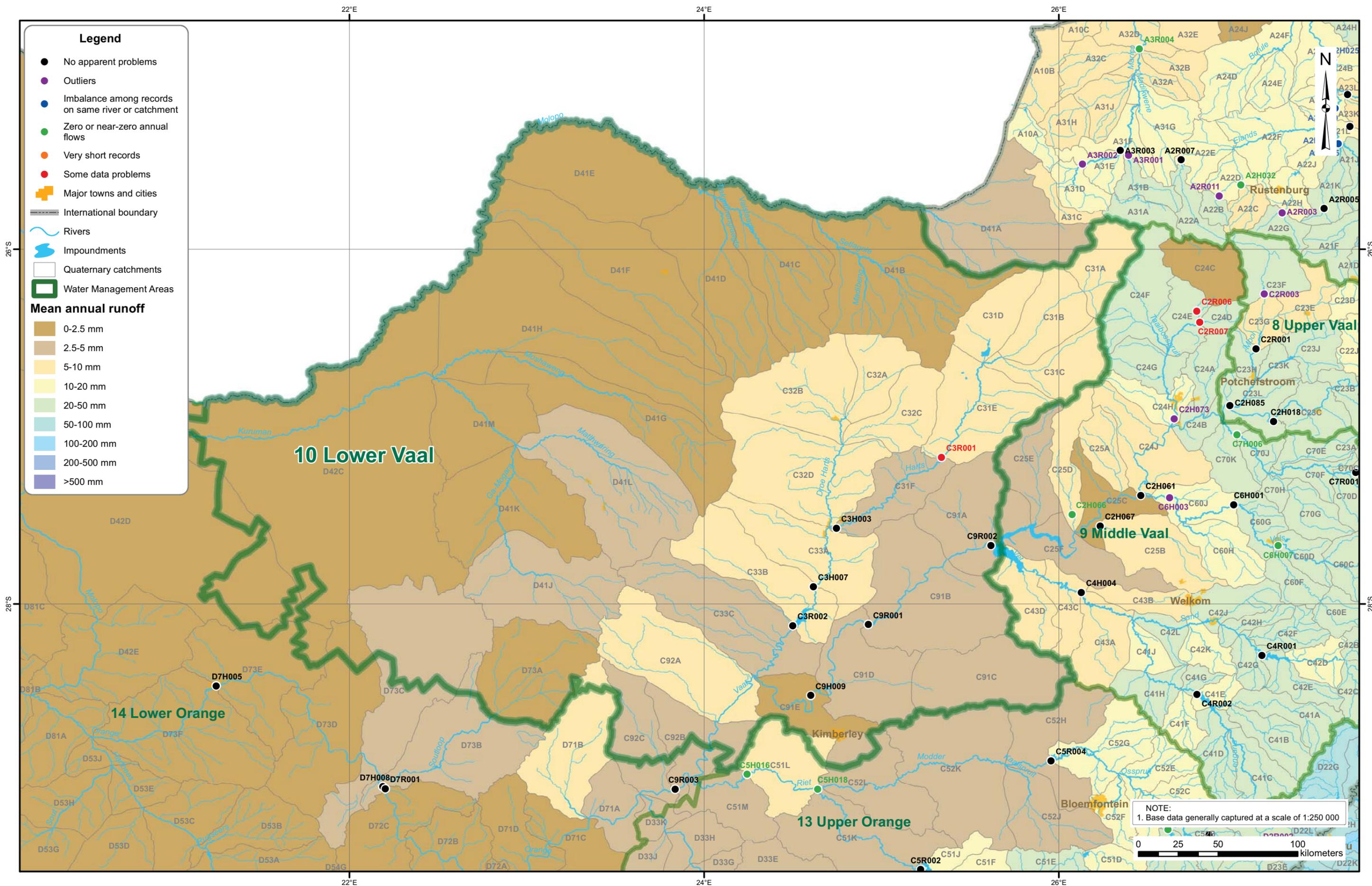


**Figure 3.7 : Runoff : Thukela WMA
(now part of new 4. Pongola-Mzimkulu WMA)**



**Figure 3.8 : Runoff : Upper Vaal WMA
(now part of new 5. Vaal WMA)**





**Figure 3.10 : Runoff : Lower Vaal WMA
(now part of new 5. Vaal WMA)**

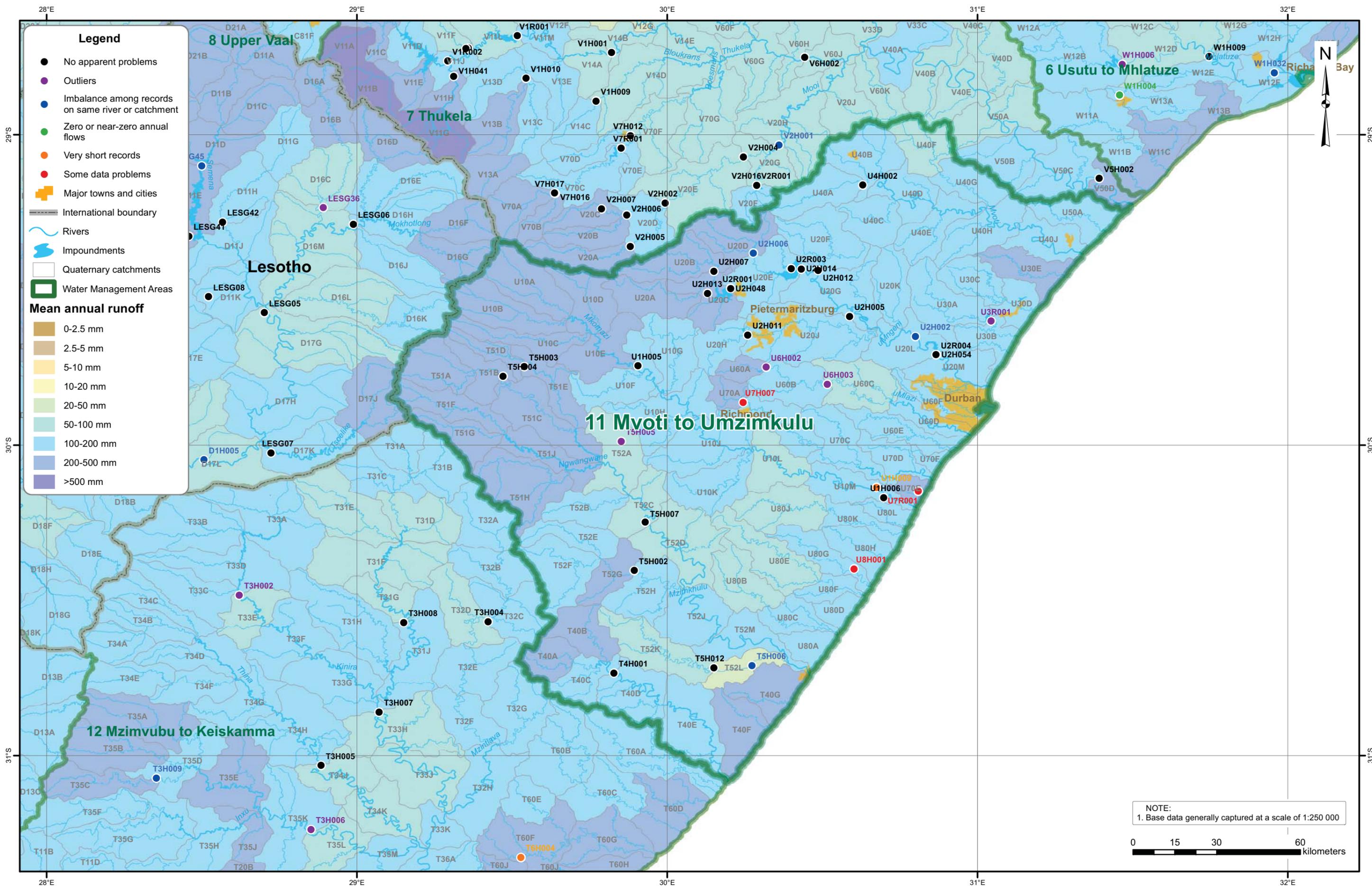
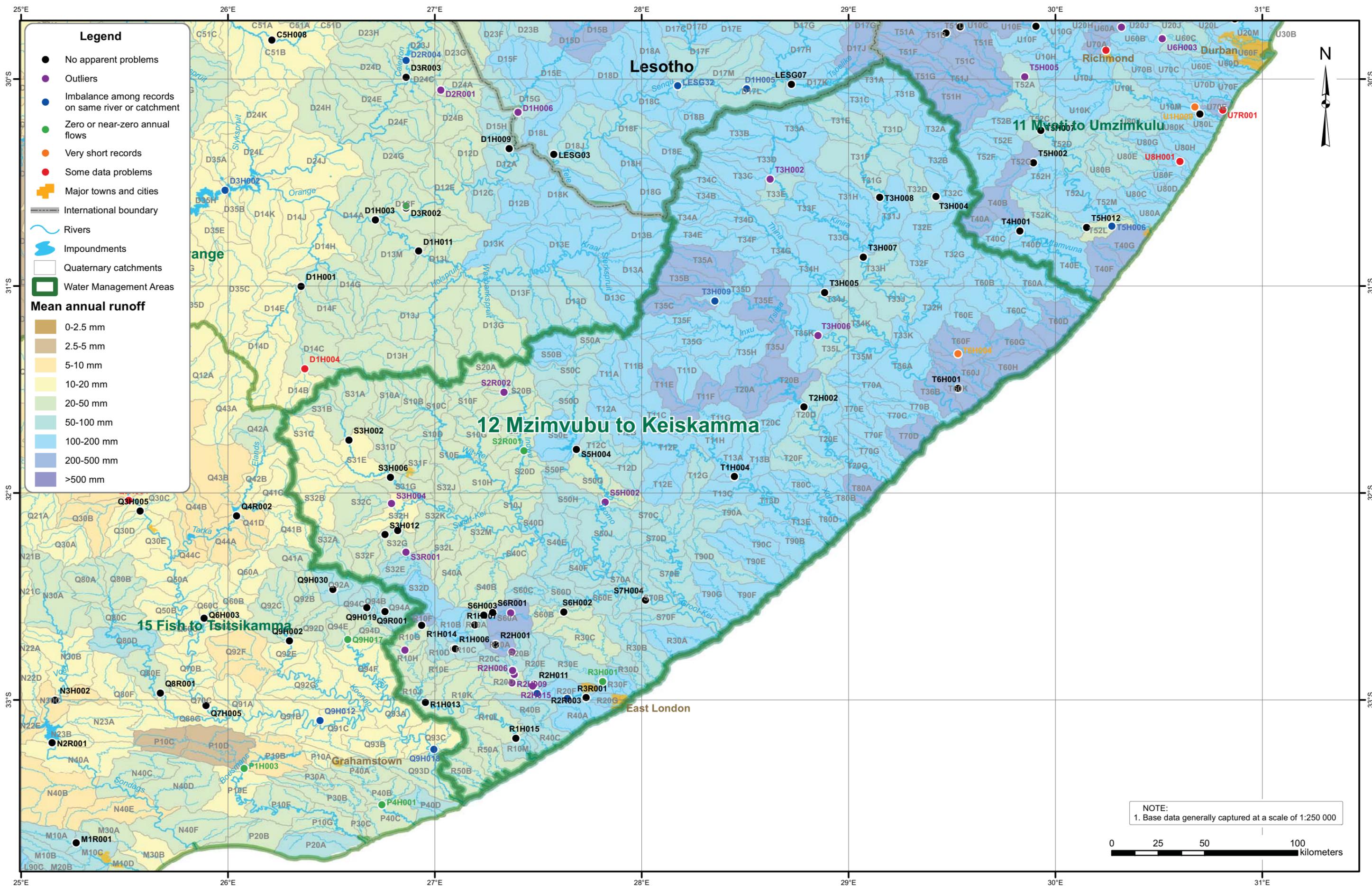
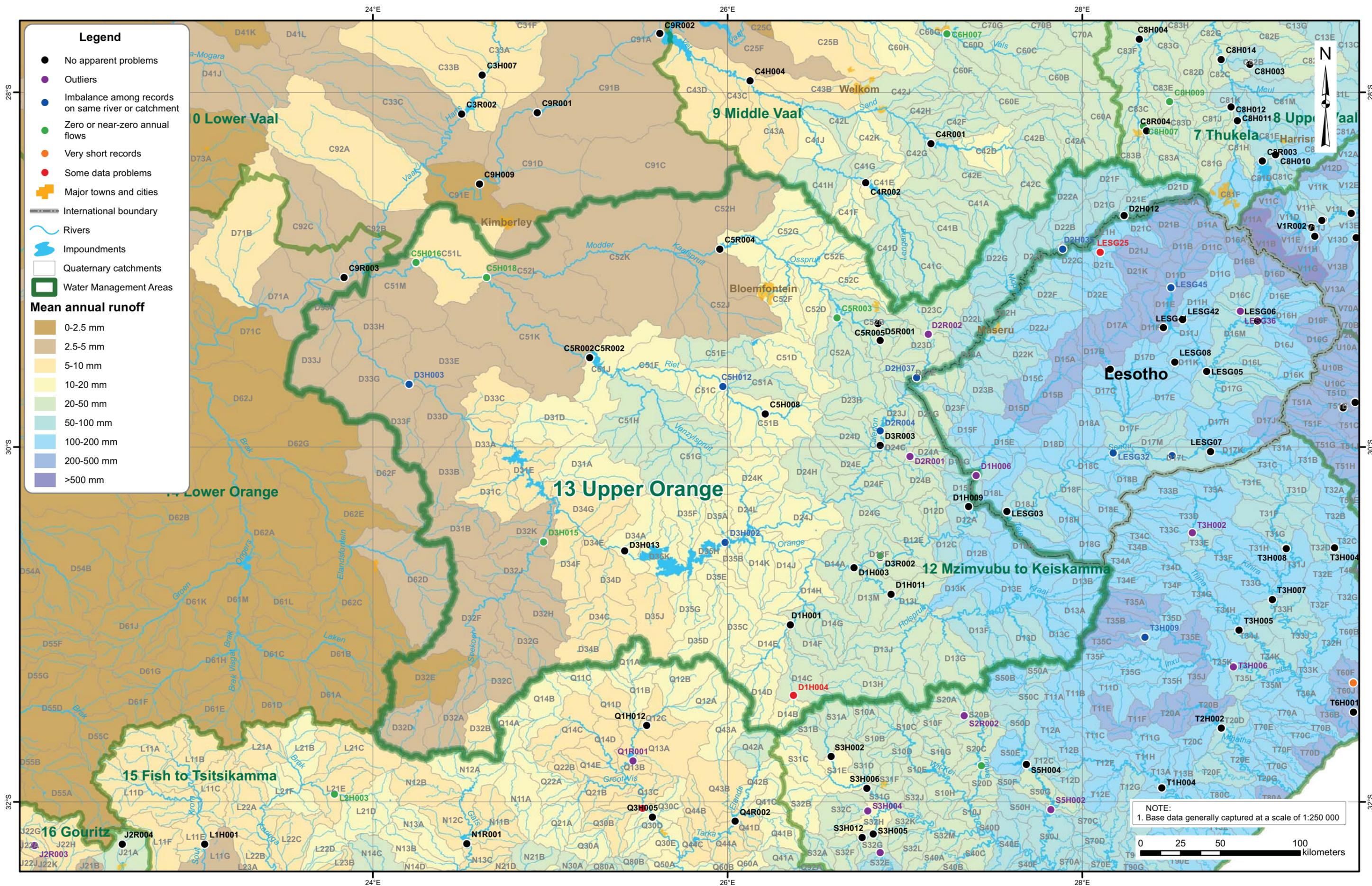


Figure 3.11 : Runoff : Mvoti to Umzimkulu WMA (now part of new 4. Pongola-Mzimkulu WMA)



**Figure 3.12 : Runoff : Mzimvubu to Keiskamma WMA
(now part of new 7. Mzimkulu-Tsitsikamma WMA)**



Legend

- No apparent problems
- Outliers
- Imbalance among records on same river or catchment
- Zero or near-zero annual flows
- Very short records
- Some data problems
- Major towns and cities
- International boundary
- Rivers
- Impoundments
- Quaternary catchments
- Water Management Areas

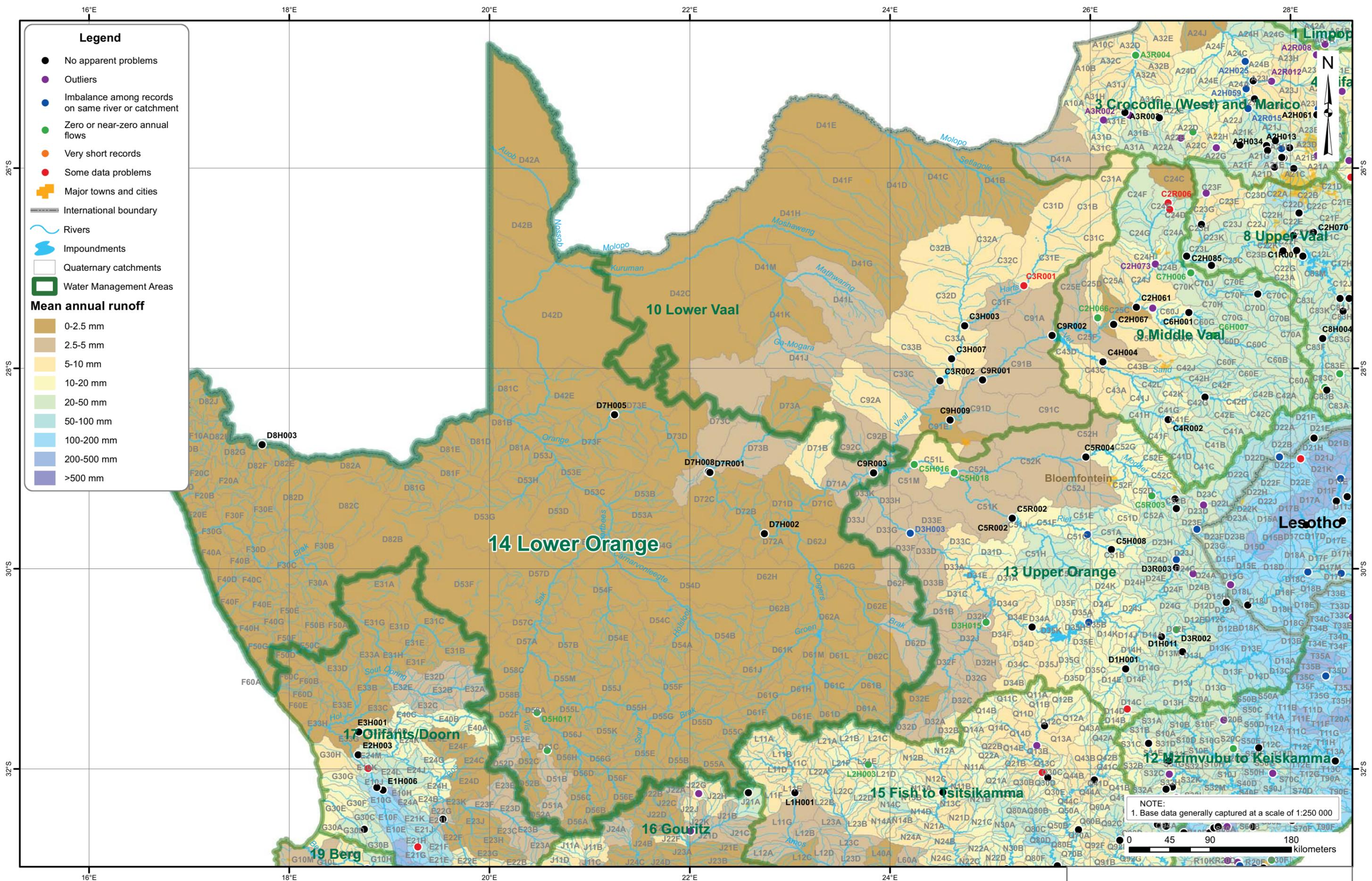
Mean annual runoff

- 0-2.5 mm
- 2.5-5 mm
- 5-10 mm
- 10-20 mm
- 20-50 mm
- 50-100 mm
- 100-200 mm
- 200-500 mm
- >500 mm

NOTE:
1. Base data generally captured at a scale of 1:250 000

0 25 50 100 kilometers

Figure 3.13 : Runoff : Upper Orange WMA (now part of new 6. Orange WMA)



**Figure 3.14 : Runoff : Lower Orange : WMA
(now part of new 6. Orange WMA)**

NOTE:
1. Base data generally captured at a scale of 1:250 000

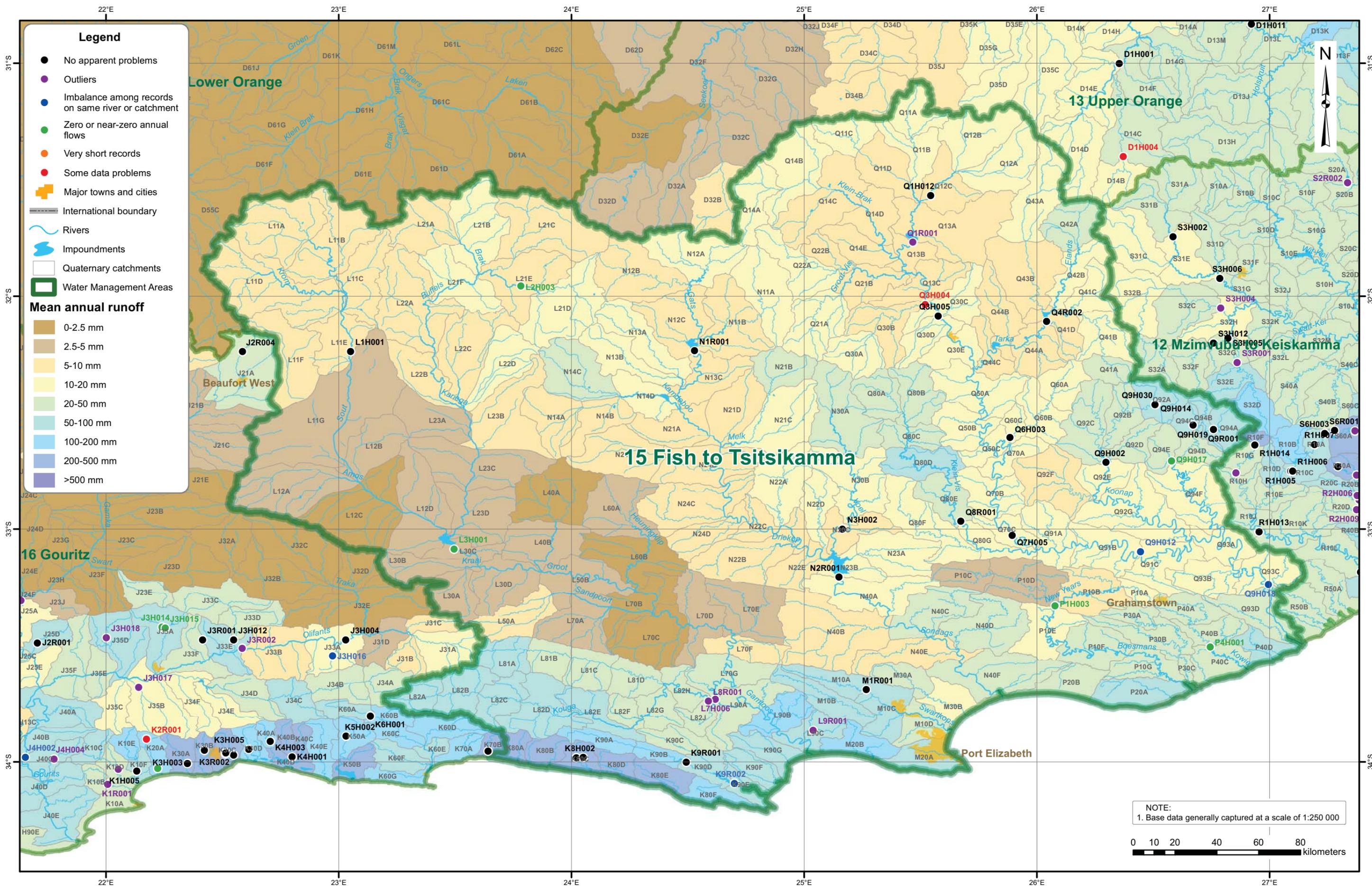


Figure 3.15 : Runoff : Fish to Tsitsikamma : WMA (now part of new 7. Mzimkulu-Tsitsikamma WMA)

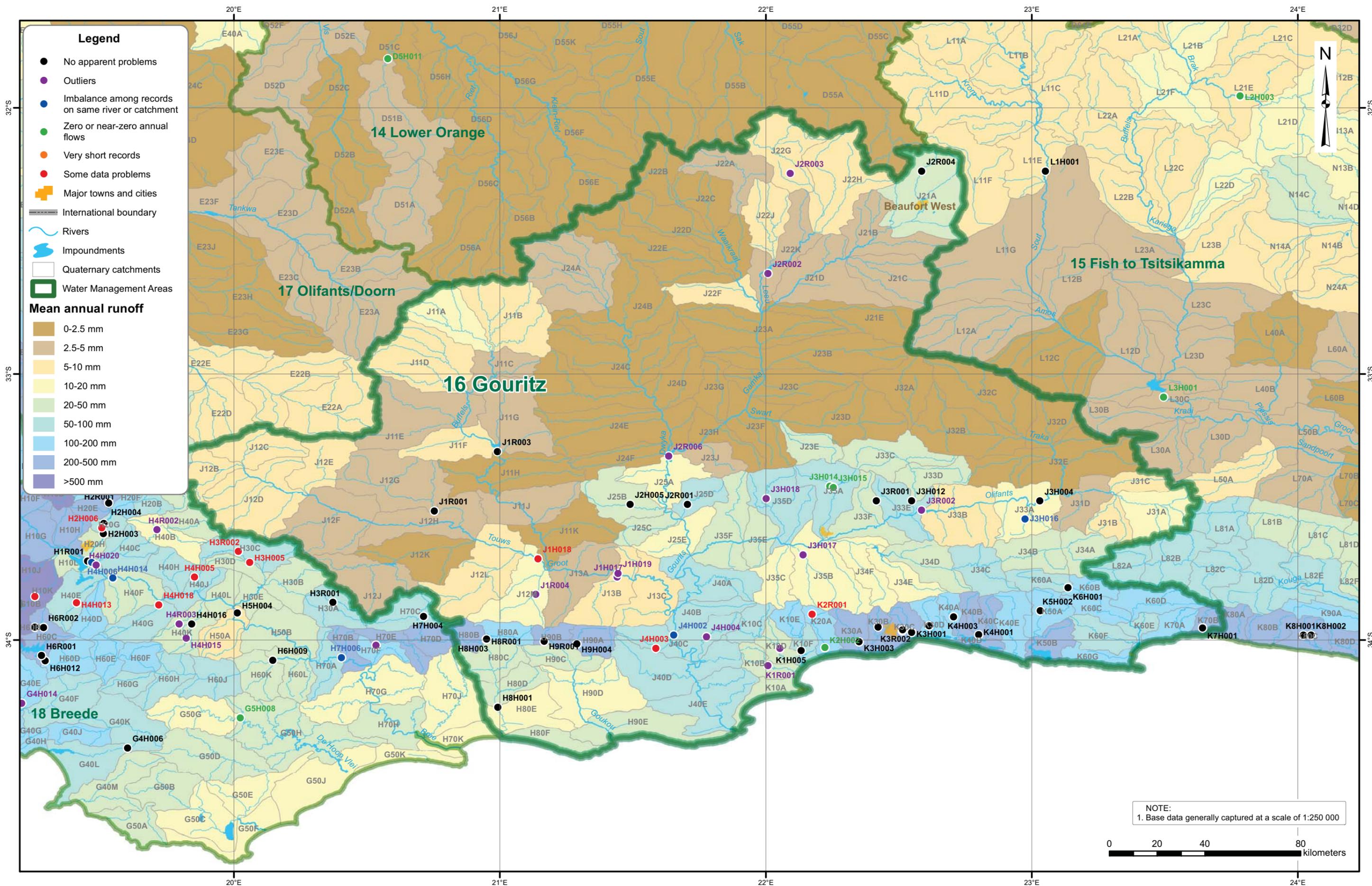
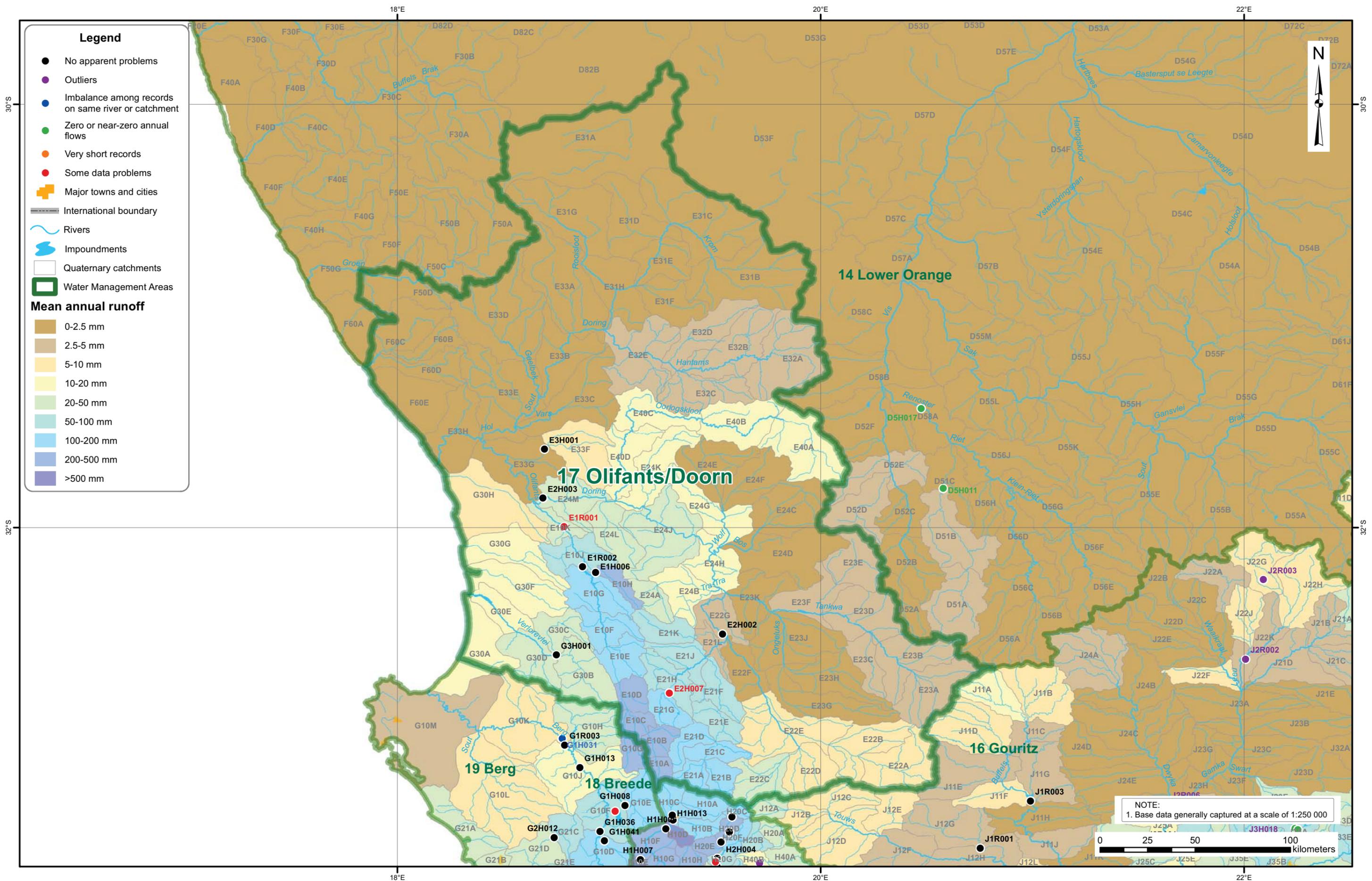


Figure 3.16 : Runoff : Gouritz : WMA
 (now part of new 8. Breede-Gouritz WMA)



Legend

- No apparent problems
- Outliers
- Imbalance among records on same river or catchment
- Zero or near-zero annual flows
- Very short records
- Some data problems
- Major towns and cities
- International boundary
- ~ Rivers
- ~ Impoundments
- Quaternary catchments
- ▭ Water Management Areas

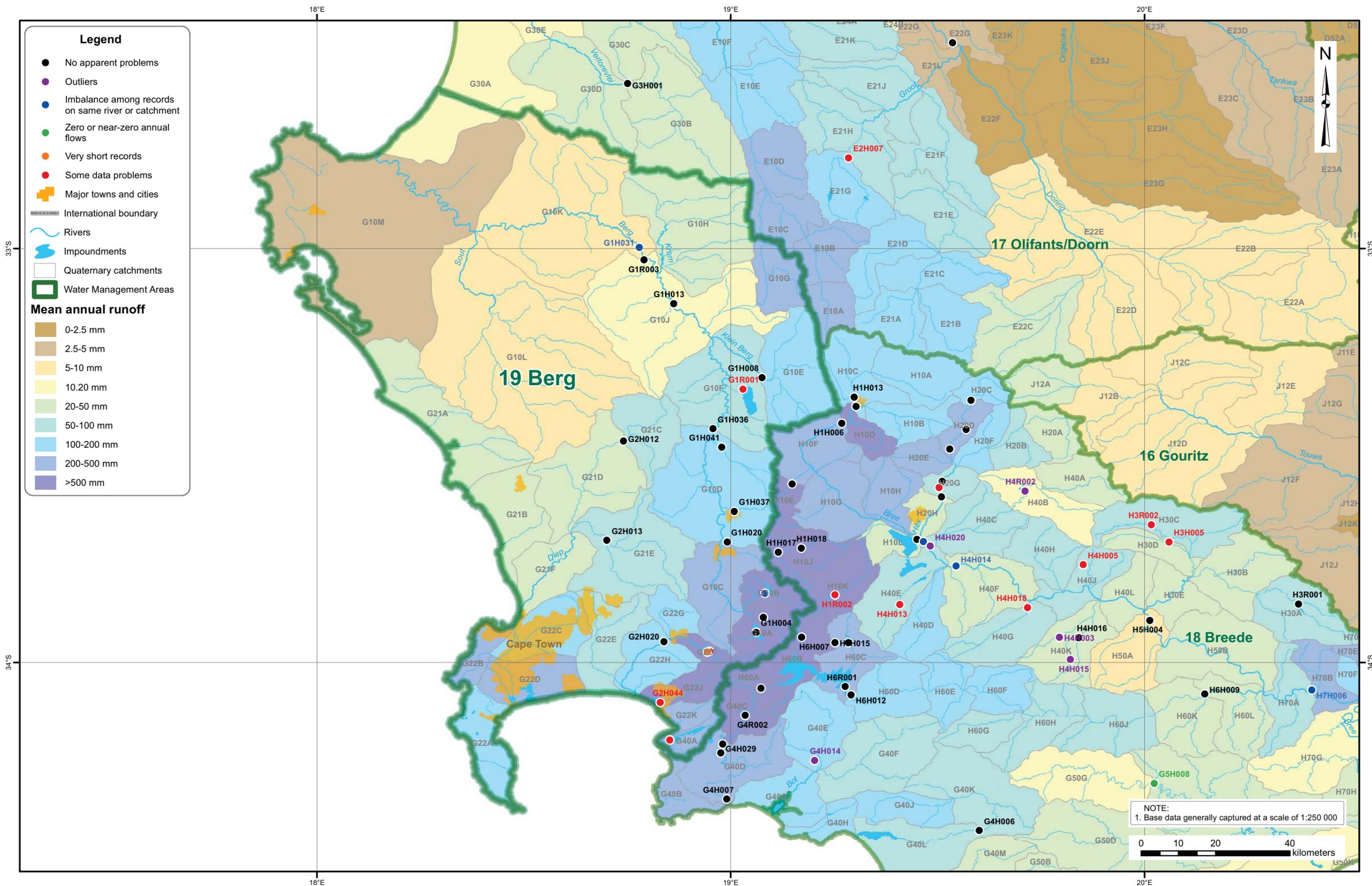
Mean annual runoff

- 0-2.5 mm
- 2.5-5 mm
- 5-10 mm
- 10-20 mm
- 20-50 mm
- 50-100 mm
- 100-200 mm
- 200-500 mm
- >500 mm

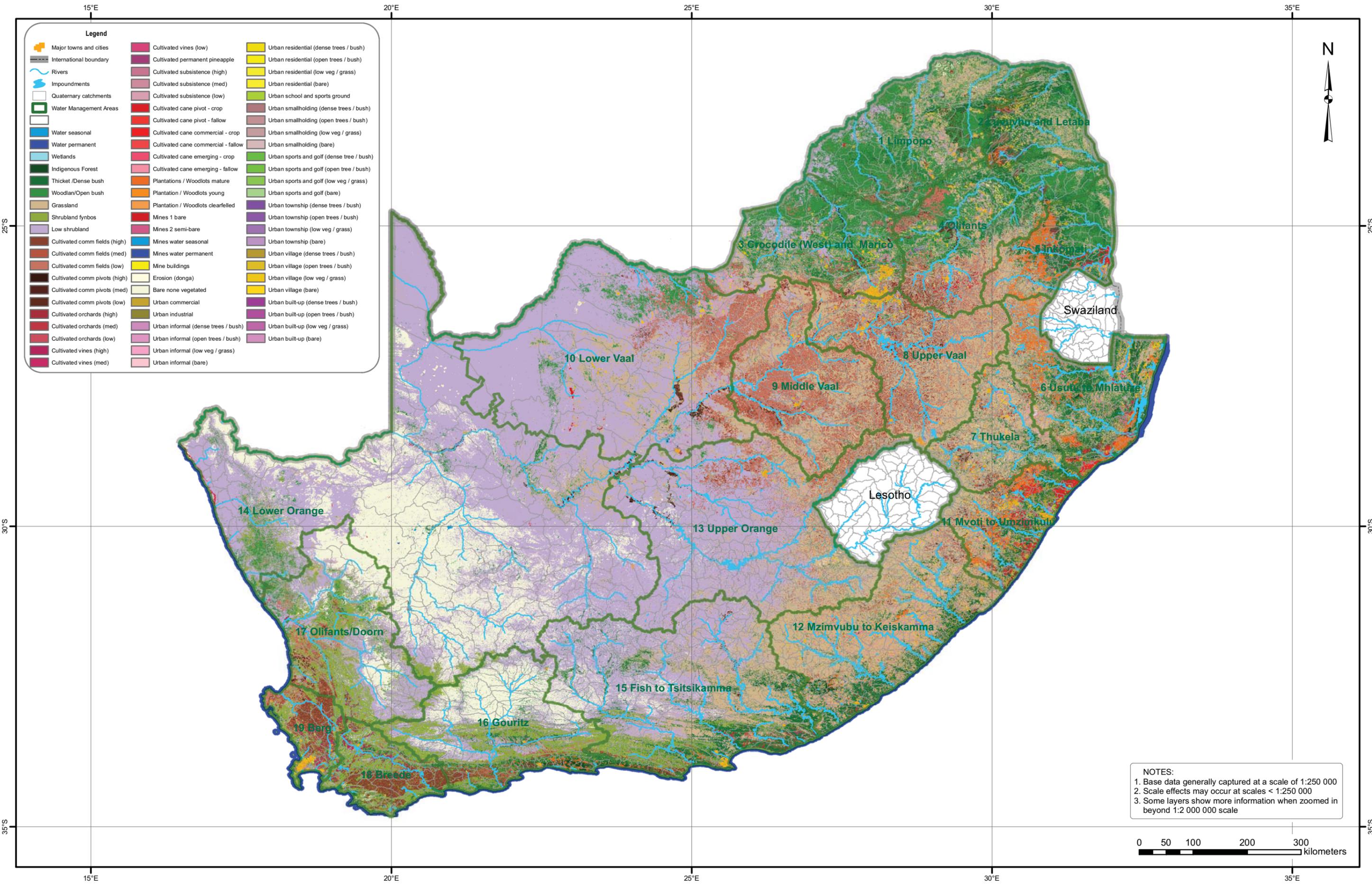
NOTE:
1. Base data generally captured at a scale of 1:250 000

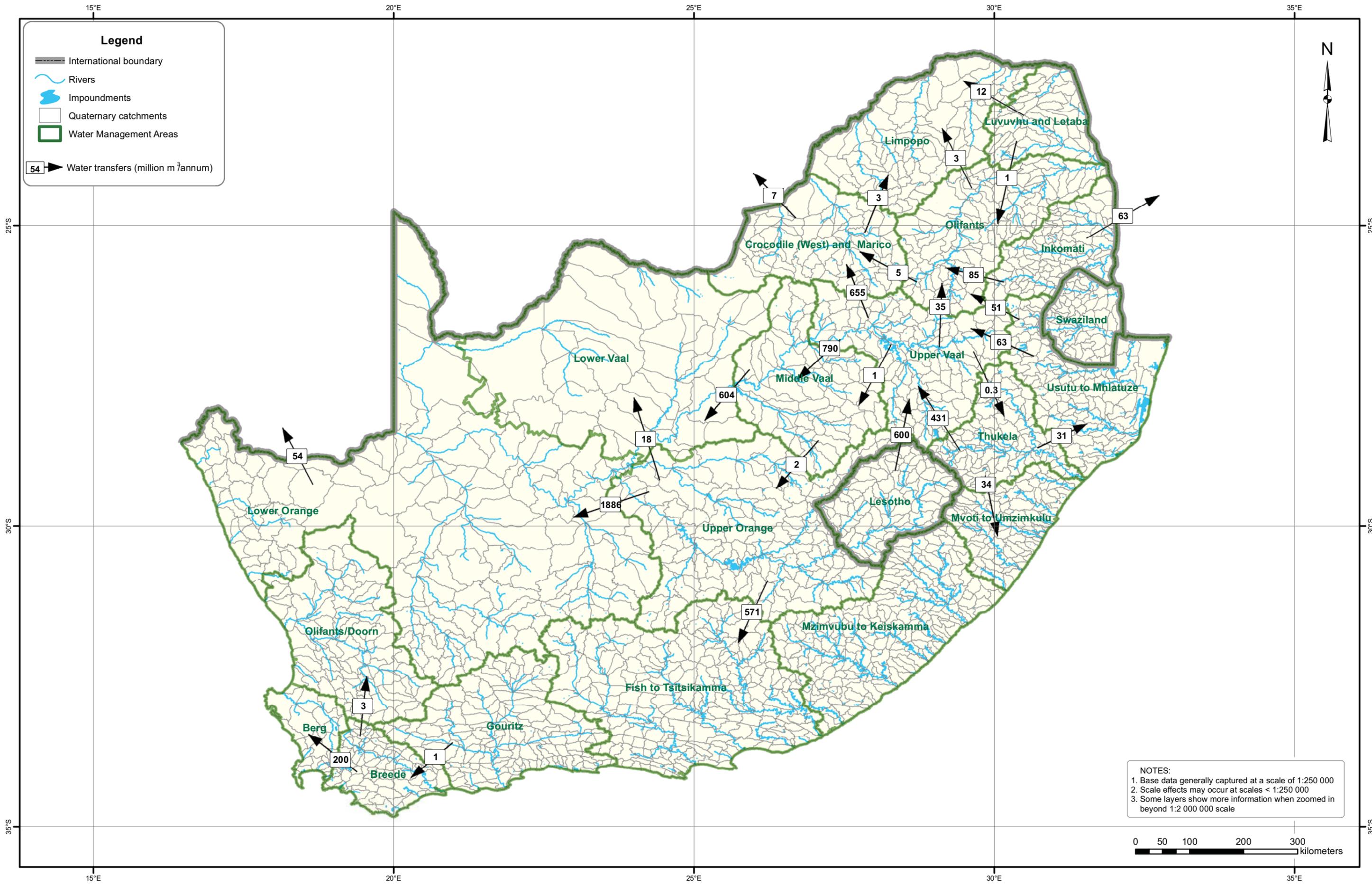
0 25 50 100 kilometers

**Figure 3.17 : Runoff : Olifants/Doorn : WMA
(now part of new 9. Berg-Olifants WMA)**

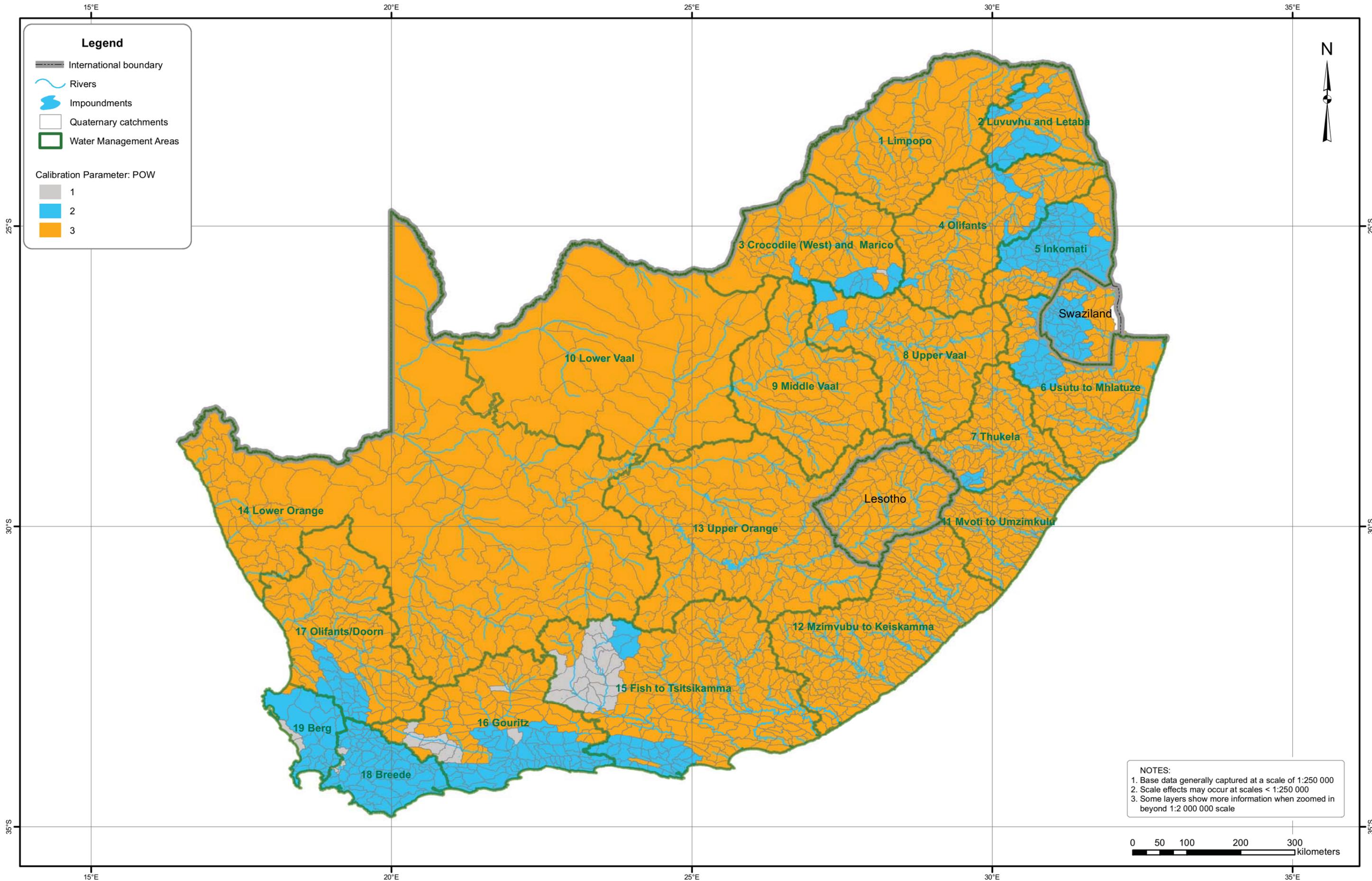


**Figure 3.19 : Runoff : Berg WMA
(now part of new 9. Berg-Olifants WMA)**





NOTES:
 1. Base data generally captured at a scale of 1:250 000
 2. Scale effects may occur at scales < 1:250 000
 3. Some layers show more information when zoomed in beyond 1:2 000 000 scale



Legend

- International boundary
- Rivers
- Impoundments
- Quaternary catchments
- Water Management Areas

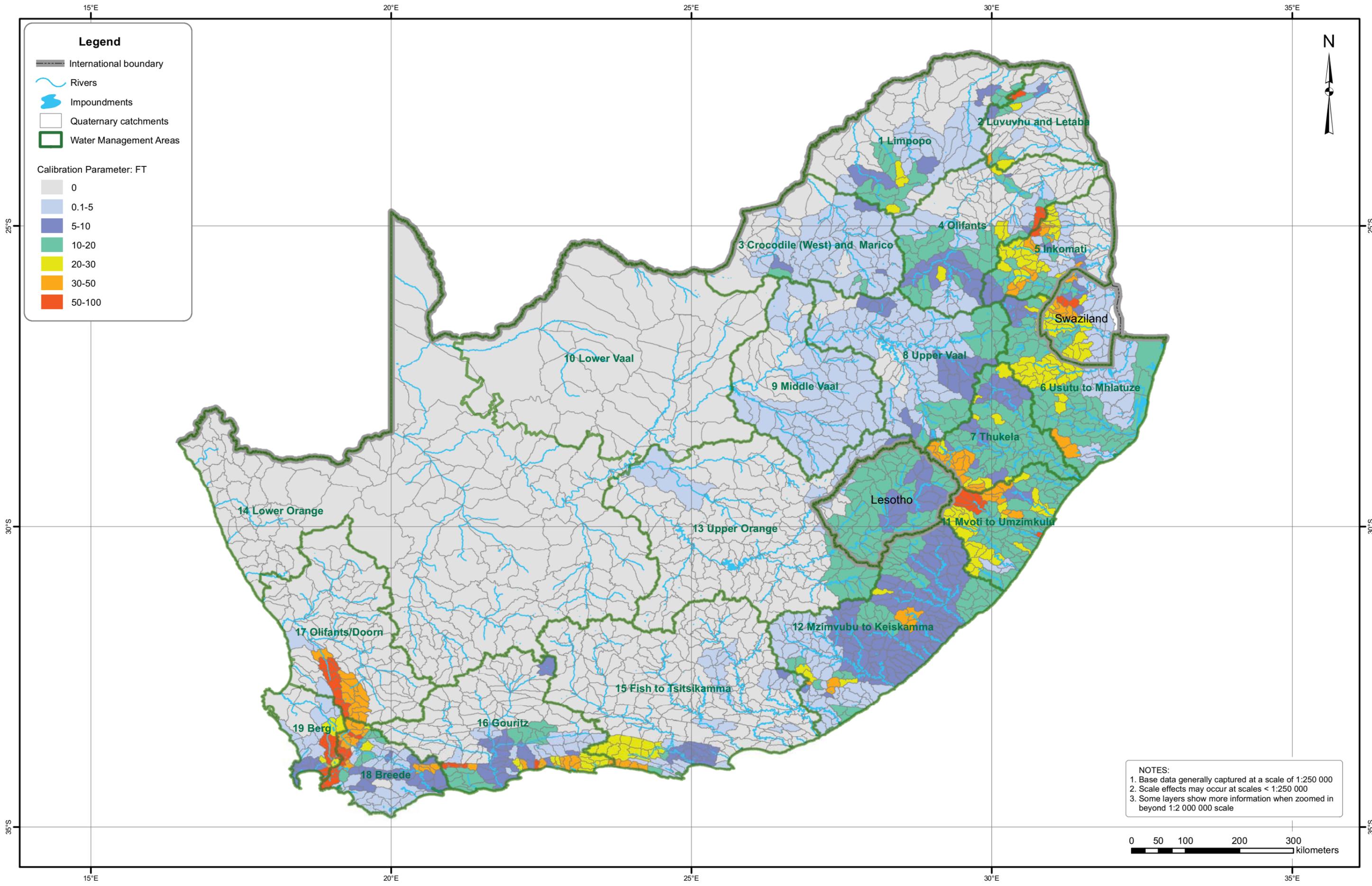
Calibration Parameter: POW

- 1
- 2
- 3

NOTES:

1. Base data generally captured at a scale of 1:250 000
2. Scale effects may occur at scales < 1:250 000
3. Some layers show more information when zoomed in beyond 1:2 000 000 scale





Legend

- International boundary
- Rivers
- Impoundments
- Quaternary catchments
- Water Management Areas

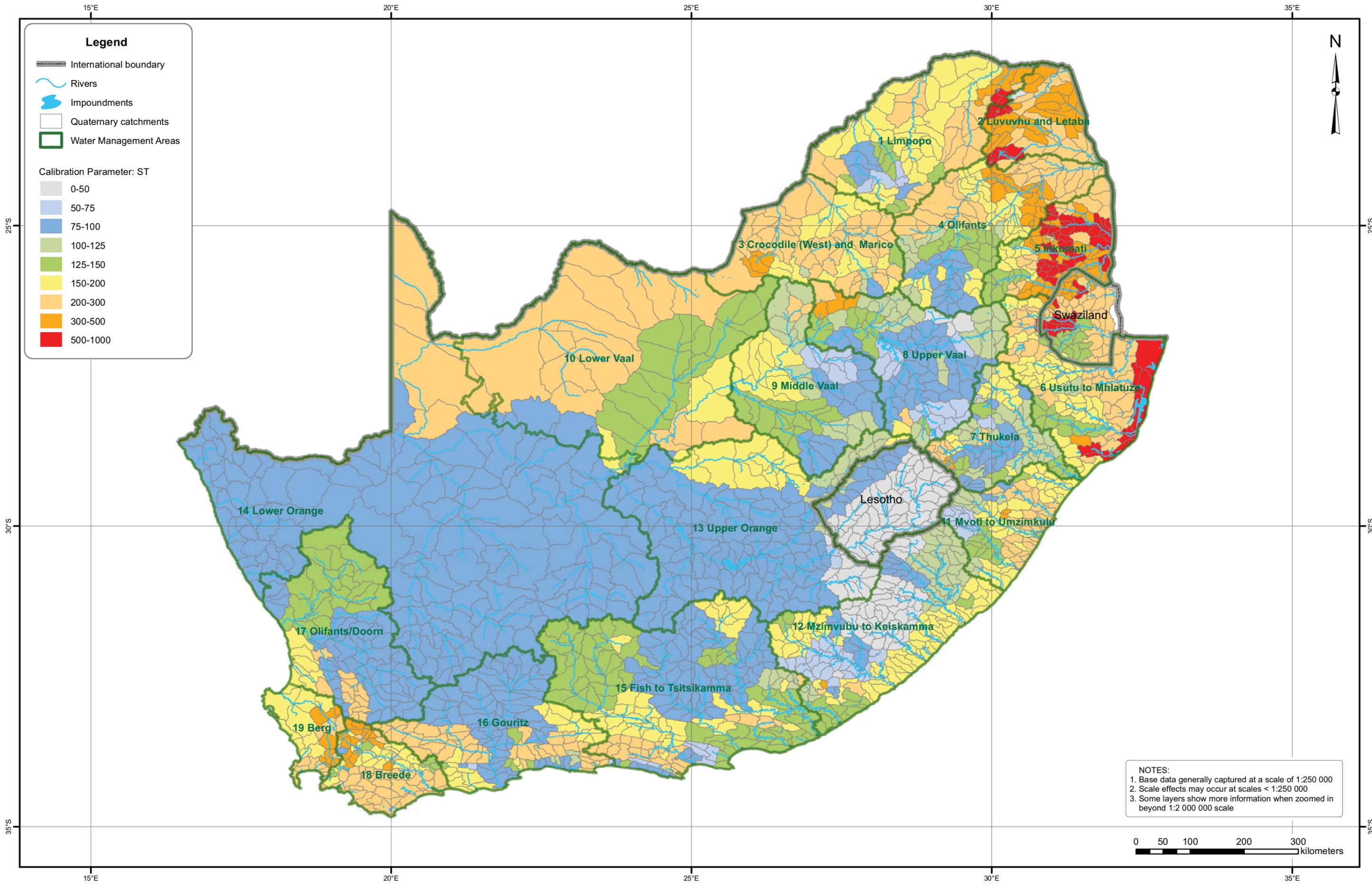
Calibration Parameter: FT

- 0
- 0.1-5
- 5-10
- 10-20
- 20-30
- 30-50
- 50-100

NOTES:

1. Base data generally captured at a scale of 1:250 000
2. Scale effects may occur at scales < 1:250 000
3. Some layers show more information when zoomed in beyond 1:2 000 000 scale





Legend

- International boundary
- Rivers
- Impoundments
- Quaternary catchments
- Water Management Areas

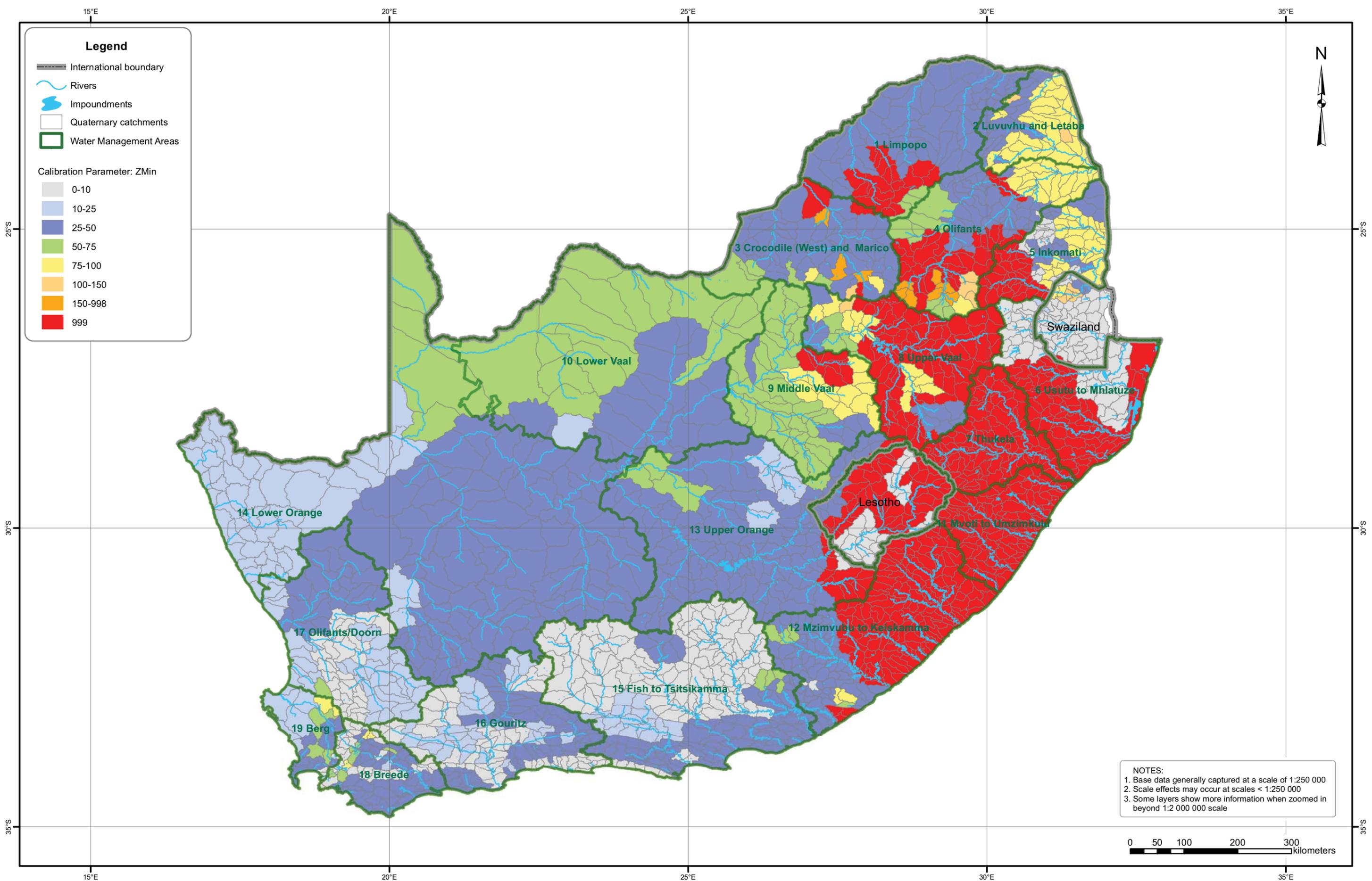
Calibration Parameter: ST

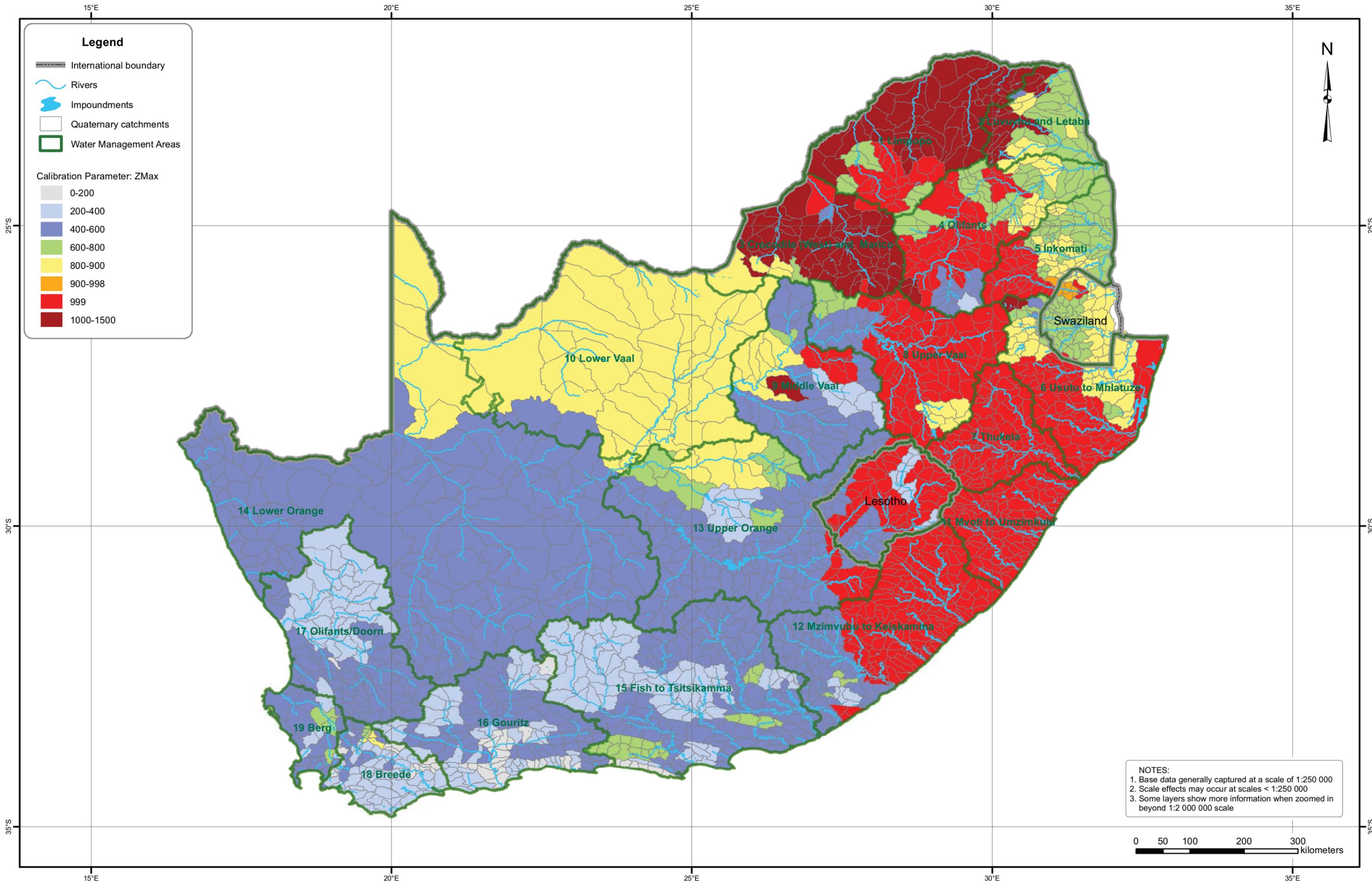
- 0-50
- 50-75
- 75-100
- 100-125
- 125-150
- 150-200
- 200-300
- 300-500
- 500-1000

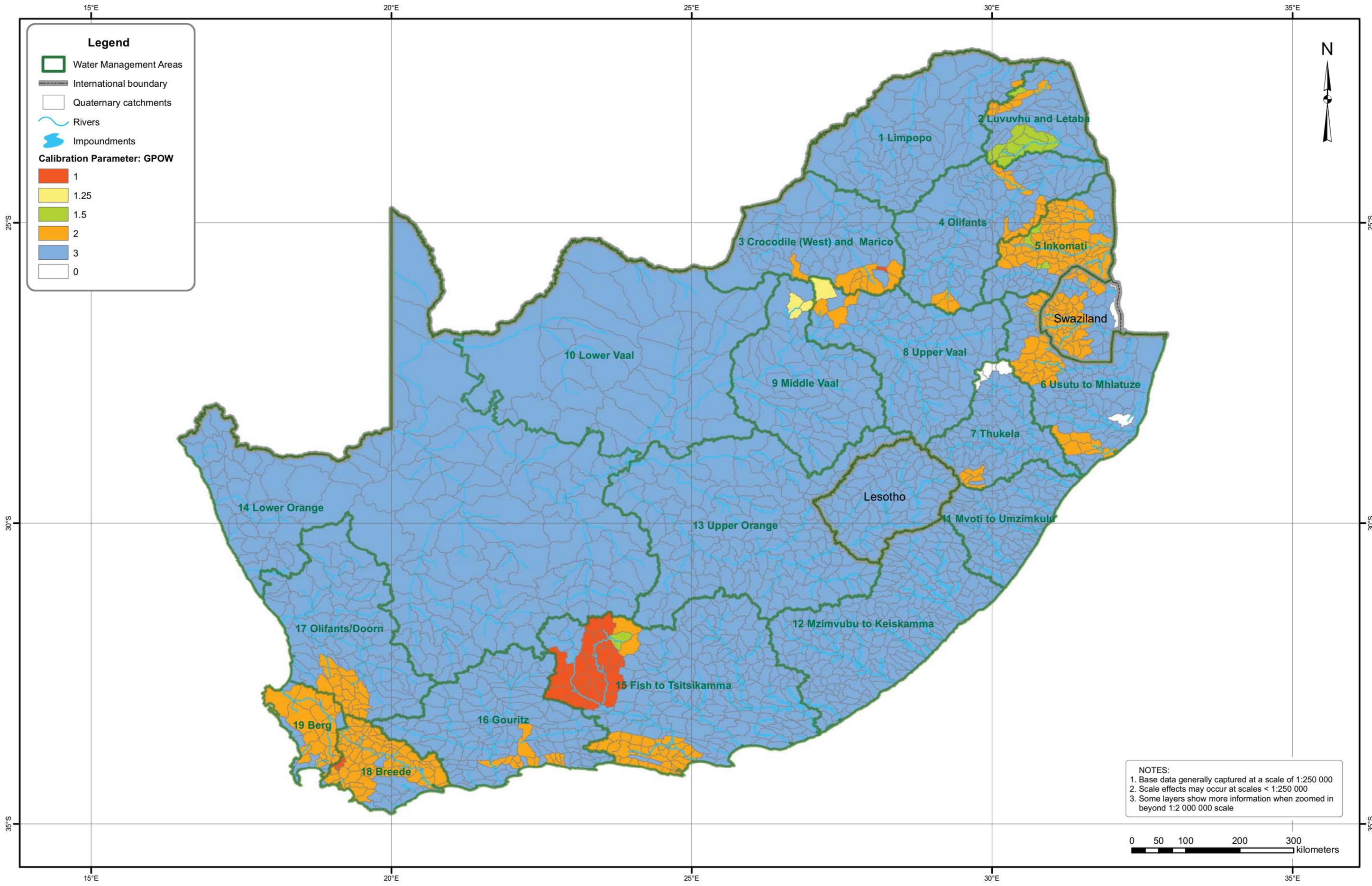
NOTES:

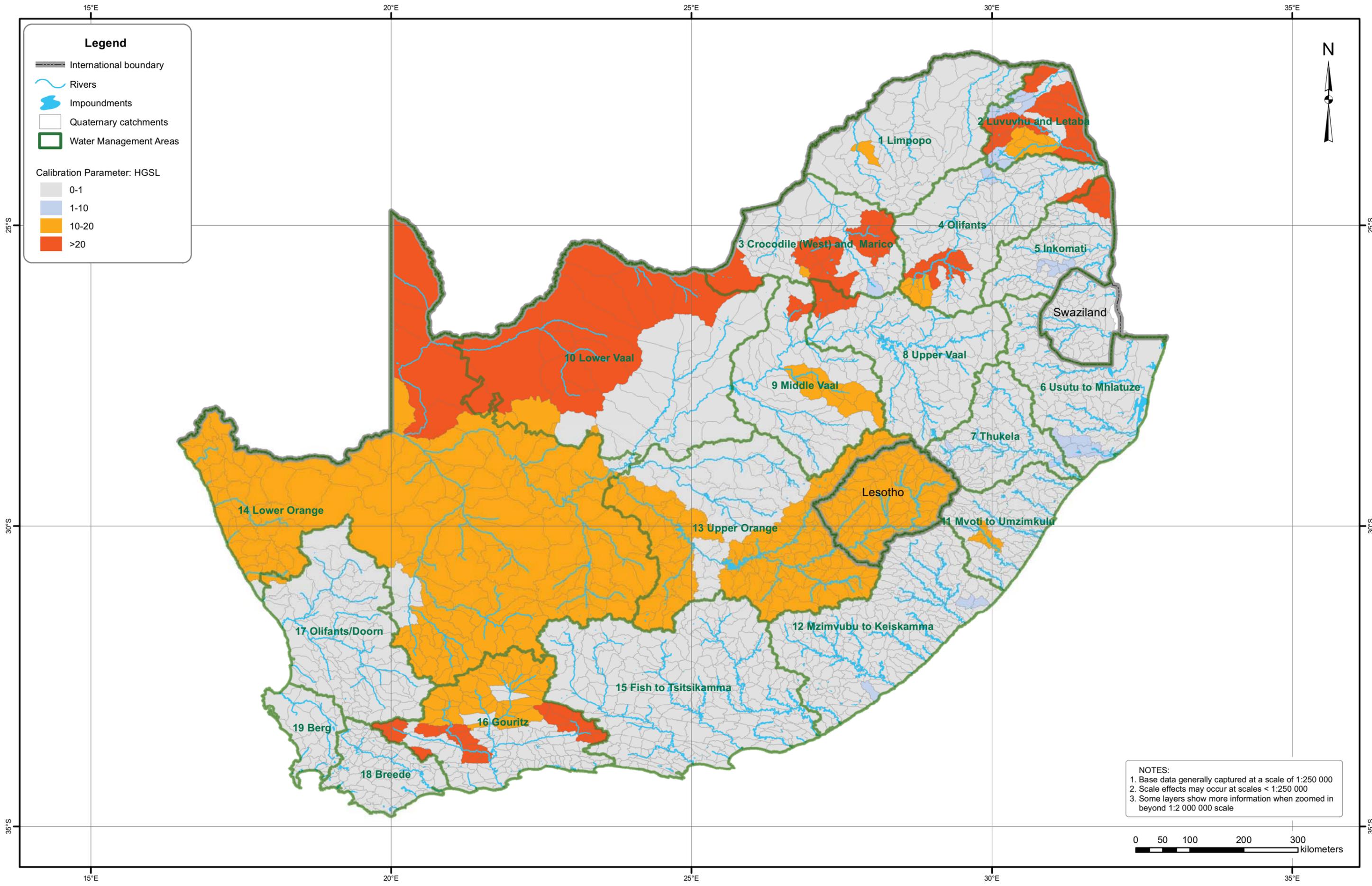
1. Base data generally captured at a scale of 1:250 000
2. Scale effects may occur at scales < 1:250 000
3. Some layers show more information when zoomed in beyond 1:2 000 000 scale

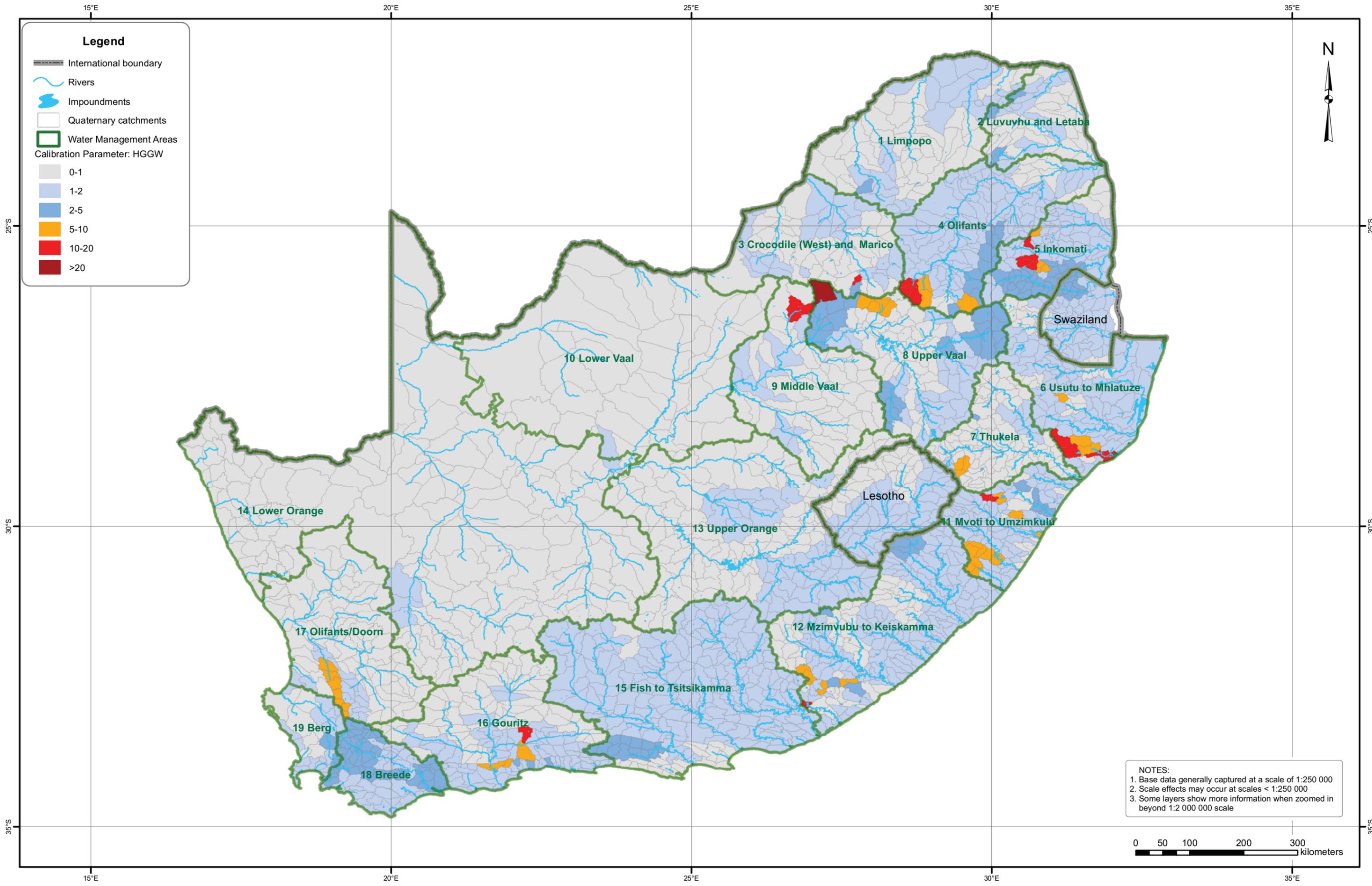






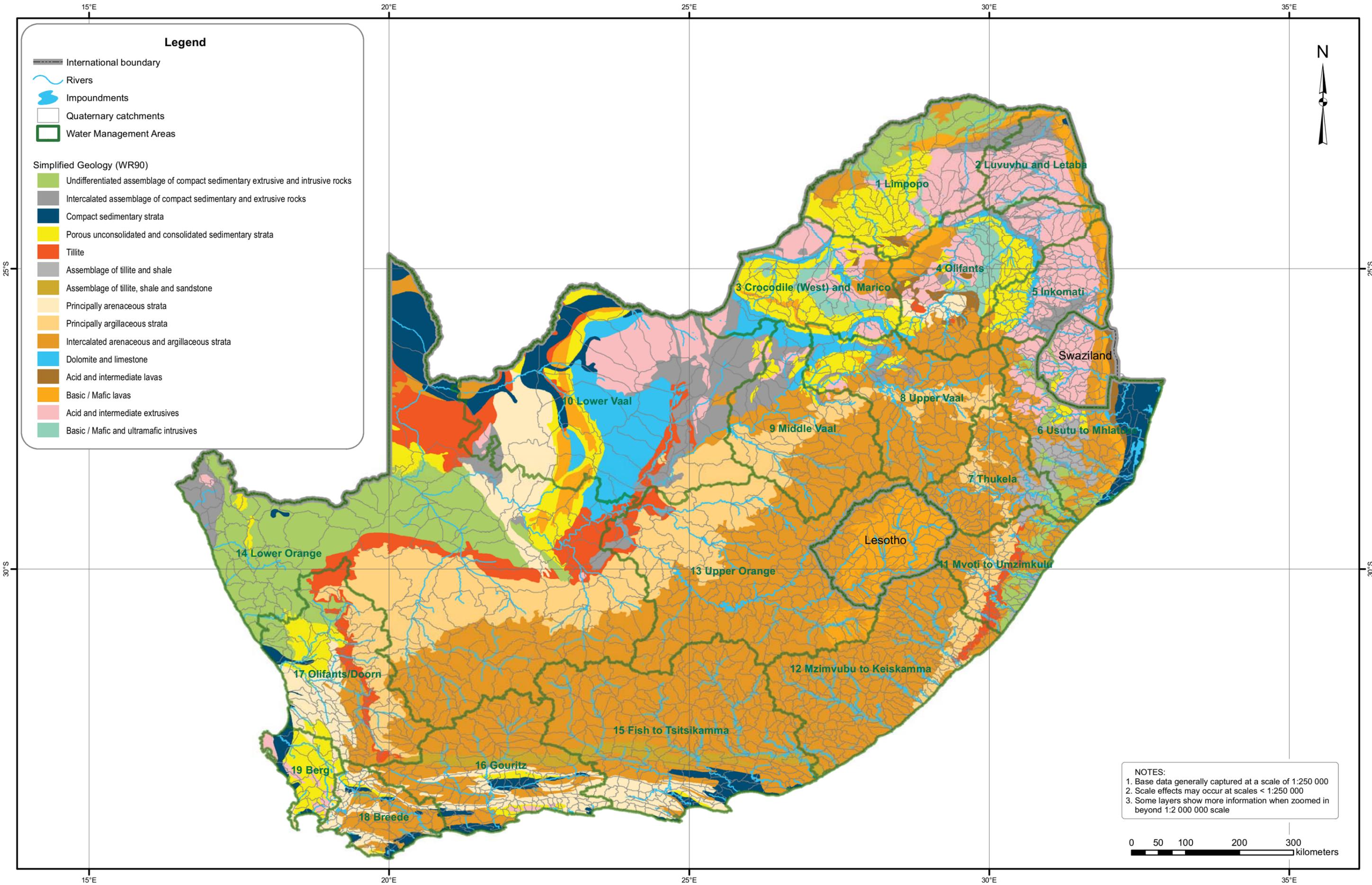


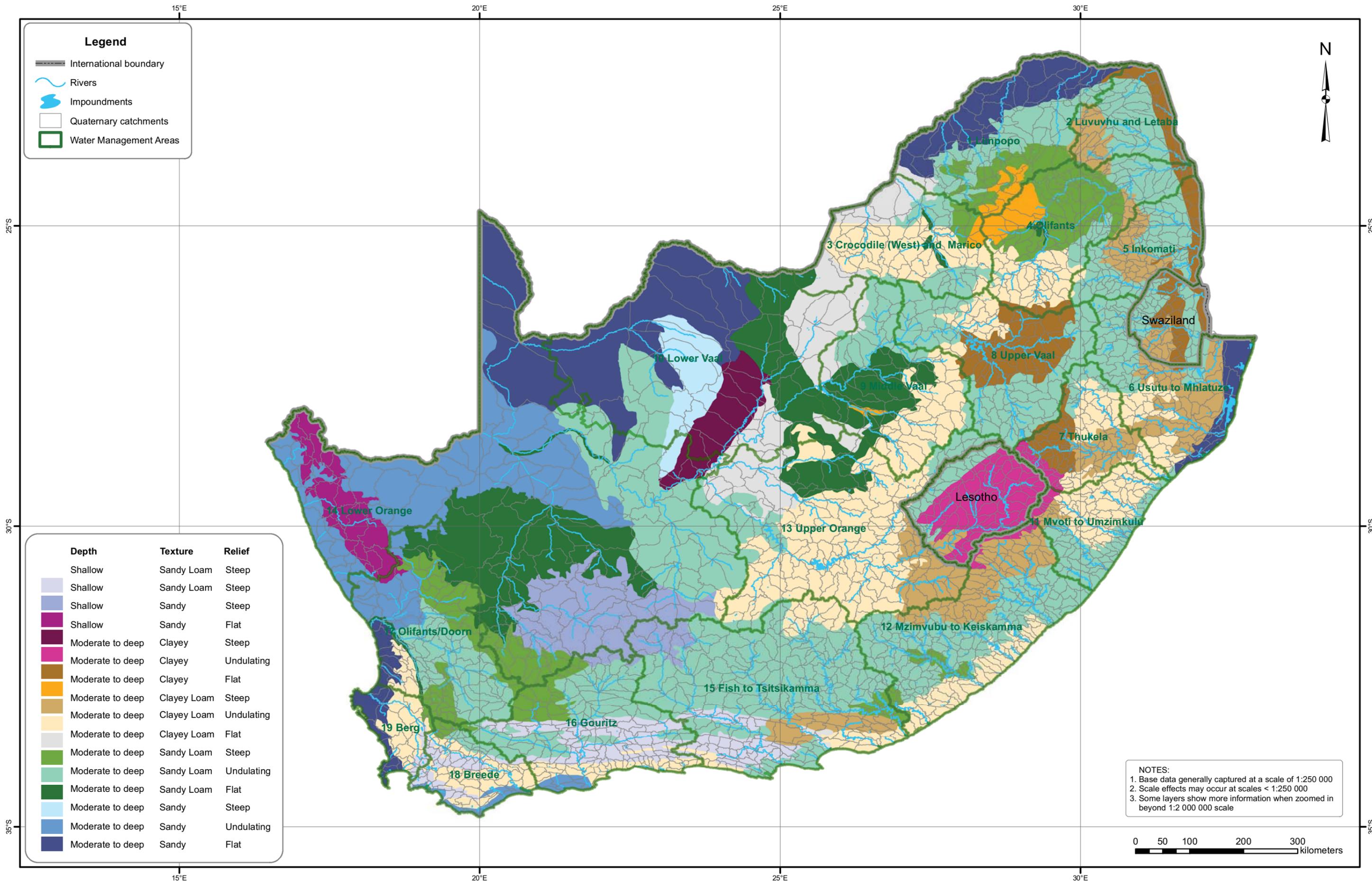


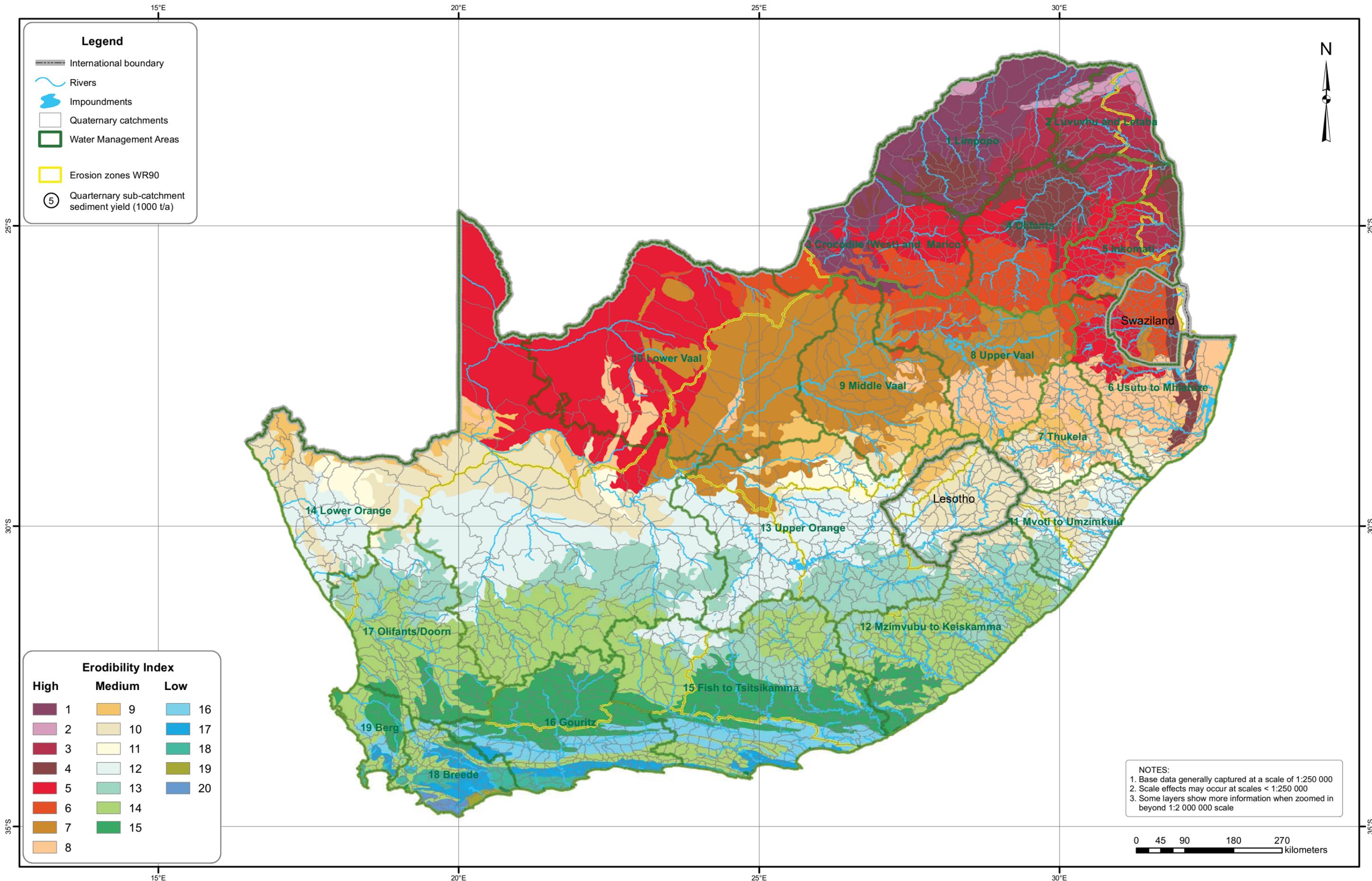


NOTES:
 1. Base data generally captured at a scale of 1:250 000
 2. Scale effects may occur at scales < 1:250 000
 3. Some layers show more information when zoomed in beyond 1:2 000 000 scale

0 50 100 200 300 kilometers







Legend

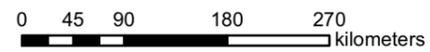
- International boundary
- Rivers
- Impoundments
- Quaternary catchments
- Water Management Areas
- Erosion zones WR90
- Quaternary sub-catchment sediment yield (1000 t/a)

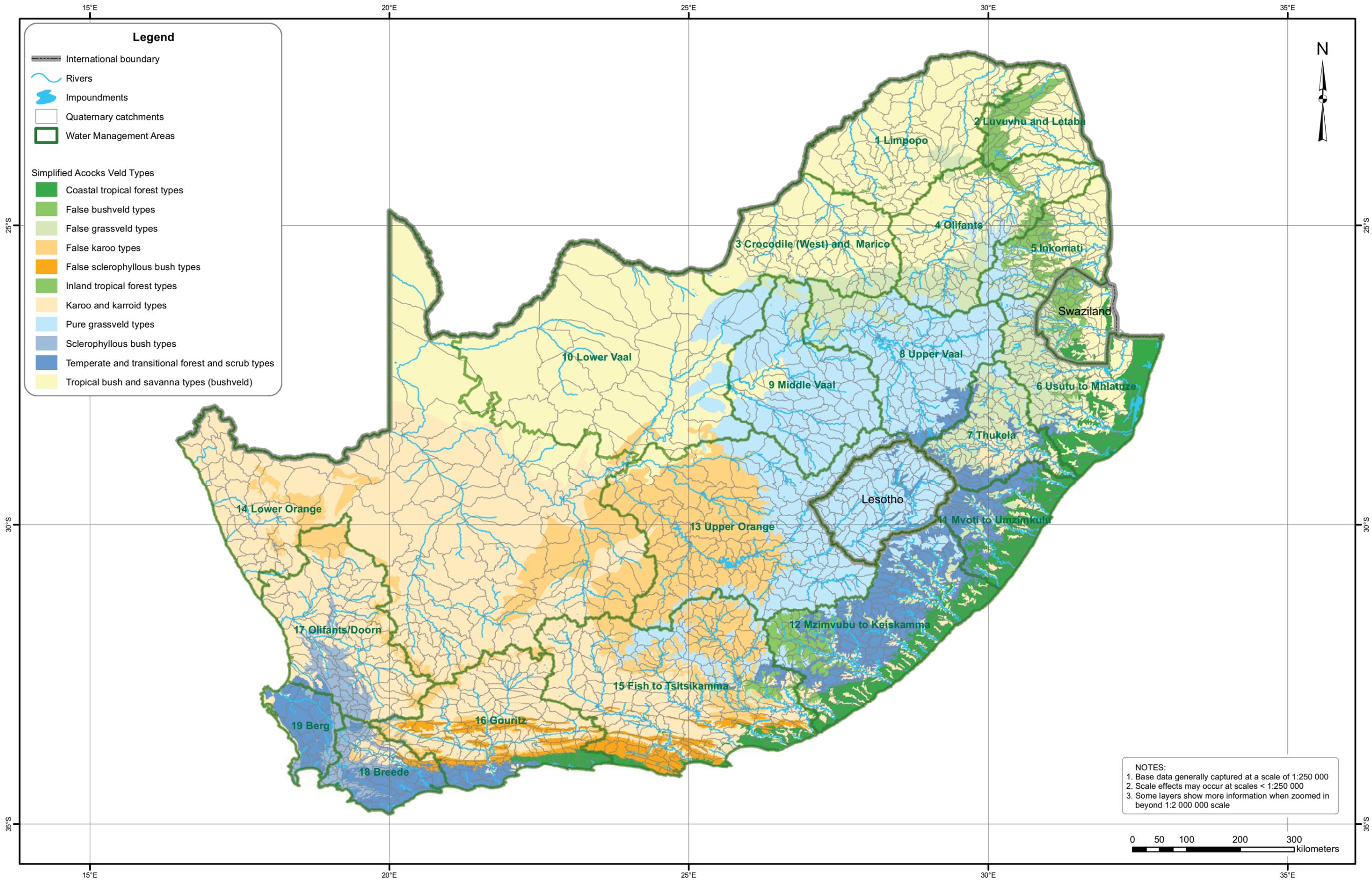
Erodibility Index

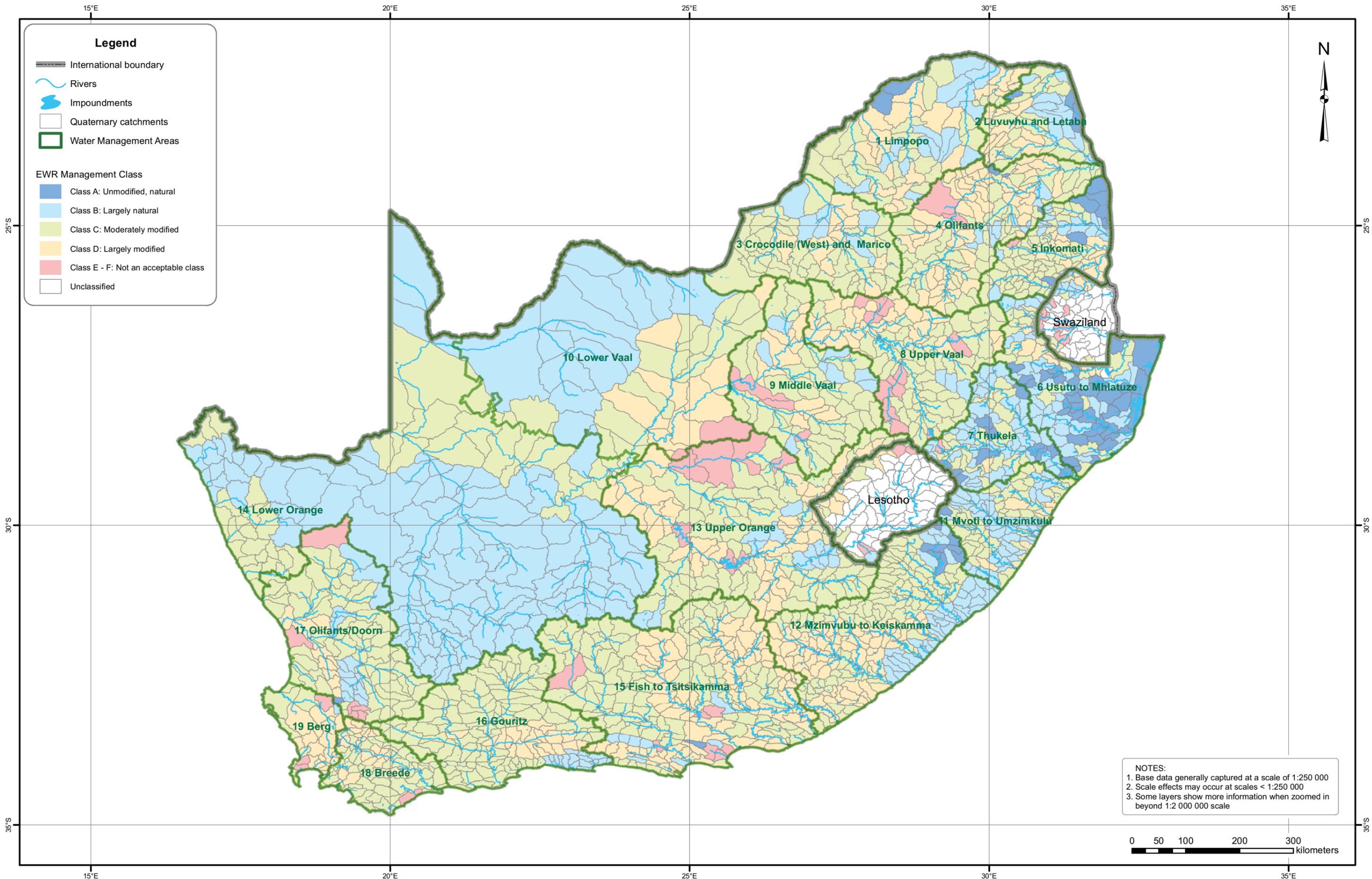
High	Medium	Low
1	9	16
2	10	17
3	11	18
4	12	19
5	13	20
6	14	
7	15	
8		

NOTES:

1. Base data generally captured at a scale of 1:250 000
2. Scale effects may occur at scales < 1:250 000
3. Some layers show more information when zoomed in beyond 1:2 000 000 scale







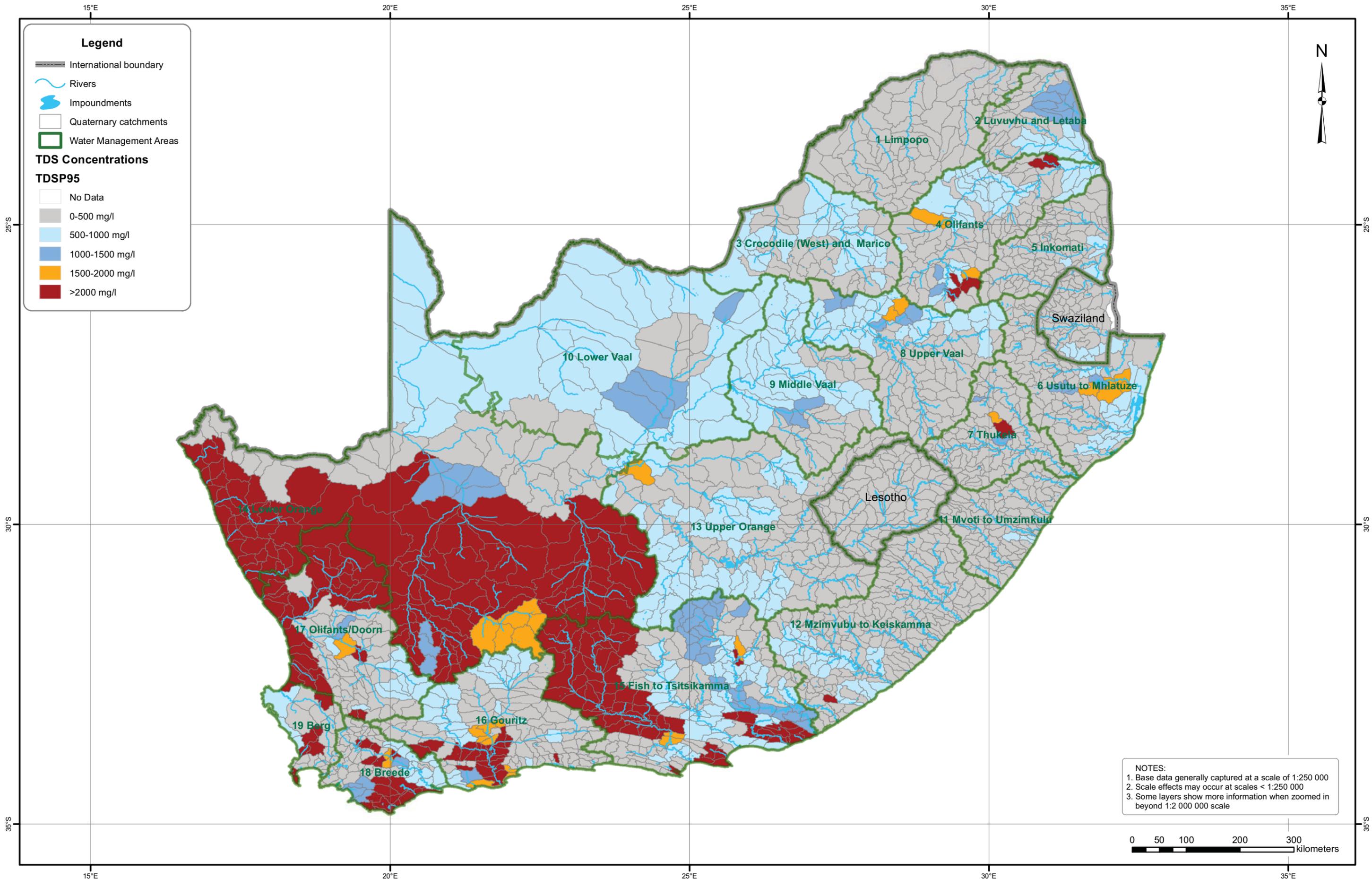
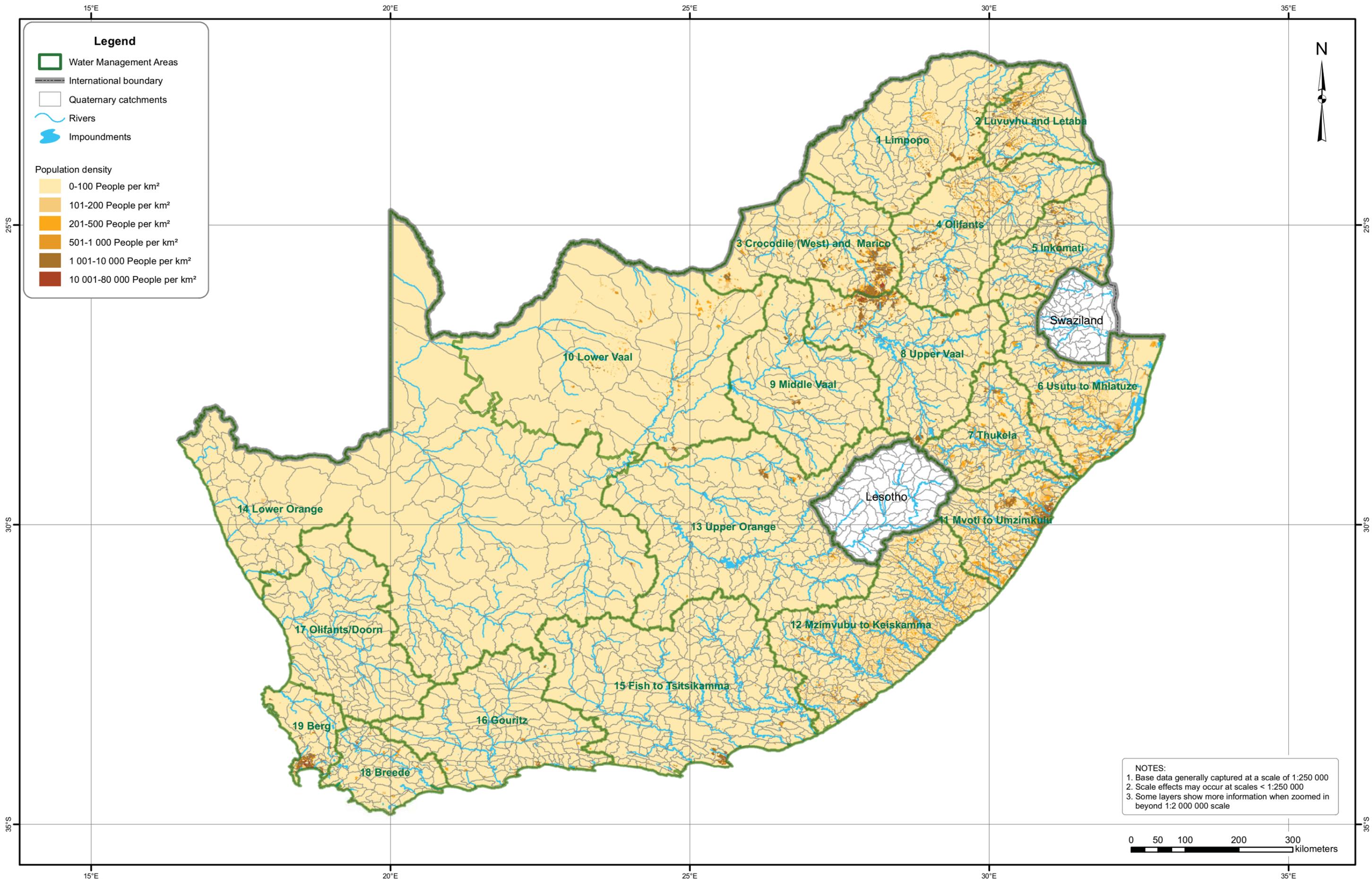


Figure 11 : Surface Water Quality - TDS



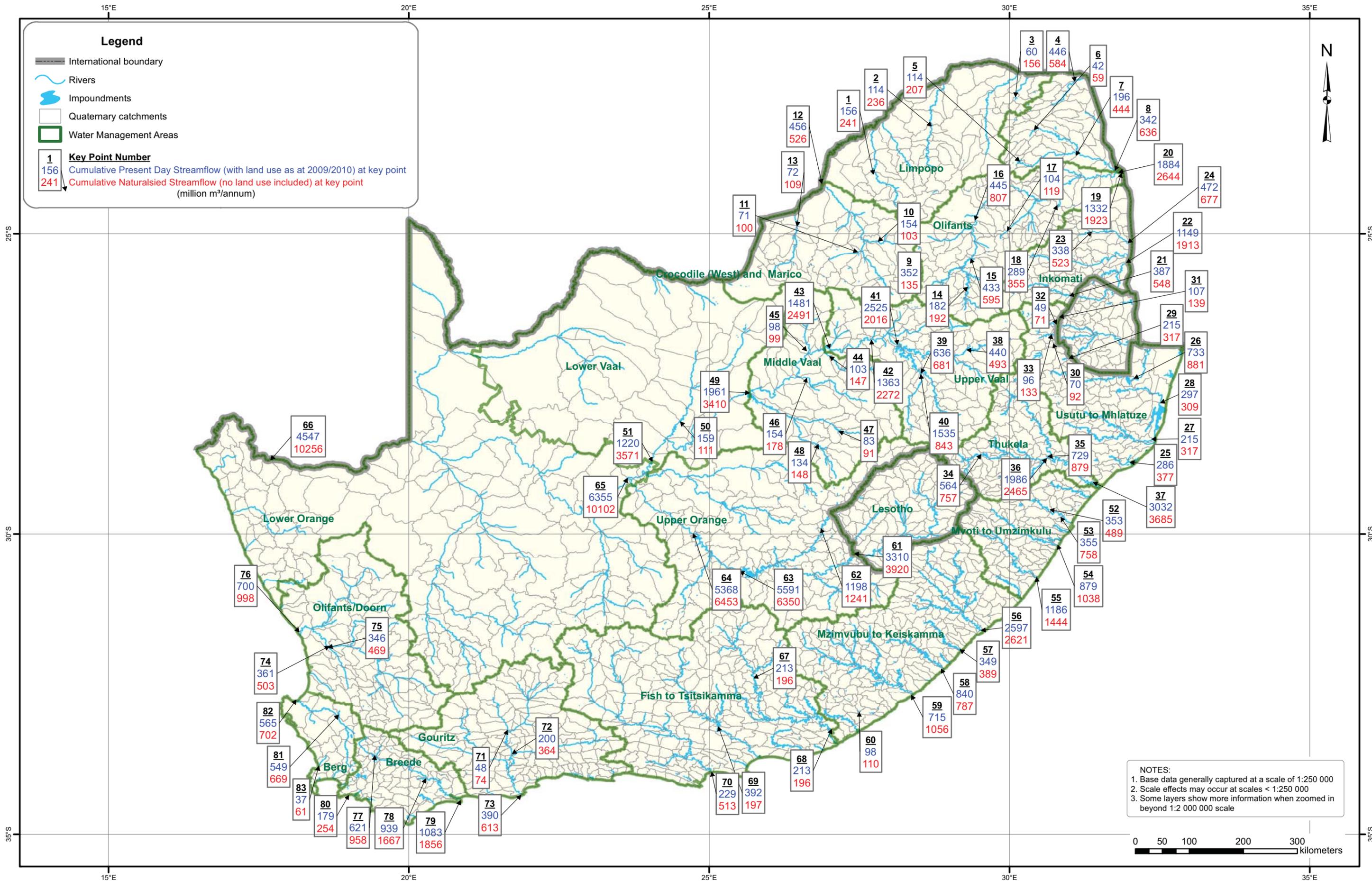


Figure 13 : Present Day and Naturalised Streamflow at Key points

WR2012 Sources of Data

Map Figure Number	WR2005 Map	Description	Shp file name	Type	Main Attribute Information	Attribute Source	Coverage obtained from	Date of Source	Scale	Data capture agency	Method of capture	Coordinate projections	Custodian	Copyright restrictions
0	Basemap	Rivers	wriall500_primary.shp, wriall500_secondary.shp	Line	Name, class, order	DWS	DWS	2006	1:500 000	Surveys & Mapping	Digitised	GEO	DWS	DWS
		Selected Major Dams (Impoundments)	dams500g_wgs84.shp	Polygon	Name, type	DWS	DWS	2006	1:500 000	Surveys & Mapping	Digitised	GEO	DWS	DWS
		Towns	major towns and cities_poly.shp	Polygon	Name, label	DWS	DWS		1:250 000	Surveys & Mapping	Digitised	GEO	DWS	DWS
		Catchments	primary catchments.shp, secondary catchments SA.shp, dter.shp, catchments-sa.shp,	Polygon	primary, secondary, tertiary, quaternary	DWS	DWS	2002	1:50 000	DWS	Digitised	GEO	DWS	DWS
		Water management areas	wma_DWS.shp	Polygon	WATMAN, major_RIV	DWS	DWS	2003	1:50 000	DWS	Digitised	GEO	DWS	DWS
		Endoreic Areas	erc.shp	Polygon	Erc_id	WR90	WR90	1995		WR90	Generated		WR90	None
1	Rainfall	South African Rainstations	rsa_rainst.shp	Point	ID, code, link, MAP	DWS	DWS	2010		DWS	-	-	WR2012	WR2012
		Rain zones WR90	rain zones wr90.shp	Polygon	RAINZ, id	WR90	WR90	1995		WR90	Generated		WR90	None
		South African mean annual precipitation	rsa_map.shp	Polygon	MAP_mm	BEEH	Agri atlas	2000		BEEH	Generated	GEO	BEEH	BEEH
2a	Evaporation - WR90	Evaporation WR90	evaporation wr90.shp	Polygon	EIP, EIP_ID	WR90	WR90	1995		WR90	Generated		WR90	None
		Evaporation Stations	evapo stations wr90.shp	Point	Station name, Reference Number	WR90	WR90	1995		WR90	Generated		WR90	None
		Evaporation zones WR90	evapo zones wr90.shp	Polygon	EZN, EVAPZ	WR90	WR90	1995		WR90	Generated		WR90	None
2b	Evaporation Apan	Mean annual evaporation Apan	rsa_mae-apan.shp	Polygon	Grid code, evaporation	BEEH	Agri Atlas	2000		BEEH	Generated	GEO	BEEH	BEEH
3	Runoff	South African stream gauges	rsa_streamg.shp	Polygon	Station, shortname, mapname, start_obs, end_obs, region, consultant, used	DWS	DWS	2010		DWS			WR2012	WR2012
		South African mean annual runoff	rsa_mar.shp	Polygon	RSA_MAR, CATNUM, MAR, curve, HYDROZ, colour	WR2012	WR2012	2010		WR2012	Generated		WR2012	WR2012
4a	Landcover	Thematic, Hillshade	LandCover.gdb	Raster	Class_Names	DEA	DEA	2014		GEOTERRAIMAGE Pty Ltd		WGS84_UTM35N	GEOTERRAIMAGE Pty Ltd	GEOTERRAIMAGE Pty Ltd
		Forest NLC 96	deforest-nlc96.shp	Polygon	FS_prov, code, symbol colour, description, land code, province	CSIR	DWS	1995	1:250 000	CSIR	Raster	GEO	CSIR	CSIR
		Irrigated areas and sugarcane NLC 96	irrigation-nlc96.shp	Polygon	KZN_prov, code, symbol colour, description, land code, province	CSIR	DWS	1995	1:250 000	CSIR	Raster	GEO	CSIR	CSIR
		Dryland agriculture NLC 96	dryland-nlc96.shp	Polygon	symbol colour, NP_prov, description, land code, province	CSIR	DWS	1995	1:250 000	CSIR	Raster	GEO	CSIR	CSIR
4b	Water transfer	Water transfers	watertransline.shp	Line	Transfers, Volume	DWS	DWS	2000	1:250000	DWS	Digitised		DWS	DWS
5a-5h	Calibration	Calibration POW, ST, FT, ZMIN, ZMAX, GPOW, HGSL, HGGN	rsa_calibration_12.shp	Polygon	Quaternary, primary, secondary, tertiary, POW12, ST12, FT12, ZMIN12, ZMAX12, GPOW12, HGSL12, HGGW12,	WR2012	WR2012	2010	-	WR2005	Generated	GEO	WR2012	WR2012
6	Geology - simplified	Geology WR90	geology wr90.shp	Polygon	GEOL, colour, lithos	GeoScience	DWS	1995	1:250 000	GeoScience	Derived	GEO	DWS	DWS
7	Soils	Soils WR90	soils wr90.shp	Polygon	SOI, SIRI_CDE, ASD, DST, DSS, RLF, DSSERIES, DSSP, DSTEXTURE, DSTP, LOWPT, HIGHPT, range, class, colour	WR90	WR90	1989	1:250 000		Derived		WR90	None
8	Sediment	Erosion zones	erosion_zones_wr90.shp	Polygon	ERO, id and reg	WR90	WR90	1995	1:500 000	Univ of Stellenbosch	Digitised		WR90	None
		Sediment yield	sediment_yld_wr90.shp	Polygon	YLD, CATNUM, Frequency, Sum Yield, YLD 1000	WR90	WR90	1995	1:500 000	Univ of Stellenbosch	Digitised		WR90	None
		Erodibility	erodibility_wr90.shp	Polygon	Sediment, Grndklas, colour, erodibility	WR90	WR90	1995	1:500 000	Univ of Stellenbosch	Digitised		WR90	None
9	Vegetation	Vegetation WR90	vegetation wr90.shp	Polygon	VEG, types, Type description, colour	WR90	WR90	1995	1:1 500 000	Dept of Agriculture		GEO	WR90	None
10	EWR	South African EWR values as per quaternary	rsa_ewr.shp	Polygon	Quaternary, primary, secondary, tertiary, rivers, EISC, PESC_desk,	DWS	DWS	2007	1:50 000	DWS	Generated		DWS	DWS
11	TDS	South African Surface TDS values per quaternary	rsa_tds_12.shp	Polygon	Quaternary, primary, secondary, tertiary, TDS_p95, R, TDSP95	WR2012	WR2012	2010		WR2005	Generated		WR2012	None
12	Population	South African population density	Census_2011_Gender.shp	Polygon	SP_code, SP_name, Aream2, Grand_Tota, Pop_Den	SSA	SSA	2011		SSA	Generated	GEO	SSA	SSA
13	Streamflow	Present Day and Naturalised Streamflow	Present_Day_and_Normal_Streamflow.shp	Point	PDS_L, ND_L	WR2012	WR2012	2010	1: 1 000 000	WR2012	Digitised	GEO	WR2012	WR2012



9781431208432