water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

2030 NDP
NATIONAL DEVELOPMENT PLAN
Our Future - make it work

The Determination Of Water Resource Classes, Reserve And Resource Quality Objectives For Secondary Catchments (A5-A9) Within The Limpopo WMA And Secondary Catchment B9 in the Olifants WMA

Public Meeting No 1

Presented by: Myra Consulting in association with Southern Waters and Anchor Research & Monitoring

Date: 12 May 2022

OUTLINE OF PRESENTATION

- Study objectives
- Approach to study
- Overview of study area
- Overview of study processes
- Summary of work done to date on
  - Rivers
  - Water Resources and Infrastructure
  - Water Quality
  - Wetlands
  - Groundwater
  - Socio-economics and Ecosystem Services

OVERVIEW OF STUDY OBJECTIVES

- Three main objectives:
  - Classify all significant water resources in the Limpopo WMA (Secondary Catchment A5-A9) and Olifants WMA (Secondary Catchment B9)
  - Determine the water quantity and quality components of the groundwater and surface water (rivers and wetlands) Reserve.
  - Determine the Resource Quality Objectives (RQOs)

The outcomes of this study will facilitate sustainable use of the water resource while maintaining ecological integrity

Process is supported by an extensive stakeholder engagement and consultation process.

OVERVIEW OF STUDY OBJECTIVES

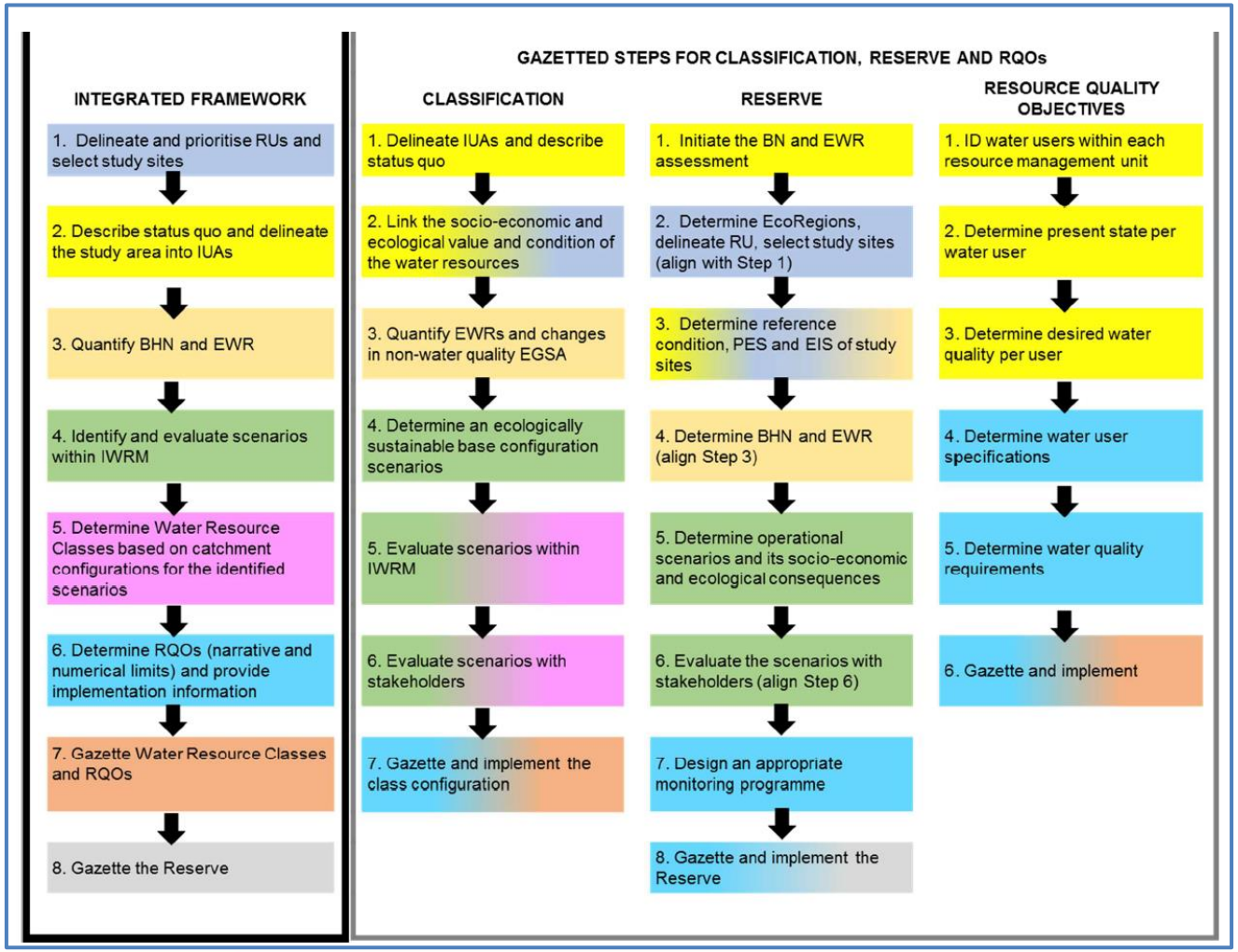
- Determination of water resource classes:
  - Essentially describes the desired condition of the water resource and conversely, the degree to which it can be utilized by incorporating the economic, social and ecological goals of the users in the catchment.

- Purpose of Reserve:
  - To identify the degree of change or impact that is considered acceptable from an ecological perspective and is unlikely to damage a water resource beyond repair.

- Determination of RQOs
  - To establish narrative and numerical limits to give effect to the set class

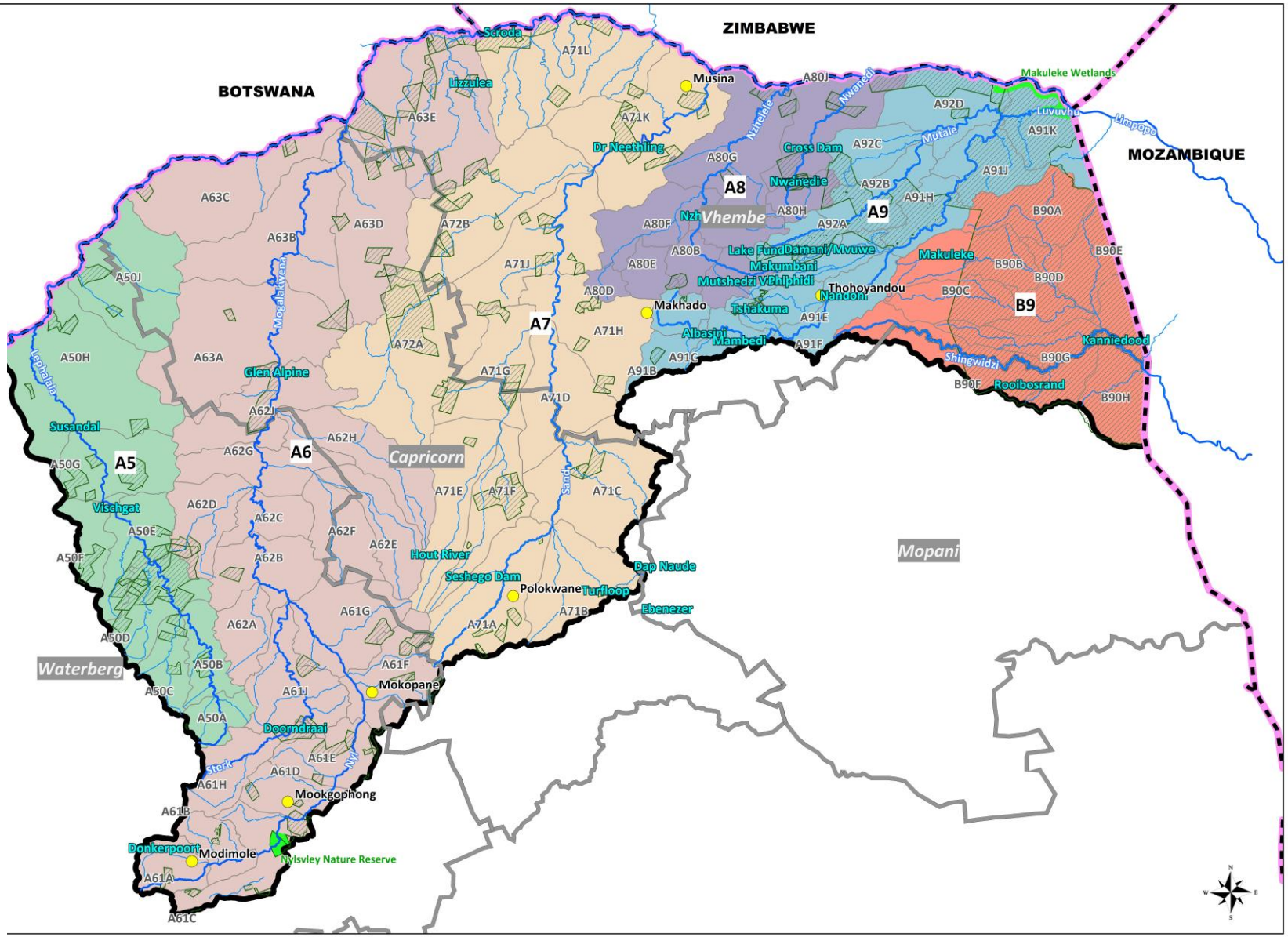
STUDY APPROACH

- Integrated framework for incorporating the gazetted steps for Classification, Reserve and RQOs will be used to guide the study.



OVERVIEW OF STUDY AREA

- Study area falls within the Waterberg, Capricorn, Vhembe, and Mopani District Municipalities of Limpopo Province.
- Includes five (5) main towns (Modimole, Mookgophong, Mokopane, Makhado and Musina) and one city (Polokwane)
- Outside of the main towns and city, population density is highest in the former homeland areas of Venda, Lebowa and Gazankulu.
- Outside of the protected areas, which include the Kruger National Park and the nature reserves, land use is dominated by agriculture.
- Other land uses include mining and forestry



ER RESOURCE CLASSES, RESERVE & RQO DETERMINATION IN THE A5-A9 & B9 SECONDARY CATCHMENTS

STUDY AREA SHOWING DISTRICT MUNICIPALITIES

Legend

Secondary Catchments
- A5 - LEPHALALE
- A6 - MOGALAKWENA
- A7 - SAND
- A8 - NZHELELE
- A9 - LUVUVHU
- B9 - SHINGWIDZI
- NULL

- Dams
- Quaternary Catchments
- Study Area
- District Municipalities Study Area
- Protected Areas
- Major Towns
- International Boundaries
- Ramsar Site
- Main Rivers
- Tributaries

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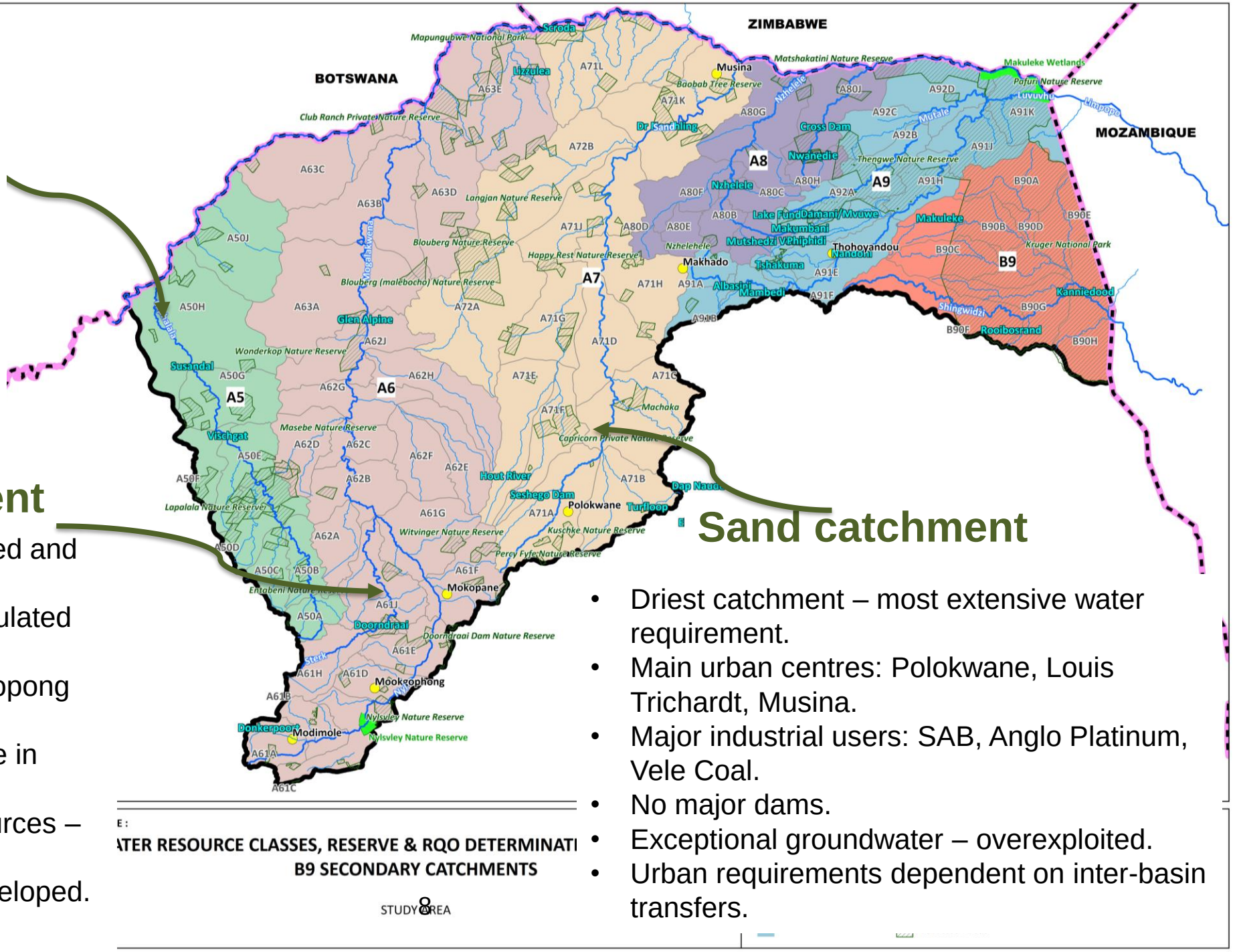
Lephalala catchment

- Middle reaches – high conservation value
- Several nature reserves and tourist attractions.
- Irrigation activities dominant in rest of catchment.
- Irrigation supplied by surface water in upper reaches and alluvial aquifer in lower reaches.
- No major towns.

Mogalakwena catchment

- Largest, mostly densely populated and industrialised.
- Central part – most densely populated >80% rural.
- Major towns: Modimolle, Mookgopong and Mokopane in upper regions.
- Nyslvley wetland – RAMSAR site in upper reaches.
- Considerable groundwater resources – exploited by irrigation sector.
- Limited surface water – fully developed.



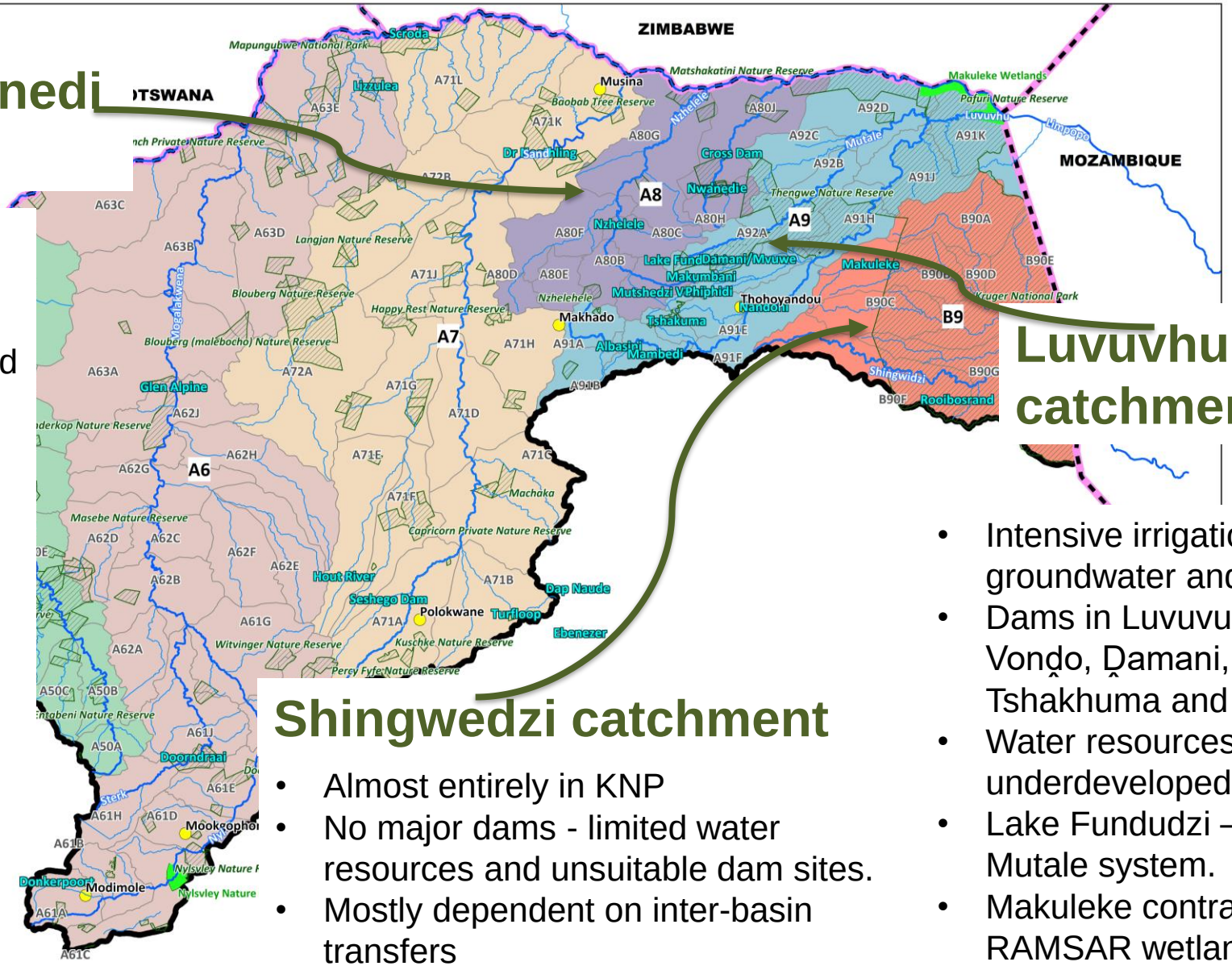
ATER RESOURCE CLASSES, RESERVE & RQO DETERMINATI
B9 SECONDARY CATCHMENTS
STUDY AREA

Sand catchment

- Driest catchment – most extensive water requirement.
- Main urban centres: Polokwane, Louis Trichardt, Musina.
- Major industrial users: SAB, Anglo Platinum, Vele Coal.
- No major dams.
- Exceptional groundwater – overexploited.
- Urban requirements dependent on inter-basin transfers.

Nzhelele and Nwanedi catchments

- Small rural catchment
- No large urban centres. Several settlements: Makhado town, Dzanani and Siloam.
- Small industries and small area of afforestation.
- Dominated by irrigation farming.
- Surface water resources developed.
- Major dams: Nzhelele, Mutshedzi, Nwanedi and Luphephe.
- Potential for coal mining

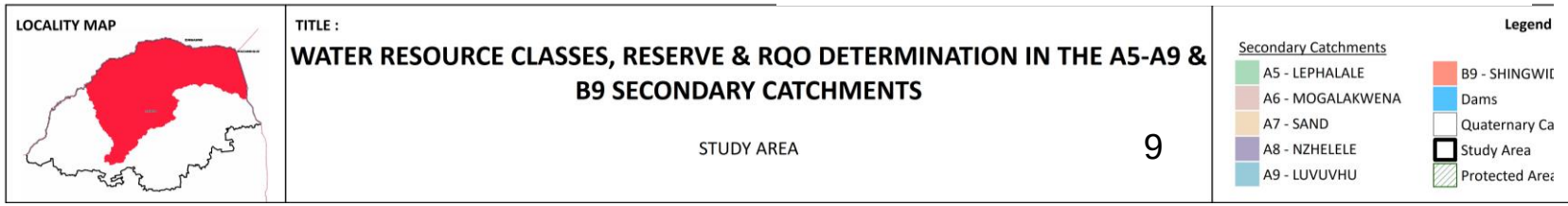


Shingwedzi catchment

- Almost entirely in KNP
- No major dams - limited water resources and unsuitable dam sites.
- Mostly dependent on inter-basin transfers

Luvuvhu and Mutale catchments

- Intensive irrigation farming – groundwater and surface water use.
- Dams in Luvuvu catchment: Albasini, Vondo, Ḏamani, Mukumbani, Tshakhuma and Nandoni.
- Water resources – Mutale – underdeveloped.
- Lake Fundudzi – sacred Lake on Mutale system.
- Makuleke contractual park - RAMSAR wetland – bordered by Luvuvhu and Limpopo Rivers. Most diverse area in Kruger National Park



PROJECT PROCESS AND RIVERS

TERMS

- Classification = balancing development against protection
  - Undertake an analysis of benefits and costs of future scenarios
  - Information grouped into IUAs = areas of interest
  - Culminates in Management Classes (I, II or III)
- Ecological Reserve = EFlows study
  - Changes in flow of water, sediments, biota with social consequences
  - Detailed study to model consequences of changes to target a condition
- RQOs (Resource Quality Objectives) = targets for monitoring
  - Ecological condition, flow and measures for protection/rehabiltation
- Gazetted Water Resource Classes, Reserve and RQOs

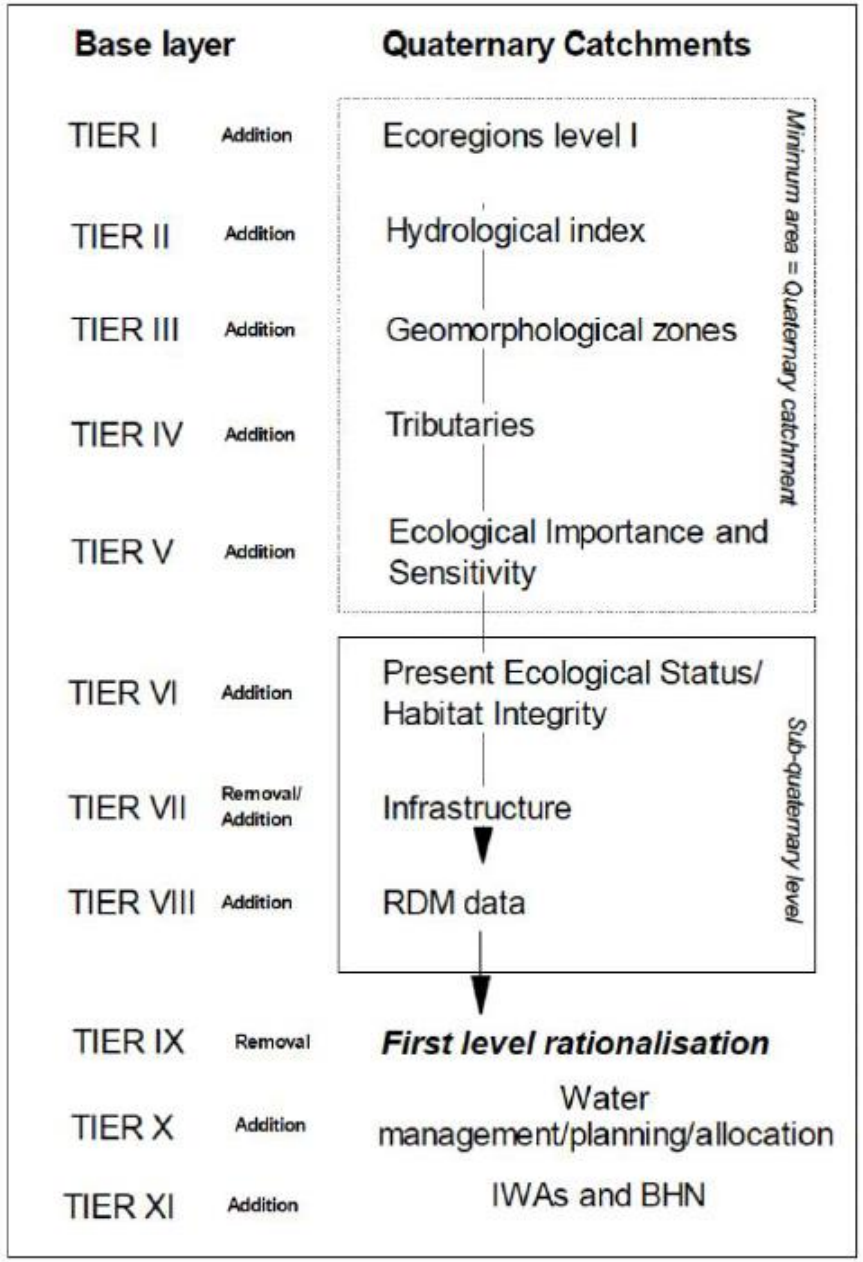
8-STEP PROCESS

1. Identify aquatic resources (rivers, wetlands, groundwater) and select study sites
2. Describe current condition and identify areas of interest (IUA)
3. Quantify Ecological Reserve (EFlows) and Basic Human Needs (BHN)
4. Model future use scenarios, balance costs and benefits
5. Select future use scenarios and associated Water Resource classes
6. Define RQOs (monitoring objectives) for areas of interest
7. Gazette Water Resource Classes and RQOs
8. Gazette the Ecological Reserve (EFlows) and Basic Human Needs

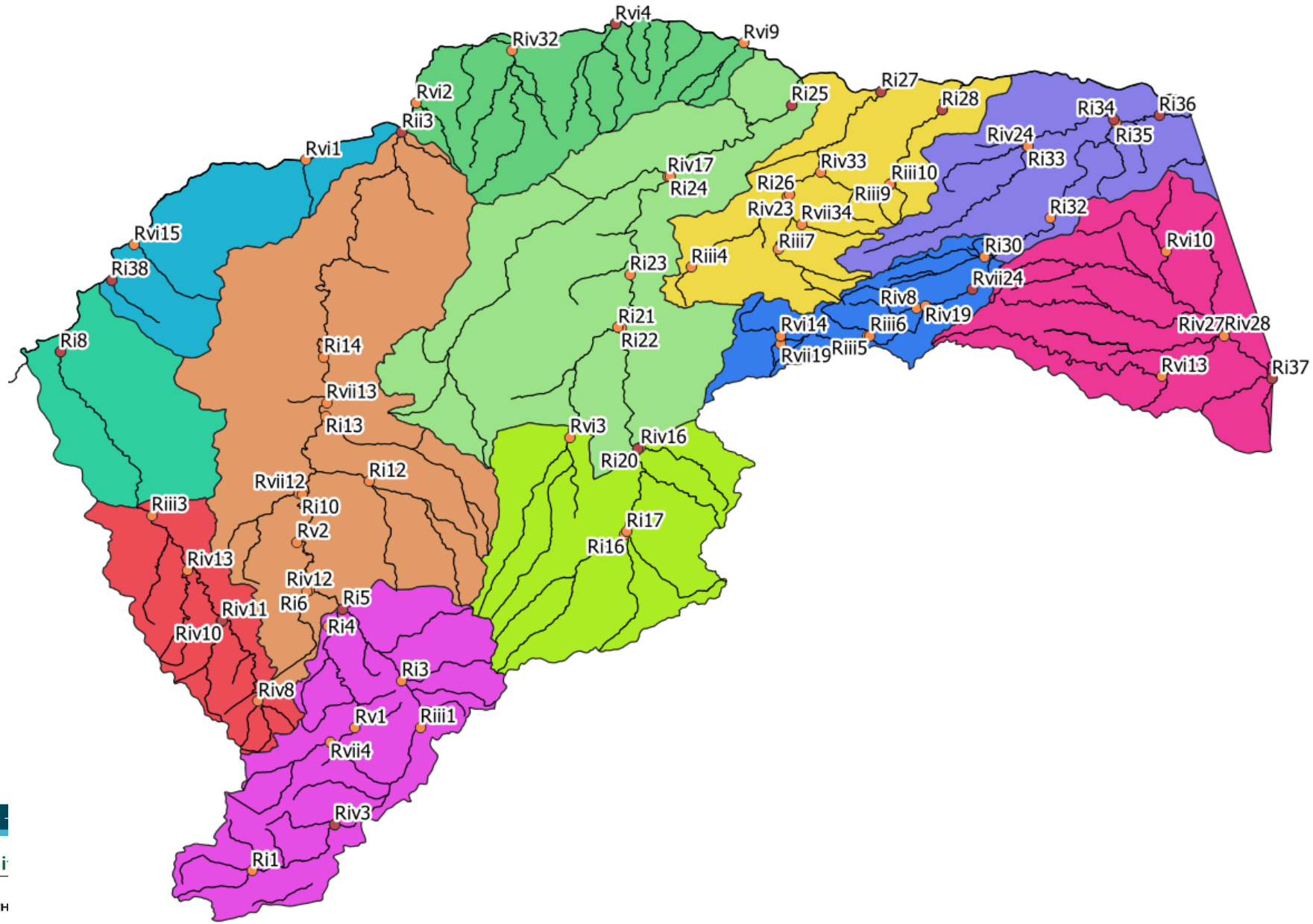
STEP 1: IDENTIFY AQUATIC RESOURCES, SELECT STUDY SITES

- Nodes = point of interest

- A series of steps to identify 1st points
  - Based on existing information
  - Decisions are ecological and infrastructure related



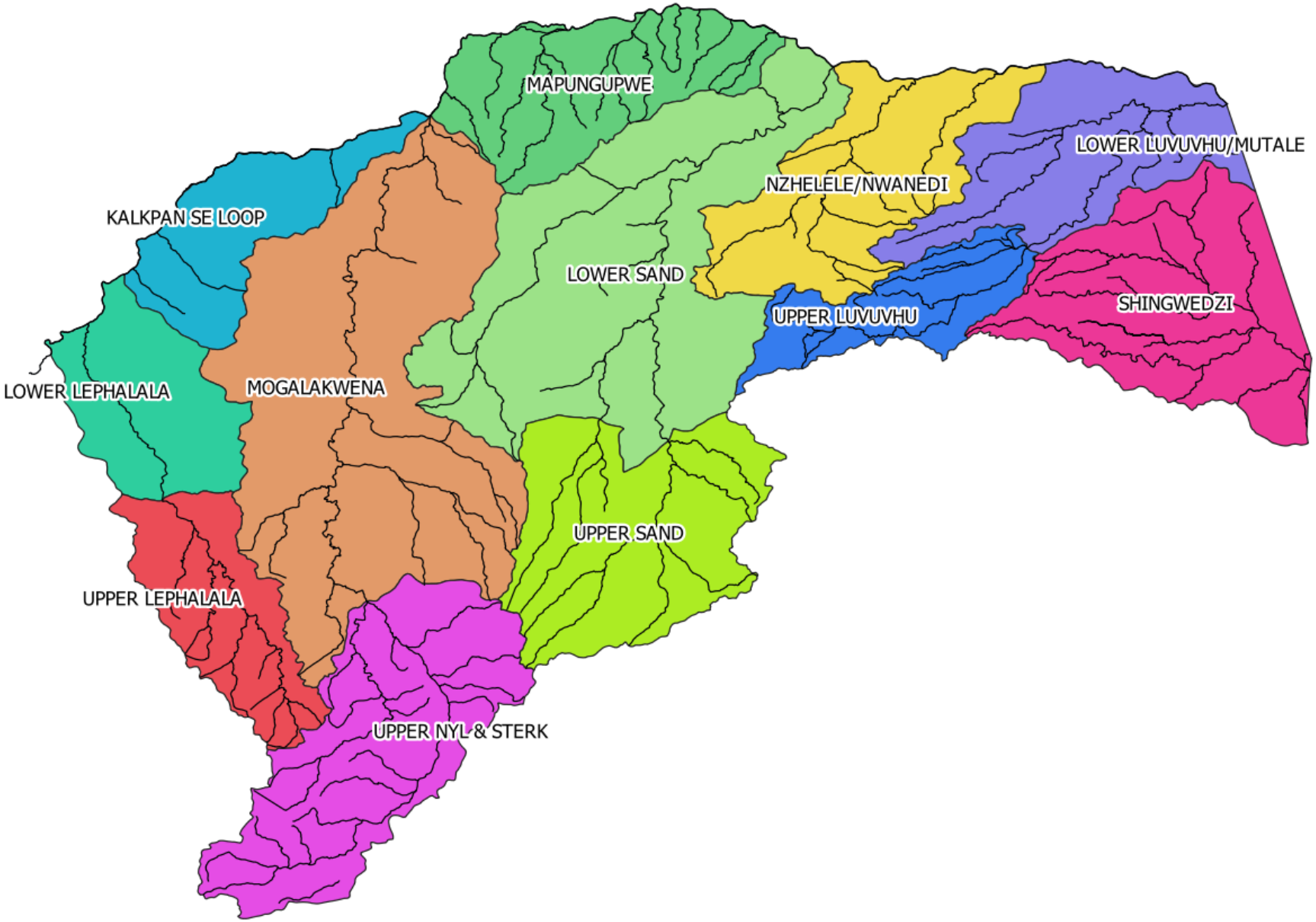
STEP 1: IDENTIFY AQUATIC RESOURCES, SELECT STUDY SITES



STEP 2: DESCRIBE CURRENT CONDITION AND IDENTIFY IUAS

- Aim to combine river, wetland, groundwater, infrastructure, landuse and socio-economic information into areas of interest
- Separate river basins from one another (hydrologically)
- Ecoregions and bioregions (habitat; geology, vegetation type)
- Geomorphic zones (headwaters, lowlands)
- Hydrological index (perenniality)
- Baseline ecological condition (PES)
- Ecological Importance and Sensitivity (conservation importance)

STEP 2: DESCRIBE CURRENT CONDITION AND IDENTIFY IUAS



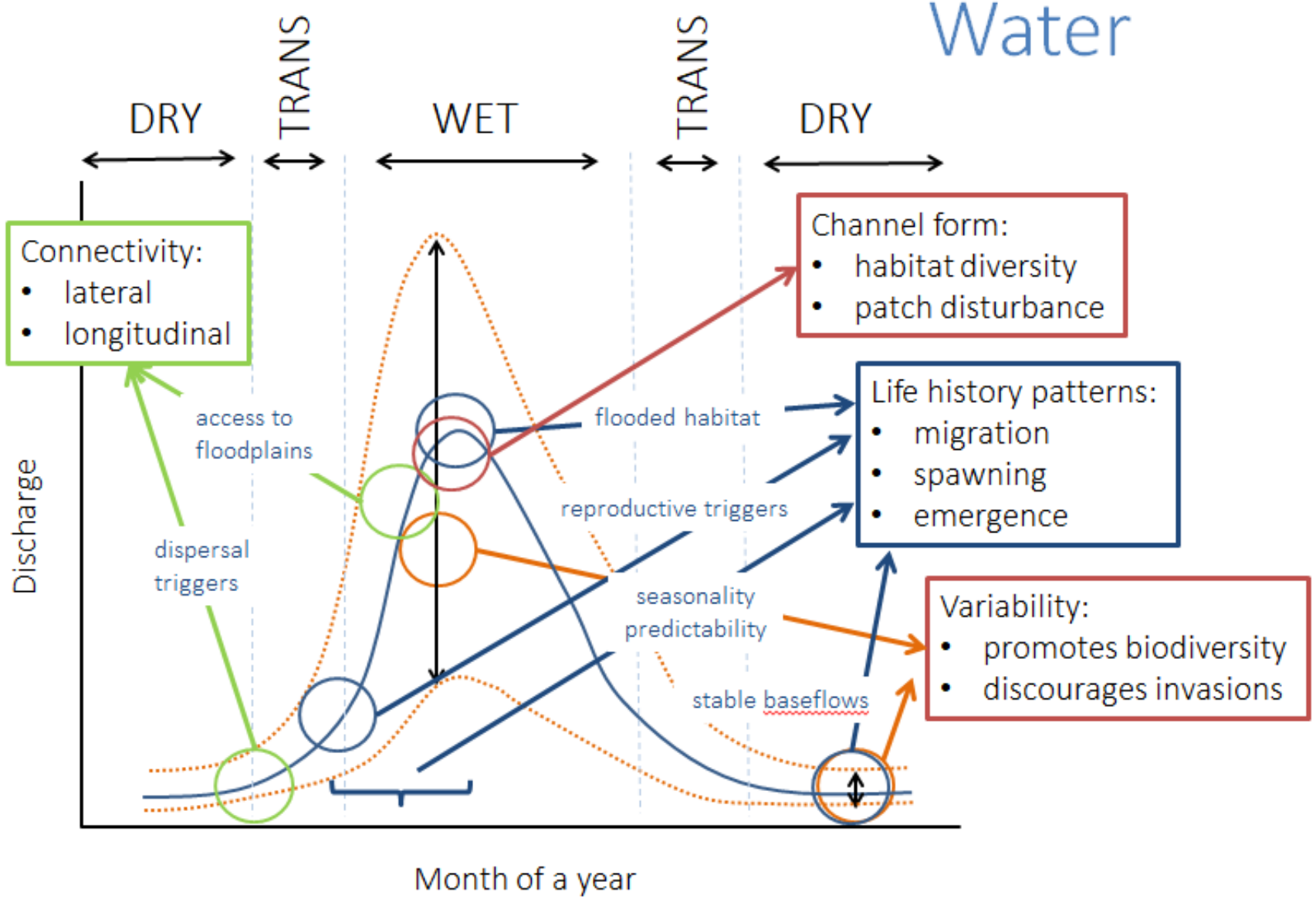
STEP 3: QUANTIFY EFLOWS (ECOLOGICAL RESERVE)

EFlows

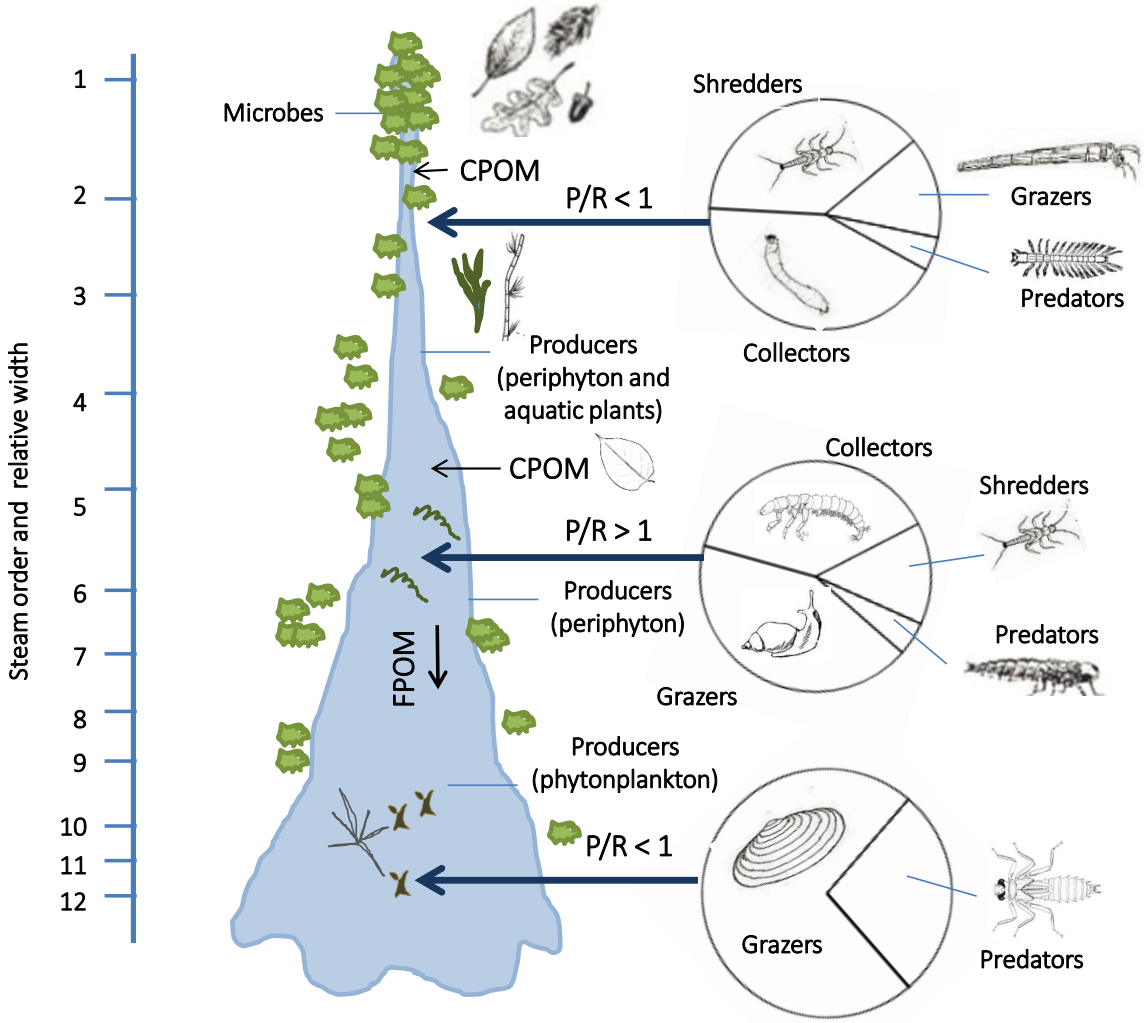
The quantity, timing and quality of the flow of water, sediment and biota necessary to sustain freshwater and estuarine ecosystems, and the human livelihoods and well-being that depend on these ecosystems."

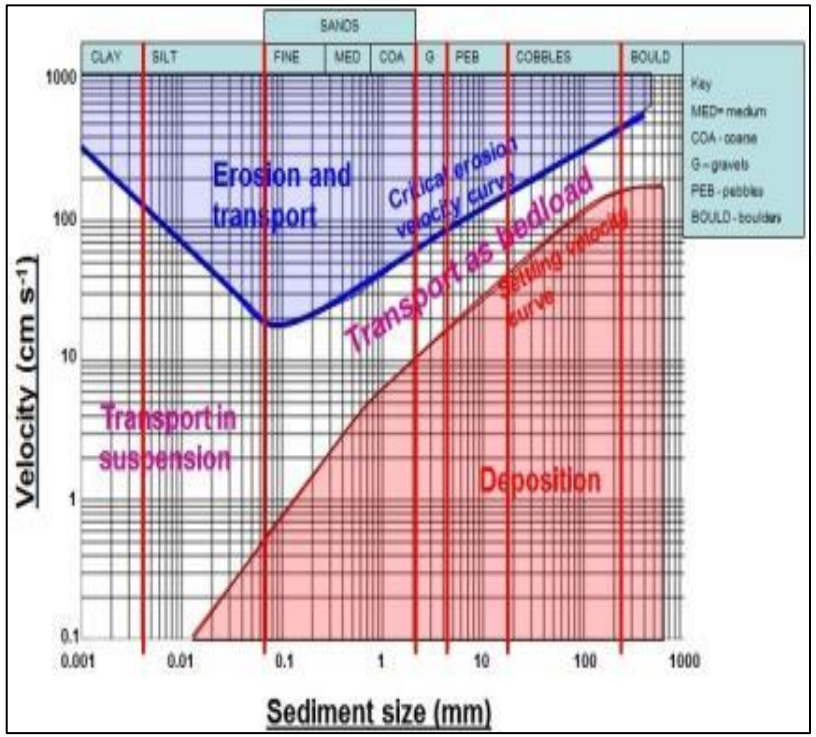
WorldBank (2018)

Water

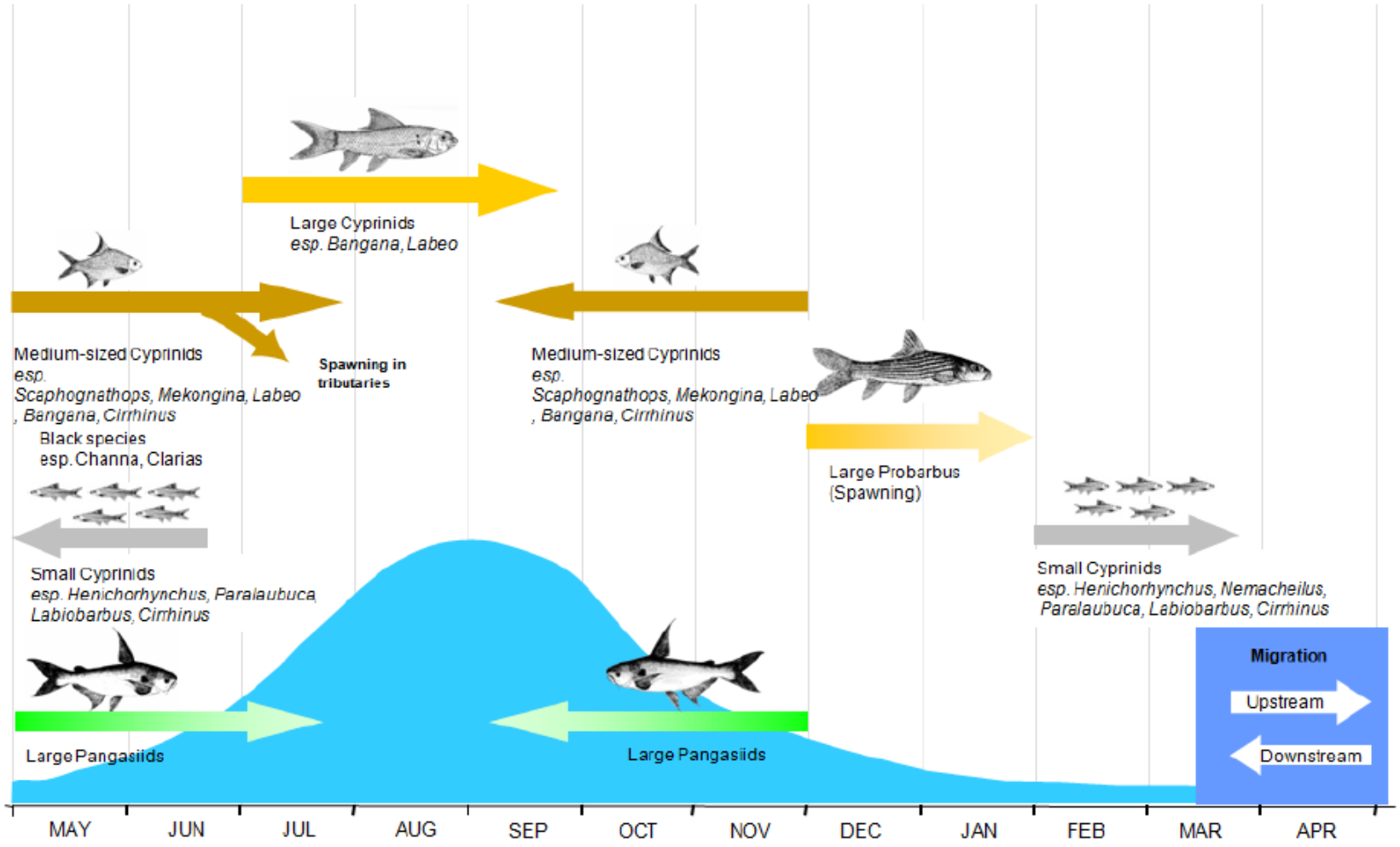

DRY
TRANS
WET
TRANS
DRY
Connectivity:
• lateral
• longitudinal
Channel form:
• habitat diversity
• patch disturbance
Life history patterns:
• migration
• spawning
• emergence
Variability:
• promotes biodiversity
• discourages invasions
access to floodplains
flooded habitat
reproductive triggers
dispersal triggers
seasonality predictability
stable baseflows
Discharge
Month of a year

Sediment


Steam order and relative width
1
2
3
4
5
6
7
8
9
10
11
12
Microbes
CPOM
P/R < 1
Shredders
Grazers
Predators
Collectors
Producers (periphyton and aquatic plants)
CPOM
Collectors
Shredders
P/R > 1
Producers (periphyton)
FPOM
Predators
Grazers
Producers (phytonplankton)
P/R < 1
Grazers
Predators


SANDS
CLAY
SILT
FINE
MED
COA
G
PEB
COBBLES
BOULD
Key
MED= medium
COA - coarse
G - gravels
PEB - pebbles
BOULD - boulders
Erosion and transport
Critical erosion velocity curve
Transport as bedload
Settling velocity curve
Transport in suspension
Deposition
Velocity (cm s-1)
1000
100
10
1
0.1
0.001
0.01
0.1
1
10
100
1000
Sediment size (mm)

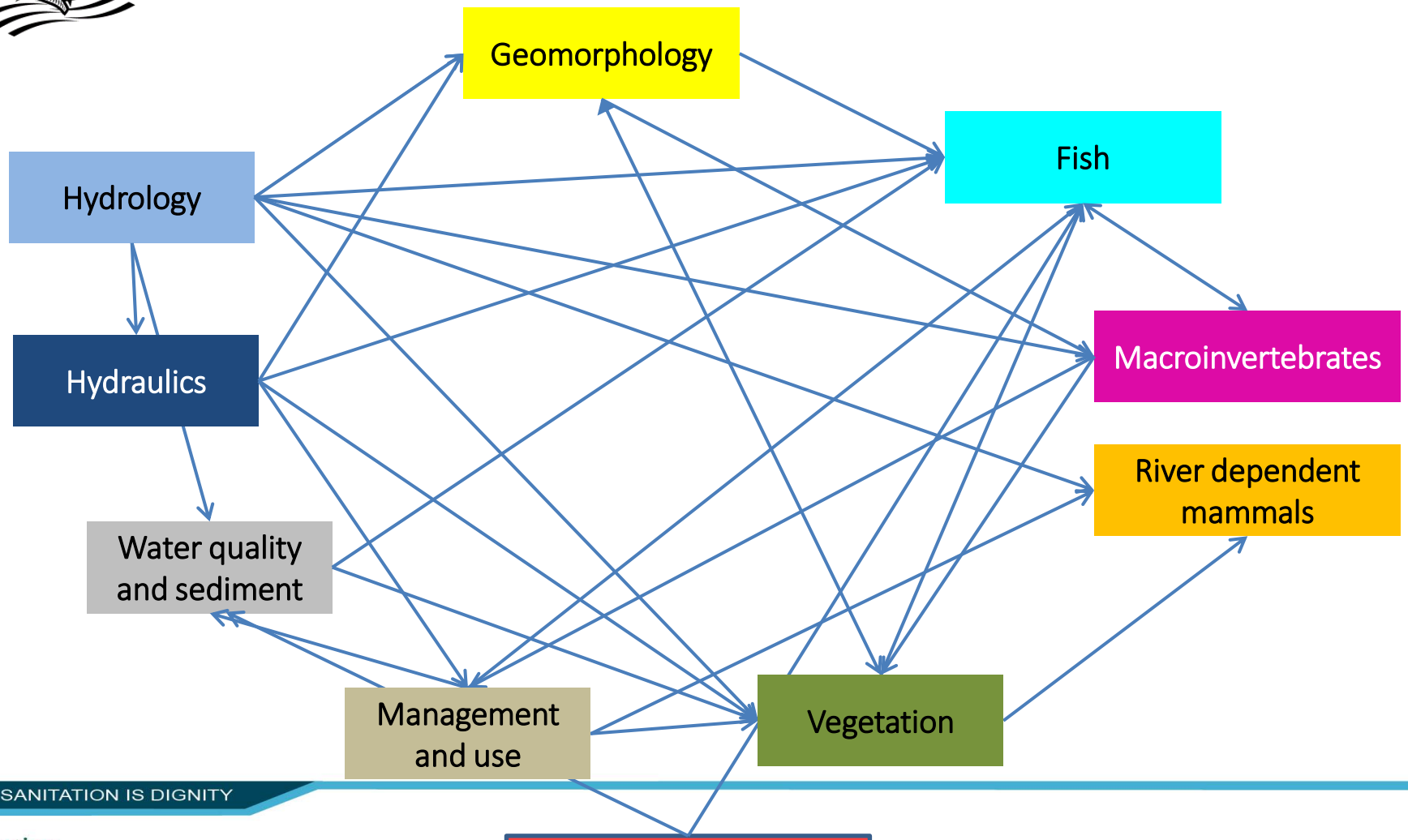
Biota



Baird and Shoemaker 2007

STEP 3: QUANTIFY EFLOWS (ECOLOGICAL RESERVE)

DRIFT – discipline ecosystem network



STEP 3: QUANTIFY EFLOWS (ECOLOGICAL RESERVE)

- DRIFT outputs for EFlow sites
  - Daily flow time series, summarised to monthly, with associated ECs for all disciplines, BEC, REC, AEC
  - Monthly time series, associated ECs for all disciplines, BES, REC, AEC
  - Detail for RQOs are EFlow sites (per discipline)

- Analysis of Classification scenarios
  - Monthly time series for all nodes, associated ECs for BES and REC

STEP 4: MODEL FUTURE USE SCENARIOS

- The balancing tool contains:
  - Baseline ecological conditions for rivers
  - Modelled current day and natural flows
  - Modelled EFlows for a range of ecological conditions
- Allows the user to toggle flow and see changes in ecological condition
- Reports surpluses and deficit in flow relative to current day
- Routes flow BALANCING to avoid deficits and undesired changes in EC (upstream to downstream in each basin)

STEP 4: MODEL FUTURE USE SCENARIOS, BALANCE OUTCOMES

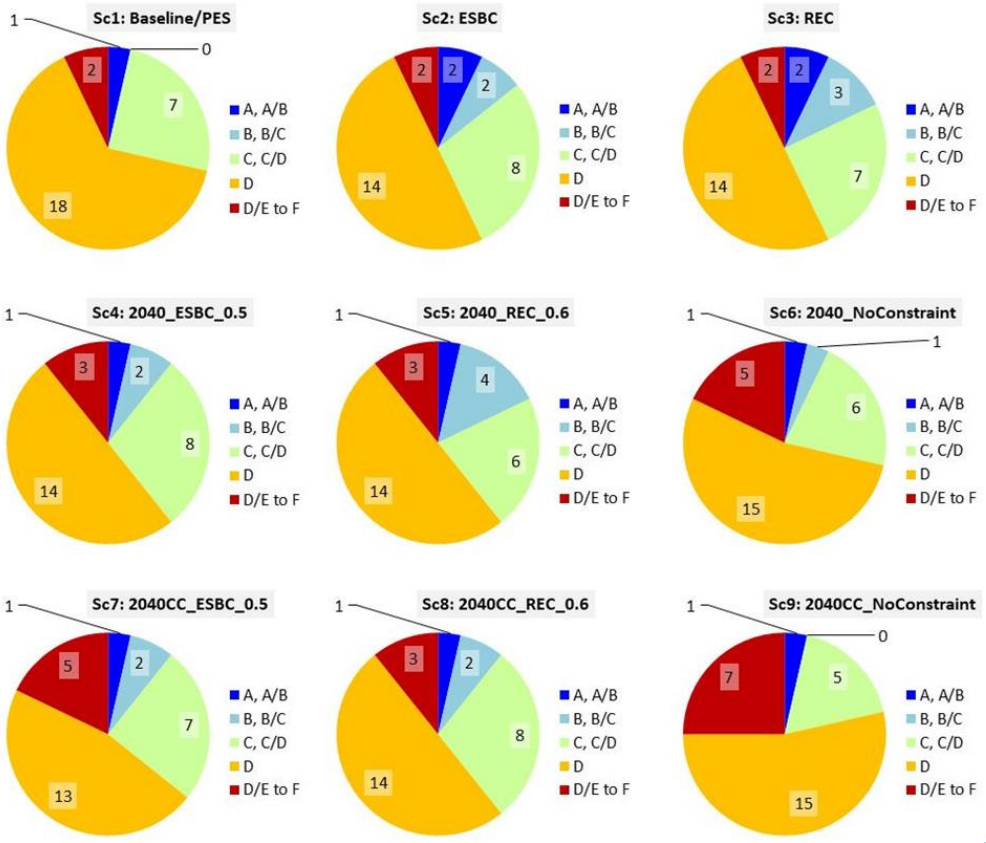
- Likely two different groups of scenarios
  - Ecological
    - BEC, REC, AECs
  - Development
    - Increased water storage, IBTs, abstractions
- Ecological
  - Toggle condition and report/view changes in flow (surpluses/deficits) and ECs downstream
- Development
  - Hydrological time series brought in, tool calculates

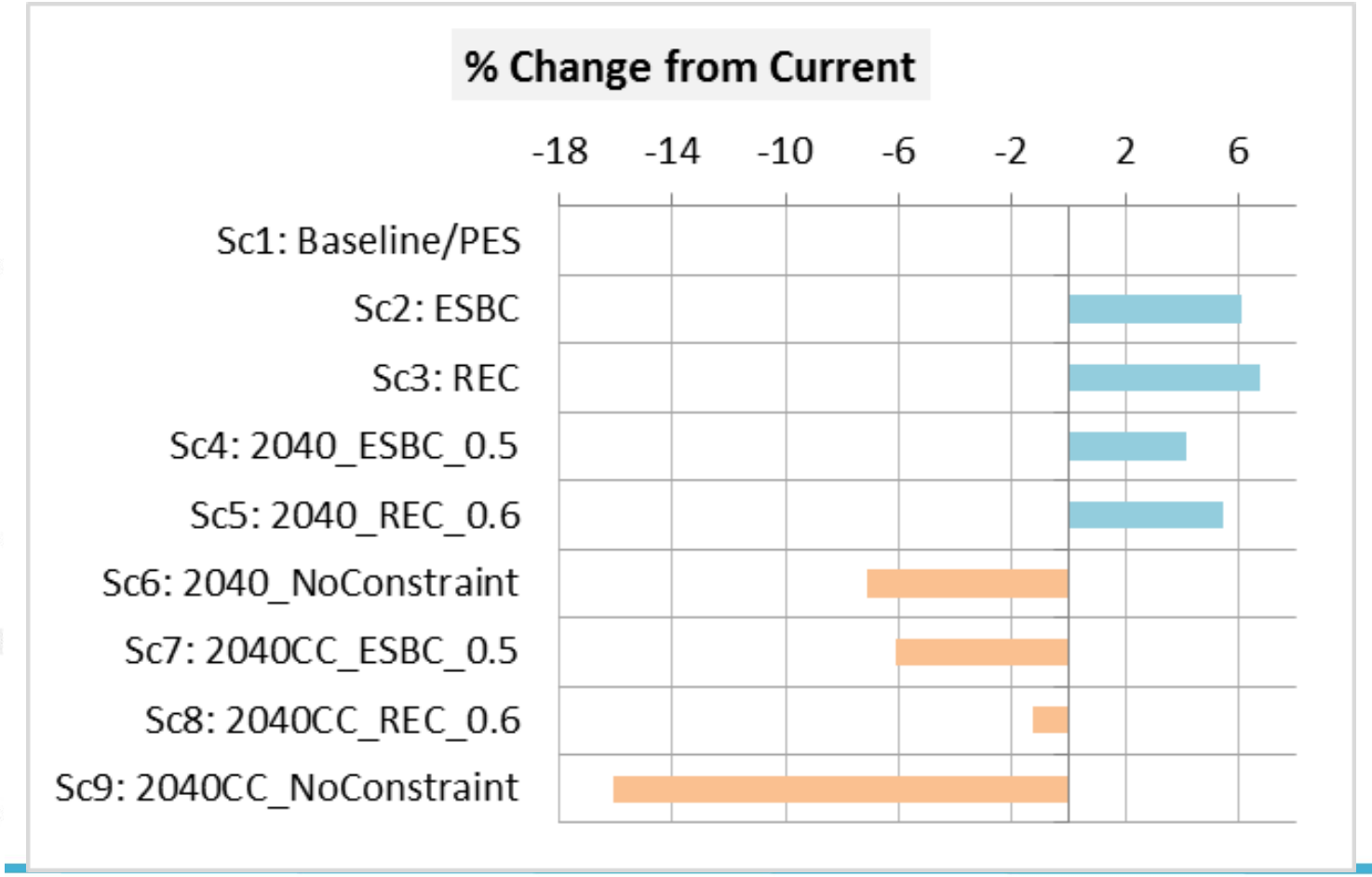
STEP 4: MODEL FUTURE USE SCENARIOS, BALANCE OUTCOMES

IUA	River	REC	Node code	Sc1: Baseline/PES				Sc4: 2040_ESBC_0.5				Sc5: 2040_REC_0.6			
				EC	Wet % nMAR	Dry % nMAR	MAR	EC	Wet % nMAR	Dry % nMAR	MAR	EC	Wet % nMAR	Dry % nMAR	MAR
UB	Berg		Bvii13	A	98.3	98.7	83.3	A	98.3	98.7	83.3	A	98.3	98.7	83.3
	Berg EWR 1	C	Bviii1	C	36.1	42.2	50.4	C	47.0	28.8	93.7	B/C	55.8	40.8	103.7
	Franschhoek		Biv5	D	53.3	3.7	31.0	D	53.3	3.7	31.0	D	53.3	3.7	31.0
	Wemmershoek		Biii2	D	16.6	2.1	25.8	D	16.6	2.1	25.8	D	16.6	2.1	25.8
	Dwars		Bvii14	C	67.8	58.7	31.7	C	68.5	59.1	31.9	C	68.4	59.1	31.8
	Berg		Biii3	E	94.6	204.0	226.3	E	122.5	254.7	291.0	E	123.4	254.7	297.9
MB	Pombers EWR 6	C	Bviii11	D	1342.6	3063.1	6.7	D	1342.6	3063.1	6.7	D	1342.6	3063.1	6.7
	Kromme EWR 7	D	Bvii3	D/E	89.9	1.9	16.5	D/E	89.9	1.9	16.5	D/E	89.9	1.9	16.5
	Berg		Bvii10	D	75.2	143.6	245.9	D	100.8	189.9	310.5	D	101.6	189.9	317.4
	Doring		Bvii15	D	38.3	0.0	2.9	D	38.1	0.0	2.9	D	38.1	0.0	2.9
	Kompanjies		Bvii4	D	43.7	0.5	18.3	D	43.7	0.5	18.3	D	43.7	0.5	18.3
	Berg EWR 3	D	Bvii5	D	32.8	17.9	266.7	B/C	95.3	98.2	581.9	B/C	96.1	98.2	588.8
BT	Berg		Biii4	C	97.2	128.2	69.1	C	97.2	128.2	69.1	C	97.2	128.2	69.1
	Berg		Bi1	C	30.3	33.2	29.6	C	30.6	33.2	30.5	B/C	30.8	33.2	30.8
	Klein Berg		Bvii16	C	23.8	35.0	2.7	C	24.1	35.0	2.9	C	24.2	35.0	2.9
LB	Klein-Berg		Bvii11	D	27.1	0.0	277.4	B/C	40.4	37.6	284.3	B/C	41.0	37.6	290.7
	Vier-en-Twintig		Biv1	D	67.4	106.6	332.3	D	90.0	146.5	397.3	D	90.7	147.2	402.2
	Leeu		Biv3	D	78.8	126.8	54.7	D	79.5	126.8	56.3	D	79.7	126.8	56.7
	Vier-en-twintig		Biv4	D	26.4	13.1	49.5	D	26.6	13.1	50.5	D	26.7	13.1	50.9
	Sandspruit		Bvii17	C	85.8	83.1	8.2	C	85.8	83.1	8.2	C	85.8	83.1	8.2
	Berg EWR 4	D	Bvii6	D	58.4	82.1	449.5	D	73.1	107.3	517.1	D	73.6	107.6	522.7
	Matjies		Biii5	D	75.7	70.6	26.8	D	75.7	70.6	26.8	D	75.7	70.6	26.8
	Berg		Bvii8	D	56.2	73.1	475.6	D	70.7	98.5	543.2	D	71.2	98.9	548.8
	Moreesburgspruit		Bvii18	D	100.0	100.0	3.3	D	100.0	100.0	3.3	D	100.0	100.0	3.3
	Berg EWR 5	D	Bvii12	D	40.1	35.2	445.3	C	60.2	77.9	517.4	C	60.9	79.2	523.4
	Sout		Bii1	D	99.6	100.0	15.6	D	99.6	100.0	15.6	D	99.6	100.0	15.6
	Berg		Biv2	D	36.7	24.8	453.1	D/E	39.3	18.6	506.4	D/E	40.5	21.2	512.7
	Berg Estuary	C	Bxi1	C	37.5	25.4	468.7	C	40.1	19.2	522.0	C	41.3	21.8	528.4

STEP 4: MODEL FUTURE USE SCENARIOS, BALANCE OUTCOMES

- ECs and flow handed down the train (WQ, wetland, GW, socio-economic)





STEP 5: SELECT FUTURE USE SCENARIO AND WATER RESPURCE CLASS SCENARIO

- Stakeholders select future use scenario
- Results about ecological condition used to define water resource classes (I, II or III)
- Each IUA (area of interest) receives a water resource class that is gazetted
- The future use selected is intended to guide development and conservation/ protection
- The conditions and flows from the selected future use scenario get carried through into the RQOs (monitoring objectives)

STEP 6: DEFINE RQOs

- RQOs
  - EFlow sites (Gazetted, Steps 7 and 8)
    - Monthly flows and target conditions
    - ECs for each discipline (monitored using *Aii* tools)
    - Descriptive statements for ecosystem attributes
    - Measurable numbers for flow/WQ/habitat/biota
  - Scenario nodes (not gazetted)
    - Support the EFlow sites
    - Monthly flows and target conditions

STEPS 7 and 8: GAZETTING

- Water resource classes
- Eflows and Basic Human Needs
- RQOs
- Gazettes are prepared and distributed for a period of 60 days, for public comment
- Once finalised, they become legally binding upon the various responsible management authorities

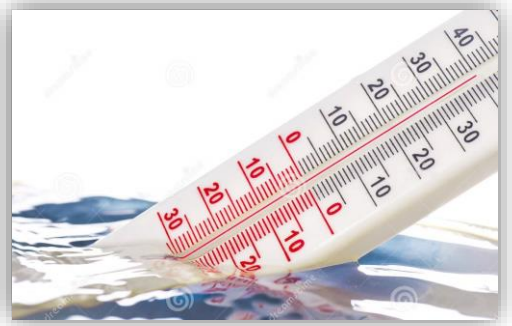
WATER QUALITY

WATER QUALITY

- Water quality describes what you can feel and see, and not see, in water in a stream, river or dam.

Particulate matter

Physical properties



Water Quality

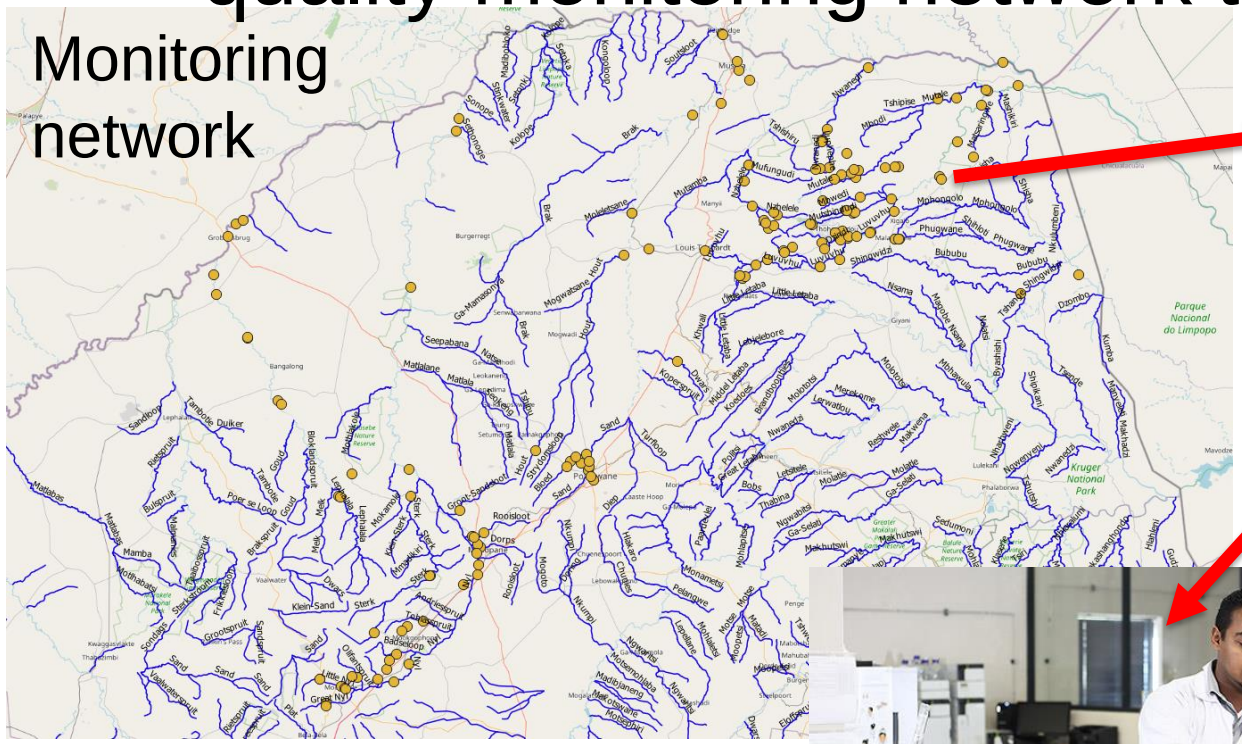
Dissolved matter

Bacteria and viruses

MEASURING WATER QUALITY

- Department of Water and Sanitation operates a water quality monitoring network throughout the country.

Monitoring network



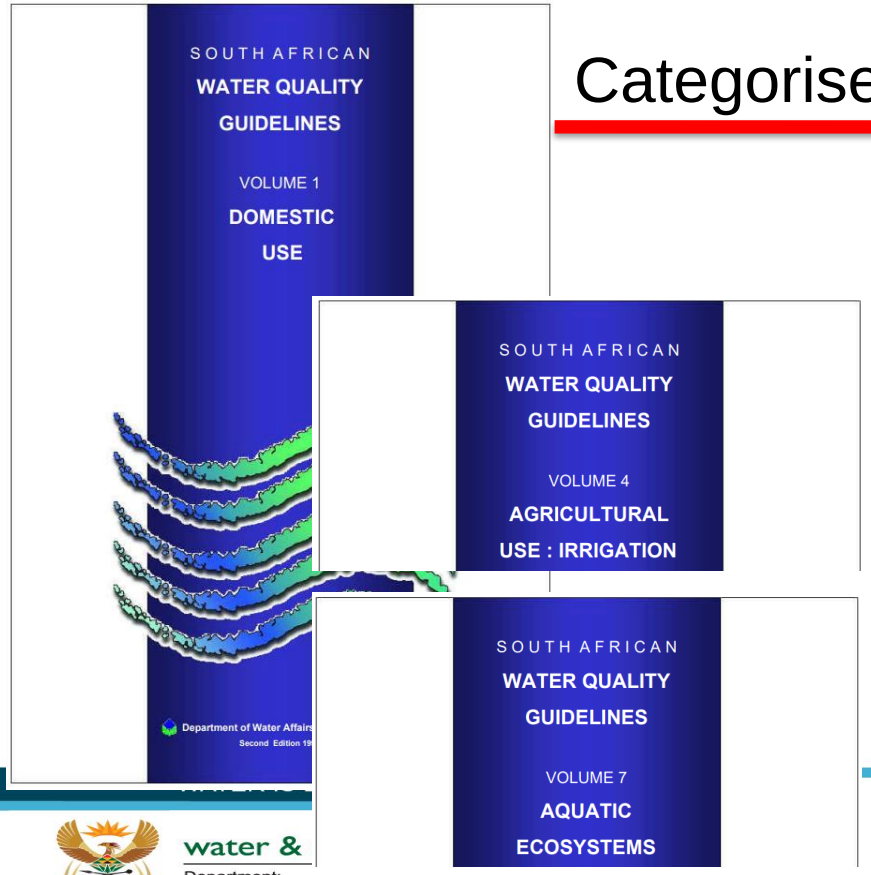
Water sampling

Storing and analysing results

Water testing in DWS laboratory

WATER QUALITY FITNESS FOR USE
How good or bad is the water quality for different uses?

- Fitness for use is based on SA Water Quality Guidelines



Categorise →

Ideal	Acceptable	Tolerable	Unacceptable

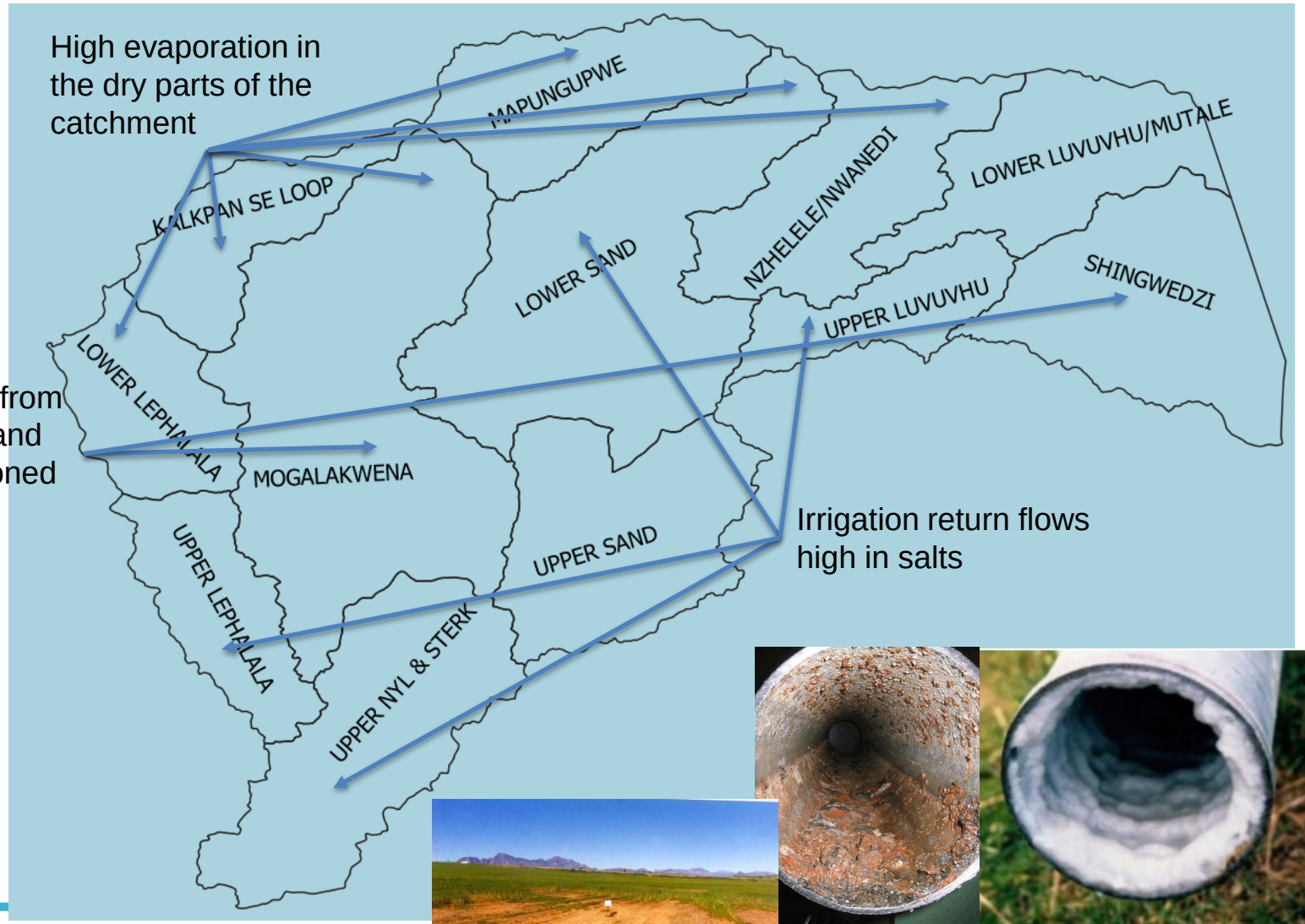
Table A1.2: Generic water quality limits for Domestic Use

WATER QUALITY GUIDELINES FOR DOMESTIC USE					
VARIABLE	UNITS	IDEAL	ACCEPTABLE	TOLERABLE	UNACCEPTABLE
PHYSICAL REQUIREMENTS					
Hardness	mg $CaCO_3$	200	300	600	>600
Turbidity	NTU	0.1	1	20	>20
CHEMICAL REQUIREMENTS					
Calcium	mg/l	10	150	300	>300
Chloride	mg/l	100	200	600	>600
Chlorine (upper)	mg/l	0.6	0.8	1.0	>1.0
Chlorine (lower)	mg/l	0.3	0.2	0.1	<0.1
Electrical Conductivity	mS/m	70	150	370	>370
Fluoride	mg/l	0.7	1.0	1.5	>1.5

WATER QUALITY – Dissolved salts

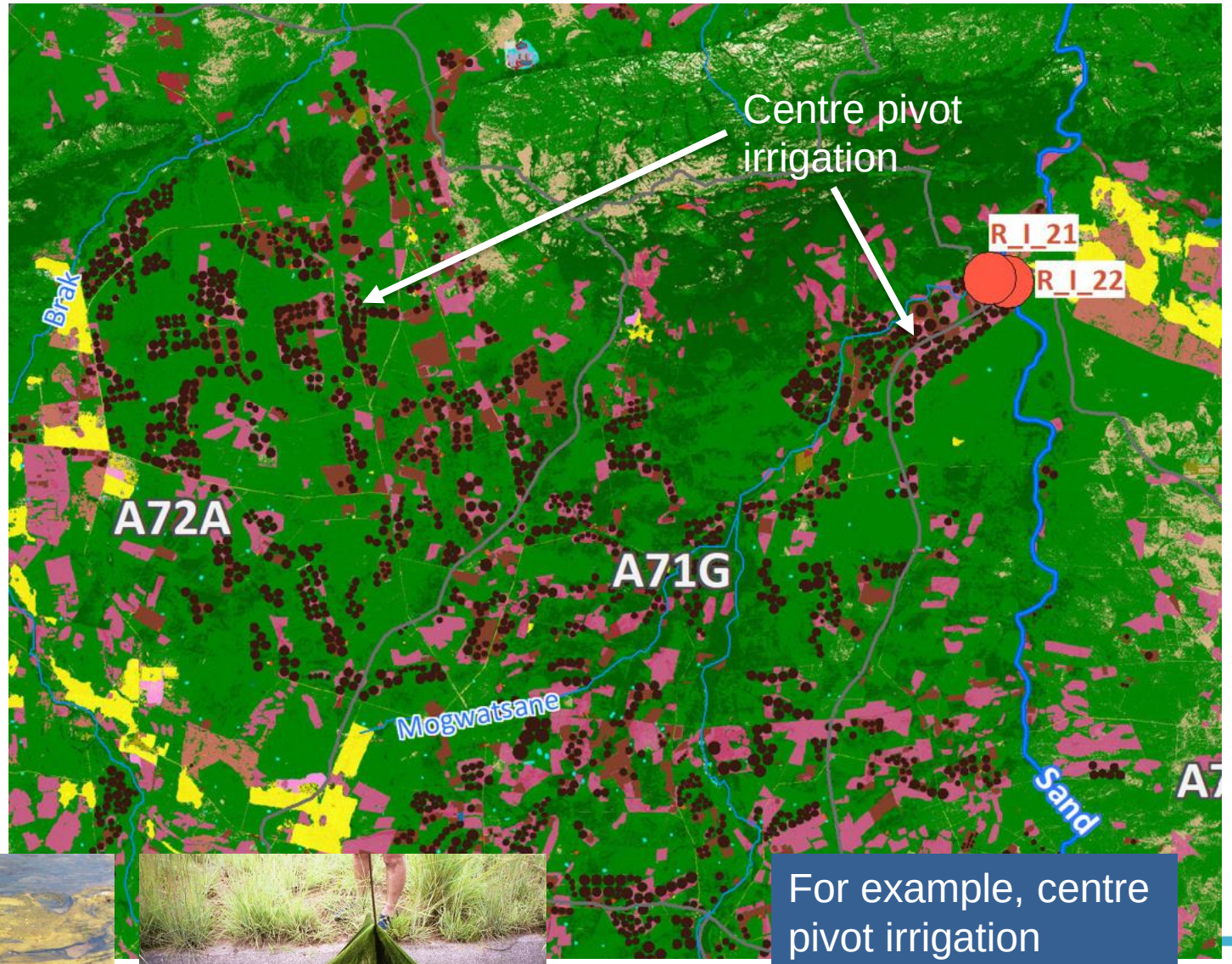
- Salts affect the
  - Taste of drinking water
  - Crop yields
  - Corrosion or scaling in household appliances

- Salts come from underlying geology, high evaporation, irrigation return flows, mining & industrial wastewater



WATER QUALITY – Nutrients

- Nutrients stimulate growth of aquatic plants
  - Algal blooms in dams
  - Taste & odours in drinking water
  - Toxic blue-green algae
  - Clogging of rivers and canals with filamentous algae
  - Dissolved oxygen
- Nutrients come from domestic wastewater, agricultural fertilizers, and urban runoff.

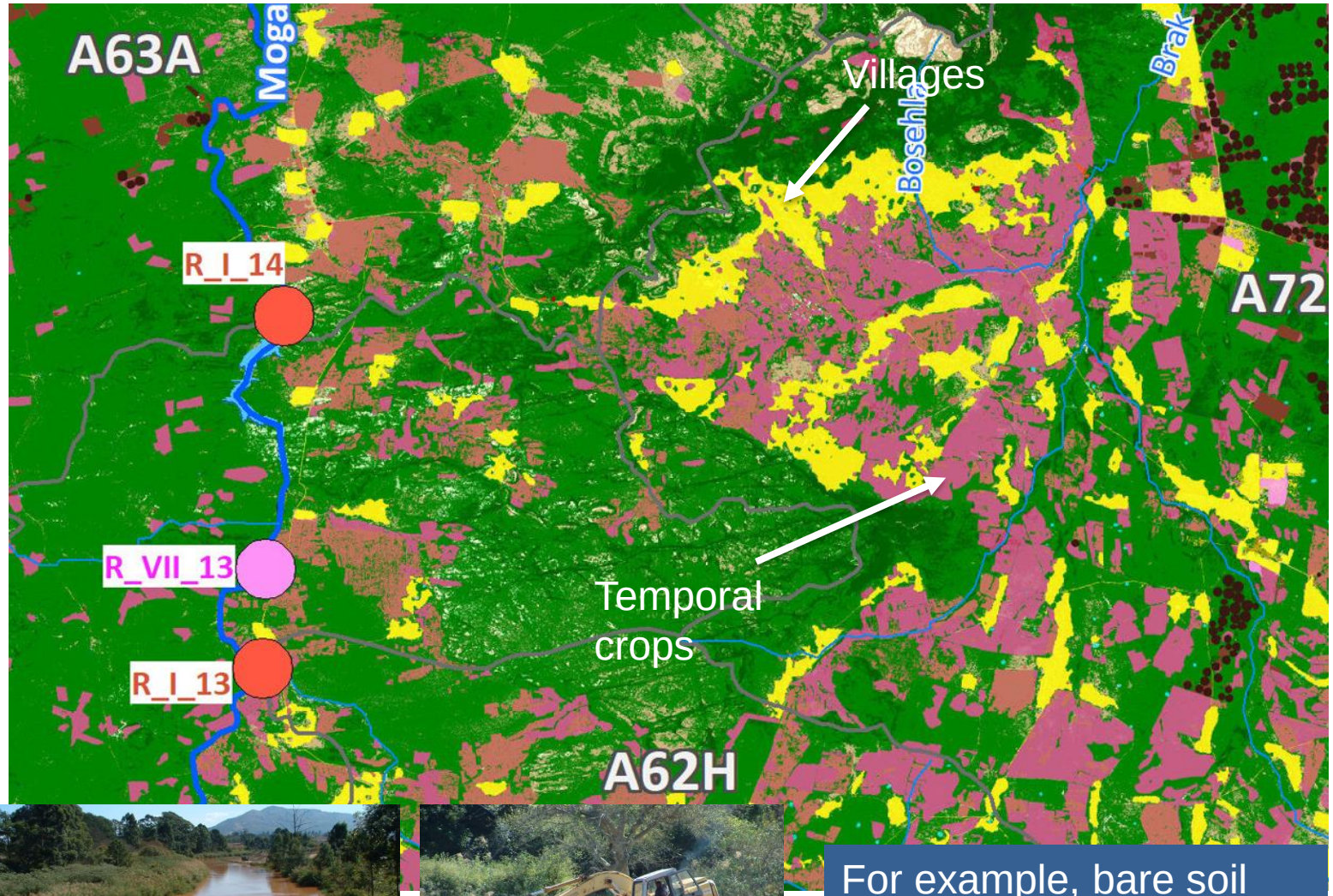


For example, centre pivot irrigation schemes

WATER QUALITY – Suspended sediments

- Suspended sediments affect the
  - Drinking water treatment
  - Storage capacity of rivers and dams
  - Reduce underwater light
  - Smothers habitat of aquatic biota
  - Transport medium for nutrients, pathogens, metals & toxic substances

- Suspended sediments come from erosion, urban runoff, mining, over grazing, sand mining, roads, deforestation

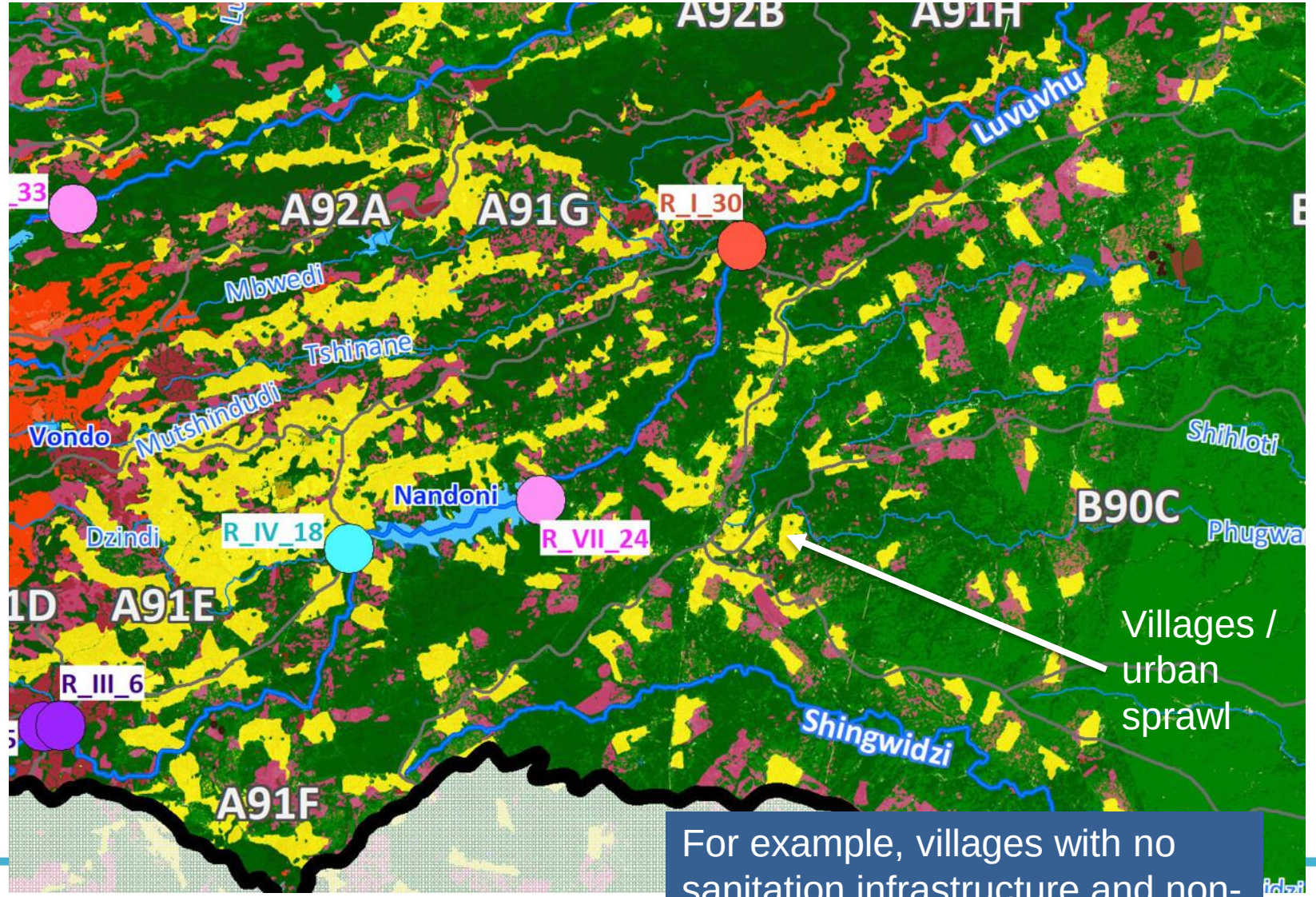


For example, bare soil and roads in villages, subsistence agriculture

WATER QUALITY – Waterborne diseases

- Waterborne diseases caused by pathogens in water….
  - Cause outbreaks of e.g. cholera, diarrhea, etc.
  - Skin diseases and rashes
  - Can be fatal to humans, especially infants, elderly and sick people

- Pathogens come from poorly treated wastewater, grey water disposal, leaking sewers and inadequate sanitation, bush toilets, feedlots.



For example, villages with no sanitation infrastructure and non-functioning sewage works

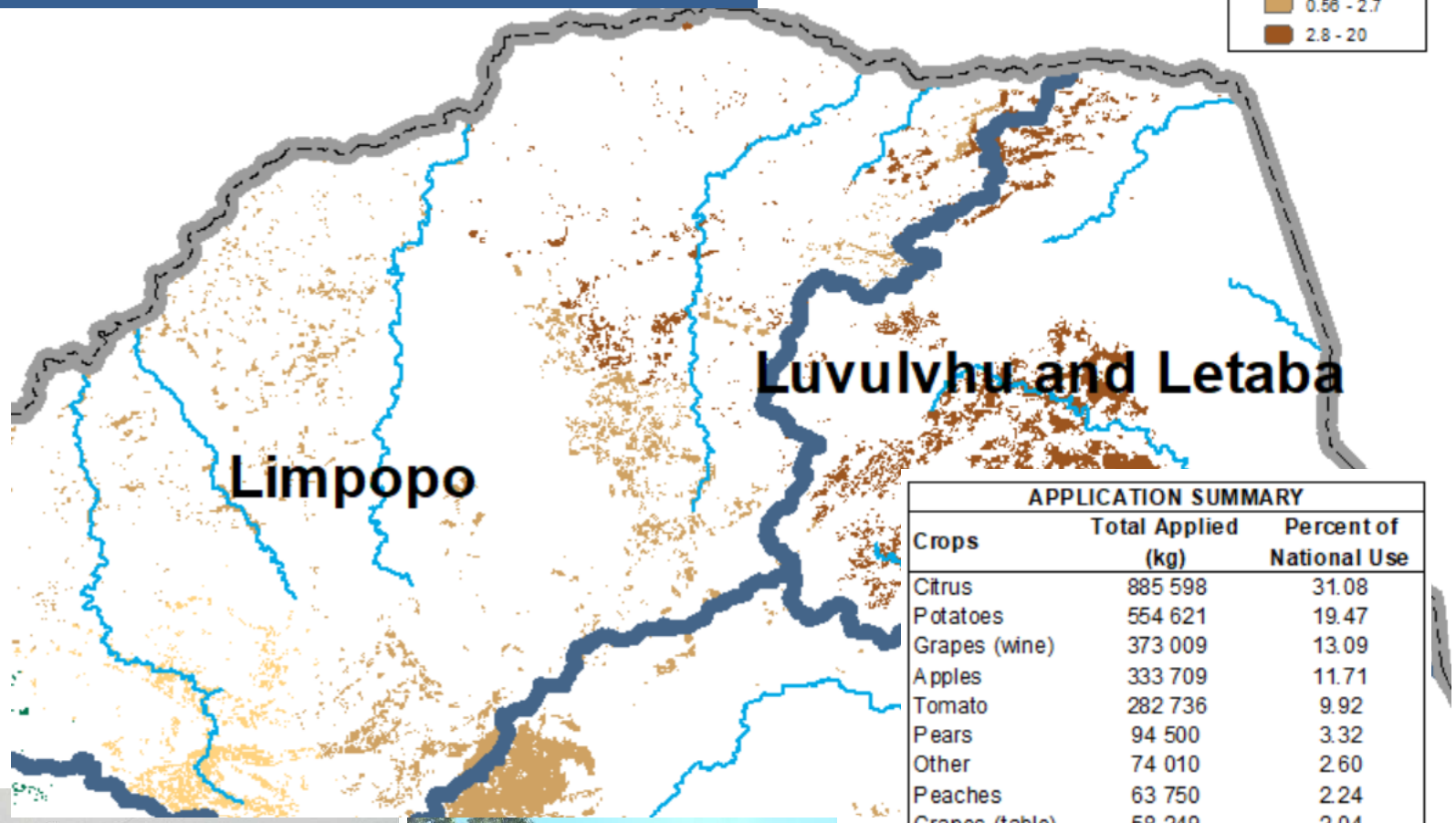
WATER QUALITY – Agricultural chemicals

- Agrochemicals refers to the wash-off of pesticides and herbicides into streams and rivers.

- Can have chronic or acute impacts on aquatic biota.

- Agrochemicals come from…
  - Spray drift into water courses
  - Wash-off of pesticides into surface and groundwater
  - Pesticides that adhere (cling to) onto soil or organic particles

For example, application of Mancozeb



APPLICATION SUMMARY		
Crops	Total Applied (kg)	Percent of National Use
Citrus	885 598	31.08
Potatoes	554 621	19.47
Grapes (wine)	373 009	13.09
Apples	333 709	11.71
Tomato	282 736	9.92
Pears	94 500	3.32
Other	74 010	2.60
Peaches	63 750	2.24
Grapes (table)	58 249	2.04
Green Beans	36 000	1.26
Plums	26 239	0.92
Groundnuts	24 750	0.87
Mangoes	24 750	0.87
Pineapples	7 349	0.26
Bananas	5 250	0.18
Apricots	4 500	0.16

WATER QUALITY – Next steps

- Prepare water quality for the DRIFT process (Ecological water quality requirements)
- Define Resource Water Quality Objectives to meet the Ecological and other user requirements (domestic, agricultural, industrial, and recreational water users)

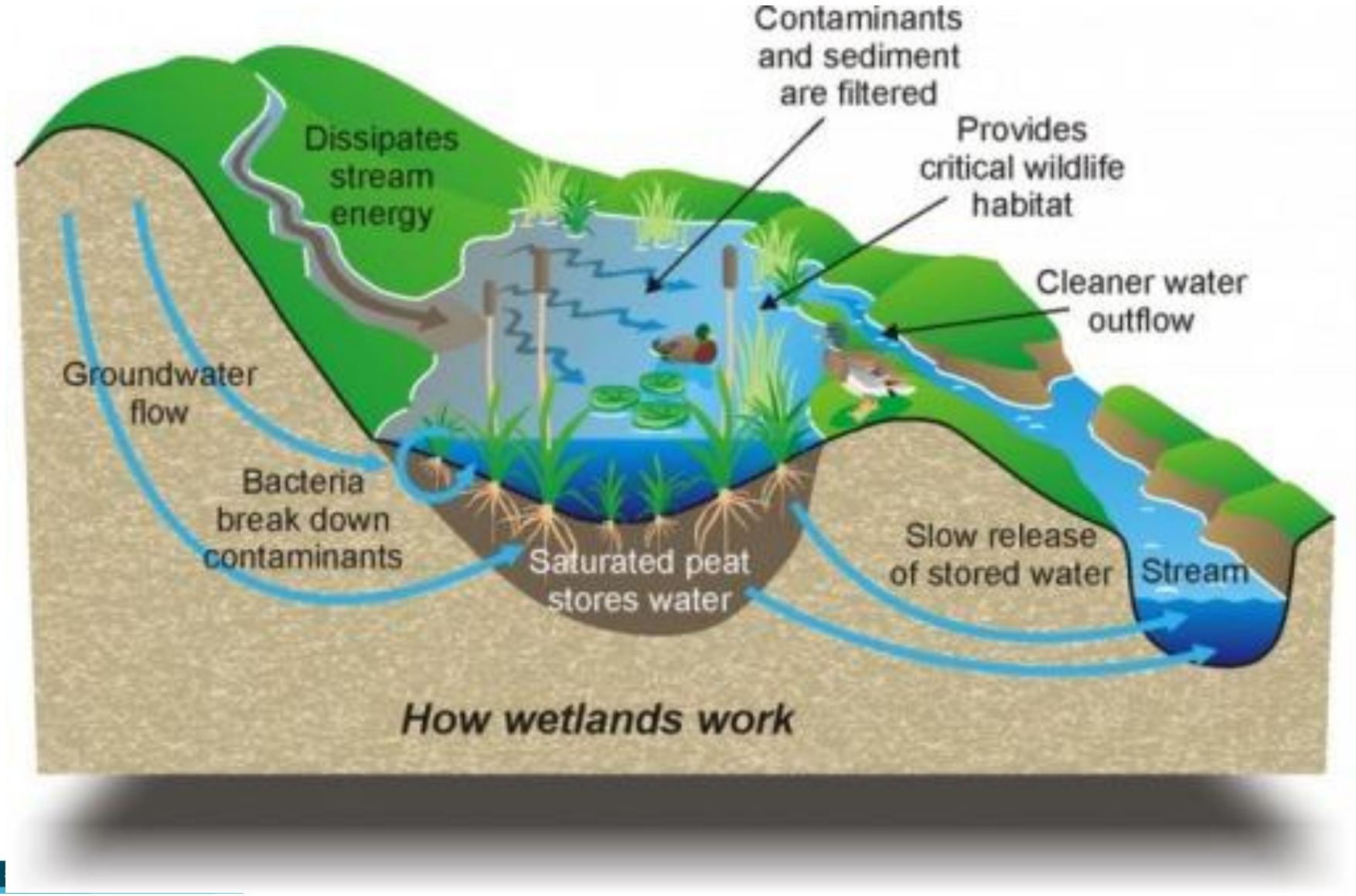
WETLANDS

WETLANDS

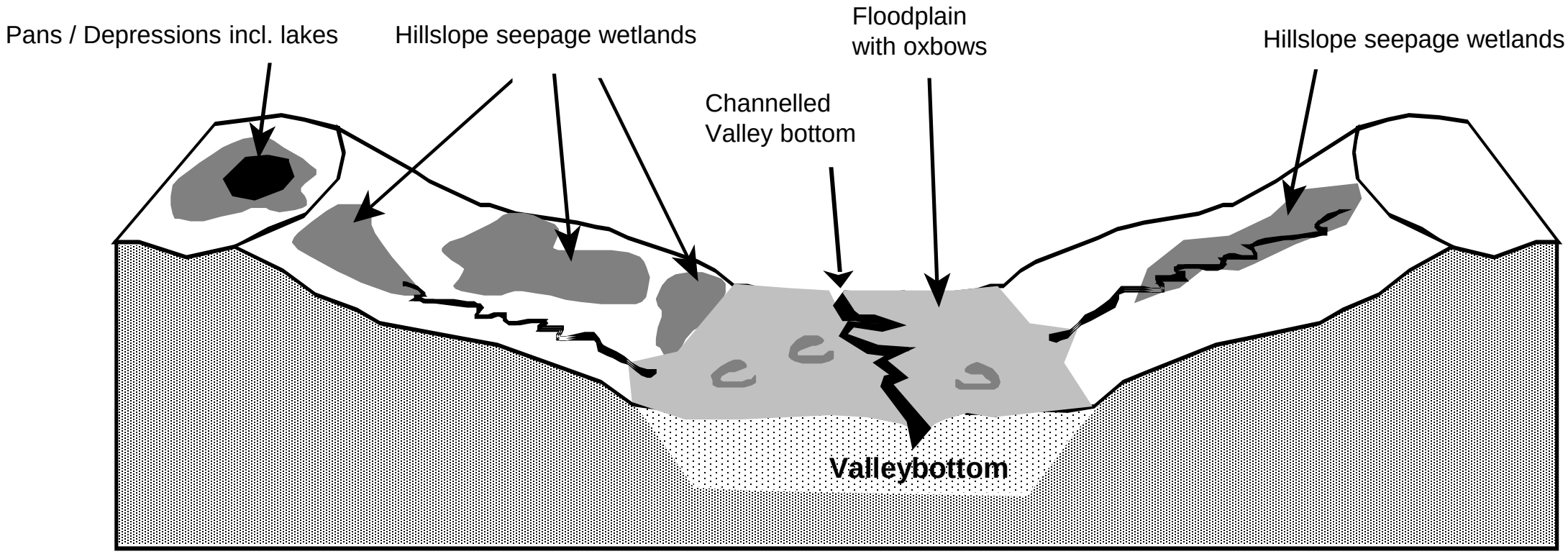
The information presented here is predominantly based on the following data sources:

- The wetland spatial distribution and metadata from the 2018 national biodiversity assessment (van Deventer *et al*., 2018).
- The wetland metadata from the National Freshwater Ecosystem Priority Areas study (NFEPA; Nel *et al.*, 2011).
- Wetland spatial and ecological data from the National Spatial Biodiversity Assessment (Driver *et al.*, 2005).

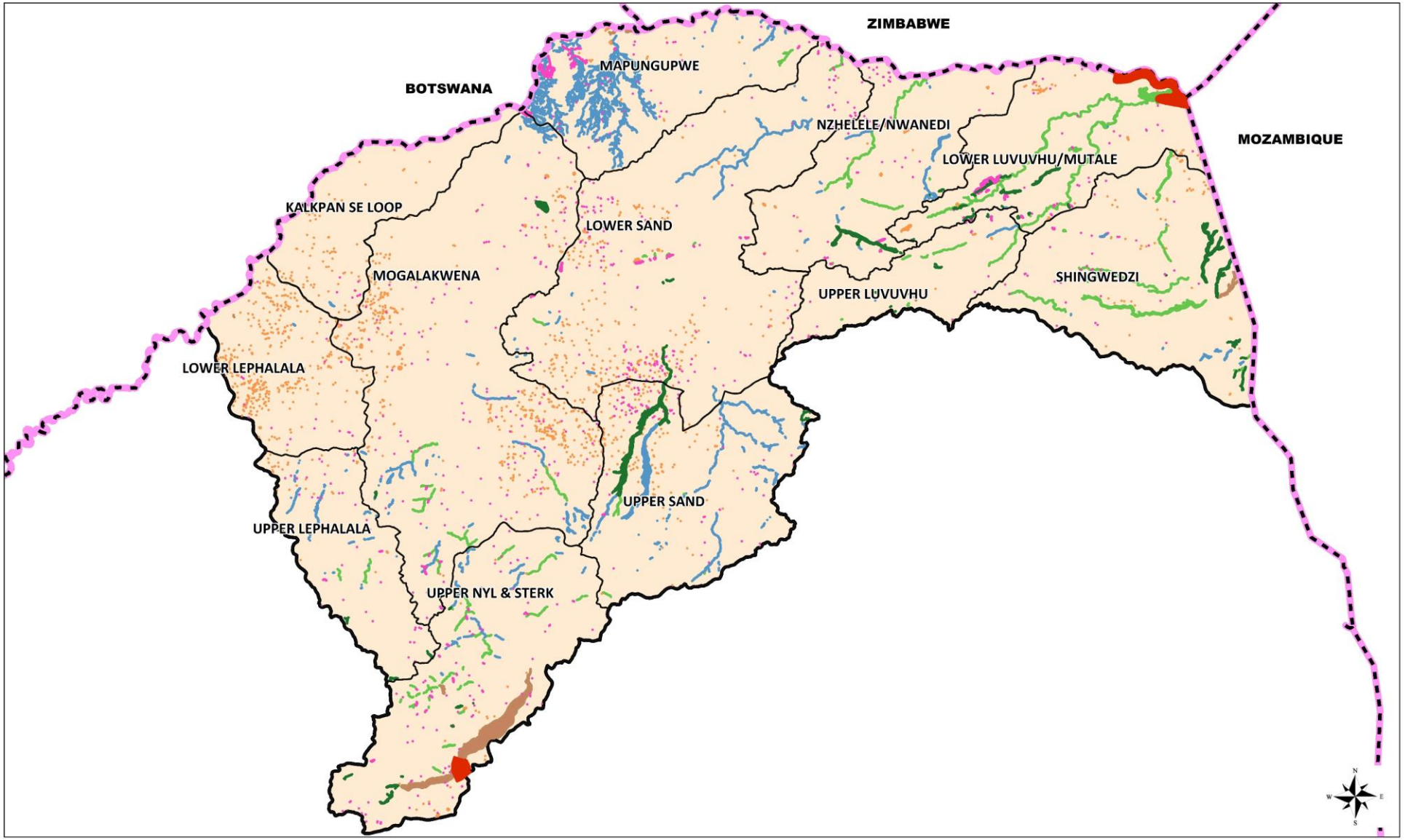
BASIC WETLAND FUNCTION



WETLAND TYPES



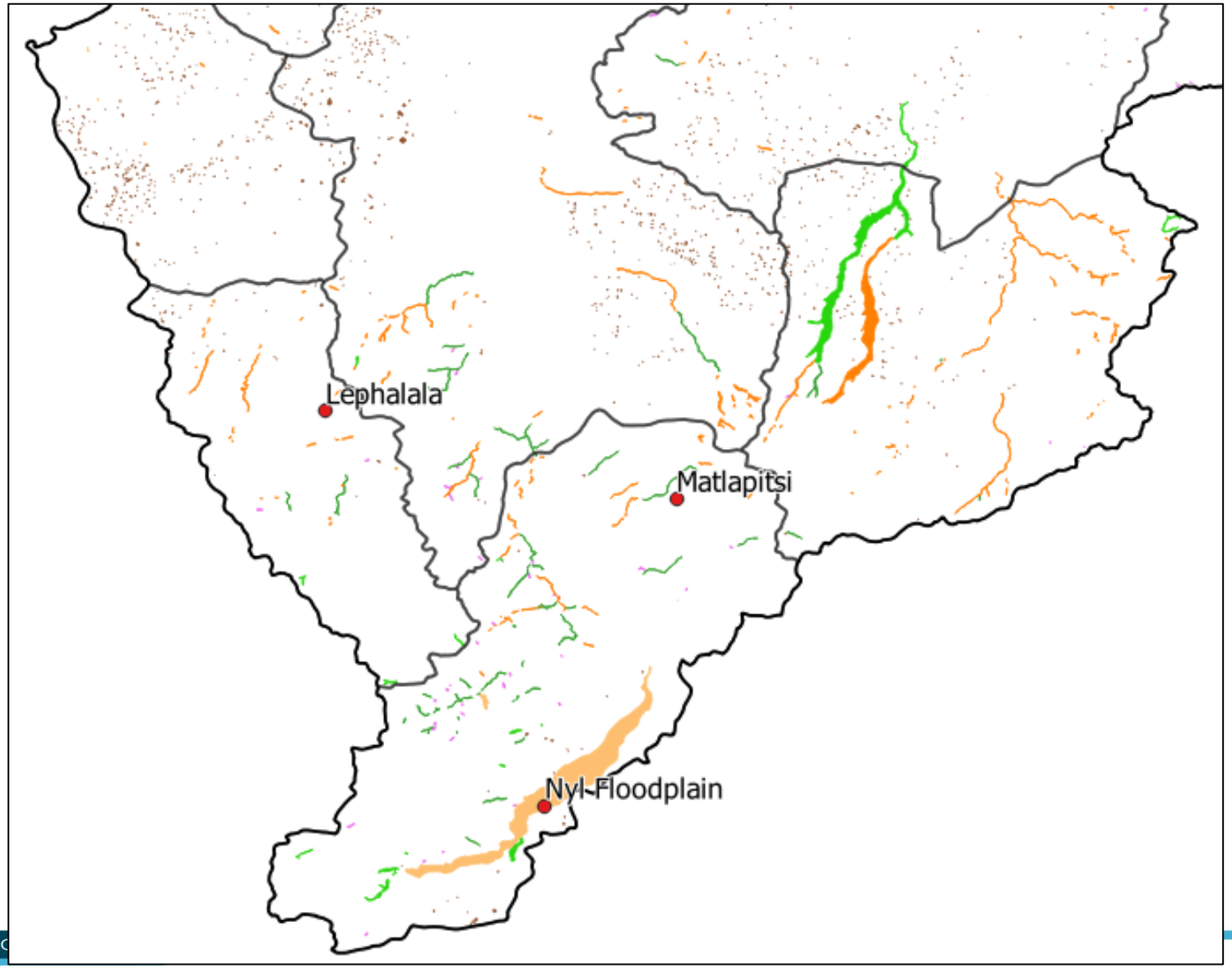
WETLANDS: Distribution of Different Types in the Study Area



Extent of wetlands (% area)

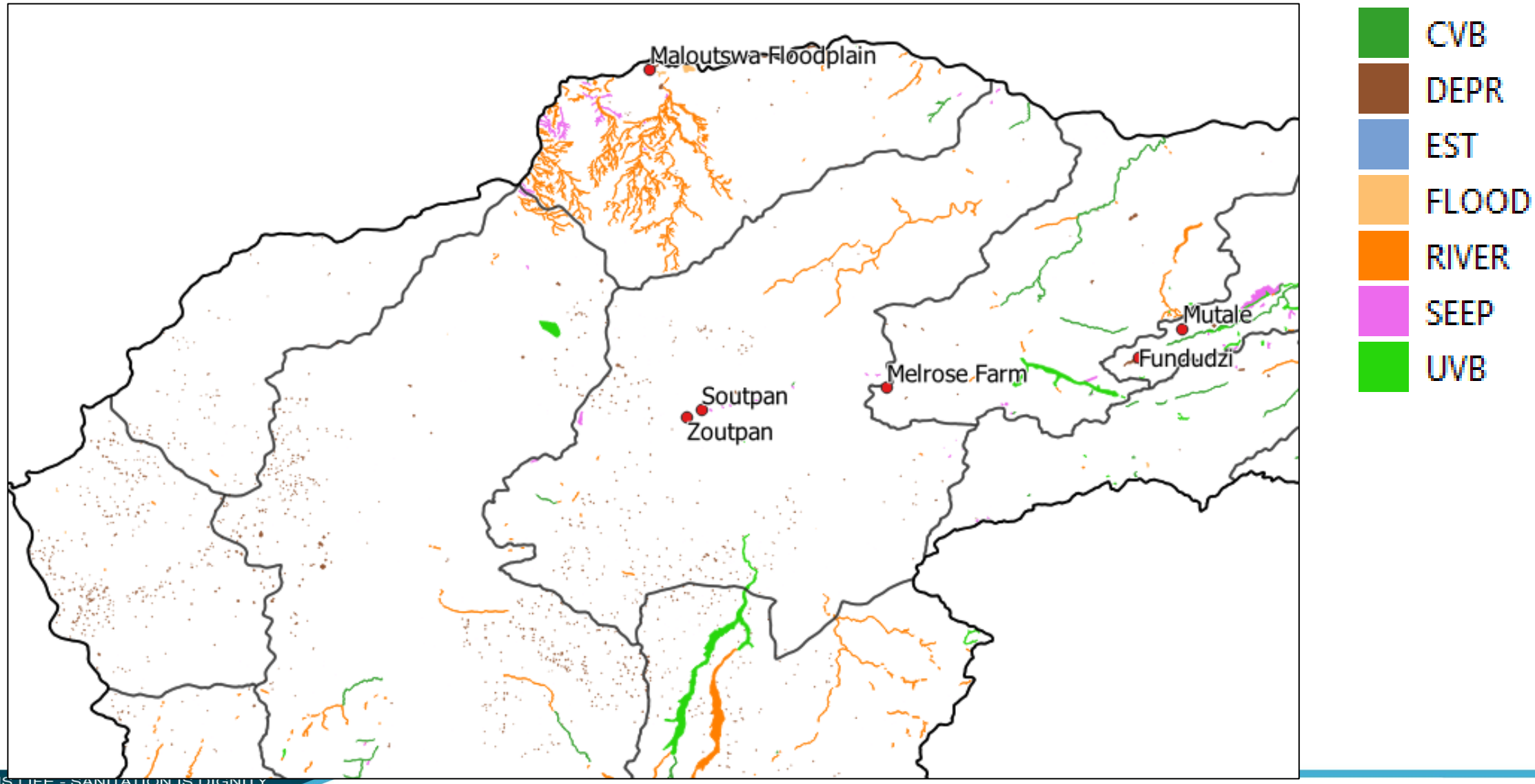
FLOOD	59.5
CVB	16.0
UVB	12.8
RIVER	10.5
DEPR	0.6
SEEP	0.6

WETLANDS: NSBA named wetlands

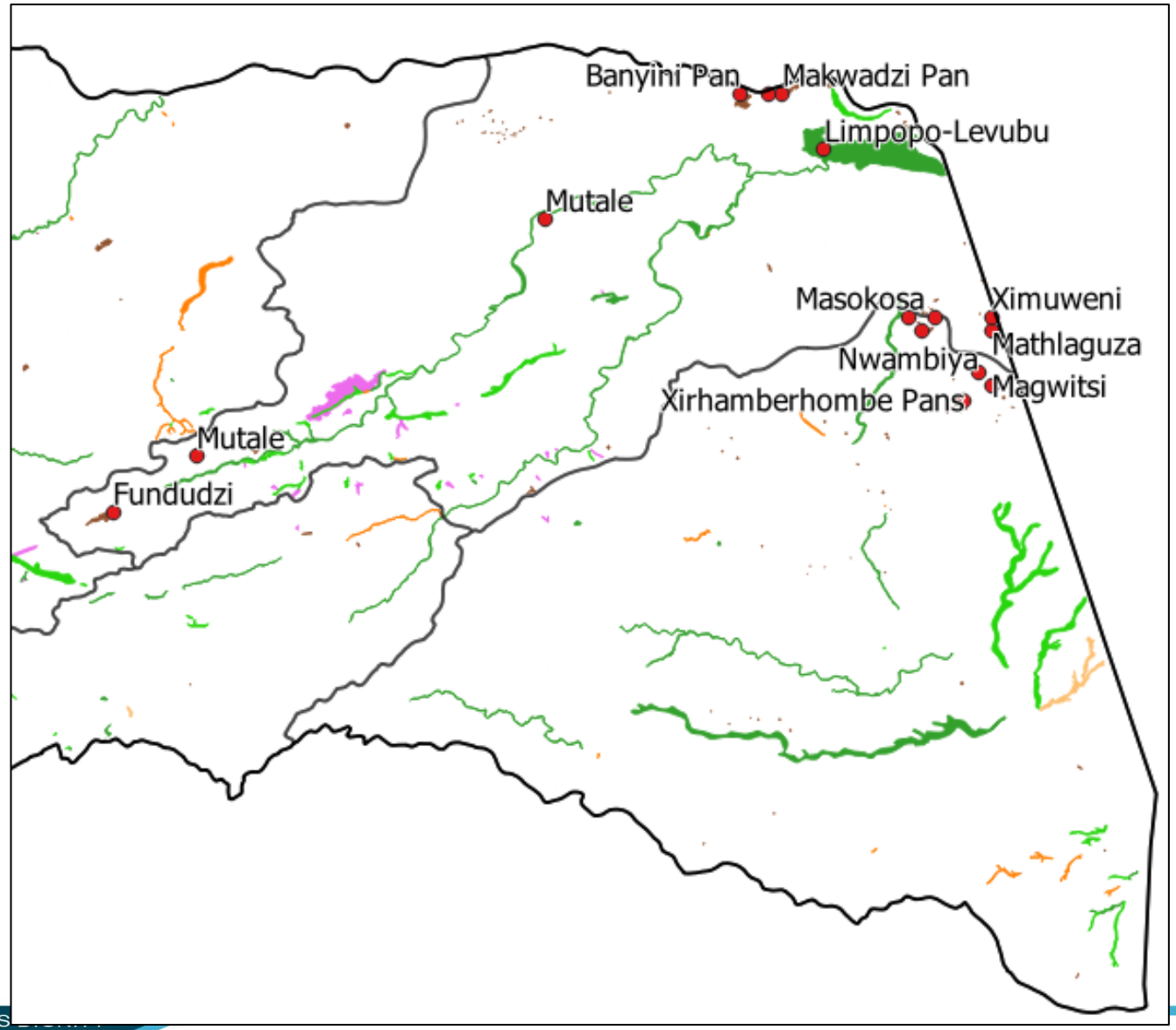


CVB
DEPR
EST
FLOOD
RIVER
SEEP
UVB

WETLANDS: NSBA named wetlands

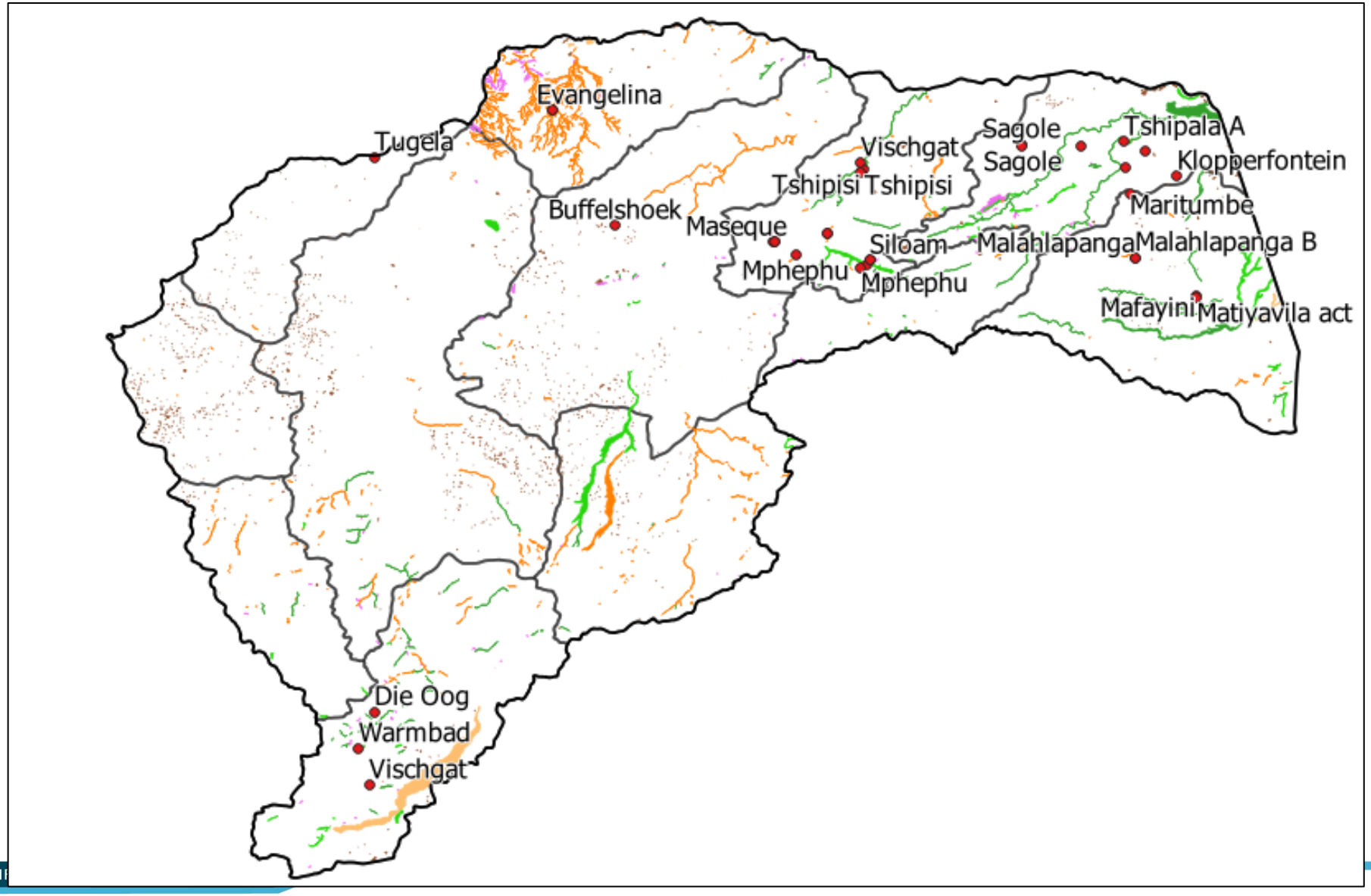


WETLANDS: NSBA named wetlands

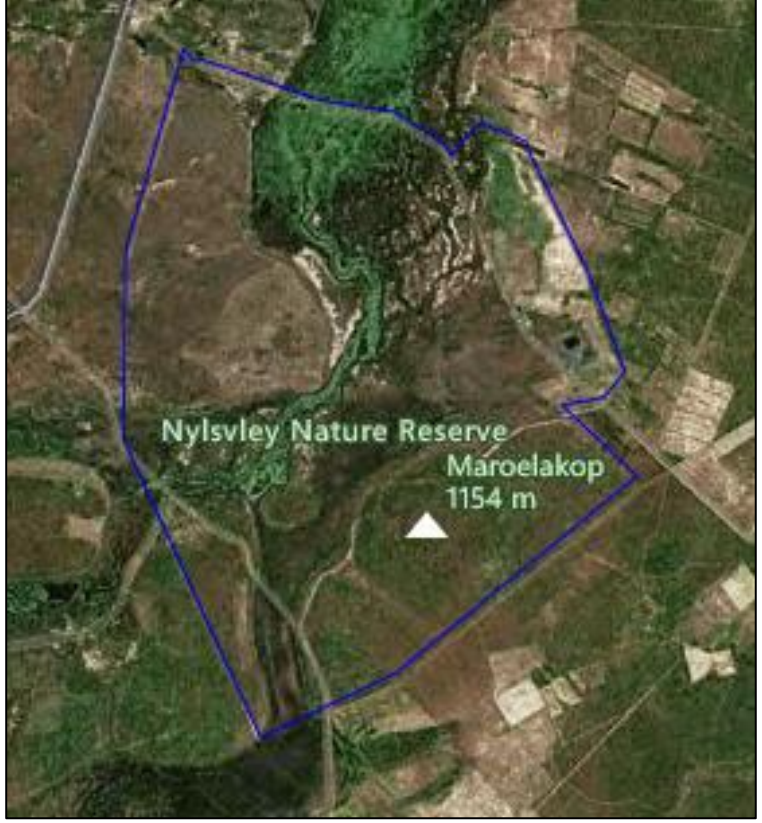


CVB
DEPR
EST
FLOOD
RIVER
SEEP
UVB

WETLANDS: Thermal springs



WETLANDS: Ramsar wetlands



Nylsvley Nature Reserve

Ramsar site no. 952

Date: 07/07/1998

Location: Limpopo Province, South Africa

Size: 3,970 ha

Coordinates: 24º39'S 028º42'E

Status/Type: Nature Reserve.

Description: The nature Reserve has riverine floodplains, flooded river basins, and seasonally flooded grassland, with the dominant wetland type being a seasonal river associated with a grassland floodplain. The wetland has the endangered roan antelope *Hippotragus equis*, and the area serves as a breeding ground for eight South African red-listed waterbirds and is the only site in South Africa which is a recorded locality for wild rice, *Oryza longistaminata*. The area is open to tourists, who usually come for birdwatching, and has high research value.

WETLANDS: Ramsar wetlands

Makuleke Wetlands

Ramsar site no. 1687

Date: 22/05/2007

Location: Limpopo, South Africa

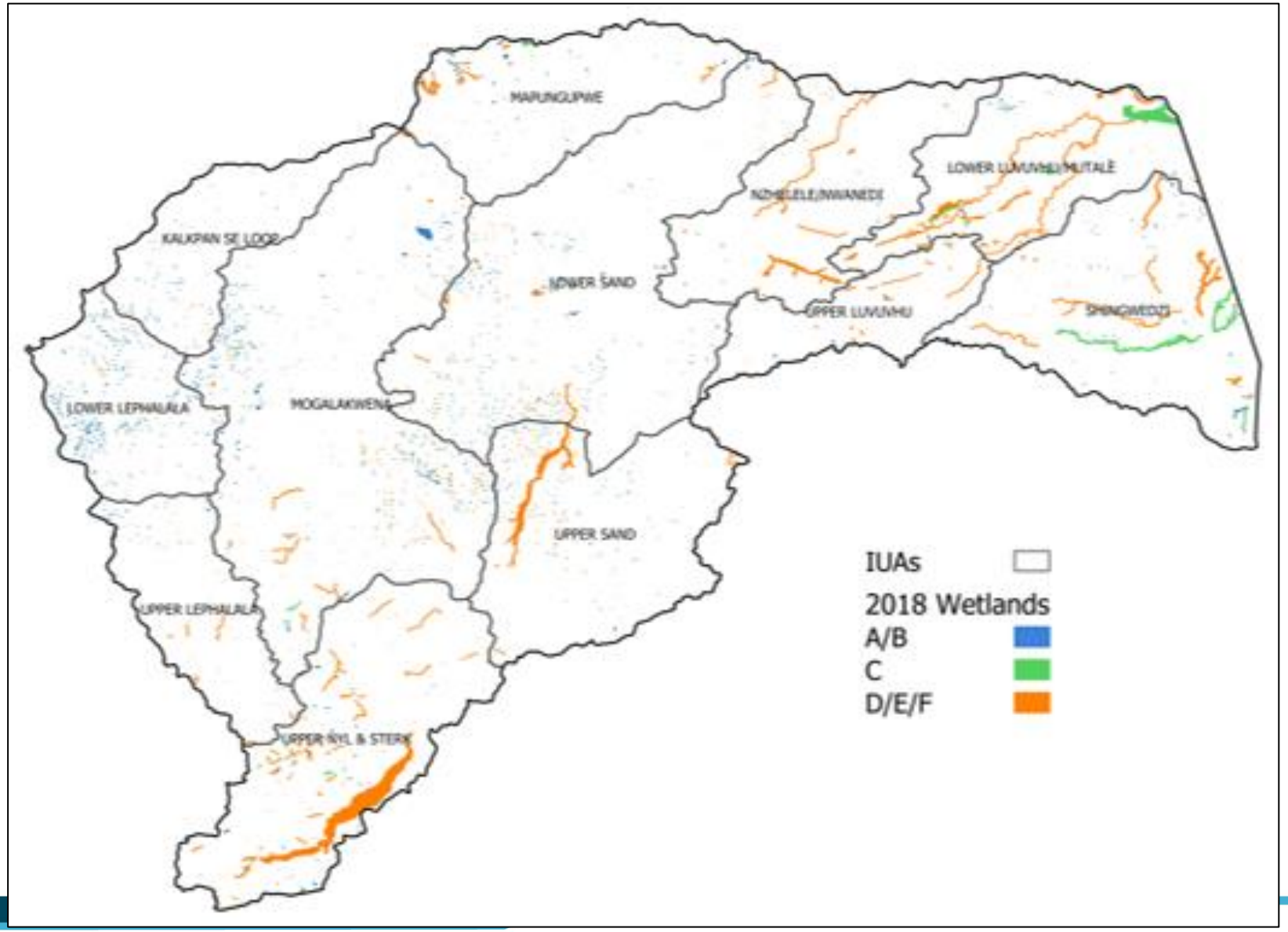
Size: 7,757 ha

Coordinates: 22°23'S 031°11'E

Status/Type: National Park

Description: An excellent example of a floodplain, most of which lies within the Kruger National Park, bordered by Zimbabwe and Mozambique to the north and east. Prominent features include riverine forests, riparian floodplain forests, floodplain grasslands, river channels and flood pans. Flood pans are of great importance in this ecosystem as they hold water right into the dry season. The floodplains are important for groundwater recharge, and maintain riparian and floodplain vegetation.

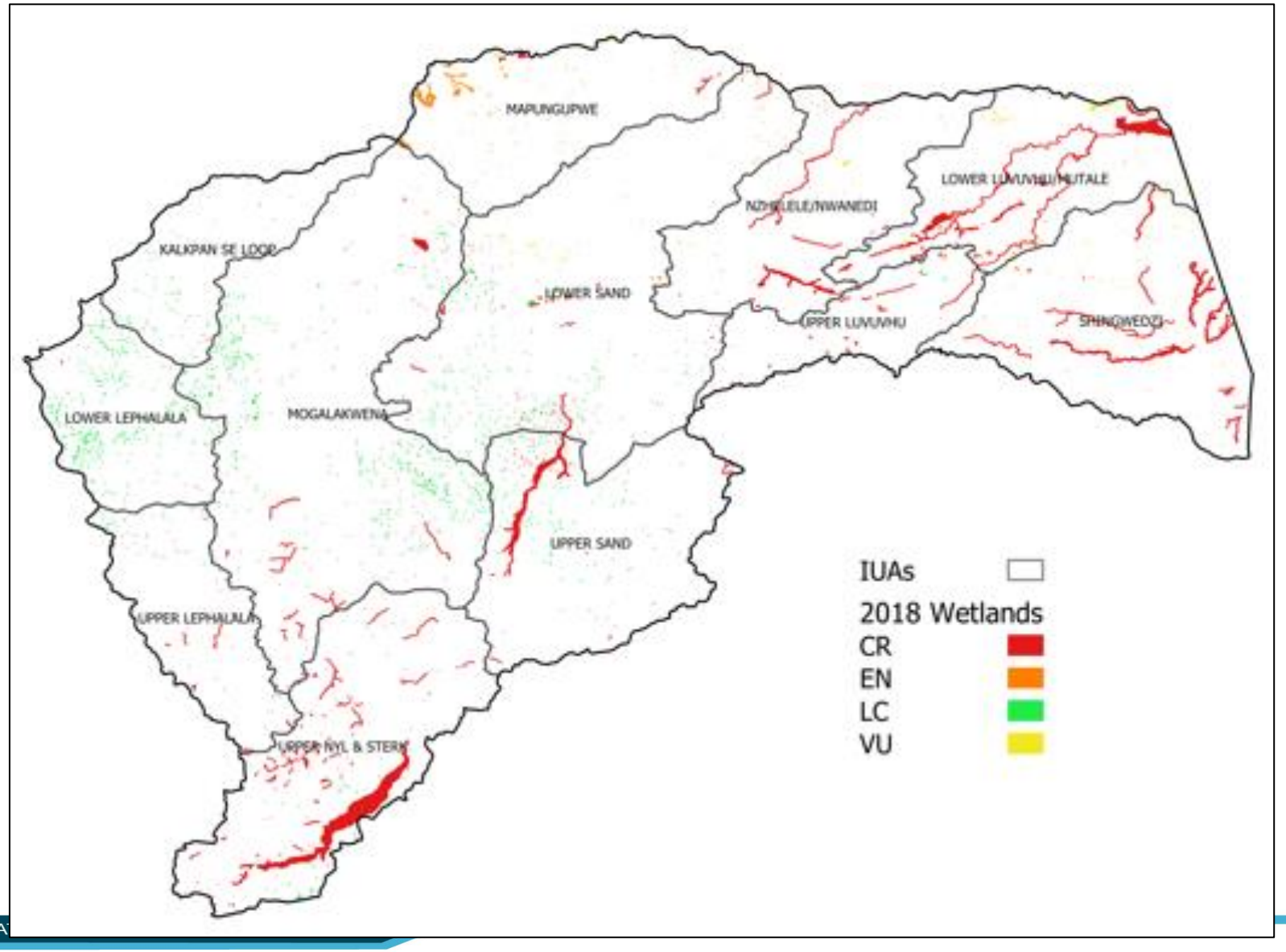
WETLAND STATUS QUO: Condition



Extent of wetlands
(% Area)

A/B	0.6
C	4.9
D/E/F	84.1
Not Assessed	10.5

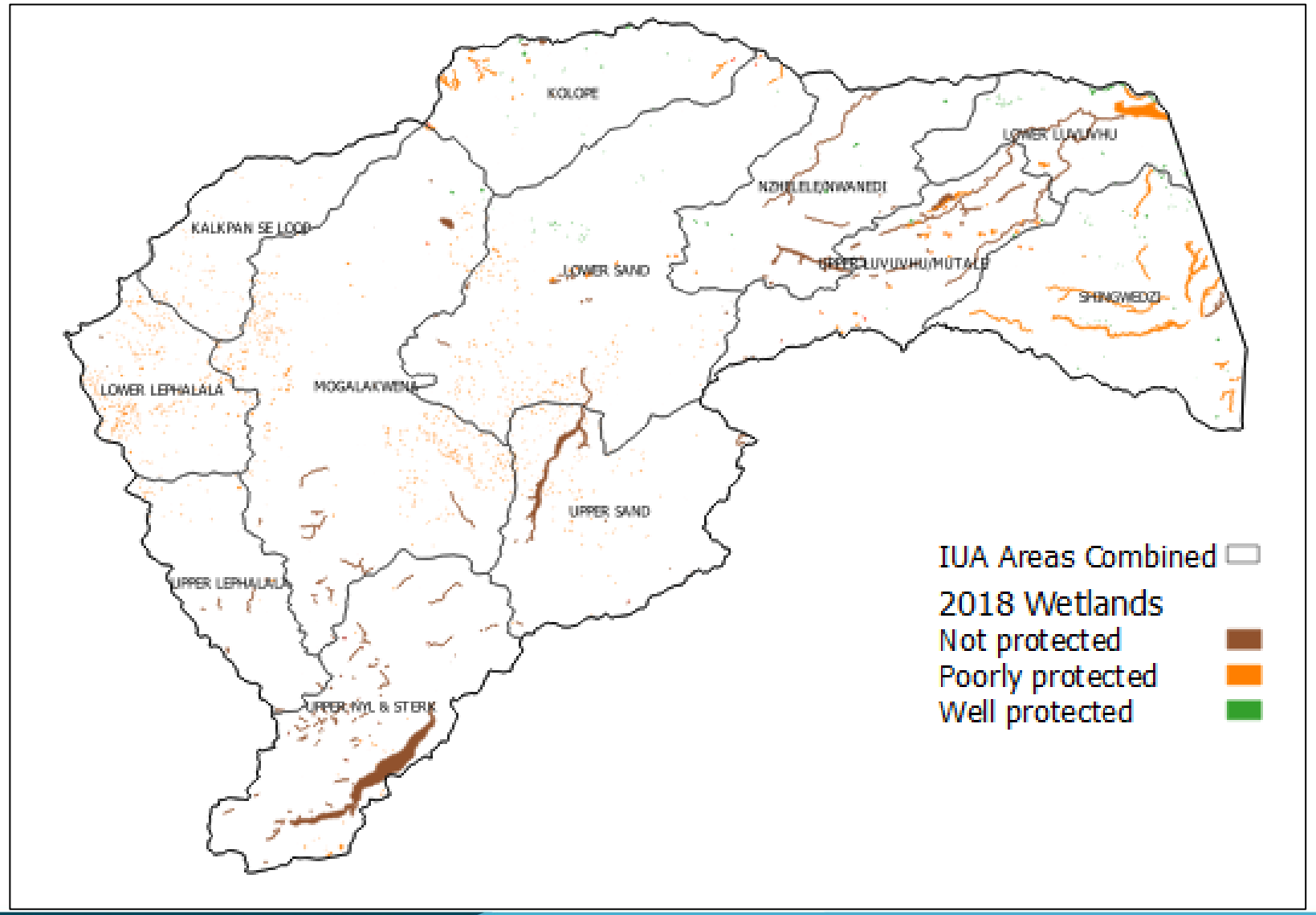
WETLAND STATUS QUO: Threat Status



Extent of wetlands (% area)

CR	**88.8**
EN	**0.2**
LC	**0.4**
VU	**0.2**
Not Assessed	**10.5**

WETLAND STATUS QUO: Protection Level



Extent of wetlands (% area)

Not protected	**82.6**
Poorly protected	**6.7**
Well protected	**0.2**
Not Assessed	**10.5**

WETLANDS: NEXT STEP

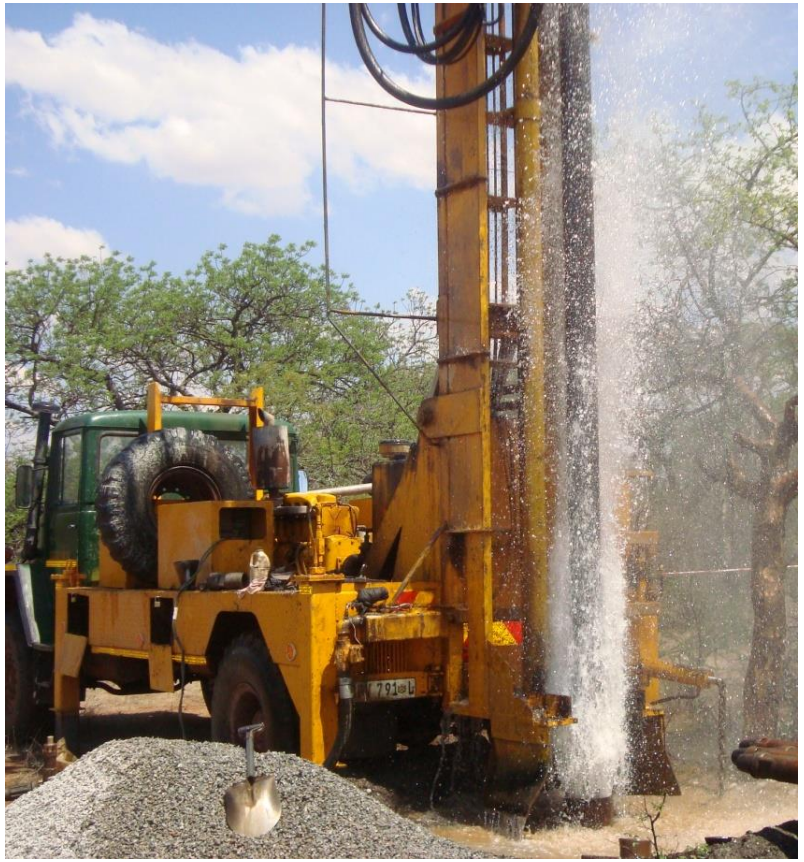
The next step in the wetland component of this study is the prioritization of wetlands and includes the following:

- Step 1: Determine dominant wetland PES at quinary catchment / RU scale
- Step 2: Determine wetland ecological importance (EI) at the same scale as above
- Step 3: Determine wetland sensitivity (ES) at the same scale as above
- Step 4: Determine the wetland importance score (IS) by integration of EI, ES and socio-cultural importance (SCI)
- Step 5: Determine integrated environmental importance of wetland/s (IEI) by integration of IS and PES
- Step 6: Determine wetland priority by integration of IEI and Water Resource use importance (WRUI)
- Step 7: Contribute to determination of High Priority Areas by integration with other components.

GROUNDWATER

GROUNDWATER

Groundwater plays an important role in water supply within the study area providing domestic, agricultural, mining, industrial water in the order of approximately 370 Mm³/year.

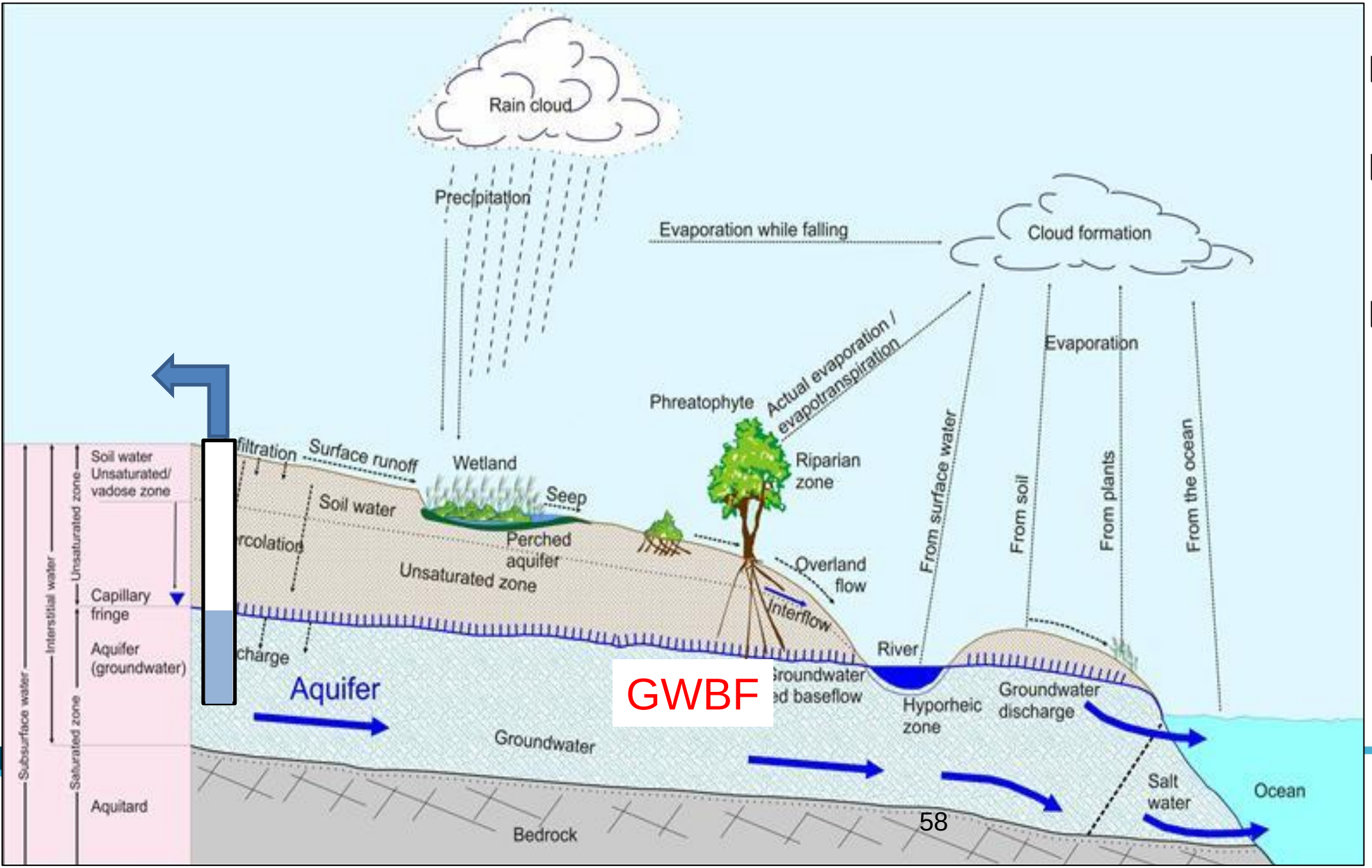


- Groundwater is also essential for maintaining river baseflow and the ecology in the dry season
- The study area hosts (6) groundwater source areas of national significance (Le Maitre, et al., 2019) and two international transboundary aquifers
- 47 towns depend on groundwater for >50% of the water supply
- Thirty-one percent of all (GW) geothermal springs in the country are found in the Limpopo province
- Groundwater is earmarked for further development in several catchments (including Strategic Economic Zones) and is already heavily used in some.

GROUNDWATER

- The study will collate and assess existing national and local groundwater datasets
- Additional knowledge will be gained on groundwater uses (through stakeholder engagement, i.e., public meetings) as the project unfolds
- The database will be augmented with site verification of priority areas (yet to be determined)
- Groundwater quality forms part of the assessment to inform Resource Quality Objectives (RQOs) → Elevated Nitrate and Fluoride (commonly reported)

GROUNDWATER



- GW and SW are connected
- GW abstraction reduces discharge to rivers
- Health of river (& Eflow for specified category) is related to level of GW use

GROUNDWATER (Water Resource Class)

Water Resource Class (WRC)

- a WRC is established for an IUA, based on set criteria (i.e. the percentage of biophysical nodes within that IUA that fall into a particular ecological category EC)
- groundwater abstraction impacts discharge, GWBF, hence river flow, hence can impact EC
- groundwater (& use) is therefore related the WRC of the IUA, and has a role in supporting this WRC through its contribution to baseflow, and hence towards part of the Eflows, and hence the EC.

GROUNDWATER (Reserve)

There is a groundwater component of the Reserve.

- A WRC may be established based on a required EC, which has related EFlows. This in turn dictates the amount of groundwater contribution to baseflow (GWBF) is required to be maintained in the river to maintain the EFlows, and hence the groundwater use that is permissible under the WRC.
- **This GWBF is protected in the Groundwater component of the Ecological Reserve**
- **Current groundwater use for people is protected in the BHN component of the Reserve**

$$Reserve(\%) = \frac{EWRgw + BHNgw}{Re} \times 100$$

where

Re	=	recharge
BHN_{gw}	=	basic human needs derived from groundwater
EWR_{gw}	=	groundwater contribution to EWR

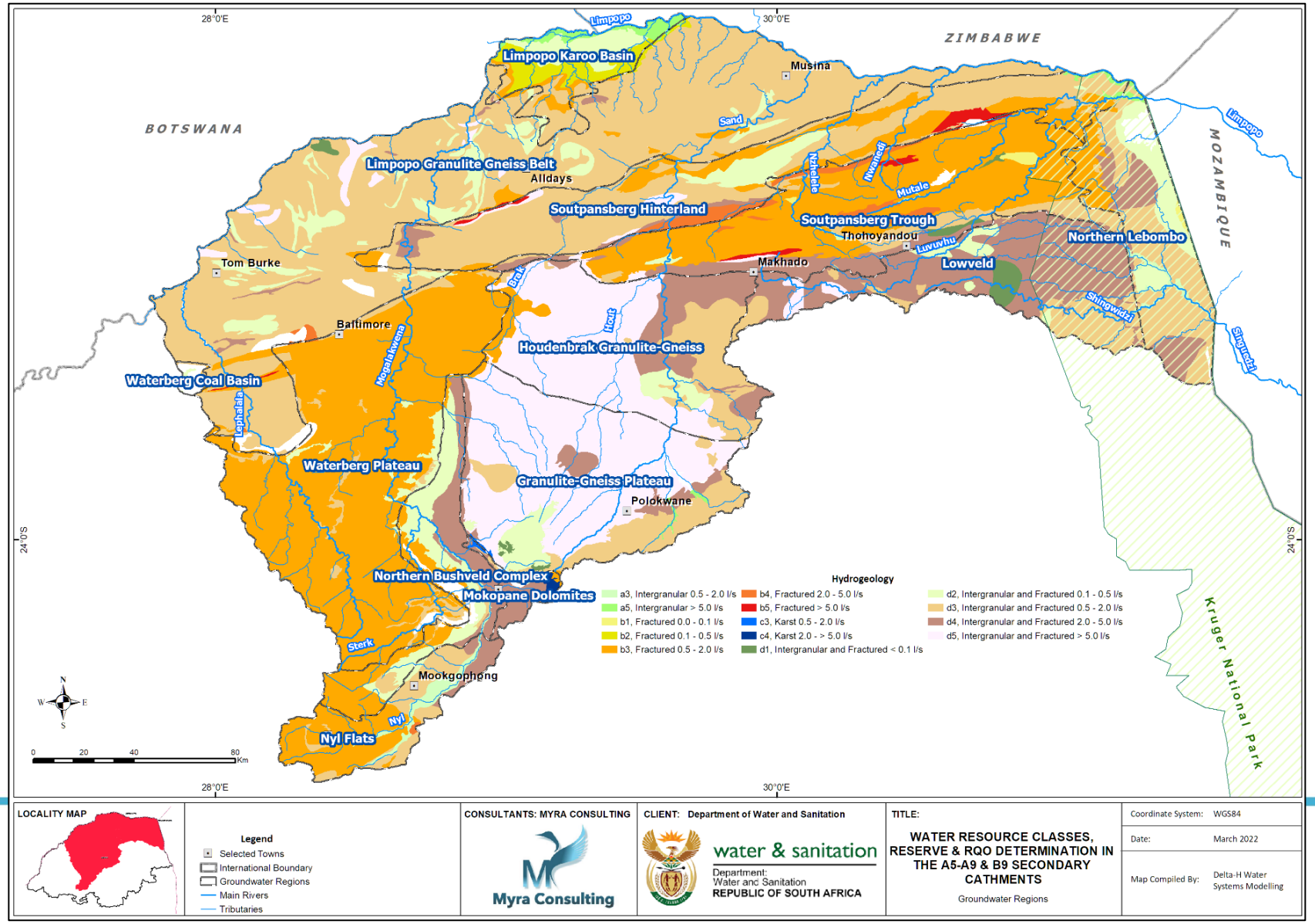
GROUNDWATER (Resource Units)

- Basis for the delineation is similar geological rocks that has uniform water bearing properties →

gw must be considered in terms of an integrated water resource

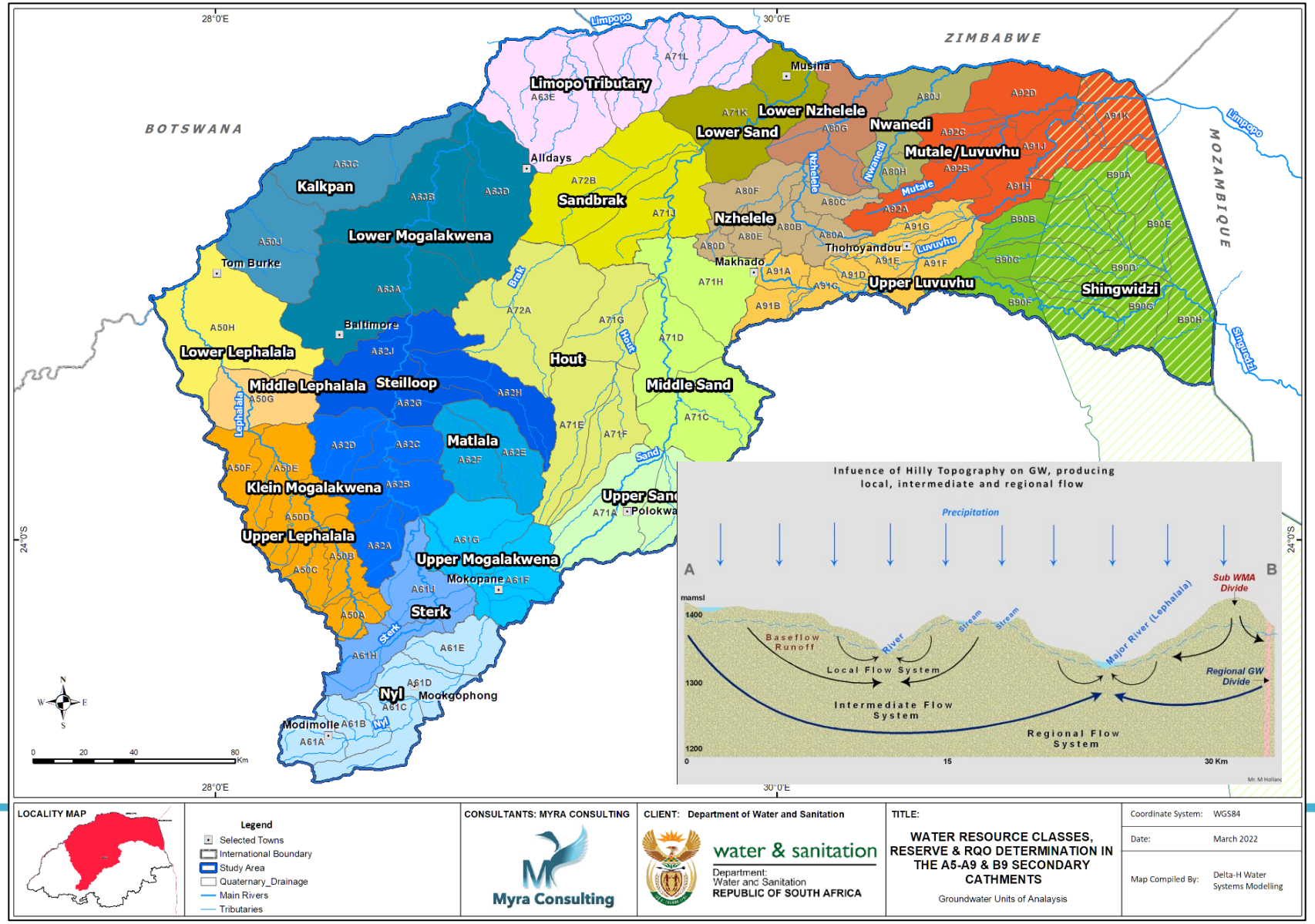
- Groundwater table mimics the surface topography at the regional scale→

catchment boundaries act as <u>groundwater divide</u>



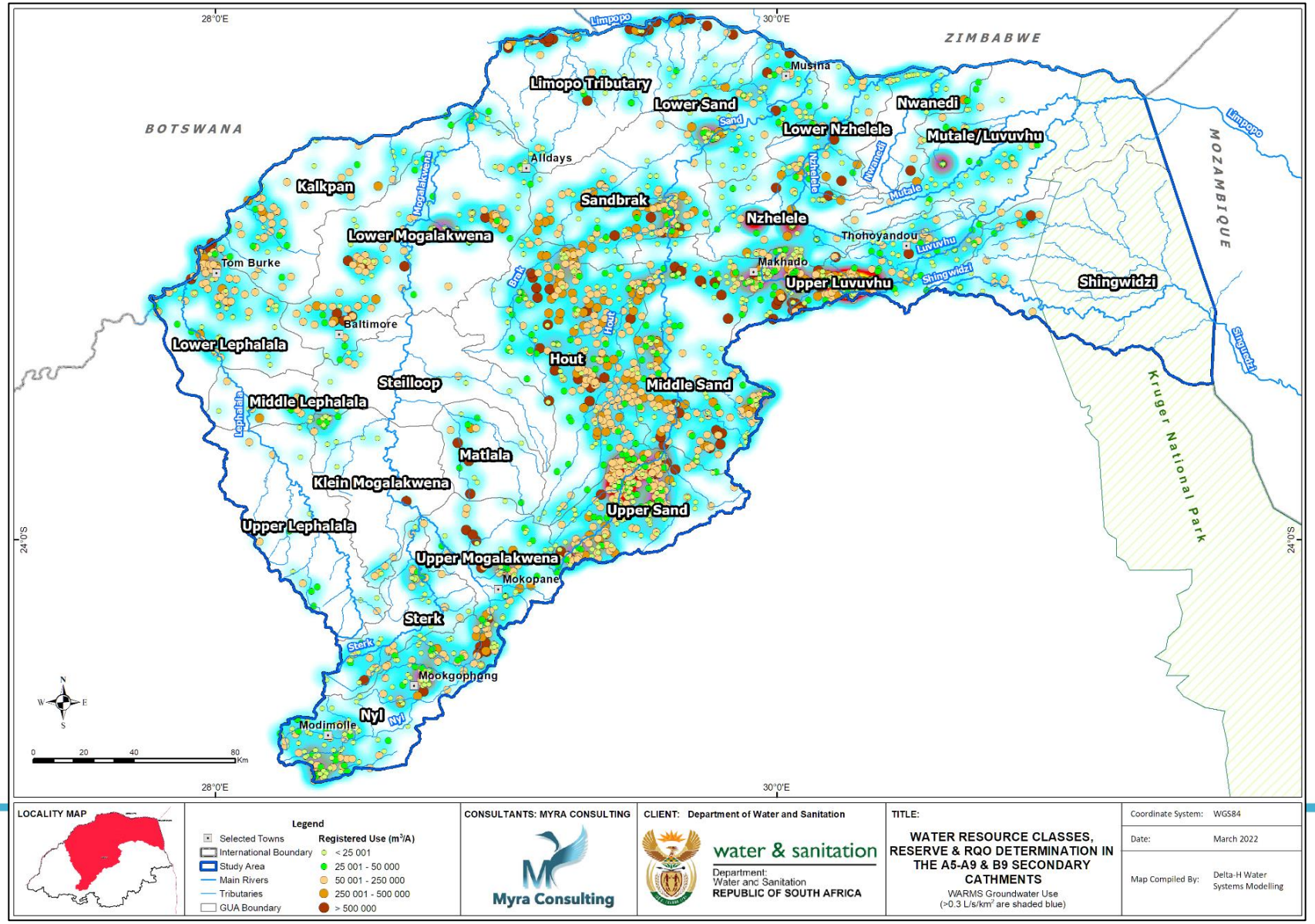
GROUNDWATER (Resource Units)

- The quaternary catchments were used as the basis for delineation, for the Groundwater Units of Analysis (GUAs)→ comprise of a single or a combination of quaternary catchments



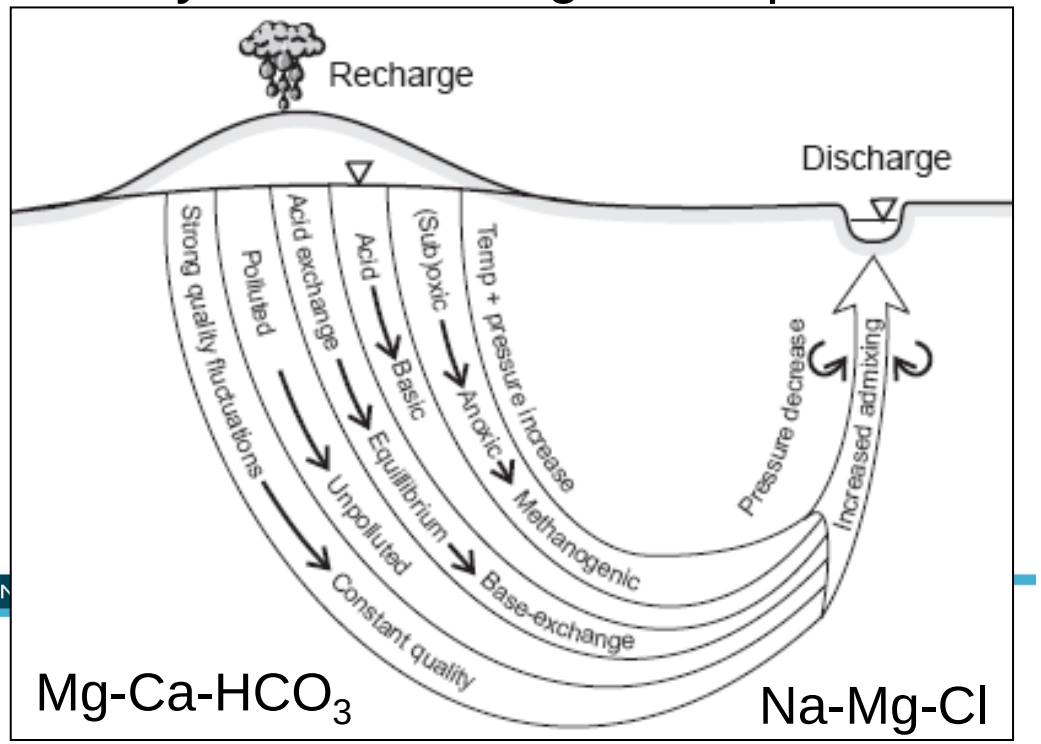
GROUNDWATER (use)

- Distribution of registered groundwater use (>0.3 L/s/km^2 shaded)→ compared against harvest (and groundwater exploitation potential) (to determine utilisation percentage)



GROUNDWATER (Assessment, e.g., GUA: A71-3)

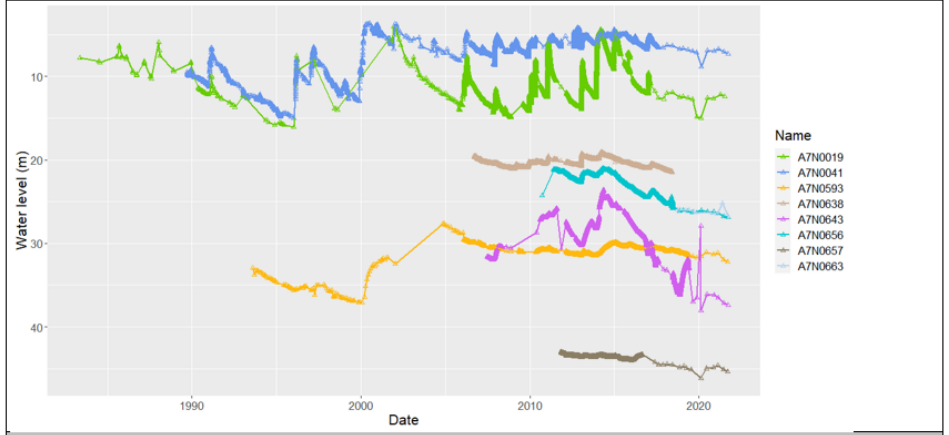
- Groundwater level trends (and fluctuations) to inform status on exploitation
- Groundwater quality analysis and trends to determine baseline conditions and future RQOs (where data permits)
- Groundwater chemistry evolves along a flow path



Available monitoring locations for trend analysis – Water Levels

Name	Start Date	End Date	Count	Max water level (mbgl)	Min water level (mbgl)	Mean water level (mbgl)	Fluctuation (min-max) (m)
A7N0019	1983/05/17	2021/07/12	10010	16.02	4.00	10.91	12.02
A7N0041	1989/09/20	2021/09/23	3361	14.99	3.63	6.05	11.36
A7N0593	1993/08/10	2021/09/16	2054	37.11	27.64	30.67	9.47
A7N0638	2006/09/12	2018/05/30	2399	21.47	19.05	20.37	2.41
A7N0643	2007/06/27	2021/09/23	10817	38.07	23.61	28.85	14.46
A7N0656	2010/09/20	2021/09/20	4308	26.84	21.04	22.67	5.80
A7N0657	2011/11/02	2021/09/14	998	45.39	43.01	43.54	2.38
A7N0663	2018/09/18	2021/09/14	10	26.67	25.15	26.11	1.52

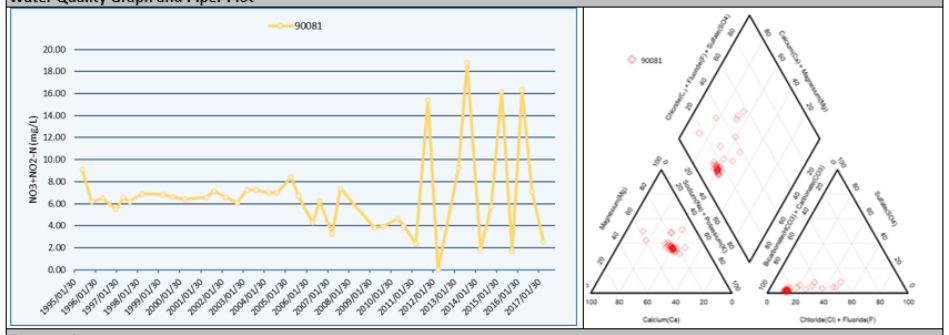
Water Level Graphs



Available monitoring locations for trend analysis -Water Quality (Chemistry)

Name	Start Date	End Date	Count	Max NO_3+NO_2 conc. (mg/L)	Min NO_3+NO_2 conc. (mg/L)	Median NO_3+NO_2 conc. (mg/L)	Exceed Drinking Water guideline
90081	1995/06/23	2017/04/19	40	18.80	0.03	6.56	Yes

Water Quality Graph and Piper Plot



Comments

The observed hydrographs for each of the stations show a fluctuation of between 2 and 15 m. A response in water levels as a result of recharge events is observed for these monitoring boreholes. The majority of water levels are deeper than 20 m.
A decrease in groundwater levels have been observed up to the late 1900's, following a recharge event resulting in a slight recovery of the groundwater levels. An overall decrease in the groundwater levels since the recharge event can be observed.
The nitrate concentration graph show extreme fluctuations from 2012 to 2017 (exceeding 10 mg/l). The groundwater signature is dominated by HCO_3 anion water facies, indicating freshly recharged groundwater that had limited time to undergo mineralisation.

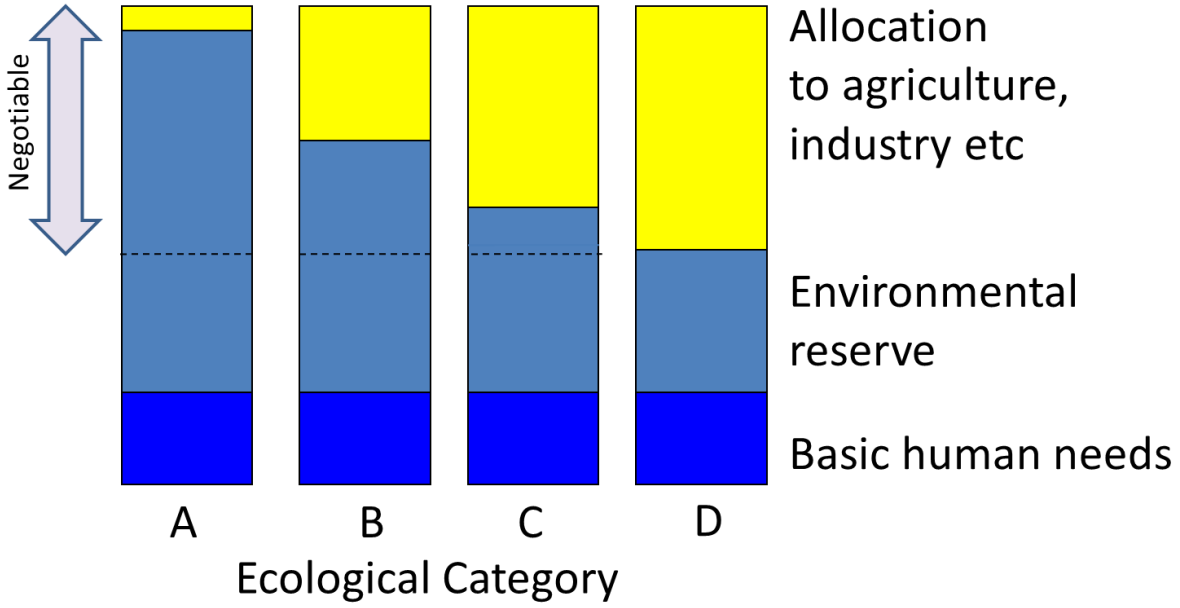
SOCIO-ECONOMICS & ECOSYSTEM SERVICES

SOCIO-ECONOMICS COMPONENT

- Review economic value of activities in the study area, with emphasis on water-dependent activities
- Estimate the value of aquatic ecosystem services
- Estimate the relationship between ecosystem health and ecosystem value
- Undertake scenario analysis to estimate costs and benefits of different levels of environmental protection (classification scenarios)

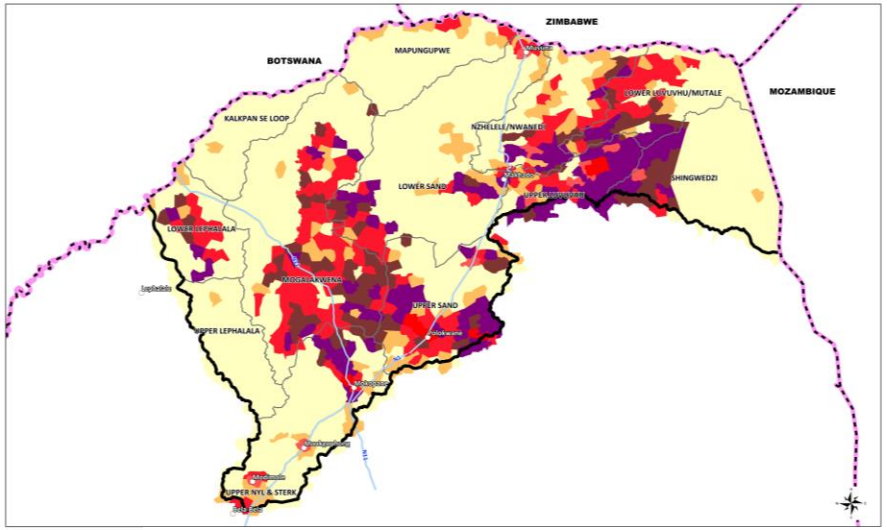
RATIONALE

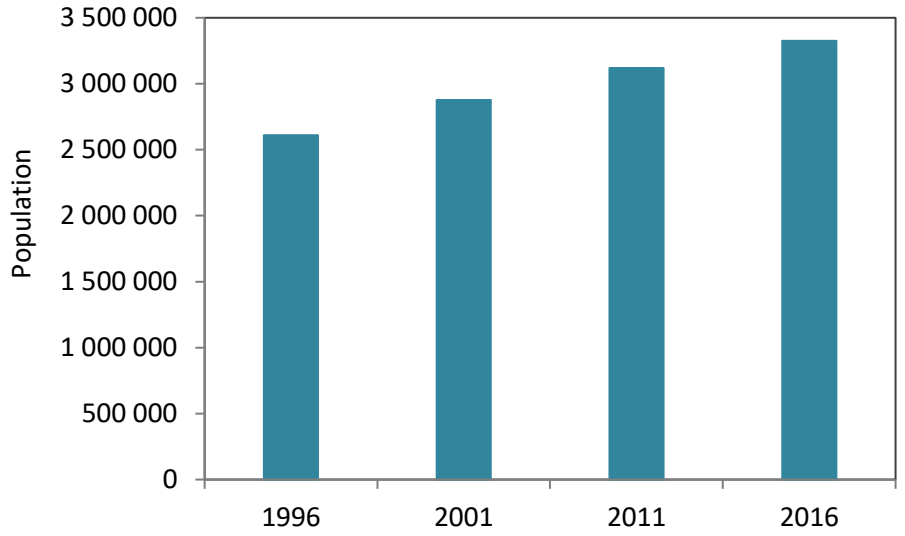
- In setting the Reserve for aquatic ecosystems,
  - Need to trade off economic value of allocating water to ecosystems versus to other uses
  - Need to take non-monetary factors into account, including meeting biodiversity conservation targets
- Increasing EC means have to either curtail water rights, or supply water from alternative sources (higher cost)



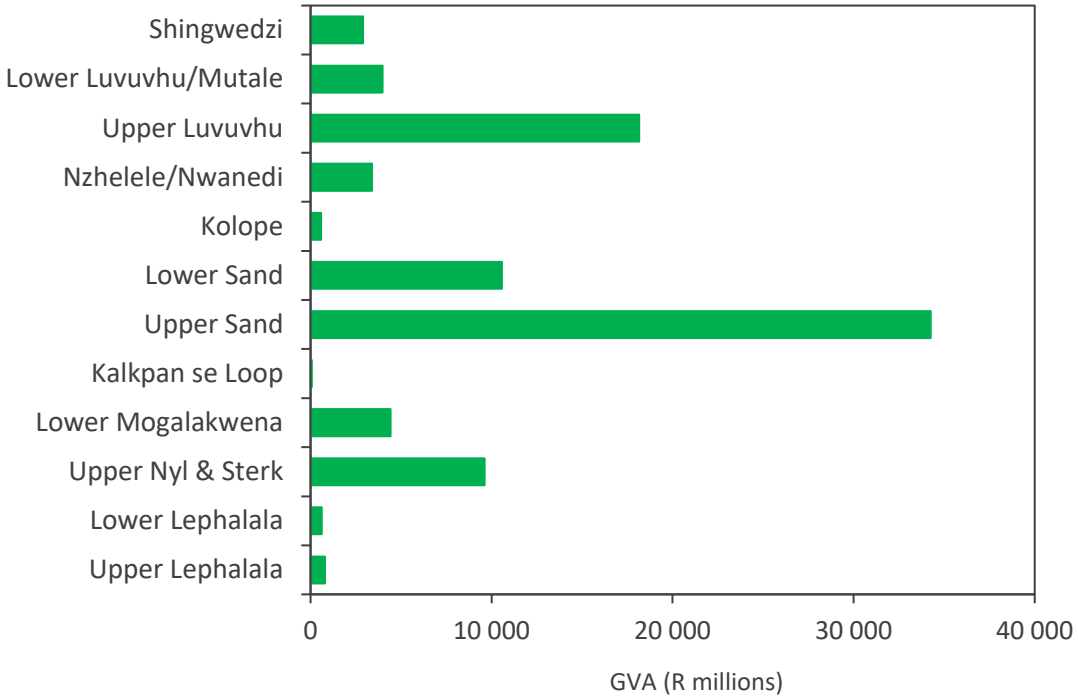
DESCRIPTION OF STATUS QUO: POPULATION OF THE STUDY AREA

- 3.3 million people
- Dense rural settlements
  - Upper Sand, Upper Luvuvhu, & Mogalakwena IUAs particularly densely populated
- Youthful population, high birth rates, high dependency ratios
- > a third of population considered poor or living in poverty
- Many households reliant on natural ecosystems for maintaining livelihoods and food security

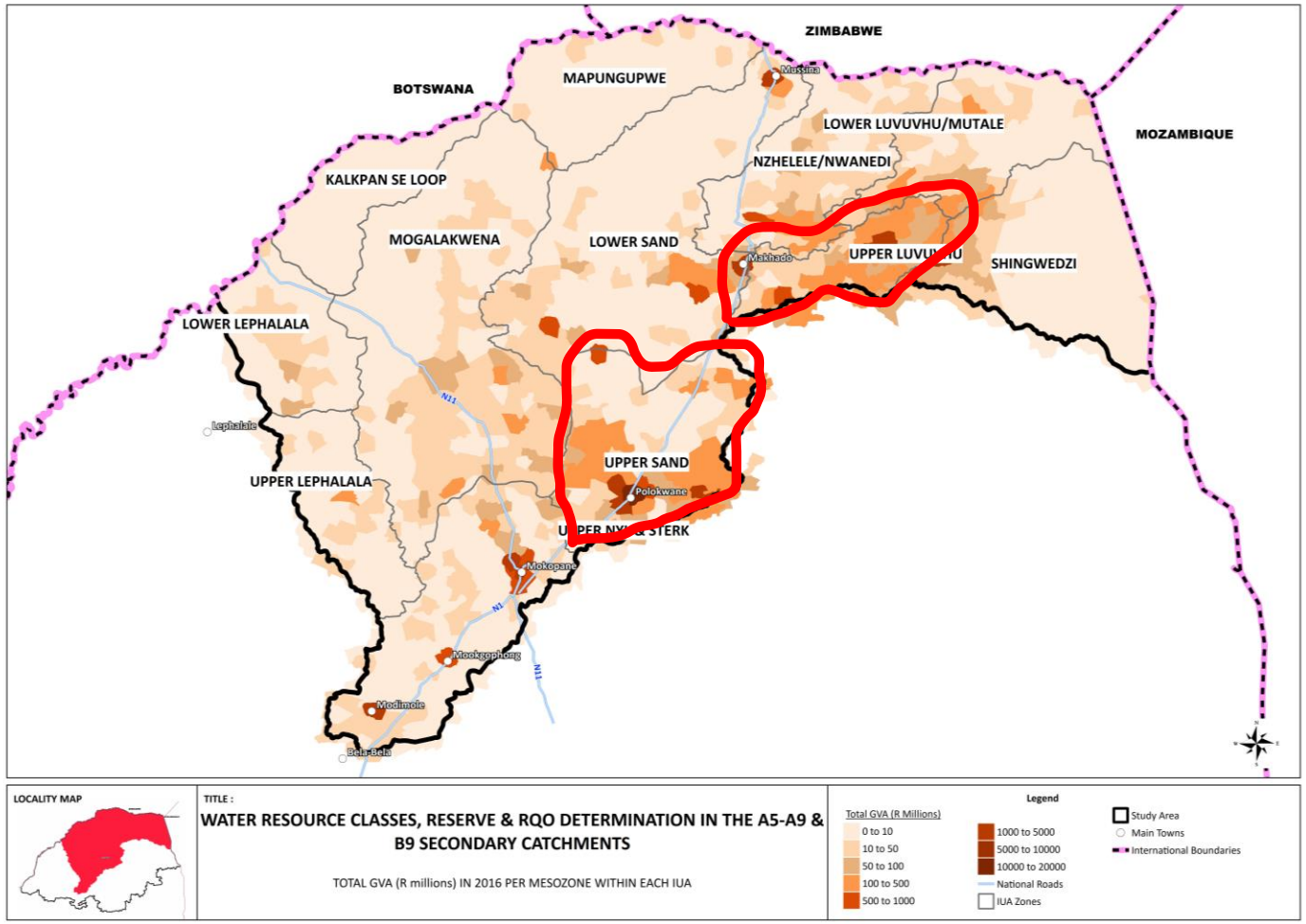




DESCRIPTION OF STATUS QUO: ECONOMIC CONTEXT

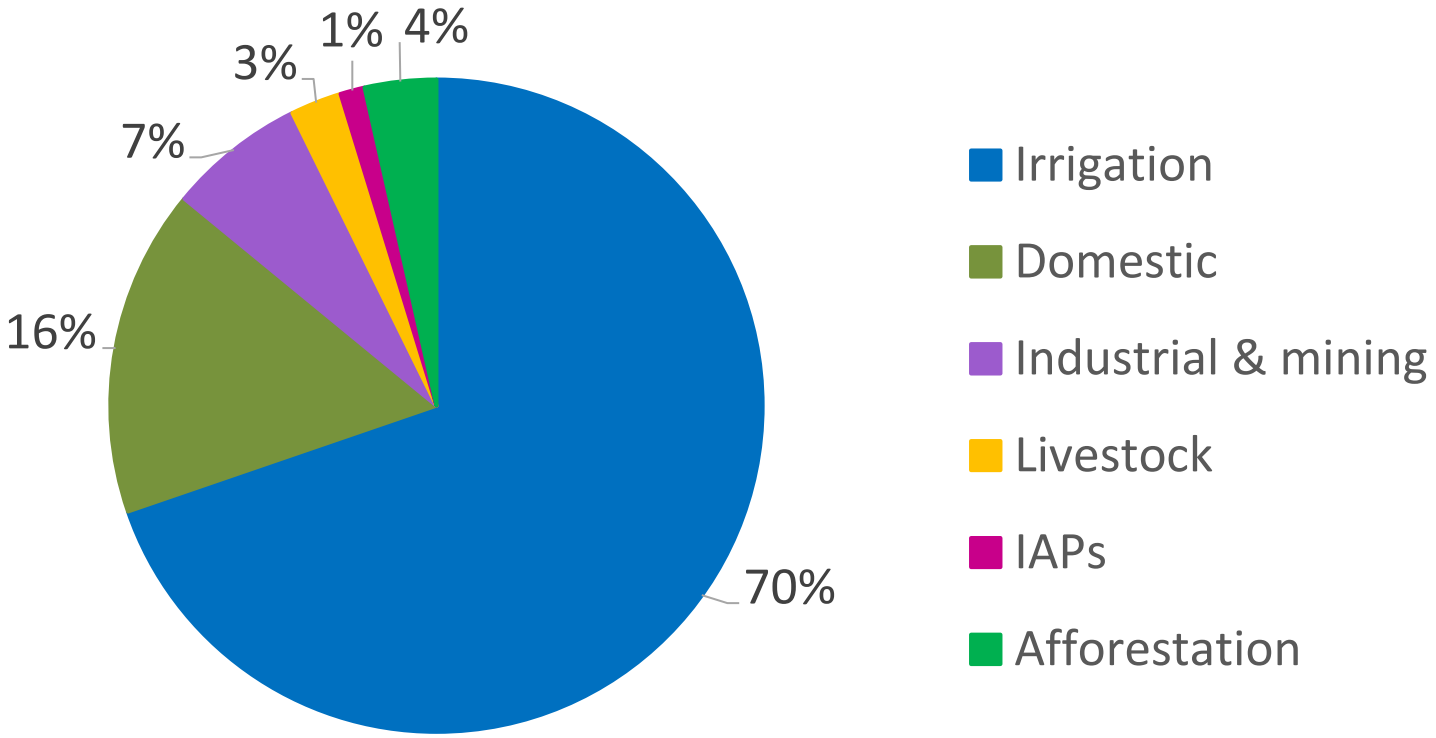


Total GVA (R million, all sectors)



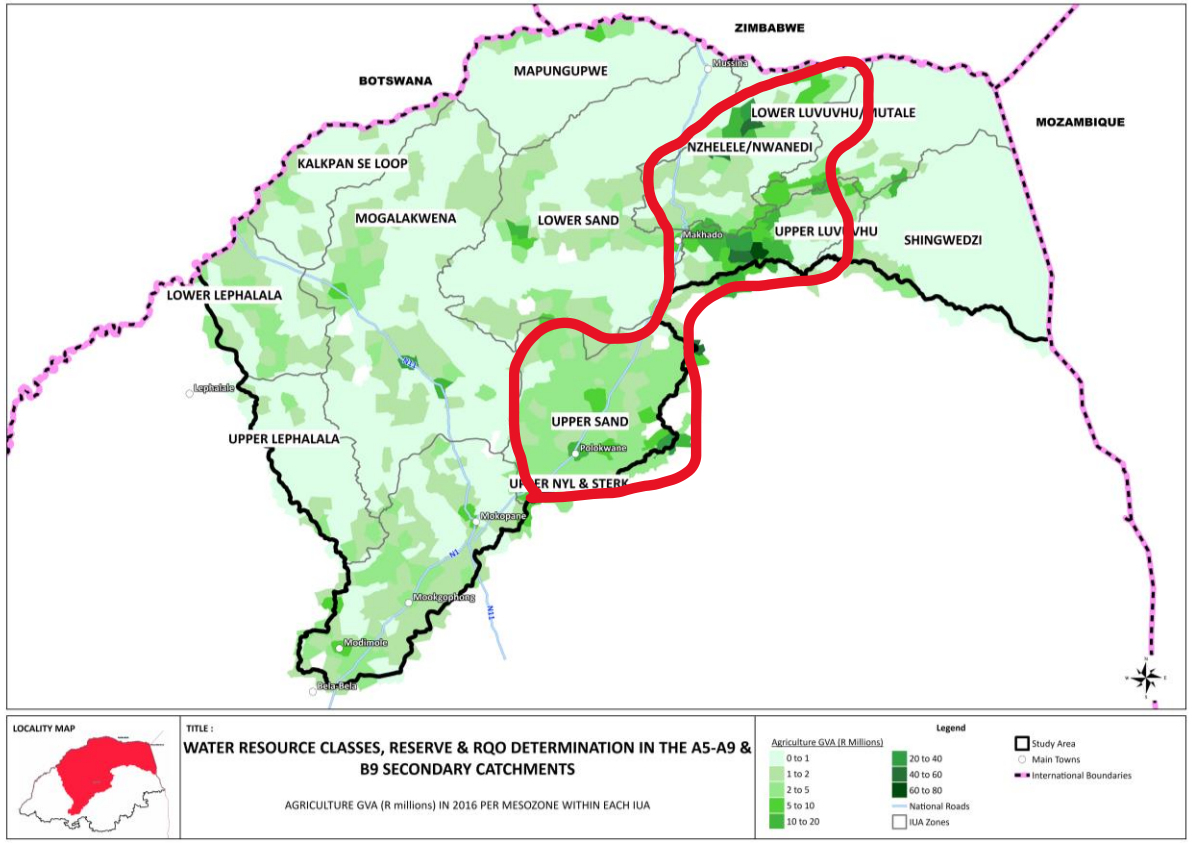
DESCRIPTION OF STATUS QUO: CURRENT WATER USE

- Bulk of water requirements in study area is for **irrigation agriculture**, followed by domestic use, industry and mining, and livestock watering



DESCRIPTION OF STATUS QUO: AGRICULTURE

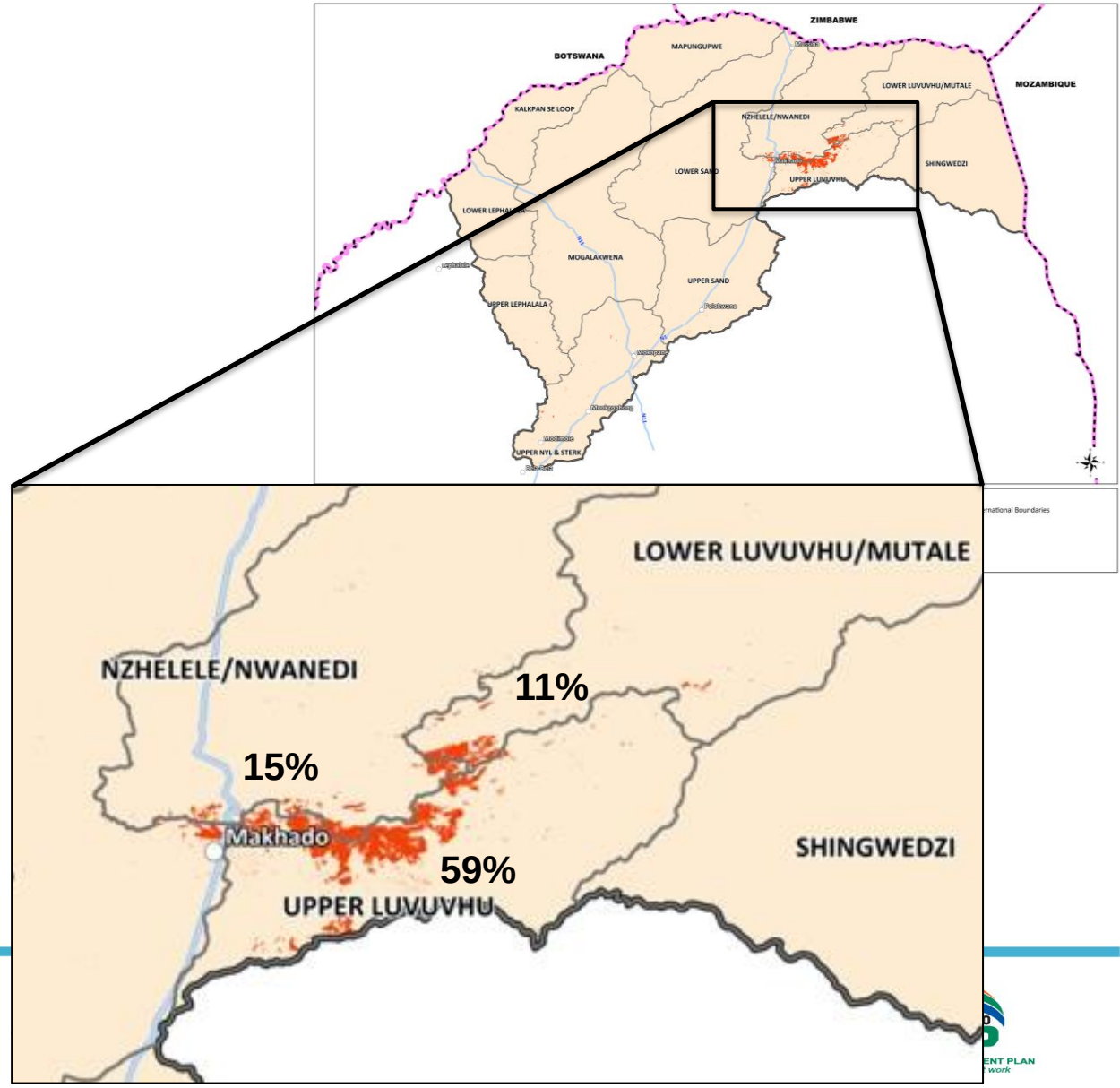
- Diverse agric. sector
  - Fruit & vegetables, cereal and oil seed products
- 74% of irrigated crops in Upper Sand, Lower Sand, Nzhelele/Nwanedi and Upper Luvuvhu IUAs
- 32 000 jobs
- Irrigated crops gross output estimated to be R5 billion in 2017



Agriculture GVA (R million)

DESCRIPTION OF STATUS QUO: FORESTRY

- 33 200 ha (68%) of commercial plantations in Limpopo are found in the study area
- Most of this is in the Upper Luvuvhu, Nzhelele/Nwanedi & Lower Luvuvhu/Mutale IUAs
- 1500 jobs
- Total gross output estimated to be R221 million in 2017



DESCRIPTION OF STATUS QUO: MINING

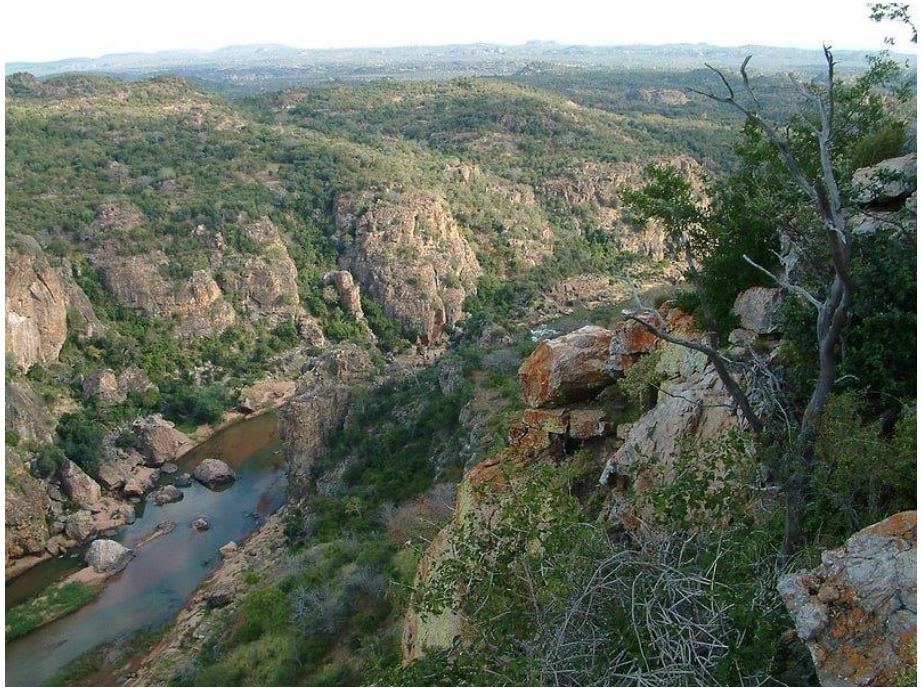
- Rich in mineral resources, mining an important economic activity
- Mining operations expanding in the study area
- Covers just over 7600 ha of land within study area
  - Mostly in Upper Nyl & Sterk, Upper Sand and Kolope IUAs
- No mineral production data available

IUA	% of total mining area
Upper Lephalala	0%
Lower Lephalala	1%
Upper Nyl & Sterk	44%
Lower Mogalakwena	6%
Kalkpan se Loop	0%
Upper Sand	11%
Lower Sand	4%
Kolope	23%
Nzhelele/Nwanedi	4%
Upper Luvuvhu	1%
Lower Luvuvhu/Mutale	4%
Shingwedzi	1%

AQUATIC ECOSYSTEM SERVICES

These are benefits obtained by people from ecosystems

- Provisioning services:
  - River water for domestic use, wild aquatic resources, wetland contribution to livestock production
- Cultural services:
  - Nature-based tourism
- Regulating services:
  - Carbon, flood attenuation, WQ improvement



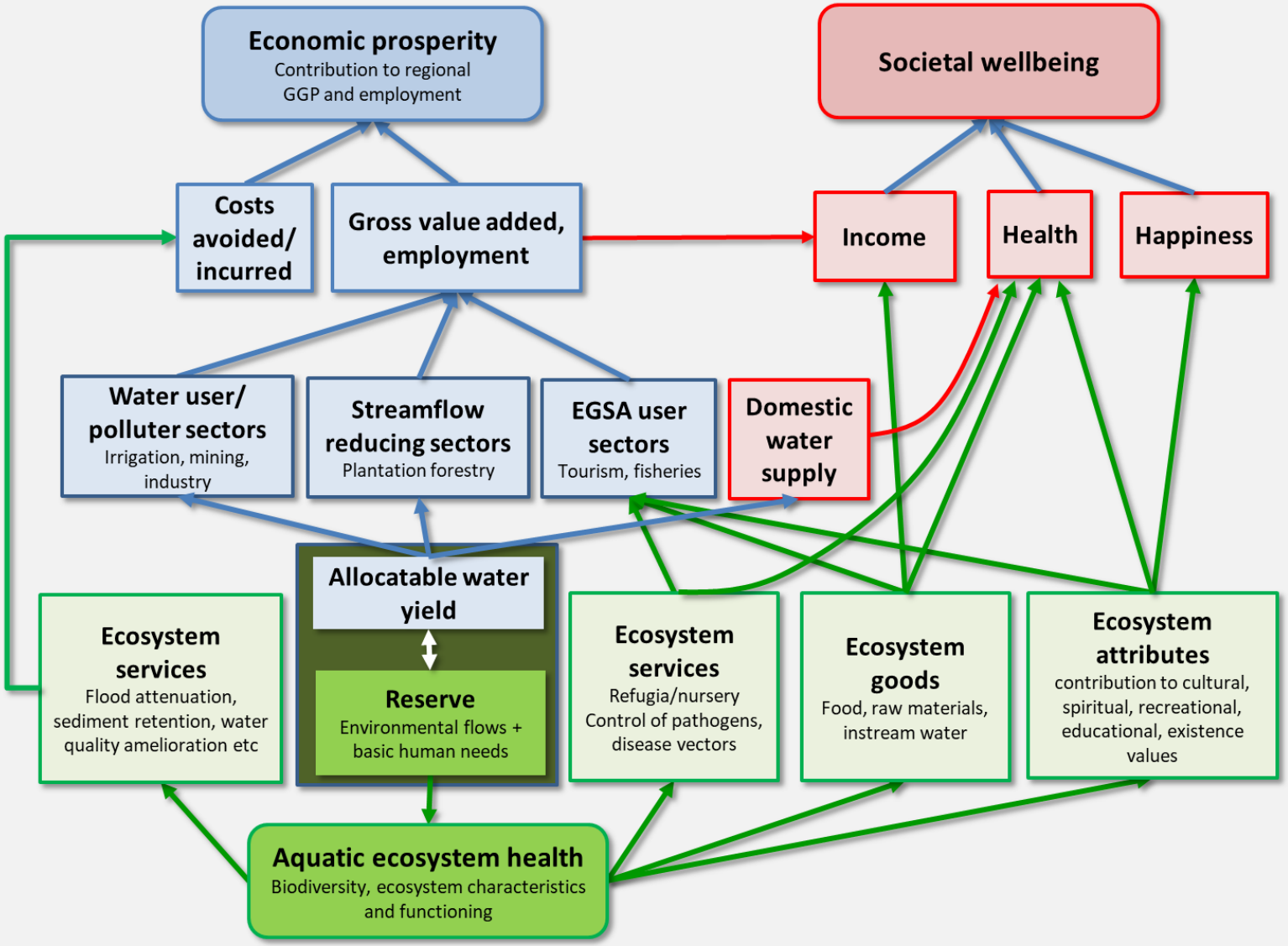
SOCIO-ECONOMICS AND ECOSYSTEM SERVICES: PRELIMINARY SUMMARY OF VALUES

- Tourism important in the north-eastern parts of study area (Kruger & surrounds)
- Provisioning services important in Lower Luvuvhu/Mutale, Upper Sand, Lower Mogalakwena IUAs
- Flood retention service highest in Upper Nyl & Sterk, Lower Luvuvhu/Mutale IUAs

Ecosystem service	Value (R million)
Harvested wild aquatic resources	45.6
Livestock production	96.5
Water for domestic use	37.5
Contribution of rivers to tourism value	203.2
Flood retention	8.5
Total	**R391.4**

Nature-based tourism, carbon and provision of aquatic resources likely sensitive to changes in ecosystem condition.

NEXT STEPS:
LINKING VALUE AND CONDITION OF WATER RESOURCES



- Linkages arising from the trade-off between water abstracted for use and water retained for the ecological Reserve.
- Next step is to determine relationship that links change in ecosystem health to a resulting economic value and social wellbeing across the study area.

PROJECT CONTACTS

DWS STUDY MANAGERS

Ms Esther Lekalake
Project Manager: Water Resources Classification
Tel: 012 336 8671
Email: Lekalakee@dws.gov.za

Ms Vuledzani Thenga
Project Manager: Surface Water Reserve Determination
Tel: 012 336 6735
Email: thengav@dws.gov.za

Mr Tichatonga Gonah
Project Manager: Groundwater Reserve Determination
Tel: 012 336 7191
Email: gonaht@dwa.gov.za

STAKEHOLDER ENGAGEMENT OFFICE

Mr Rajesh Manilall
Tel: 012 336 9800
Email:
limpopoolifantswrcs@myraconsulting.co.za

TECHNICAL ENQUIRIES

Ms Adhishri Singh
Project Leader
Myra Consulting (Pty) Ltd
Email: adhishri@myraconsulting.co.za