DSI's research infrastructures to advance science: Expanded Freshwater and Terrestrial Environmental Observation Network (EFTEON)

WRC Dialogue: Developing a Hydrology Research Strategy to Enhance Water Security in South Africa

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NRF National Research Foundation | SAEON South African Environmental Observation Network

The South African Research Infrastructure Roadmap (SARIR)

A 20-year duration initiative by Department of Science and Innovation, launched in 2017

Aims to keep South African researchers globally competitive with respect to equipment and facilities that are too large and long-term to be effectively managed by individual institutions

After a five-year planning and proposal phase, 13 initial Infrastructures were selected – 3 hosted by SAEON

- Expanded Freshwater and Terrestrial Environmental Observation Network (EFTEON) and
- Shallow Marine and Costal RI (SMCRI)
- South African Marine and Antarctic Facility

In start-up phase presently. Plans to run indefinitely, but at least 15 years

An open-data and research platform for use by many individuals and institutions

South African Research Infrastructure Roadmap (SARIR)

http://bit.ly/2u18qNX

1. Expanded Freshwater and Terrestrial Environmental Observation Network
2. Nuclear Medicine Research Facility
3. SA Network of health and demographic surveillance sites (SAPRIN)
4. National Centre for digital language resources
5. Shallow Marine and Coastal RI
6. Natural Science collection facility
7. Distributed platform for “Omics” research
8. Biobanks
9. Biogeochemical research infrastructure platform (BioGRIP)
10. South African Polar Research Institute (SAPRI)
11. Nano-Micro manufacturing facility
12. Solar research facility
13. Material characterisation facility

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AEON
National Research Foundation | South African Environmental Observation Network

Some key features

- **EFTEON is NOT a funding agency – it is a research infrastructure**
- This is a ***research*** infrastructure, not a national environmental monitoring infrastructure
  - Researchers, are the target users, not compliance
  - Engagement with relevant operational focused organisations (NHMS, agricultural, NAAQMN etc.)
  - Collaboration with other research infrastructure (where appropriate or possible)
    - SMCRI and SAPRI
    - SA Network of Health and Demographic surveillance sites
    - Natural science collection facility and Biobanks facility
    - BioGRIP
- The core data will be ***open access***. They will be accessible and free-for-use
- ***Site platform*** to host your own measurements and experiments- integral to concept

EFTEON Design

Conceived as a modular, networked research infrastructure to support studies on coupled social-ecological systems in South Africa.

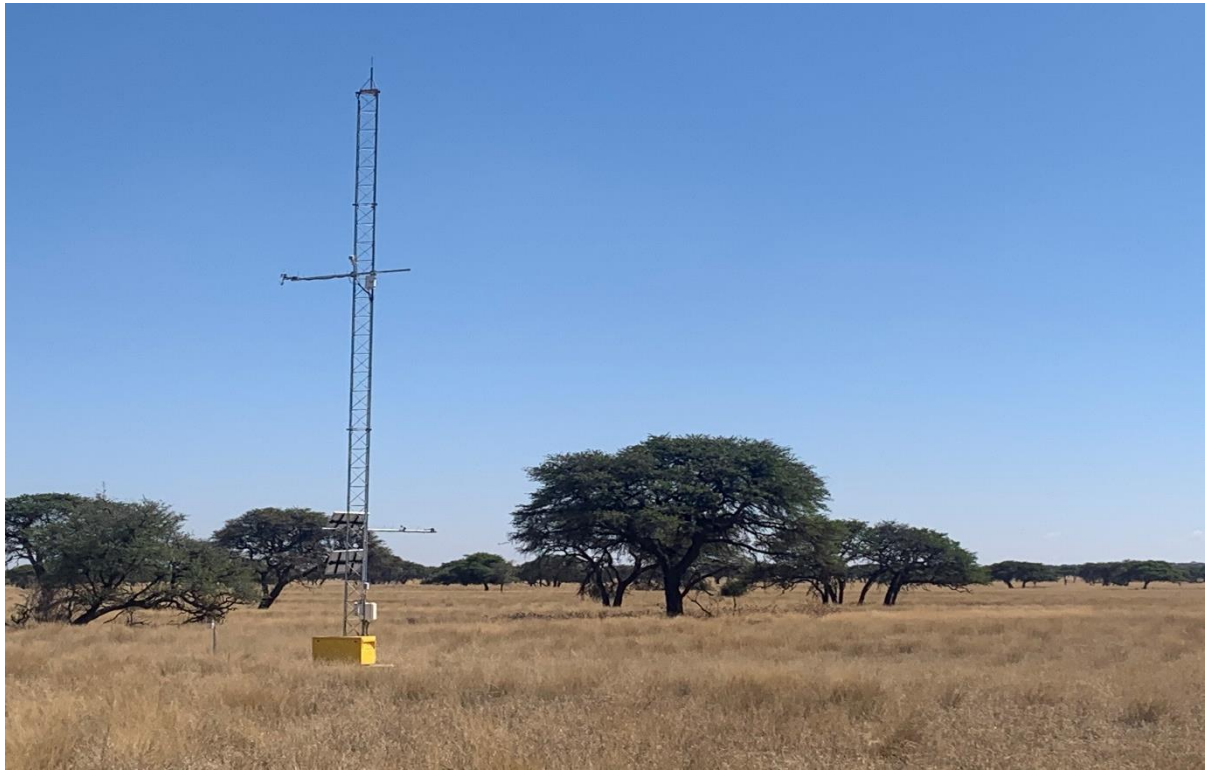
Hosted by the South African Environmental Observation Network – Expanding existing offering

Design based on 6 distributed landscapes

Representing important South African Ecosystem-Human complexes.

Representatives of major biomes and human transformed ecosystems and their embedded aquatic systems

Supported by a national co-ordination and data management facility (shared with the SMCRI and general SAEON operations) .

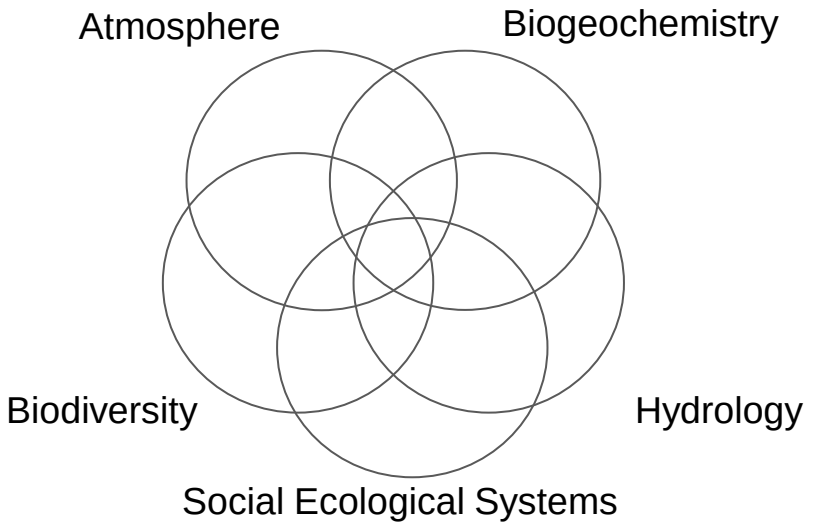


View of the Benfontein Savanna site

Each landscape will have heavily-instrumented core sites for fresh water and terrestrial observations and a linked network of lightly instrumented subsidiary sites, plus a survey system for collecting social data and biodiversity data

What will the infrastructure look like?

- Biogeochemistry
  - Flux measurements (CO_2, H_2O, Energy, eventually other GHGs CH_3, N_2O)
  - Atmospheric deposition (nitrogen, sulphur, acid deposition)
  - Phenology
  - Respiration
- Meteorology and Atmospheric Science
  - Meteorological equipment (Weather stations and rainfall)
  - Atmospheric chemistry (Sampling container, ozone, passive sampling, potentially PM, Aeronet)
- Hydrology
  - Continuous surface and groundwater level and water quality monitoring
  - Regular sampling for lab analysis (chemistry , isotopes)
- Biodiversity (repeated sampling)
  - Vegetation
  - Freshwater
  - eDNA (water and soil)
- Social Ecological Systems
  - Ecosystem service use and valuation
- Spatial data
  - Flights – LIDAR and hyperspectral imaging (SAEON plane)
  - Model Datasets
  - Commercial RS products (TBC)



- Common core set of instrumentation/data collection across landscapes
- Each theme's activities coordinated by a national thematic committee
- Landscape level activities informed by separate Landscape fora - informing additional sampling and guiding local relevance

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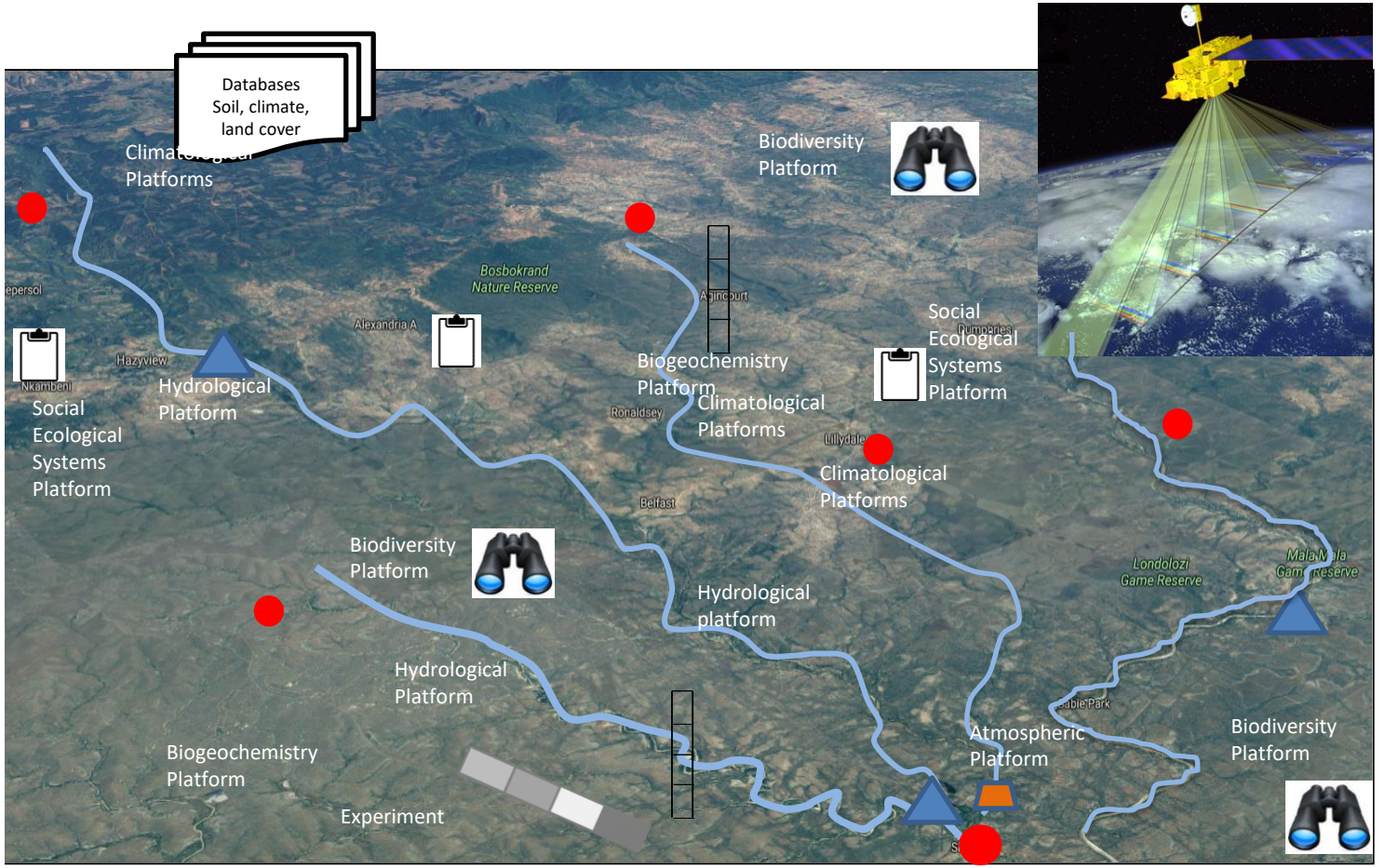
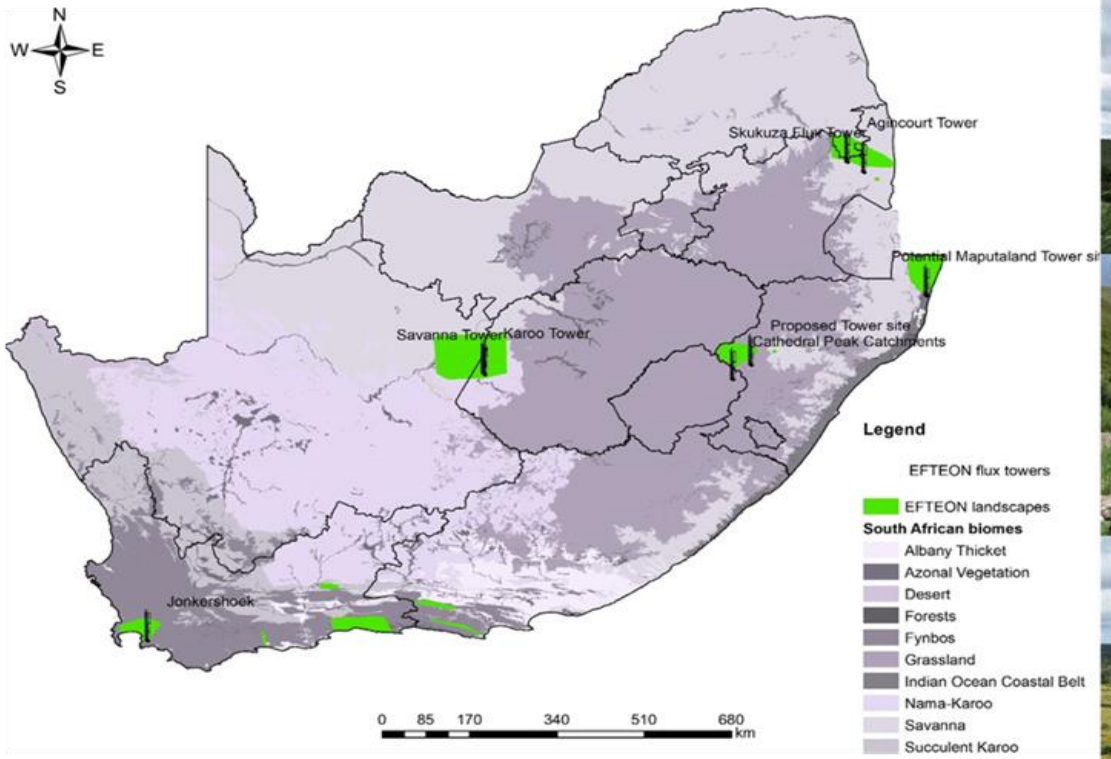


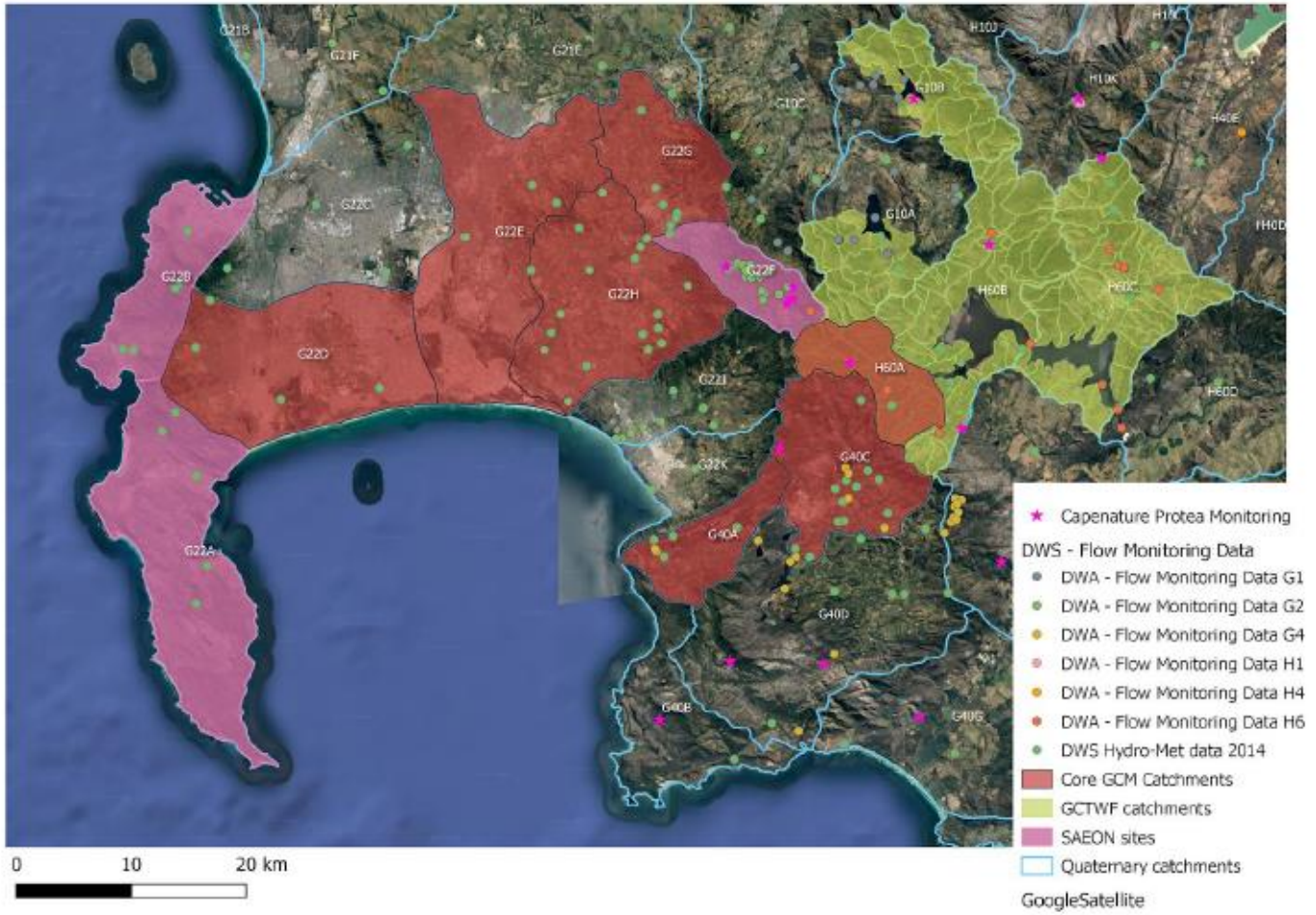
Expanded Freshwater and Terrestrial Environmental Observation Network (EFTEON)

Platforms

- Biogeochemistry
  - Exchange of C, N and P
- Hydrology
  - Water Quality and Quantity
- Meteorology and Atmospheric Science
  - Meteorology and climate
  - Atmospheric chemistry
- Biodiversity
  - Diversity
  - Abundance
- Social Ecological Systems
  - Theory of change
  - Availability of resources
  - Use of Resources
  - Valuation of resources



Proposed landscape extent Greater Cape Town



***Map 2**. Existing catchment monitoring infrastructure in and surrounding GCM-LTER landscape. This map is not comprehensive nor fully up to date but does illustrate the relative situation of the instrumentation. Please also see https://fynbos.saeon.ac.za/dashboards/efteon/ for an interactive view of existing hydrological, meteorological and vegetation survey observations in the landscape.*

Proposed landscape extent Kimberley

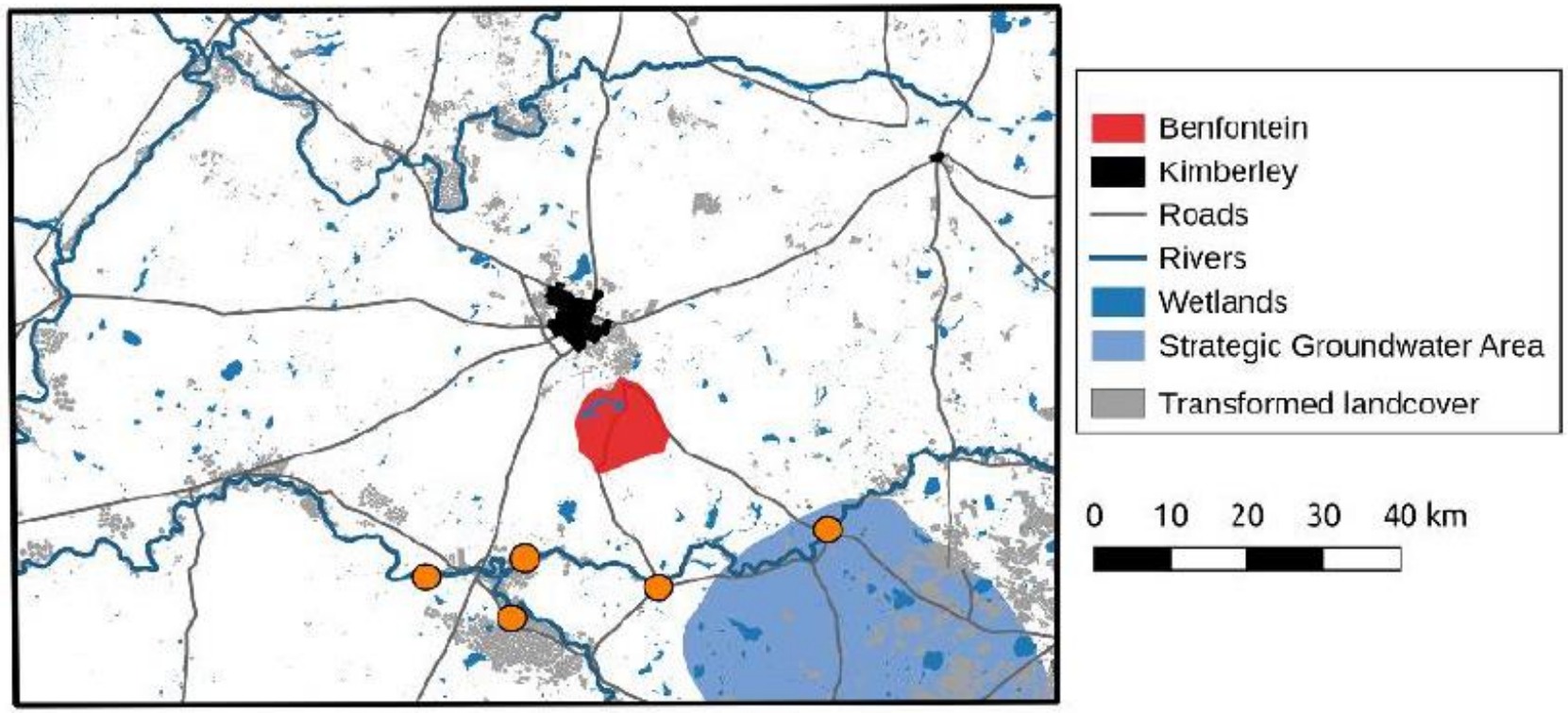
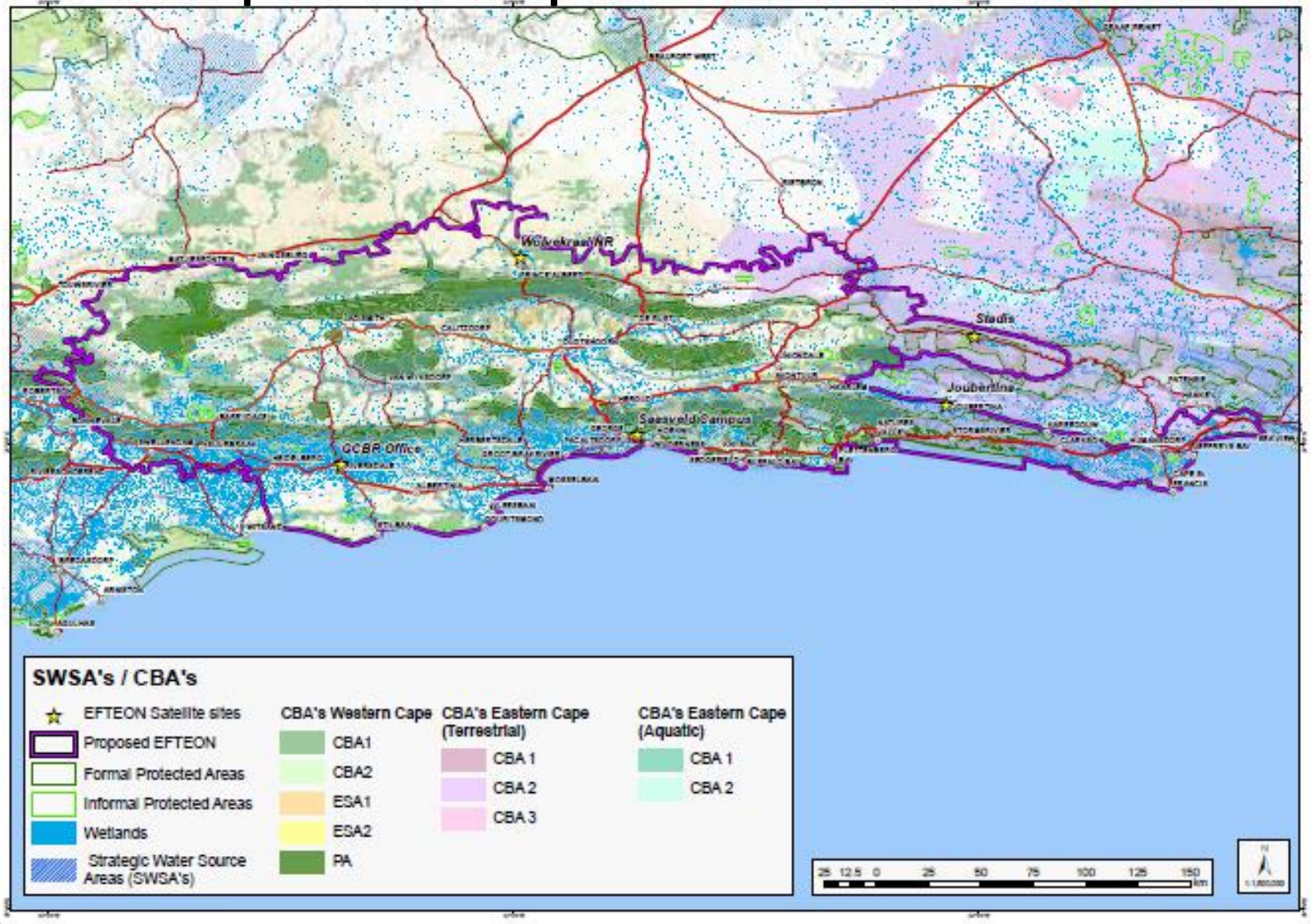


Figure 5: The water-related environmental features of the KIMTRI landscape centred around the core site, Benfontein Game Reserve. There are three main rivers in this landscape: the Vaal River to the North of Kimberley; the Modder River that flows from east to west; and the Riet River, which joins the Modder River south of Kimberley. Additionally, rain-fed wetlands (pans) cover large parts of the wider landscape, including the core site at Benfontein. Lastly, the De Aar Strategic Groundwater Source Area is to the south-east of the core site, illustrating the national significance of the area for sub-
ology. (Orange circles on the map denote long-term monitoring sites by the University of the Free State, with
a).

Proposed landscape extent Garden Route



6. Strategic Water Source Areas (SWSAs) and Critical Biodiversity Areas (CBAs) in the Garden Route Gateway ape.

Proposed landscape extent N Drakensberg

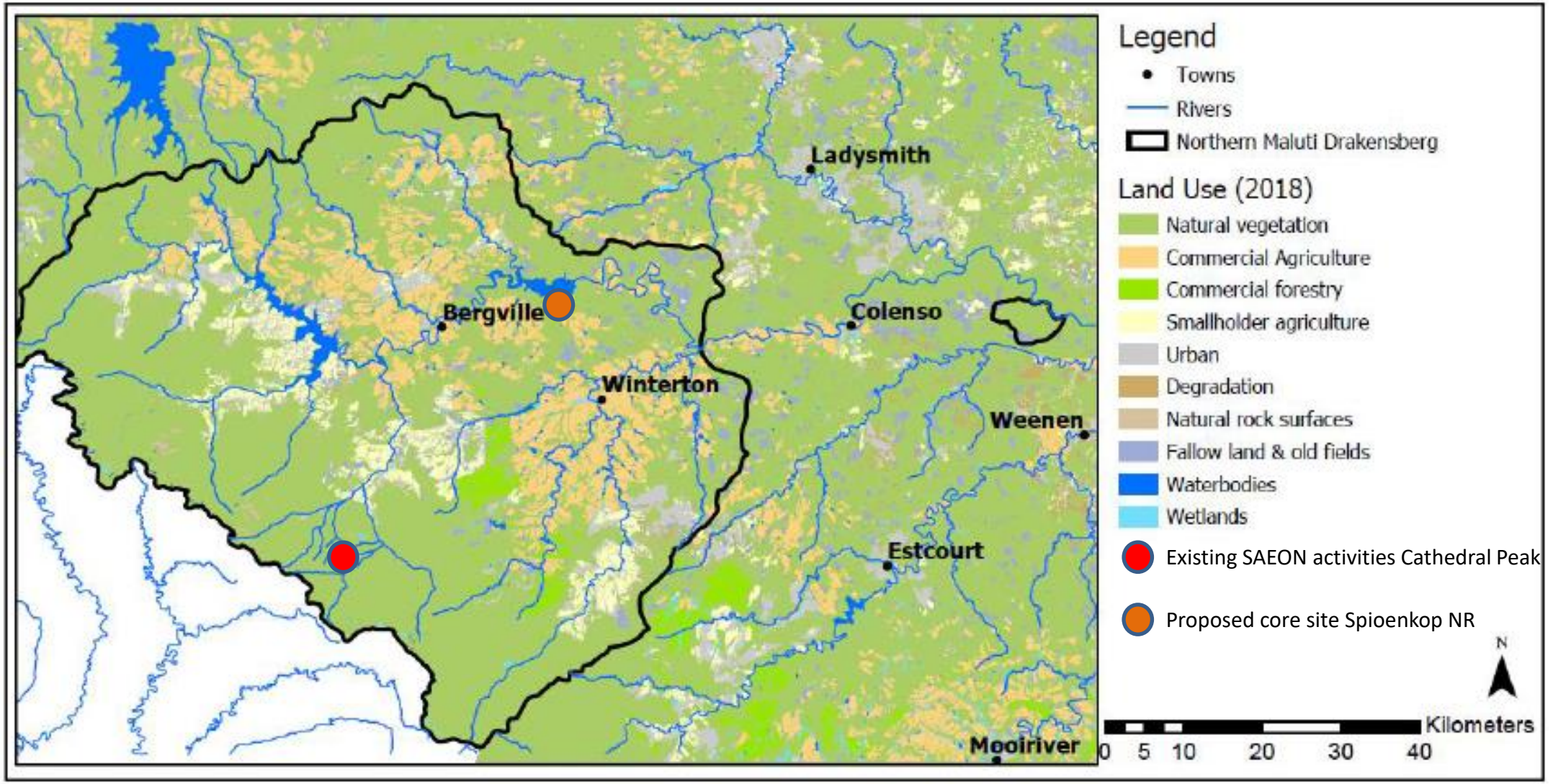


Figure 4: Broad grouping of land cover types in the Northern Drakensberg landscape (adapted from SANLC, 2018)

Proposed landscape extent N Drakensberg

Figure 11: Existing meteorological and hydrological monitoring stations in Northern Drakensberg landscape

Proposed landscape extent Lowveld

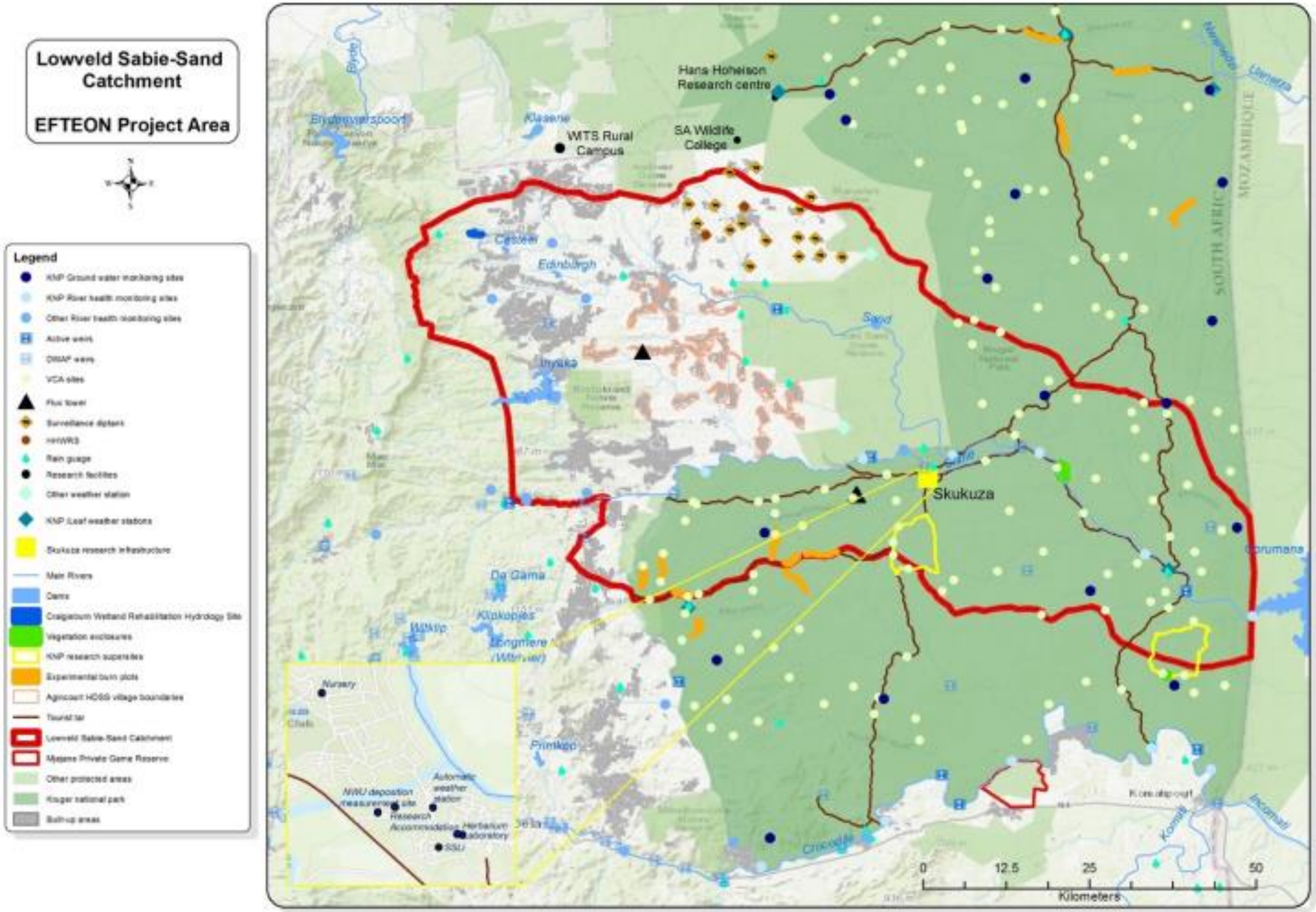
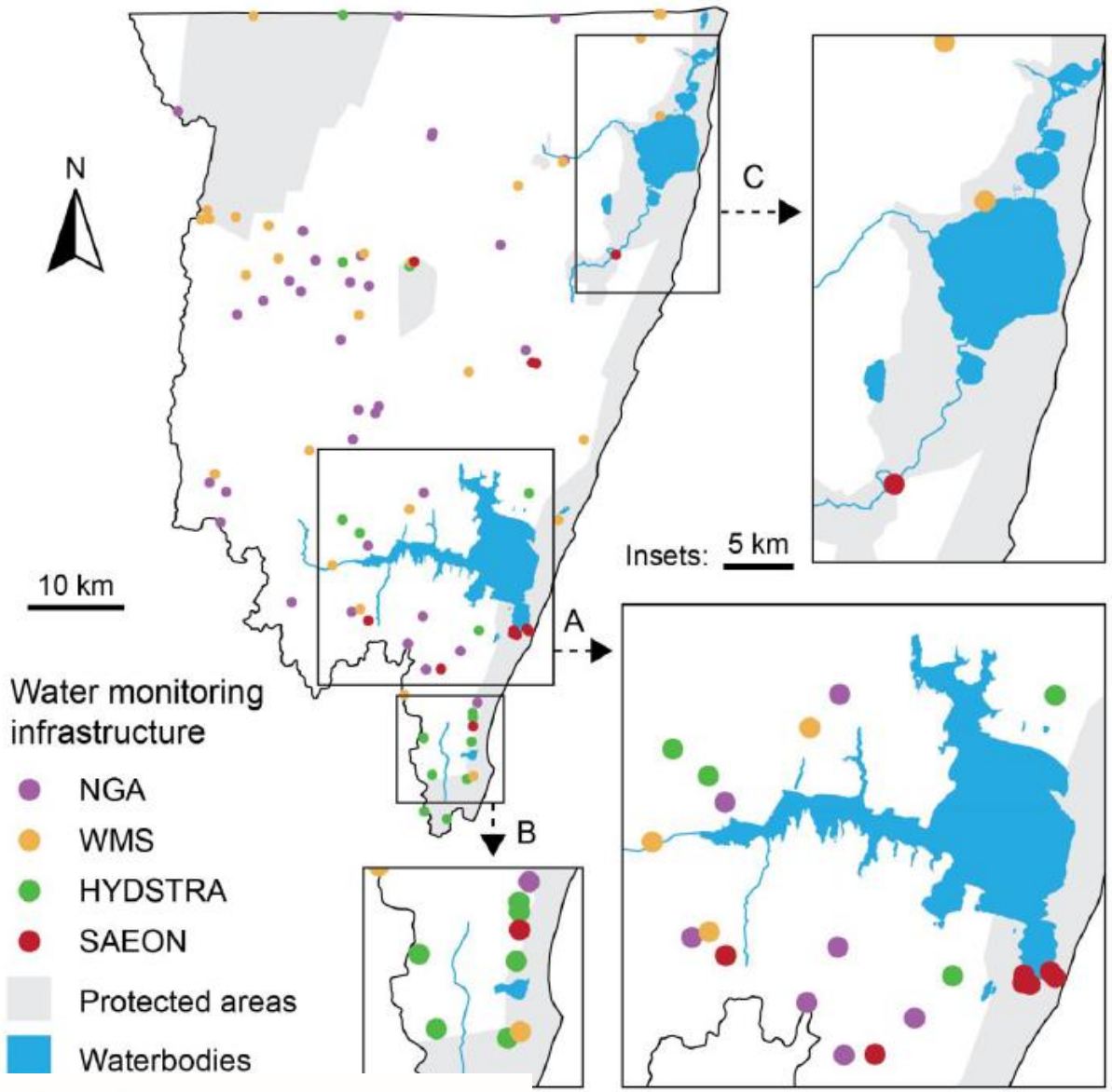
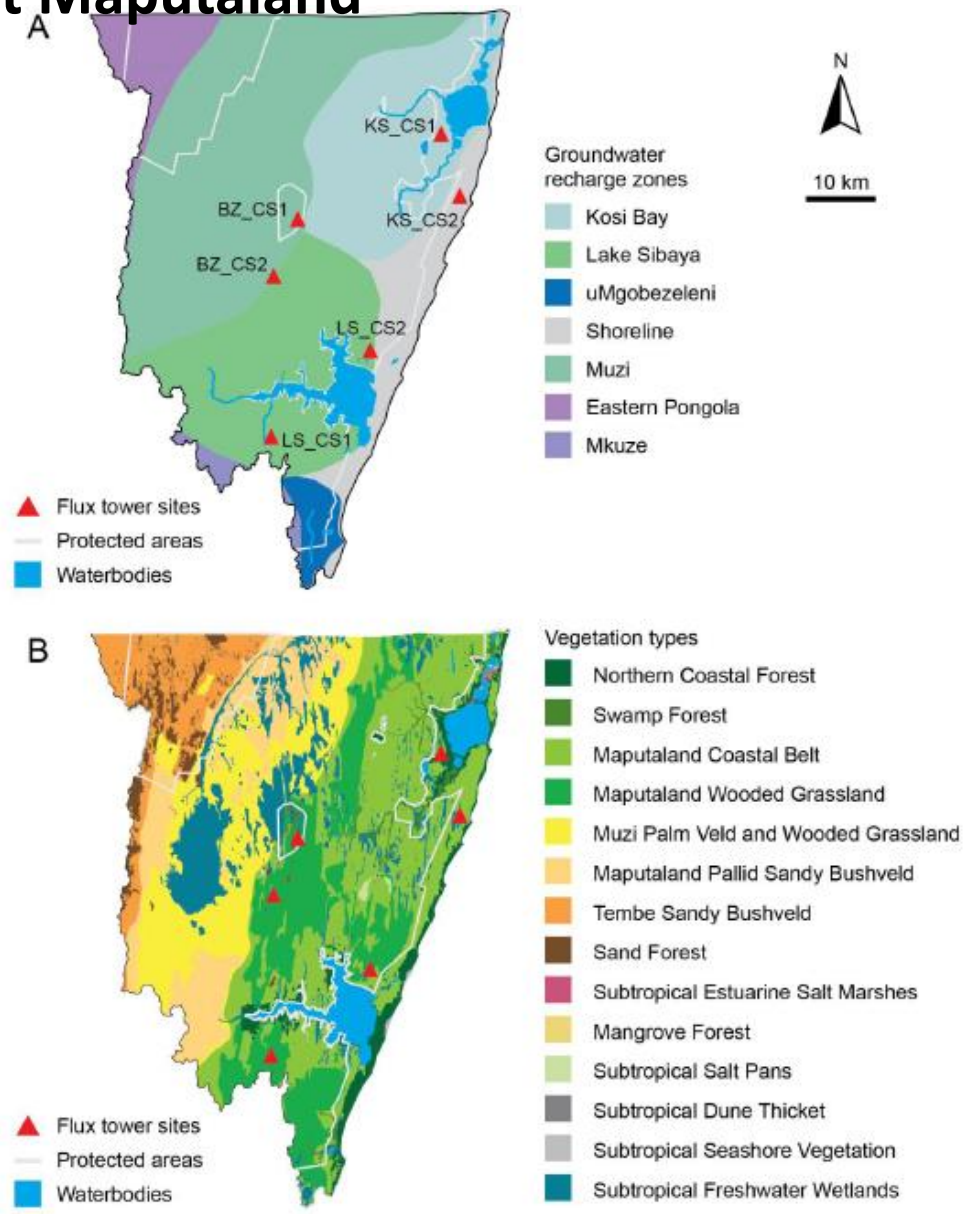


Figure 5. Existing long-term observation sites and experiments, as well as partner institution nodes in the landscape.

Proposed landscape extent Maputaland





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ıment W70A, including the National Groundwater Archive (NGA), YDSTRA monitoring points, and SAEON groundwater monitoring A), uMgobezeleni (B) and Kosi Bay (C) sites.

Figure 18: Proposed flux tower sites in Indian Ocean Coastal Belt Biome grassland, in relation to groundwater recharge zones (A) and vegetation types (B). The flux tower site labels in (A) correspond to the labels in Table 1 and the text. Groundwater recharge zones were mapped following Bruce Kelbe (pers comm), and vegetation types follow the National Vegetation Map 2012.

ntal

Upland catchment > lower catchment > ocean

Multiple, nested and interacting social ecological systems along the way!!!

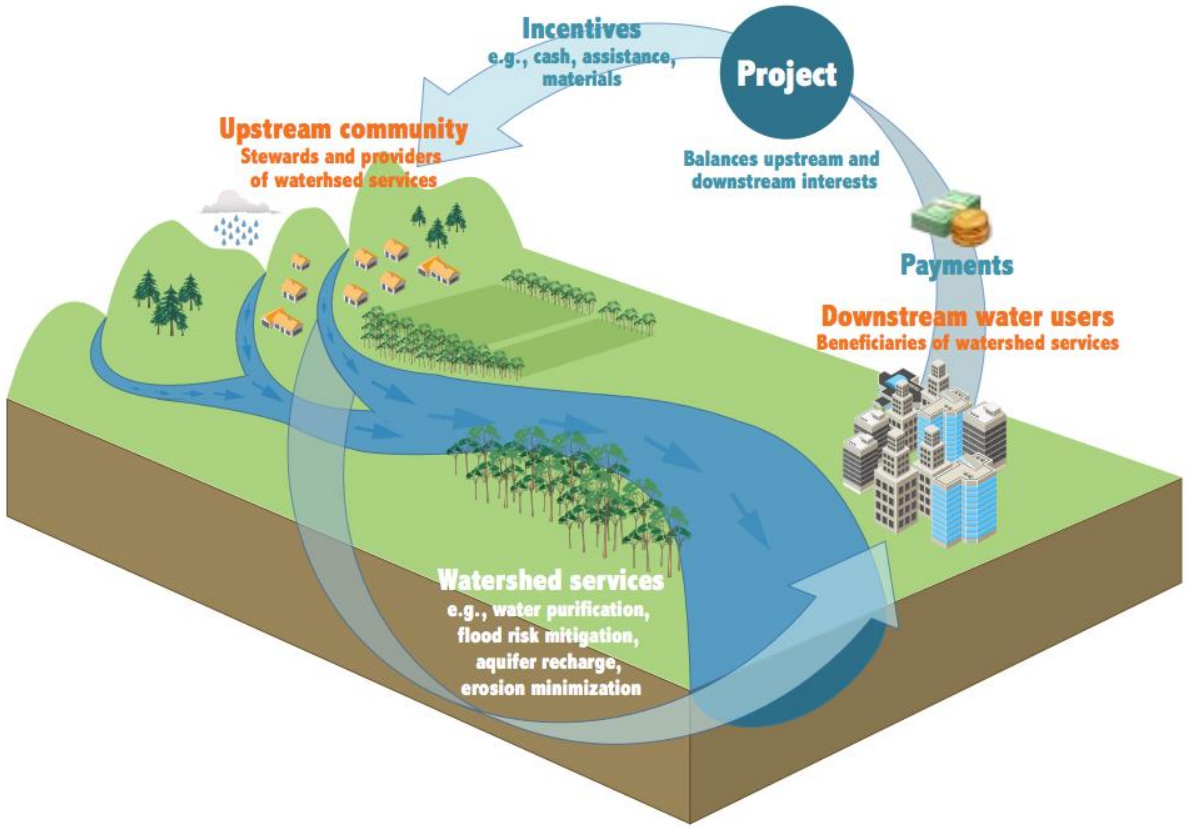
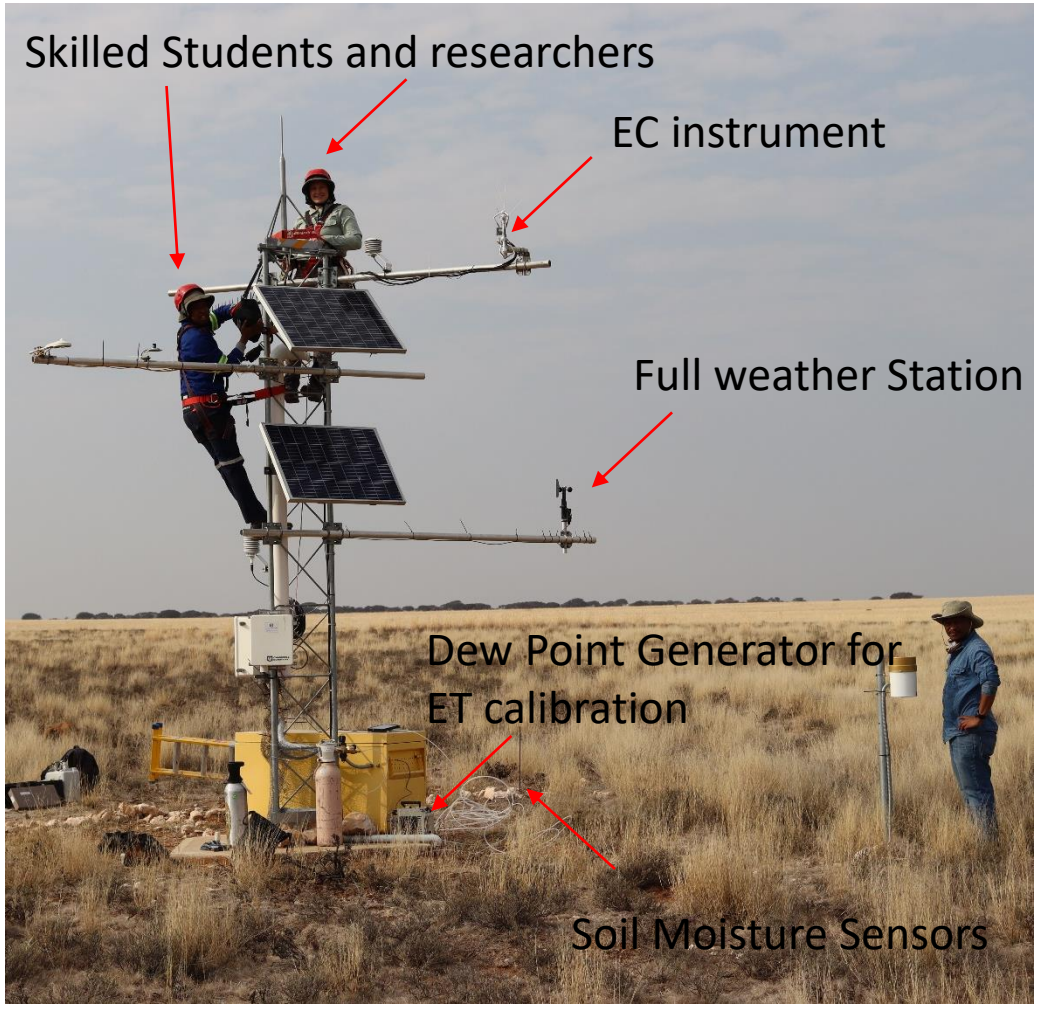


Figure 7. The transfer of services and funding within a Water Fund © Forest Trends, 2012

- ➔ Upper/lower catchment dichotomy
- ➔ Catchment to coast (linking to SMCRI)
- ➔ Social Ecological Systems

Planned Observations

- Biogeochemistry Platform
  - Eddy Covariance (Procured 7 sets of instruments)
    - CO_2, Water, Energy Exchange
    - Hydrology impact –
      - Land surface/ atmosphere exchange of water vapour
        - » Modelling
  - Atmospheric Wet Deposition (Hydrology and Atmosphere Platform- DEBITS methodology)
    - Hydrology impact
      - Water quality
  - Soil Respiration
  - Phenology and LAI



Planned Observations

- Hydrological Platform (NRF Bid Adjudication Committee)
  - Water Depth, Conductivity, and Temperature
    - 14 per landscape
  - Continuous Water Quality
    - pH
    - Turbidity
    - DOM
    - DO_2
  - Samplers for taking water samples in open water or boreholes with temperature and conductivity (1 per landscape)
  - Field capable spectrophotometer (1 per landscape)
  - Isotope Measurement (Rainfall, surface water, groundwater)
  - Other repeated water quality measurements TBD

Planned Observations

- Atmospheric Platform
  - Meteorological Measurements
    - Initial Procurement (per landscape)
      - 1x AWS/ landscape
      - 3x Enhanced Rain station/ landscape
      - 3x Rainguage/ landscape
      - Meteorological calibration equipment
    - Rain Intensity
  - Hydrology Impact
    - Improved meteorological measurements

Instrument	Variable	System
Anemometer	Wind speed	AWS, ERS, EC
	Wind direction	
Temperature Humidity Sensor	Atmospheric Temperature	AWS, ERS, EC
	Humidity	
Rain Gauge (Tipping Bucket)	Precipitation	AWS, ERS, RS, EC
Barometer	Atmospheric Pressure	AWS, ERS, EC
Pyranometer	Incoming Radiation	AWS, EC
UV Sensor	UV radiation	AWS (Potential)
Grass minimum sensor	Soil temperature	AWS (Potential)
Leaf Wetness sensor	Leaf Wetness	AWS (Potential)

Planned Observations

- Atmospheric Platform
  - Meteorological Measurements (Procured)
  - Atmospheric sampling infrastructure
  - Passive atmospheric sampling
    - Passive Samplers for average concentrations of NO_2, SO_2, O_3, NH_3, HNO_3 (DEBITS Methodology)
      - 2 replicates/ species
      - Monthly
    - Aerosol Composition
      - Proposed Methodology
        - » 2x 10µm impactor (Quartz and Teflon Filters)
        - » Analysis of Organic and Inorganic compounds
    - Aeronet (still proposed)
      - Atmospheric Column

Planned Observations

- Biodiversity Platform (Exact range and methodologies not defined)

Functional Type / Properties	Woody Plants	Grasses and herbaceous plants	Soil microbes	Large mammals (?)	Small mammals (?)	Terrestrial invertebrates (specific groups)	Aquatic vertebrates	Aquatic invertebrates	Sediments
Diversity	√	√		√	√	√	√	√	
Abundance	√	√		√	√				
Phenology	√	√							
Biogeochemistry	√	√							
Biomass and productivity	√	√		√					
Metagenomics			√						√

Planned Observations

- Social Ecological Systems (Exact range and methodologies not defined)
  - Theory of Change
  - Quantification of the availability of ecosystem services
  - Rates of utilisation of those services
  - Value and functioning of regulatory services
  - Quantification of ecosystem dis-services
  - Hydrology Impact
    - Water use and water availability
    - Understanding decisions around the managing water use

Planned Observations

- Landscape Assessments (Exact range and methodologies not defined)
  - Soil Attributes
  - Remote Sensing Platform
    - SAEON Aircraft
      - High Resolution Photography
      - Lidar
  - Repeat photography around other installations
  - Some selected commercial RS or model products where applicable

Impact for Hydrology Research

- Deployment of Landscape Scale Research infrastructure with a harmonised national footprint
- Integrated transdisciplinary approach
- Includes human and biodiversity components in provision of hydrological services
- Implicit linkages between hydrology, meteorology, and biogeochemical processes
- For use as a research platform to train students and develop technical skills – infrastructure in place to facilitate training and skills development

Thank You

Advisory Structures