

SOUTH AFRICA ECOLOGICAL CONSERVATION II

Identifying and Mapping Riparian
Areas in South Africa with Earth
Observations

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Introduction to Riparian Zones

Riparian zones are transitional areas that exist between riverine and terrestrial ecosystems.

They are critical ecological areas that support high biodiversity and provide essential ecosystem services, including:

Bank
Stabilization

Flood
Control

Water
Filtering

Habitat
Provisioning



Orange River, Northern Cape Province, South Africa
Image Credit: Nancy Job

Community Concerns



Riparian zones in South Africa are threatened, endangering vital ecosystem services.

Climate change is expected to exacerbate these threats into the future.



Local communities rely on healthy riparian ecosystems for environmental health & economic stability.

Project Partners

- The South African National Biodiversity Institute (SANBI)
- Western Cape Government, Department of Environmental Affairs and Development Planning

Our partners face challenges in conserving riparian ecosystem due to **limited geospatial data**, hindering management efforts.

This project will help our project partners identify target areas for riparian conservation and understand their distribution across the nation through a **GIS-based inventory of riparian zones**.



Grotto Beach, Hermanus, South Africa
Image Credit: Kerry Cawse-Nicholson

Objectives

ESTIMATE the extent of woody riparian vegetation across South Africa



MAP historical changes in riparian zones from 2013 – 2024



DEVELOP a scalable and reproduceable methodology for future use



Riparian Mapping (DEVELOP Summer '24)

Part 1 Overview

- Mapped riparian zones in two pilot study sites:

Study Area

Northwest Province

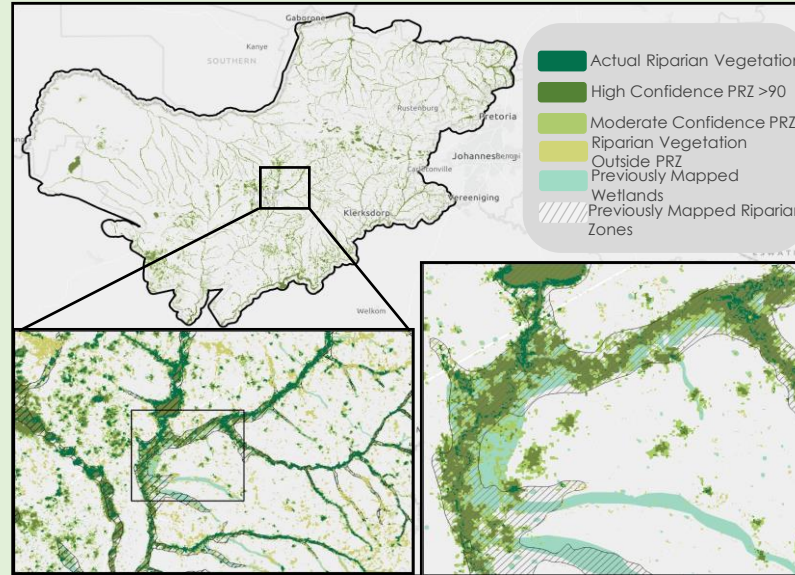


Southern Cape

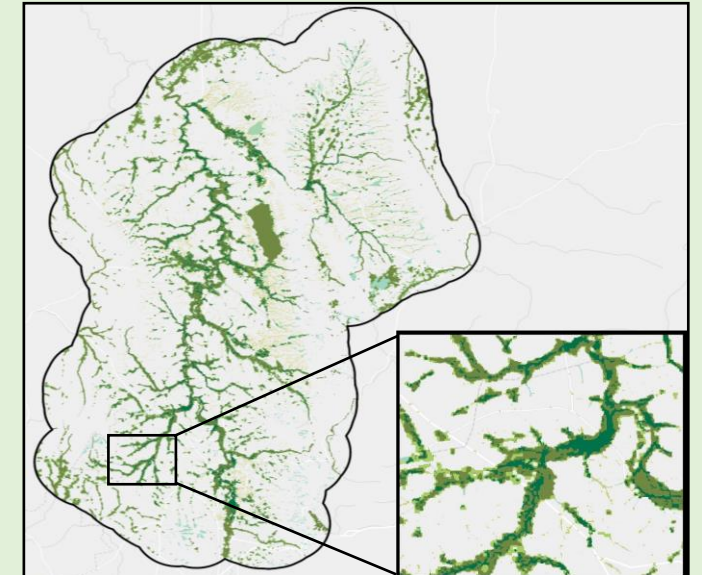


Results

Northwest Province



Southern Cape



Findings

Demonstrated the feasibility of using Earth observations to delineate riparian zones

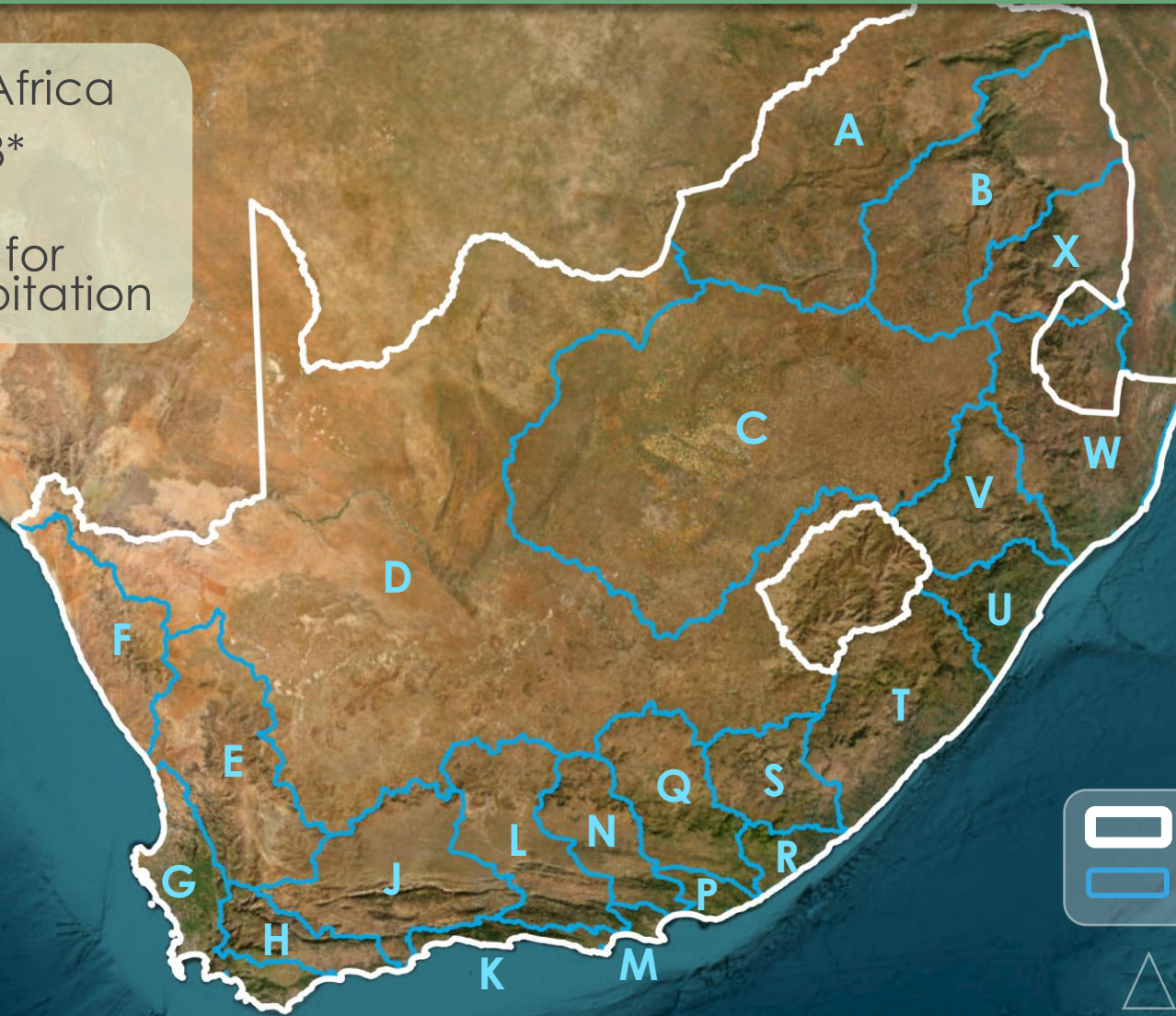
Highlighted critical conservation areas

Study Area and Period

Study Location: South Africa

Study Period: April 2023*

*representative month for average annual precipitation

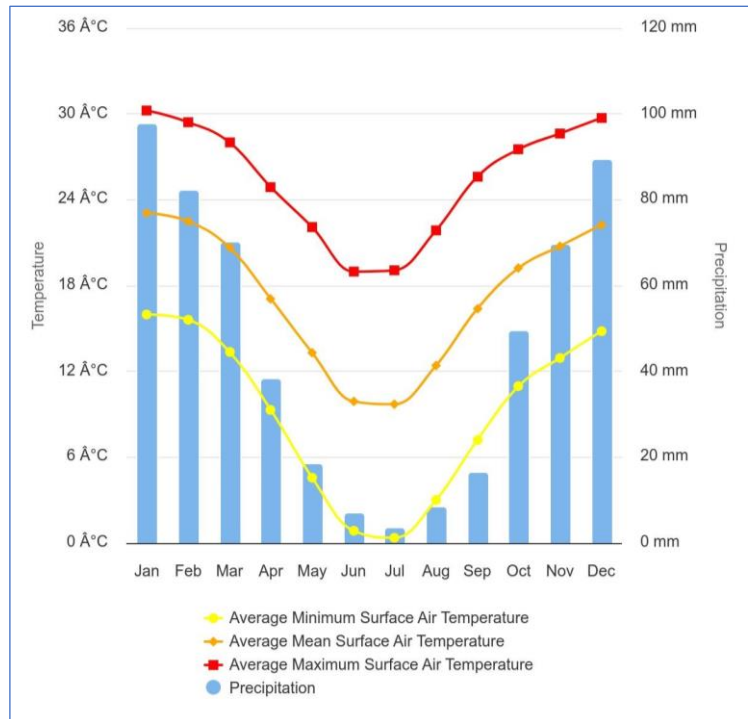


 National Boundary of South Africa
 Primary Catchment Areas



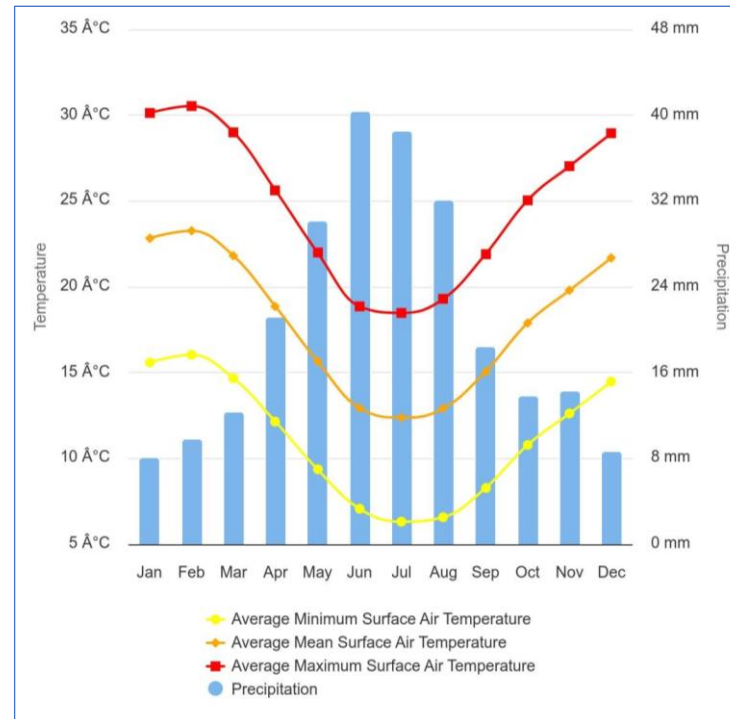
Study Period Considerations

- The **wettest and driest three-month periods of the year**, based on most recent 30-year climate averages (1991 – 2020), vary significantly from region to region in South Africa.



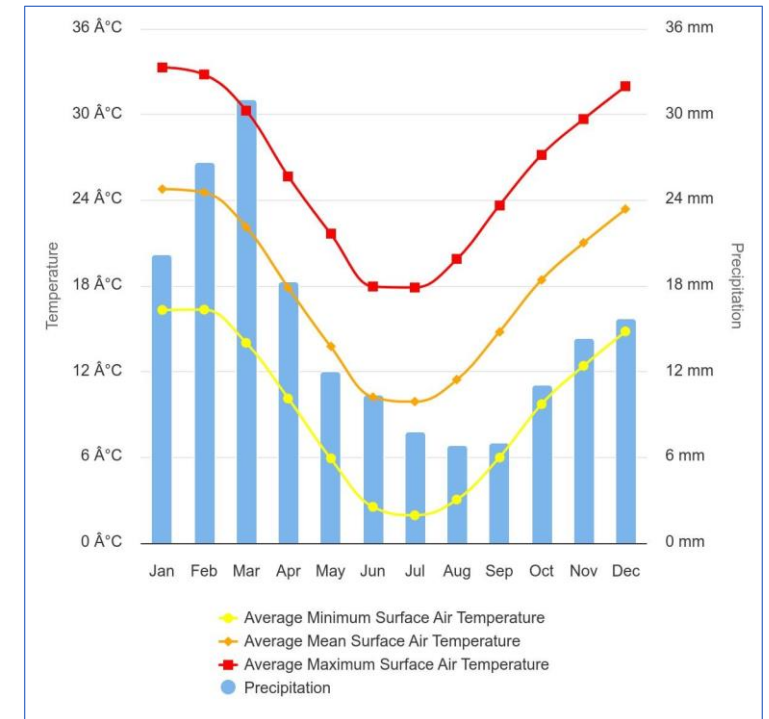
Monthly Climatology of Northeast Provinces (Watershed # ESA162937)

Wet Period: December-January-February



Monthly Climatology of Western Cape (Watershed #ESA001503)

Wet Period: June-July-August



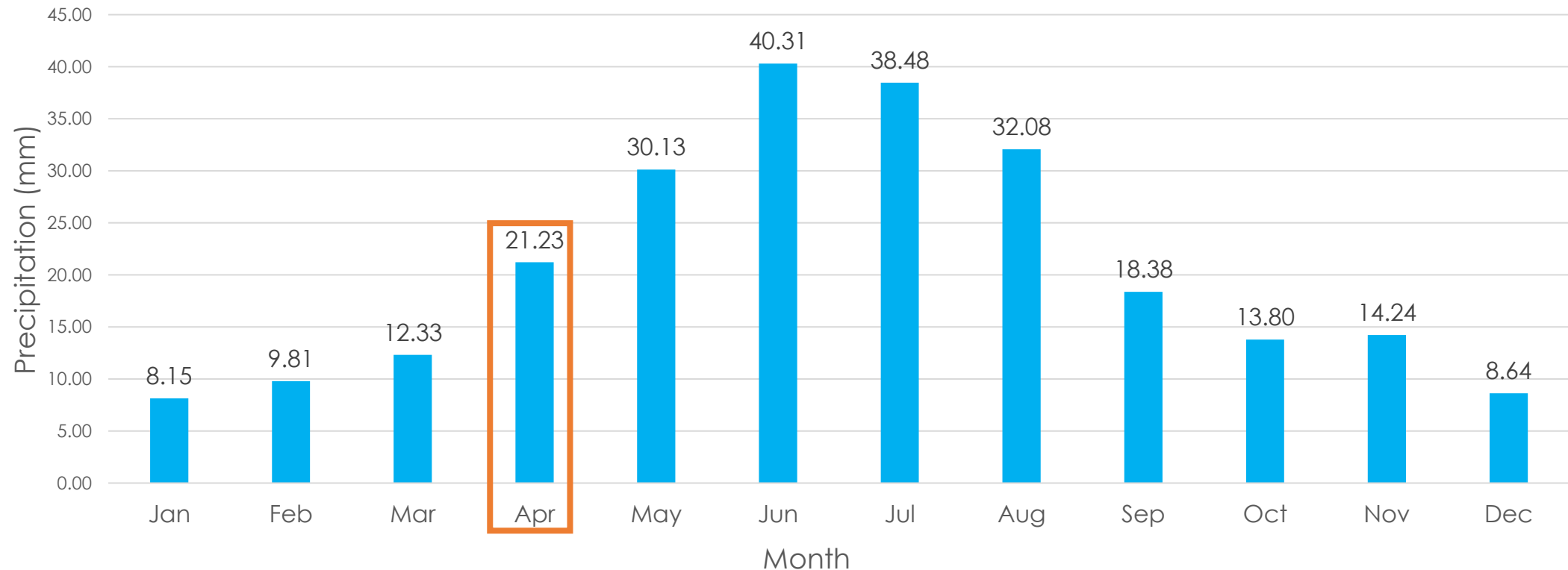
Monthly Climatology of Northern Cape and Semi-Arid Regions (Watershed #ESA162620)

Wet Period: January-February-March

Study Period Selection

- Based on 30-year climate normals (1991 – 2020), average annual precipitation in South Africa is 20.6 mm.

Monthly Average Precipitation (30-year Climate Normals)



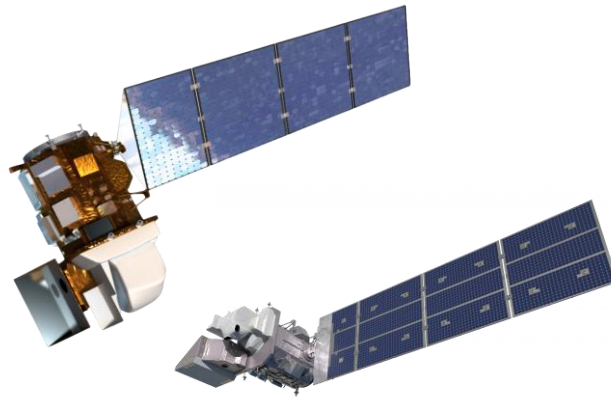
The month of April was selected as the representative study period since its precipitation levels closely align with the annual average.

Source: World Bank Climate Change Knowledge Portal, Observed, historical data is produced by the Climatic Research Unit (CRU) of University of East Anglia.

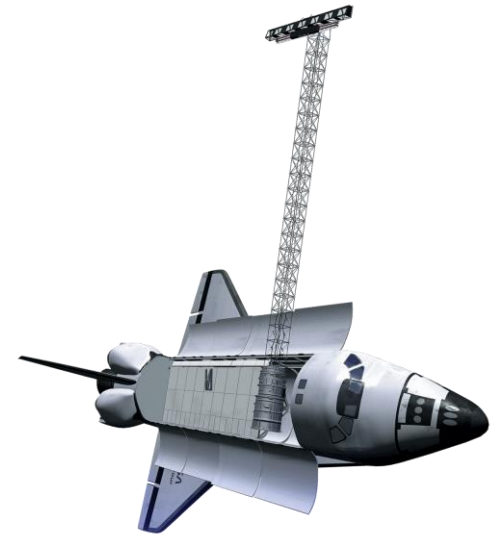
Earth Observations



Sentinel-2a and 2b MSI



Landsat 8 OLI/9 OLI-2

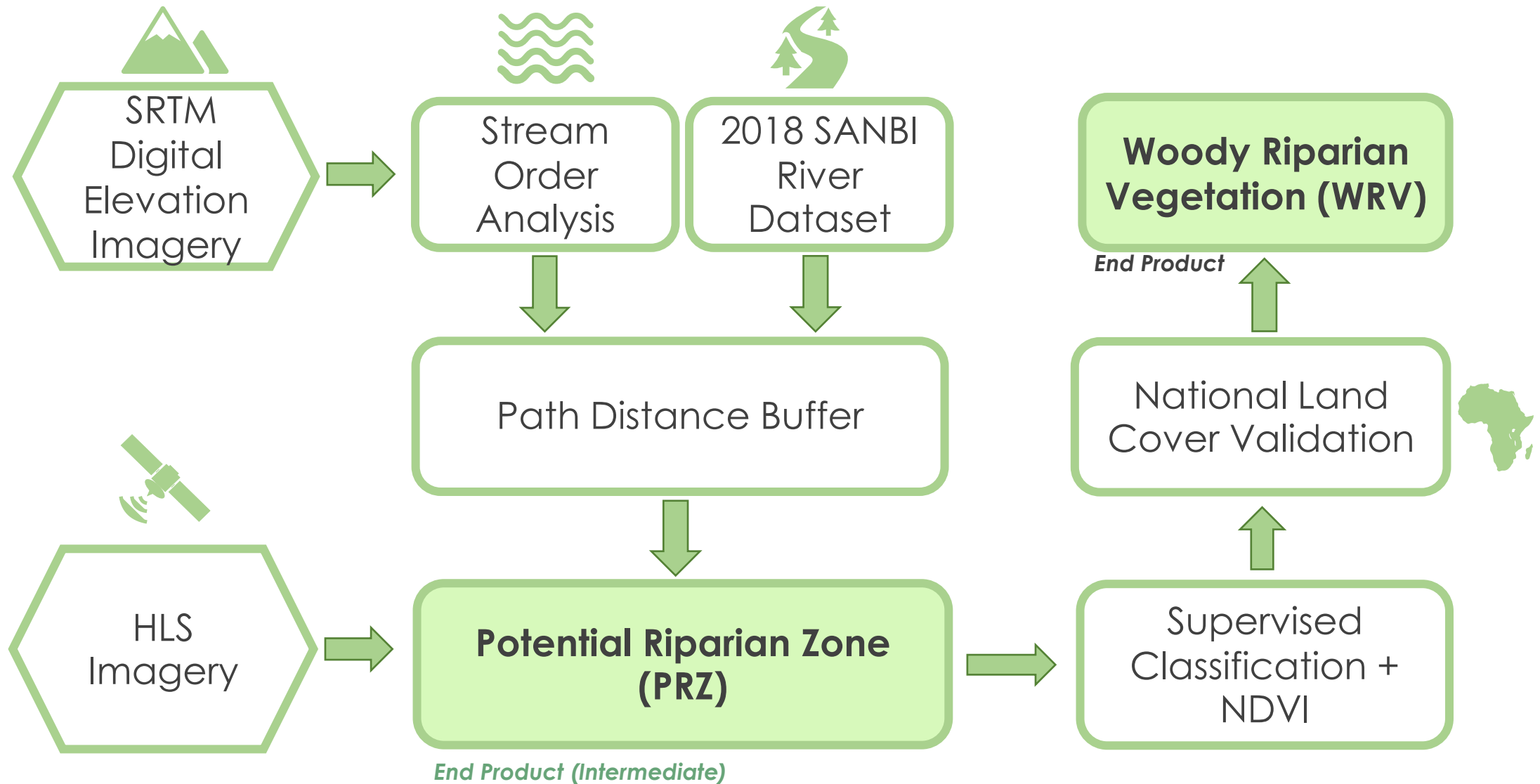


Shuttle Radar
Topography Mission

**Harmonized Landsat and Sentinel-2 Dataset
(HLS)**

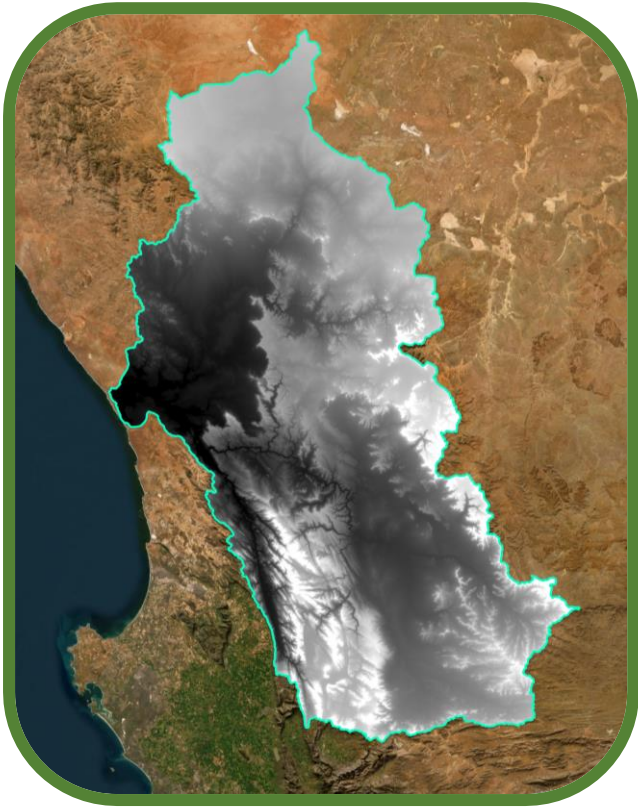
(SRTM)

Methodology Overview

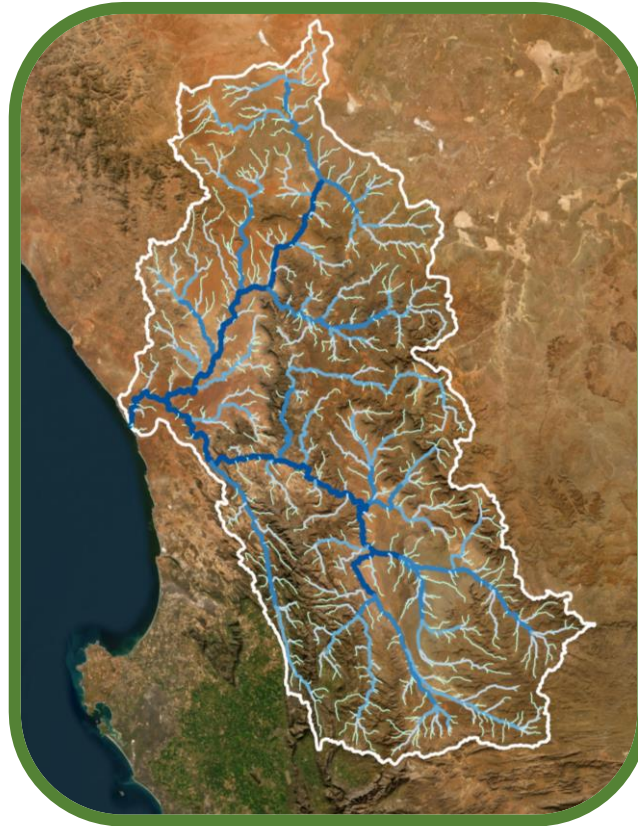
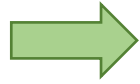


Methodology: Potential Riparian Zone Analysis

Methodology – Potential Riparian Zone



Mosaic SRTM DEM imagery and **clip** to region of interest

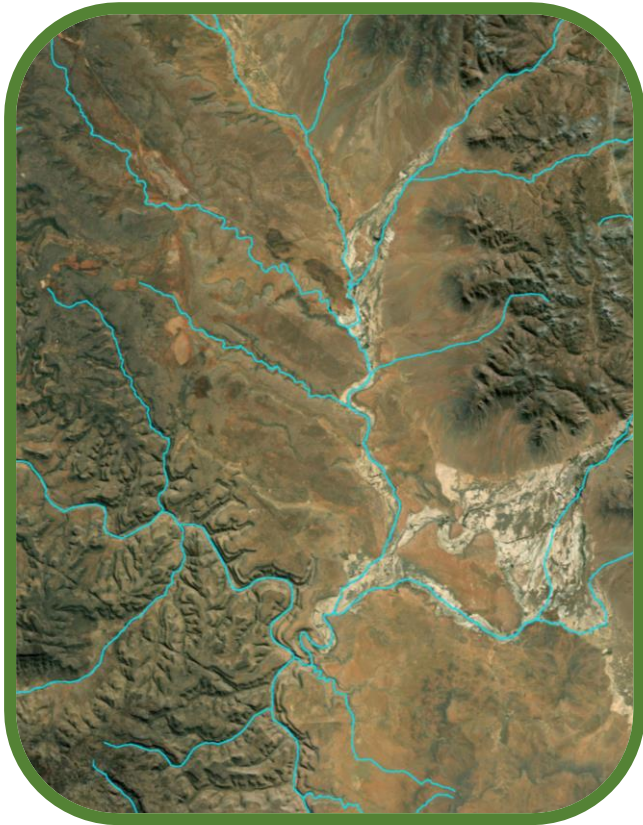


Perform a **Stream Order Analysis** to estimate river systems

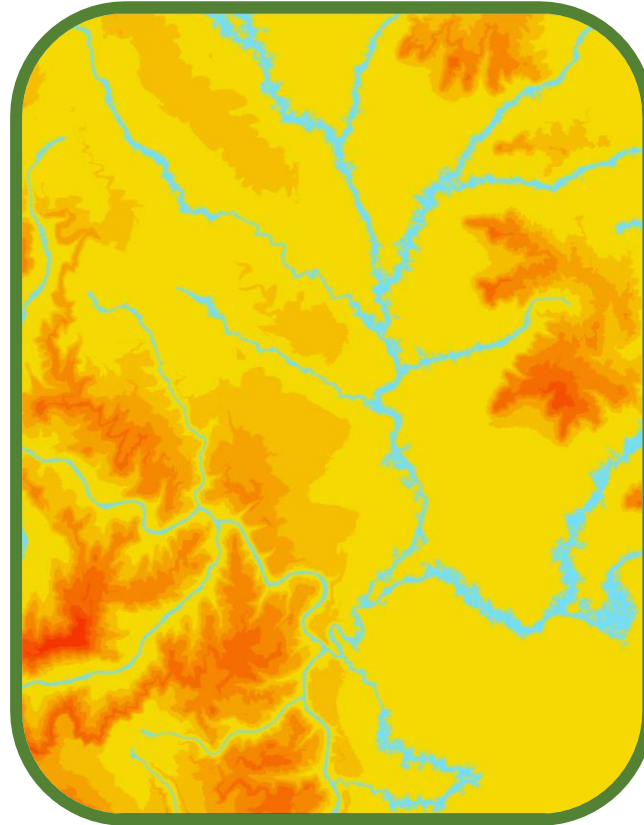


Create **buffer** based on Stream Order Analysis

Methodology – Potential Riparian Zone



Generate **Euclidian Distance** from the National Rivers Dataset

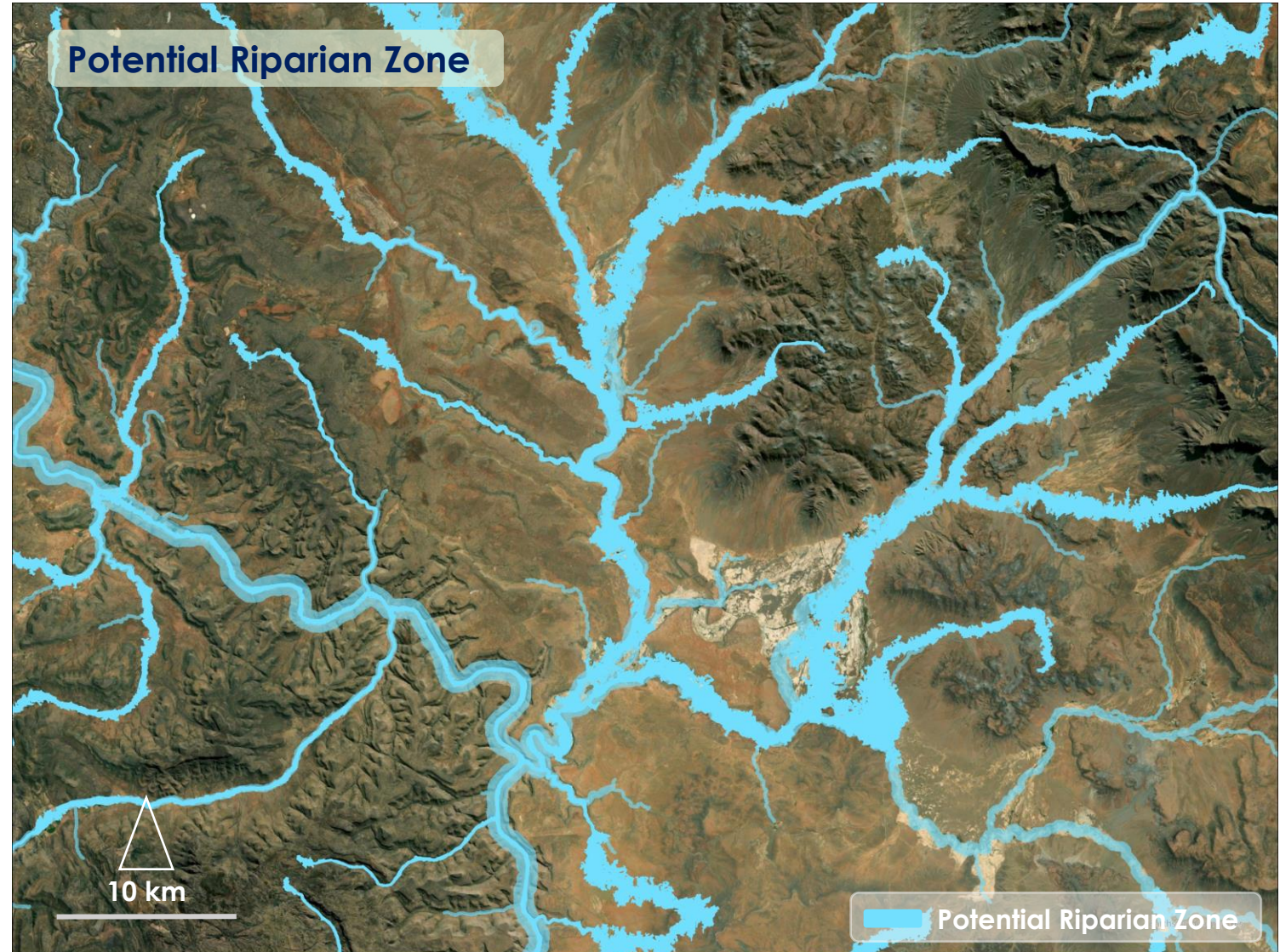
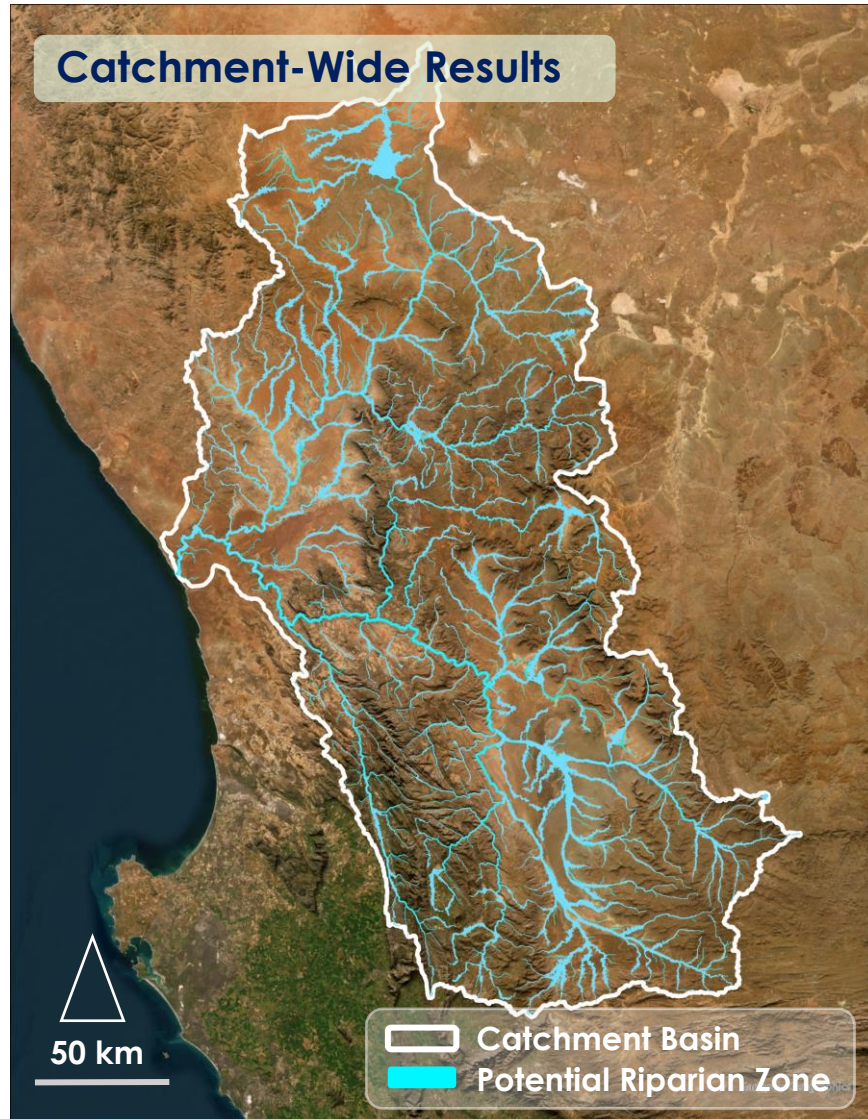


Use **Path Distance** tool on merged raster



Reclassification and **buffering**

Results – Potential Riparian Zone



Methodology:
Calculating Woody
Riparian Vegetation

Methodology – Woody Riparian Vegetation



Generate a **composite raster** with shortwave infrared, near-infrared, and green bands to differentiate between water bodies and vegetation



Clip composite raster to the **potential riparian zone** for classification

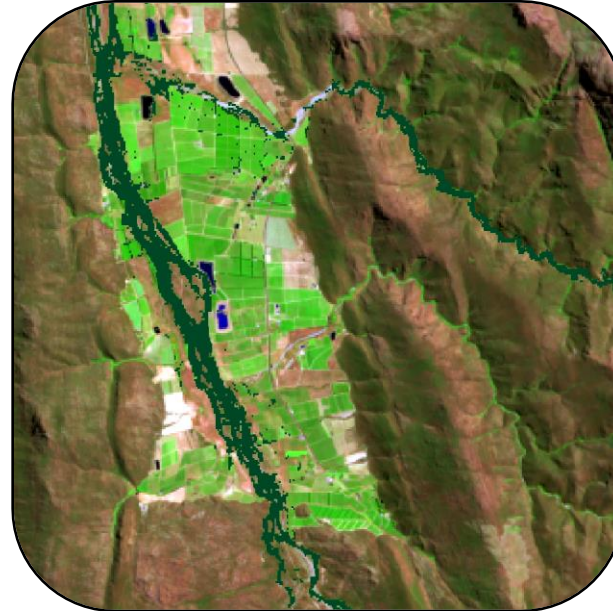


Create a **training sample** for woody and non-woody riparian areas

Methodology – Woody Riparian Vegetation



Classify woody riparian vegetation using **Random Forest** classification
training model accuracy = 0.9865

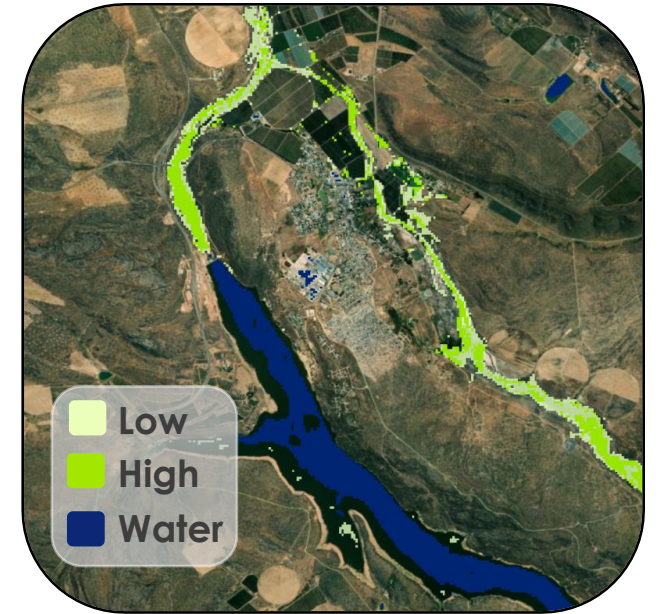
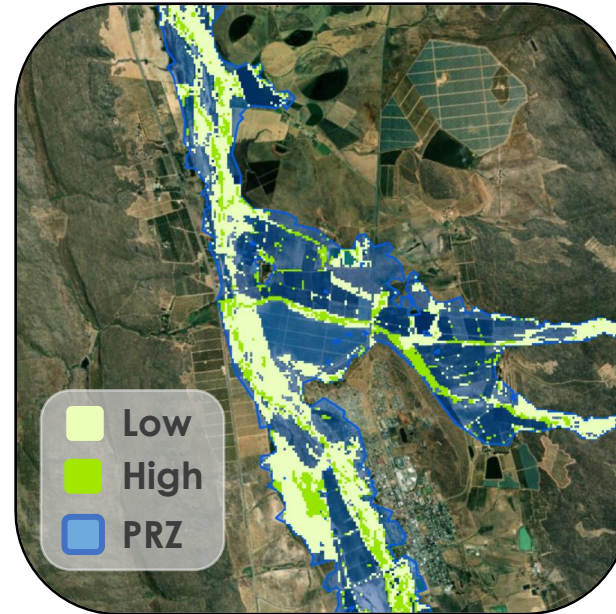
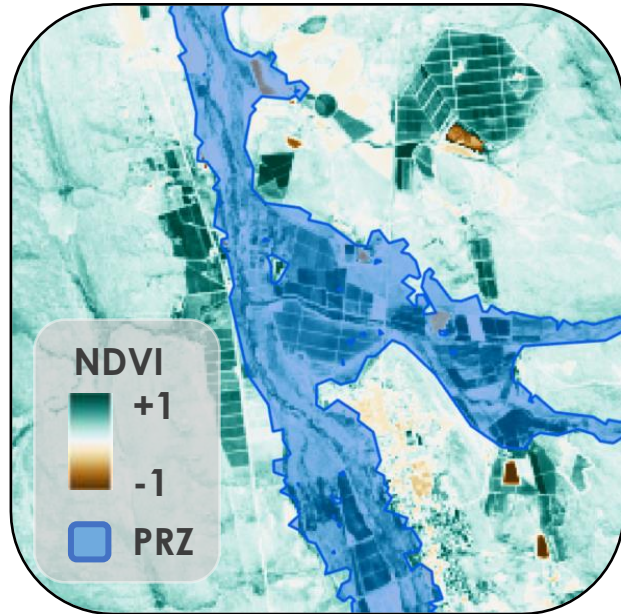


Extract agricultural and urban areas from classified results



Intersect classification with a national land cover layer to determine "High Confidence" and "Low Confidence" riparian areas

Simplified Methodology – NDVI + NDWI

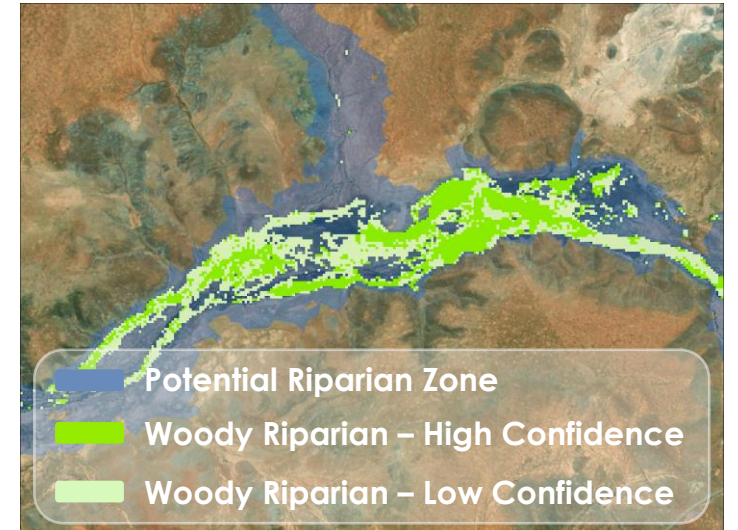
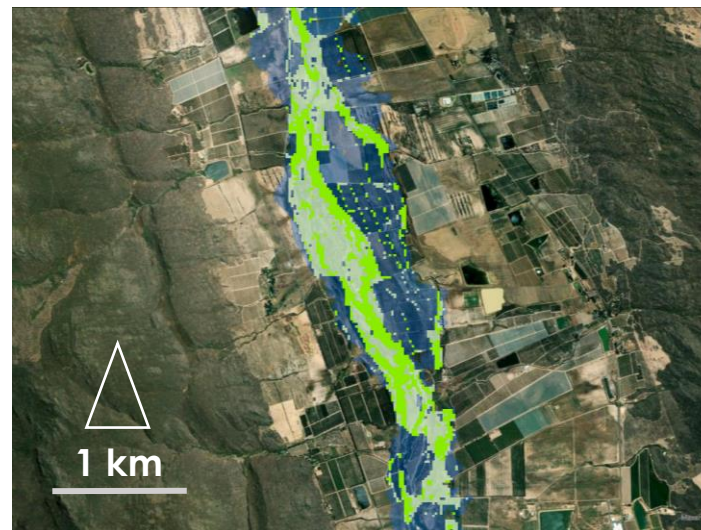
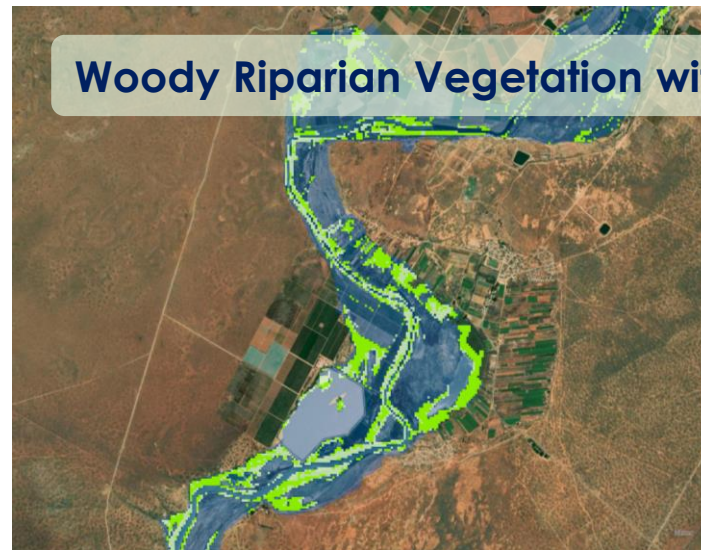
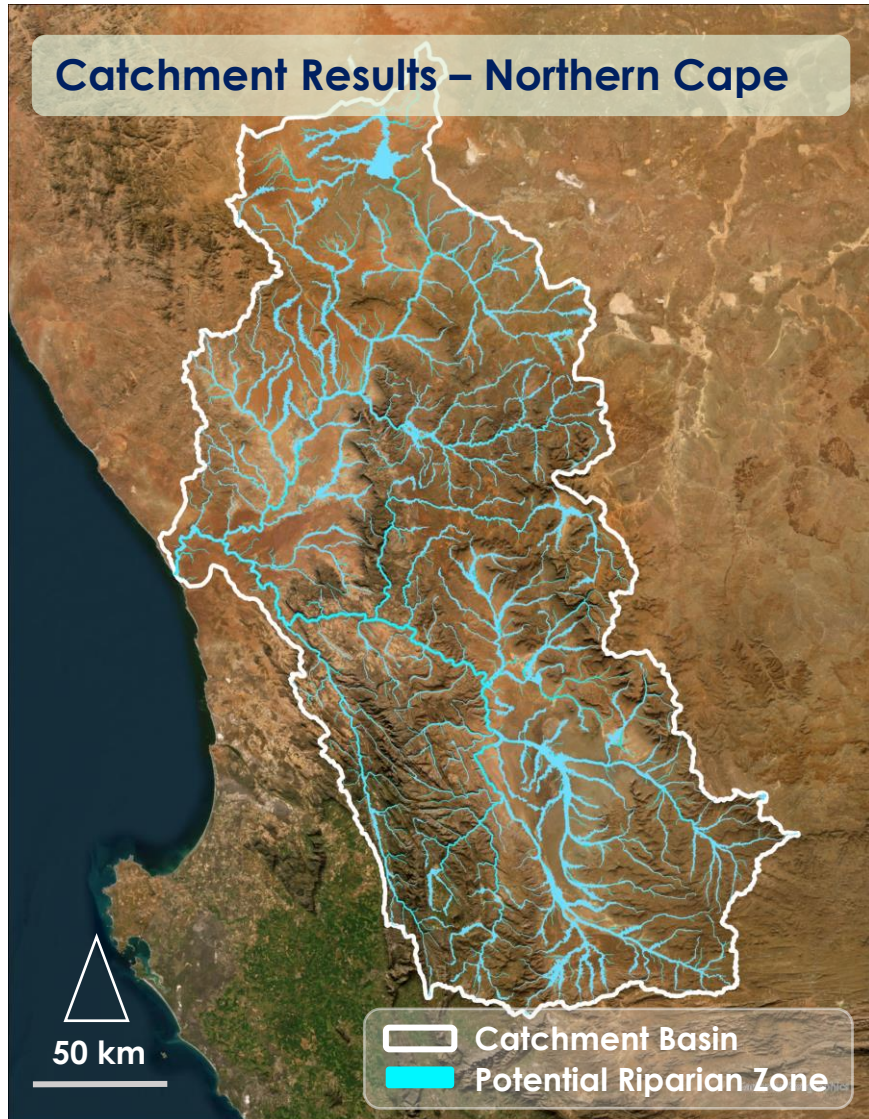


Normalized Difference Vegetation Index (near-infrared and red bands)

Reclassify **NDVI > 0.3** and determine "High Confidence" and "Low Confidence" riparian areas

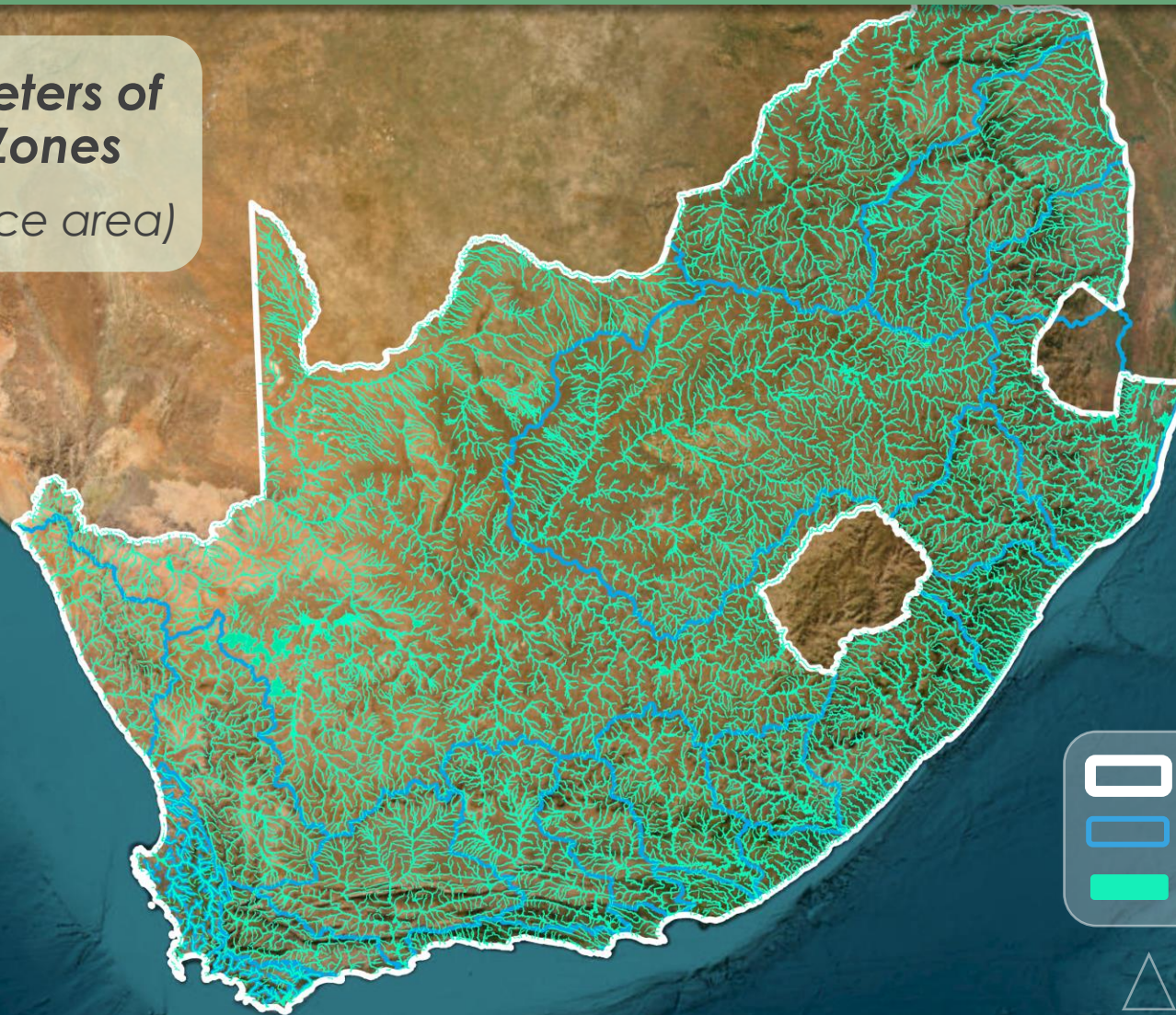
Normalized Difference Water Index to identify surface bodies

Results – Woody Riparian Vegetation



Results – National Potential Riparian Zone

**79,873 square kilometers of
Potential Riparian Zones**
(6.54% of national surface area)



-  National Boundary of South Africa
-  Primary Catchment Areas
-  Potential Riparian Zones



0 125 250 500 km

Results – Data Analysis

	Western Cape Province	National
Potential Riparian Zone	7,642 square kilometers 5.89 % of the province surface area	79,873 square kilometers 6.54 % of the national surface area
	Western Cape <i>(Basin E Testing Area near Northern Cape)</i>	Western Cape <i>(Basin G Testing Area around Cape Town)</i>
Woody Riparian Vegetation (Total)	564 square kilometers 1.15 % of the catchment area (49,065 square kilometers)	335 square kilometers 1.32 % of the catchment area (25,298 square kilometers)
Woody Riparian Vegetation (High Confidence)	154 square kilometers 0.31 % of the catchment area (49,065 square kilometers)	134 square kilometers 0.53 % of the catchment area (25,298 square kilometers)

Errors and Uncertainties



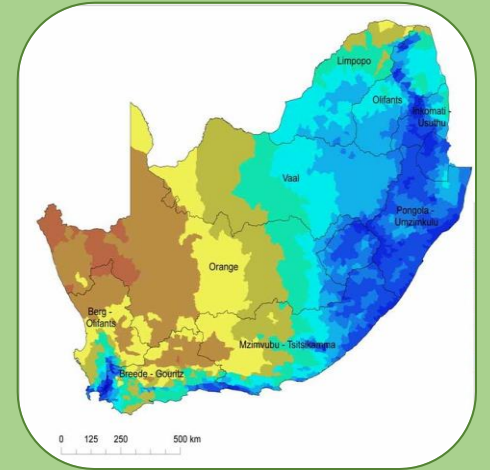
Moderate HLS resolution (30m)



Stream order may capture streams that have been modified



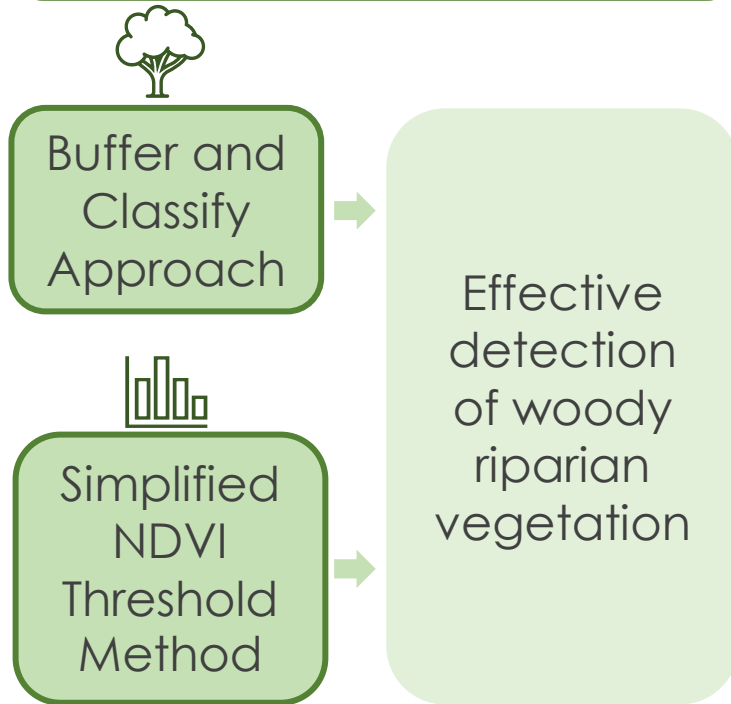
Training based on satellite imagery; national land cover data used for ground truthing



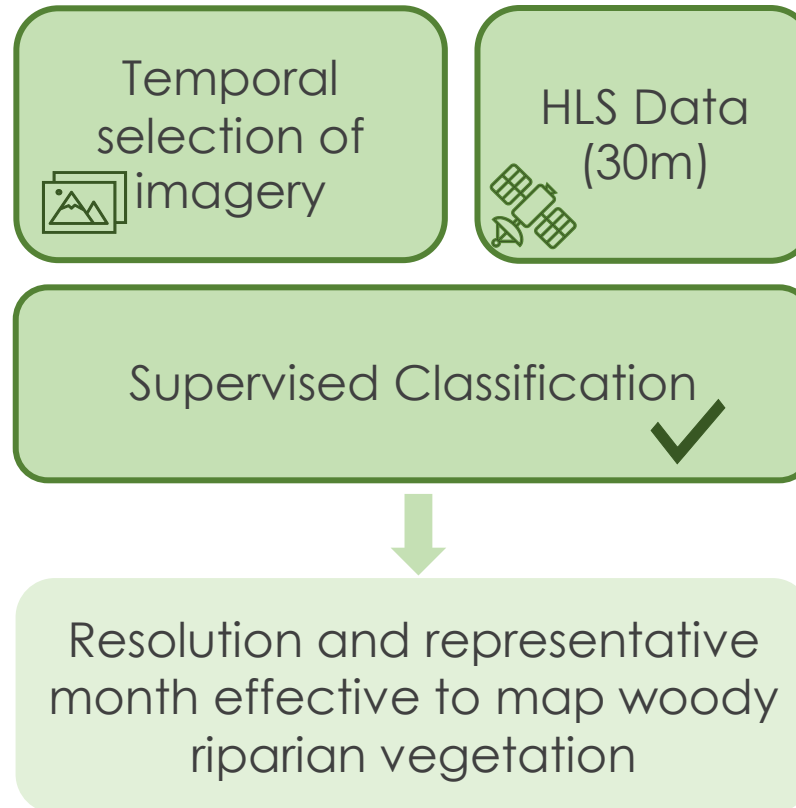
Variability in rainfall between different regions

Conclusions

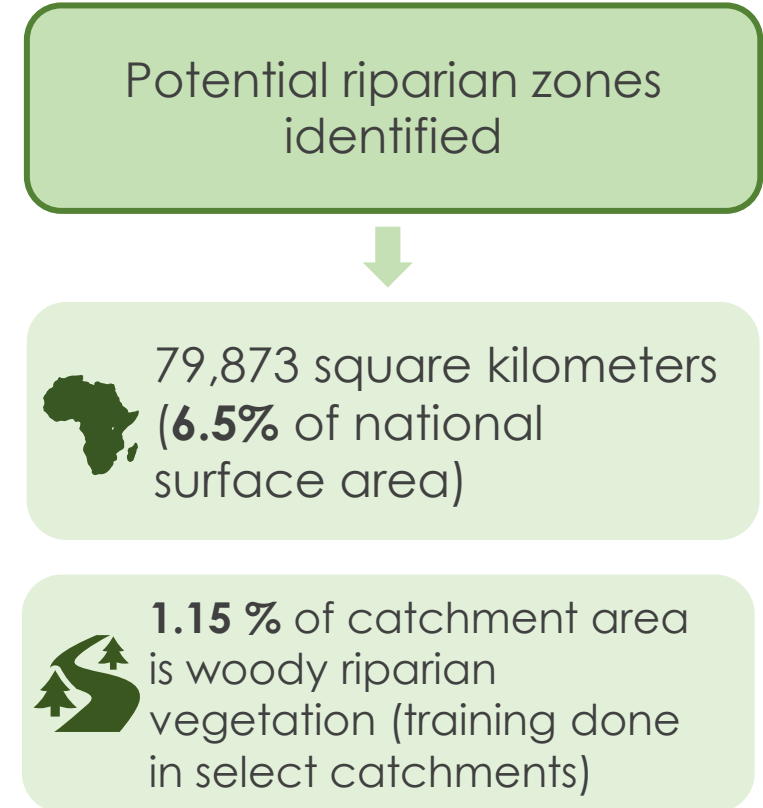
Methodology



Changes to Methods



Key Findings



Partner Implementation

The geospatial products created in this project will provide SANBI with invaluable data on riparian zones, allowing them to:

Prioritize conservation and restoration of riparian ecosystems based on the identified high confidence woody riparian vegetation

Monitor changes in riparian vegetation over time by comparing the current woody riparian vegetation to future updates

Integrate the comprehensive woody riparian vegetation dataset into SANBI's biodiversity planning and decision-making processes to better protect riparian habitats and the species they support

Acknowledgments

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- Nancy Job (SANBI – Freshwater Team Lead)

Center Lead

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