Detecting and characterizing climate change impacts in South Africa through EO and GIS: Opportunistic tools to guide intervention and response

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Water Research Commission

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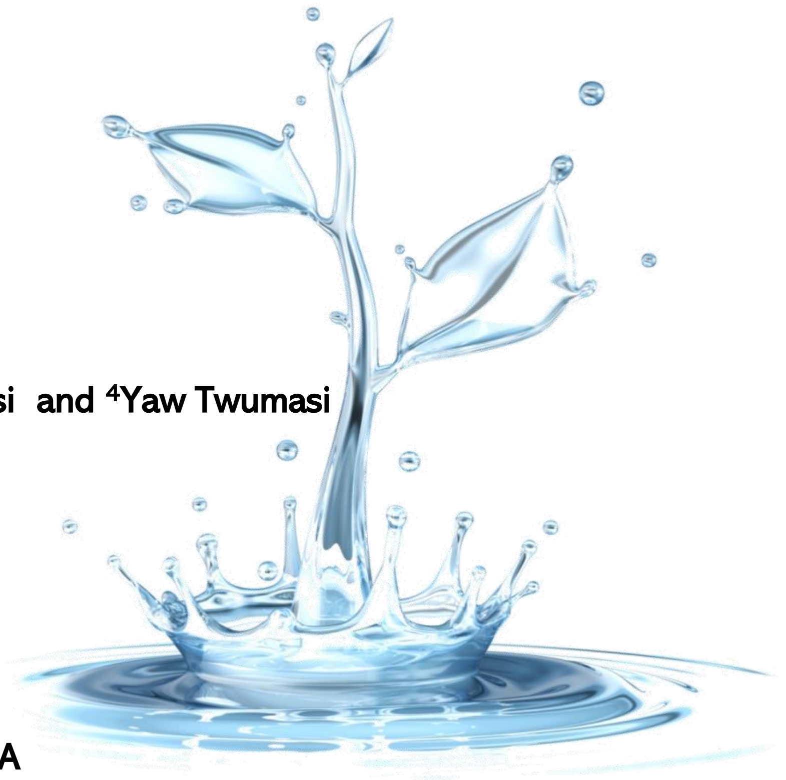


13 September 2023

Outline

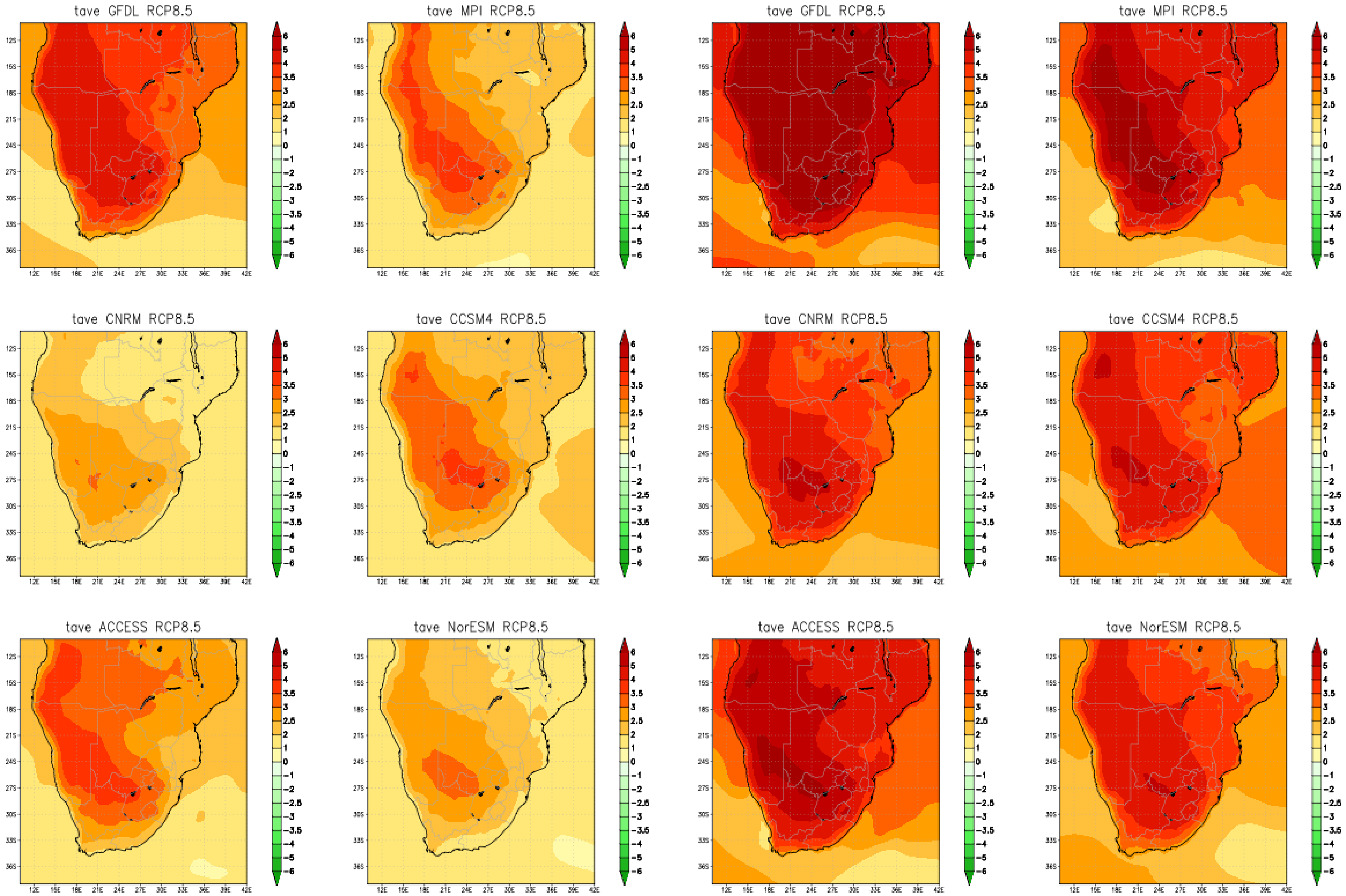
- **Introduction**
- **Projected Climate Changes for South Africa**
- **EO/GIS Applications**
- **Concluding Remarks**

Introduction

- Southern Africa region is extremely vulnerable to the impacts of climate change.
- Climate change pose negative impacts on water resources and development.
- Changes in climate and increased variability brings significant implications to different water-linked sectors.
- Different sectors have an important role to play in improving the adaptive capacity and increasing the resilience to climate change.
- EO/Geoinformatic tools serves an important function in characterizing risks, vulnerabilities and hazards, while guiding the response.
- This therefore contributes significantly to preparedness/adaptation, risk aversion and management of the disasters.

Projected Climate Changes for South Africa

Future Projected Changes in Temperature



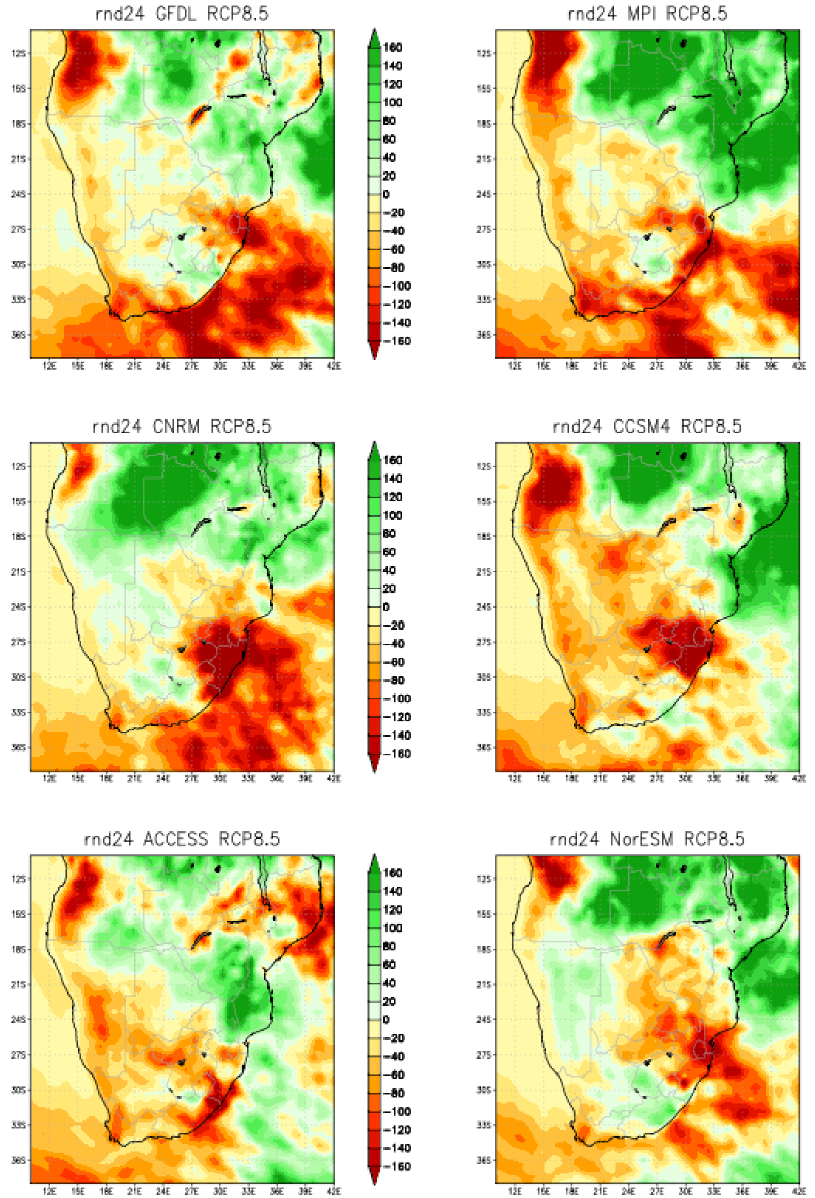
CCAM-CABLE projected changes in annual mean temperature (°C) under RCP 8.5 for the period 2046-2065 relative to 1961-1990

CCAM-CABLE projected changes in annual mean temperature (°C) under RCP 8.5 for the period 2070-2099 relative to 1961-1990.

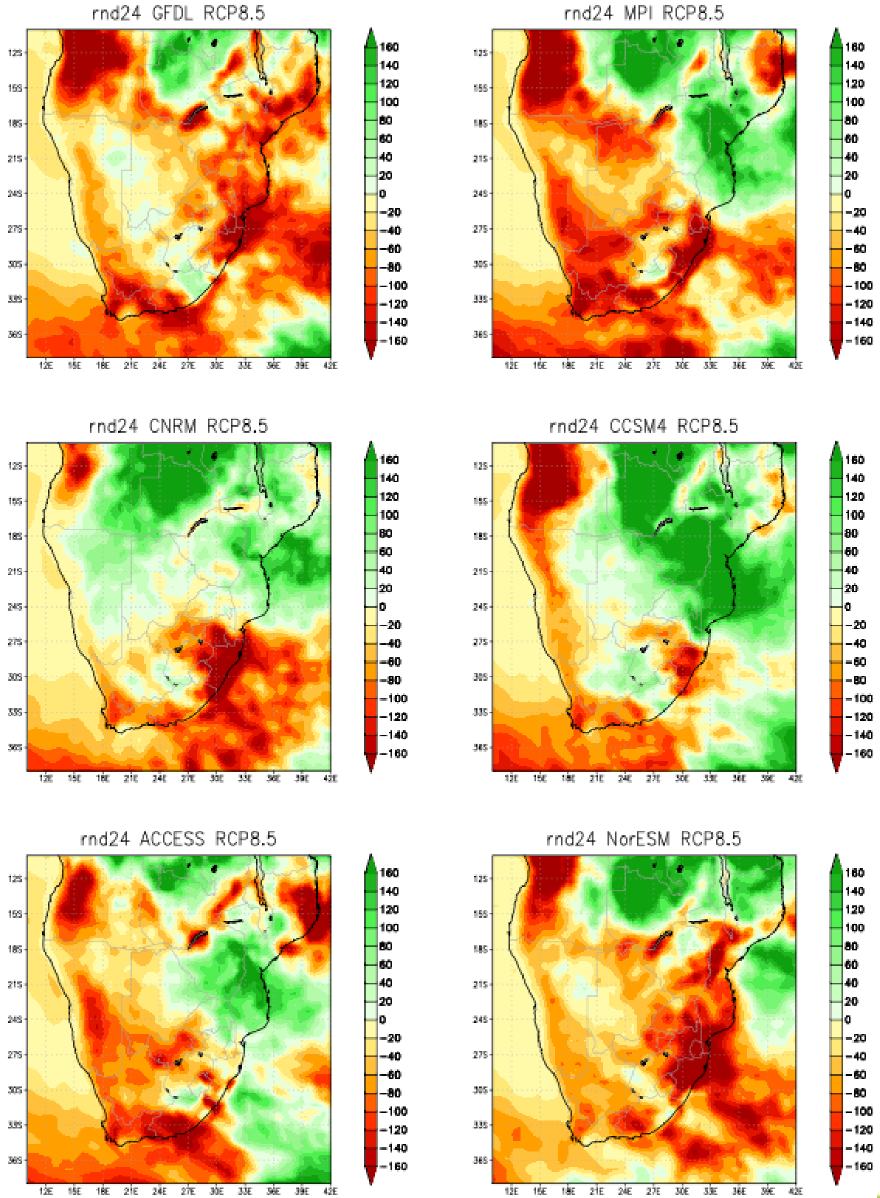
- Drastic increases in temperature are projected for South Africa (Heat Waves).
- Rising temperatures are projected to have a range of negative impacts on southern Africa, including reductions in crop yield and livestock production.
- These will directly impact on water security through inducing enhanced evaporation and land-use change.

Engelbrecht et al., 2020, WRC Report

Future Projected Changes in Rainfall



CCAM-CABLE projected changes in annual rainfall (mm) under RCP 8.5 for the period 2046-2065 relative to 1961-1990.

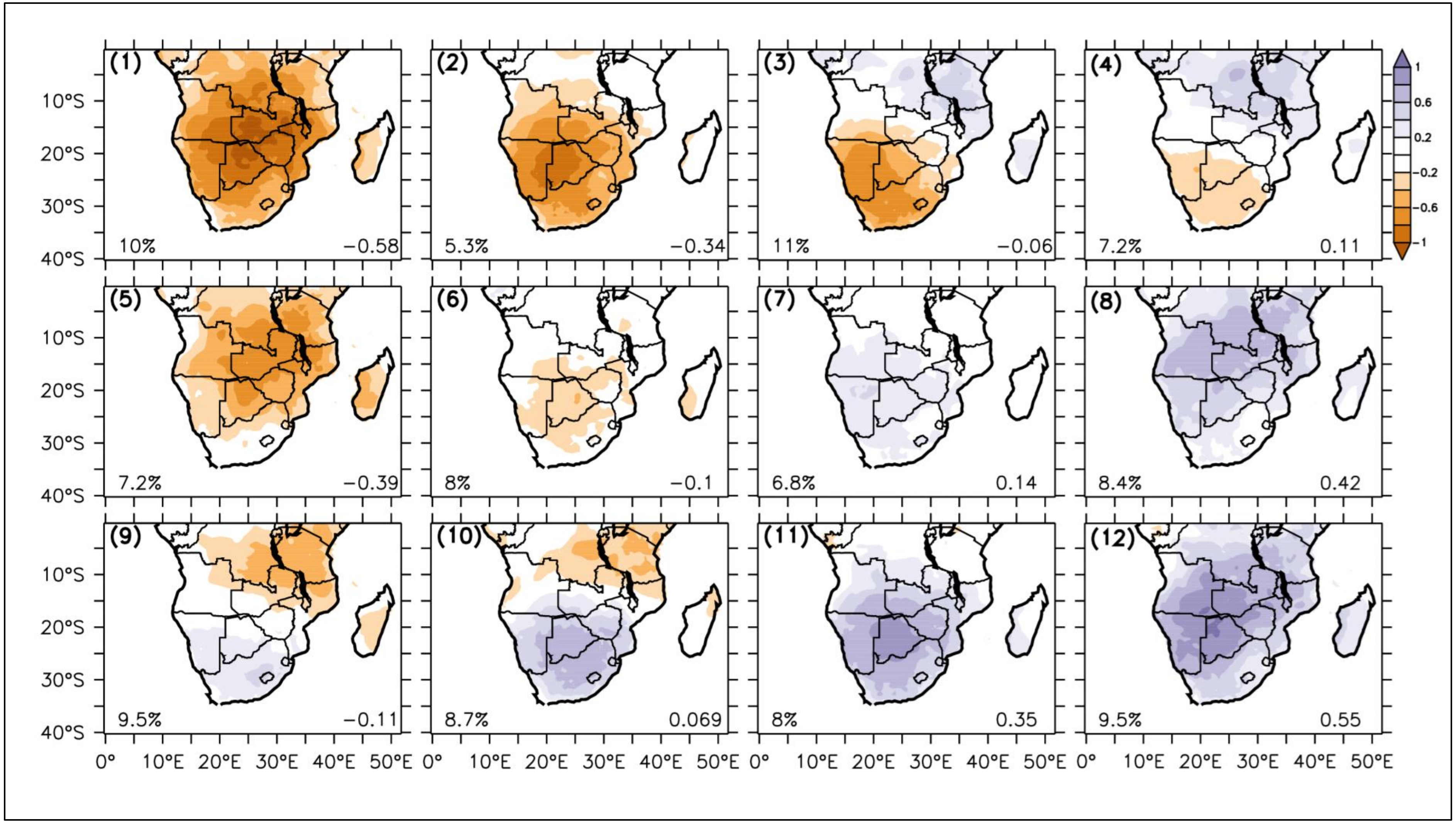


CCAM-CABLE projected changes in annual rainfall (mm) under RCP 8.5 for the period 2070-2099 relative to 1961-1990.

- Substantial rainfall decreases over the eastern escarpment of South Africa, including Lesotho by the end of the century.
- Unprecedented dry years may occur as early as the period 2016-2035, and by the mid-future period of 2046-2065 multi-year droughts may be frequently occurring over eastern South Africa.
- This will seriously compromise South Africa's water security, including that of Gauteng, and may significantly hamper future industrial development in the country.
- Rainfall increases are projected over much of Mozambique, a signal of change that is likely the result of more landfalling tropical cyclones.
- Some of the downscalings are indicative of this pattern of change extending southwards into north eastern South Africa.

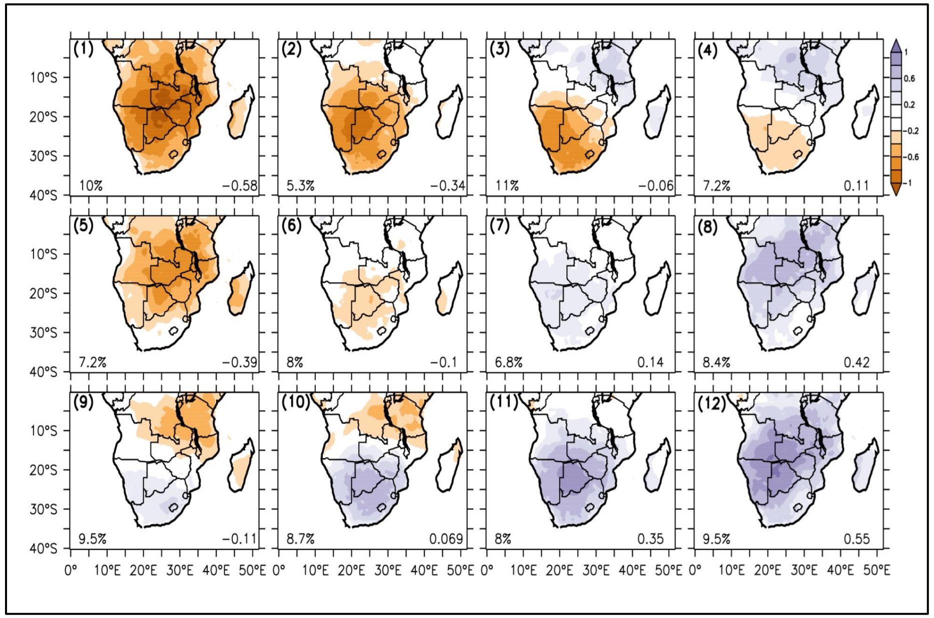
Engelbrecht et al., 2020, WRC Report

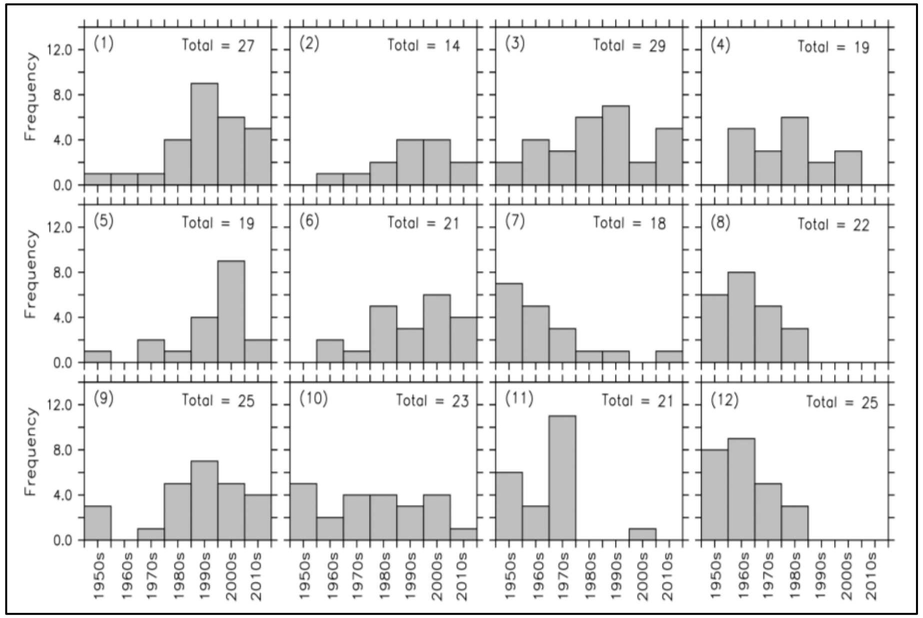
Major Drought Patterns over Southern Africa (observed)

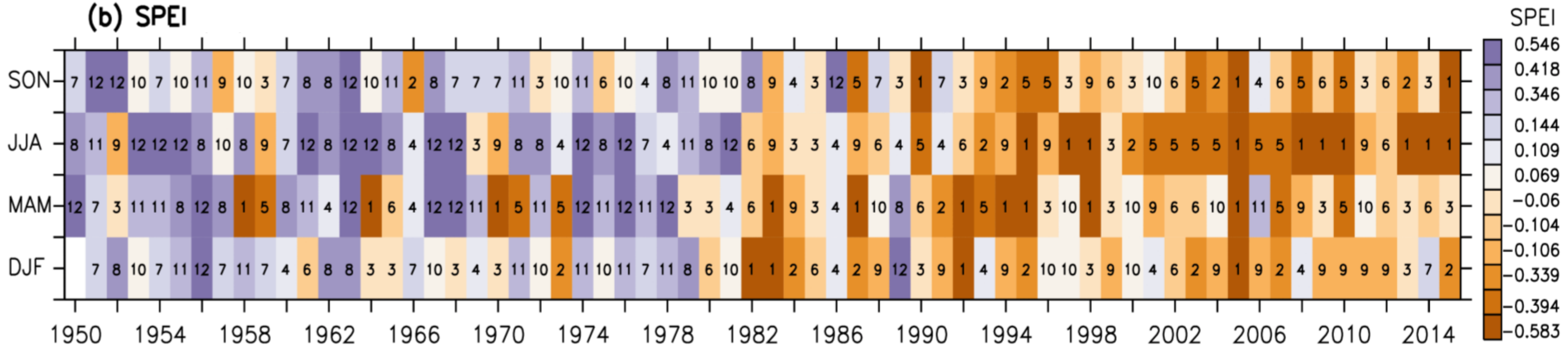


Abiodun et al., 2017, WRC Report

Major Drought Patterns over Southern Africa (Frequency and Trends)







Abiodun et al., 2017, WRC Report

EO/GIS Applications

Adaptive Infrastructural Response to Floods…

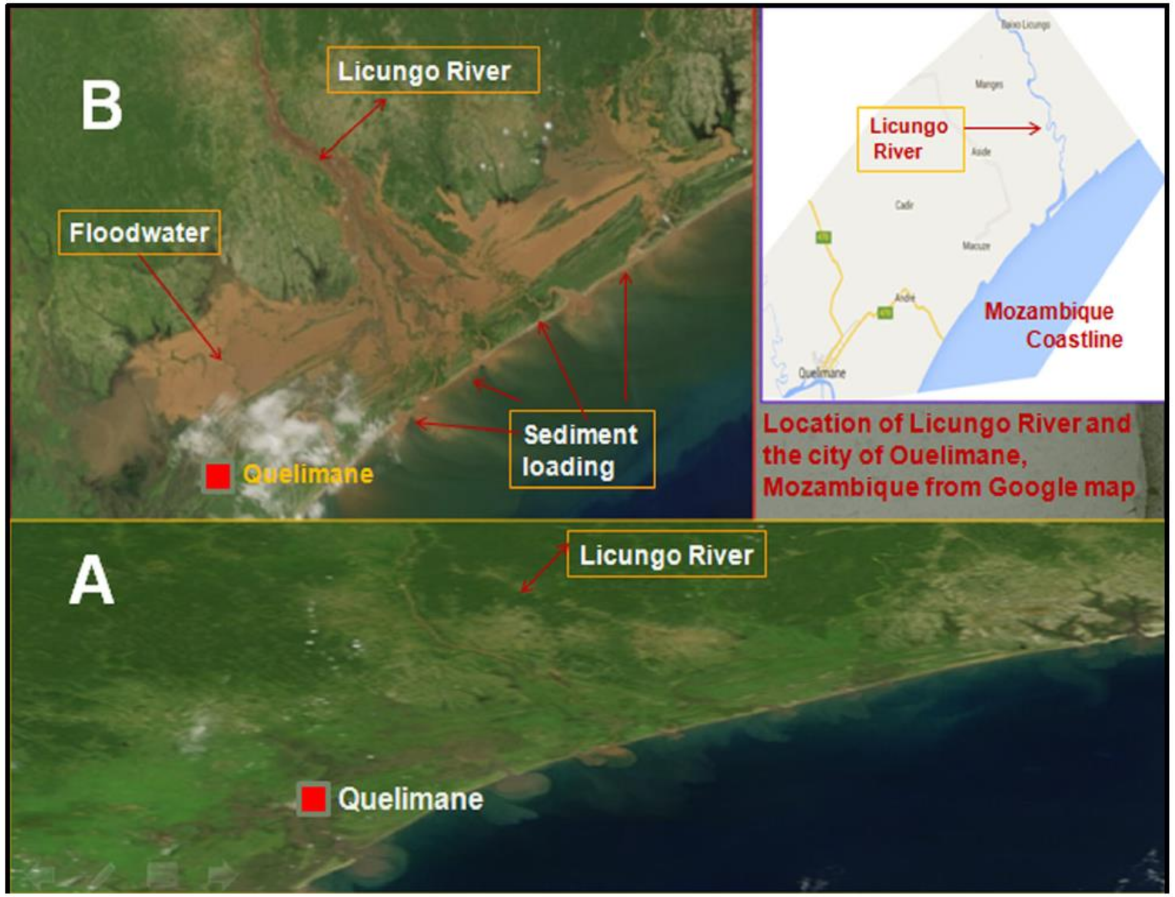
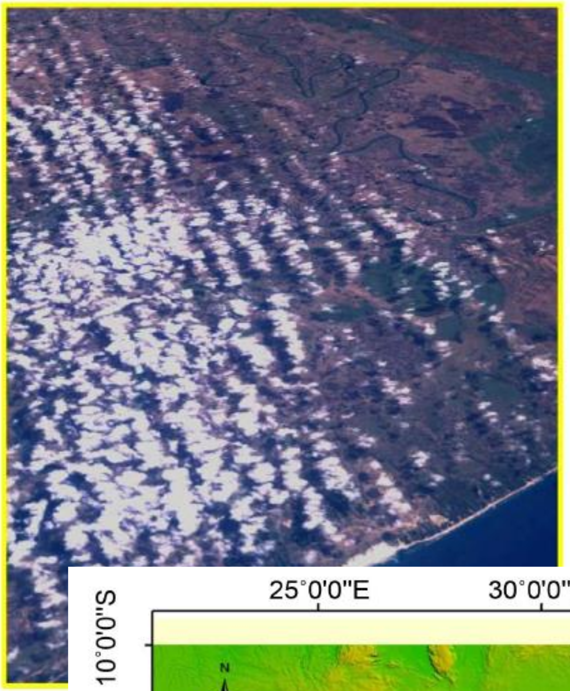
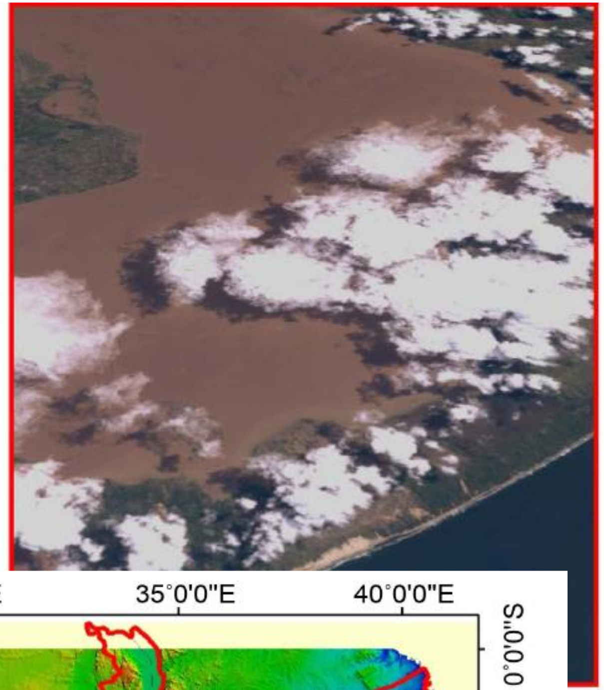
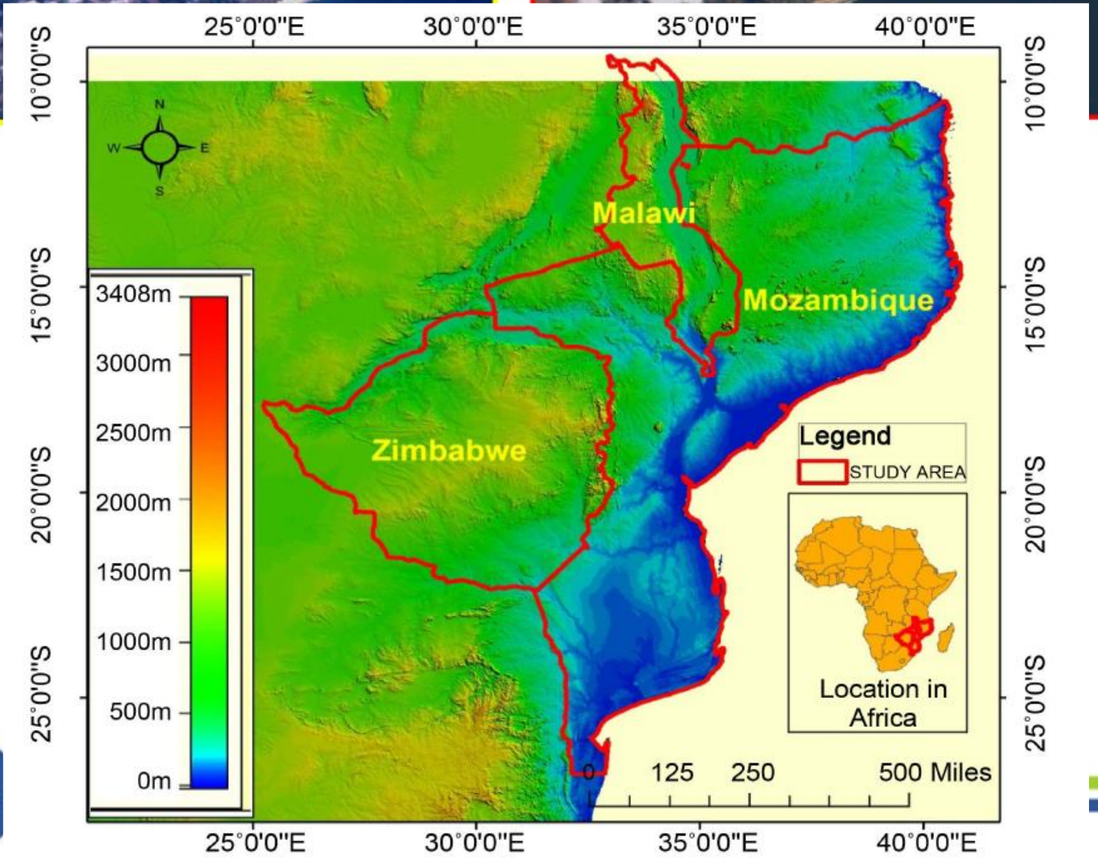


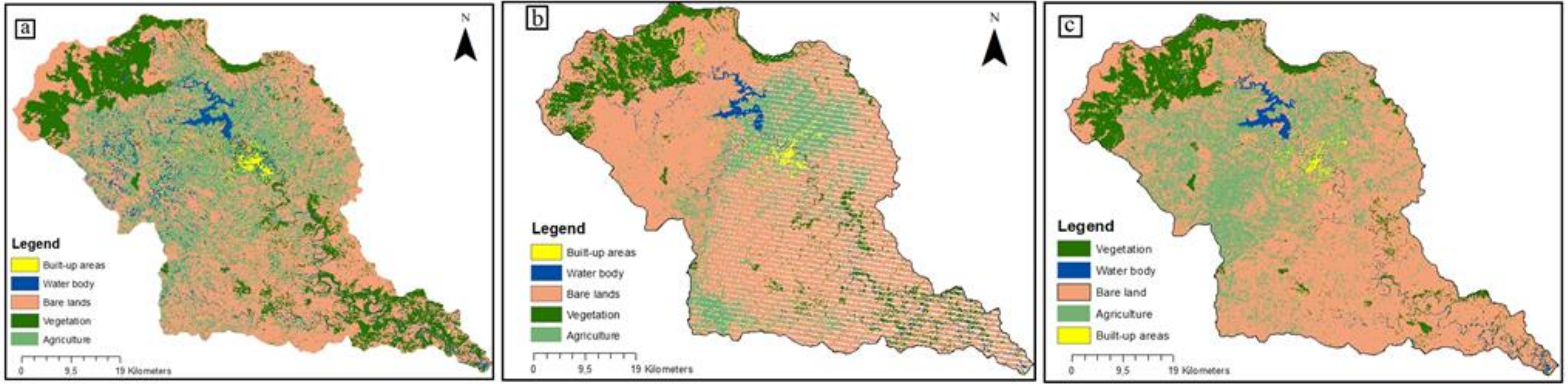
Figure 7. Image of mozambique before and after floods. Image A February 1, 2014 (before the floods) and Image B January 17, 2015 (during the floods) [43]. Heavy rainfall in early January through March 2015 caused Licungo River in mozambique to over flow its bank.

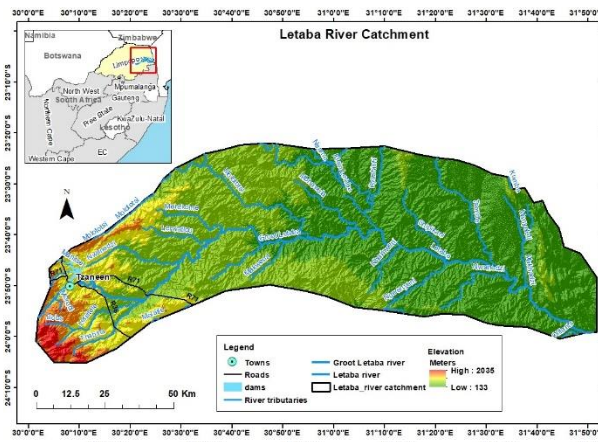
Twumasi, Y.A., Merem, E.C., Ayala-Silva, T., Osei, A., Petja, B.M. and Alexander, K. (2017) Techniques of Remote Sensing and GIS as Tools for Visualizing Impact of Climate Change-Induced Flood in the Southern African Region. American Journal of Climate Change , 6, 306-327. https://doi.org/10.4236/ajcc.2017.62016

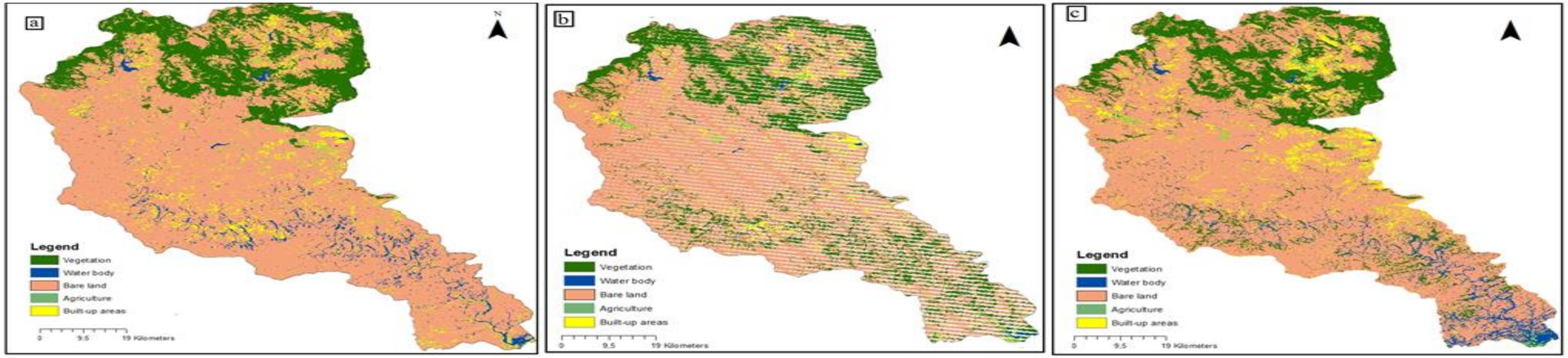


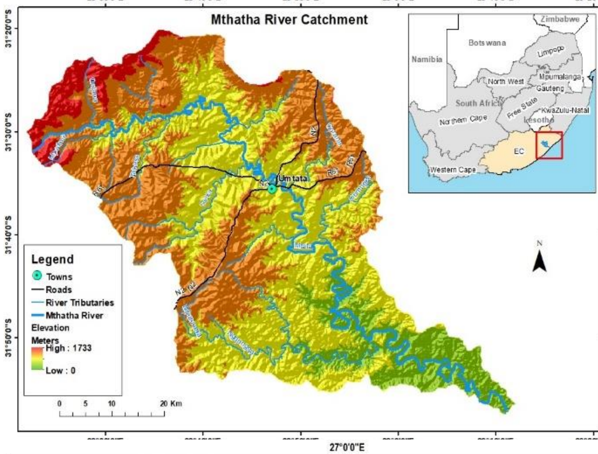




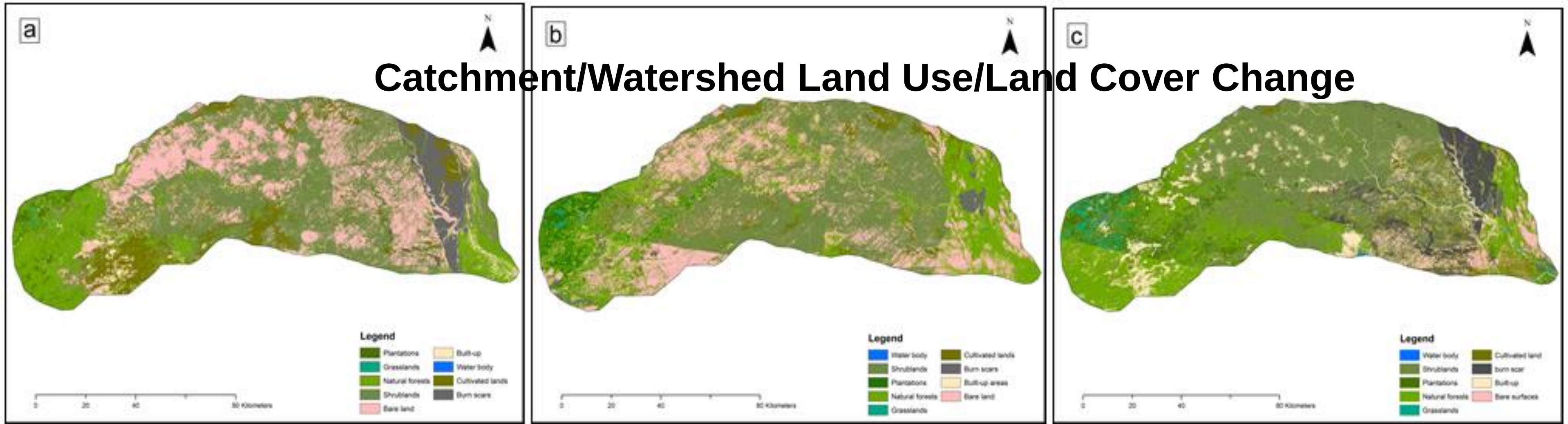


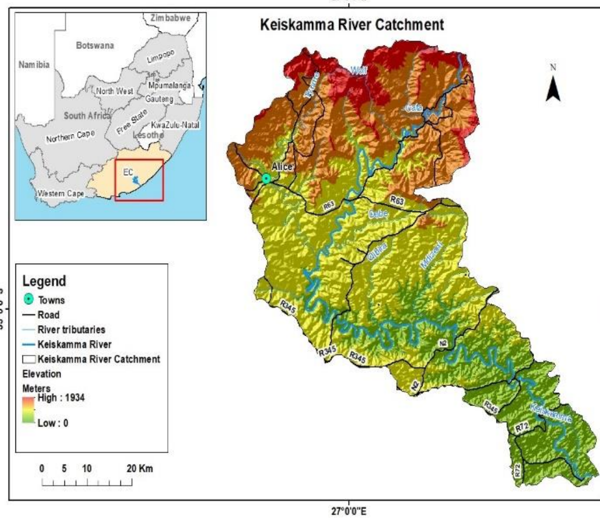






Catchment/Watershed Land Use/Land Cover Change

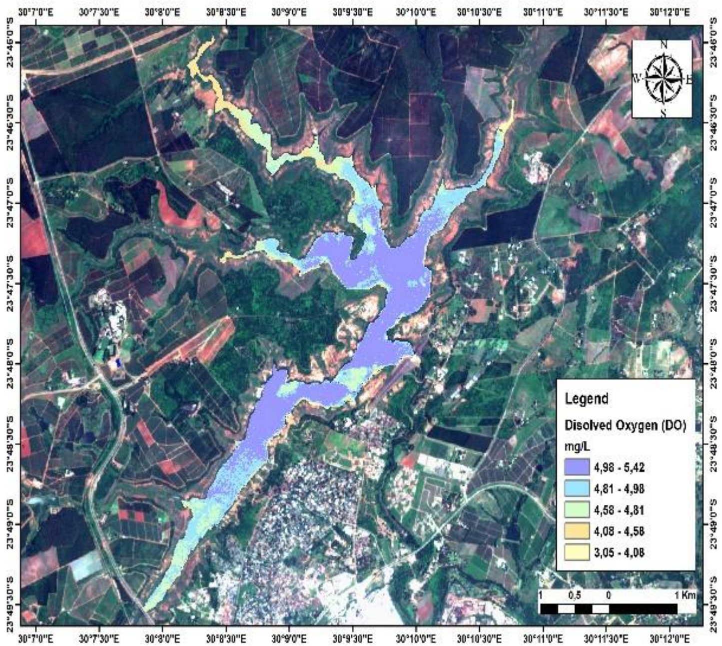


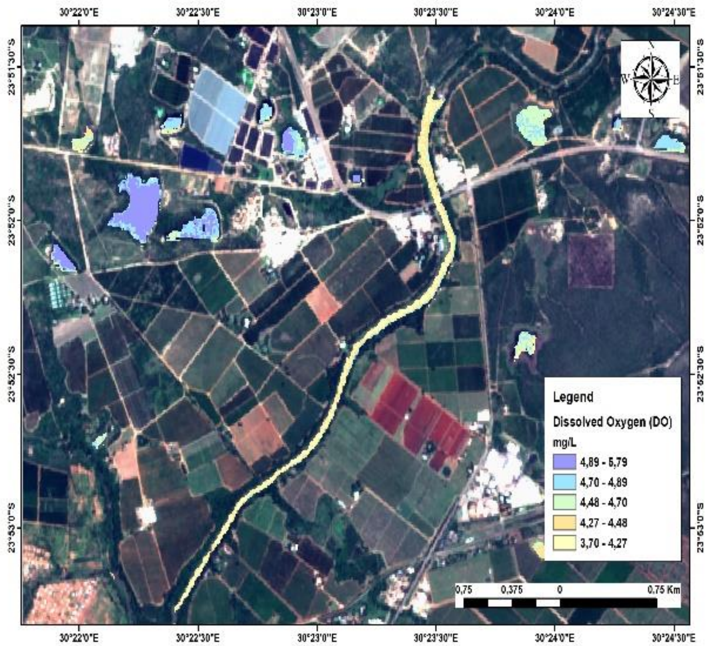


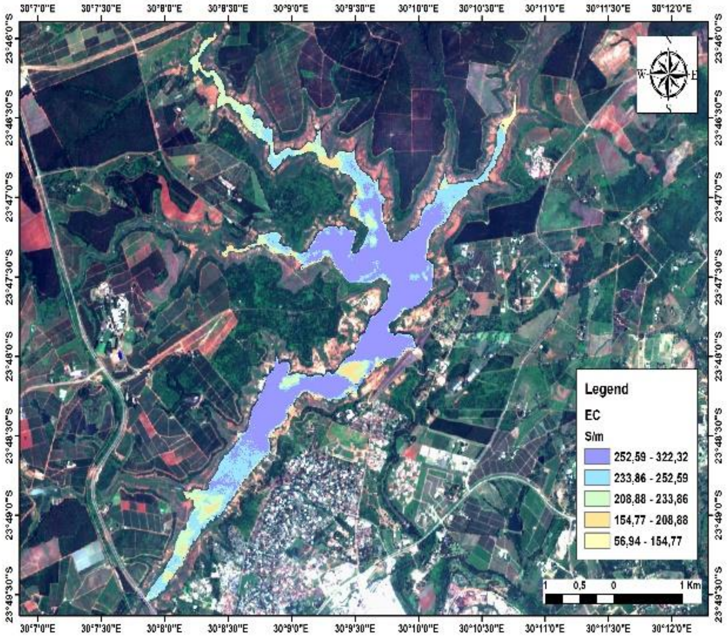
Spatial and temporal Change in Land Use and Land Cover vs Water Quality

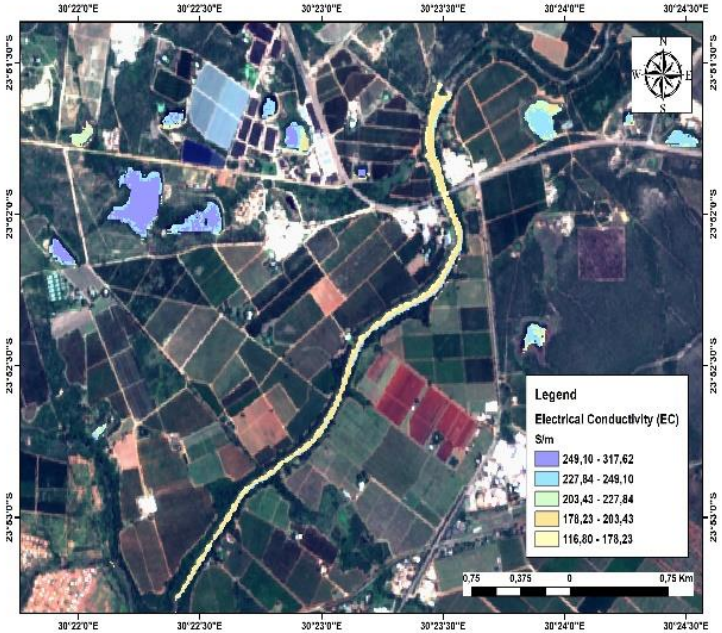
Class name	Area (ha)			%age composition		%age change
Greater Letaba	**1994**	**2005**	**2020**	**1994**	**2005**	**2020**
Bare surfaces	228190	222590	47599	24,60	24,00	5,13
Built-up	5481	25169	118476	0,59	2,71	12,77
Burn scars	54856	16225	32478	5,91	1,75	3,50
Cultivated lands	98682	58508	63852	10,64	6,31	6,88
Grasslands	1152	12350	12721	0,12	1,33	1,37
Natural forests	137000	221885	118029	14,77	23,92	12,72
Plantations	17267	36267	65088	1,86	3,91	7,02
Shrublands	361975	361708	290406	39,02	38,99	31,31
Waterbodies	717	1110	1889	0,08	0,12	0,20
Total area mapped (ha)	927593	927593	927593	---	---	---

Variables	DO	EC	TDS	SAL	PH	Temp
B02	0,518	0,627	0,561	0,727	-0,450	0,049
B03	0,587	0,713	0,651	0,767	-0,484	0,010
B04	0,643	0,797	0,750	0,764	-0,502	-0,073
B05	0,565	0,684	0,632	0,684	-0,458	0,022
B06	0,147	-0,020	-0,013	0,080	0,003	-0,094
B07	0,128	-0,057	-0,042	0,019	0,038	-0,121
B08	0,048	-0,012	-0,066	0,194	-0,088	0,229
B8A	0,056	-0,154	-0,134	-0,052	0,085	-0,118
B11	0,004	-0,168	-0,173	0,008	0,000	-0,002
B12	0,039	-0,116	-0,146	0,119	-0,114	0,104
NDWI	0,052	0,096	0,123	-0,011	0,000	-0,156
mNDWI	0,038	0,251	0,218	0,175	-0,082	0,154
NDWI plus VI	-0,333	-0,478	-0,501	-0,267	0,212	0,266
mNDWI plus VI	-0,177	-0,258	-0,288	-0,091	0,081	0,223
LSWI plus VI	0,128	0,432	0,345	0,407	-0,207	0,400
AWEIsh1	0,350	0,543	0,533	0,391	-0,264	-0,113
AWEInsh	0,232	0,449	0,431	0,295	-0,192	-0,004
GNDVI	-0,052	-0,096	-0,123	0,011	0,000	0,156
NDTI	0,649	0,859	0,890	0,506	-0,411	-0,403

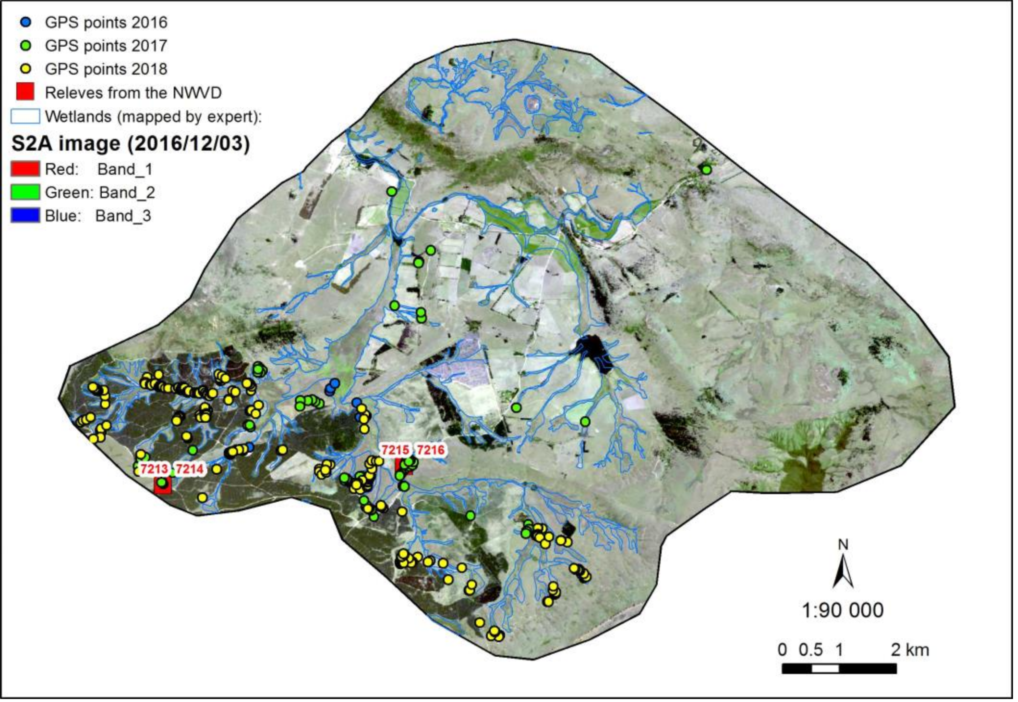


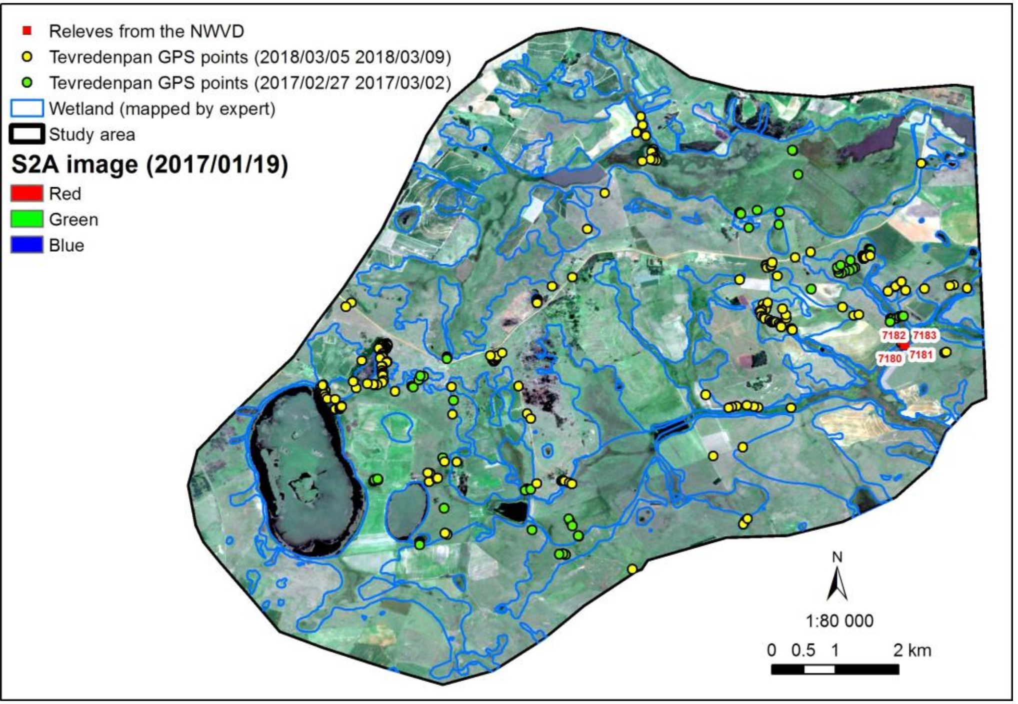


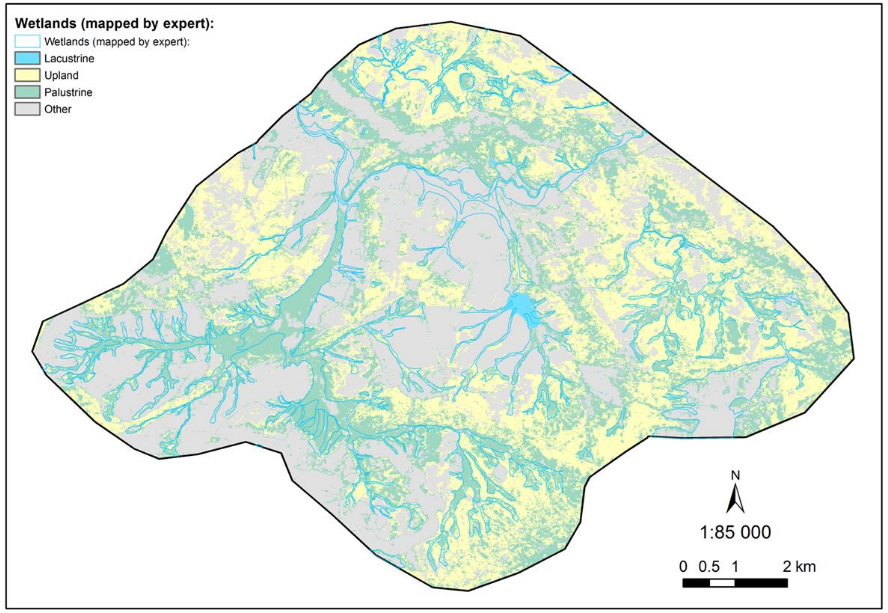


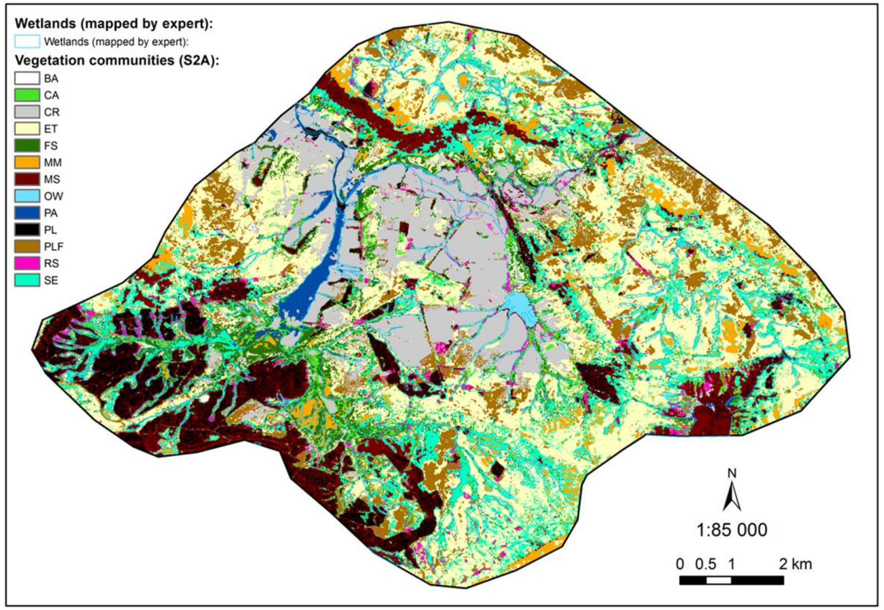


Wetlands

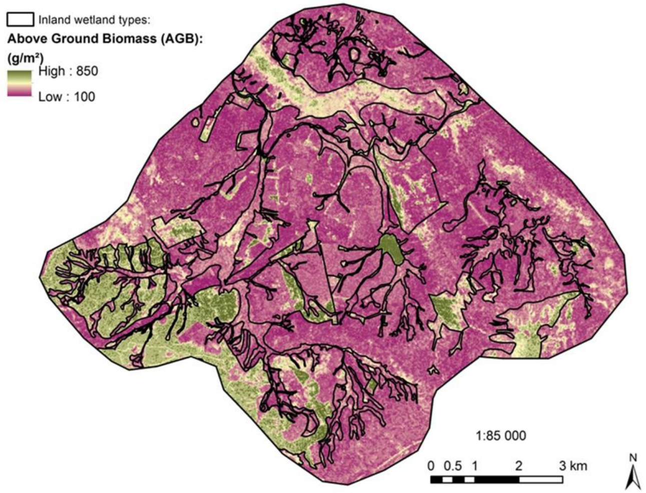


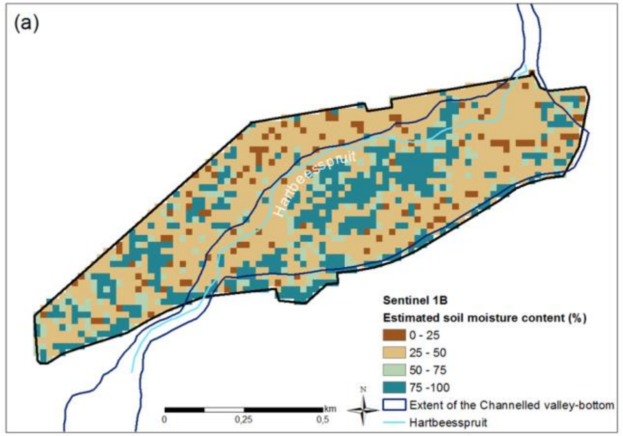


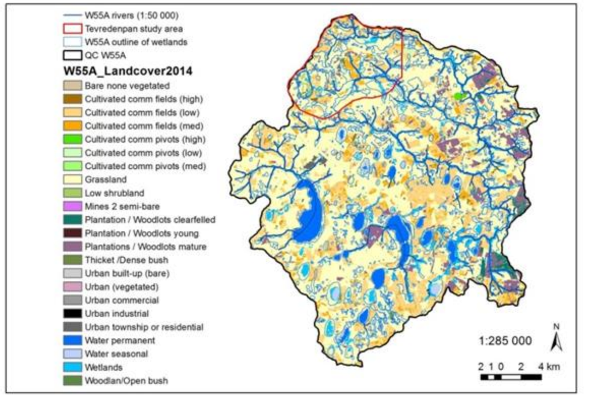




Resultant map for Hogsback predicted from the Sentinel-2A image: (A) wetland vs upland and (B) vegetation communities. ***BA = Bare soil; CA = Carex spp; CR = cropland; ET = Eragrostis spp and Themeda spp; FS = Ficinia spp.; MM = Merxmuellera macowanii; MS = mountain slope; OW = open water; PA = Phragmites australis; PL = plantations; PLF = plantations felled; RS = Rubus spp.; SE = Sedge dominant.***







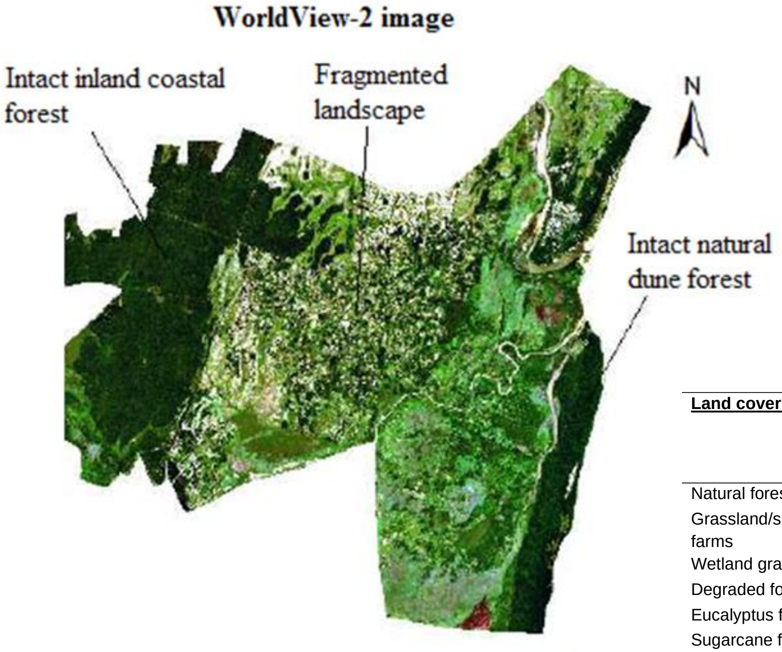
Van Deventer et al., 2020, eds, WRC Project 2545

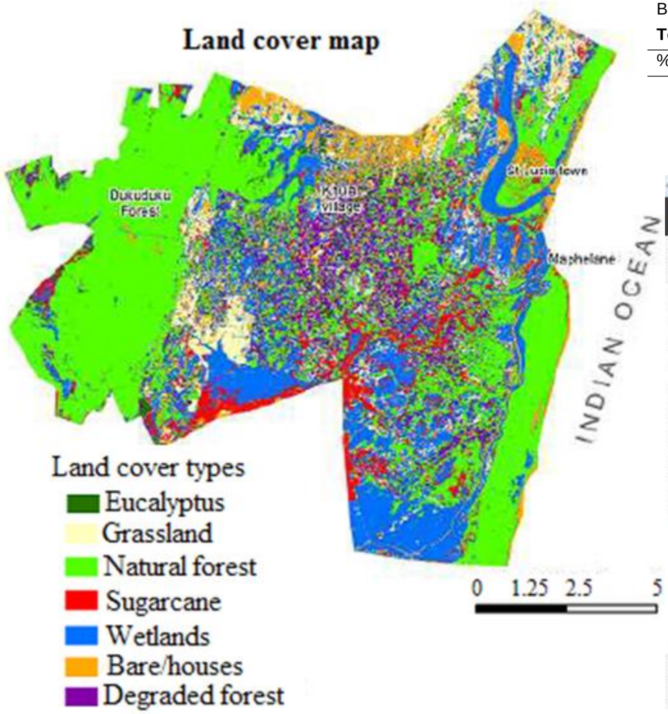
Estuaries

- Submerged Macrophytes
- Salt Marsh
- Reeds
- Swamp Forest
- Grass and Shrubs
- Groundwater-fed comms.
- Juncus
- Mangroves

Areas classified

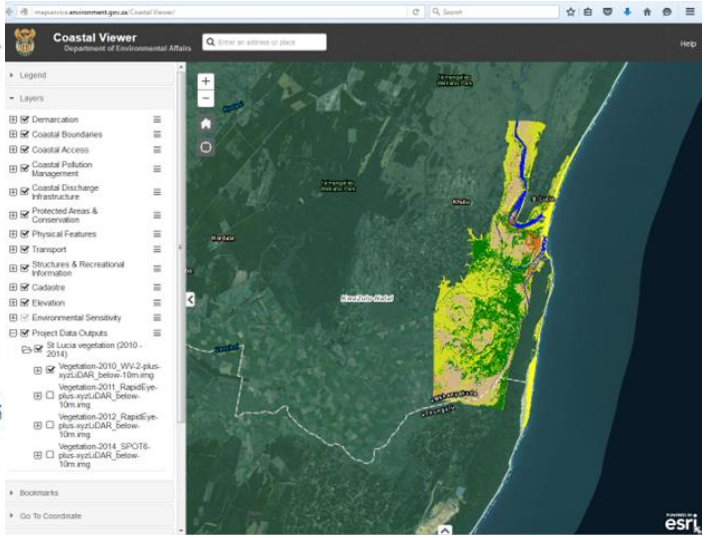
- SPOT6 & RapidEye Coverage
- WorldView-2 Coverage





Broad landscape types:

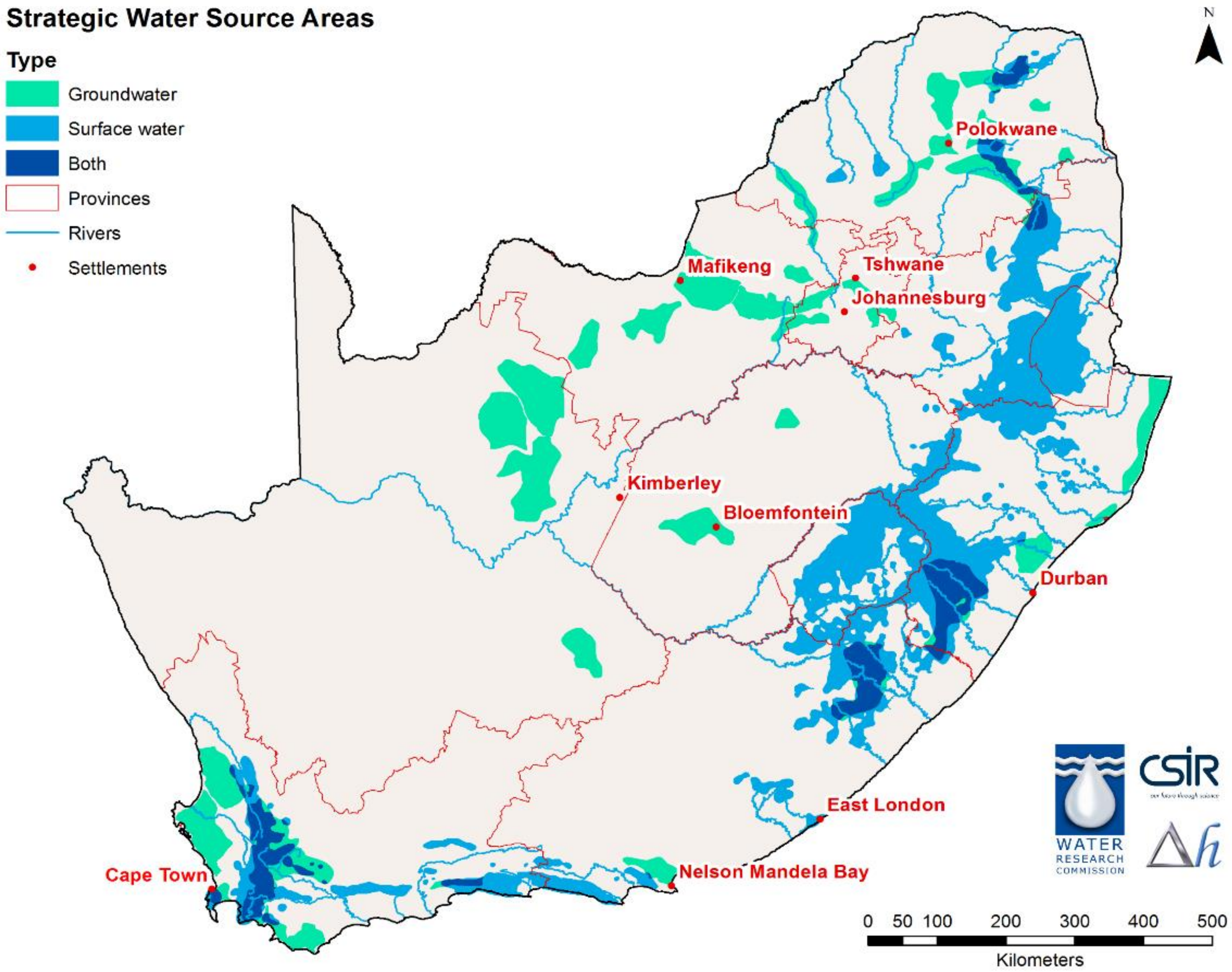
Land cover class (LC)	Fragmented landscape (ha)	Intact forest (ha)	Swamp wetland (ha)	Total area (ha)	% of LC class:
Natural forest	1 821	4 430	1 305	**7 555**	41.7
Grassland/subsistence farms	1 243	5	366	**1 615**	8.9
Wetland grasslands	2 211	94	2 352	**4 657**	25.7
Degraded forest	867	18	310	**1 195**	6.6
Eucalyptus farms	195	18	0	**214**	1.2
Sugarcane farms	683	19	678	**1 380**	7.6
Bare soil and settlements	1 150	38	294	**1 481**	8.2
Total area (ha)	**8 169**	**4 623**	**5 305**	18 097	
% of landscape type	45	26	29		

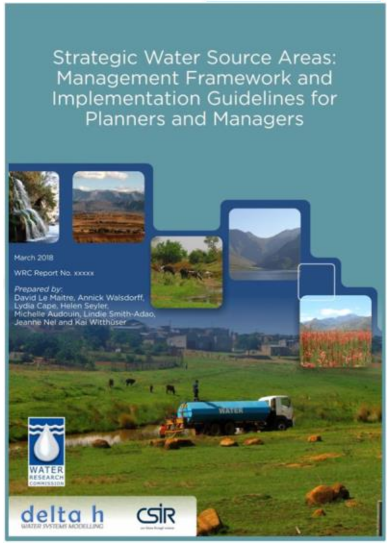


Change detection and improving mapping accuracy

Cho et al., 2016, eds, WRC Project 2268

Adaptive Response for Strategic Water Source Areas

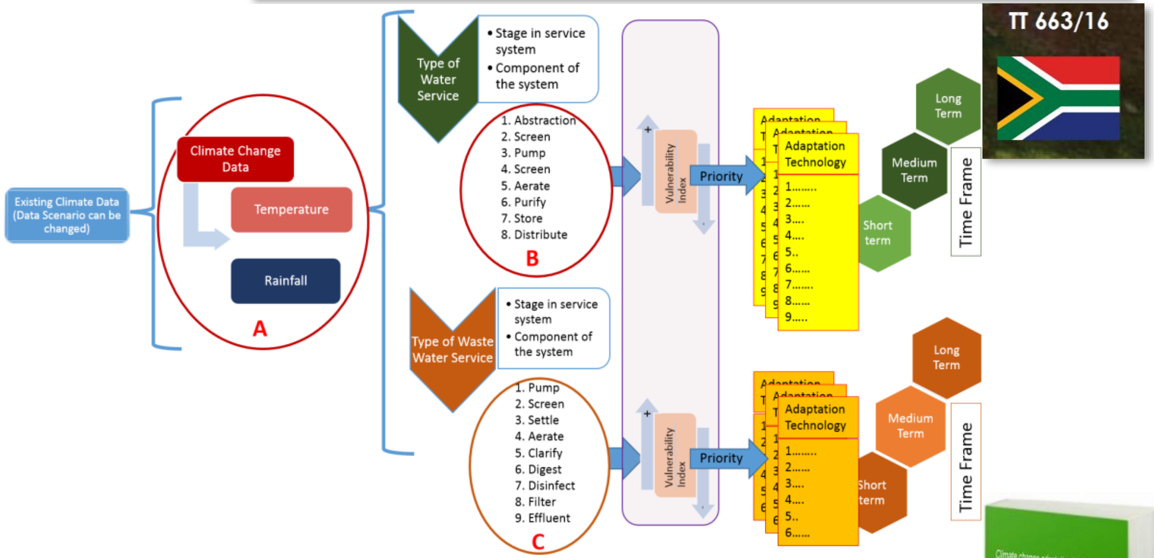




Multitiered Approach: SWA level, Regional and Local Scale Response

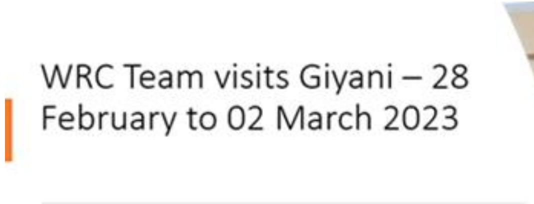
- Protect SWAs.
- Build Adaptive Capacity.
- Local Scale Adaptation.
- Factor in Risk Reduction and Response to Extremes.
- Building Resilience (DDM)

Adaptive Climate Change Technologies and Approaches for Local Governments: Water Sector Response



GLSCRP

Aims to develop, research and demonstrate, practical water-linked climate adaptation solutions at local, community and catchment scale for the benefit of 5000 Giyani community members in order to improve water utilisation, community resilience and local economic growth for local and women-led enterprises



WRC Team visits Giyani – 28 February to 02 March 2023

The WRC and its partners hosted a three-day WRC Knowledge Transfer Products Expo in Limpopo, Giyani. The event demonstrated water-wise technologies which can improve emerging farmers' resilience to climate change and increase agricultural production. The event was held on 28 February to 02 March 2023 at Mopani Farmers Association Distribution and Packhouse Centre in Ndhambi village located in Dzumeri Tribal Authority. During the three days, training and demonstration of the climate smart technologies was conducted for the emerging farmers and local entrepreneurs. The event also provided an opportunity for the WRC team to engage with other stakeholders in technical discussion sessions and brought exposure on innovative farming practices, new farming opportunities and irrigation management for the small-scale farmers in Giyani.

applied sciences

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Feasibility of Solar-Powered Groundwater Pumping Systems in Rural Areas of Greater Giyani Municipality (Limpopo, South Africa)

Nebojša Jovanović; Mandelwa Mpambo; Alana Willoughby; Eugene Maswanganye; Dominic Mazvimavi; Brilliant Petja; Virginia Molose; Zanele Sifundza; Kenny Phasha; Basani Ngoveni; Gondai Matanga; Derick du Toit

GLSCRP GIYANI LOCAL SCALE CLIMATE RESILIENCE PROGRAMME

WATER RESEARCH COMMISSION

Government of Flanders

award

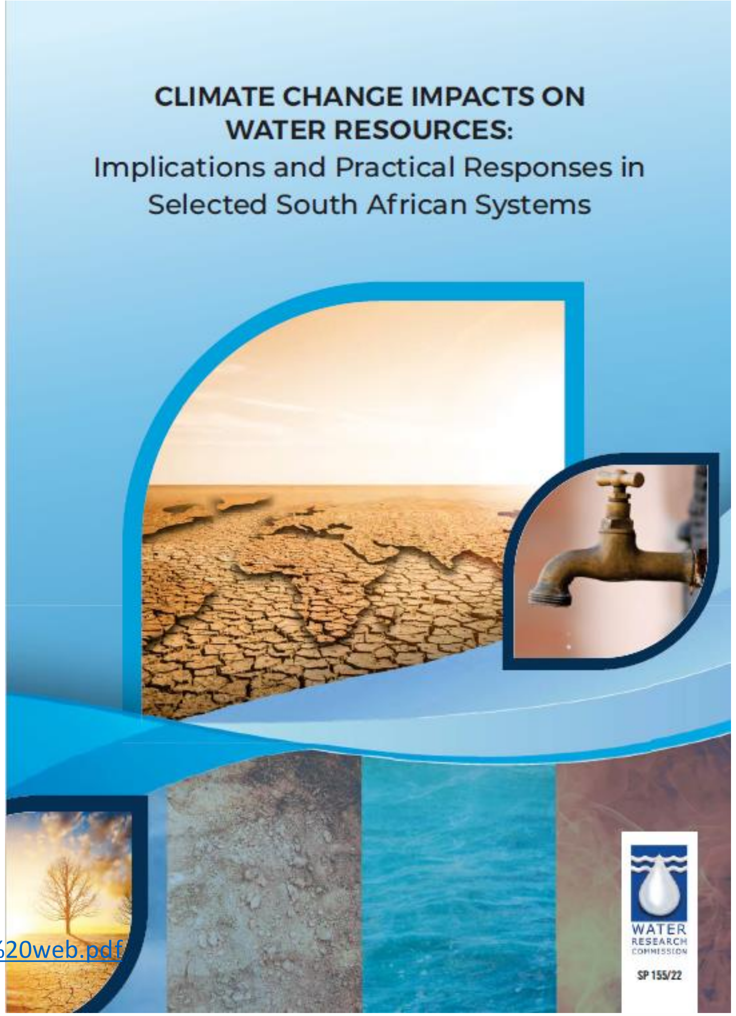
UNIVERSITY of the WESTERN CAPE

TSOGANG

Concluding Remarks

- Climate will always play a significant role in development.
- Changes and shifts in climate have a bearing on sectoral development.
- Proactive planning is a prerequisite for risk reduction and operational response.
- Research plays a crucial role in informed decision making.
- It is in our hands to make the necessary transformative adaptive pathways and response.

THANK YOU



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