Developing Innovative Products, Services : current and future offerings to build a sustainable EO ecosystem in South Africa

Morwapula Mashalane

15 February 2024

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EO Applications

Maritime
- Ship detection
- Oil Spill monitoring

Natural resource management
- Water resource management
- Energy infrastructure optimisation
- Oil and Gas
- Mining
- Vegetation

Defence and Security
- Border management
- Conflicts

Air quality
- Air pollution
- Climate change

Agriculture
- Precision farming
- Crop health mapping
- Crop pests
- Illicit crop monitoring

Forestry
- Forest stock mapping
- Burn scar mapping
- Deforestation

Risk management
- Continental scale mapping
- Urban growth
- Land cover classification
- Financial planning
- Informal settlement encroachments
- Policy and regulations

Disaster Monitoring
- Flooding
- Land subsidence and Land slides
- Seafloor Oil spills

Built-environment
- Human settlements
- Infrastructure

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Advantages (data democracy & costs)

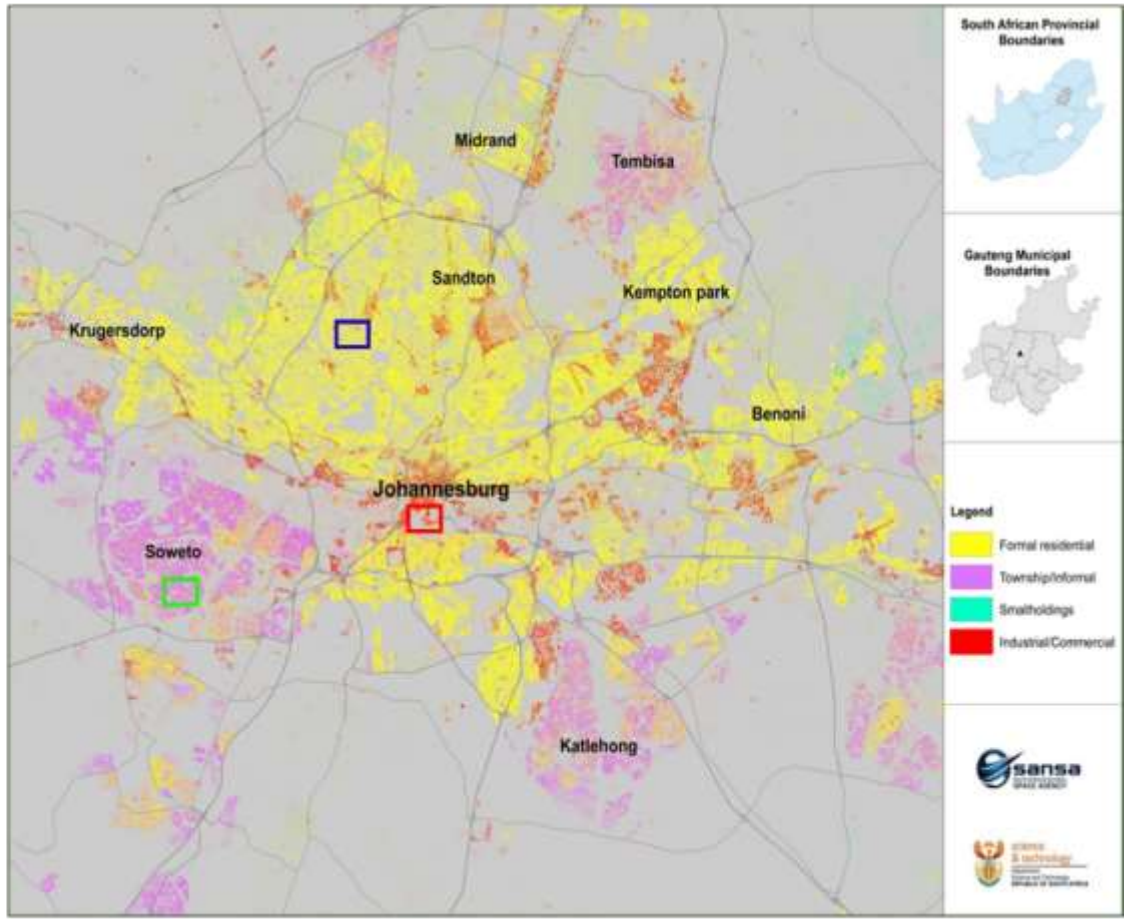
- Relatively cheap compared to traditional methods of surveying.
- Many data providers have opted for data democracy.
- Costs (if any) are limited to extraction and processing as costs of production and delivery
- Many are freely available to the scientific community
- Many more are commercial, but prices are becoming accessible

Advantages of satellite based remote sensing

- Large areal coverage (inaccessible areas)
- Resolutions spatial/spectral/radiometric/temporal
- Multi – sensors
- Multi –users
- Operational monitoring
- Multiple Applications
- See what the human eye cannot see

Understanding of the status of human settlements

- ✓ Higher urbanization rates are expected to take place in developing countries
- ✓ Increased land for habitation
- ✓ Human settlements indicate where people live, socialize and work
- ✓ Population is not always up-to-date
- ✓ High spatial resolution imagery provides the data to map and monitor settlements
- ✓ Human settlement give an indication of standard of living
- ✓ Base during planning of services



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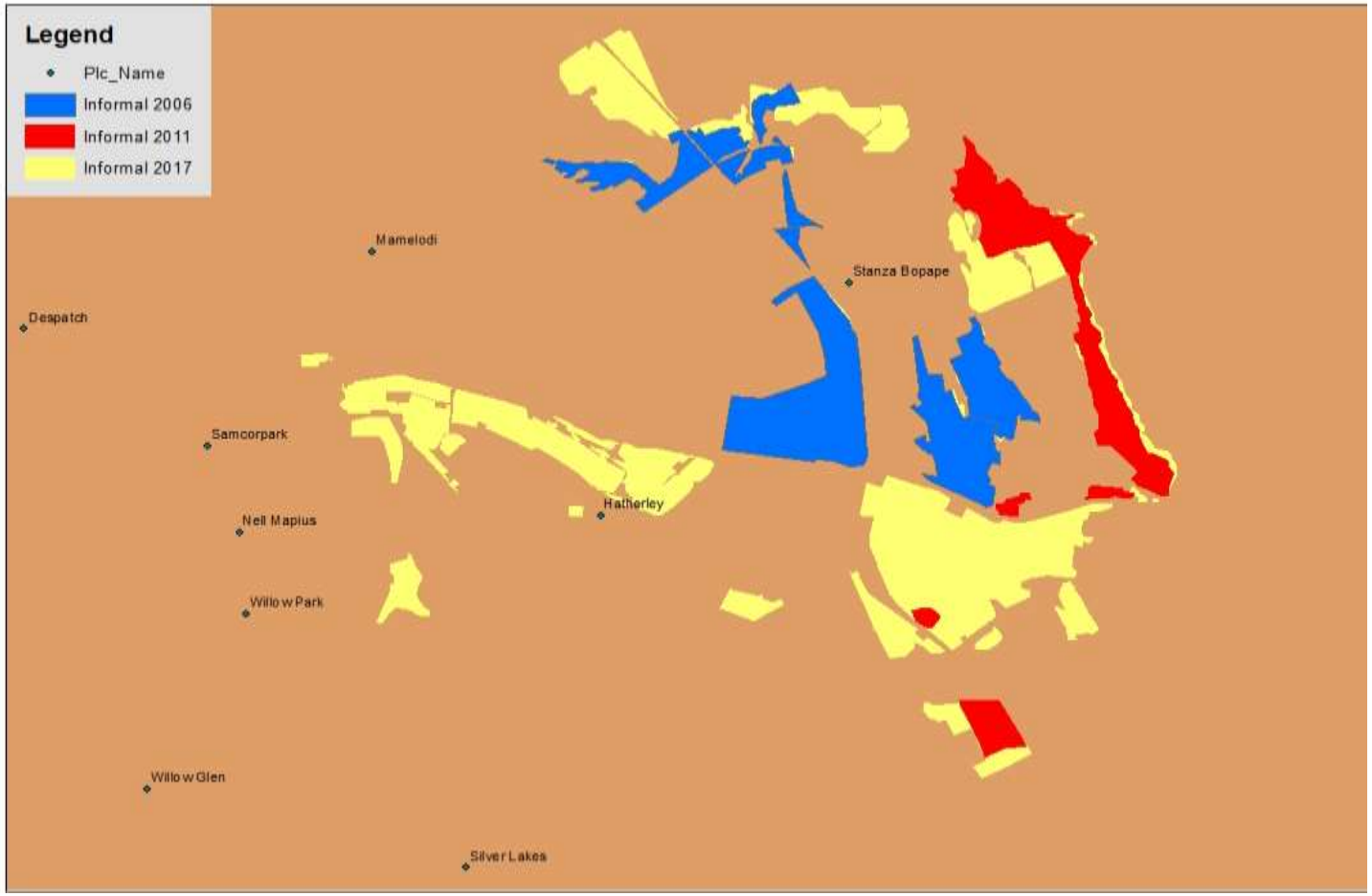
Mapping informal settlements

- Over 1 billion people live in slums
- Urbanization: increased development of informal settlements/slums
- Illegal, lack access to services, vulnerable to natural and man-made disasters
- May lead to environmental degradation



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Infrastructure development projects

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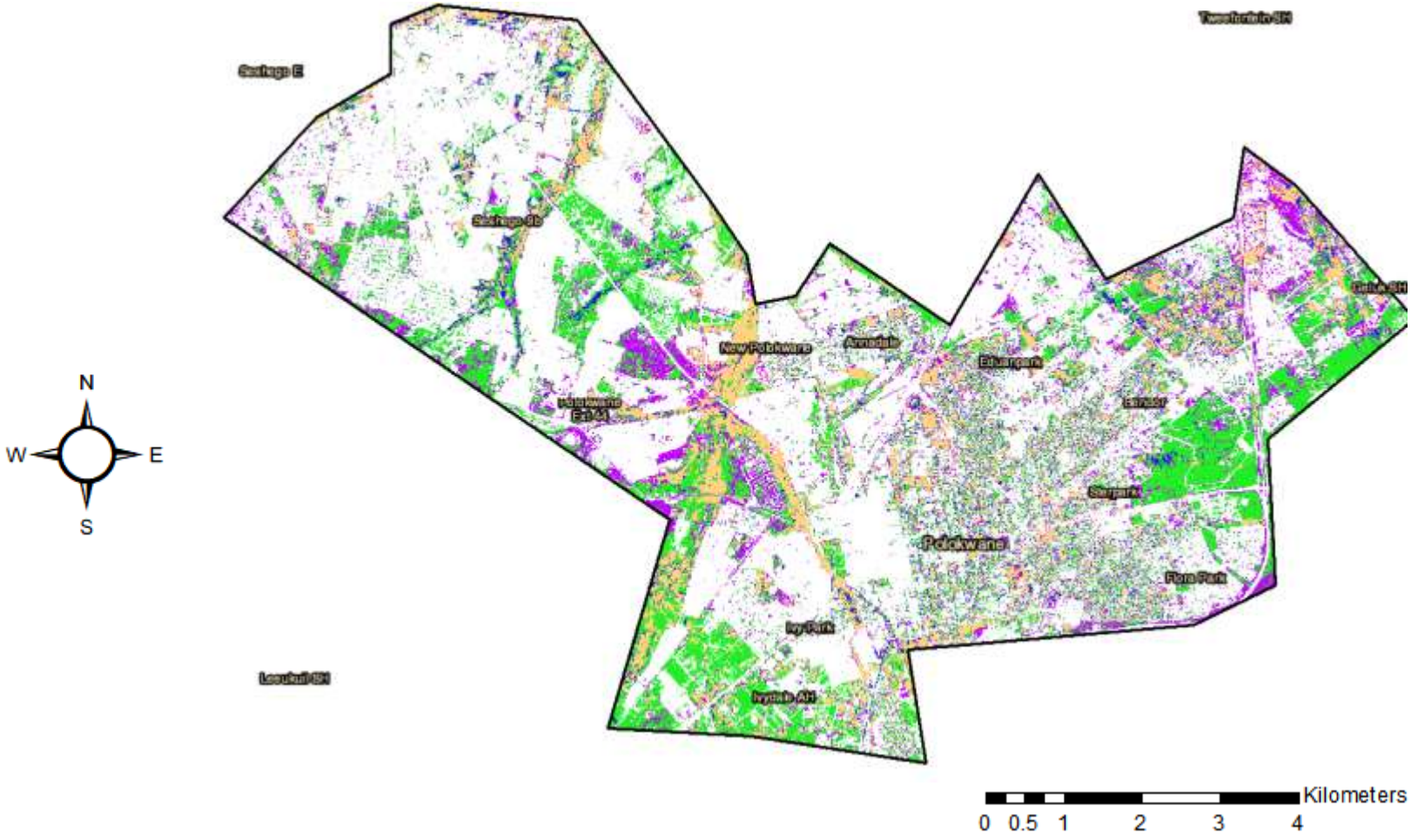
Urban Green Spaces

Changes in urban green spaces over time



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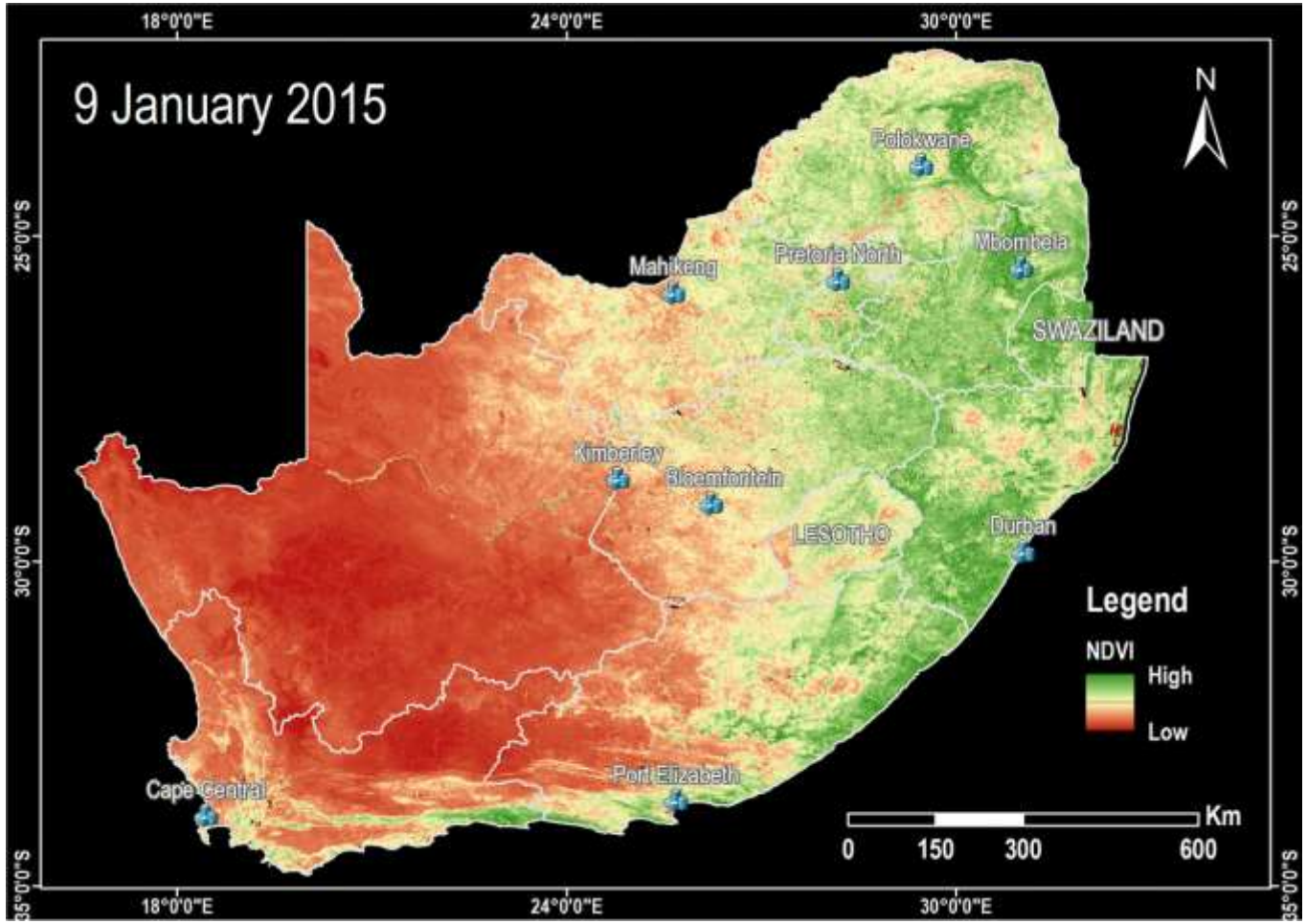
Drought: Vegetation indices indicator



- **Assist livestock farmers with development of risk management and coping strategies.**
- **Support implementation, improvement and update of policies and assessing their effectiveness.**

Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983)(CARA)
"the grazing/browsing capacity of veld and the maximum number and the kind of animals which may be kept on veld."

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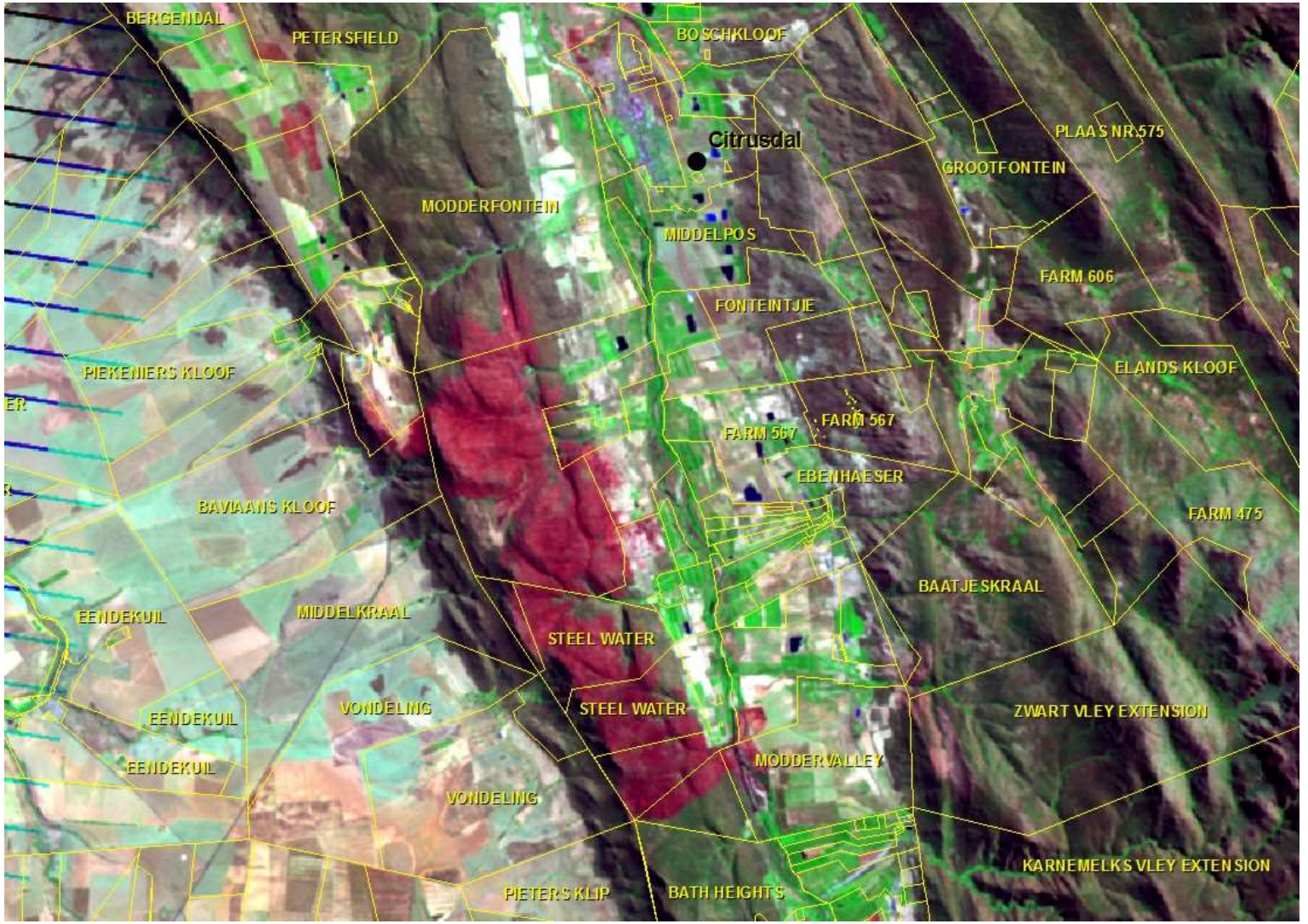
Veldfire assessment



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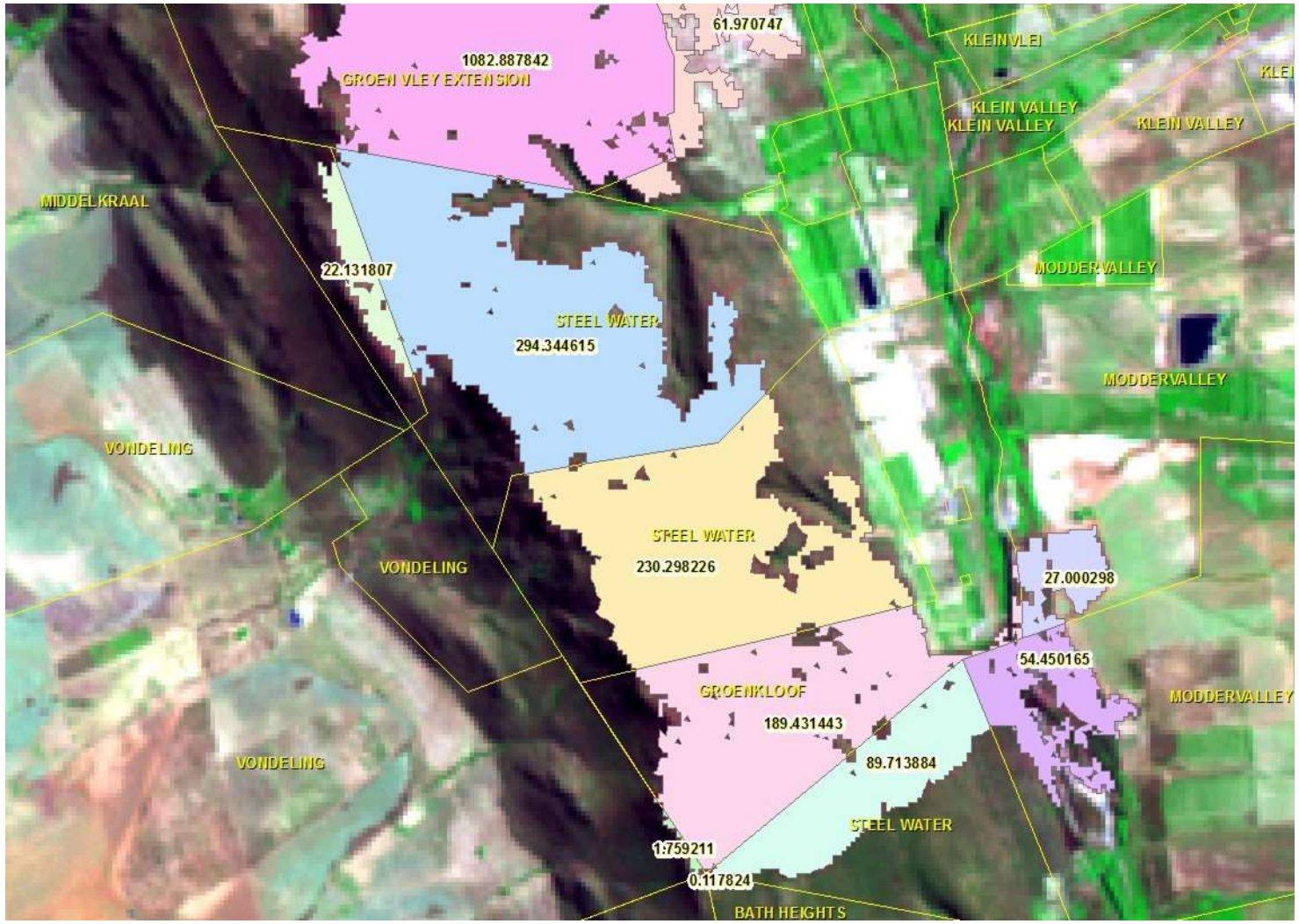

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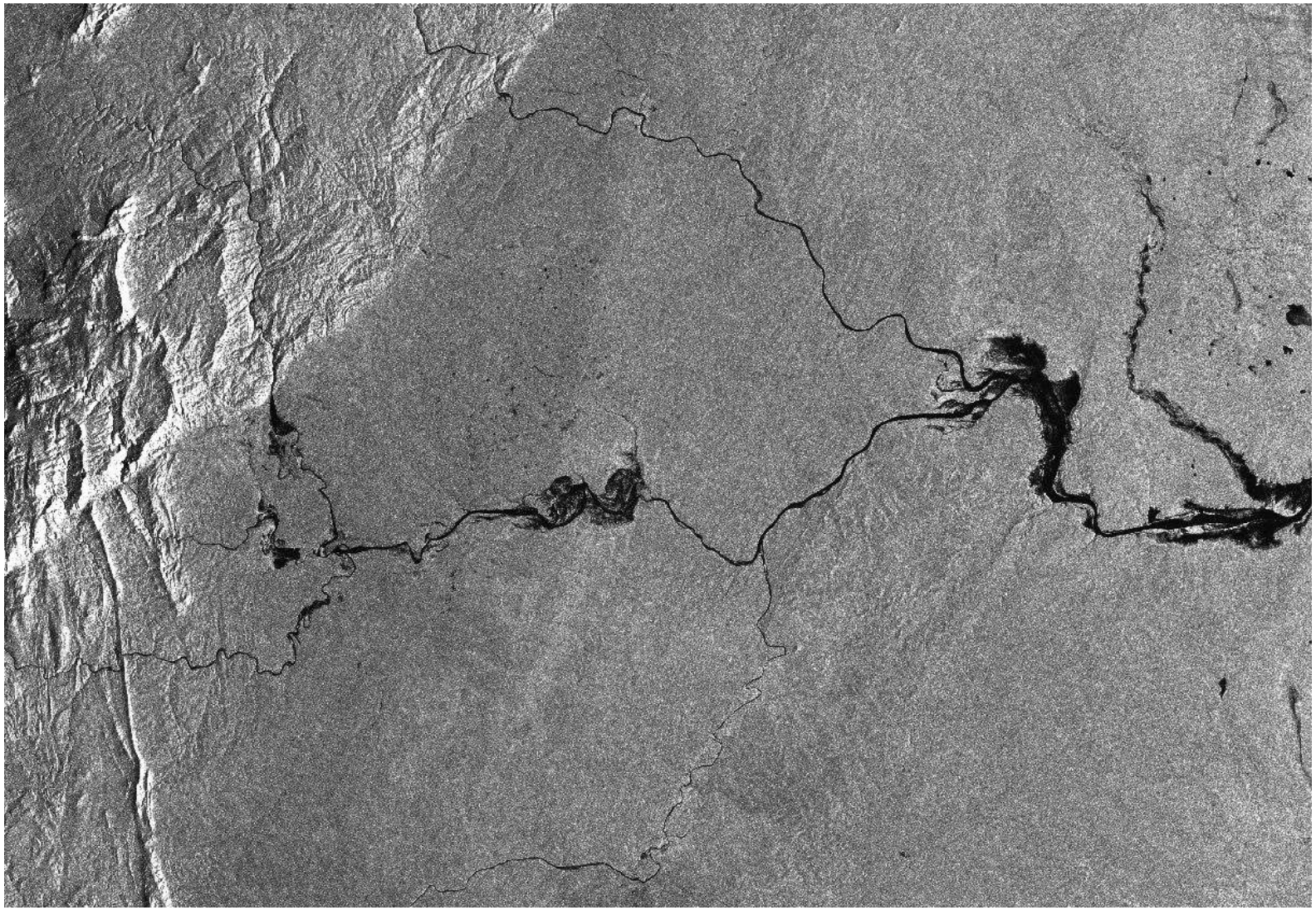
In-situ flood mapping



Flood damage mapping

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Flood damage mapping cont…

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Flood damage mapping cont…

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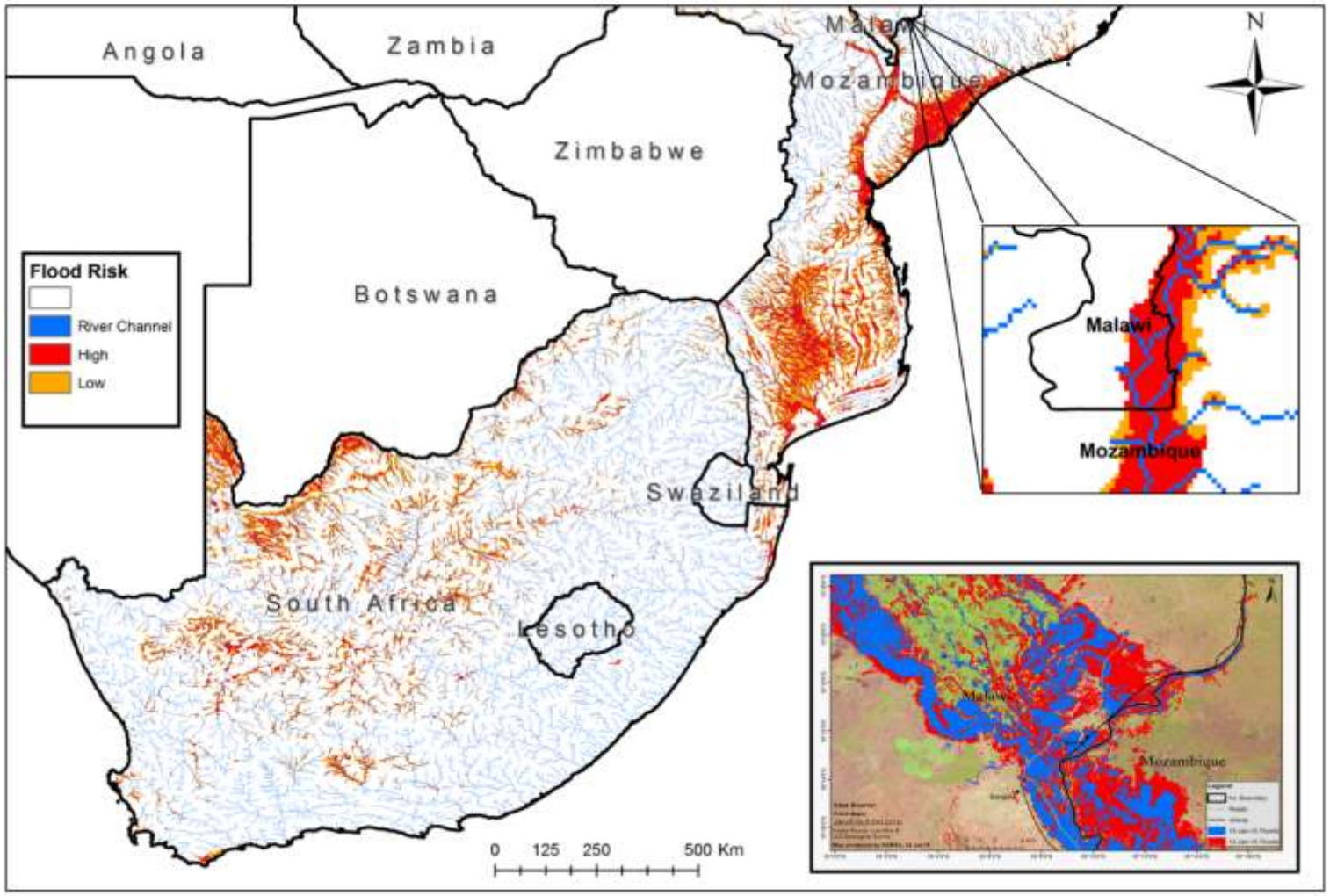
Flood Risk Map



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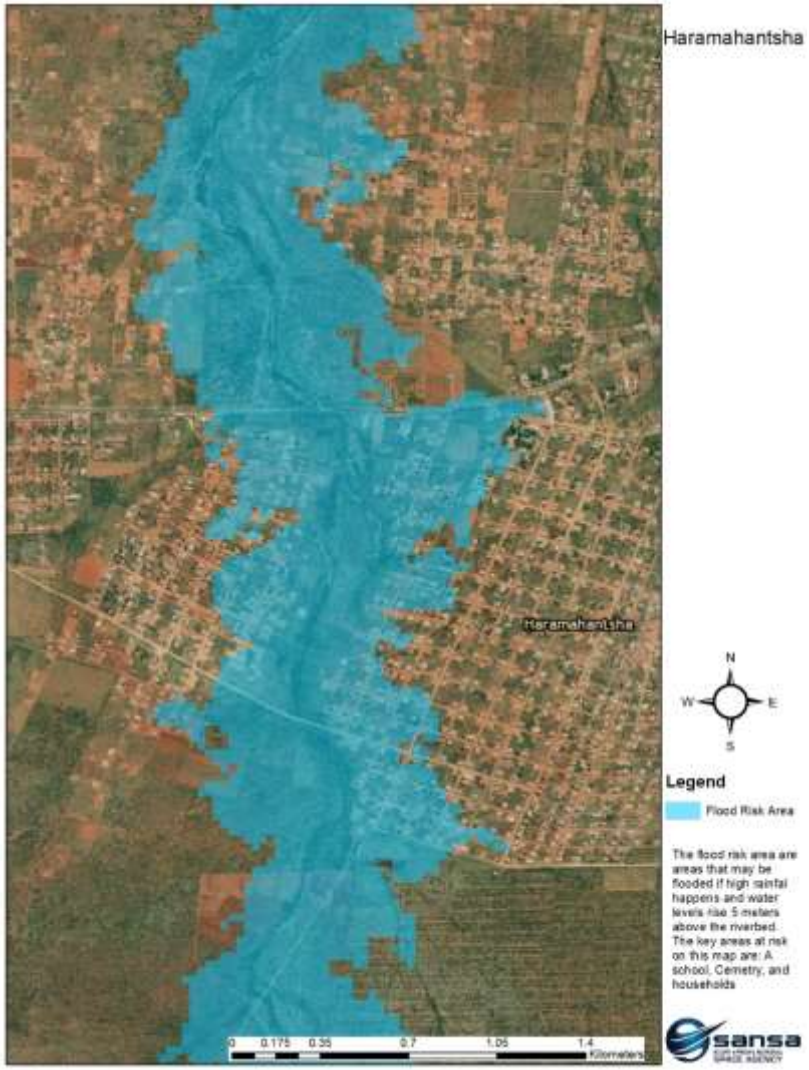
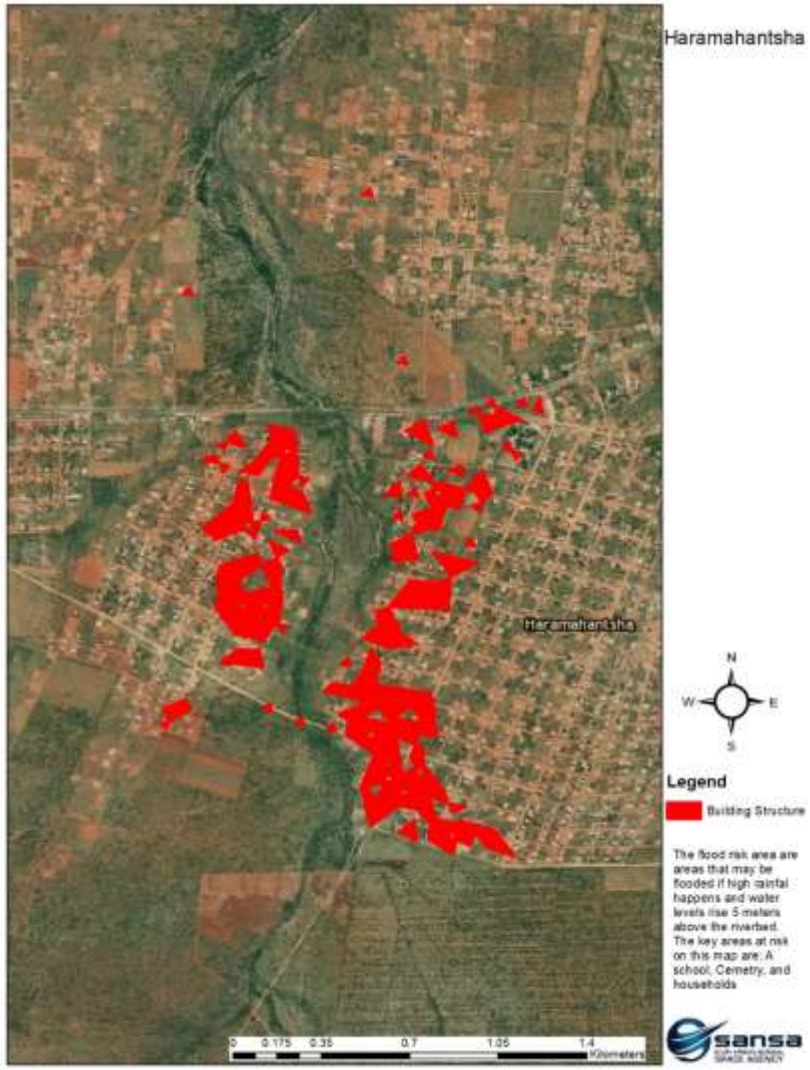
Flood Risk Map: Vhembe District Municipality





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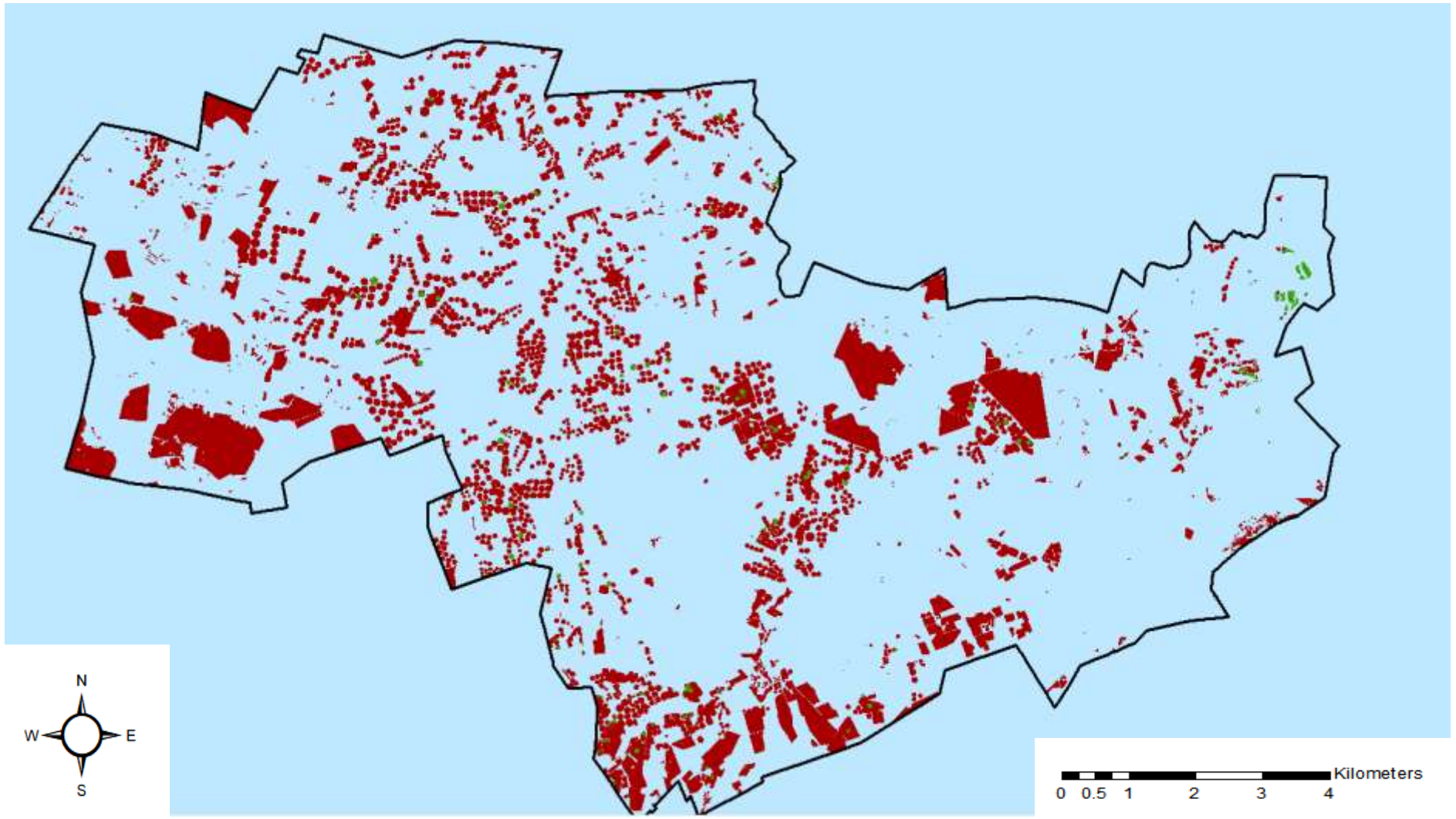
Cropped Arable Land: Polokwane



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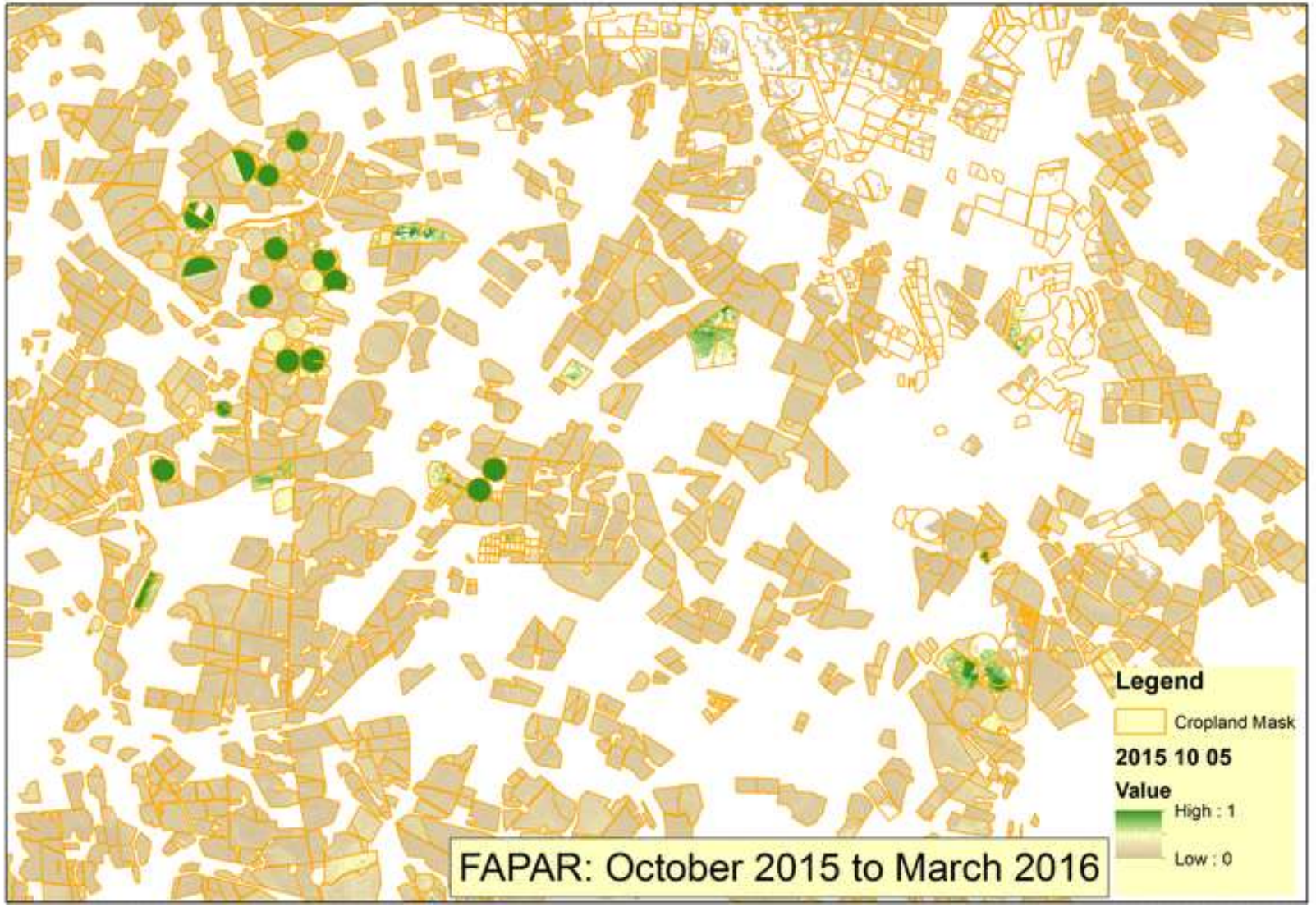
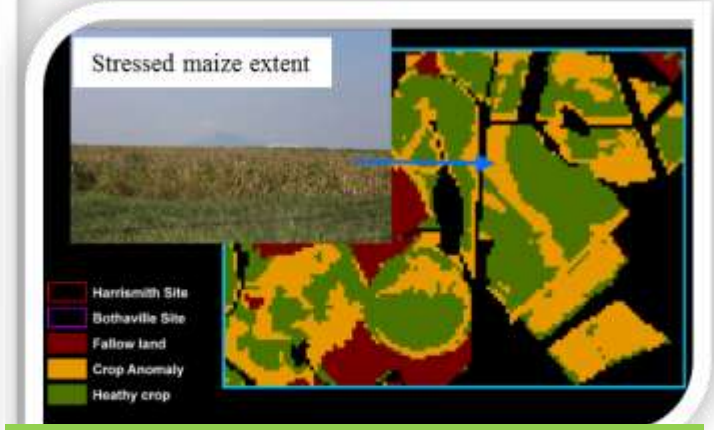
Cropland change



Crop Condition & Growth Monitoring

CROP STRESS DUE TO : hail, pests, diseases, water & nutrient deficiency, etc



Biophysical parameters such as Leaf Area Index, canopy chlorophyll, fAPAR, canopy water, etc are used.

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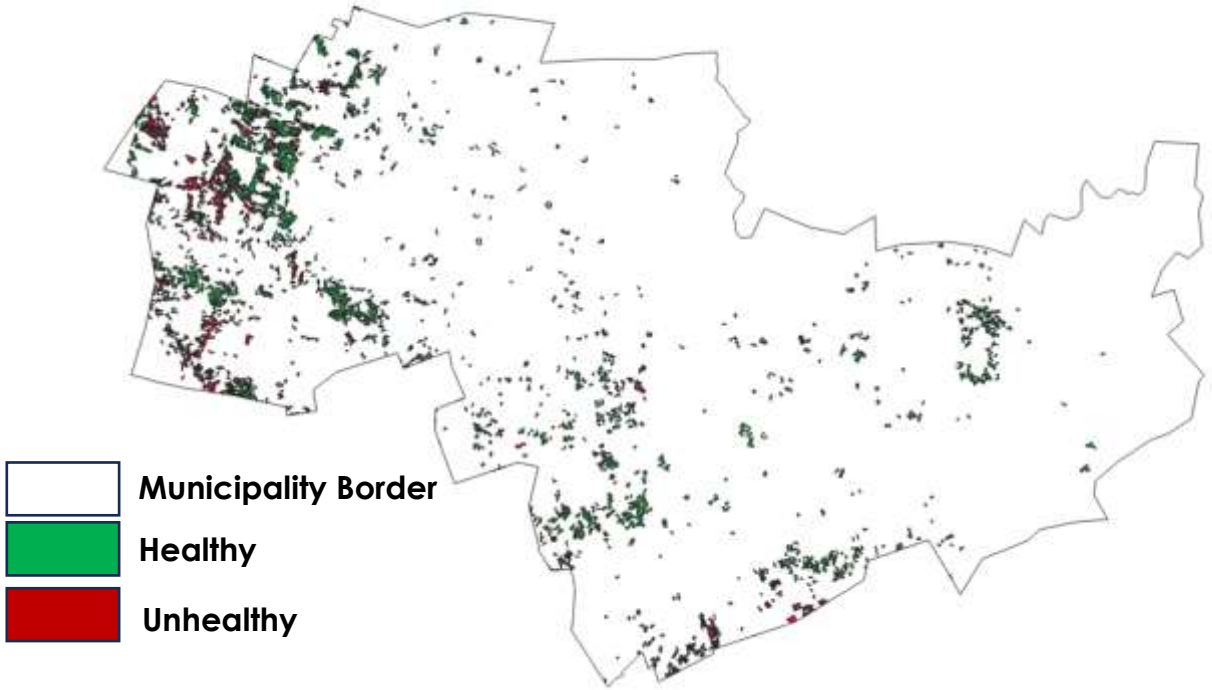
Rangelands Health monitoring



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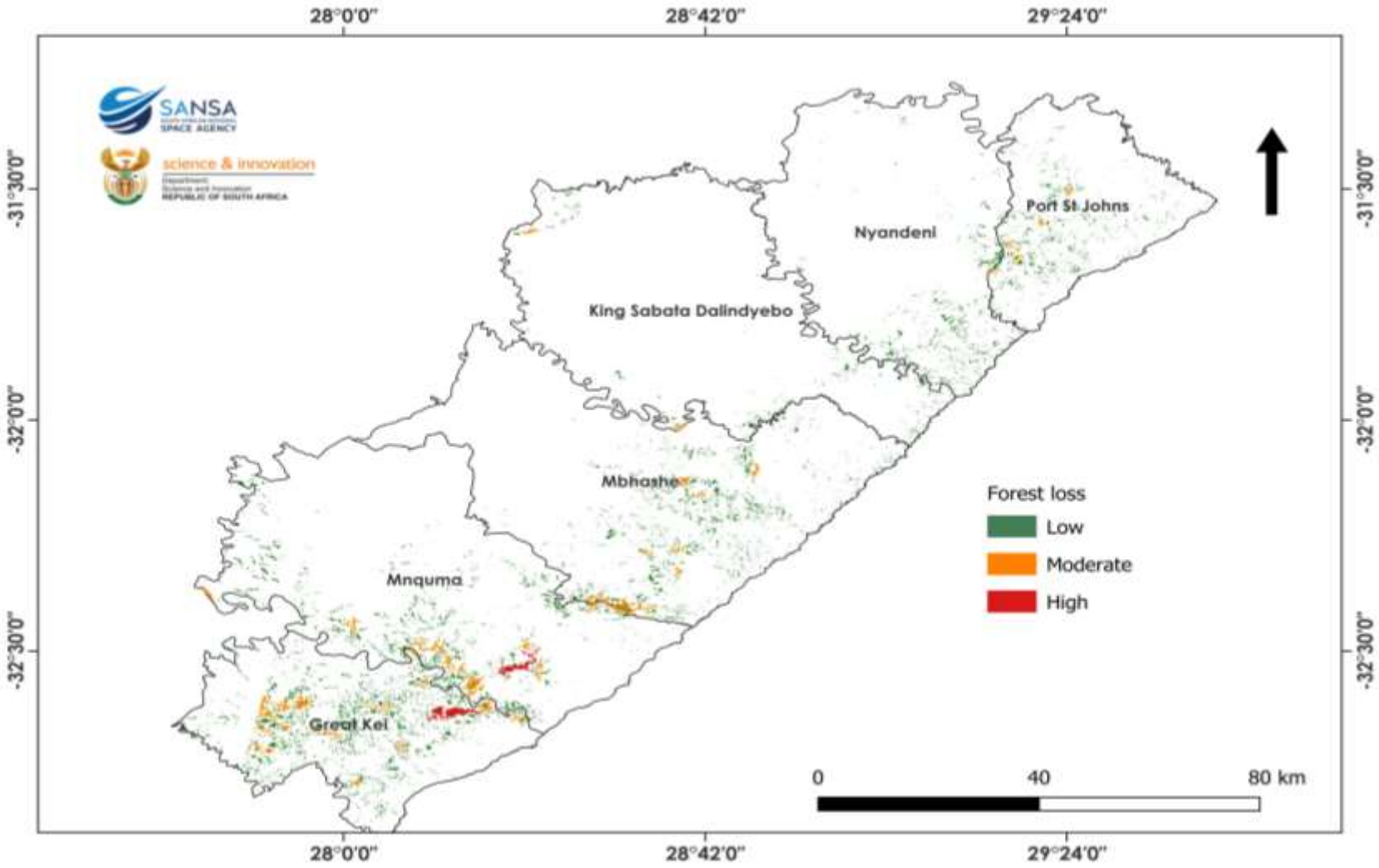
Rotation/rest grazing system

	Dec/Jan/Feb	Mar/Apr/May	June/July/Aug	Sept/Oct/Nov	Rest
Year 1	Camp A	Camp B	Camp C	Camp A	Camp D
Year 2	Camp B	Camp C	Camp D	Camp B	Camp A
Year 3	Camp C	Camp D	Camp A	Camp C	Camp B
Year 4	Camp D	Camp A	Camp B	Camp D	Camp C

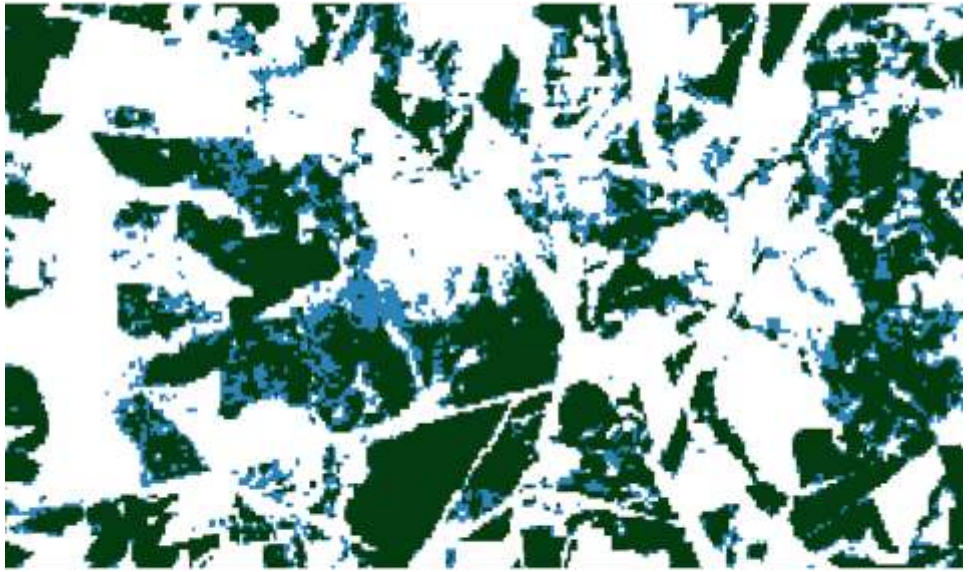
Deforestation Mapping



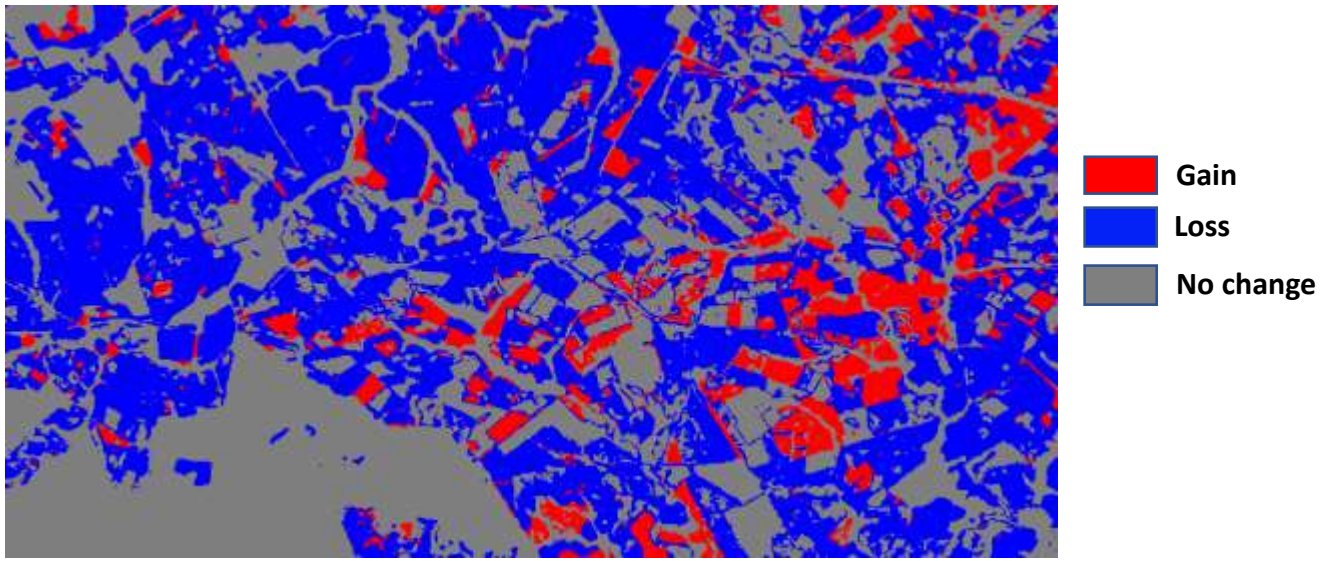
Mapping the extent and intensity of deforestation

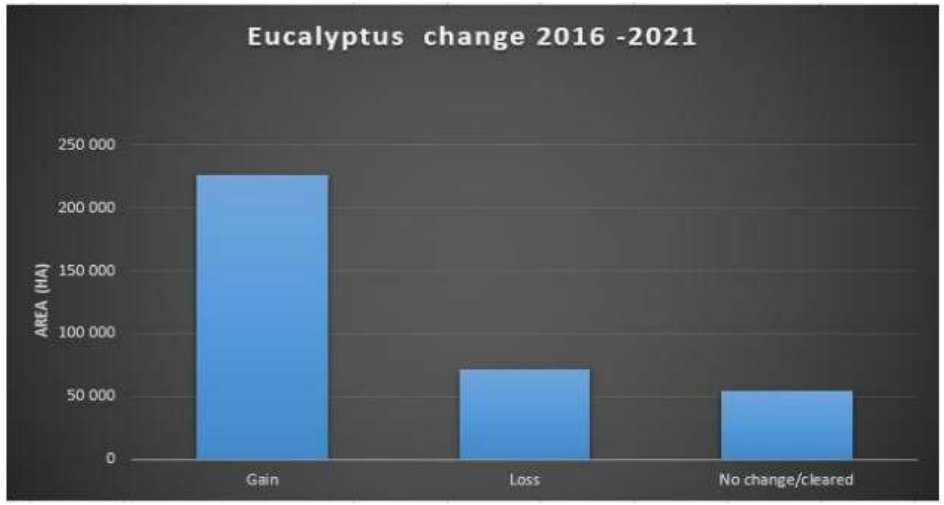
Forest type & change mapping

Eucalyptus and Pine extent - 2021



Changes in eucalyptus between 2016 and 2021





- **Provide information about the size of the plantation area for water use monitoring.**
- **Monitor changes from one plantation to another for compliance purposes.**

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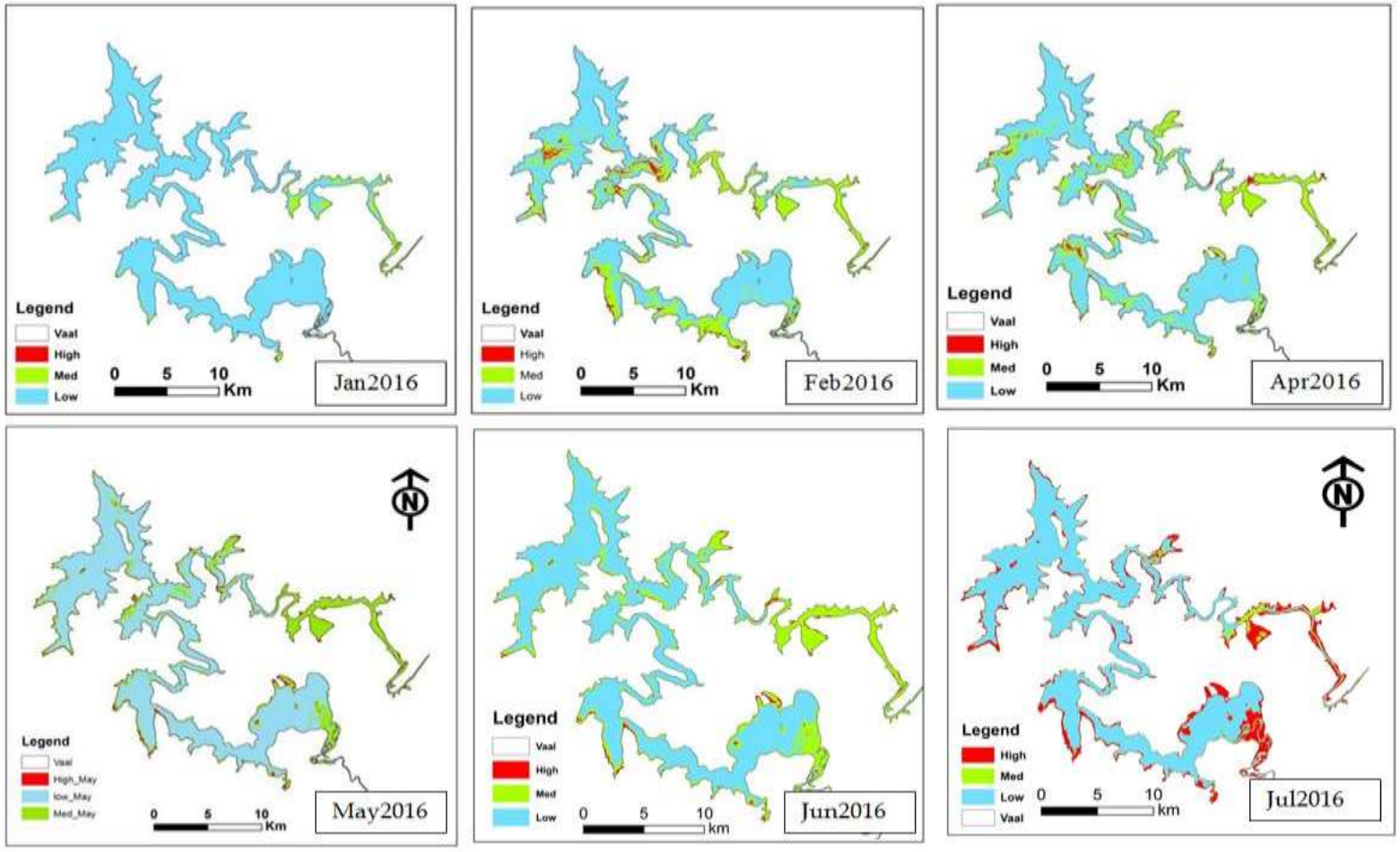
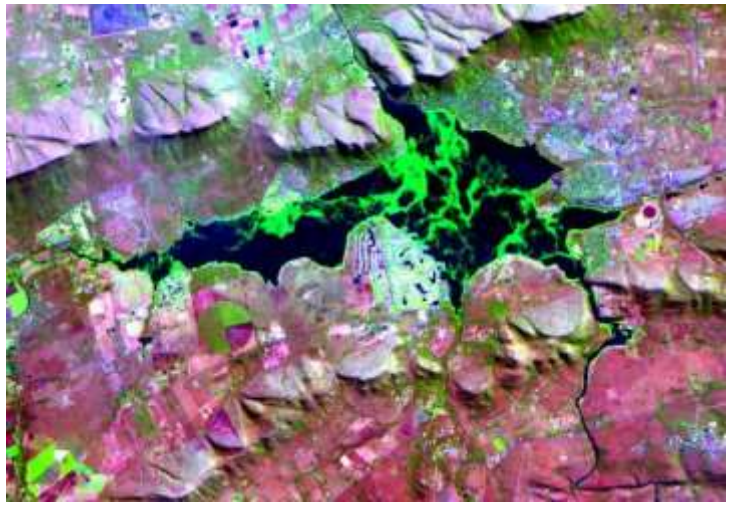
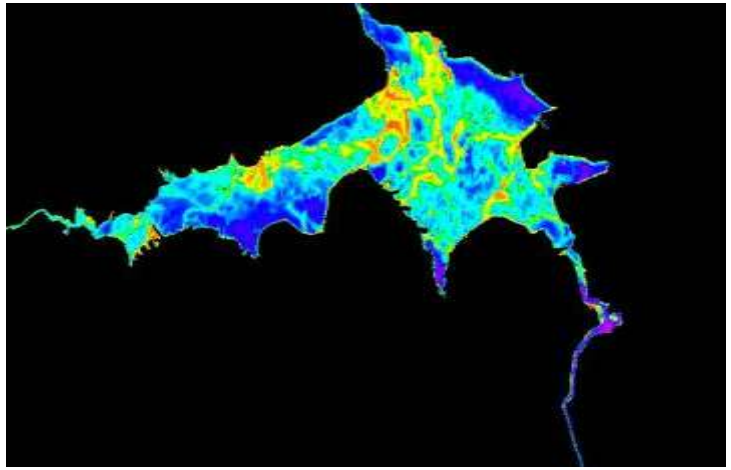
Water Quality: Algal bloom monitoring (Vaal Dam & Hartbeespoort Dam)







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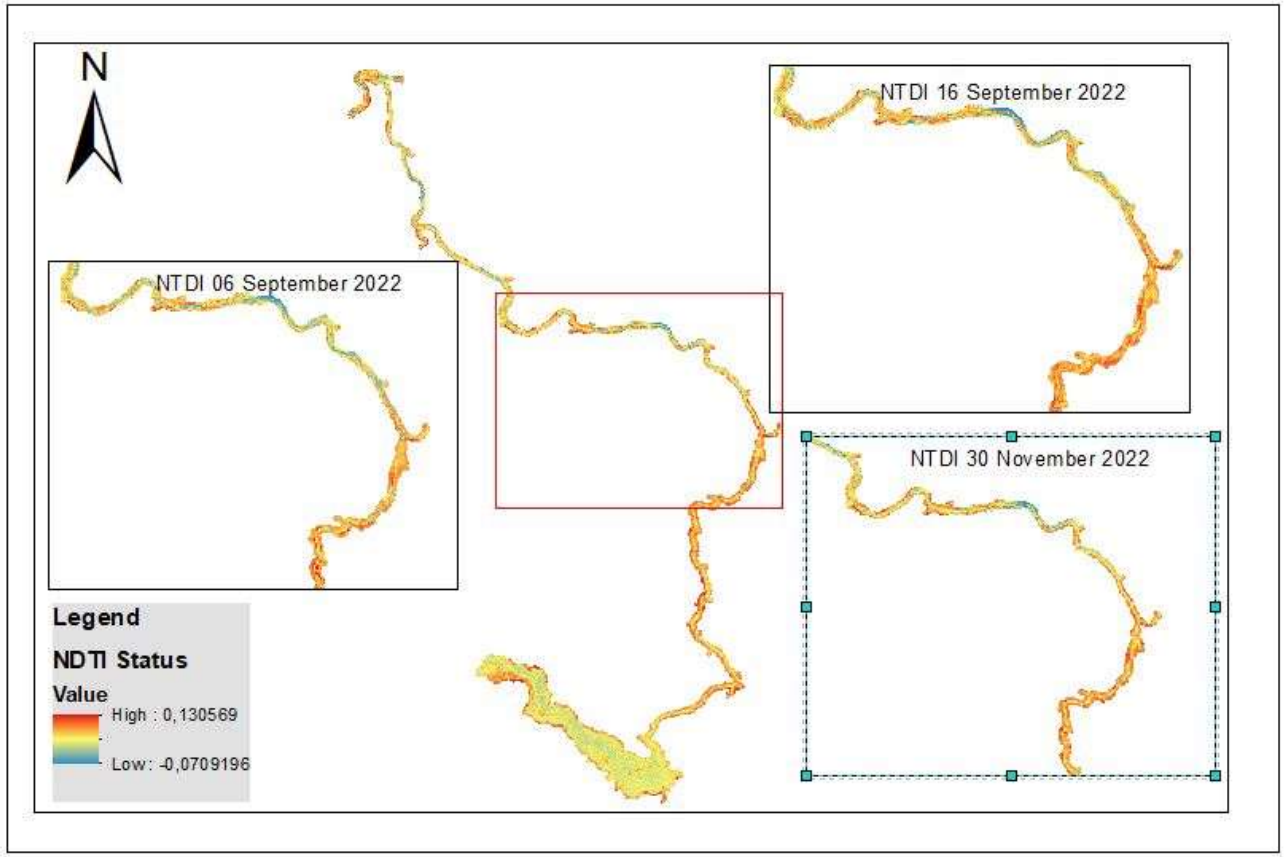
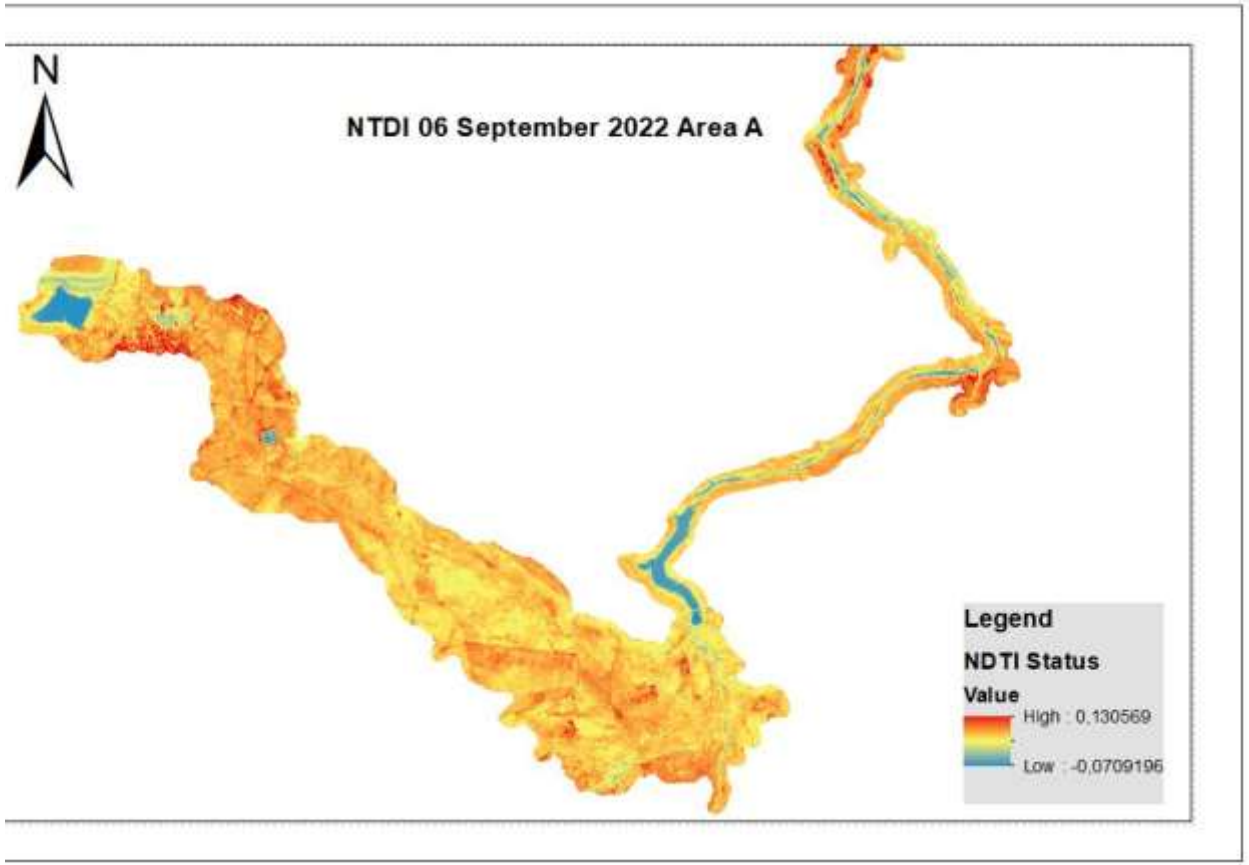
Water Quality: Turbidity monitoring





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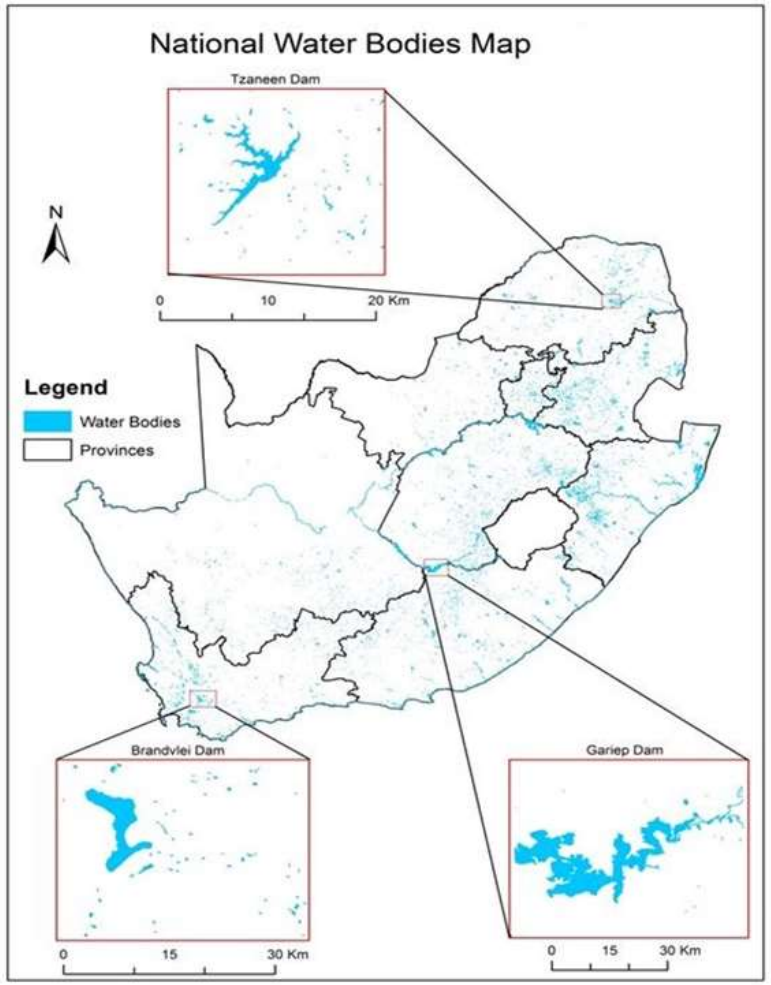
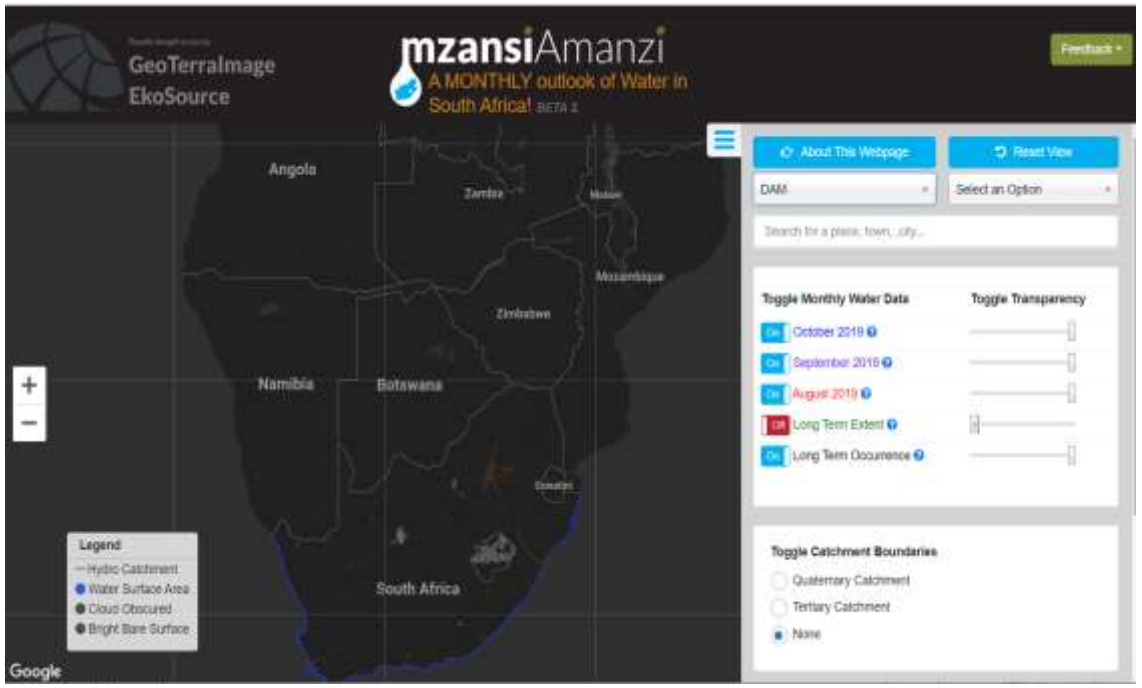
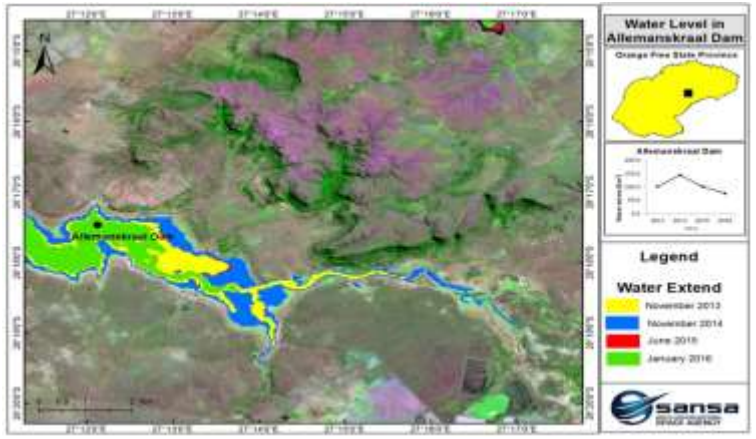
Water body mapping







Water Level Mapping in Allemanskraal Dam

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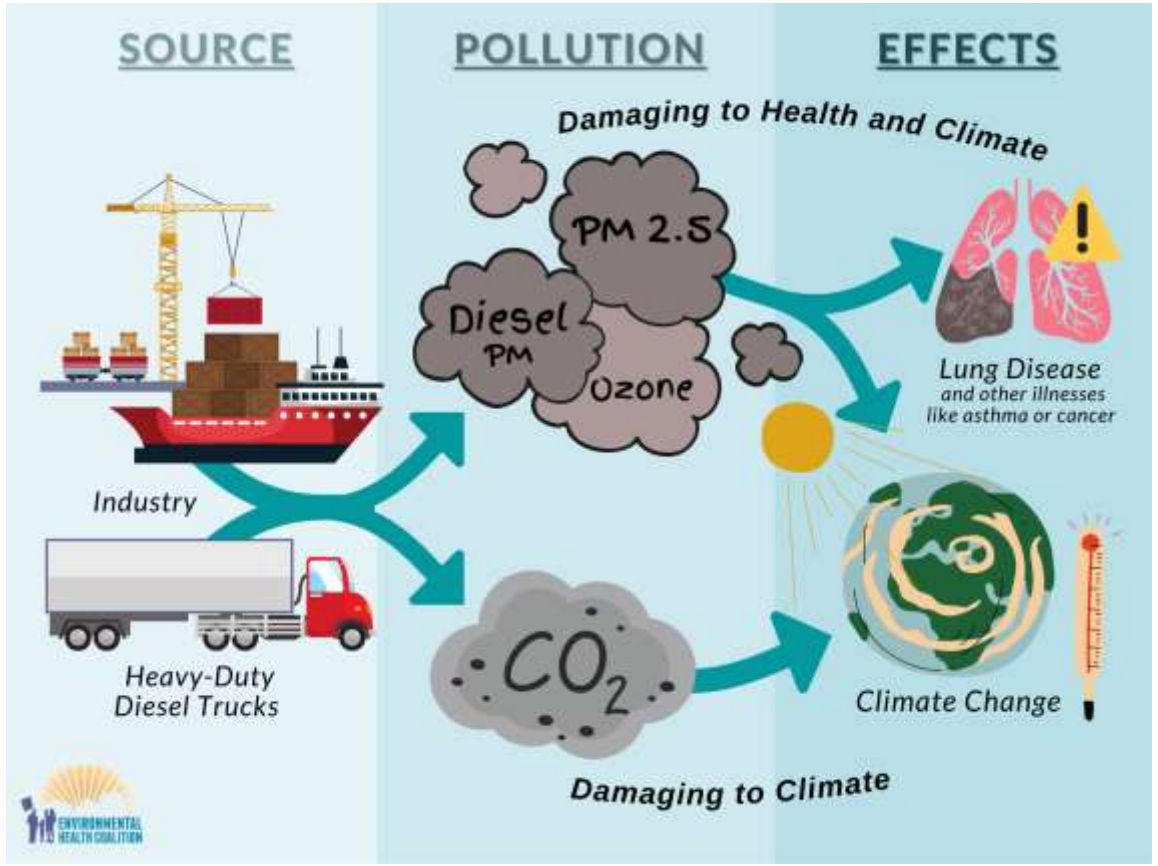
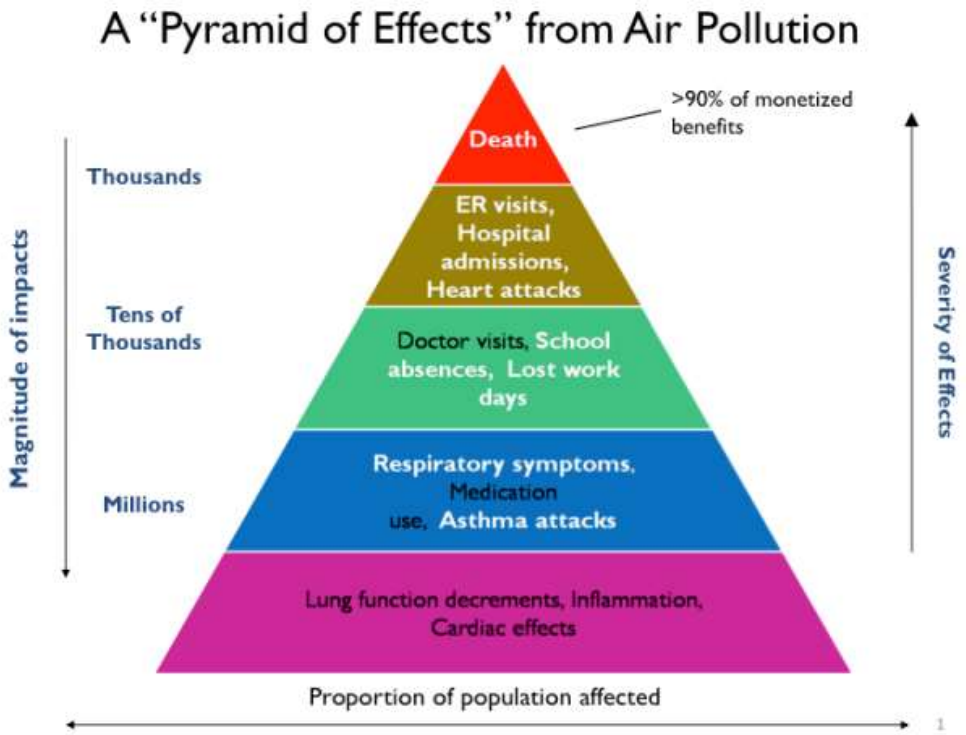
Air quality: Effects of air pollution





https://www.epa.gov/benmap/how-benmap-ce-estimates-health-and-economic-effects-air-pollution

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Sentinel-5P (TROPOMI)

Sulphur dioxide (SO2) Nitrogen dioxide (NO2) Ozone (O3) Carbon monoxide (CO) Methane (CH4)

Spatial resolution **Up to 7.0* km x 3.5 km.**

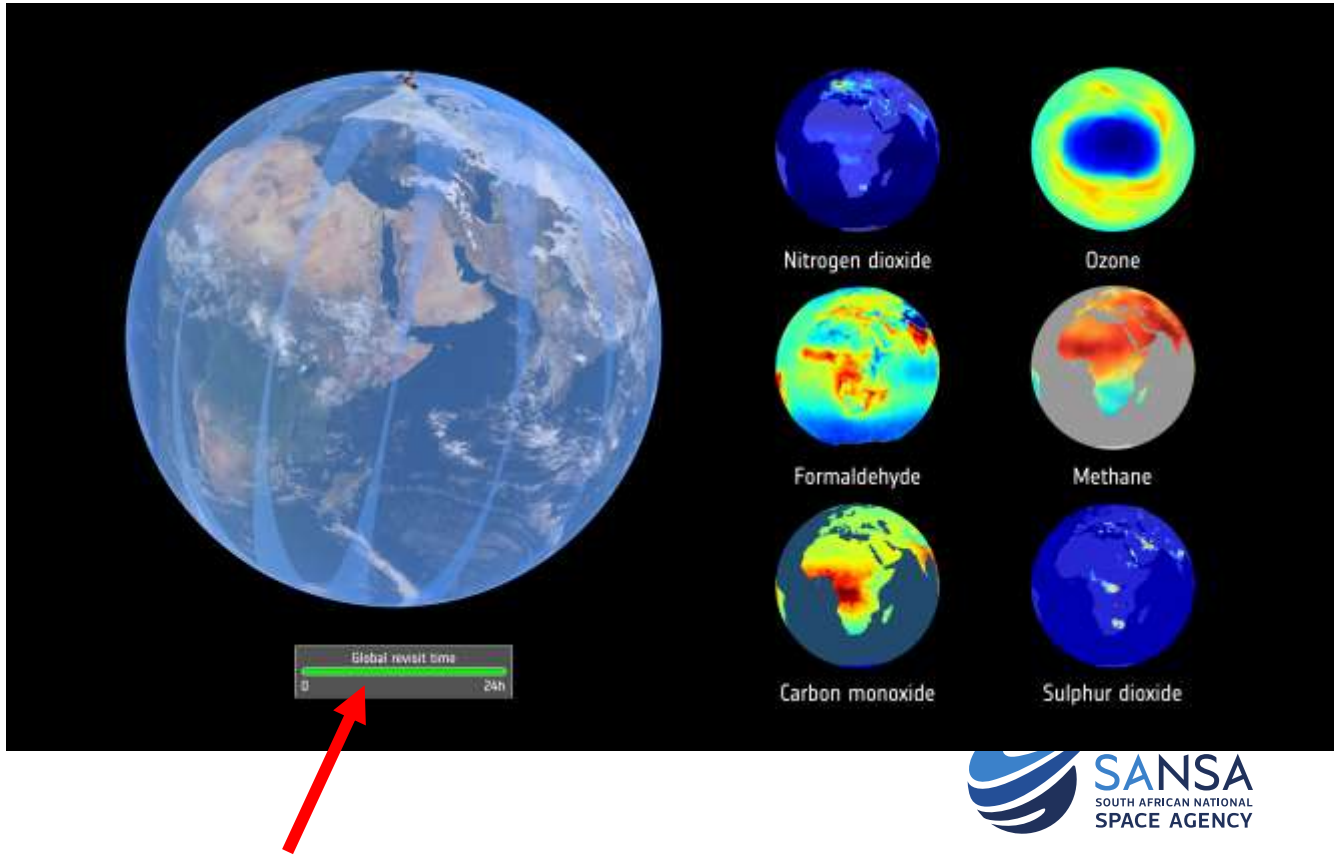
Revisit time **Less than one day.**

Data availability **Since April 2018.**

NRTI-for near real-time

OFFL -for offline

RPRO-for reprocessing



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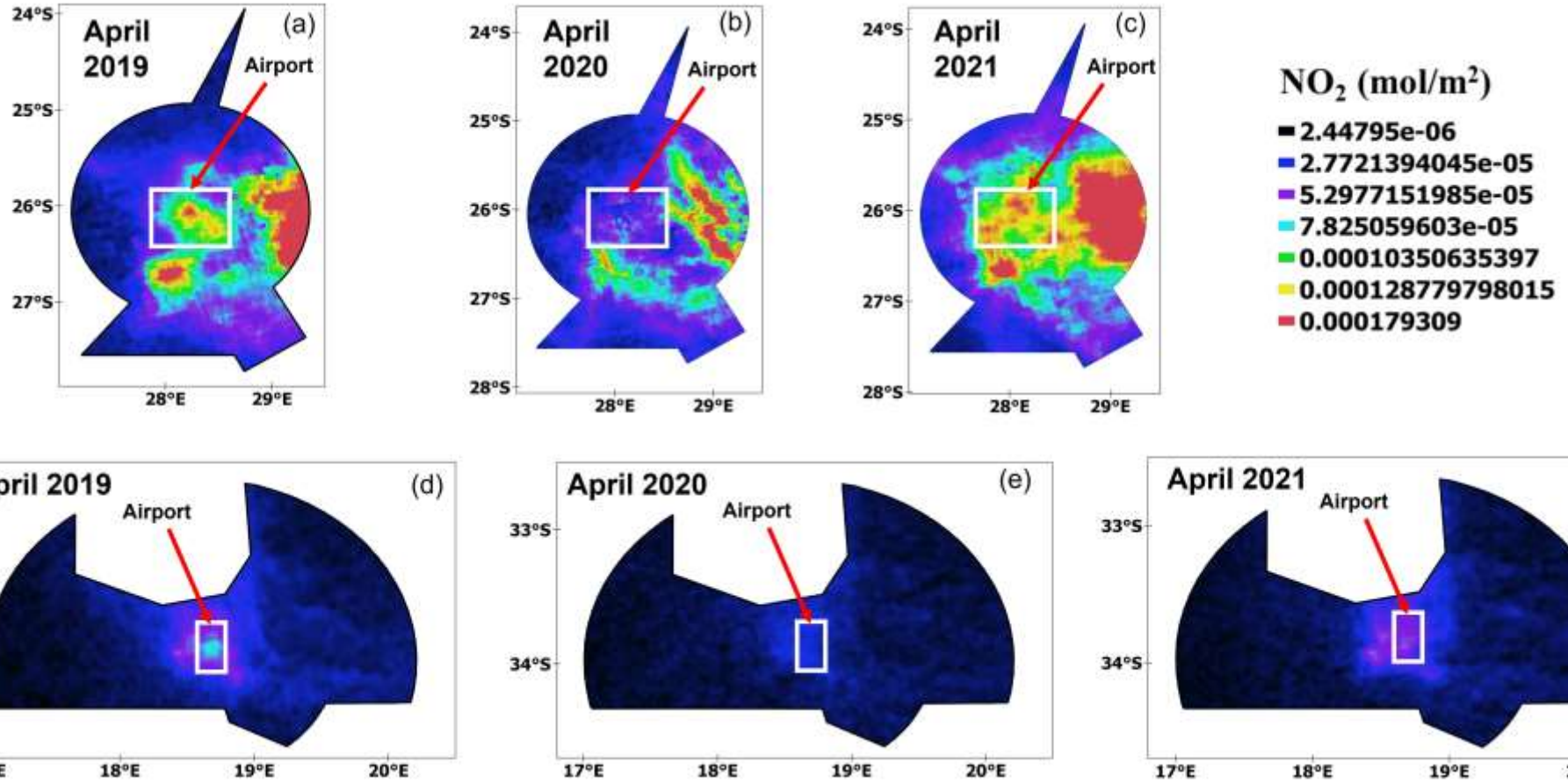
Example data from GEE: NO2 emissions from aircrafts at ORTIA and CPIA



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Shikwambana, L.; Kganyago, M. Assessing the Responses of Aviation-Related SO2 and NO2 Emissions to COVID-19 Lockdown Regulations in South Africa. Remote Sens. **2021**, 13, 4156. https://doi.org/10.3390/rs13204156

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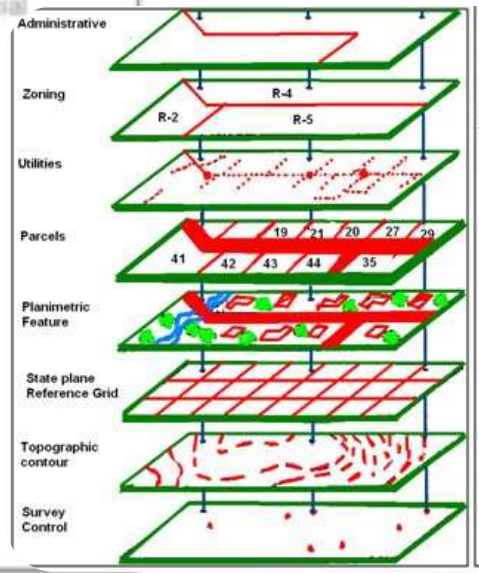
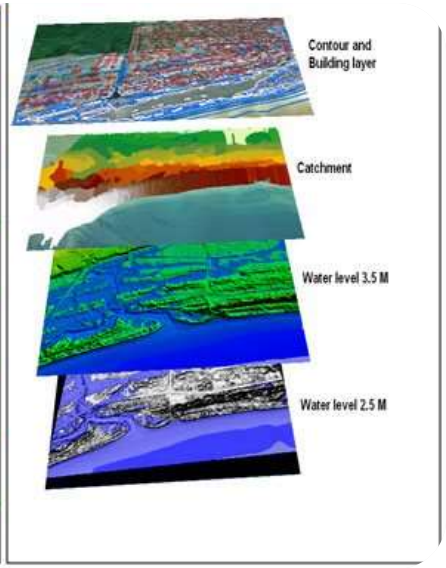
Future aspirations: Data integration

Why: Services provided by government in integrated manner





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https://www.ezitech.africa/services-municipal.html

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Benefits of data integration

Data integrity and data quality.

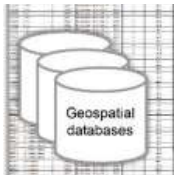
Easy, available and fast connections between data stores

Seamless data analysis and knowledge transfer between users

Better collaboration

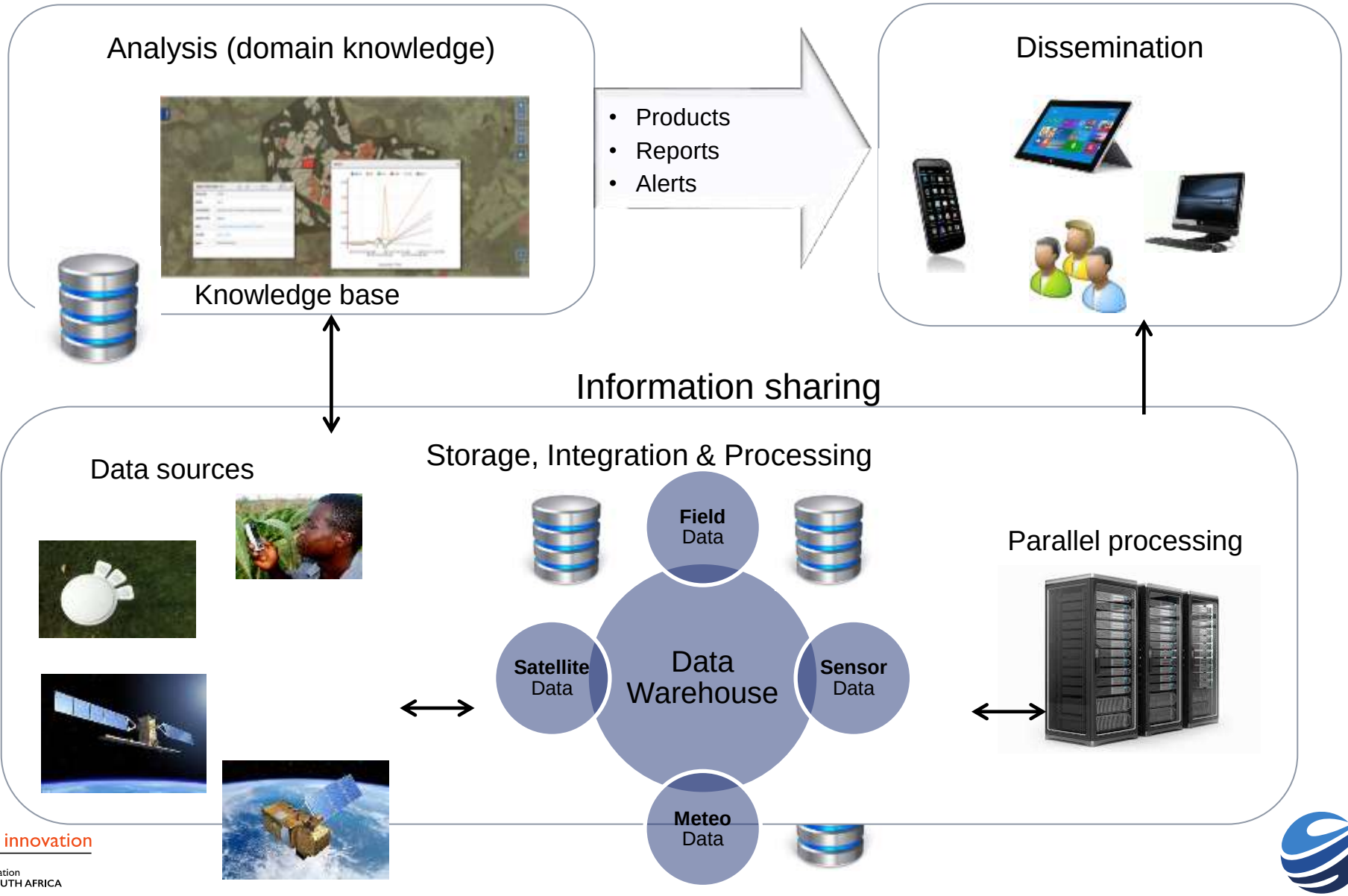
Complete real-time business insight, intelligence and analytics

Better and more precise information can be collected (Using and analyzing different data

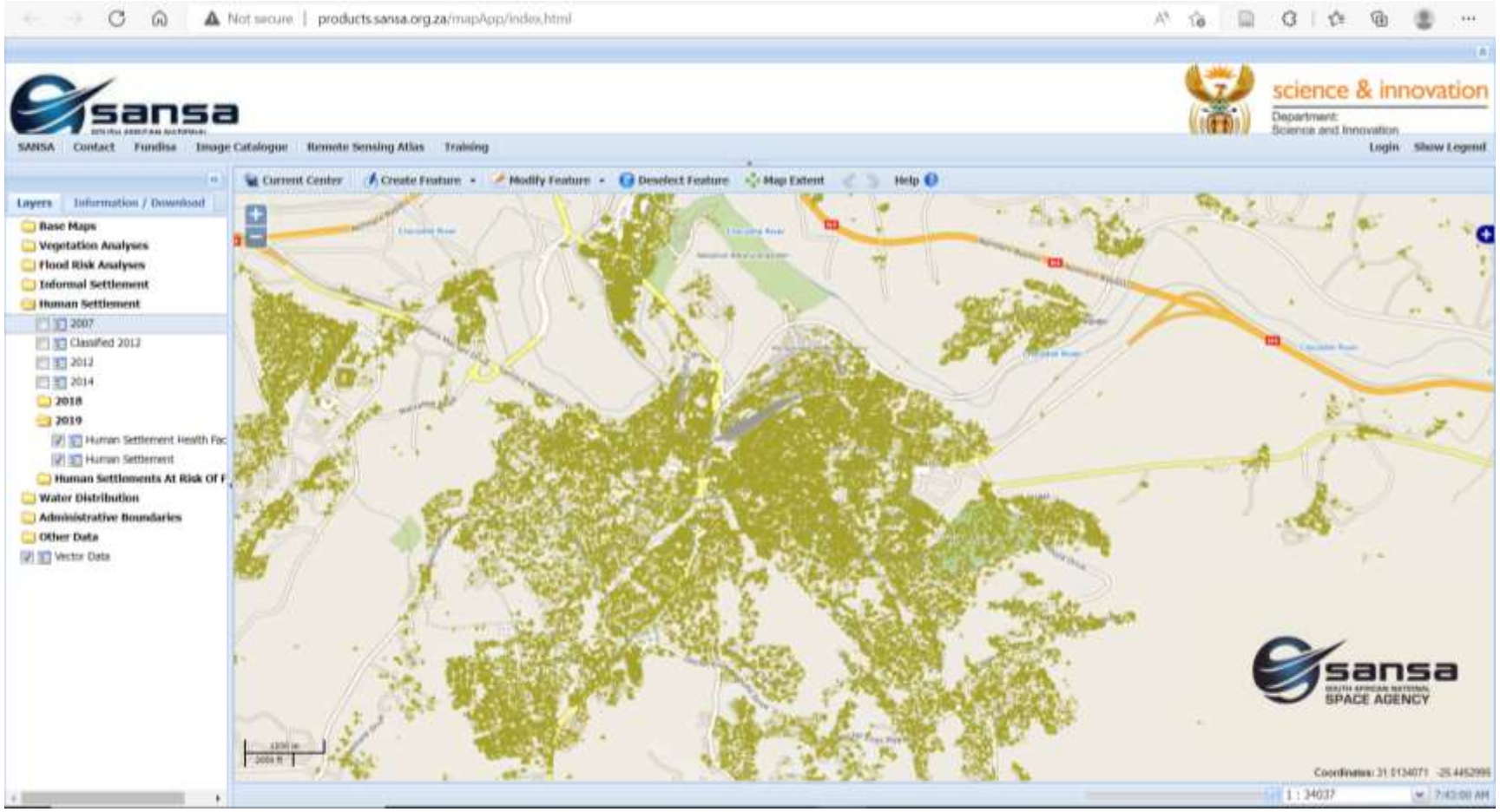


Integration of GIS & RS lead to synergistic approach to spatial data handling

Information Chain



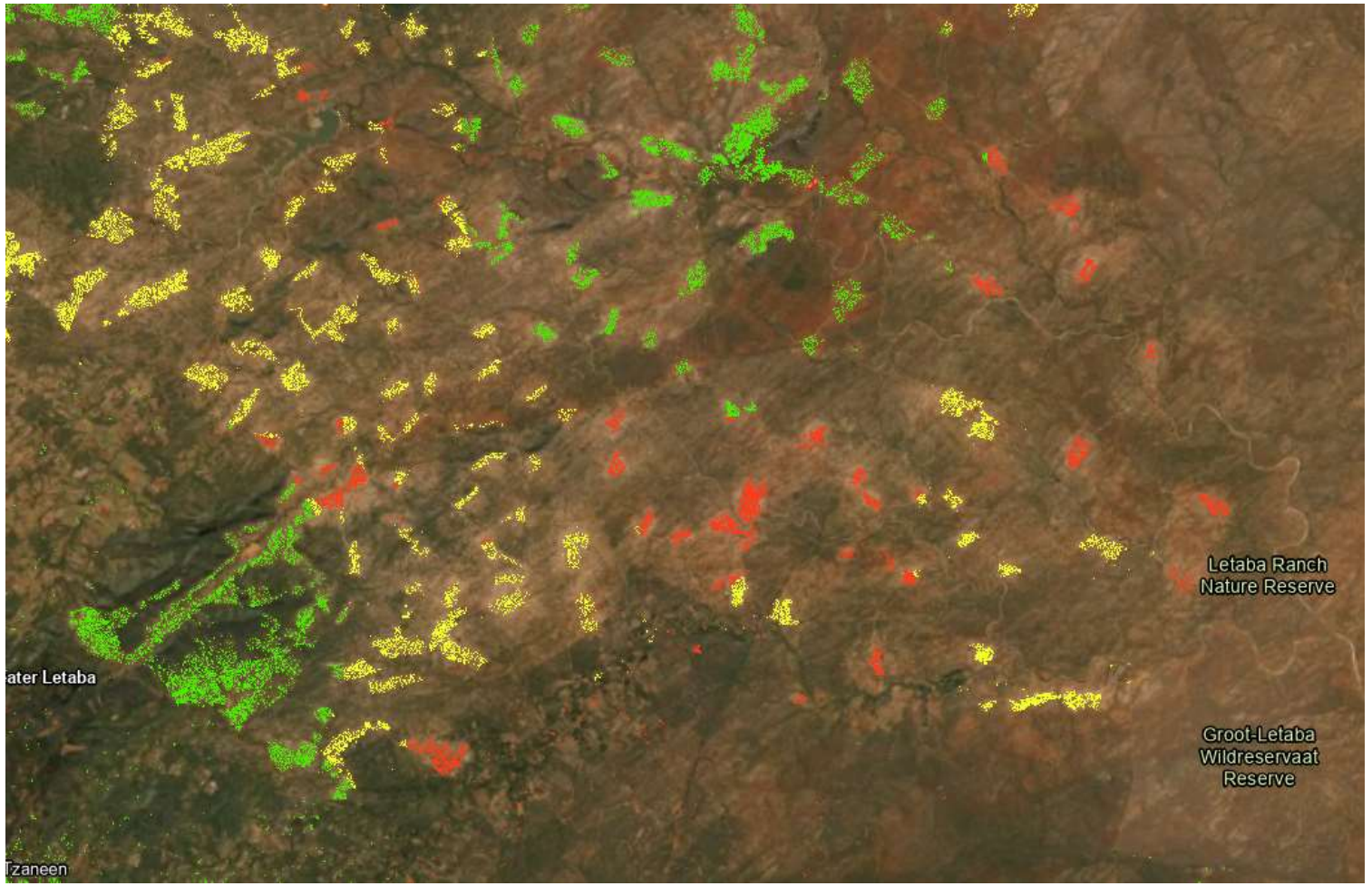
Access to value added products-Urban mapping and infrastructure monitoring



- http://products.sansa.org.za/mapApp/index.html

Assessment of areas that require services

- ✓ Health services should be 5km from the settlements
- ✓ Identification of areas that are far from the services
- ✓ Accessibility to be assessed using road network
- ✓ Identification of suitable sites for new health facility
- ✓ Human settlement density



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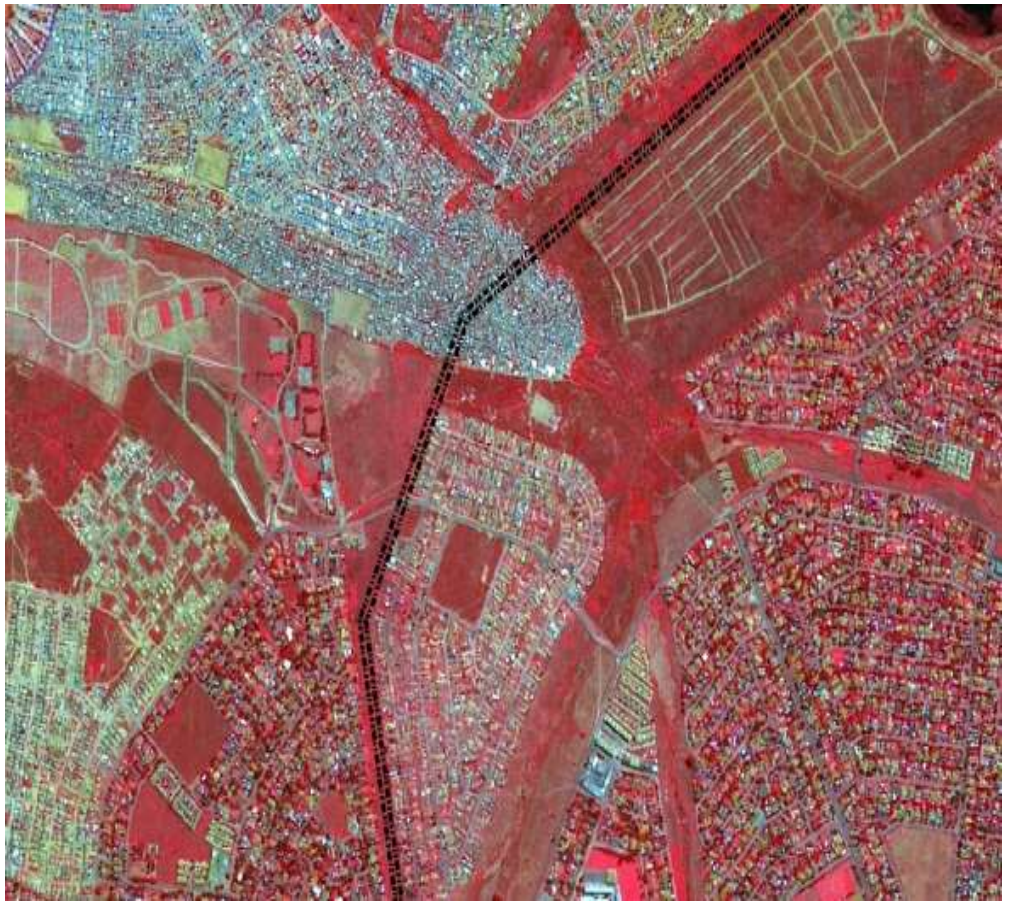
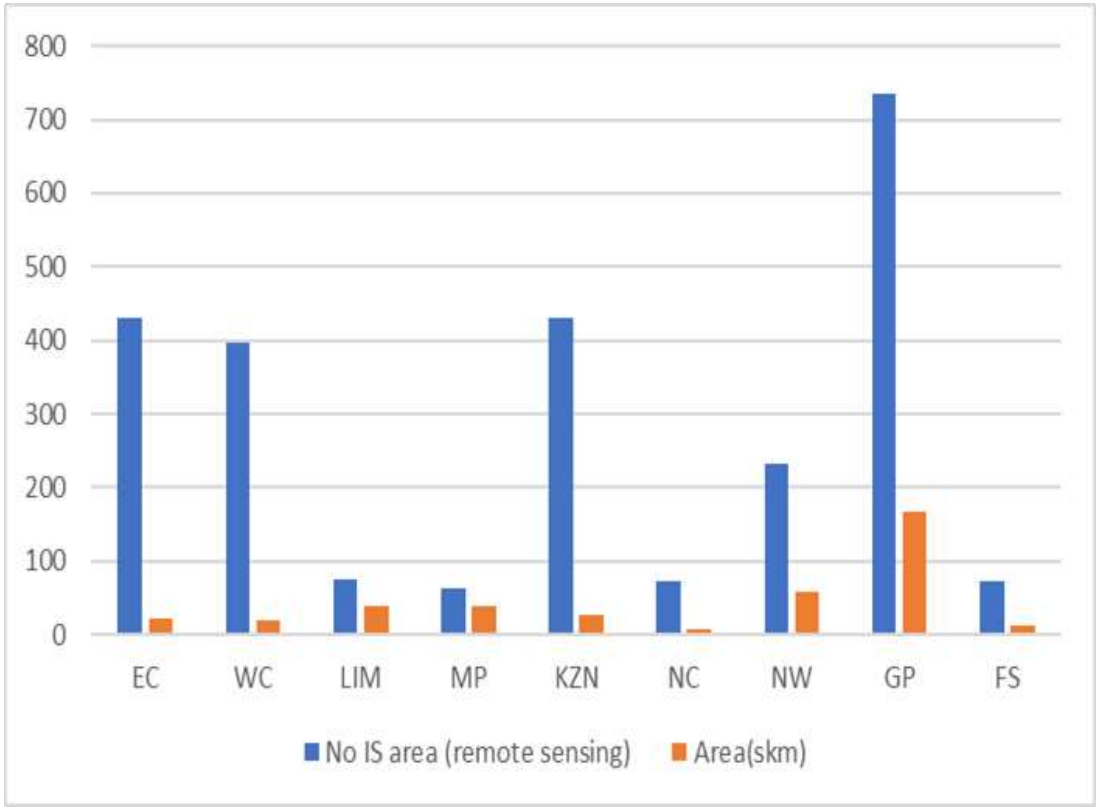
Servitude/asset management

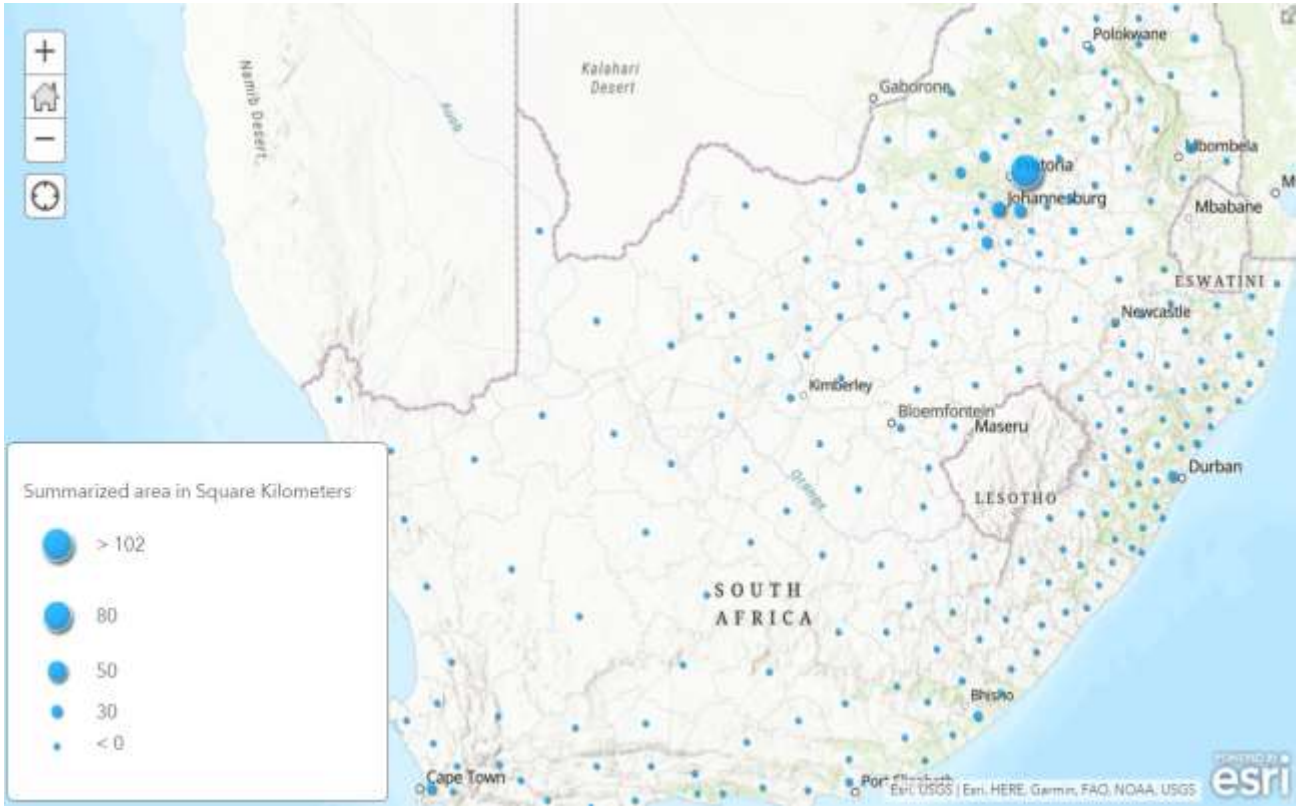
- ✓ Safety
- ✓ Environmental regulations
- ✓ Regular monitoring using satellite and crowd sourcing
- ✓ Suitability analysis for Human settlement



Mapping of informal settlements: Indication of areas that require services

Informal settlement: not included in disaster management; no waste collection; vulnerable to disaster





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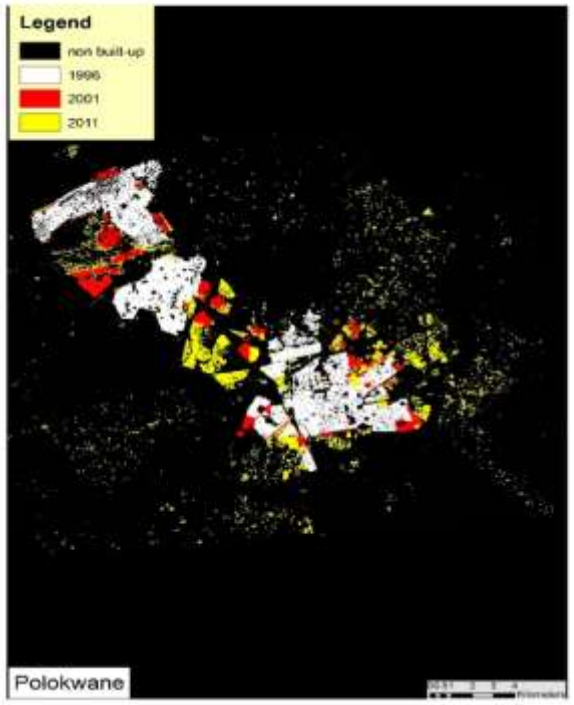
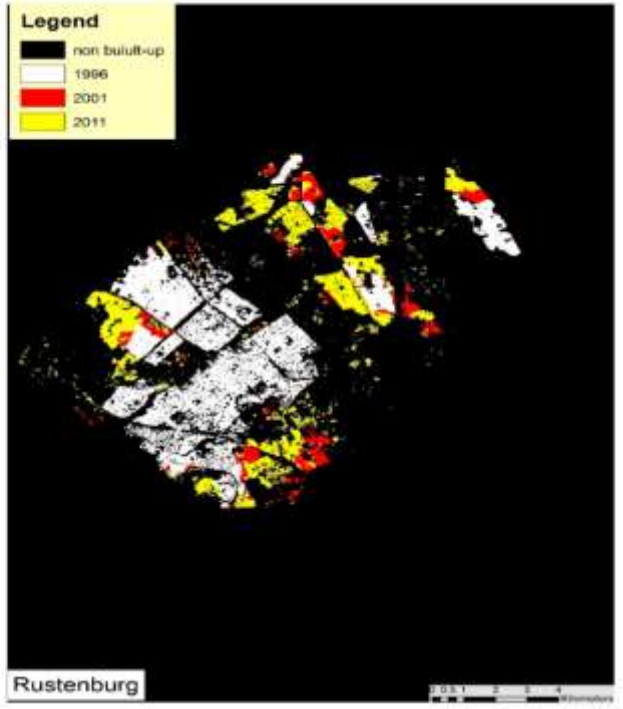
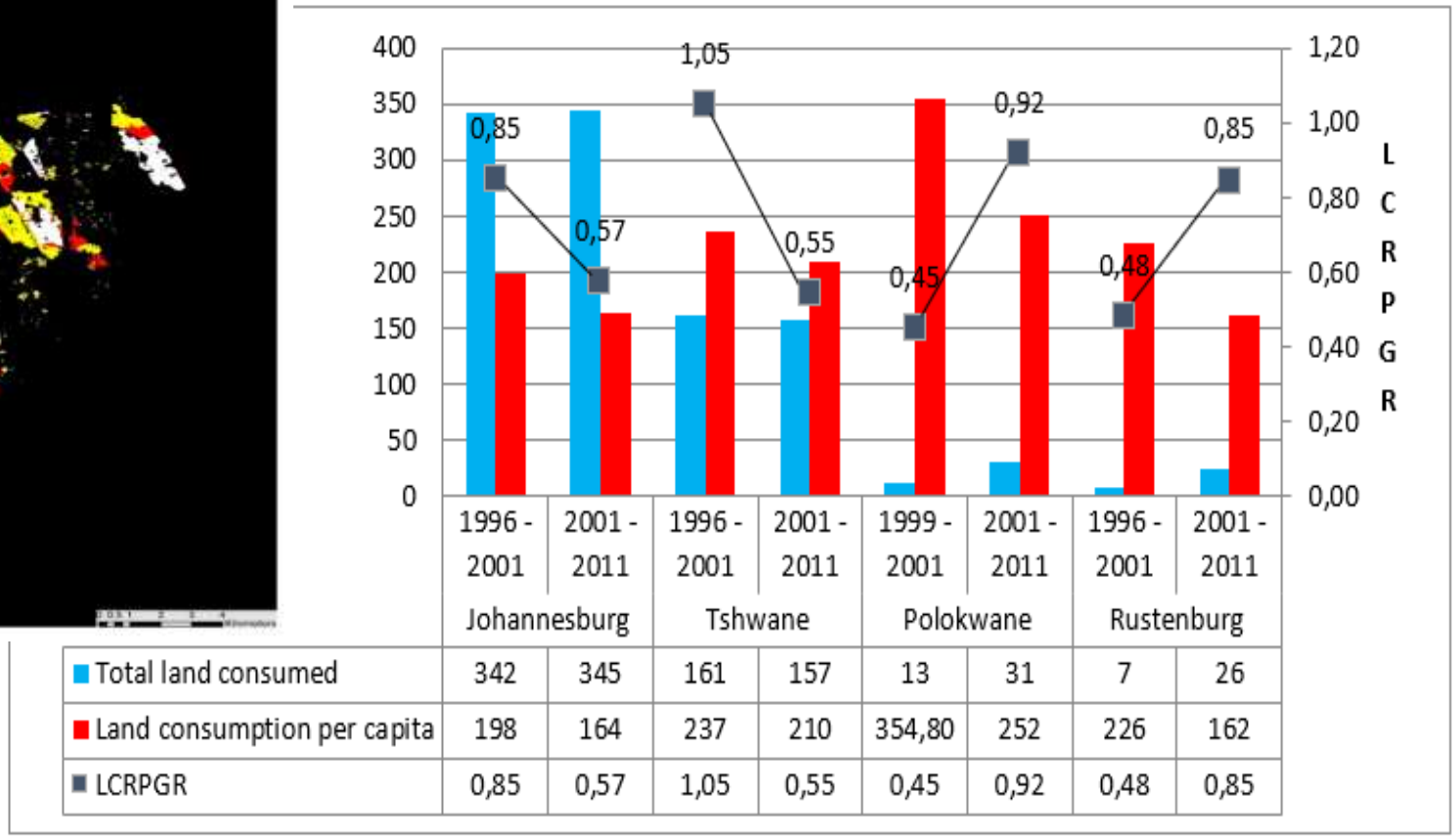
SGD 11.3.1 reporting

Ratio of Land Consumption Rate to Population Growth Rate (LCRPGR)







	Johannesburg		Tshwane		Polokwane		Rustenburg	
Total land consumed	342	345	161	157	13	31	7	26
Land consumption per capita	198	164	237	210	354,80	252	226	162
LCRPGR	0,85	0,57	1,05	0,55	0,45	0,92	0,48	0,85

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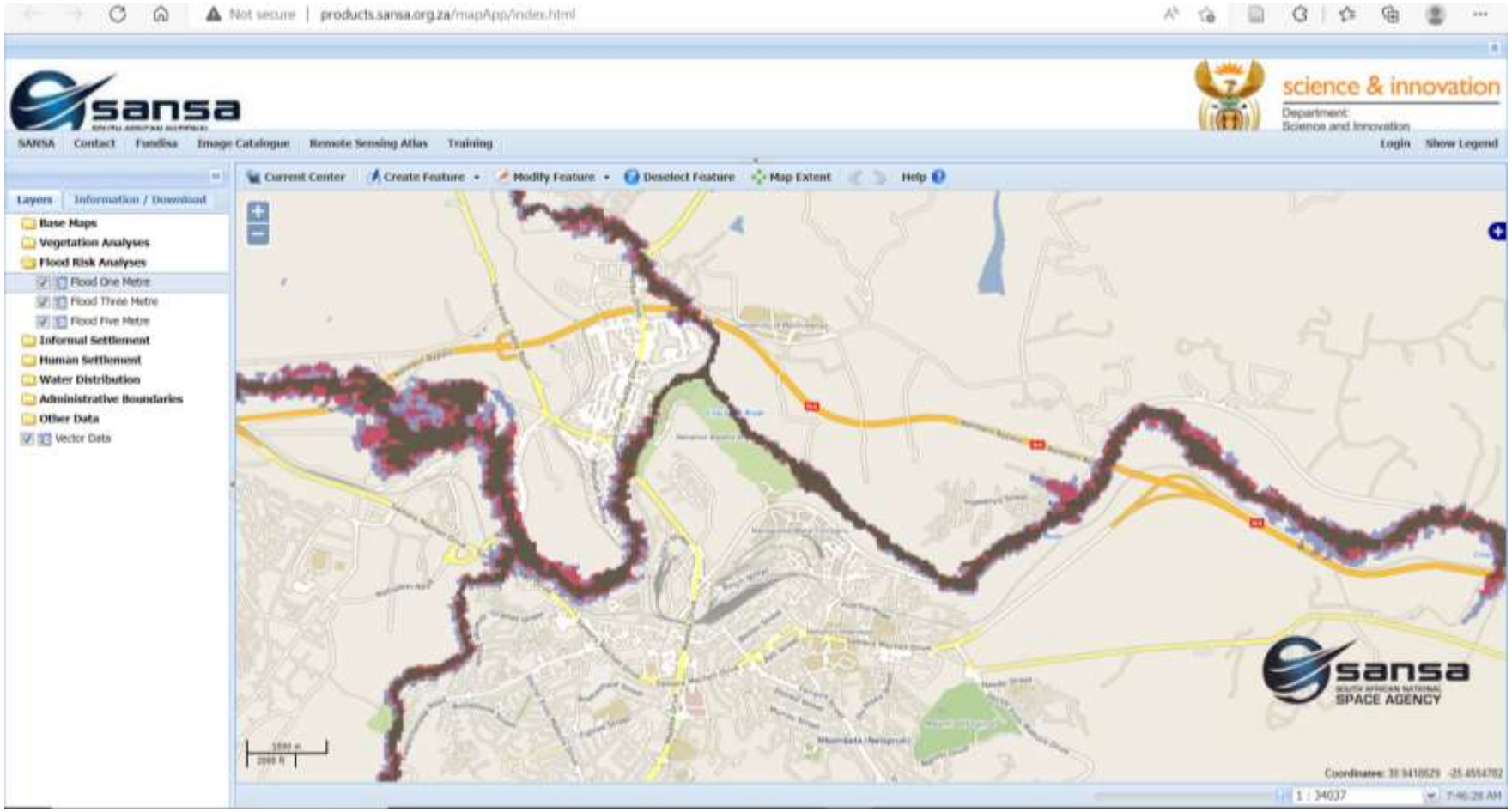
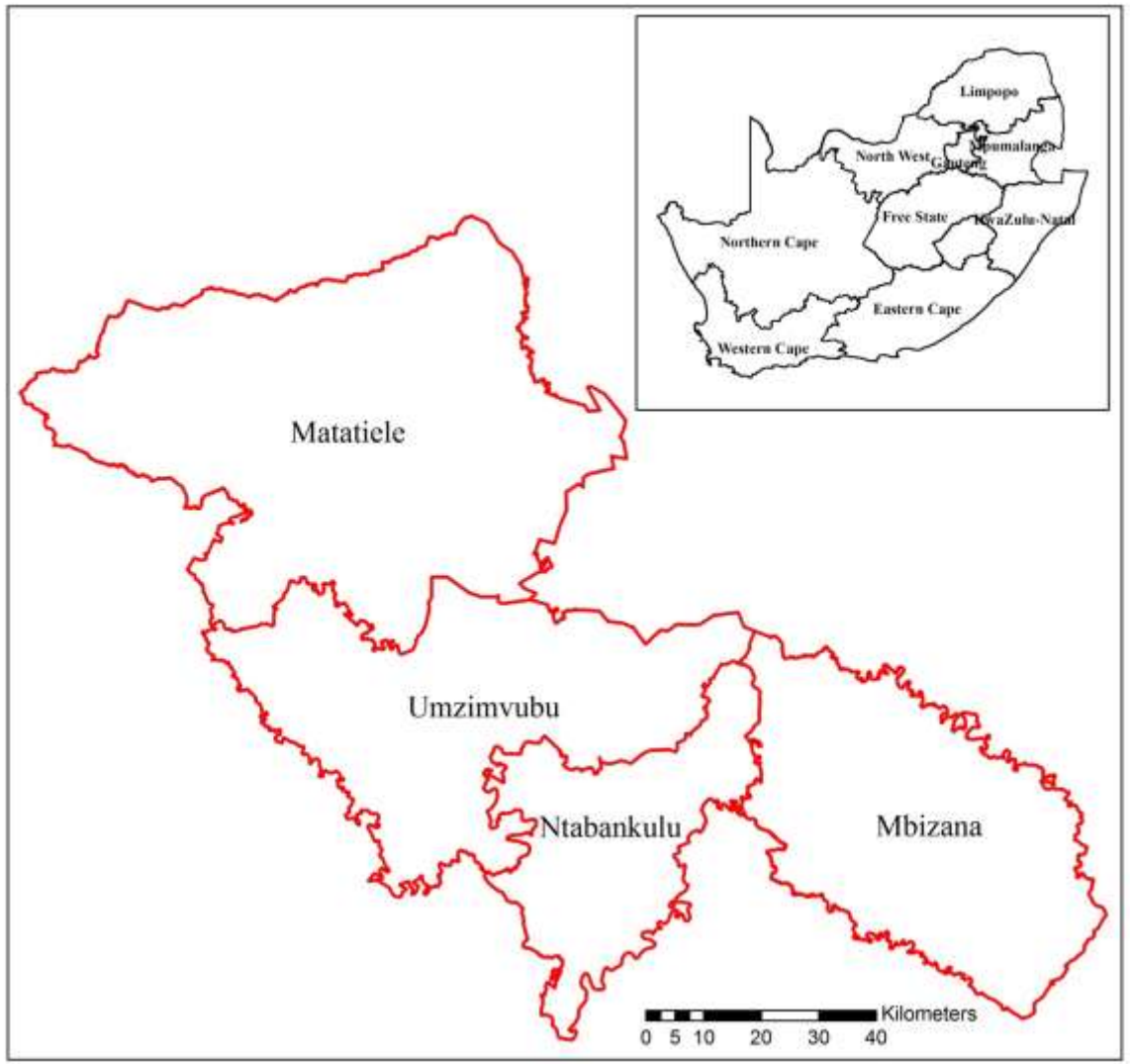
Access to value added products-Flood early warning info



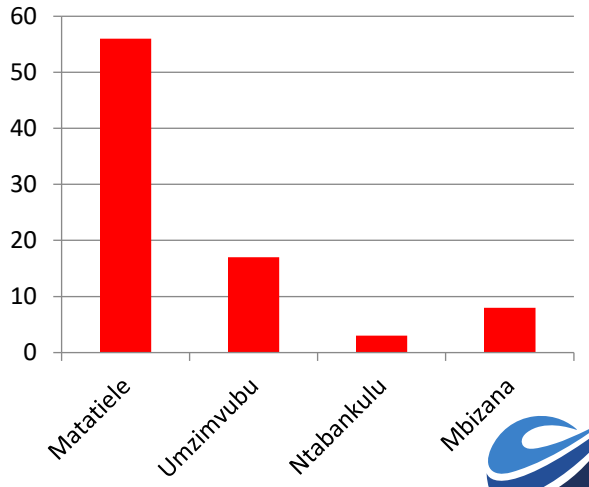
- http://products.sansa.org.za/mapApp/index.html

Alfred Nzo District Flood Risk Profile



86 structures at risk of flooding, in 44 Stats SA Enumerated areas. 27 located in Traditional residential, 9 Traditional Vacant, 1 Urban residential, 7 in farms

Number of settlements at risk of floods



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Crop area estimates

Service Area	Sum (excluding Pivot Irrigation, Horticulture / Viticulture & Shadenet)	Area: Pivot Irrigation, Horticulture / Viticulture & Shadenet (ha)	Planted (ha)	Fallow (ha)	Sum (excluding Pivot Irrigation, Horticulture / Viticulture & Shadenet) - P.Pastures	P.Patures	% Planted	Image Date
Bloemfontein	146950.69	9854.68	9277.01	137673.68	143113.69	3837.00	**6.48**	**06-12-2016**
Bultfontein	125527.90	4622.97	8277.18	117250.72	118827.90	6700.00	**6.97**	**06-12-2016**
Hoopstad	211018.85	10954.49	30988.69	180030.16	204621.85	6397.00	**15.14**	**06-12-2016**
KOPPIES	30016.07	461.15	11726.49	18289.58	29561.07	455.00	**39.67**	**03-12-2016**
KROONSTAD	32311.63	412.99	18598.99	13712.64	32133.63	178.00	**57.88**	**03-12-2016**
VENTERSDORP	64289.82	4821.76	31709.65	32580.17	64096.82	193.00	**49.47**	**06-12-2016**
VIERFONTEIN	29920.77	916.21	7849.11	22071.66	29859.77	61.00	**26.29**	**06-12-2016**
Wesselsbron	128143.98	5543.07	15017.74	113126.24	122169.98	5974.00	**12.29**	**06-12-2016**

Service Area	Sum (excluding Pivot Irrigation, Horticulture / Viticulture & Shadenet)	NODATA	Area: Pivot Irrigation, Horticulture / Viticulture & Shadenet (ha)	Planted (ha)	Fallow (ha)	Sum (excluding Pivot Irrigation, Horticulture / Viticulture & Shadenet) - P.Pastures	P.Patures	% Planted	Image Date
Bloemfontein	149919.80	132.32	9854.68	71743.50	78043.98	146082.80	3837.00	49.11	16-02-2017
Bultfontein	127252.98	310.75	4622.97	87122.73	39819.50	120552.98	6700.00	72.27	16-02-2017
Hoopstad	220380.8756	2819.00	10954.49	178521.7051	39040.17	213983.8756	6397	83.43	16-02-2017
KOPPIES	30596.65	68.38	461.15	30210.66	317.61	30596.65	455.00	98.74	09-02-2017
KROONSTAD	33048.82	25.57	412.99	32557.68	465.57	32870.82	178.00	99.05	09-02-2017
VENTERSDORP	65890.13527	406.76	4821.76	65402.41	80.97	65697.14	193	99.55	16-02-2017
VIERFONTEIN	30315.5676	56.04	916.21	30235.95	23.58	30254.5676	61	99.94	16-02-2017
Wesselsbron	132564.1547	276.12	5543.07	127991.88	4296.15	126590.1547	5974	96.75	16-02-2017

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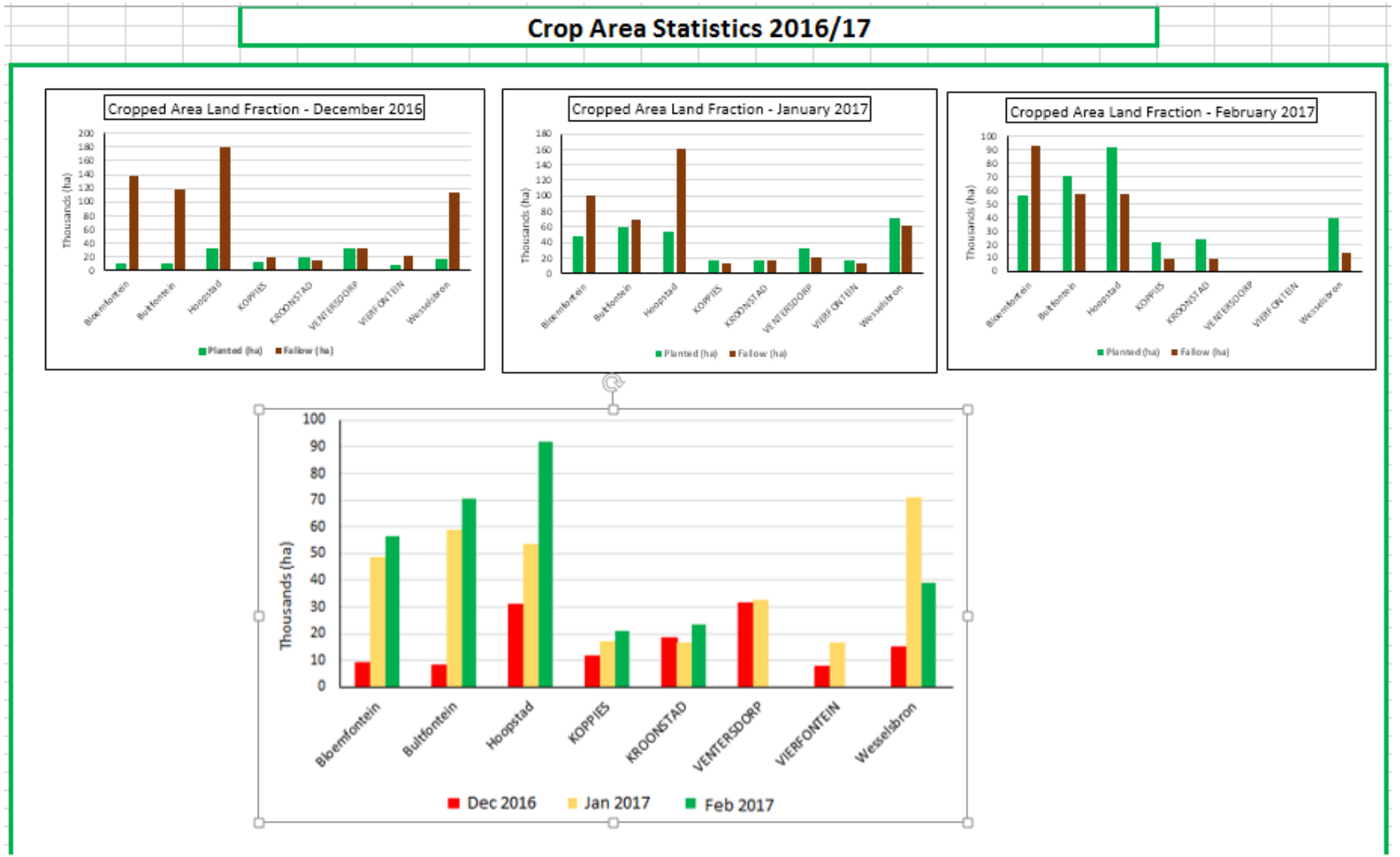
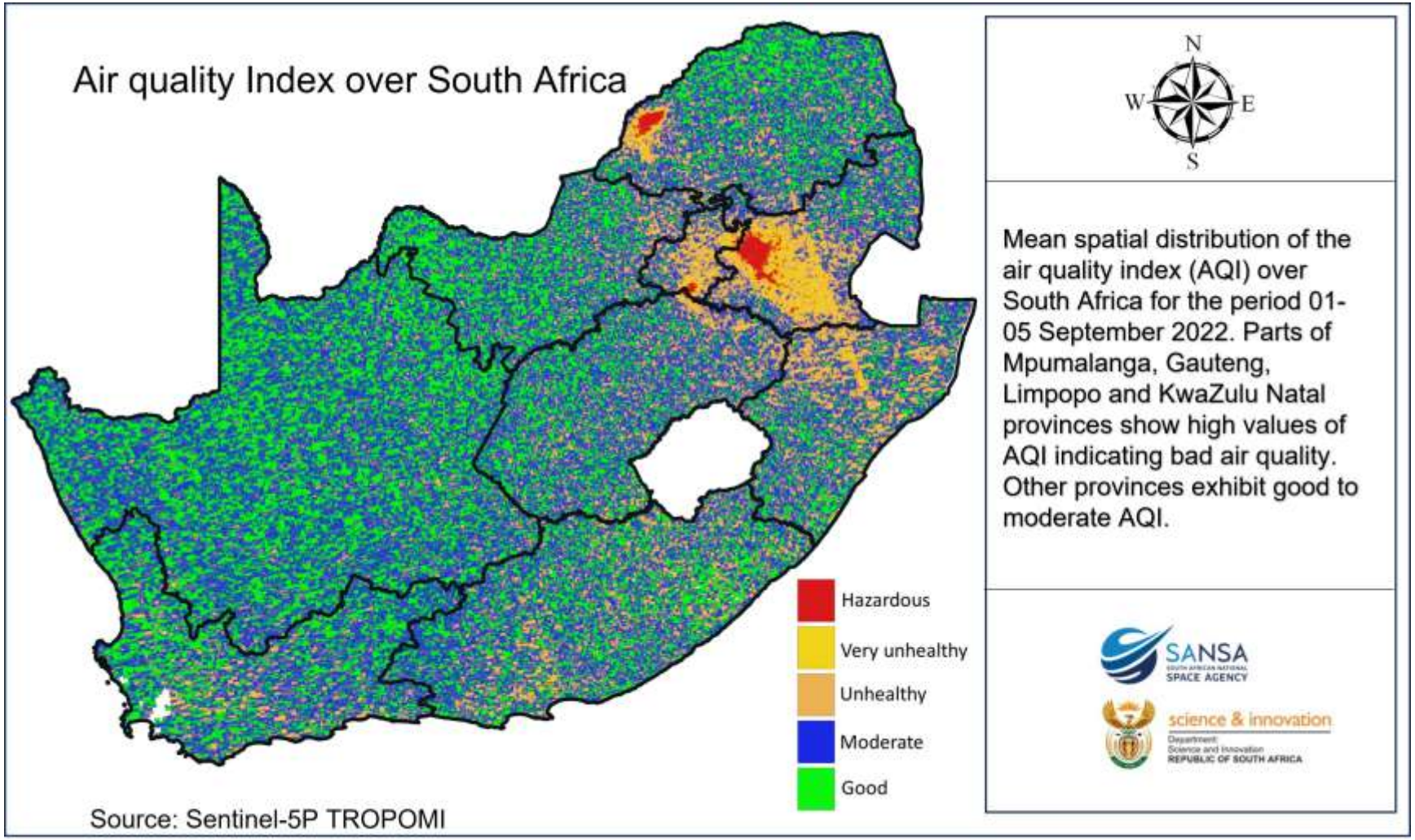
Cropped Area Estimation



Calculated Air Quality Index over South Africa using GEE



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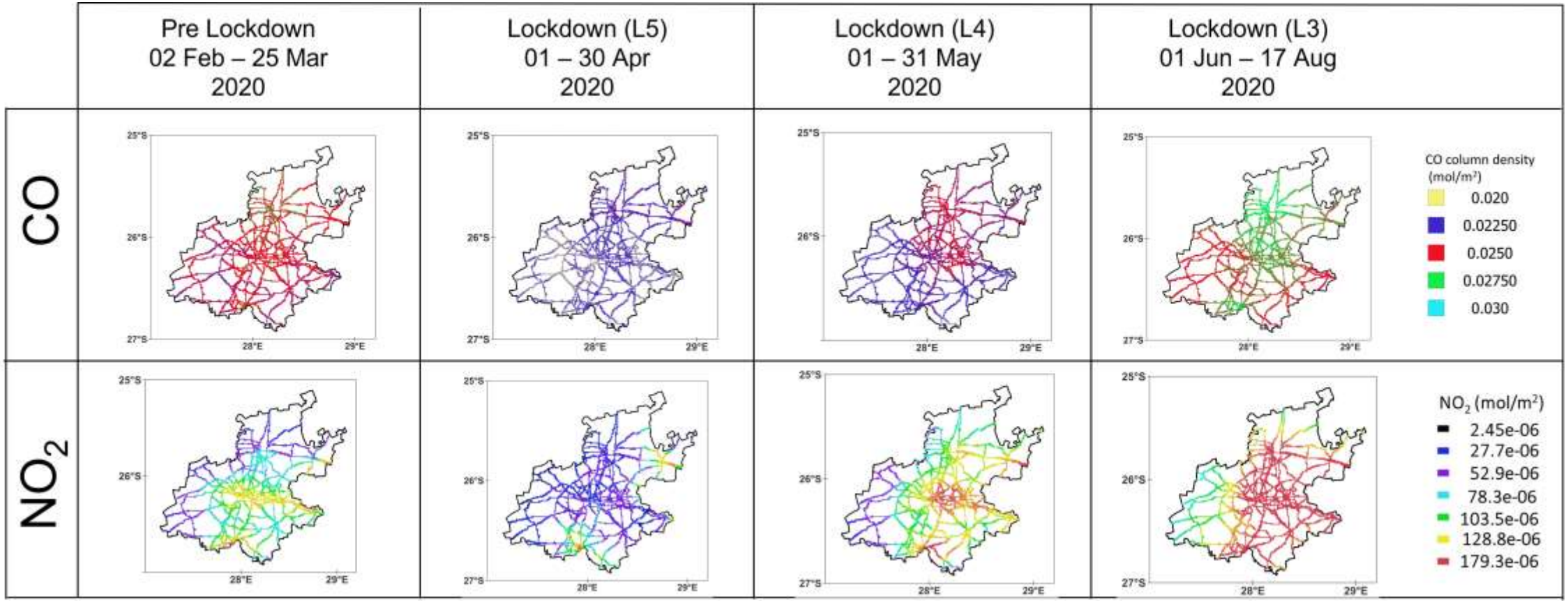
Measurements of emissions from major highways in Gauteng Province, South Africa example



Shikwambana, L., Kganyago, M., Mhangara, P. (2023). TROPOMI Utilized for the Monitoring of Emissions on Major Road Networks: A Case Study in South Africa During the COVID-19 Lockdown. In: Li, P., Elumalai, V. (eds) Recent Advances in Environmental Sustainability. EESIWC 2021. Environmental Earth Sciences. Springer.

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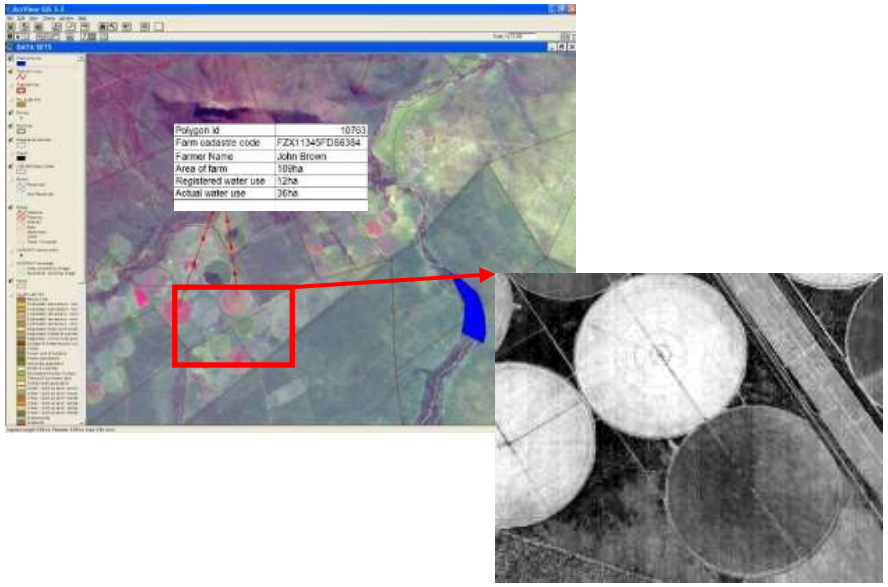
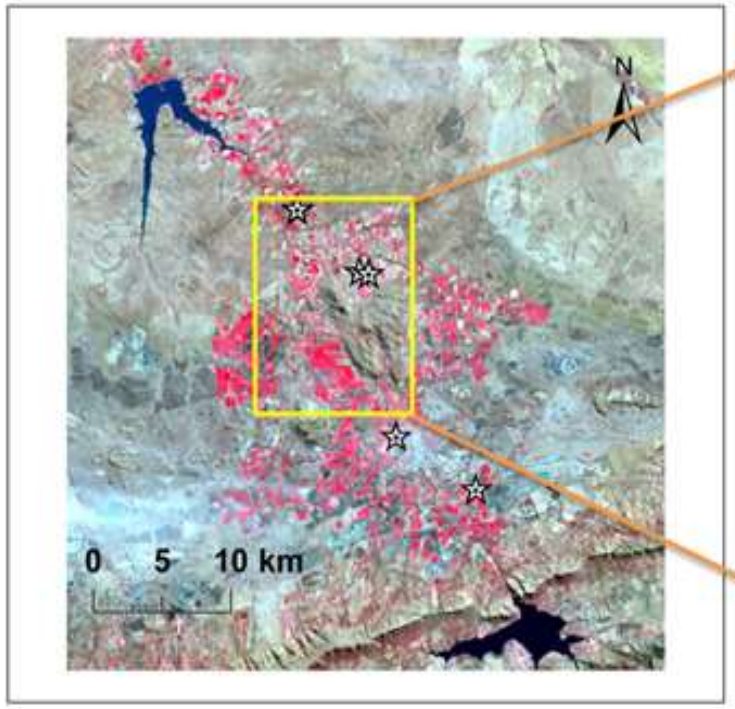
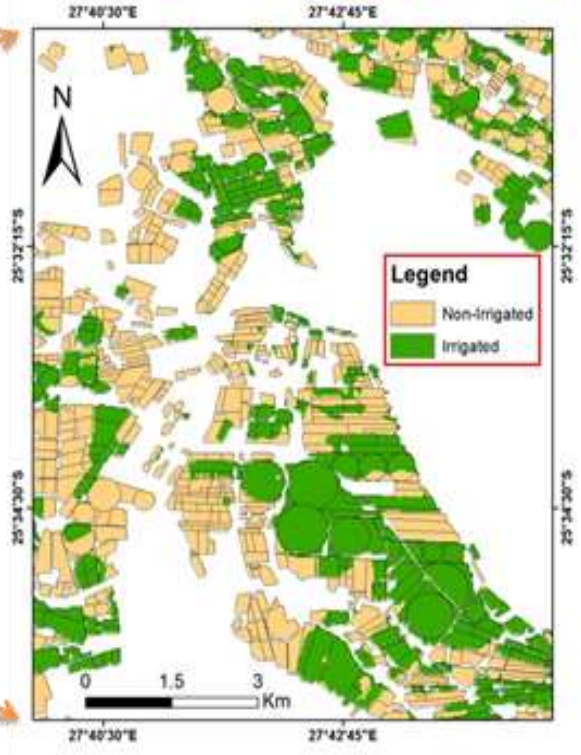
Determination of existing lawful water use







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