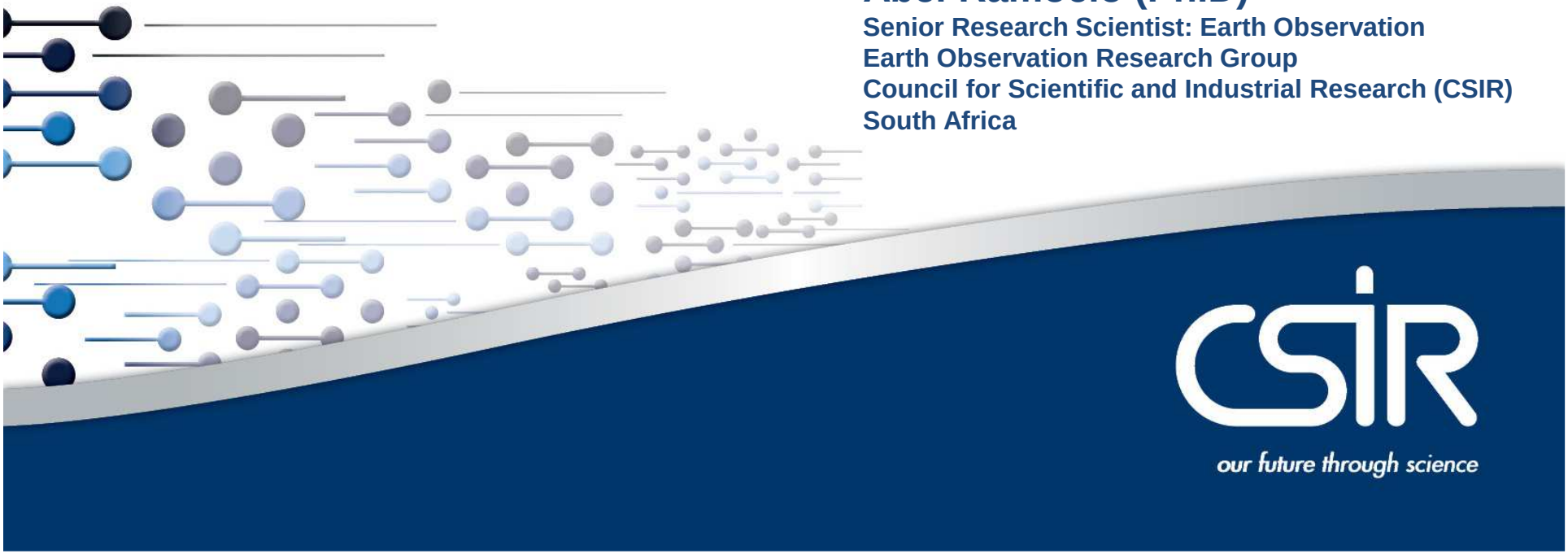
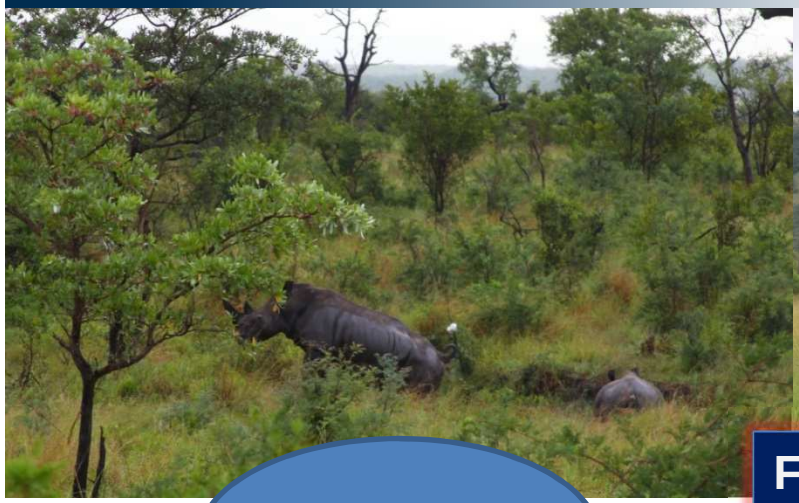
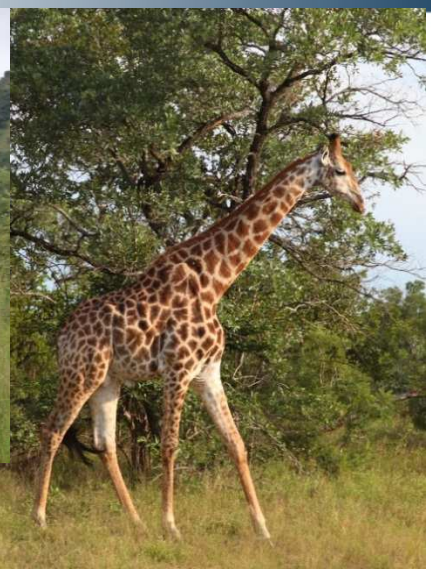
Progress: EO based estimation of grass nutrients and biomass as indicators of rangeland (forage) quality and quantity in the savanna environments

Abel Ramoelo (Ph.D)
Senior Research Scientist: Earth Observation
Earth Observation Research Group
Council for Scientific and Industrial Research (CSIR)
South Africa



Introduction





Conserve

Feeding Patterns of Grazers and the Browsers

Livestock production – Poverty alleviation

Biodiversity is a critical ecosystem service – enabling **Ecotourism** and provide **food resources**

Grazing areas for Livestock productions and Wildlife

Global Change – LULC and Climate change

Indicators of rangeland quality and quantity

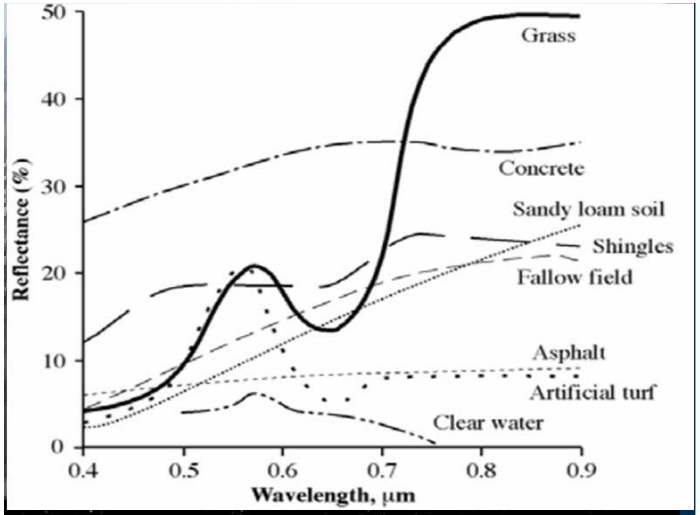
- Grass **nitrogen concentration** (N%) as an indicator grass quality, and also correlate to protein—major nutrient for herbivores
- **Grass biomass** as indicator of quantity of grazing resources
- …affects the movement and feeding patterns of domestic and wild herbivores
- …spatial zoning for **grazing camps**, **stocking rates**, **carrying capacity** of herbivores in rangelands

Scaling leaf N and biomass estimations

- Distribution of grass nutrients and biomass occur at various scales such as
  - Local (e.g. Site level)
  - Regional (e.g entire KNP and surrounding areas)
  - Global

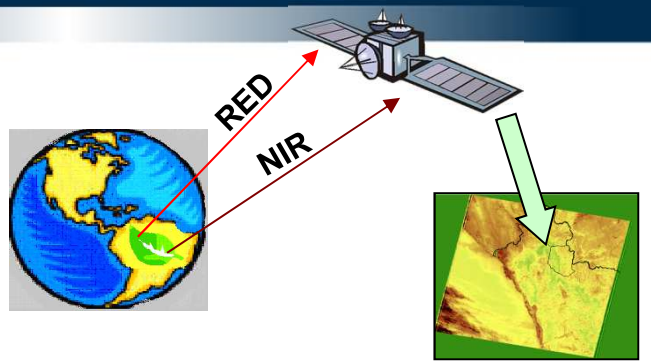
Point-based testing of ecological theories

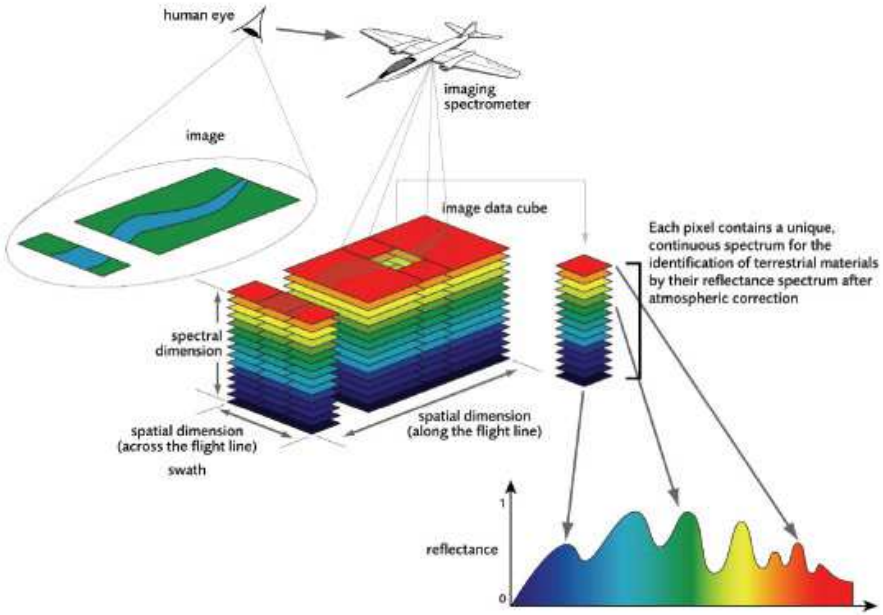
- Traditional field techniques to measure grass nutrient and biomass concentrations are **laborious and time consuming**.



Remote Sensing

•..obtained by sensing and recording reflected or emitted energy and processing, analyzing, and applying this information.





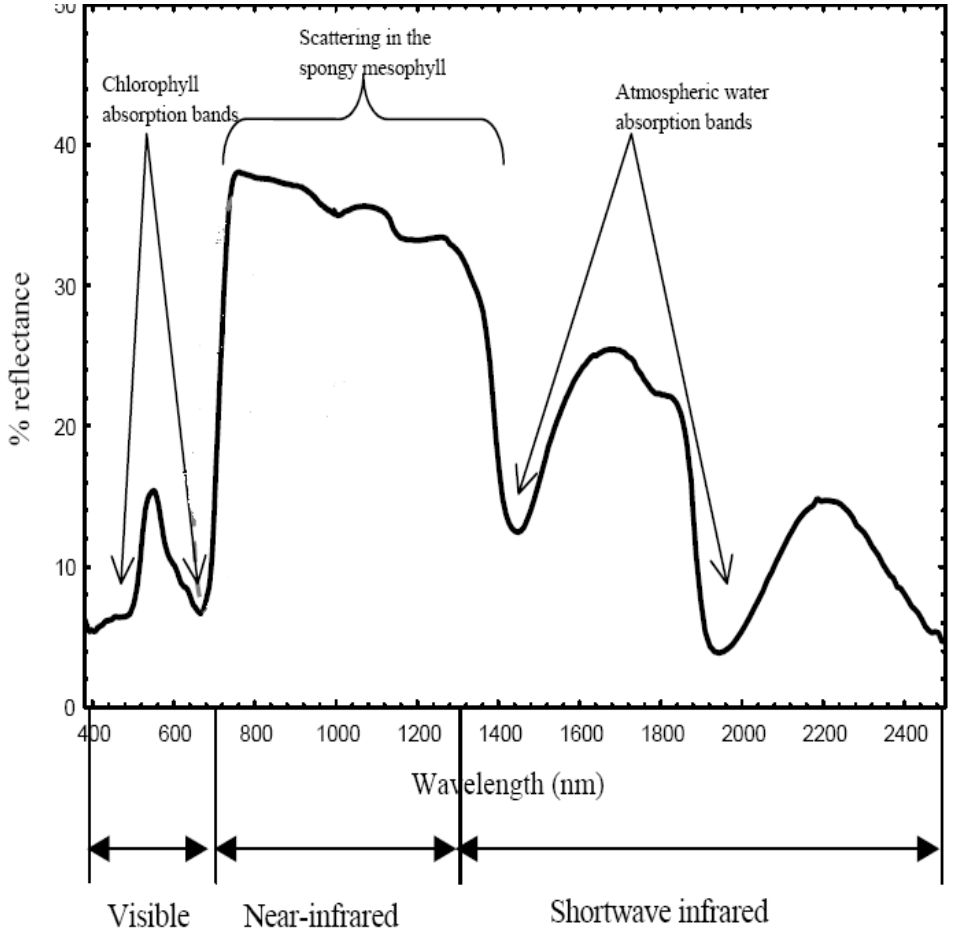
•…interactions between earth surface materials and electromagnetic energy.

www.csir.co.za

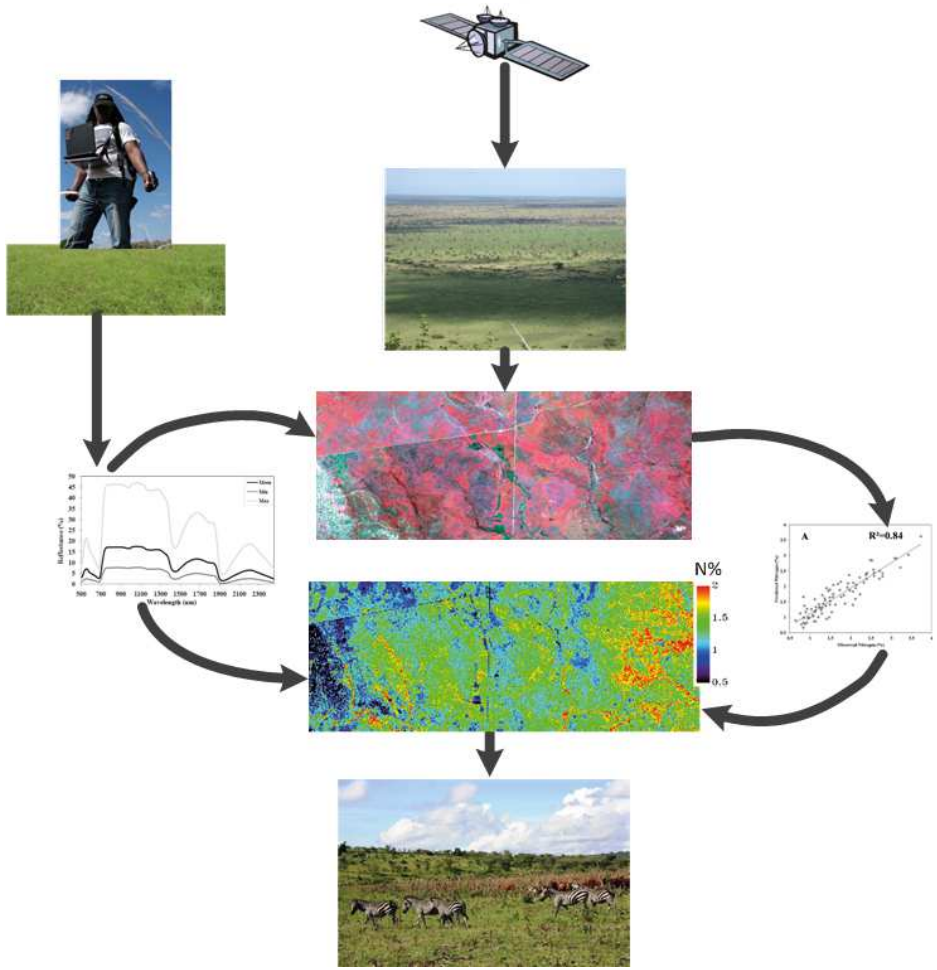
CSIR
our future through science

Application of remote sensing

- **Remote sensing techniques** provide an opportunity to map leaf N and biomass at various scales.
  - successes (**Hyperspectral/ Spectroscopy**)-**N** & **Chlorophyll**
  - Challenges (Regional estimation)
  - Spectral and Spatial Resolution
  - **New RapidEye, WorldView 2**
  - **Sentinel-2**
  - **Biomass has been plausible to estimate using remote Sensing – various scales**



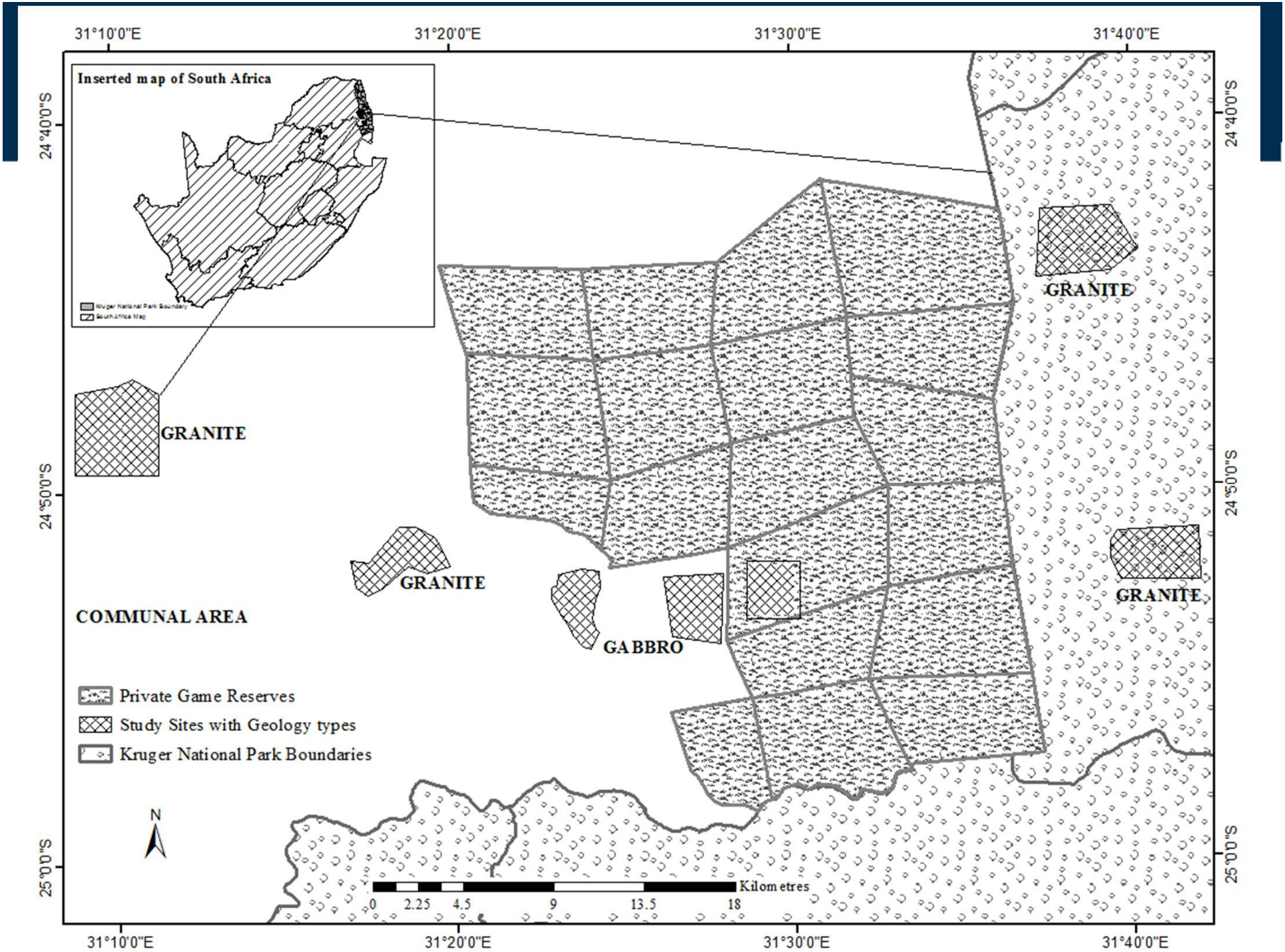
General workflow for estimating leaf N and biomass



Spatial-based testing of ecological theories

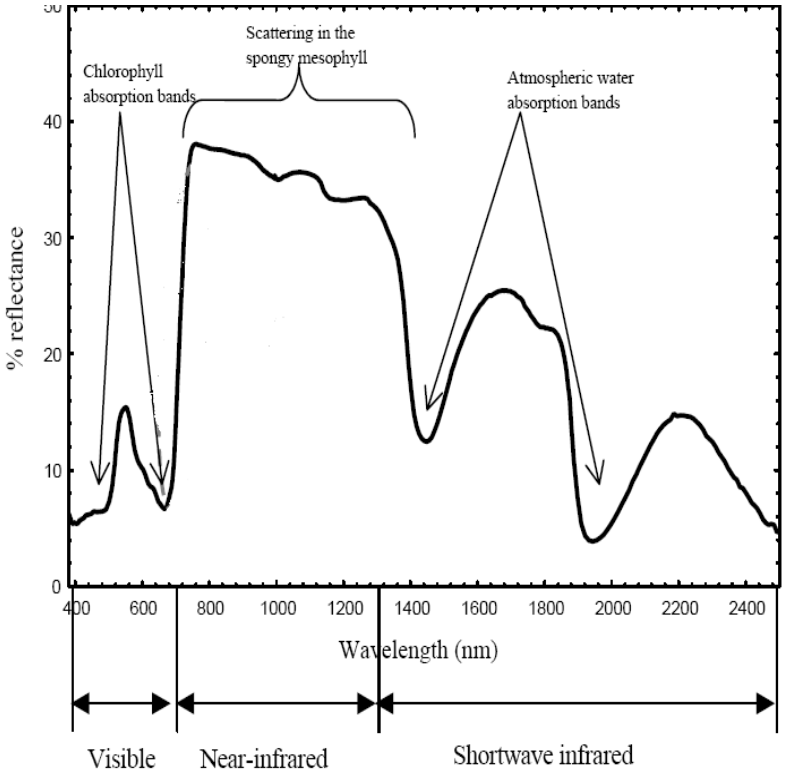
Presentation Objective

To showcase some of the rangeland products (leaf N and biomass) developed in and around Kruger National Park (KNP)


31°10'0"E
31°20'0"E
31°30'0"E
31°40'0"E
24°40'0"S
24°50'0"S
25°0'0"S
Inserted map of South Africa
Kruger National Park Boundary
South Africa Map
GRANITE
GRANITE
GRANITE
GRANITE
GABBRO
COMMUNAL AREA
Private Game Reserves
Study Sites with Geology types
Kruger National Park Boundaries
N
0 2.25 4.5 9 13.5 18
Kilometres

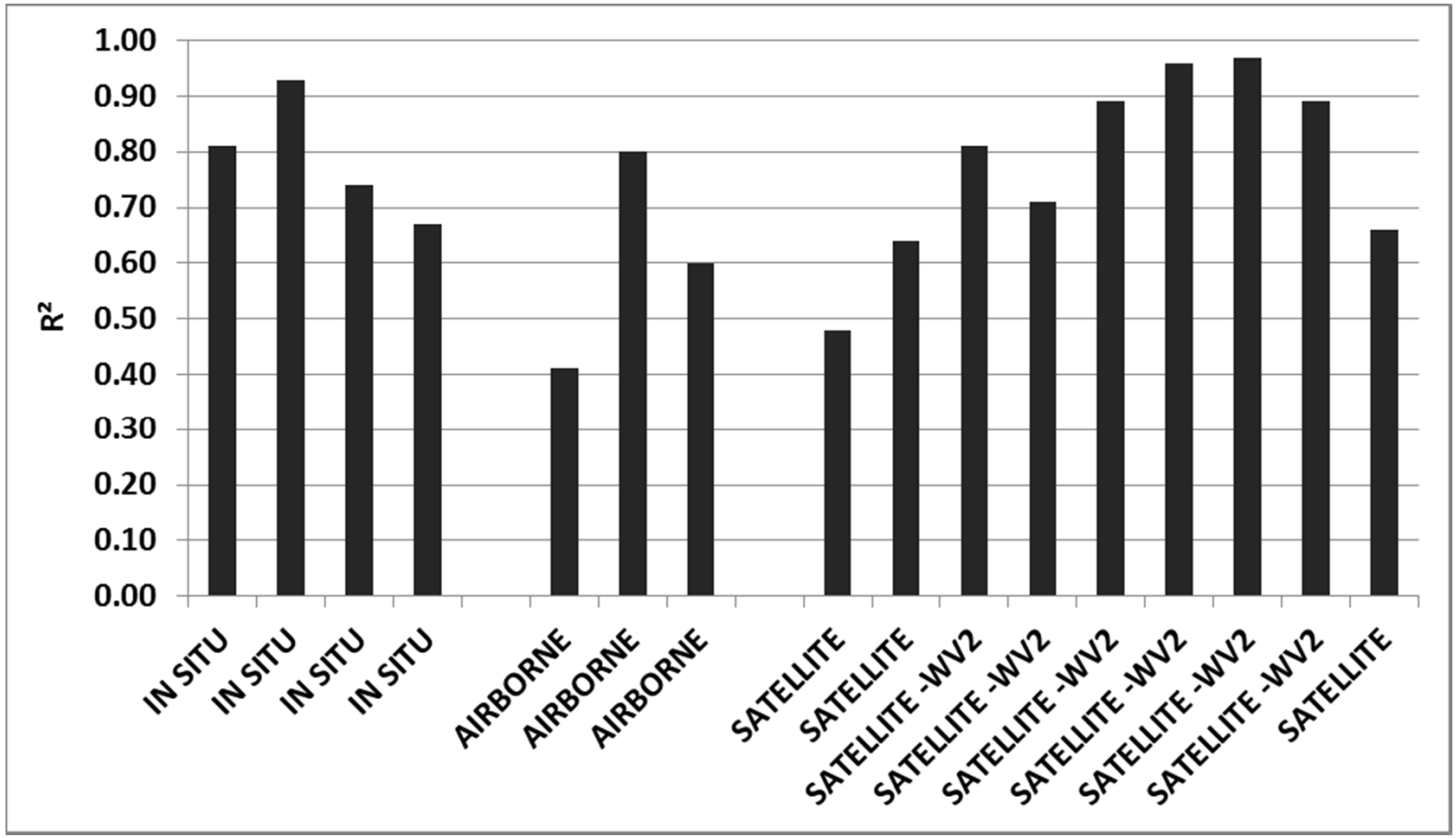
Statistics used for EO based leaf N and biomass retrieval

- **The estimation of leaf N and biomass has been empirically-based,**
  - **Simple regression – use of vegetation indices**
    - **Narrow and broadband based**
  - **Multivariate (Parametric) : PLSR, SMLR**
    - **Known absorption features**
    - **Full spectrum**
    - **Vegetation indices**
    - **Integrated modelling approach (VI+ Ecol.)**
  - **Machine learning algorithms : ANN, RF.**
    - **Vegetation indices (narrow and broadband)**
    - **Absorption features**

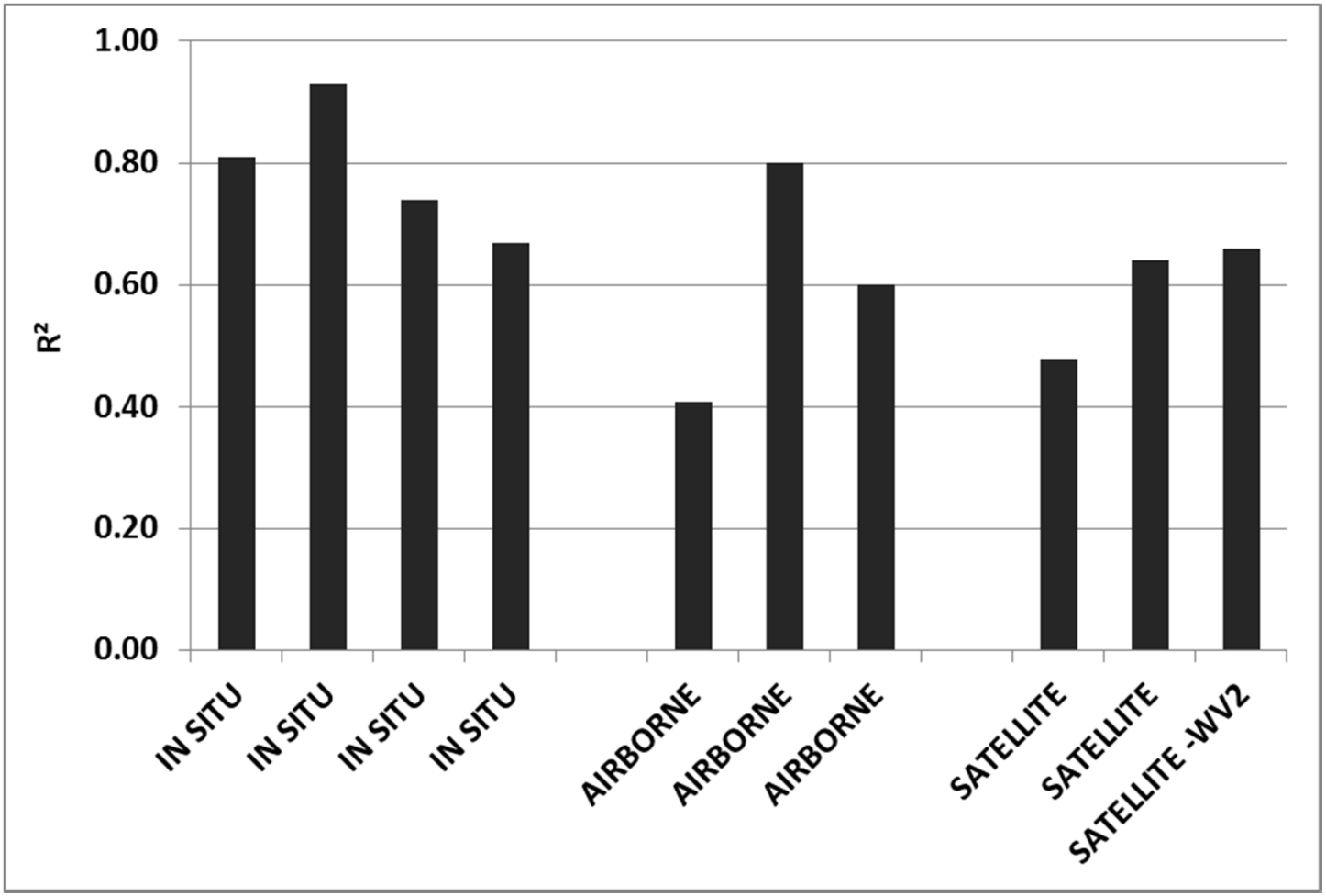


Prepared for 50th Annual Congress of the Grassland Society of Southern Africa, Royal Showground, Pietermartizburg, South Africa, 19 – 23 October 2015.

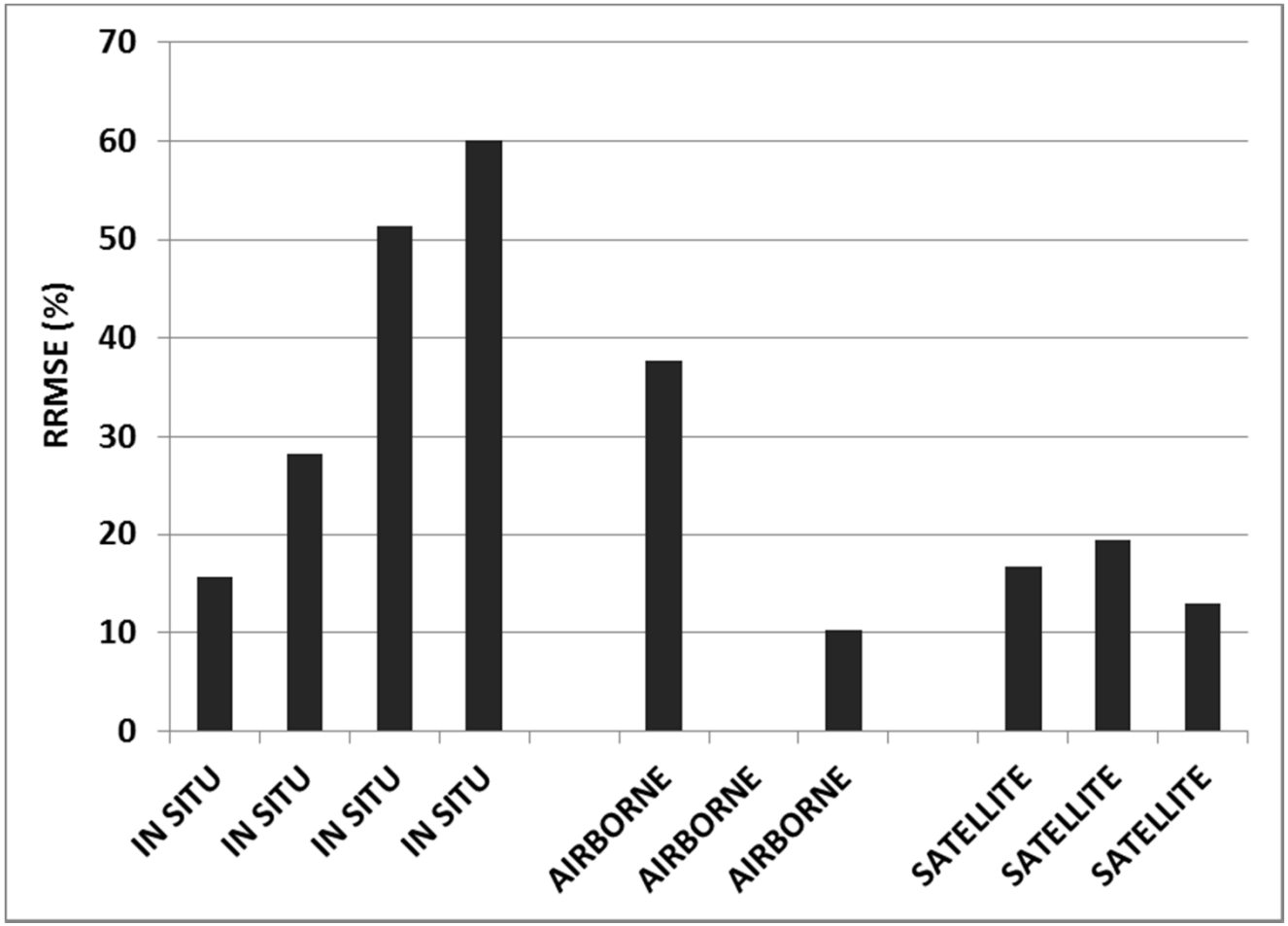
Progress on remote sensing based Leaf N(%) estimation



Progress on remote sensing based Leaf N(%) estimation

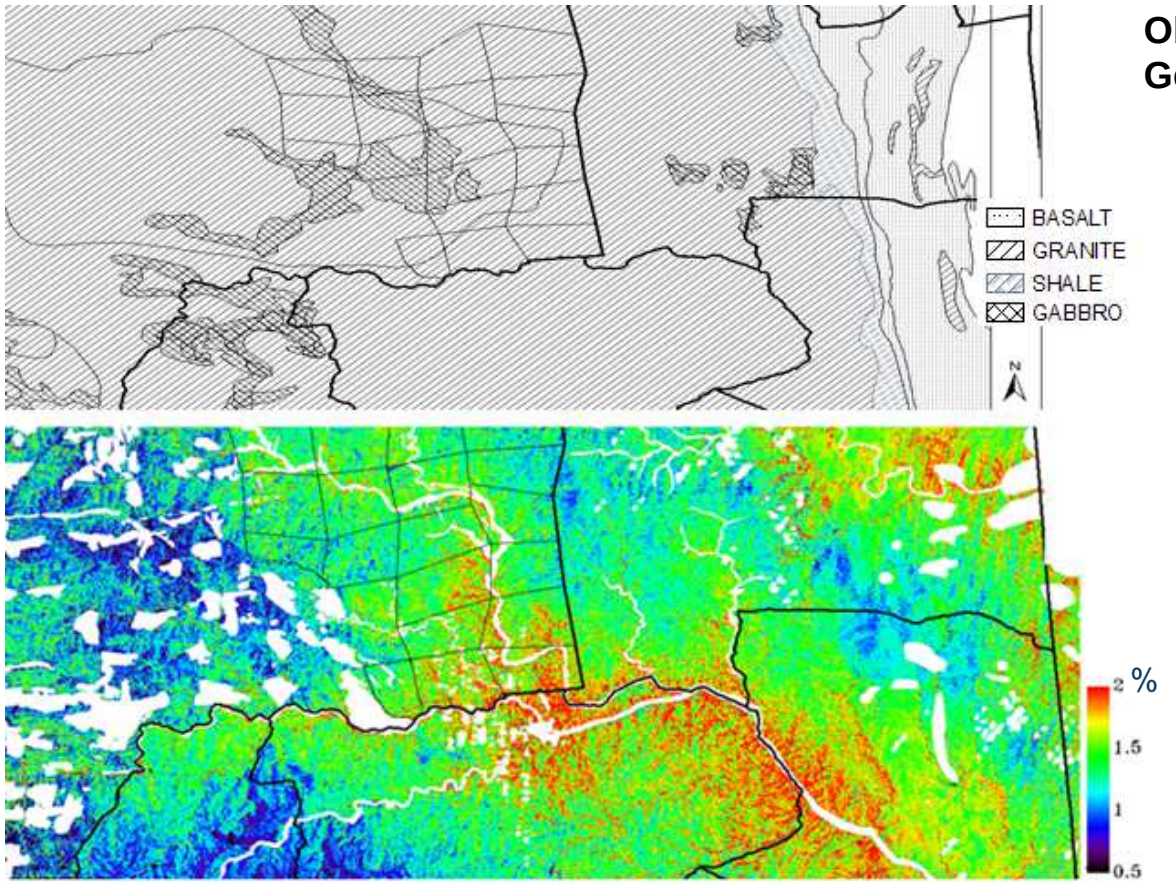


Progress on remote sensing based Leaf N(%) estimation

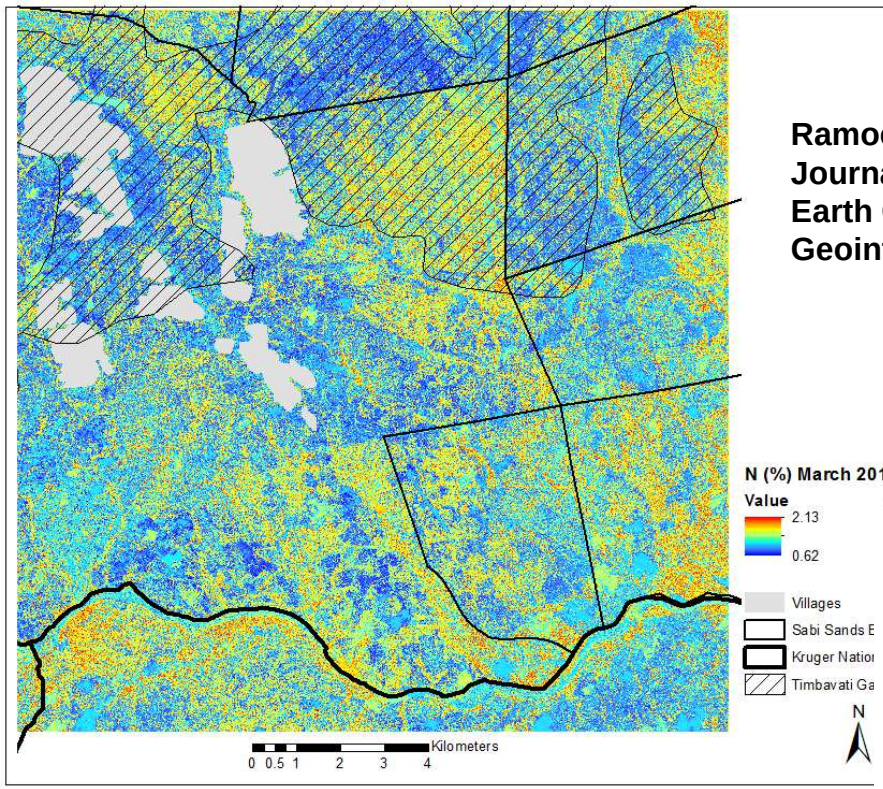


Examples of mapping leaf N (%) – based on RapidEye

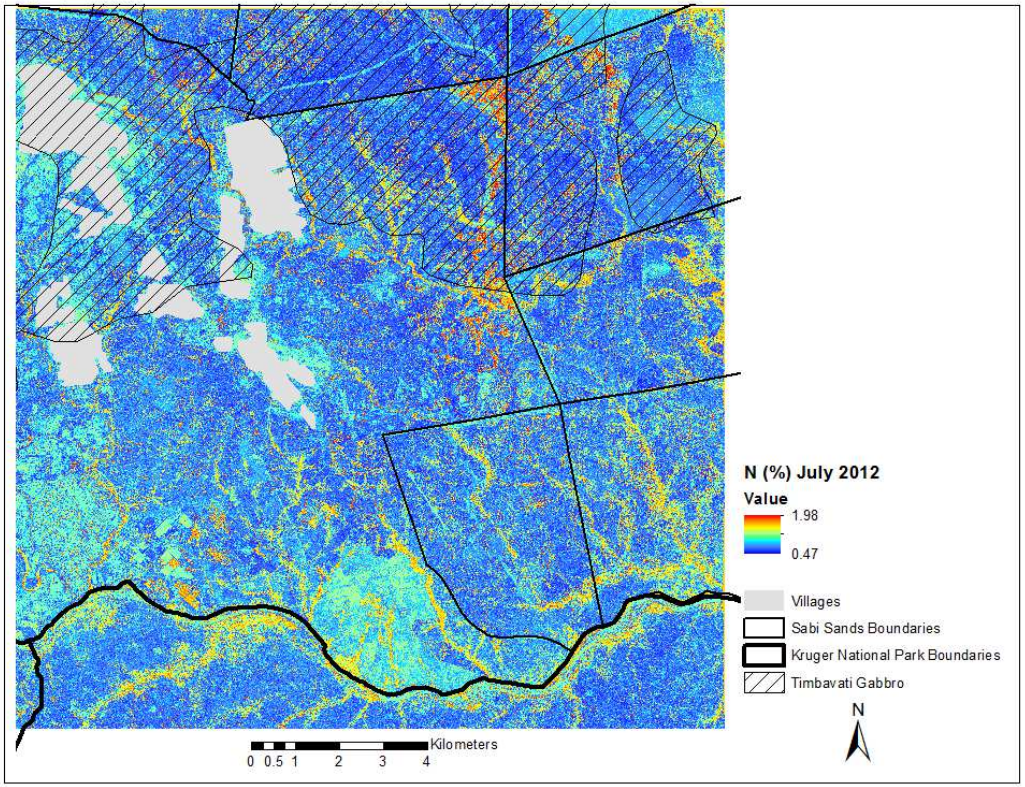
Ramoelo et al. 2012, Journal of Applied Earth Observation and Geoinformatics (JAG)



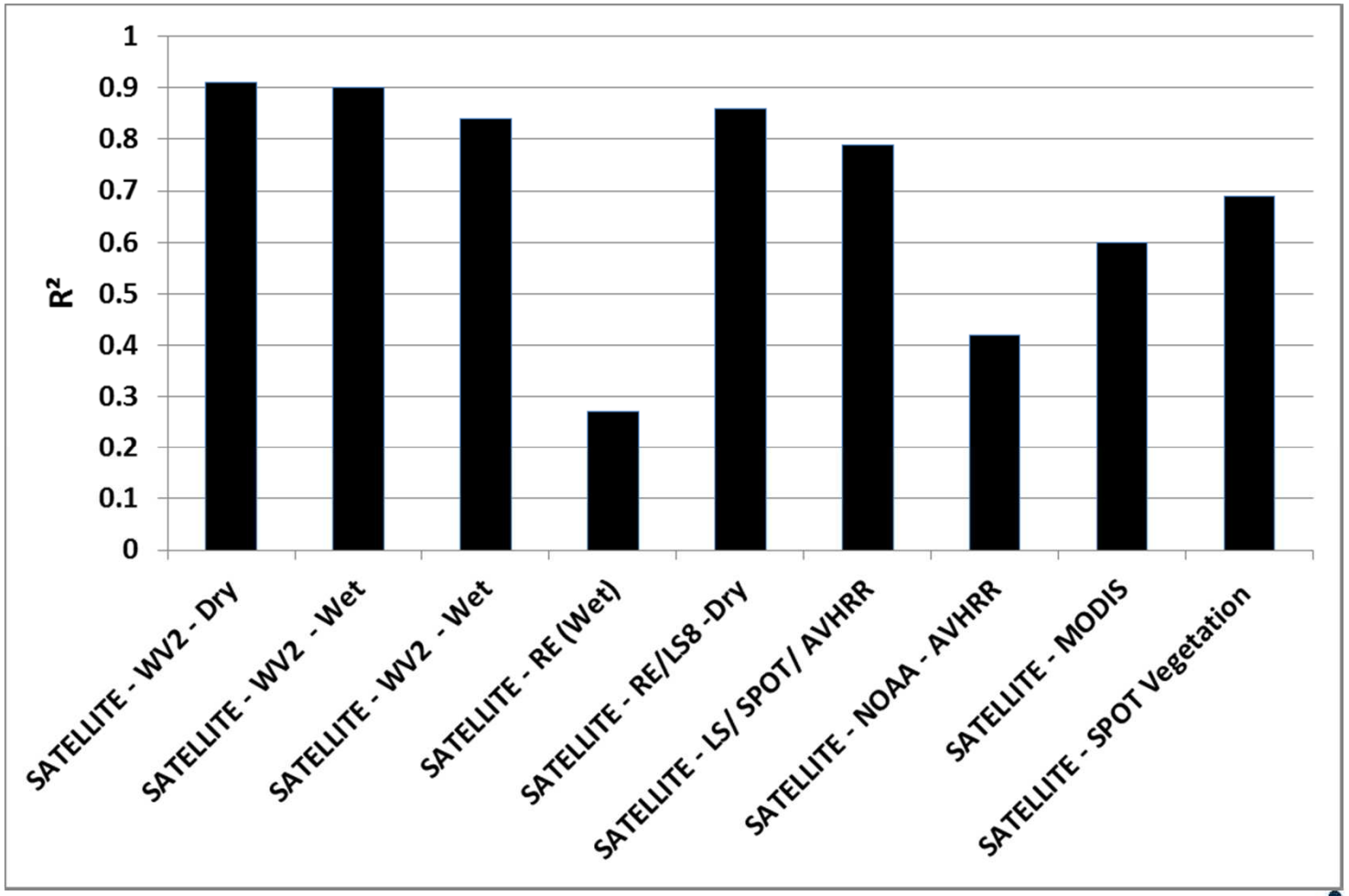
Examples of mapping leaf N (%) – WV-2



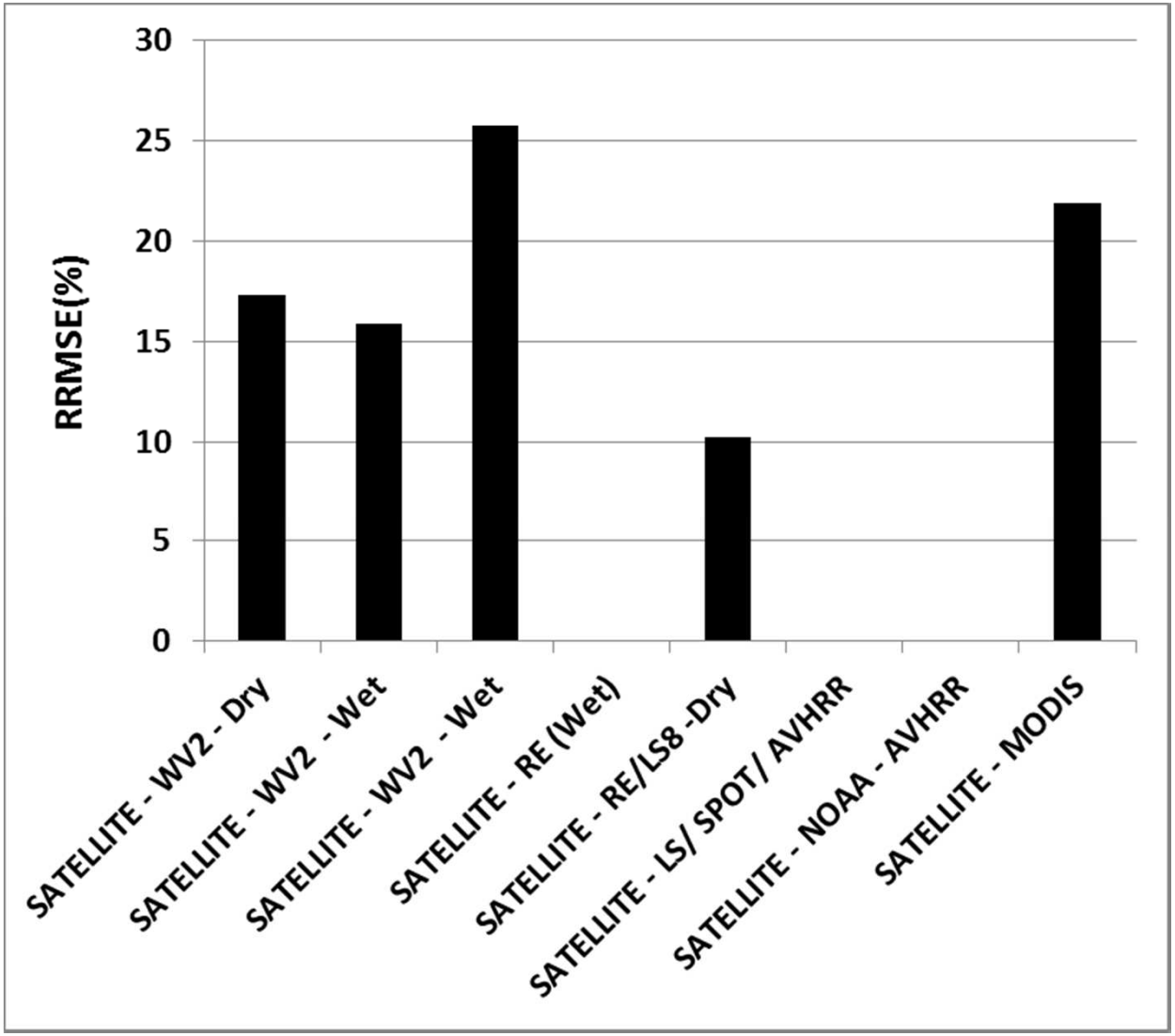
Ramoelo et al. 2015, Journal of Applied Earth Observation and Geoinformatics (JAG)



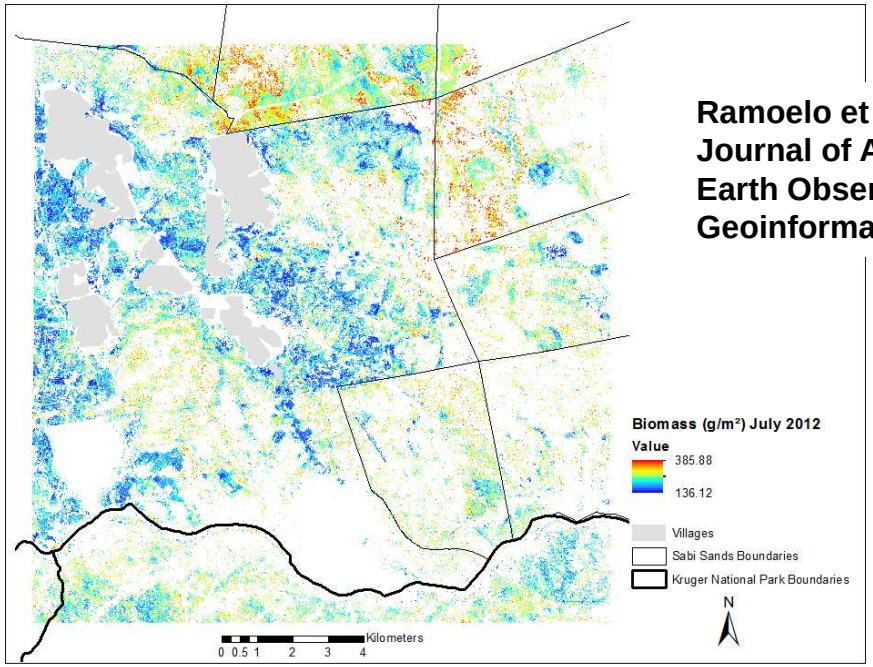
Progress on remote sensing based biomass estimation



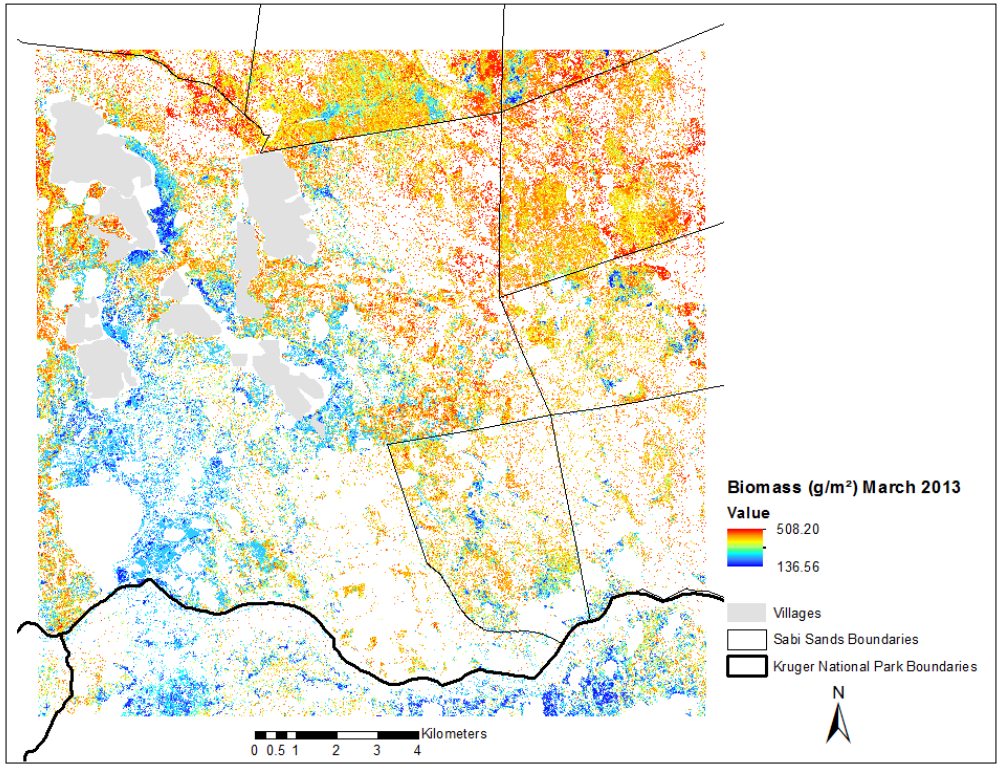
Progress on remote sensing based biomass estimation



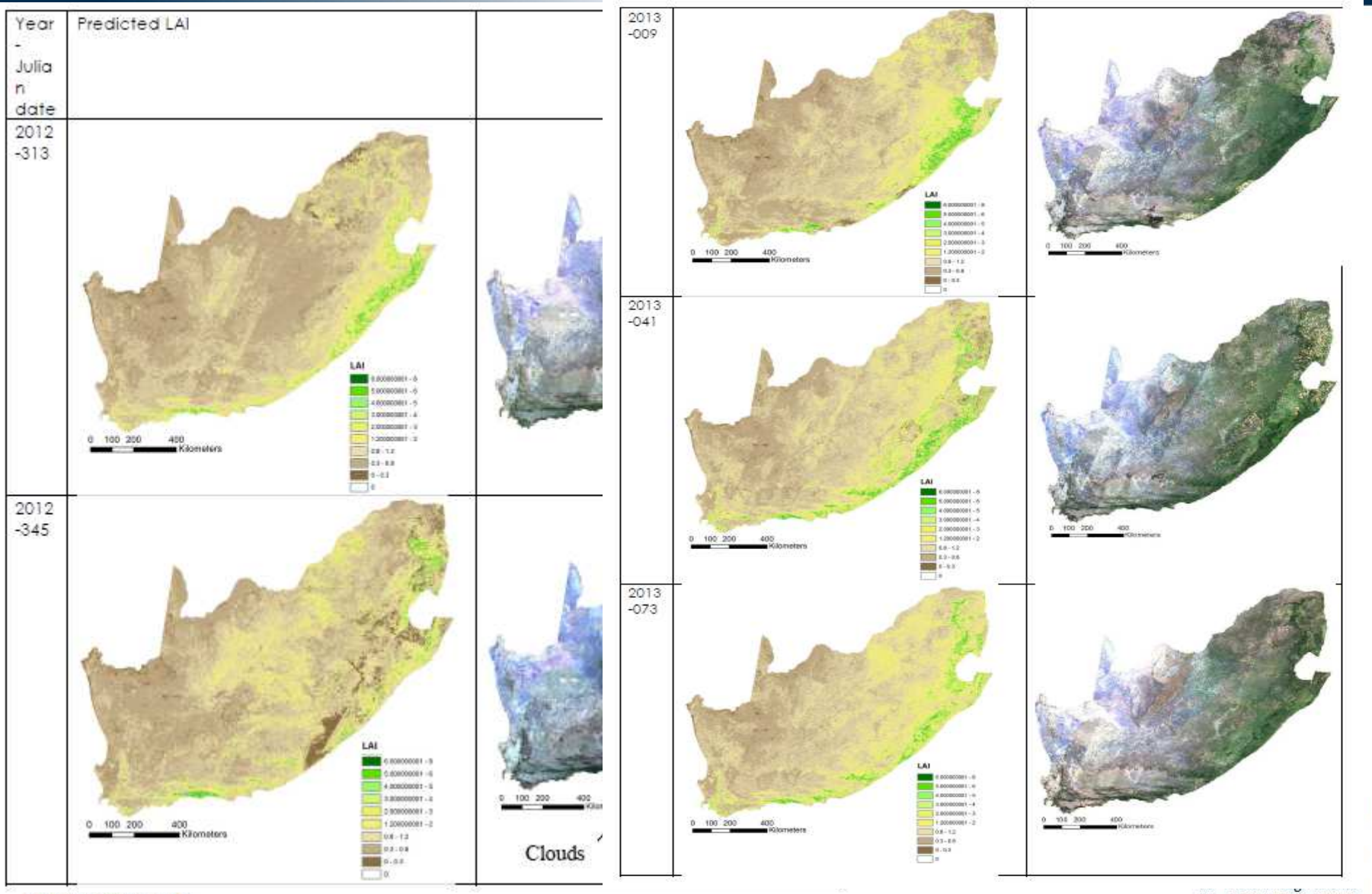
Examples of biomass maps – WorldView-2



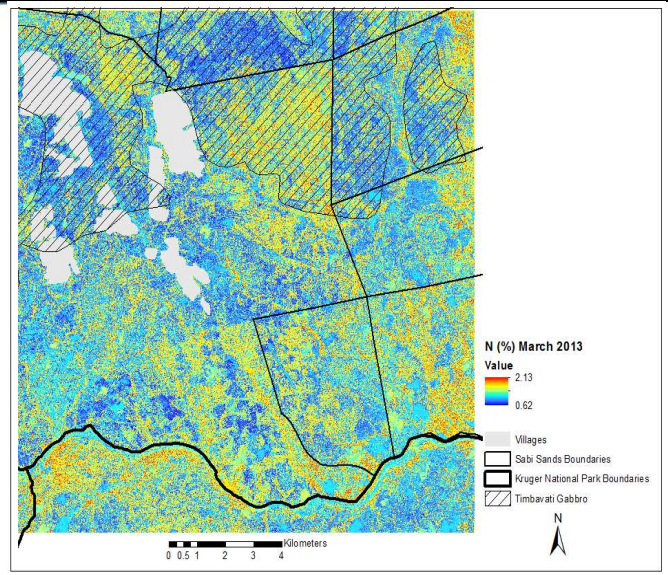
Ramoelo et al. 2015, Journal of Applied Earth Observation and Geoinformatics (JAG)



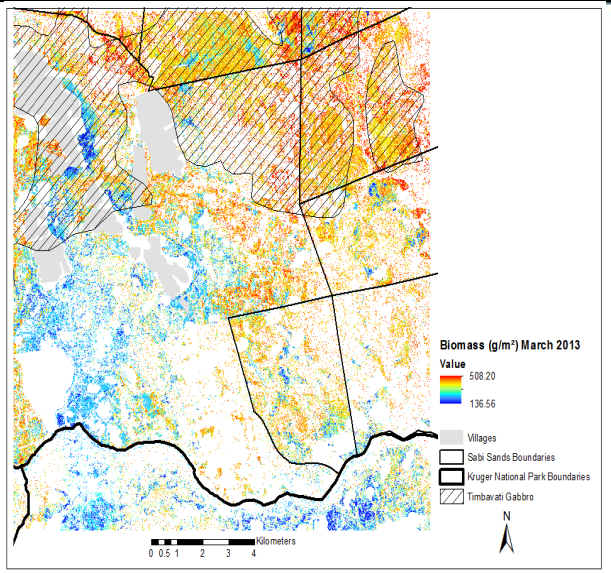
Towards near-real time estimation of herbaceous biomass



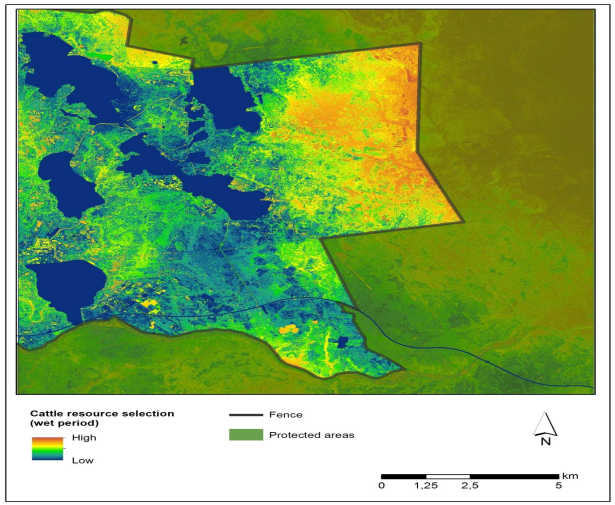
Contact Risk Modelling (Diseases: Buffalo and Cattle)



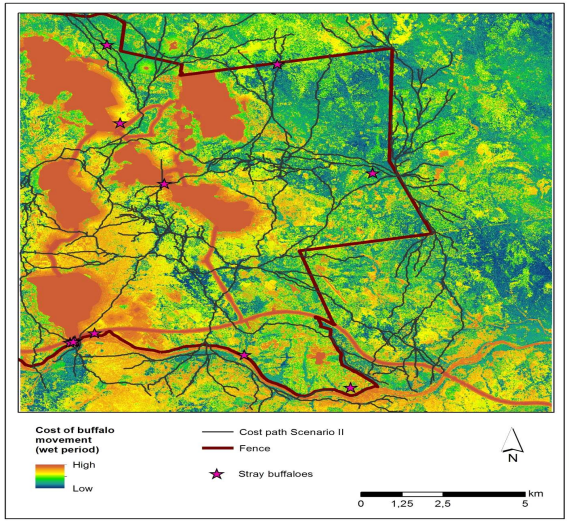
Leaf Nitrogen



Grass biomass



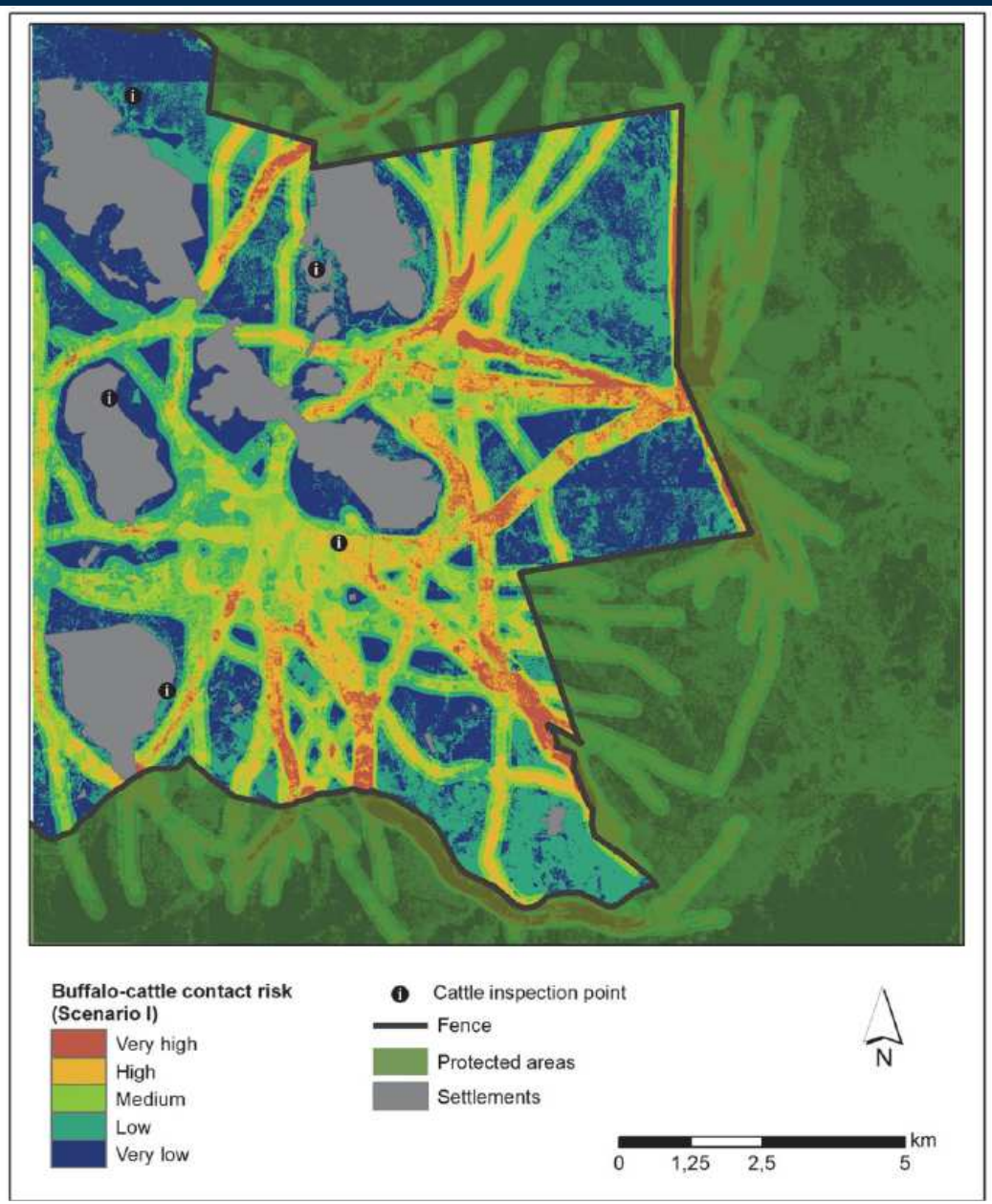
Cattle resource selection



Buffalo's least cost-paths

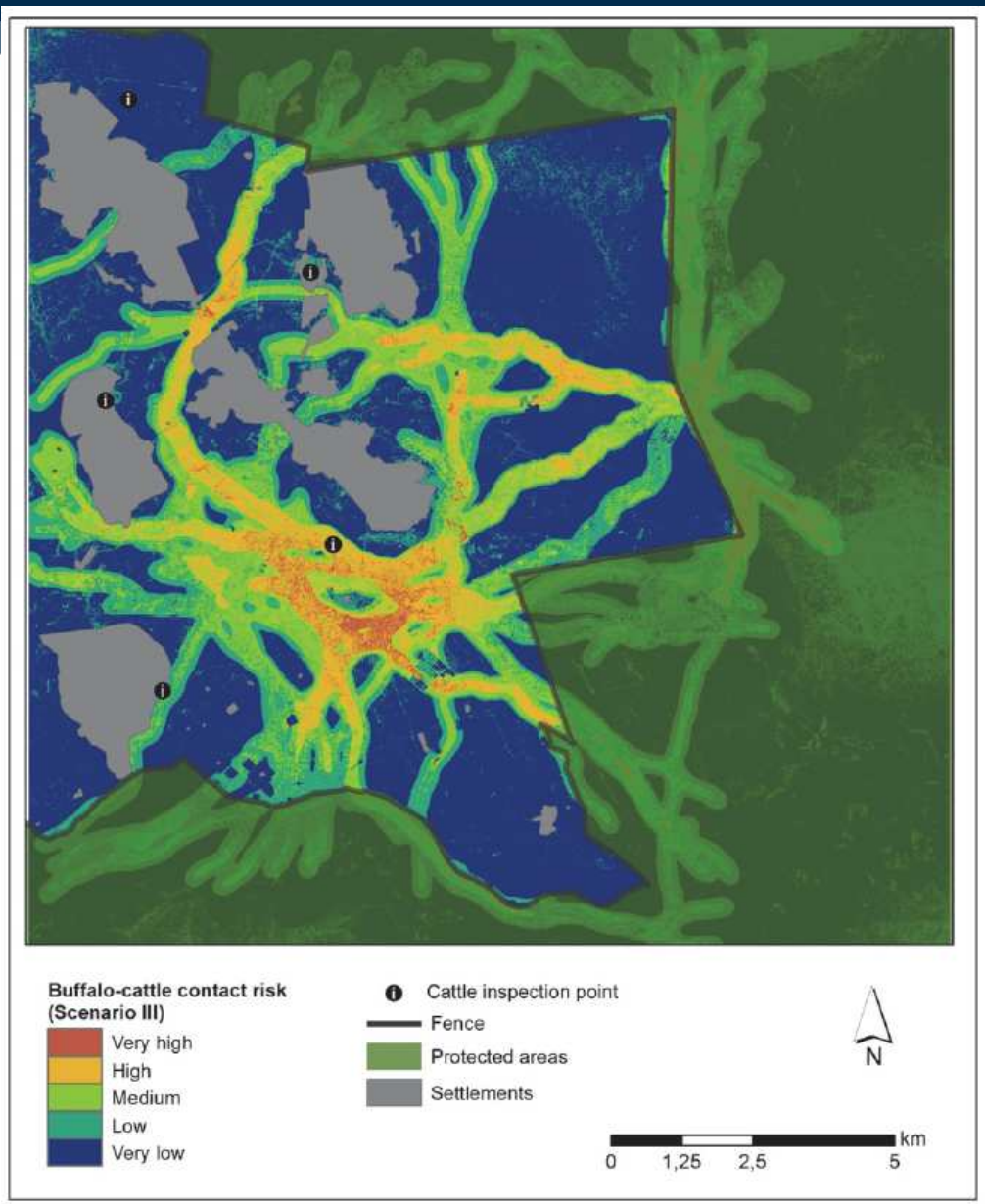
Kaszat et al. *in prep*

Buffalo – Cattle Contact Risk (Wet Season – leaf N and Biomass



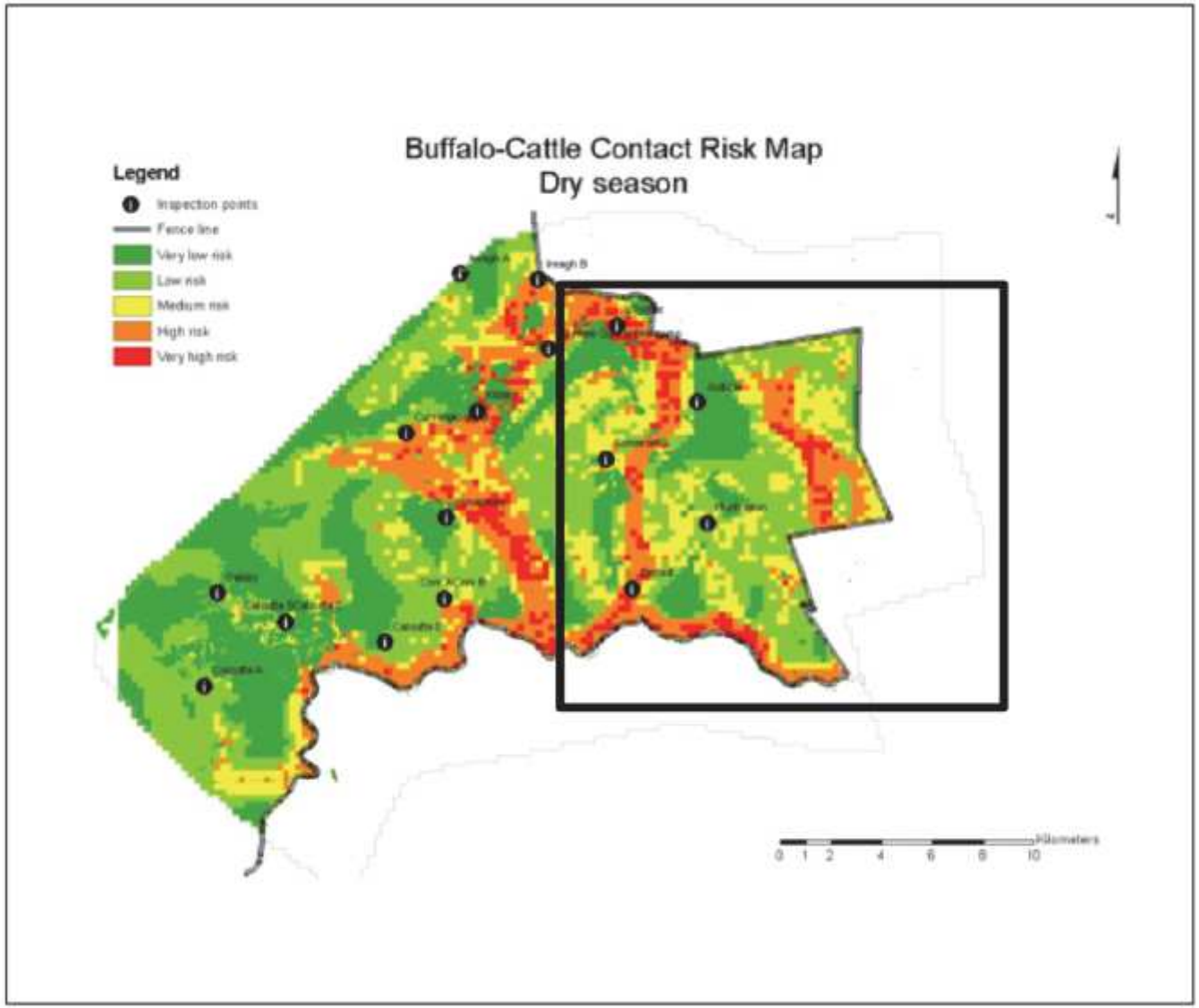
Kaszat et al. *in prep*

Buffalo – Cattle Contact Risk (Dry Season – leaf N and Biomass)



Kaszat et al. *in prep*

Buffalo – Cattle Contact Risk (Dry Season – leaf N and Biomass)



Kaszat et al. *in prep*

Summary and Conclusions

- Several opportunities
  - **RapidEye, WV-2 and Sentinel-2 data (Free for Africa)** provide an opportunity to assess grass quality and quantity for planning and management rangeland systems.
  - There is a potential to develop near-real time systems for assessing these indicators (especially biomass)
    - Integration of remote sensing and yield or production mechanistic models
    - Multi-scale or sensor approach (**Sentinel->Landsat 8 -> MODIS**)
  - Grass species mapping (classification and modelling)

- Leaf N and biomass can be used as model input to determine
  - **Carrying capacity** for browsers and grazers
  - **Spatial zoning** for grazing camps
  - **Contact risk models-** Livestock and Wildlife

- **GEOGLAM-RAPP – we are ready to contribute!**

Acknowledgement

- CSIR
- BELPSO
- NRF Thuthuka Post PhD Track
- NRF PDP
- University of Wageningen
- University of Twente
- **Co-investigators: Dr. Moses Cho, Dr. Renaud Mathieu et al.**