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Remote sensing and understanding environmental changes:
Linkages with One Health Initiative

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Presentation Outline

- Why monitor the environment?
- Drivers of biodiversity loss and climate change (reflection)
- How do we measure the environment?
- What is remote sensing?
- Advantages for using remote sensing
- Remote sensing/ Environment Change in a context of One Health Initiative
- Application Examples
  - Land use and land cover mapping and change detection
  - Long term vegetation changes using vegetation indices
  - Biochemical and biochemical vs animal contact risk analysis
- Summary

Why monitor the environment?

- What is changing in our environment?
- Identify areas of change, e.g. deforestation or reforestation

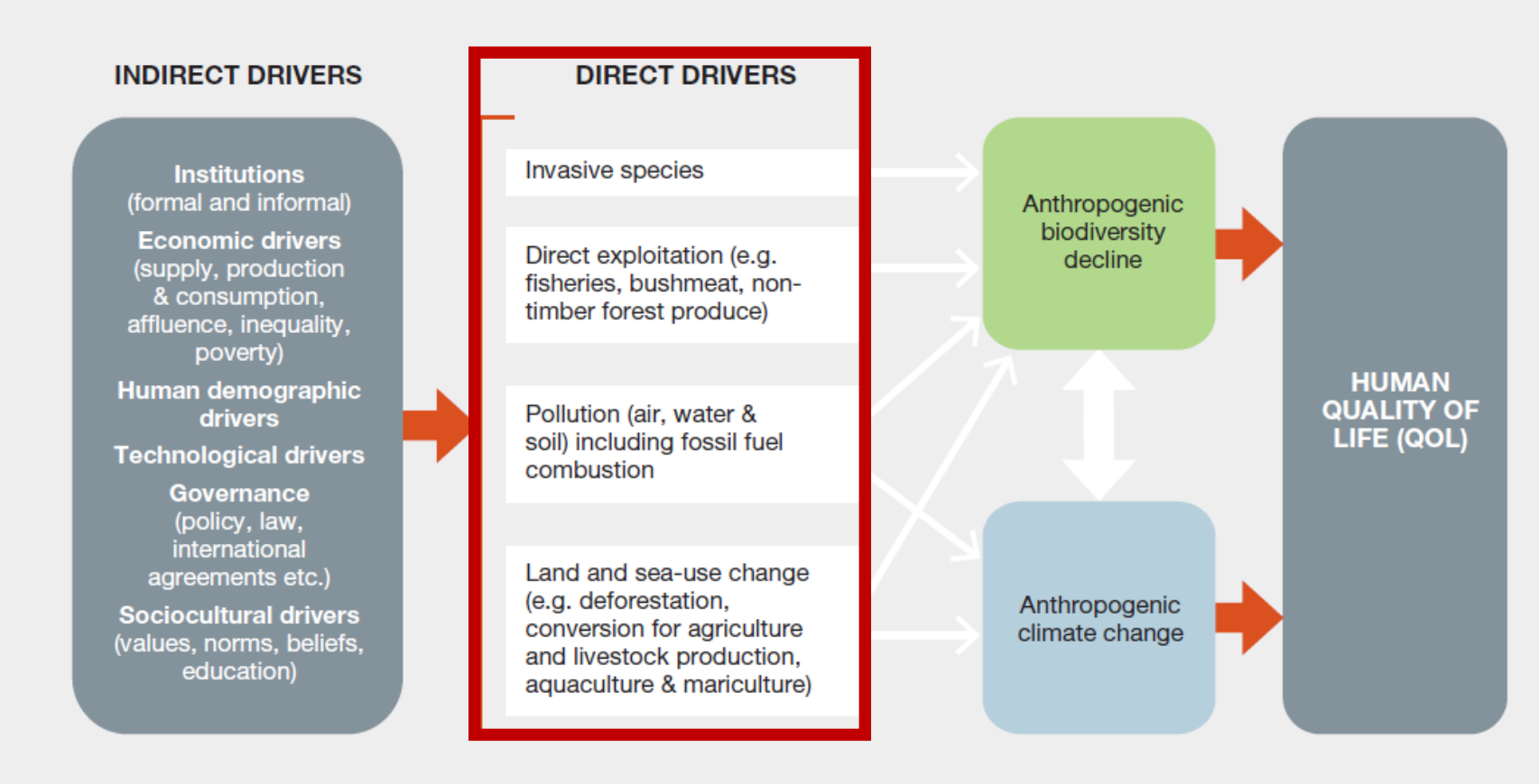
- Identify or quantify seasonal patterns of change
- Monitor growth of urban or villages or townships

- Predict future change based on the past change
- Understand climate change impact

- Monitor changes in species habitats or ecosystems
- Monitor changes in agricultural patterns
- Determine risk and vulnerability…

Horning et al. 2010

Drivers of biodiversity loss and climate change due to human activities



- **In addition to changes in climate, due to projected increase in human population, is land use change – which often lead to land degradation and biodiversity loss.**

IPBES-IPCC report 2021 Biodiversity and Climate Change

How do we monitor our environment?

Observation

Analysis and measurements

Monitoring over space and time

Decision support

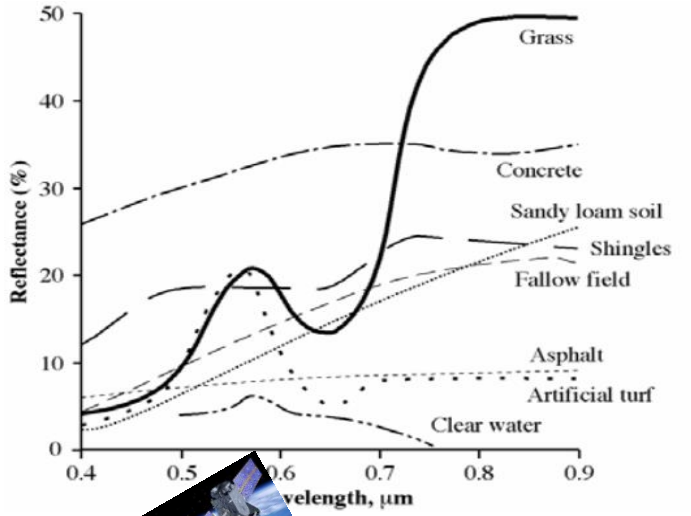
- Conventional techniques
  - Field data collection (forest variables, soil, climate, etc)
  - Limited in time & tedious, costly and laborious

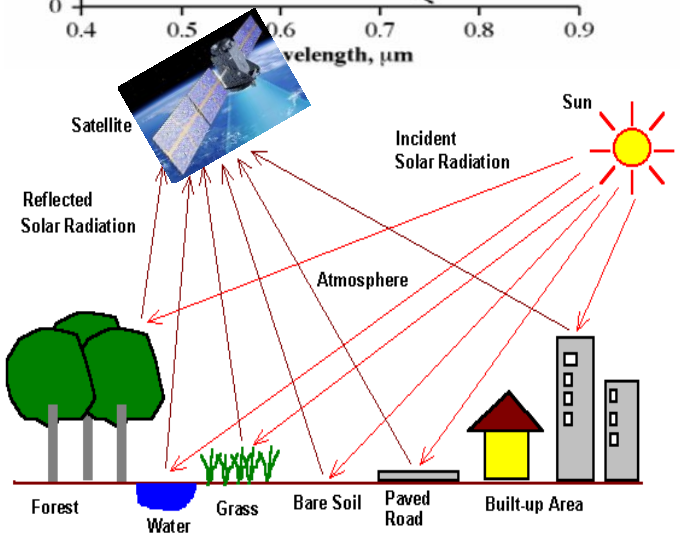
- Remote sensing techniques
  - Land surface characterization
  - Land use and land cover mapping change
  - Land use and land cover change detection mapping
  - Use of vegetation indices for long-term vegetation changes (trend analysis, image differencing)
    - Vegetation indices – measures vigor or greenness of vegetation
    - Commonly used one is the Normalized Difference Vegetation Index (NDVI)
  - Quantification of biochemical and biophysical variables

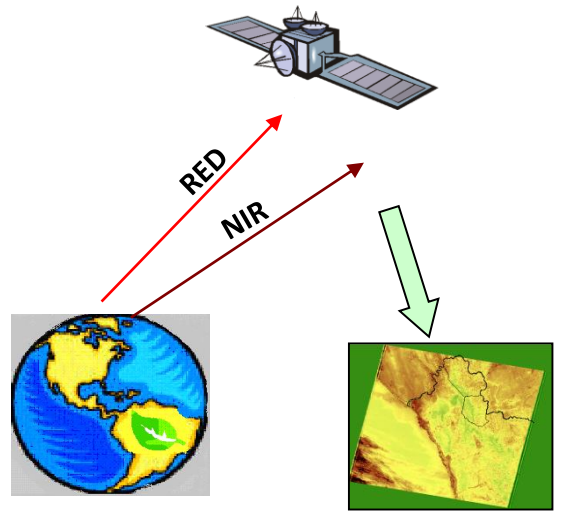
Jensen, 2000; 2004

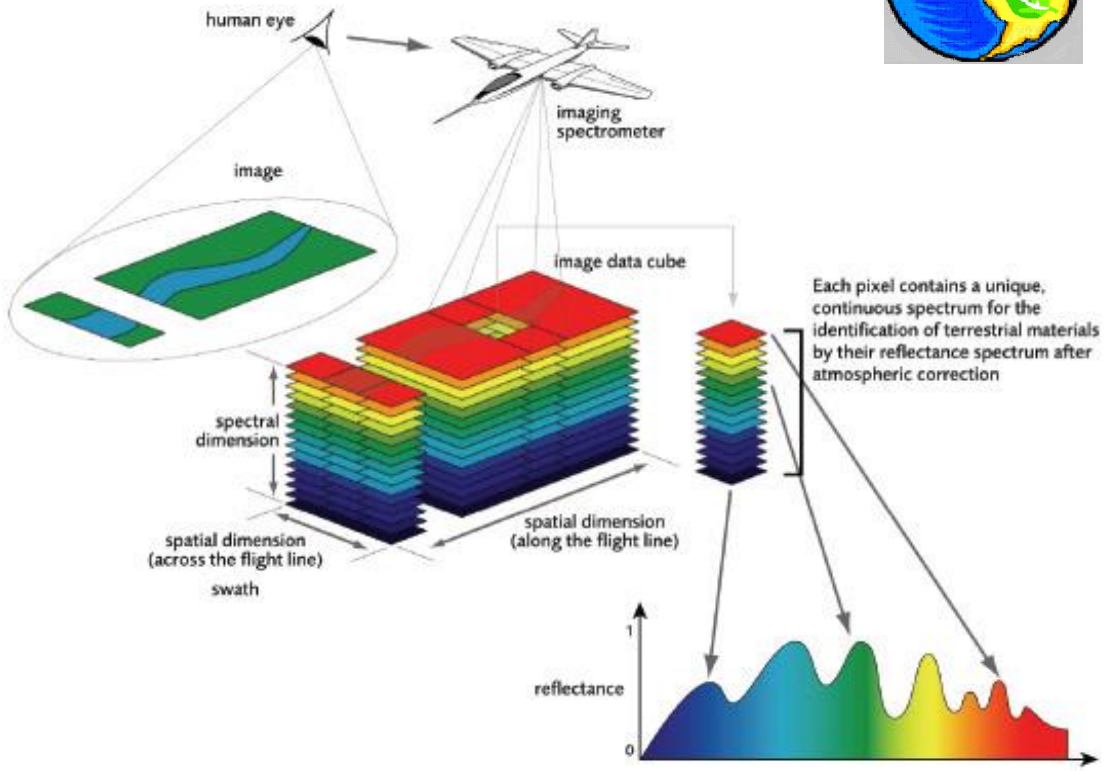
What is Remote sensing?

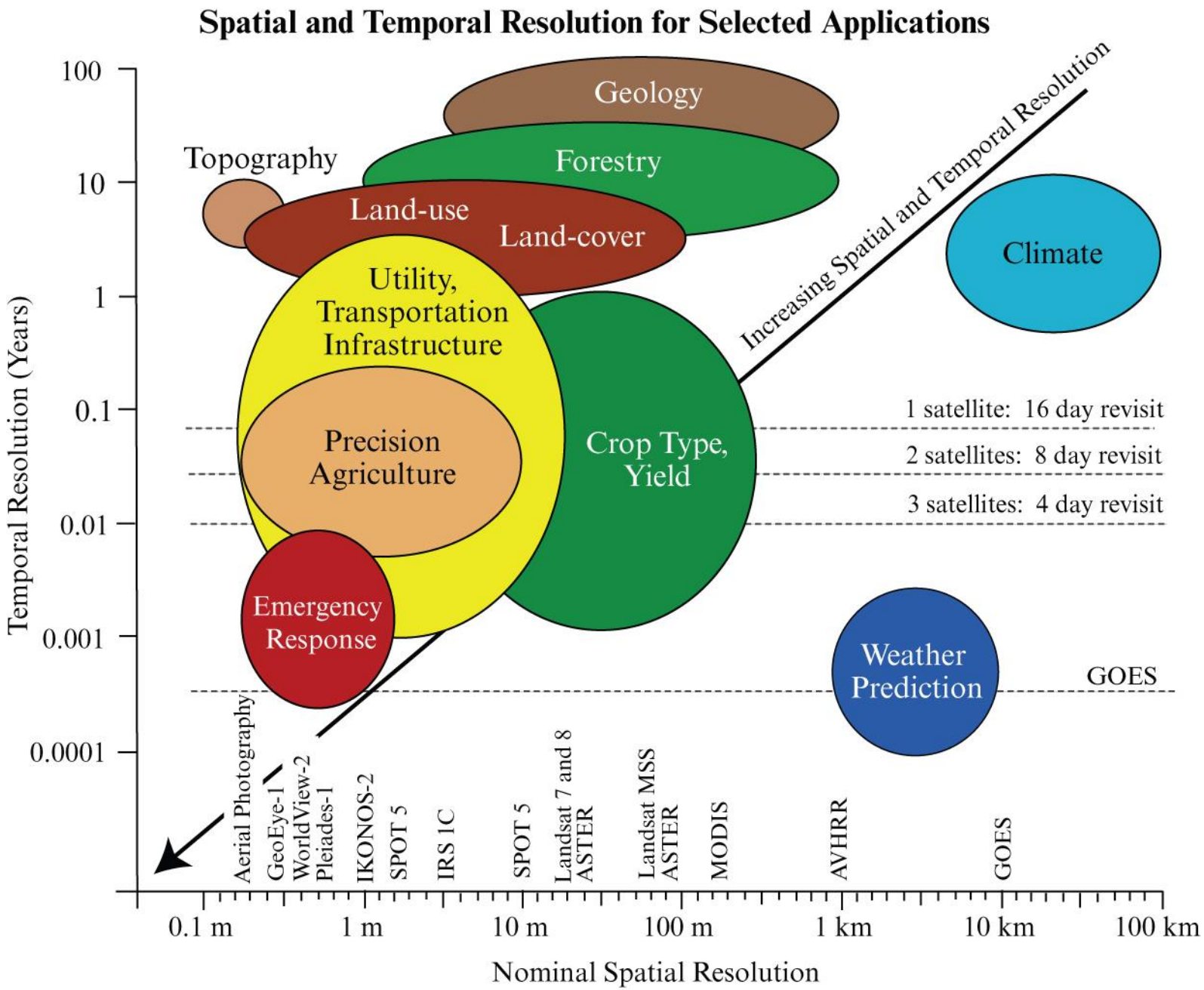
"the *art*, *science*, and *technology* of obtaining reliable information about physical objects and the environment, through the process of recording, measuring and interpreting imagery and digital representations of energy patterns derived from noncontact sensor systems" (Colwell 1997; Jensen 2000)





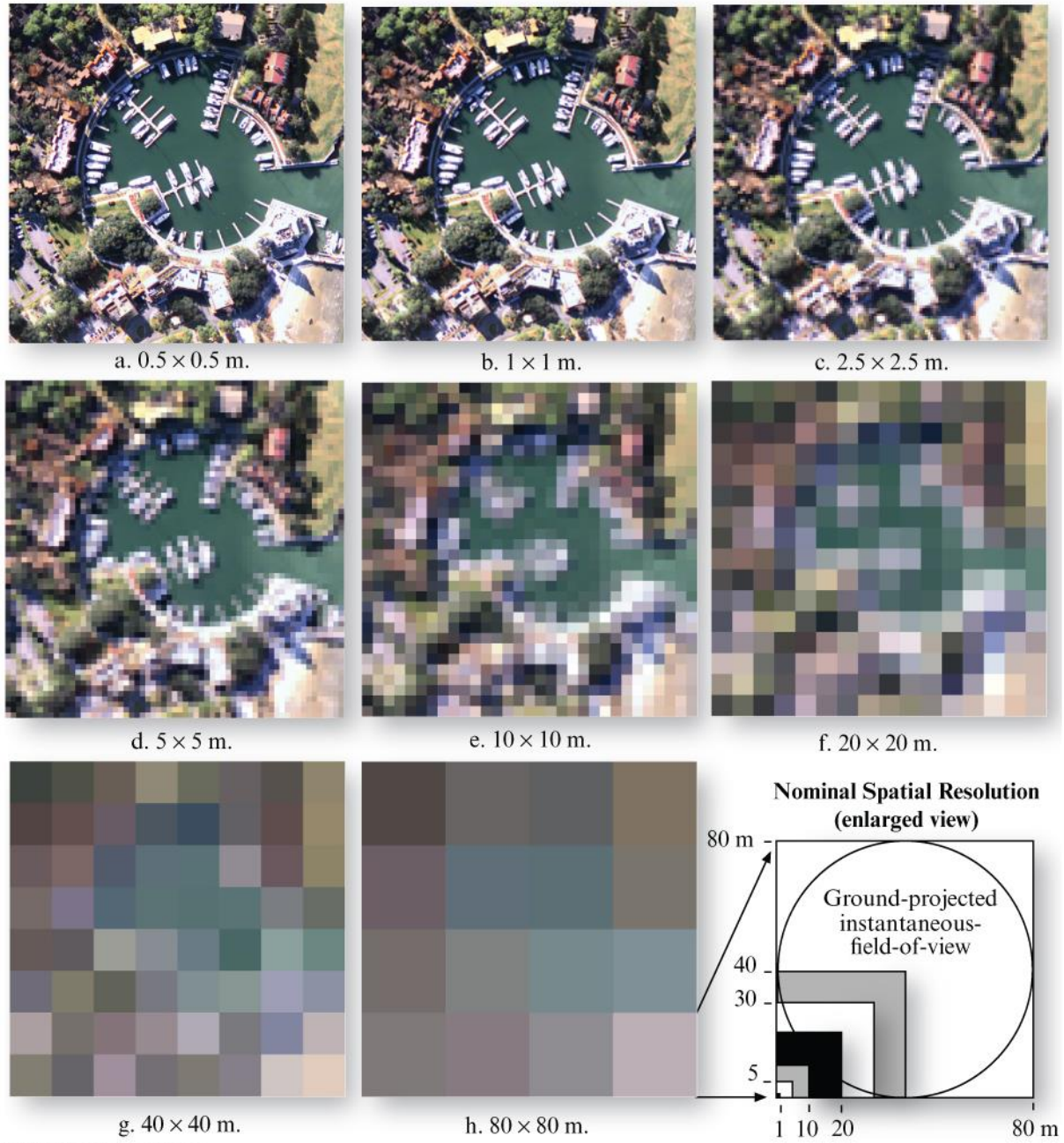






Jensen, 2000; 2004

Imagery of Harbor Town in Hilton Head, SC, at Various Spatial Resolutions

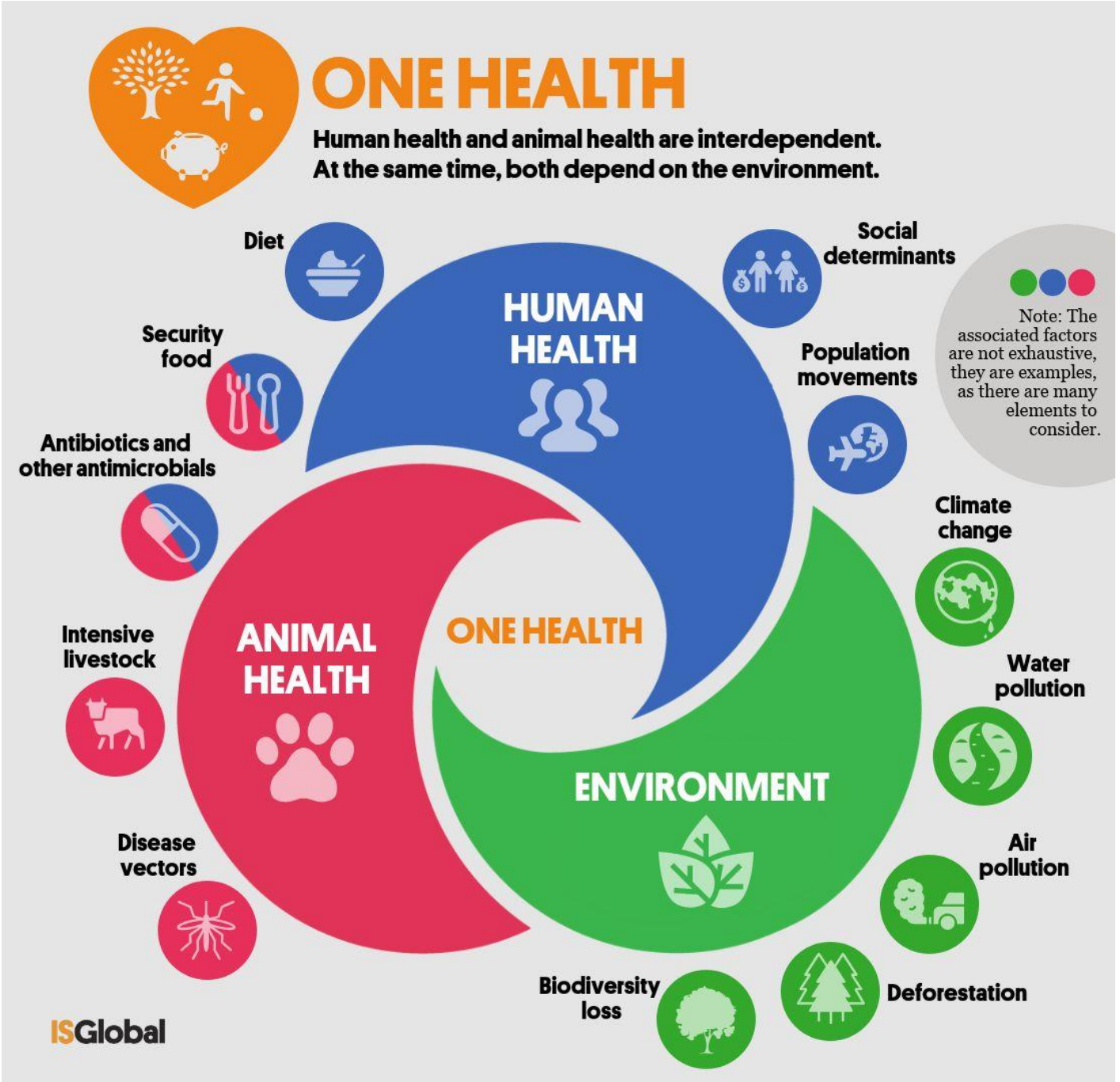


Jensen, 2000; 2004

Advantages for using remote sensing

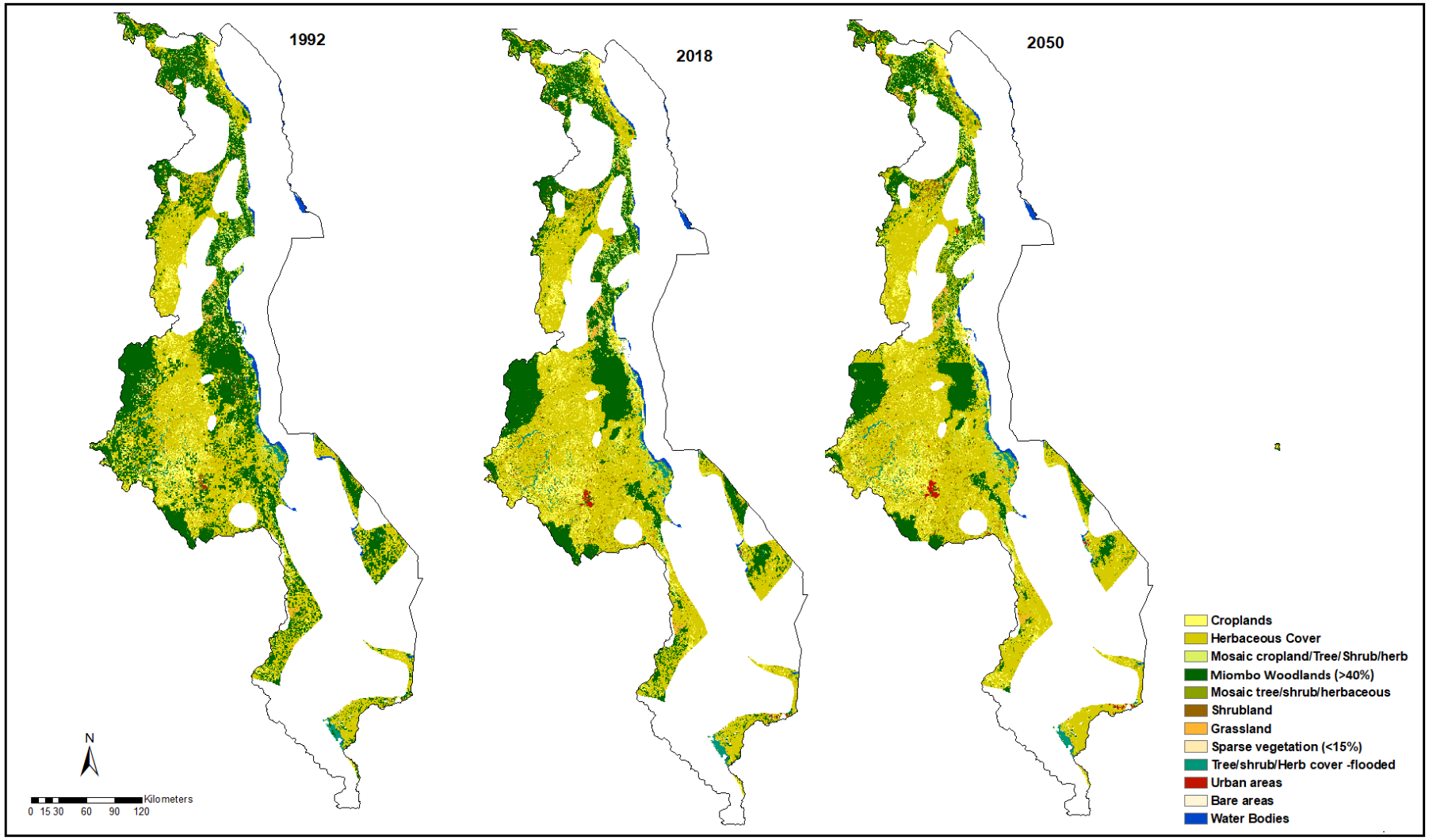
- Greater spatial representation
- Greater frequency .. acquired data
- Covers larger or wider areas
- Non-intrusive and systematic manner

- Acquire in inaccessible areas
- Reduced costs for monitoring
- Greater speed for ….
- ..information to decision makers



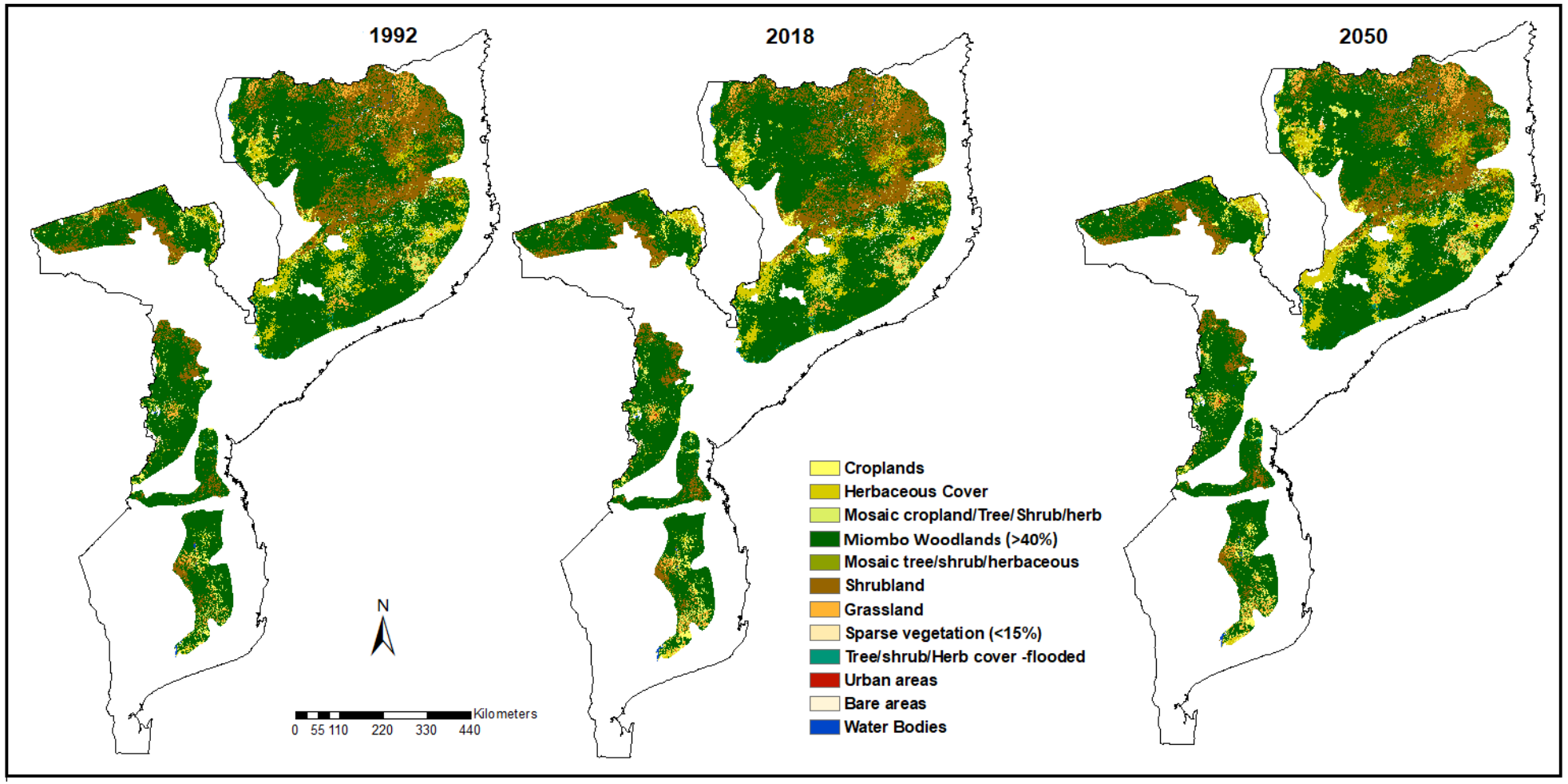
- …..One Health
- We should understand the interdependence of human and animal health – Collaborative…
- We should also understand the influence of the environment on these interdependences (e.g. spread and transmission of diseases…)
- The list of associated factors is not exhaustive….
- Spatially explicit and temporal environmental data are critical…

(1) Land use and land cover mapping (Malawi)



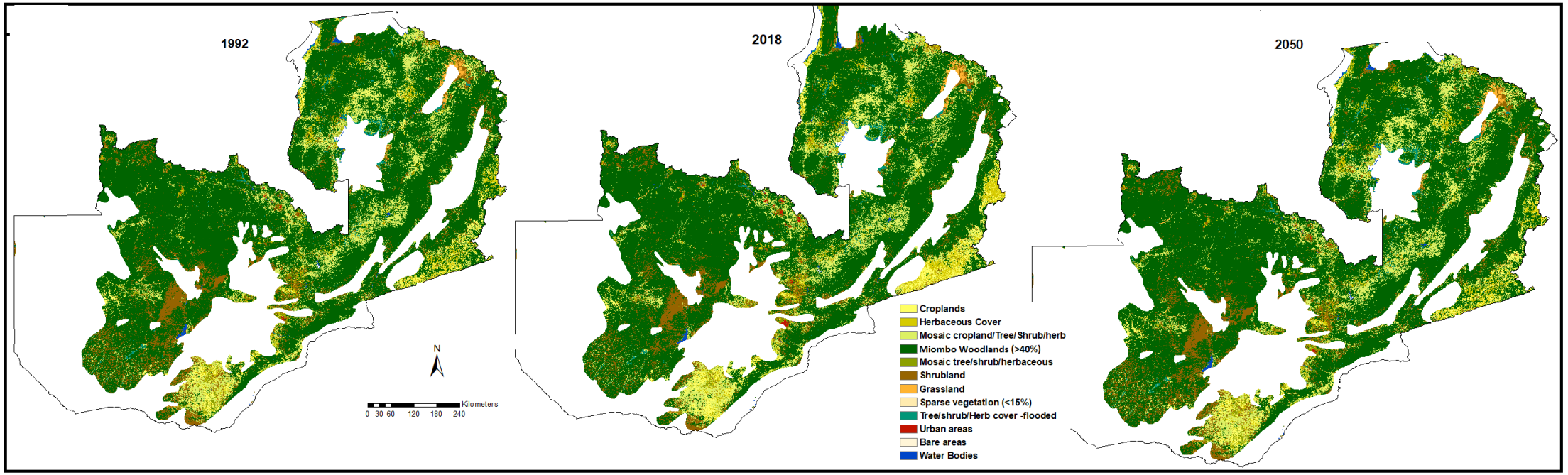
Dziba, Ramoelo *et al*. 2021

(2) Land use and land cover mapping (Moz)



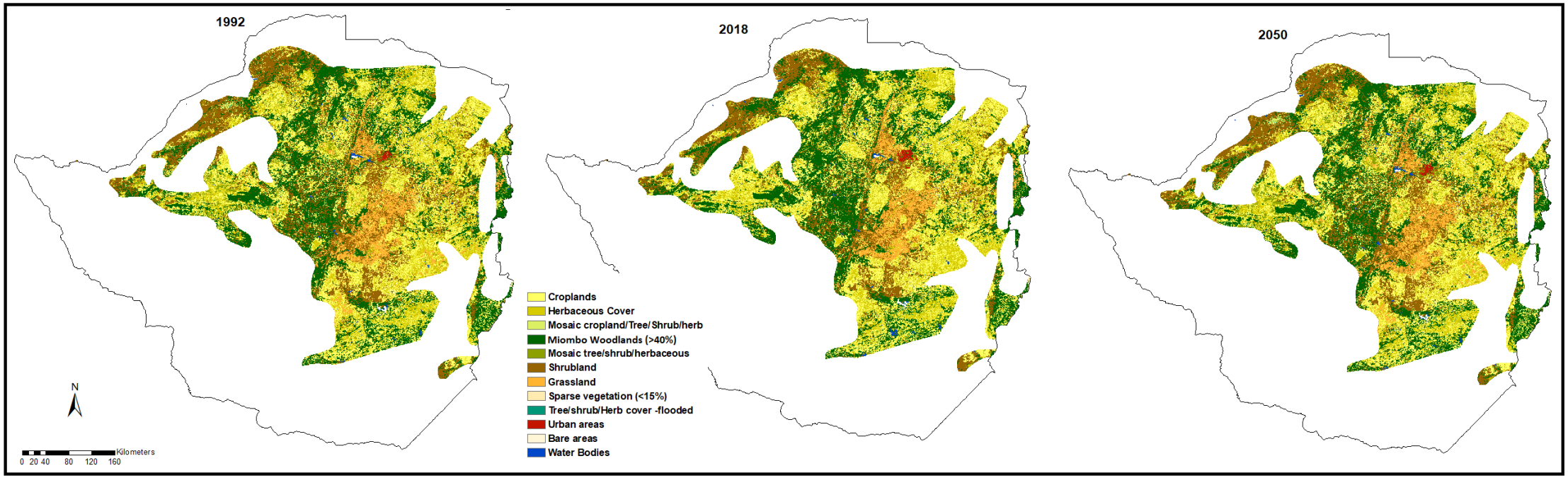
Dziba, Ramoelo *et al.* 2021

(3) Land use and land cover mapping (Zambia)



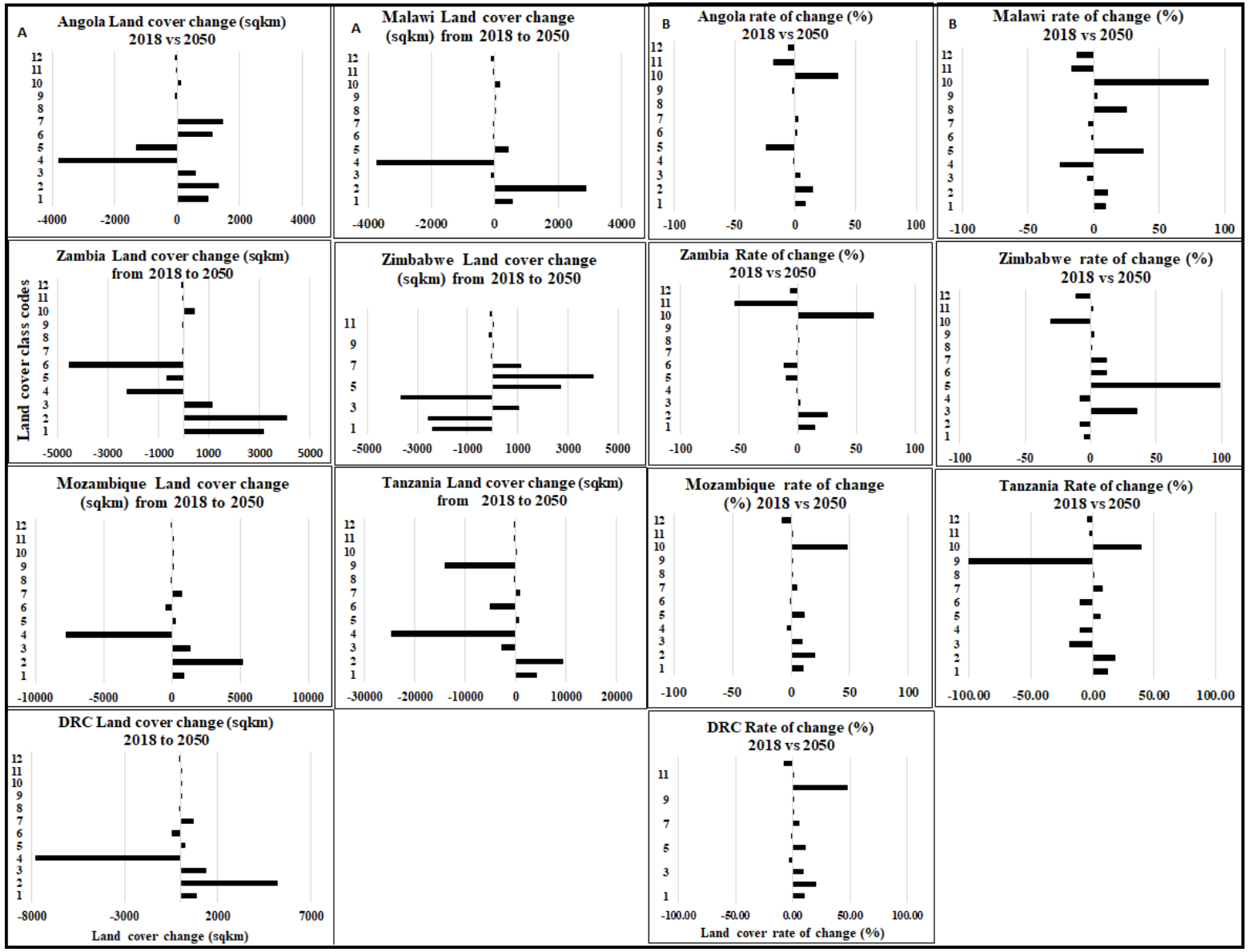
Dziba, Ramoelo *et al.* 2021

(4) Land use and land cover mapping (Zimbabwe)



Dziba, Ramoelo *et al.* 2021

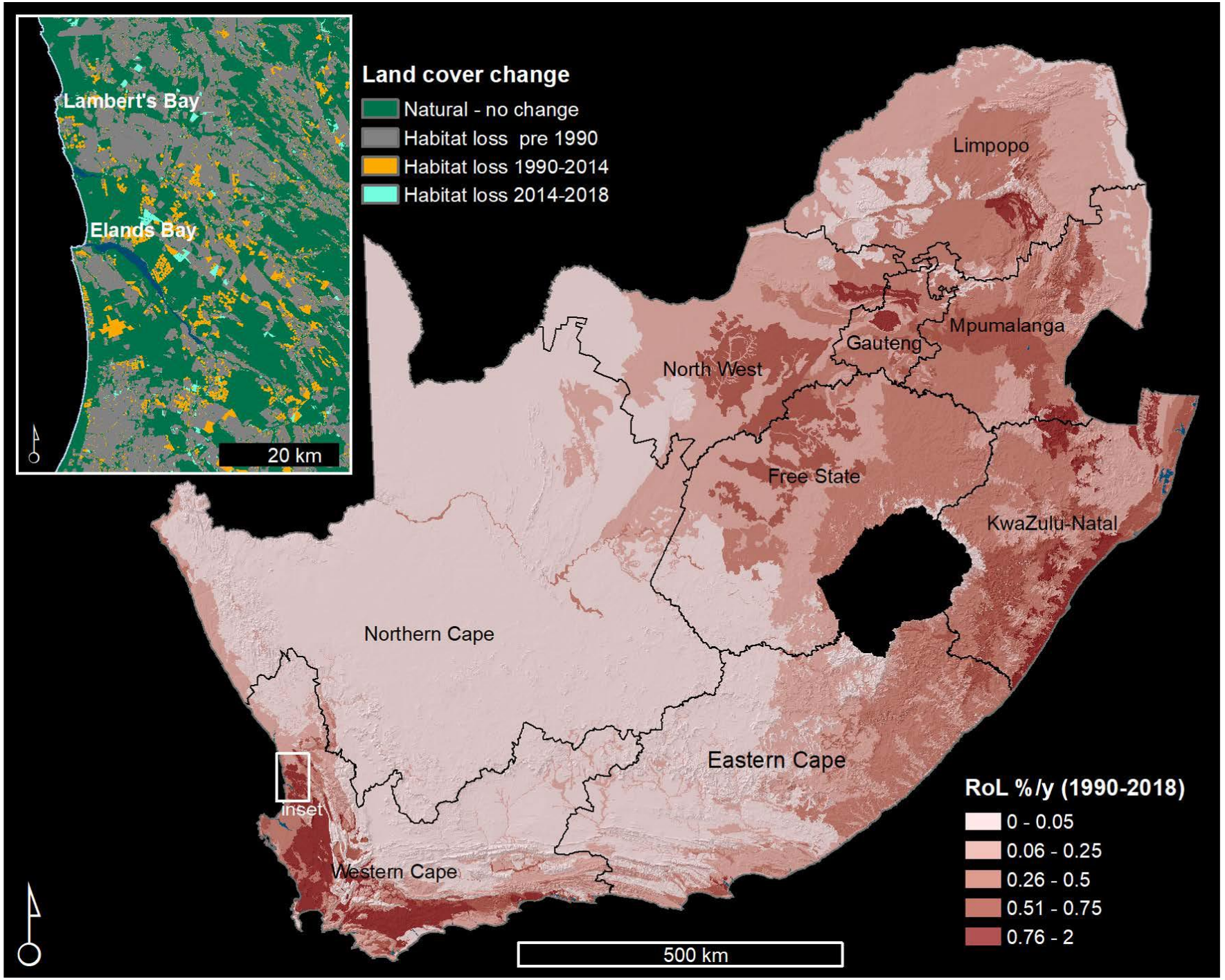
Land use and cover change detection



New code	CCI classes	Land cover class description
1	10, 20	Croplands
2	11	Herbaceous Cover
3	30, 40	Mosaic Crop, Tree, Shrublands, Herbaceous cover
4	50, 60, 61, 62	Miombo Woodlands (>40%)
5	100, 110	Mosaic Tree, Shrublands, Herbaceous cover
6	120, 122	Shrublands
7	130	Grasslands
8	150	Sparse vegetation (<15%)
9	170, 180	Tree, Shrublands, Herbaceous cover—flooded
10	190	Urban areas
11	200, 201	Bare areas
12	210	Water bodies

Dziba, Ramoelo *et al.* 2021

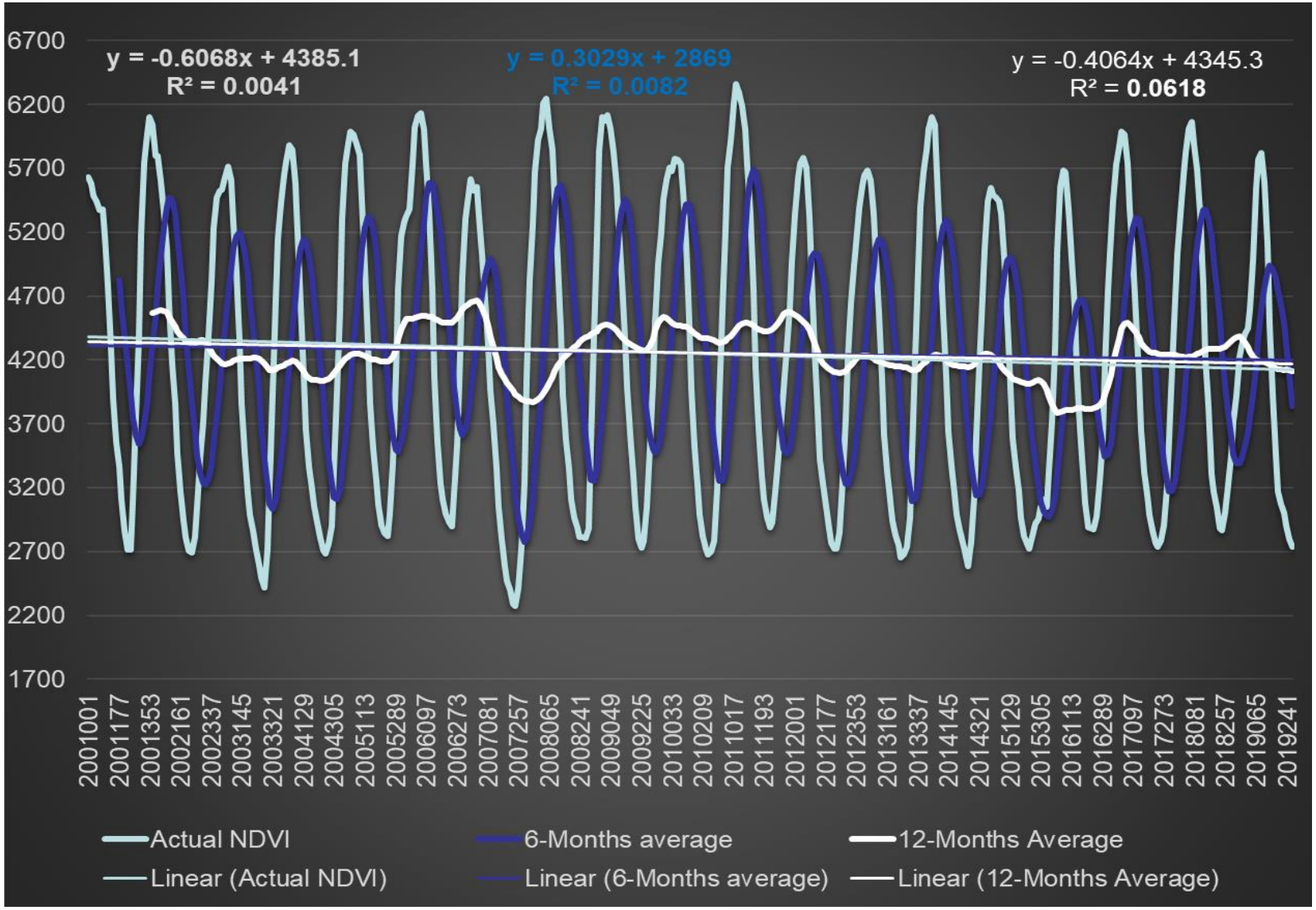
Biodiversity loss in RSA



- RSA lost 0.12% of natural vegetation per year (1990-2018)
- Rate of loss was more between 2014-2018 (~0.24%)

Skowno et al. 2021

Long-term vegetation changes at Golden Gate HNP



Ramoelo 2021 in prep

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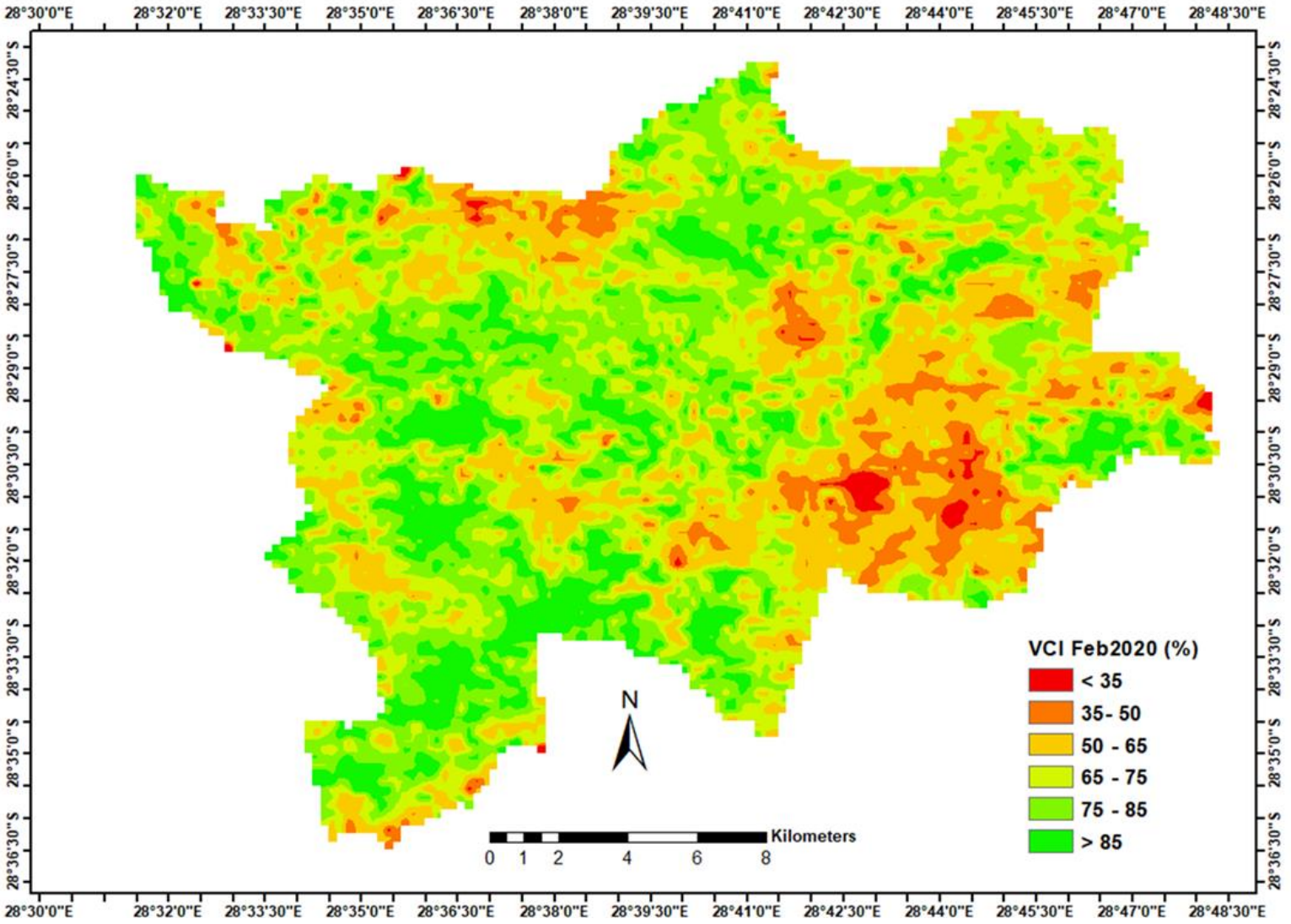
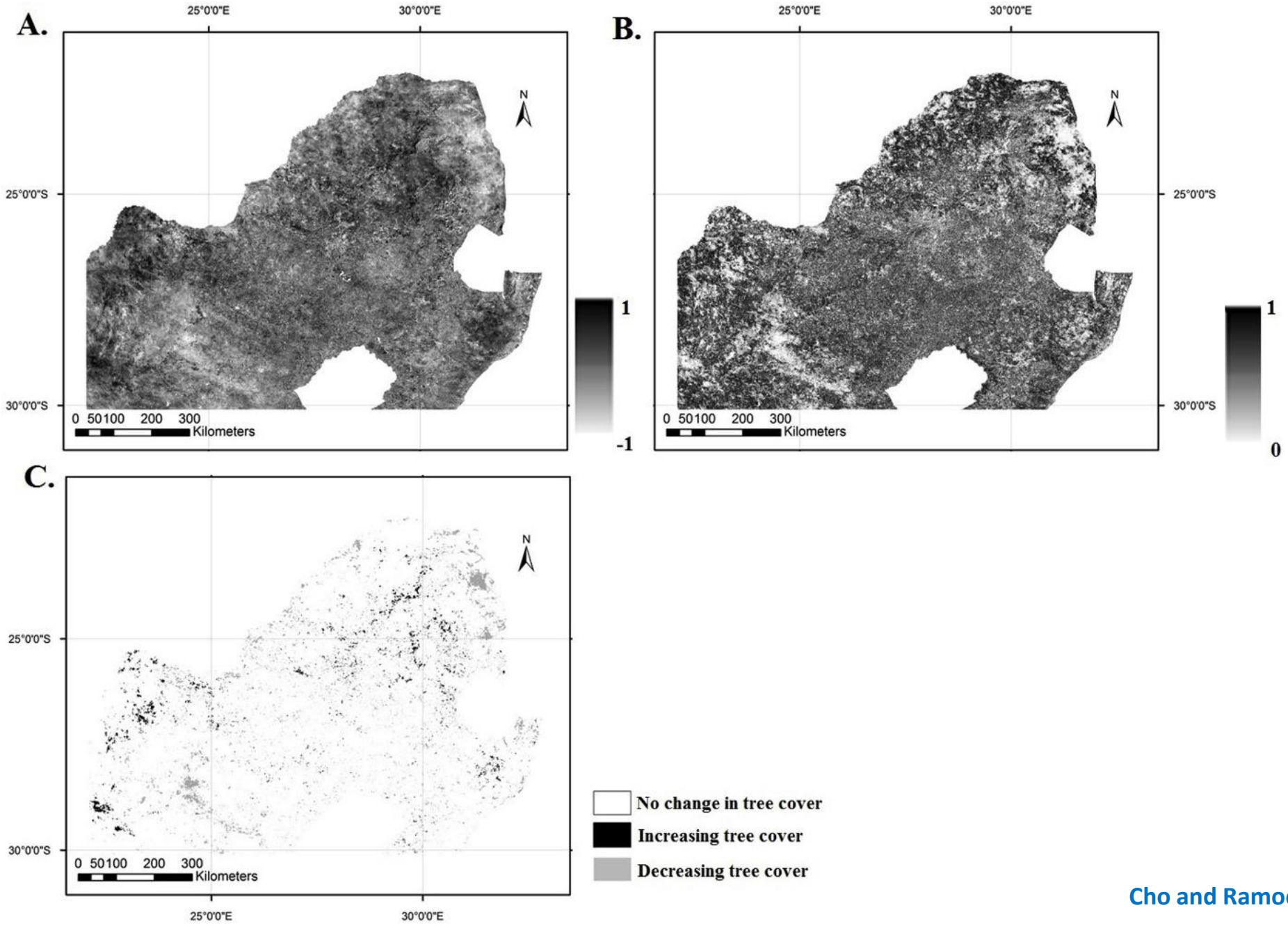


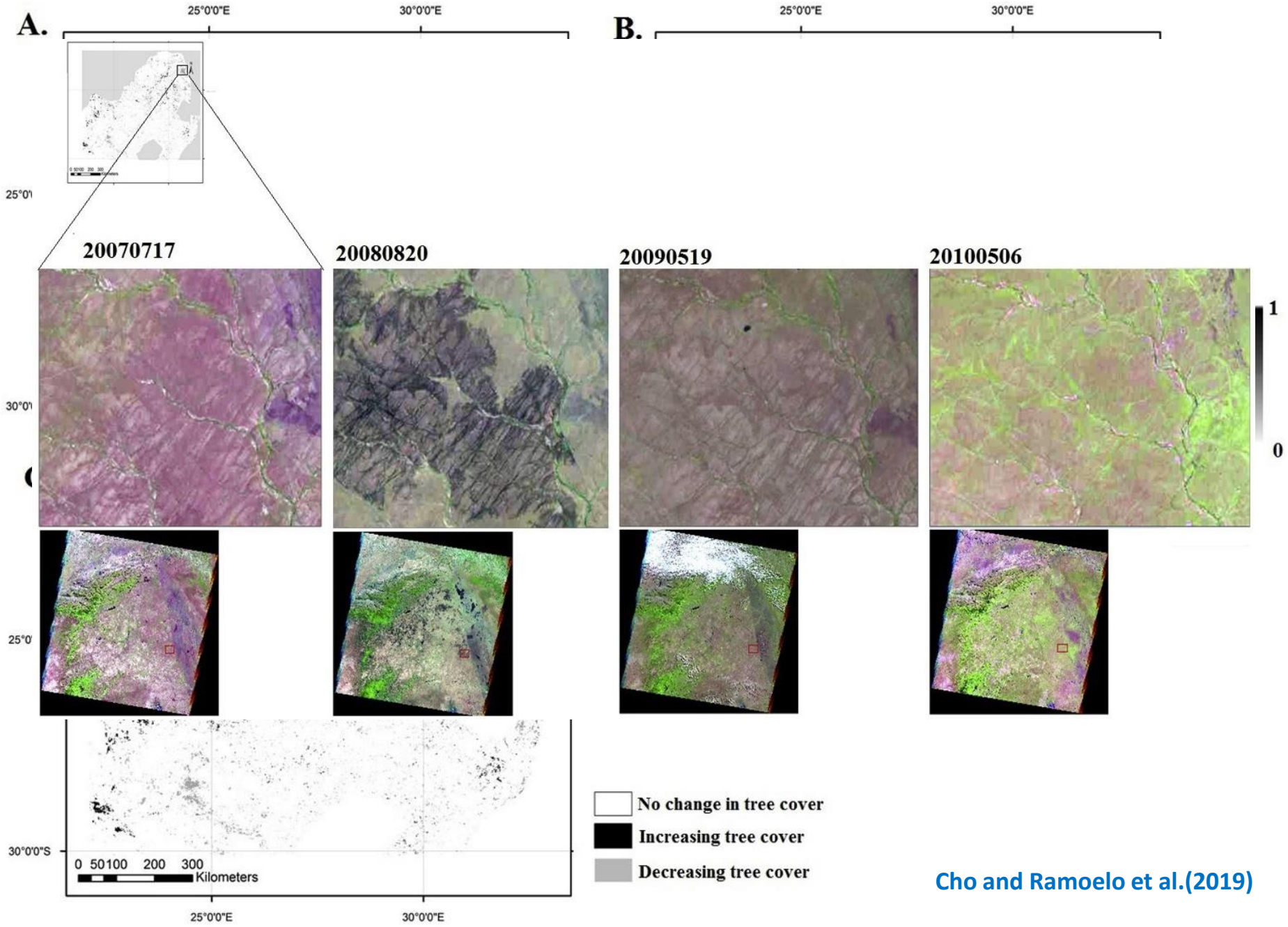
Ramoelo 2021 in prep

Long-term tree cover changes – Bush encroachment



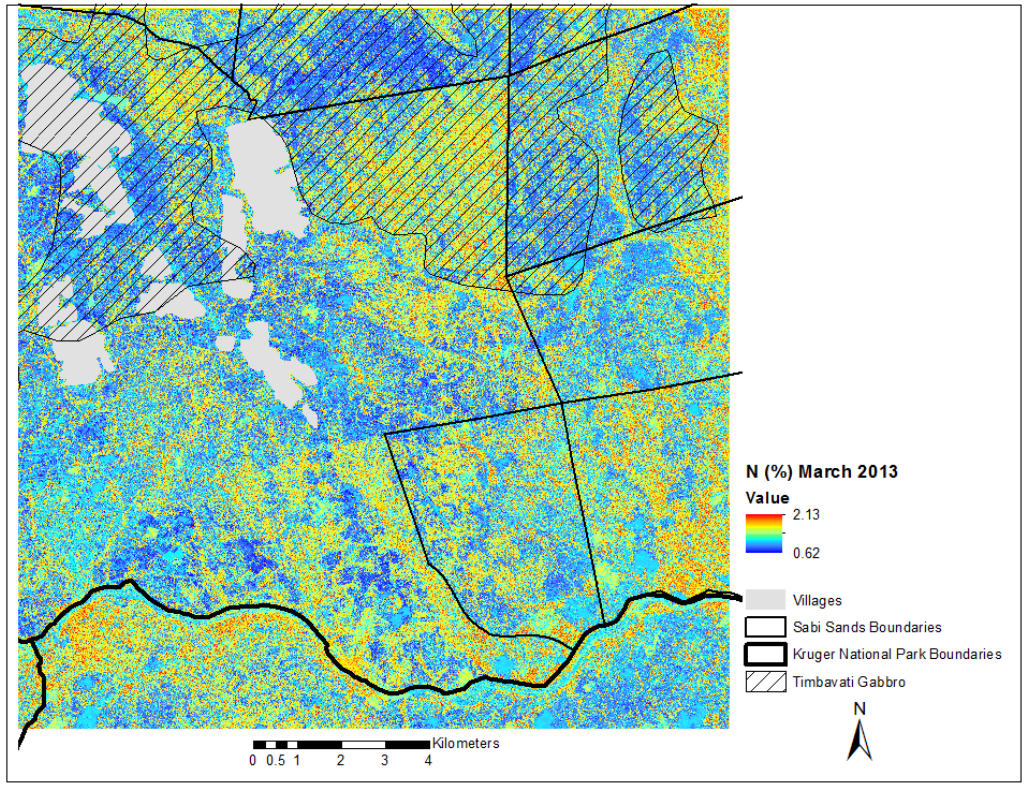
Cho and Ramoelo et al.(2019)

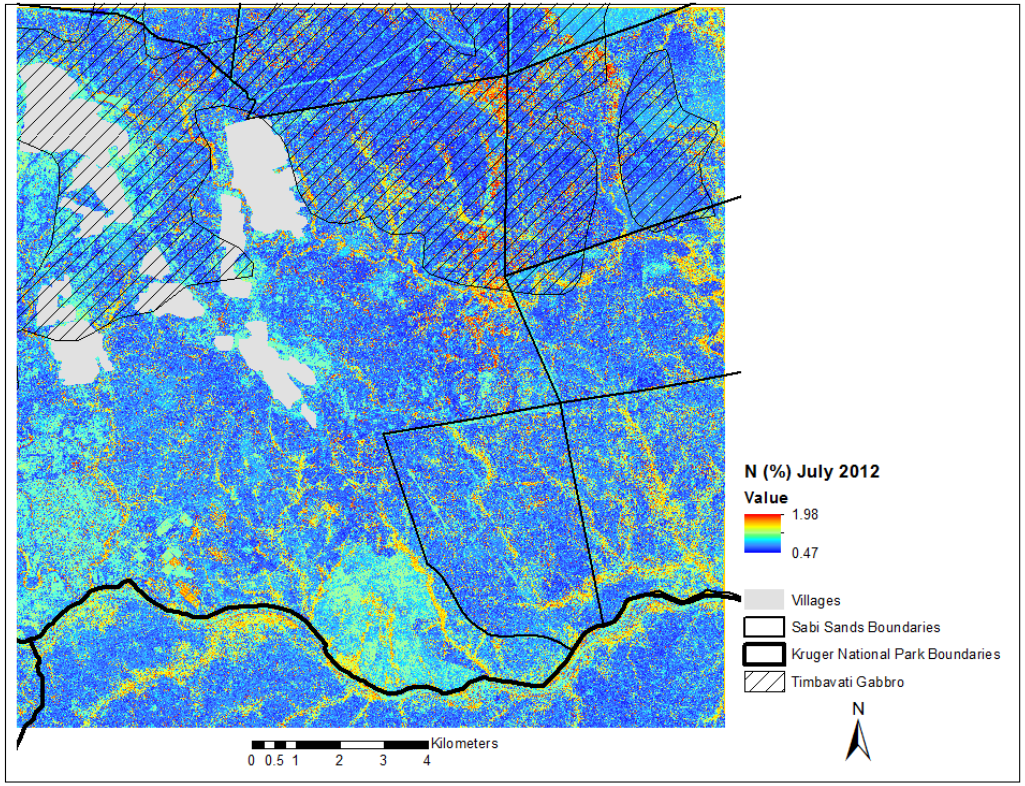
Long-term tree cover changes – Bush encroachment



Cho and Ramoelo et al.(2019)

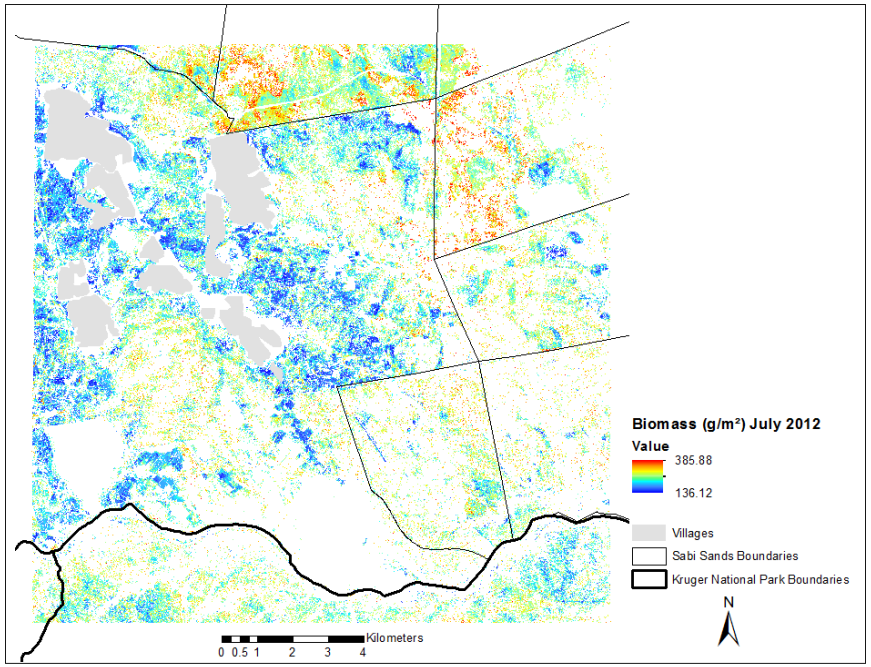
Leaf Biochemicals (N) –WorldView-2

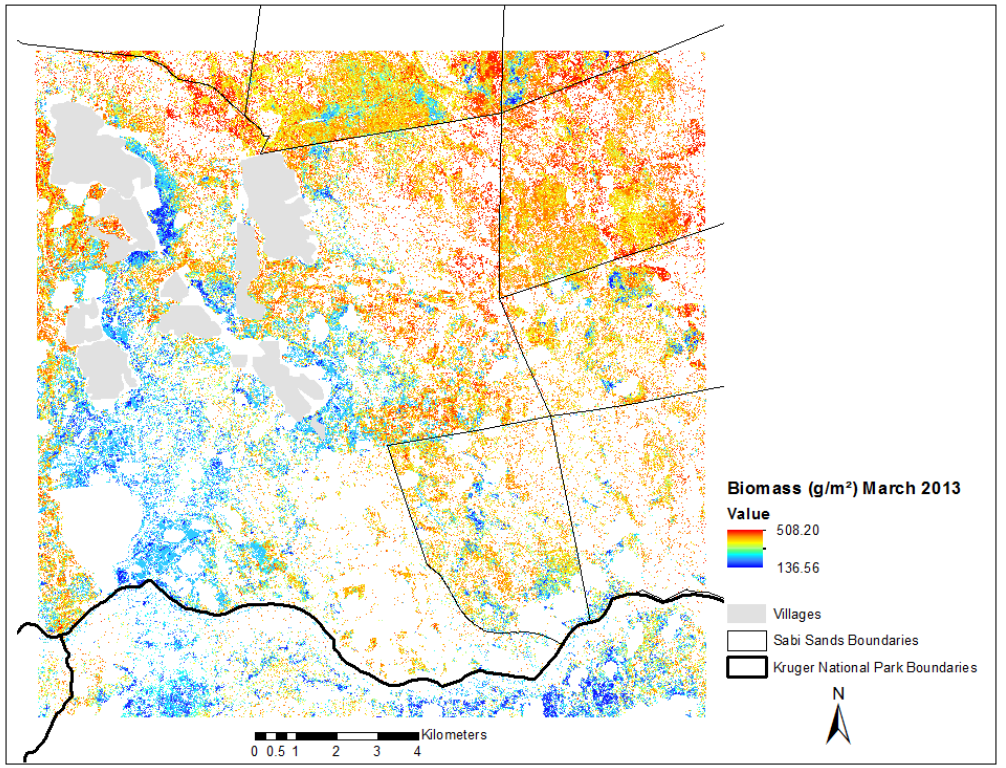




Ramoelo *et al*. 2015. *JAG*

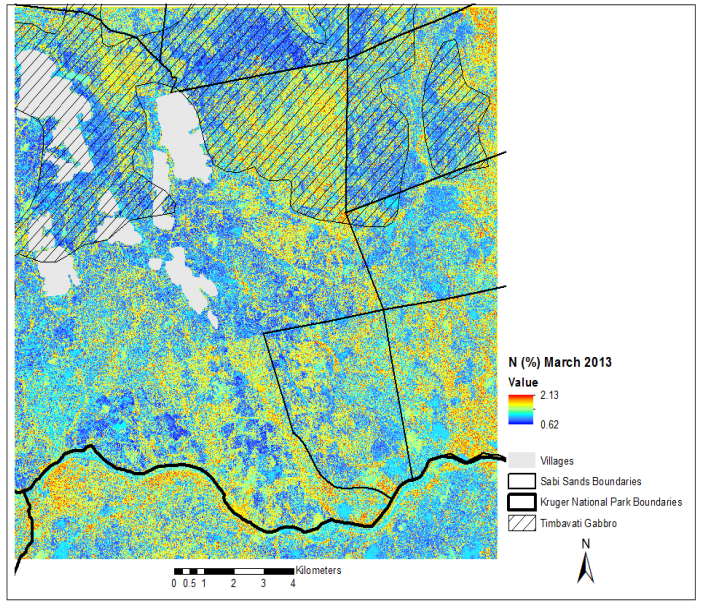
Biomass maps – WorldView-2



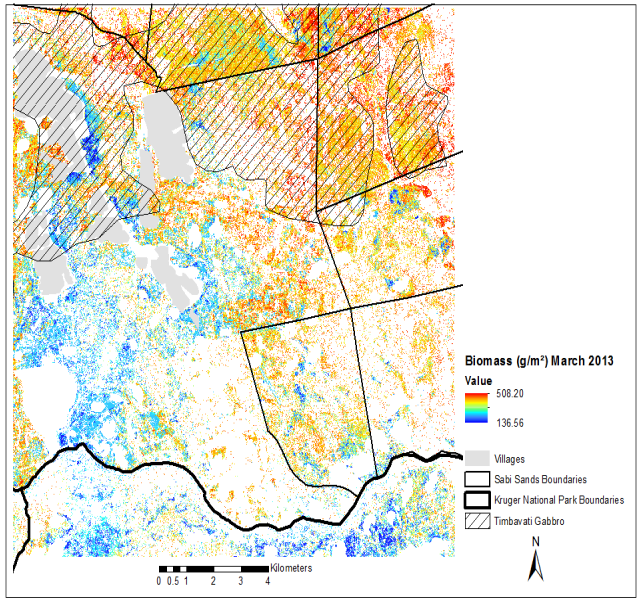


Ramoelo *et al*. 2015. *JAG*

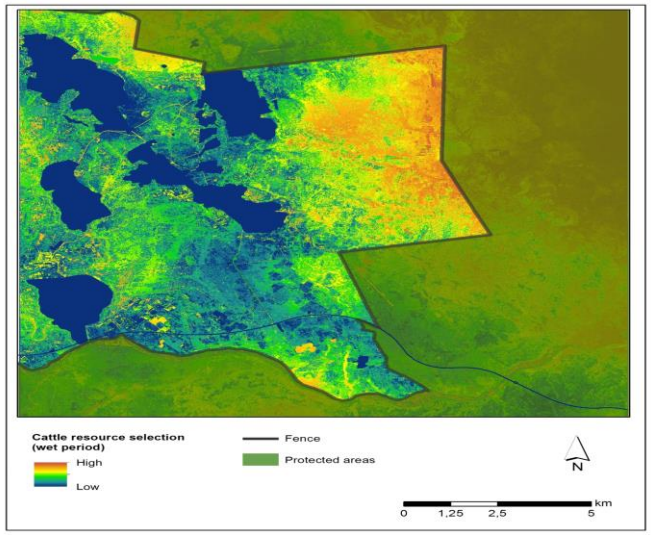
Buffalo Cattle Contact Risk (wet/dry – based grass N and Biomass)



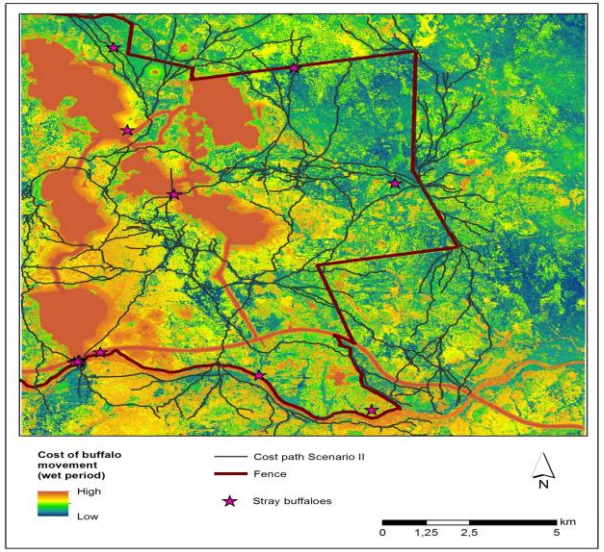
Leaf Nitrogen



Grass biomass



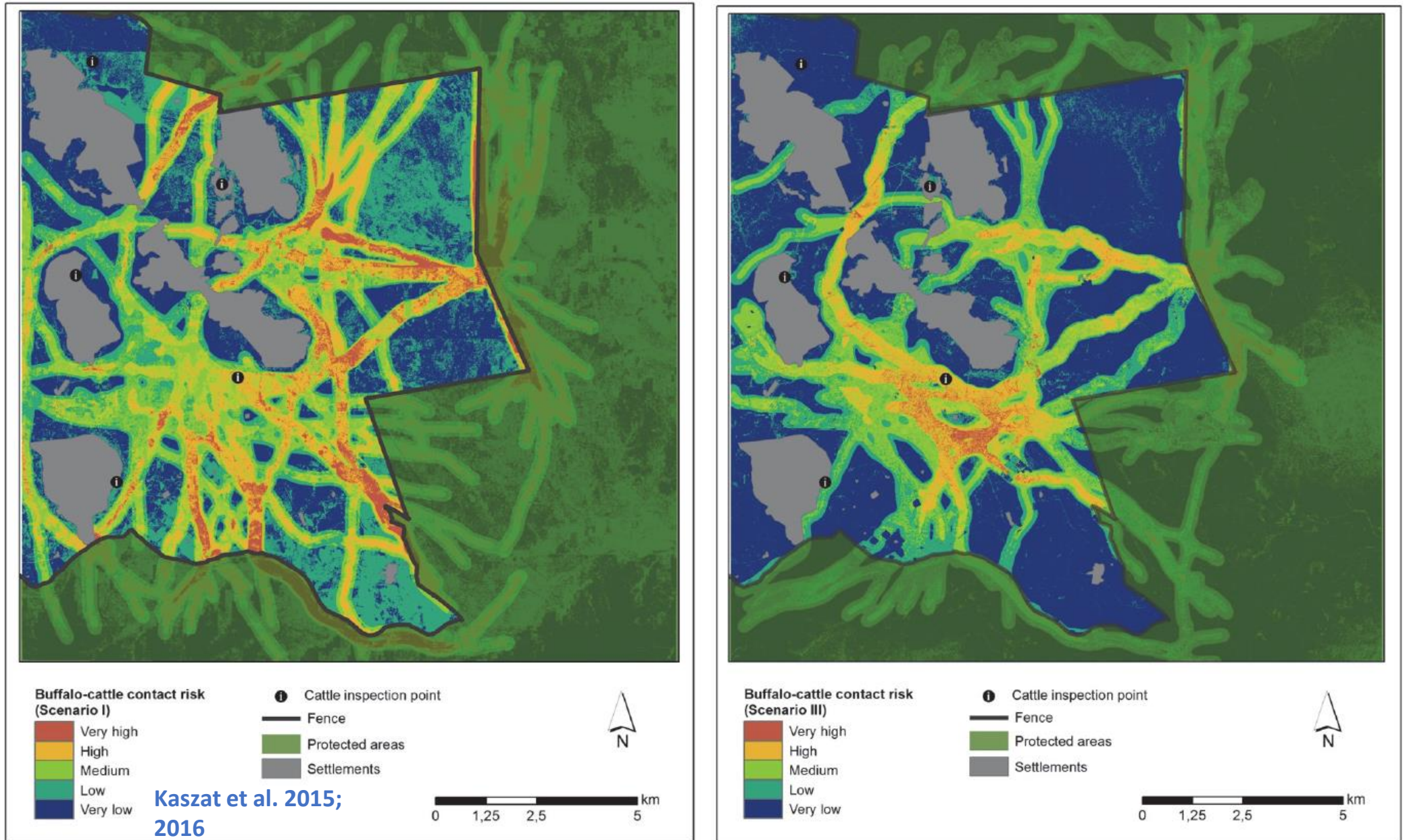
Cattle resource selection



Buffalo's least cost-paths

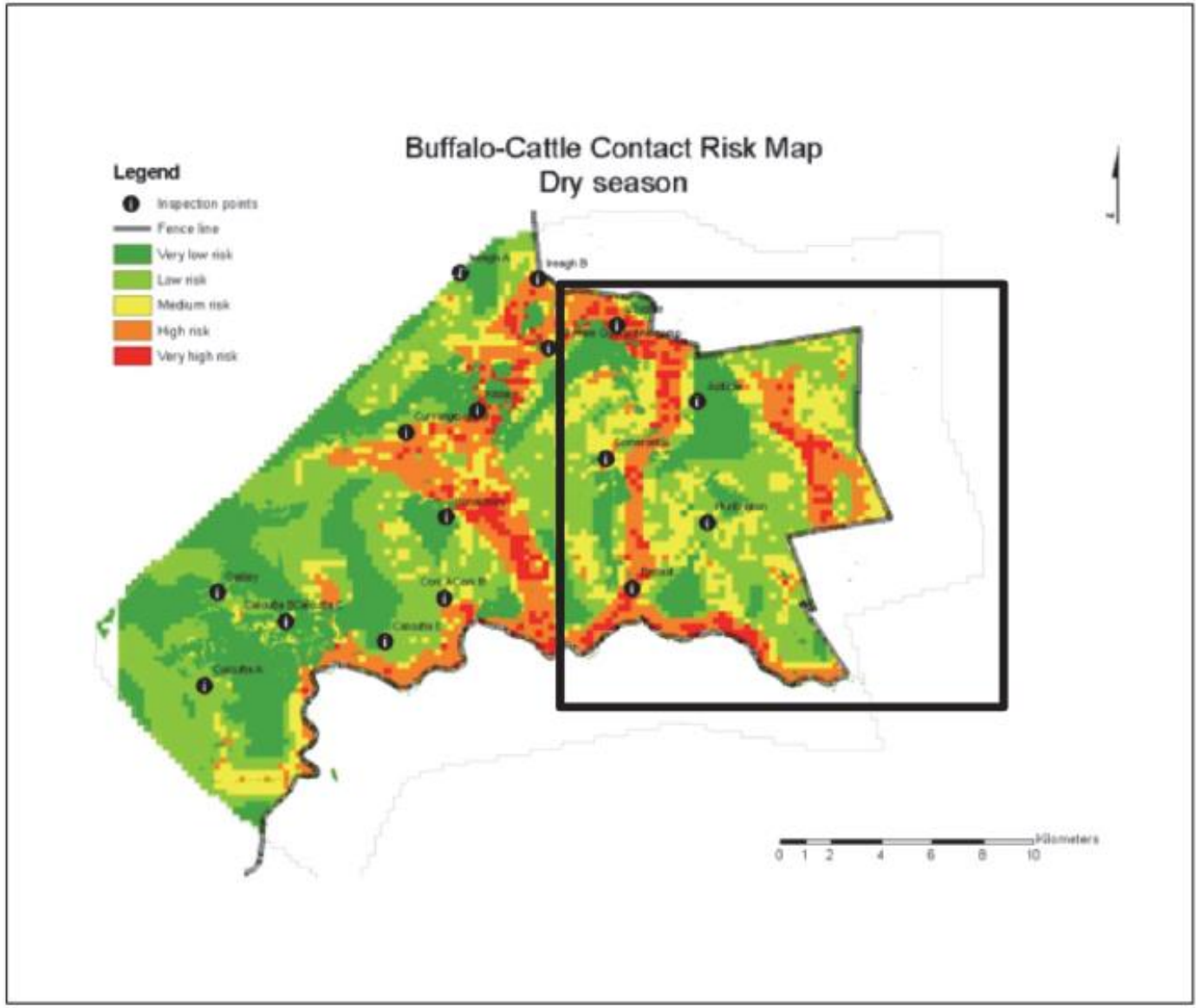
Ramoelo et al. 2015 JAG; Kaszat et al. *2015; 2016*

Buffalo Cattle Contact Risk (wet/dry season – based grass N and Biomass)



Kaszat et al. 2015; 2016

Buffalo Cattle Contact Risk (dry season – based grass N and Biomass)



Kaszat et al. 2015; 2016

Summary and Reflection….

- **Environmental** and climate changes – and their influence on spread and transmission of zoonotic and infectious diseases.
- **Land use and cover changes** – expansion of settlement and agricultural areas leading to **biodiversity or natural habitat loss.**
- **Climate changes** – looking at prevalence and frequencies of drought, and other environmental disasters (floods etc).
- Role of **availability of grazing and browsing resources**, and associated drivers such as **land degradation/ overgrazing/ bush encroachment/invasive species** in understanding the spread of the diseases and health risks.
- **Edaphic** (soil types, physical and chemical properties) and topographic drivers).
- **Pollution** (water, air etc)
- **Human-Animal Conflict Risk** using the integration of socio-economic, animal and environmental data, **i.e. Big Data Integration, and Modelling**

Acknowledgement

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Thank you

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