Impact of climate change on plant and bird diversity in Africa

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3 School of Geography, University of Nottingham, United Kingdom
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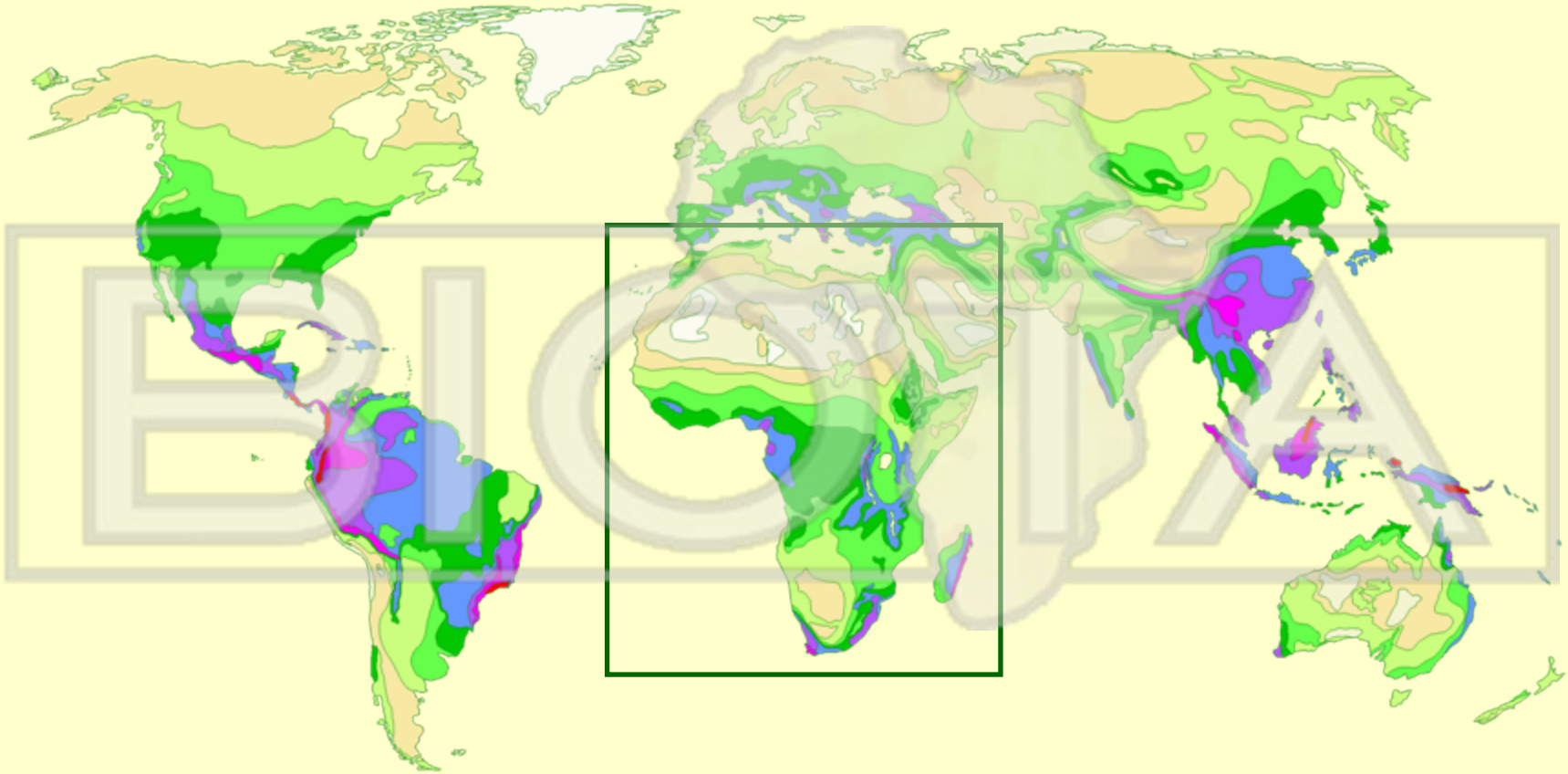
5 Potsdam Institute for Climate Impact Research, Germany
6 University of Copenhagen, Denmark

Outline

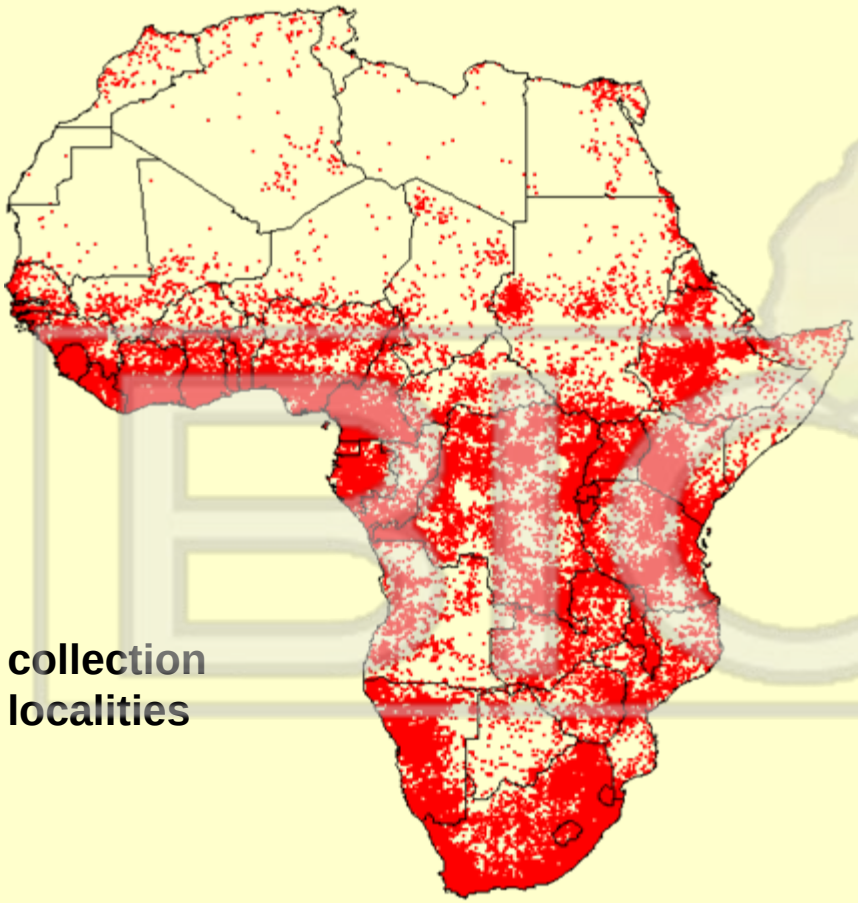
- Introduction: Mapping species richness patterns
- Birds and plants: cross-taxon species richness
- Climate change
  - Continental plant species richness
  - Case study Morocco: bioclimate and plants
  - Case study Kenya: plant and bird interactions
- Summary and Outlook

Mapping species richness



Barthlott et al. 1996, 1999, &2005

A Biogeographic Information System on African Plant Diversity



● collection localities

>350,000 collections

>4,500 species

spatial resolution:
0.5° (50x50km)

collaboratively established within BIOTA-AFRICA

data provided by more than 20 scientists and institutions

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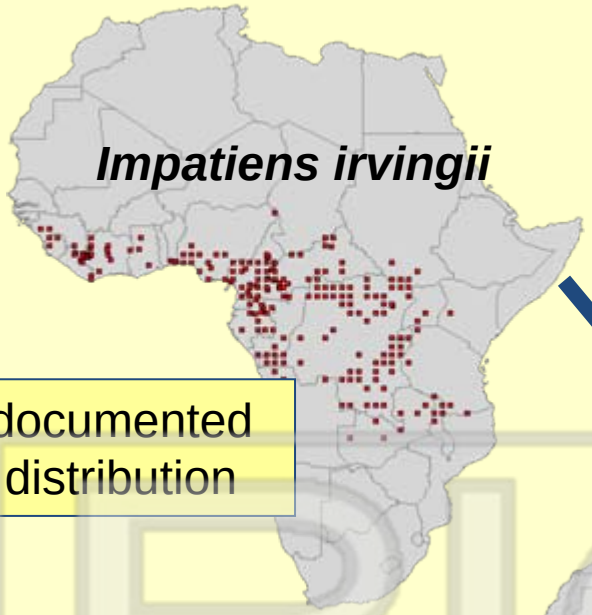
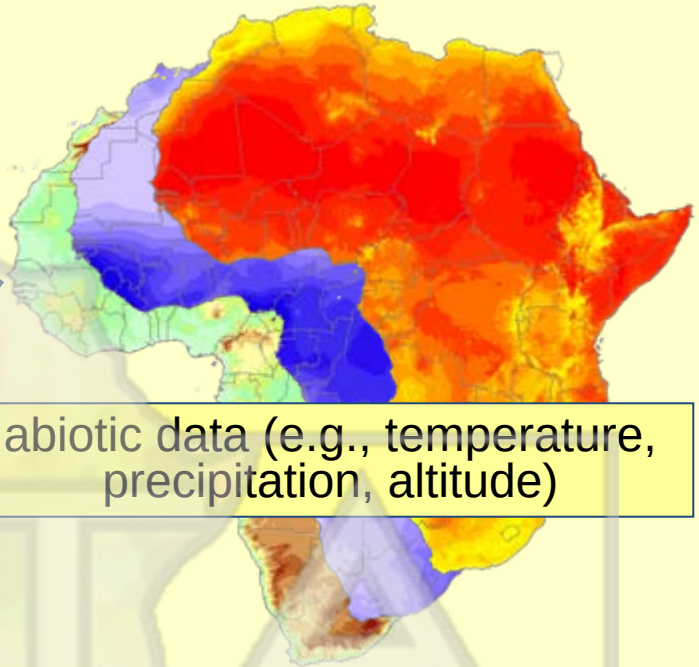
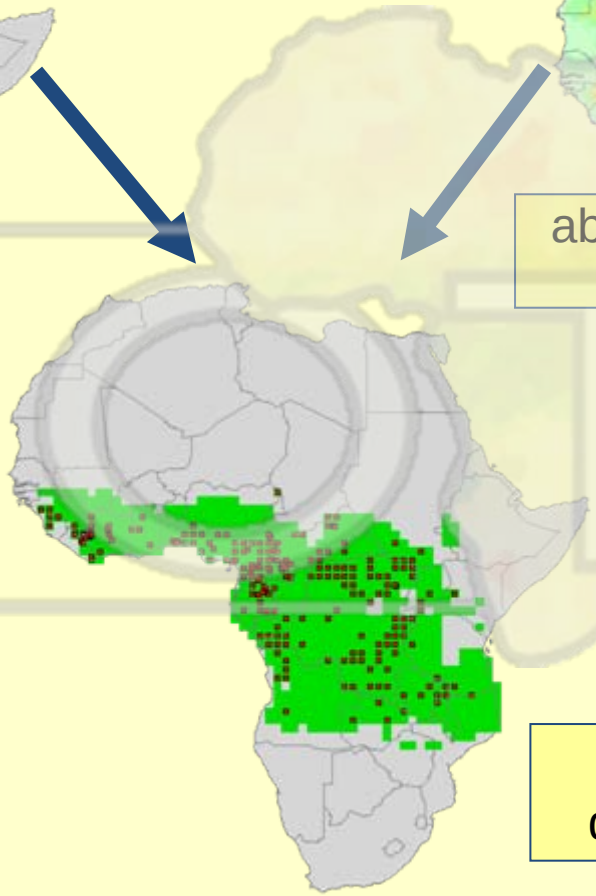
Species distribution models



documented distribution

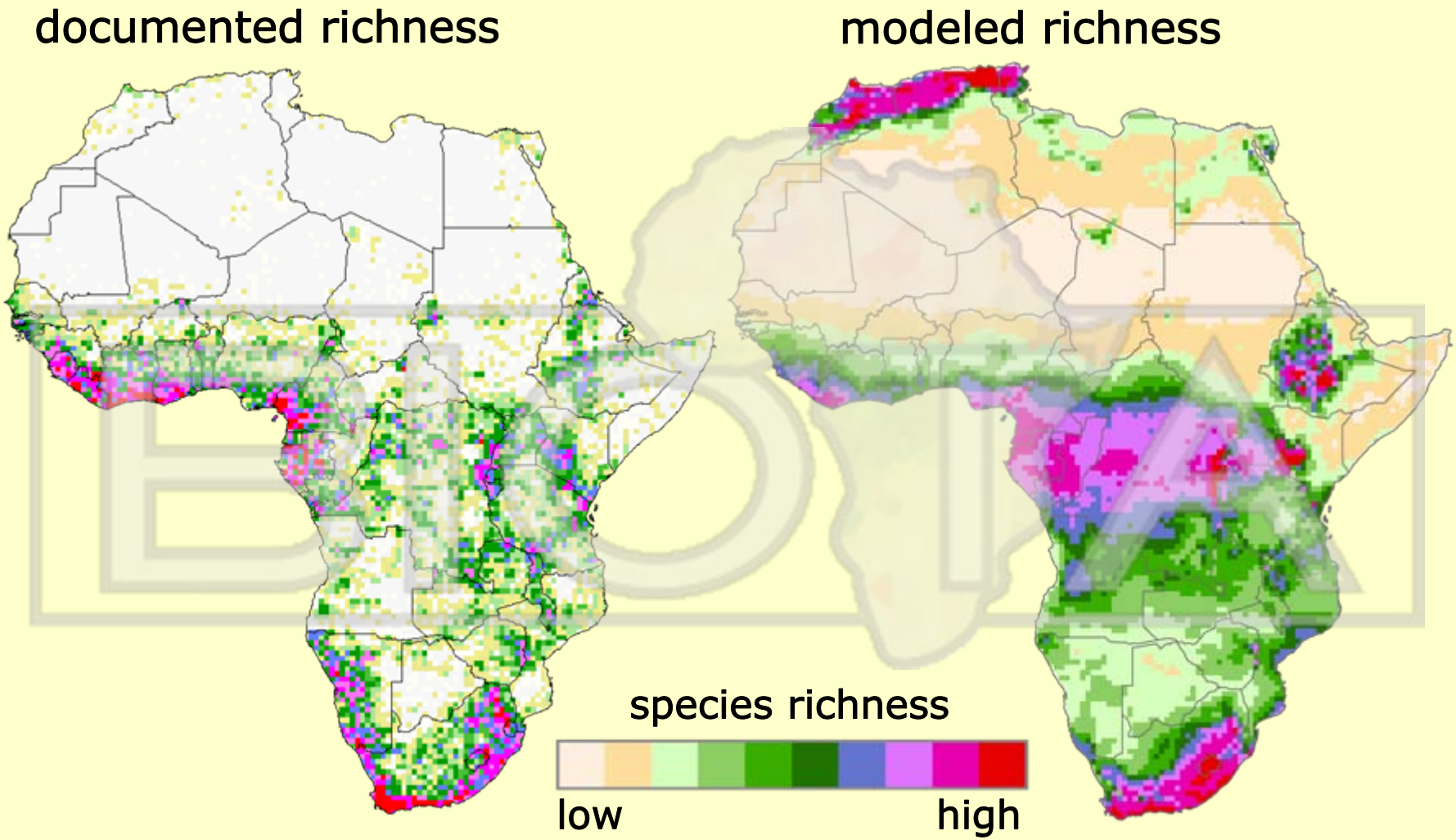


abiotic data (e.g., temperature, precipitation, altitude)



potential distribution

Documented and modeled species richness



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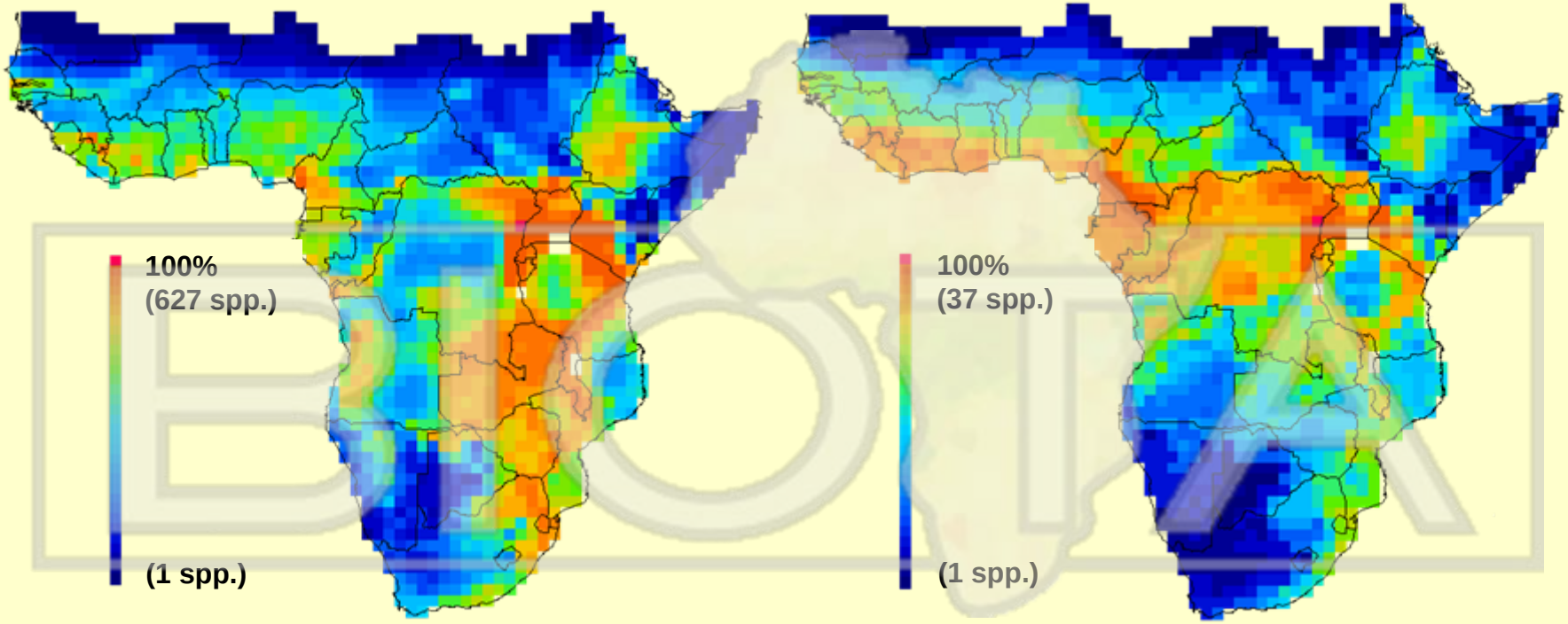
Birds and plants: Cross-taxon species richness

Bird distribution across Africa

All birds

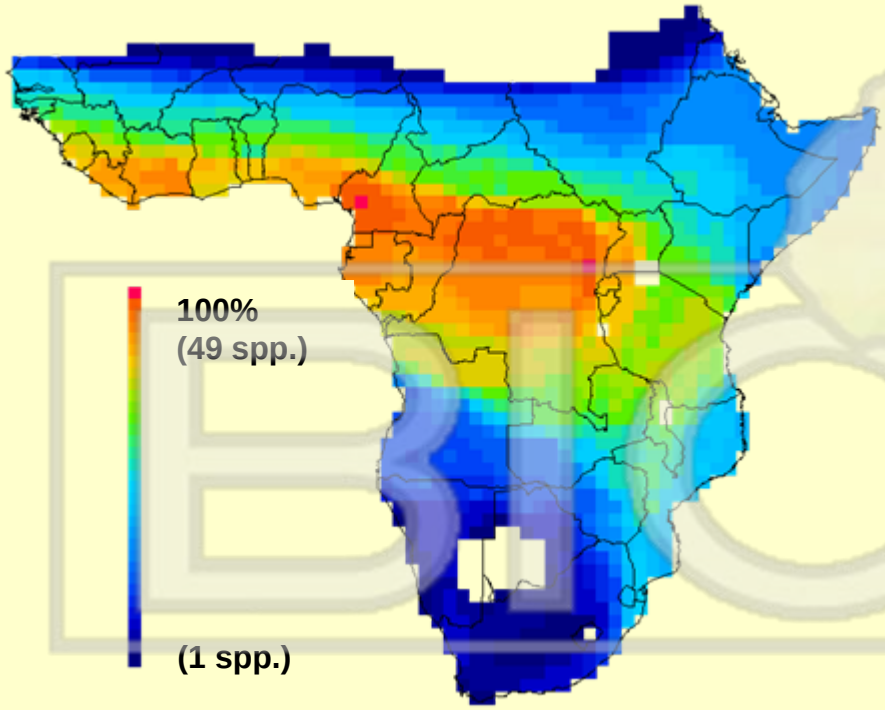
Fruit-eating birds



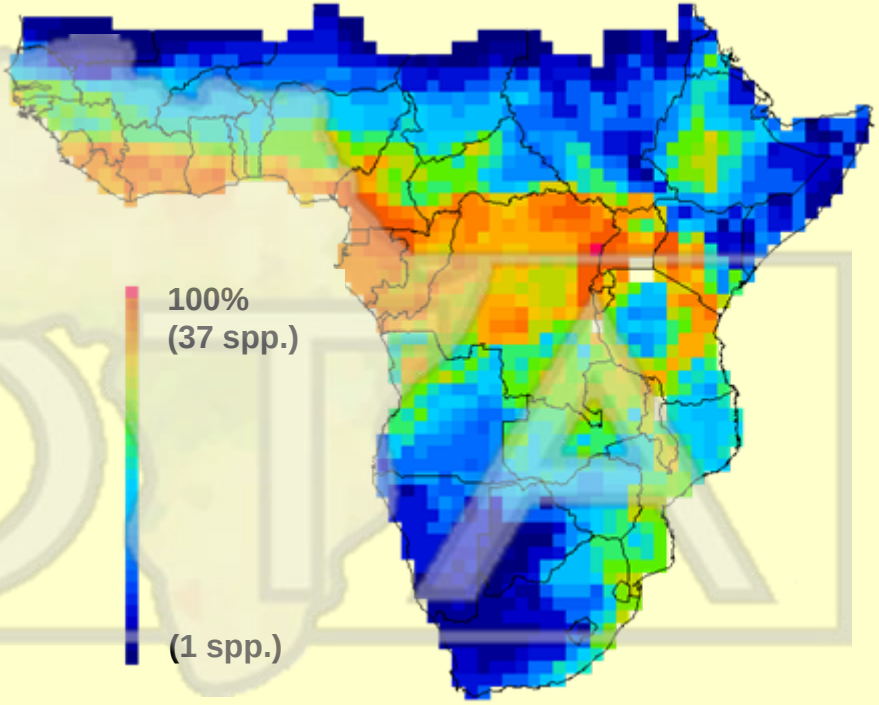
Kissling, Rahbek, Böhning-Gaese, *Proc. Royal Soc. London B* 2007

Fruit-eating birds versus fruit-bearing trees

Ficus trees



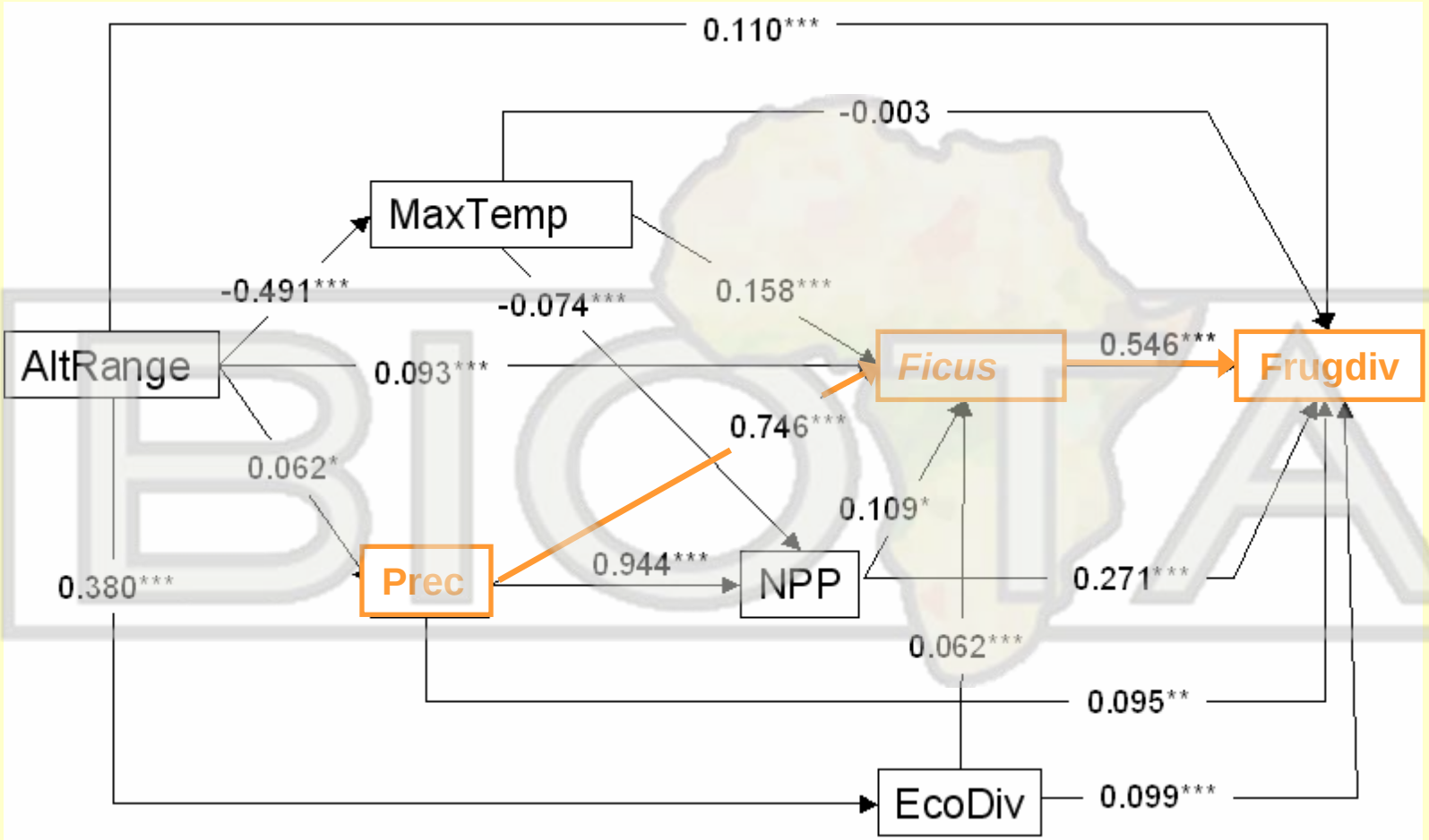
Fruit-eating birds



Kissling, Rahbek, Böhning-Gaese, *Proc. Royal Soc. London B* 2007

Fruit-eating birds versus fruit-bearing trees

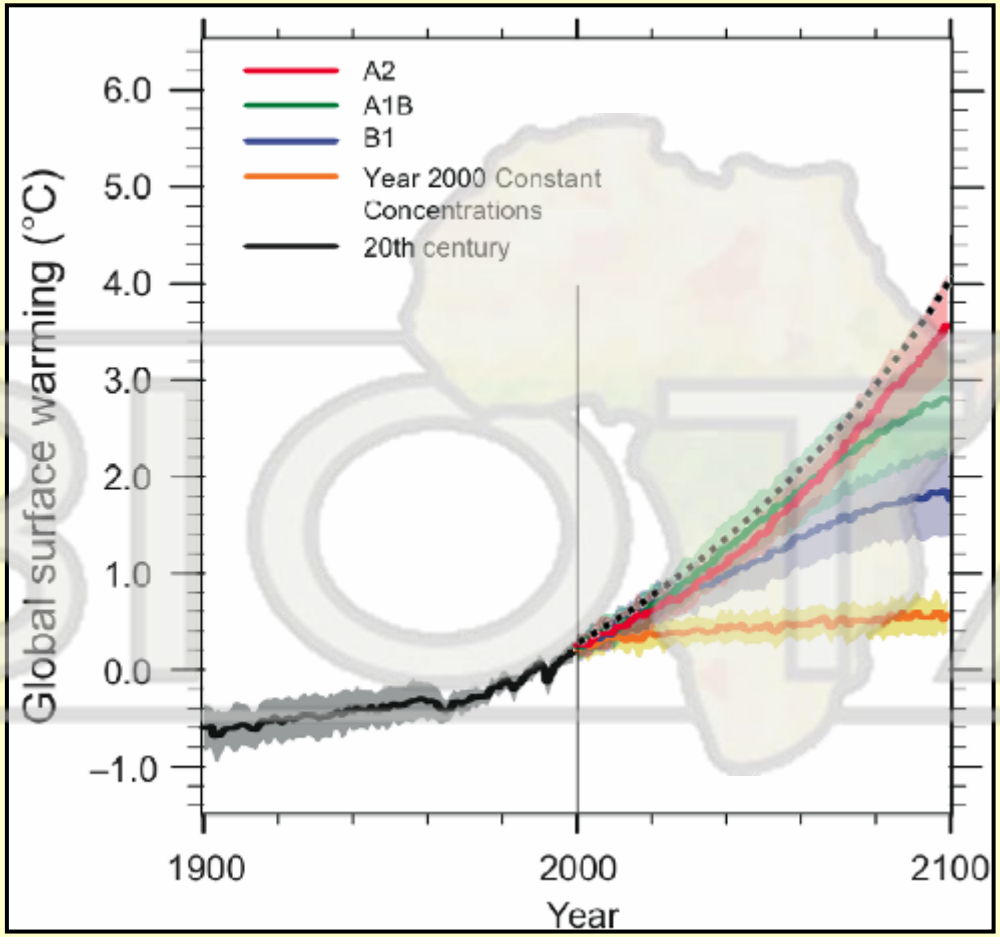
Path analysis



r^2 = 0.808, model fit: NFI = 0.923

Kissling et al. *Proc. Royal Soc. London B* 2007

Plant diversity and climate change



WMO

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

UNEP

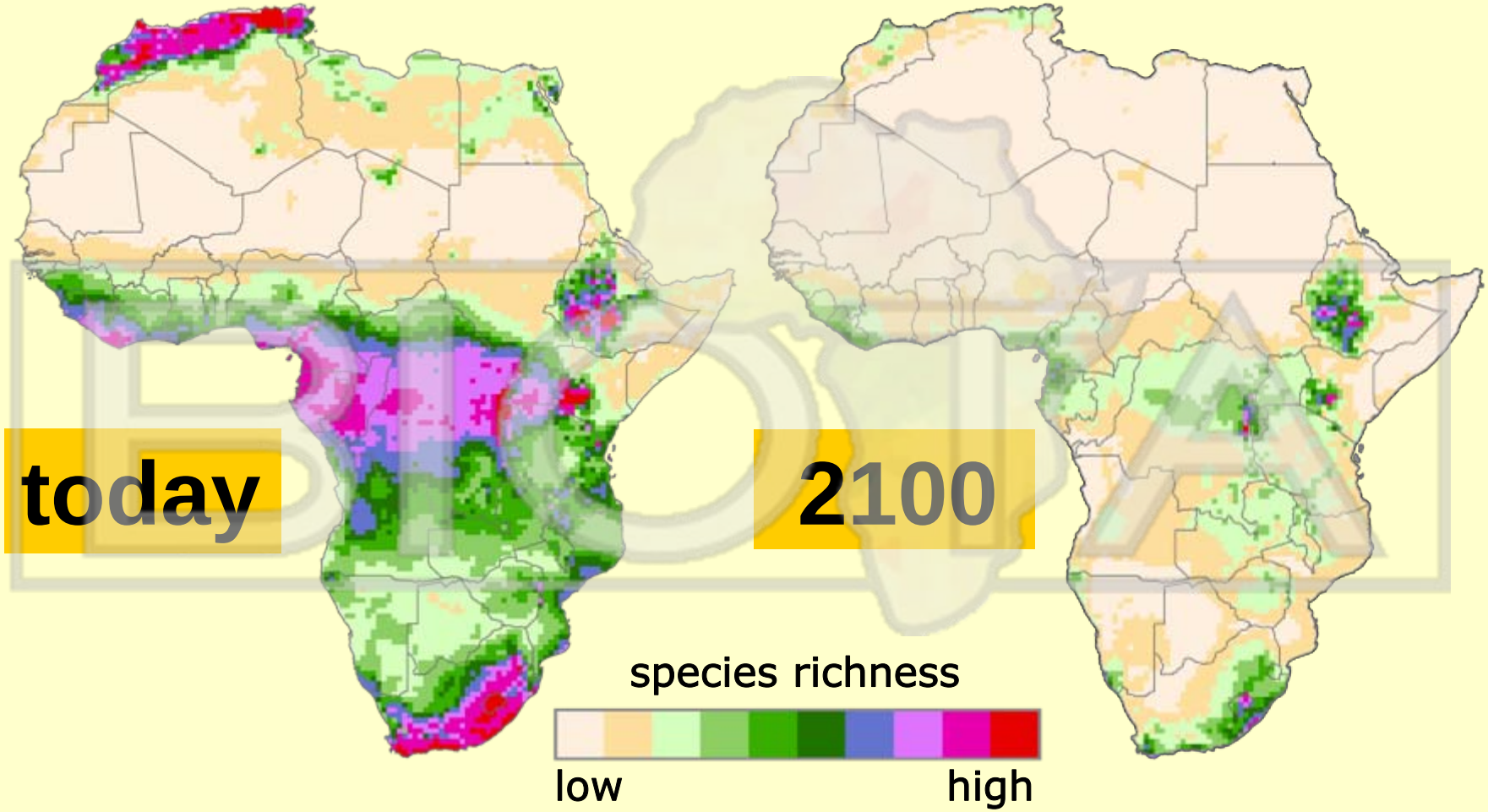
Impact of climate change – Assumptions

- Plant distributions delimited by current climate
- Bird distributions delimited by climate and vegetation
- Species distributions in equilibrium with their climatic envelope

→ Shifts of potential species distributions

Possible changes in species richness until 2100

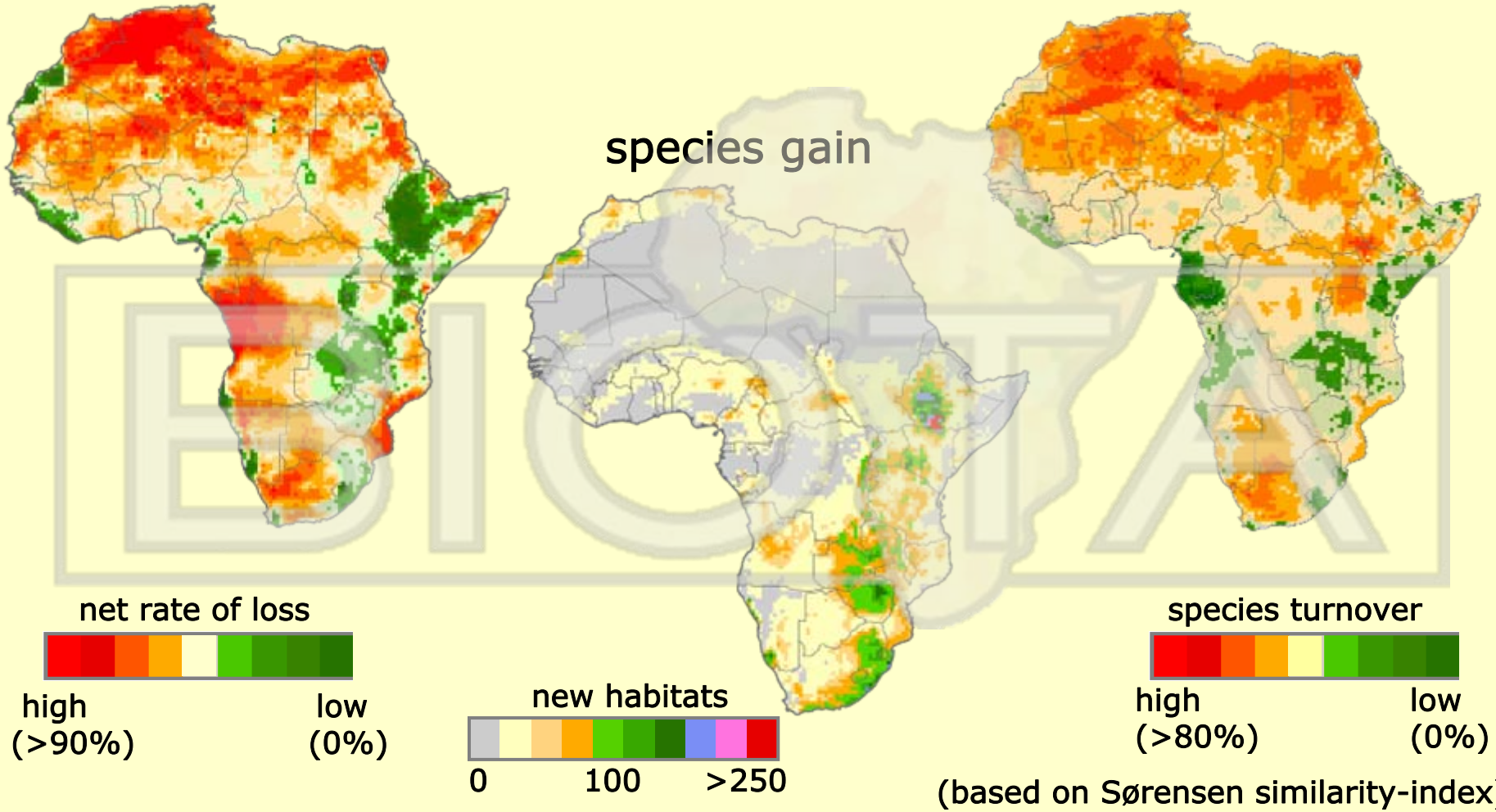
(HadCM3 climate model, IPCC A1FI Scenario, +4°C)



Plants 2100: winner- and loser-regions

net species loss [%]

species turnover



(based on Sørensen similarity-index)

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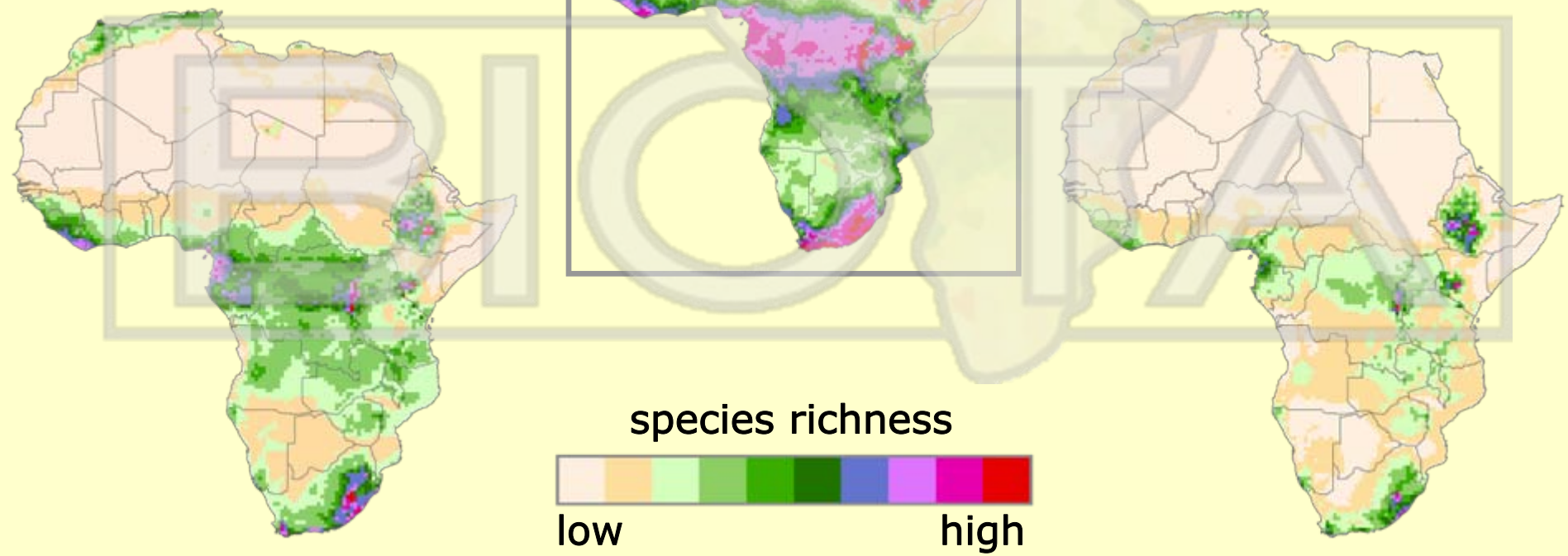
Comparison of scenarios and climate models

+2°C scenario (2100, B1) -46%

TODAY

+4°C scenario (2100, A1FI) -68%



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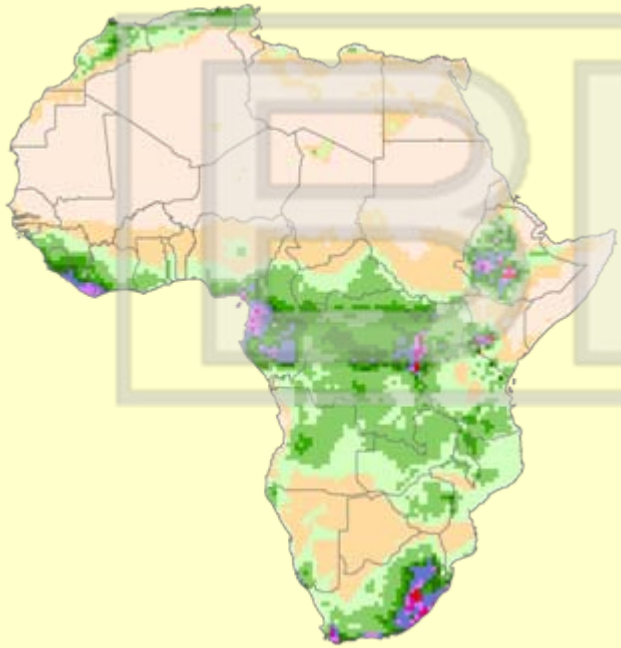
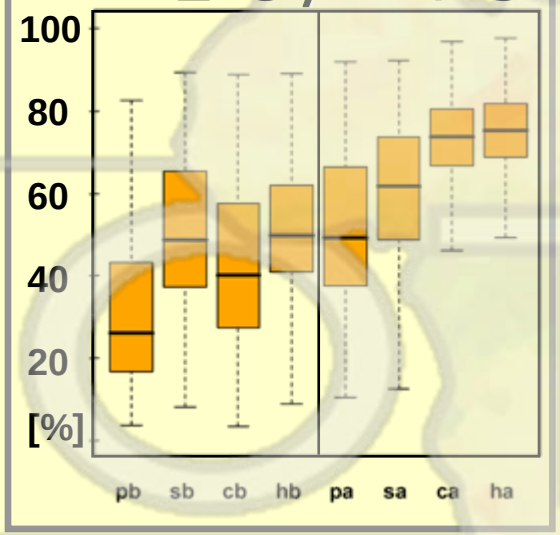
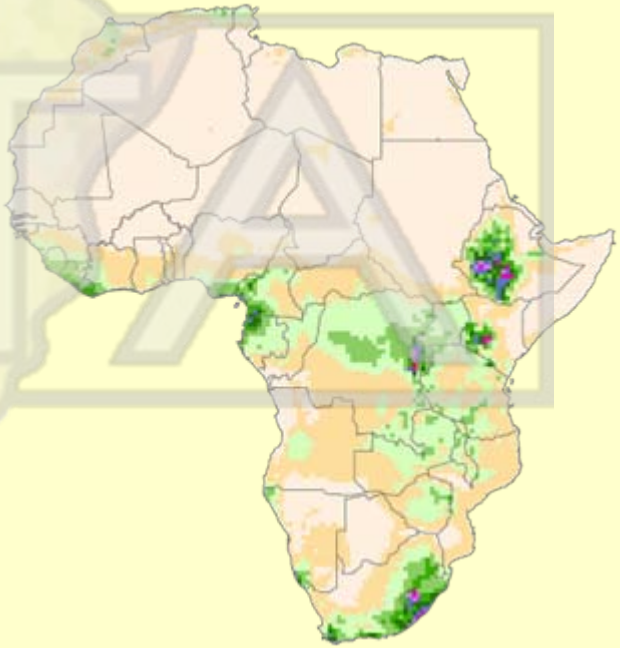


diversity loss per model [%]

+2°C / +4°C



+4°C scenario (2100, A1FI) -68%



species richness

low — high

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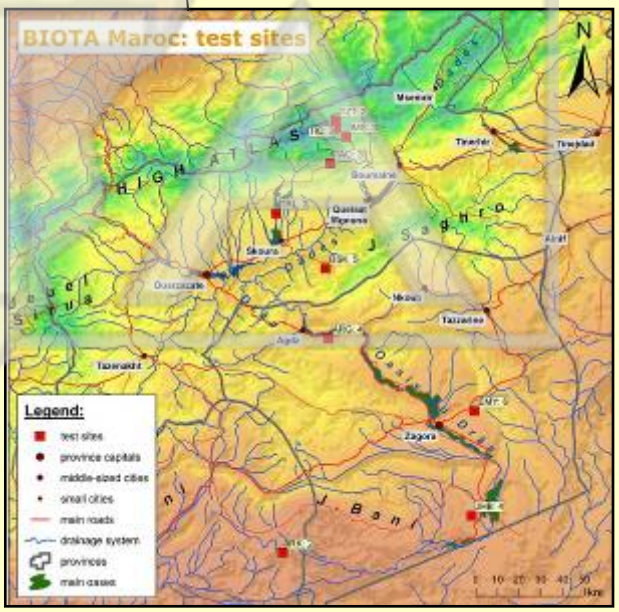
Case study Morocco

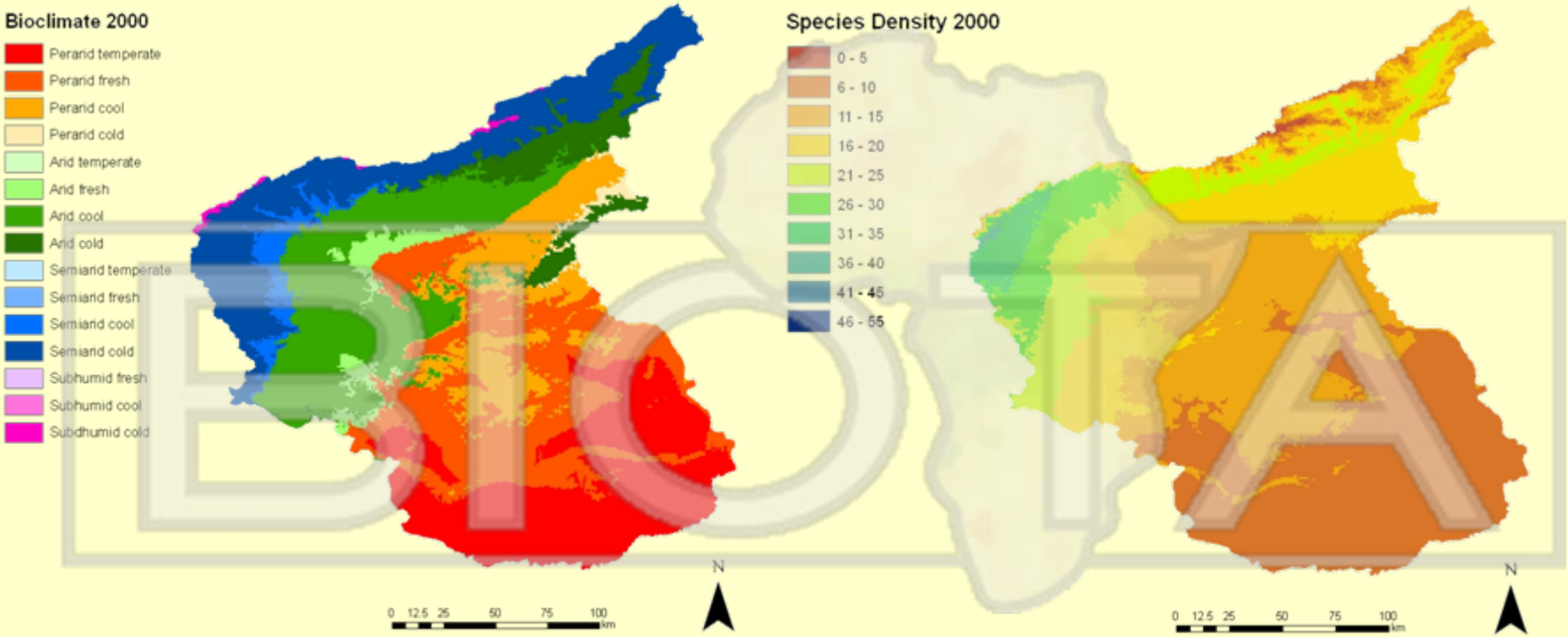
bioclimate
and plant species
richness



Case study Morocco

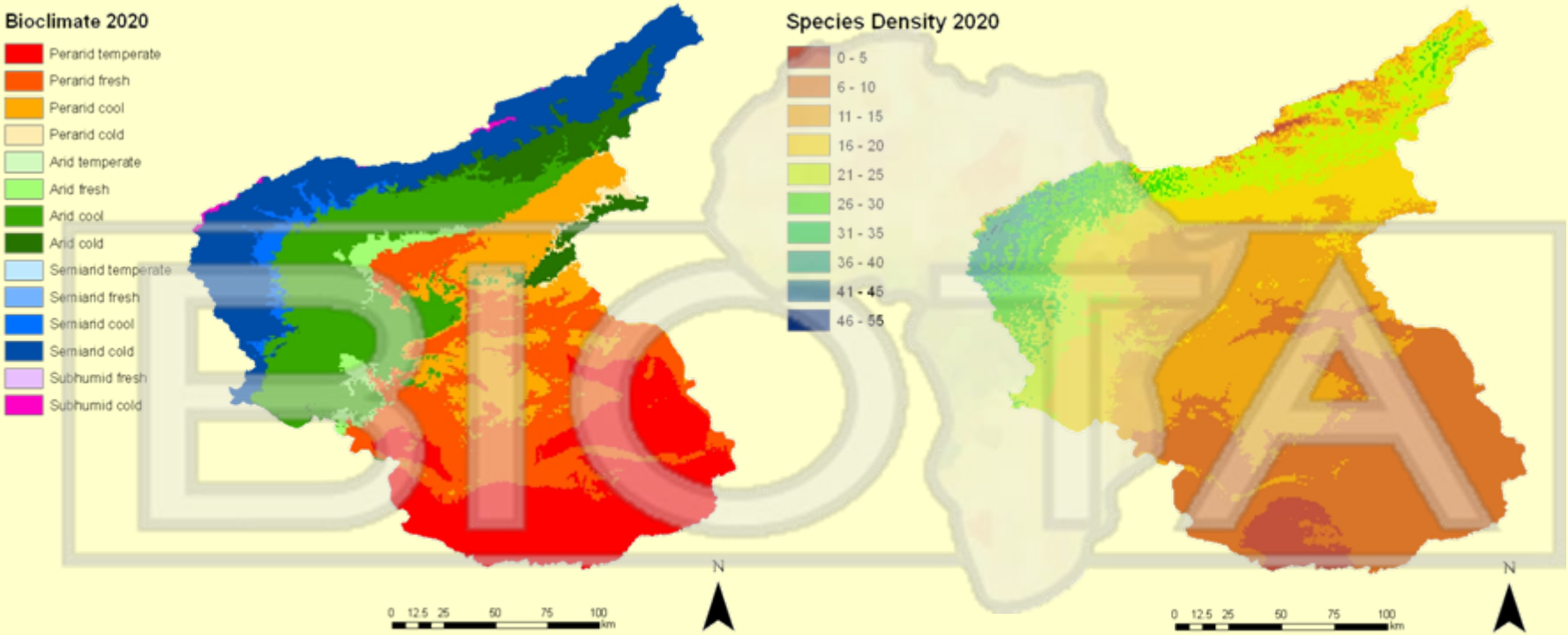
- Future changes of bioclimate and species richness (IPCC A2, HadCM3)
- Drâa Basin, southern Morocco (597 relevés)
- Bioclimatic Emberger Index based on temperature and precipitation
- Statistical Model: poisson GLM

Changes in bioclimate and species density until 2080 in the Drâa Basin, Morocco



2000

Changes in bioclimate and species density until 2080 in the Drâa Basin, Morocco



2020

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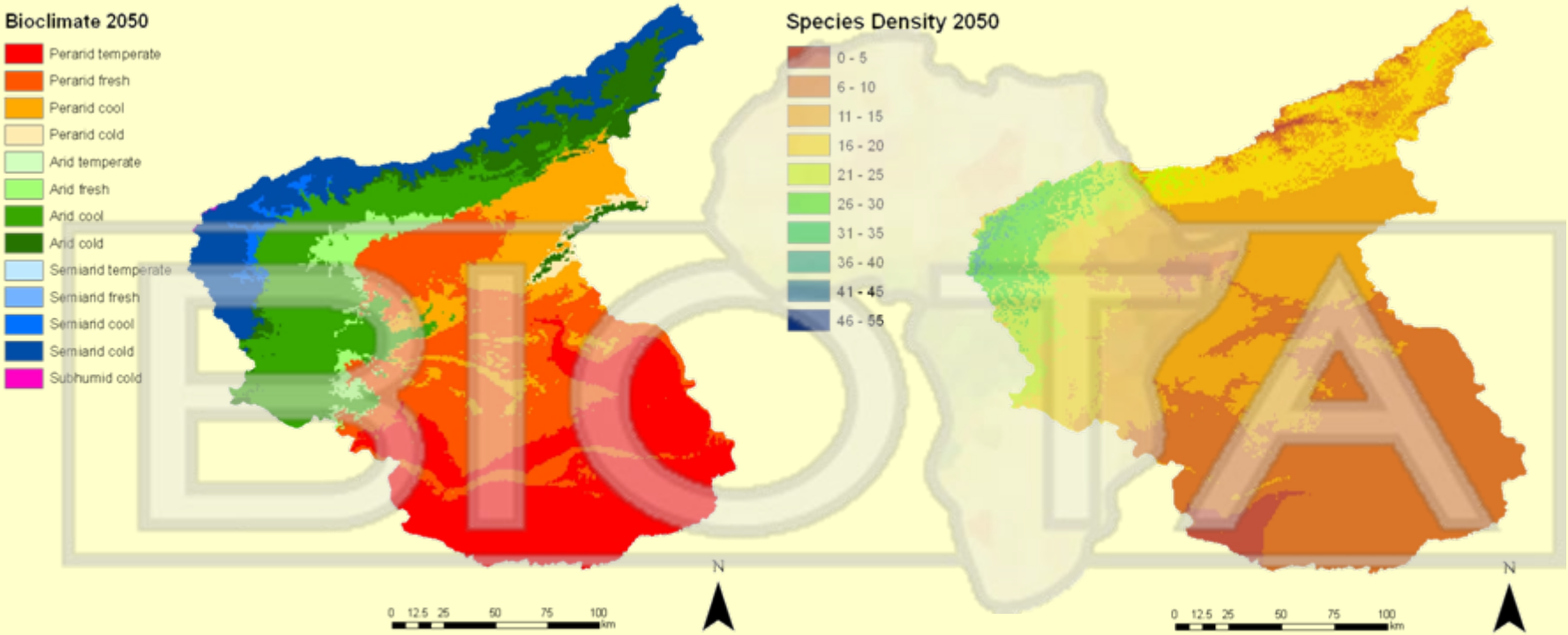
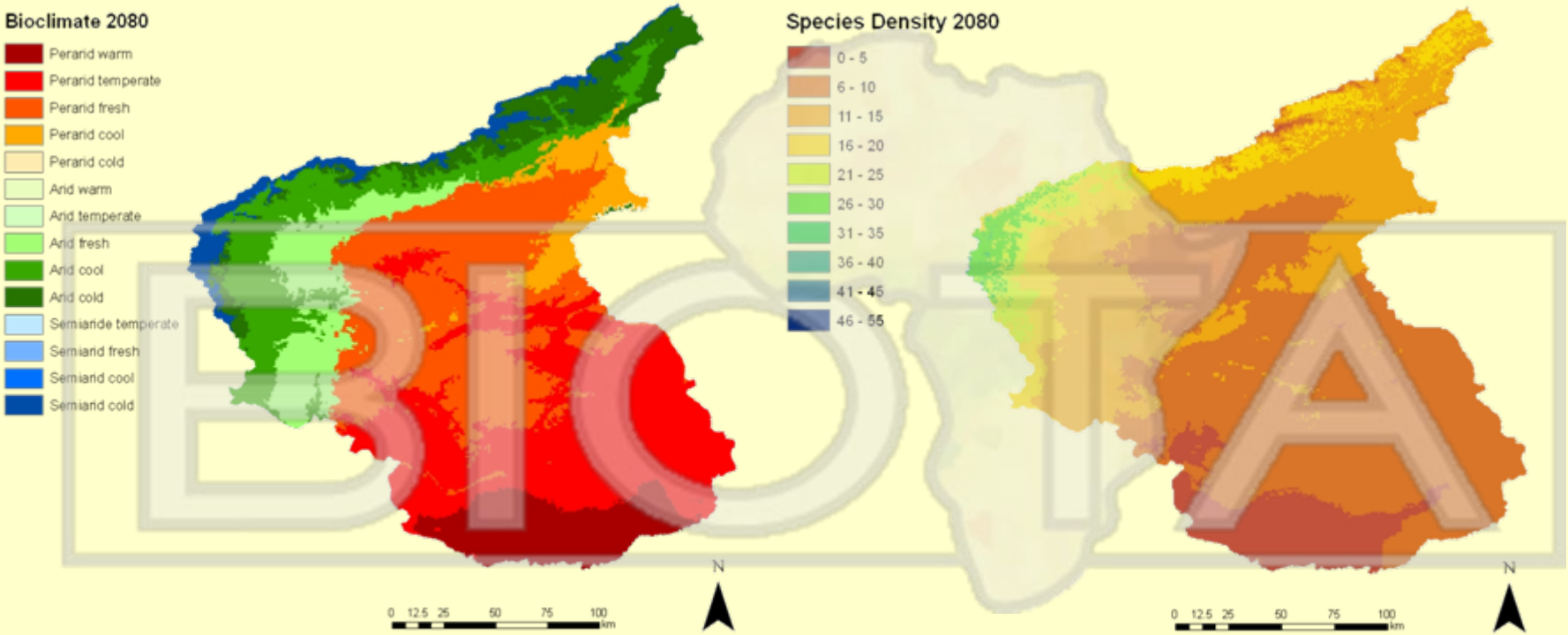
Changes in bioclimate and species density until 2080 in the Drâa Basin, Morocco



2050

Changes in bioclimate and species density until 2080 in the Drâa Basin, Morocco



2080

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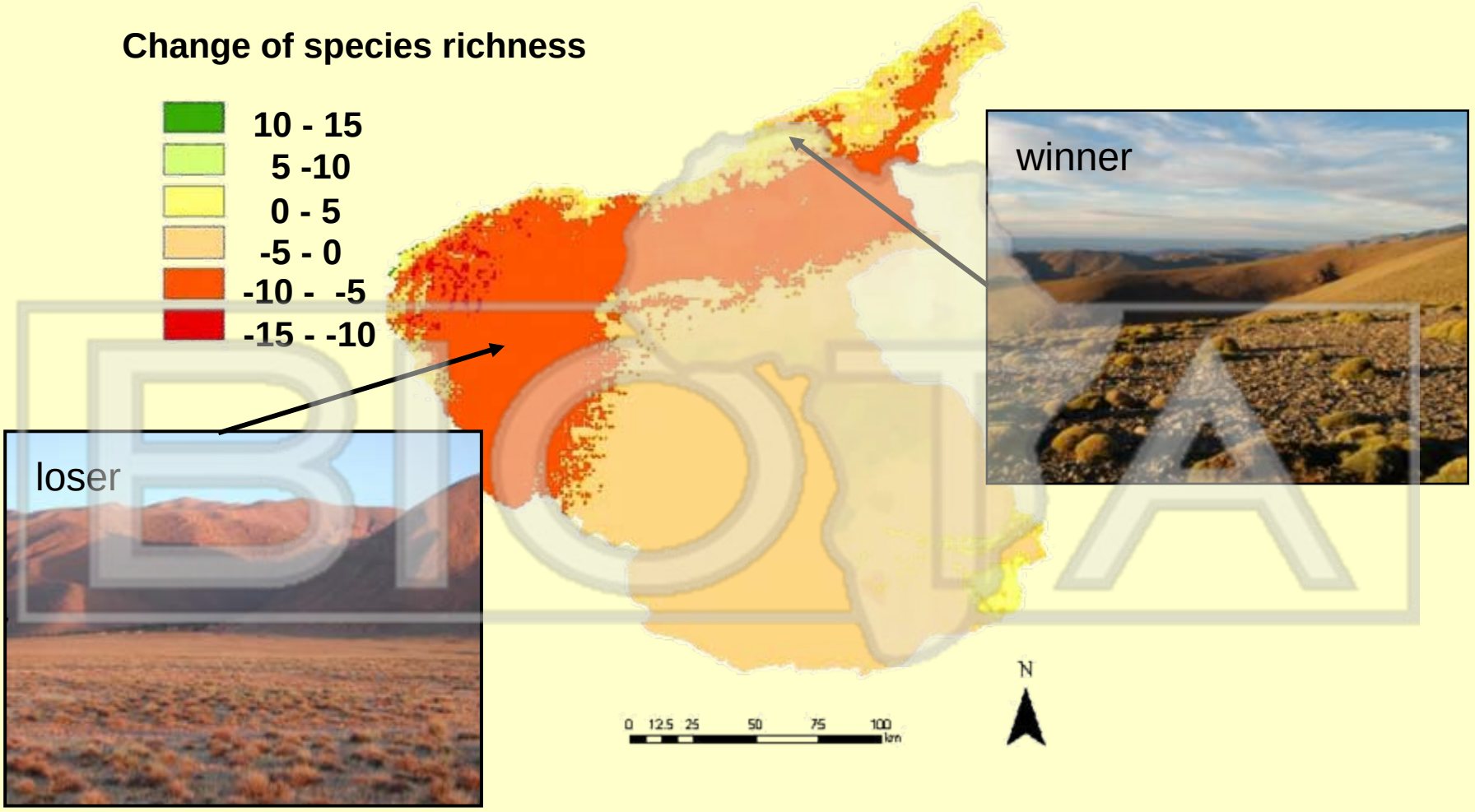
Plants 2080: winner- and loser-regions



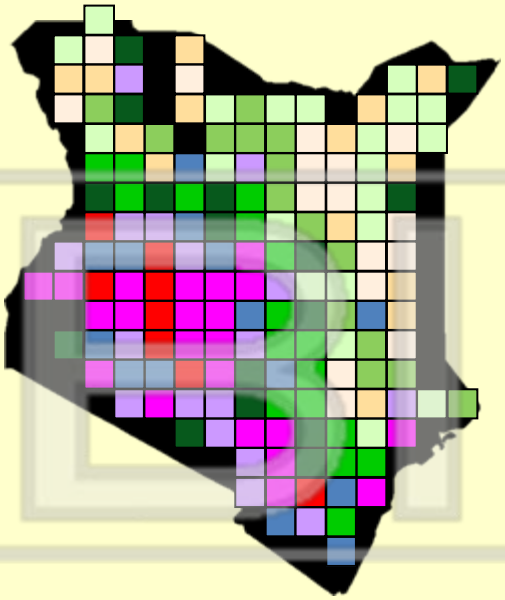
Case study Kenya

cross-taxon diversity:

birds and plants

Birds and Plants: species richness patterns

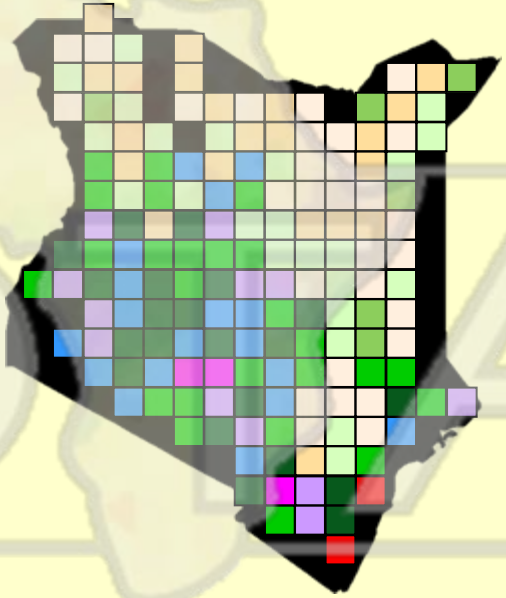
(A) Bird richness



612

0

(B) Woody plant richness



483

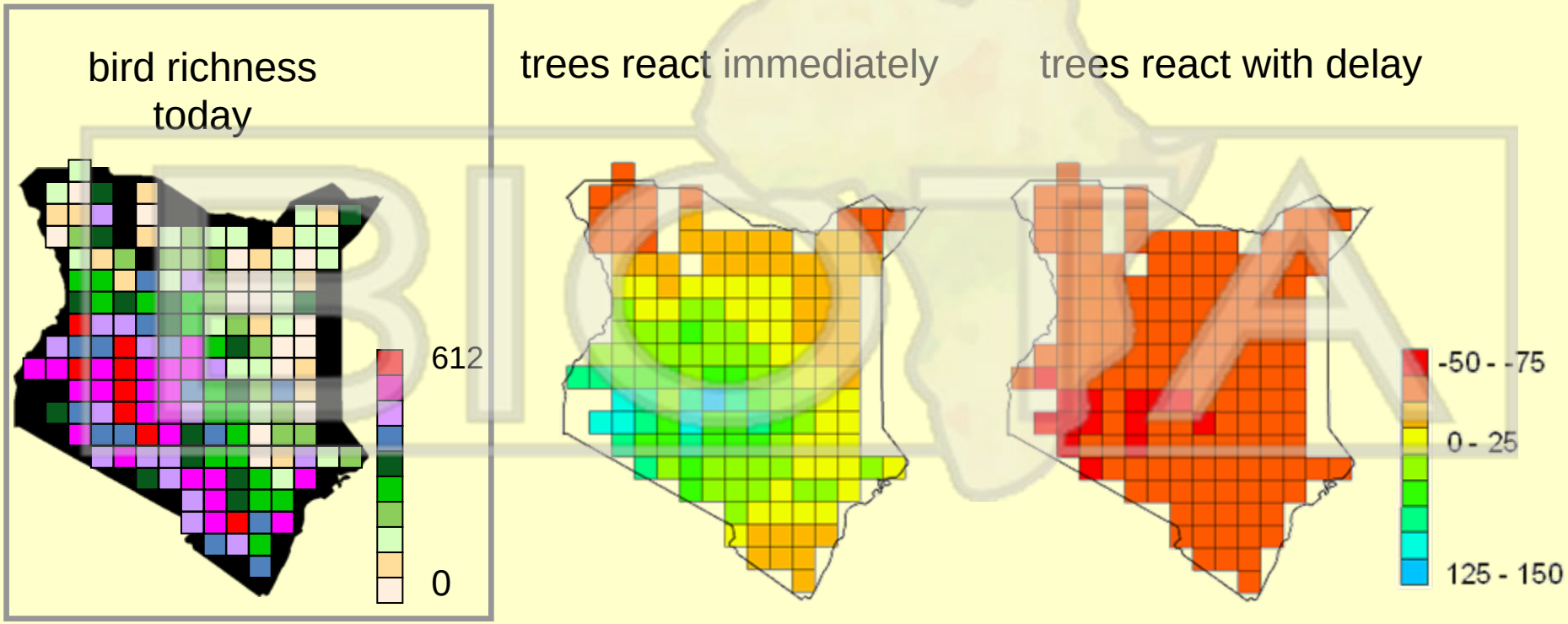
0

Kissling, Field, Korntheuer, Heyder, Böhning-Gaese, *in preparation*

Birds and trees: future scenarios

Possible changes in bird species richness in Kenya (2069-2098)

Birds-trees-climate – model



Kissling, Field, Korntheuer, Heyder, Böhning-Gaese, *in preparation*

Summary

- Models: decline in plant richness for most parts of Africa
- Decline strongest in arid and semi-arid areas
- Large differences across different scenarios and models
- Strong biotic interactions between plants and birds
- Birds depend more on vegetation than directly on climate

Future Visions

- Include functional aspects into models
  - Biotic interaction networks
  - Evolutional / phylogenetic aspects
  - Population dynamics
  - Pollination and dispersal
  - Adaptation capability
  - Ecosystem resiliance
- Incorporate effects of landuse and habitat degradation
- Develop climate change mitigation and adaptation strategies

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German Federal Ministry for Education and Research (BMBF): BIOTA-AFRICA Programme

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