NASA - CI PARTNERSHIP: MAPPING ECOSYSTEMS IN SUB-SAHARAN AFRICA

Dr. Miroslav Honzák

Pretoria, October 2019

CONSERVATION INTERNATIONAL

NASA

PARTNERSHIP GOALS

- Support the Gaborone Declaration for Sustainability in Africa (GDSA) countries in Natural Capital Accounting by developing a **repeatable and easy-to-implement method for mapping of ecosystem extent** at the national scale

- Pilot the methodology in **four GDSA countries** (i.e., Liberia, Gabon, Botswana, and TBD)

GDSA TARGETS

Natural Capital Accounting

- integrate the value of nature into decisions and policies

Sustainable Development

- sustainability reflected in national plans and production systems

Environmental-Economic Monitoring

- ensure decisions reflect change towards sustainability

Corporate Leadership

- accelerate the transformation to sustainability

gaborone declaration
for sustainability
in africa

ECOSYSTEM EXTENT MAPPING

REQUIREMENTS

- Ecosystem extent maps need to move beyond land-cover and capture the underlying ecosystems that provide services
- The maps should be directly applicable and support the development of other SEEA accounts
- The methods need to be replicable, transferable and easy-to-implement at low cost

APPROACH

Lead: Woody Turner
Coordinator: Keith Gaddis
Technical Team:


Dr. Lola Fatoyinbo

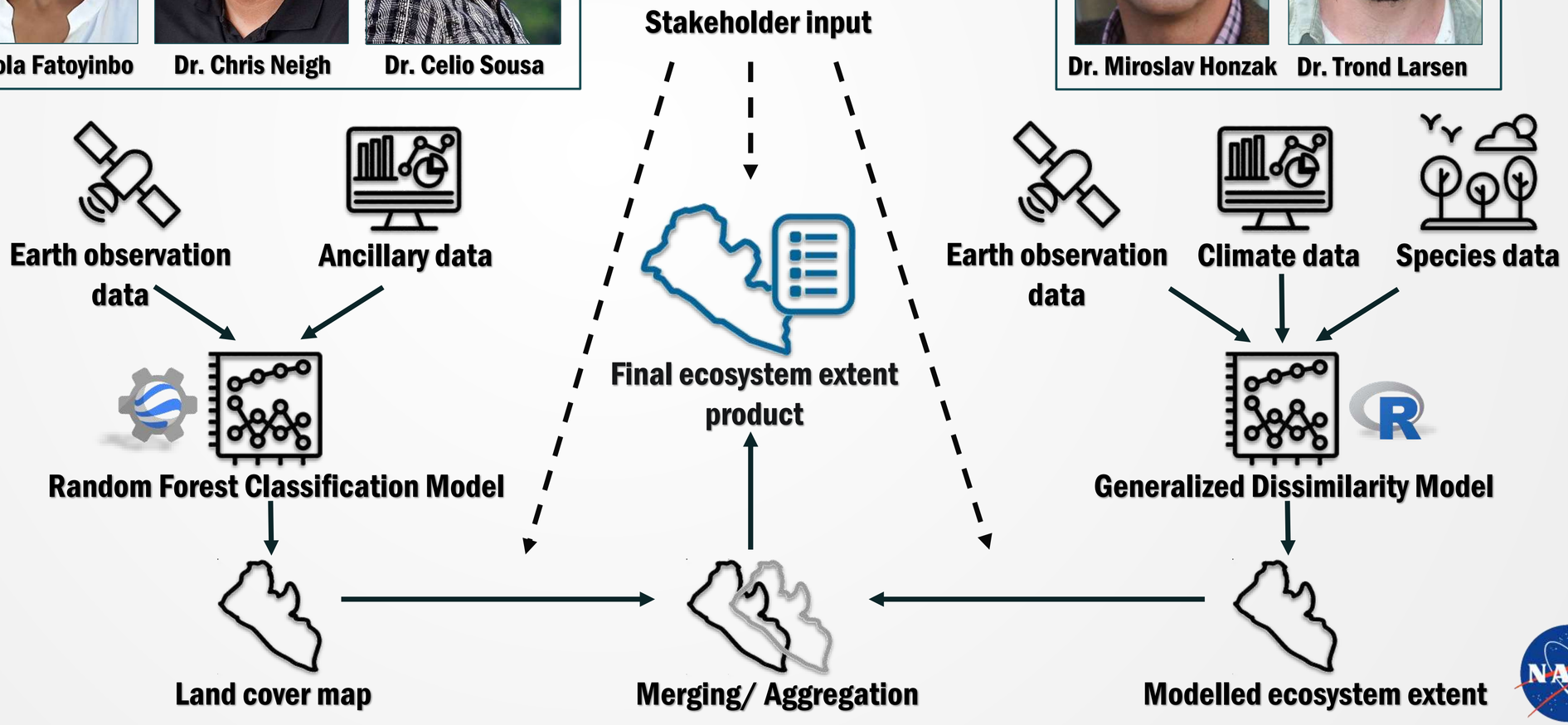

Dr. Chris Neigh


Dr. Celio Sousa

Lead: Daniel Juhn
Technical Team:


Dr. Miroslav Honzak


Dr. Trond Larsen

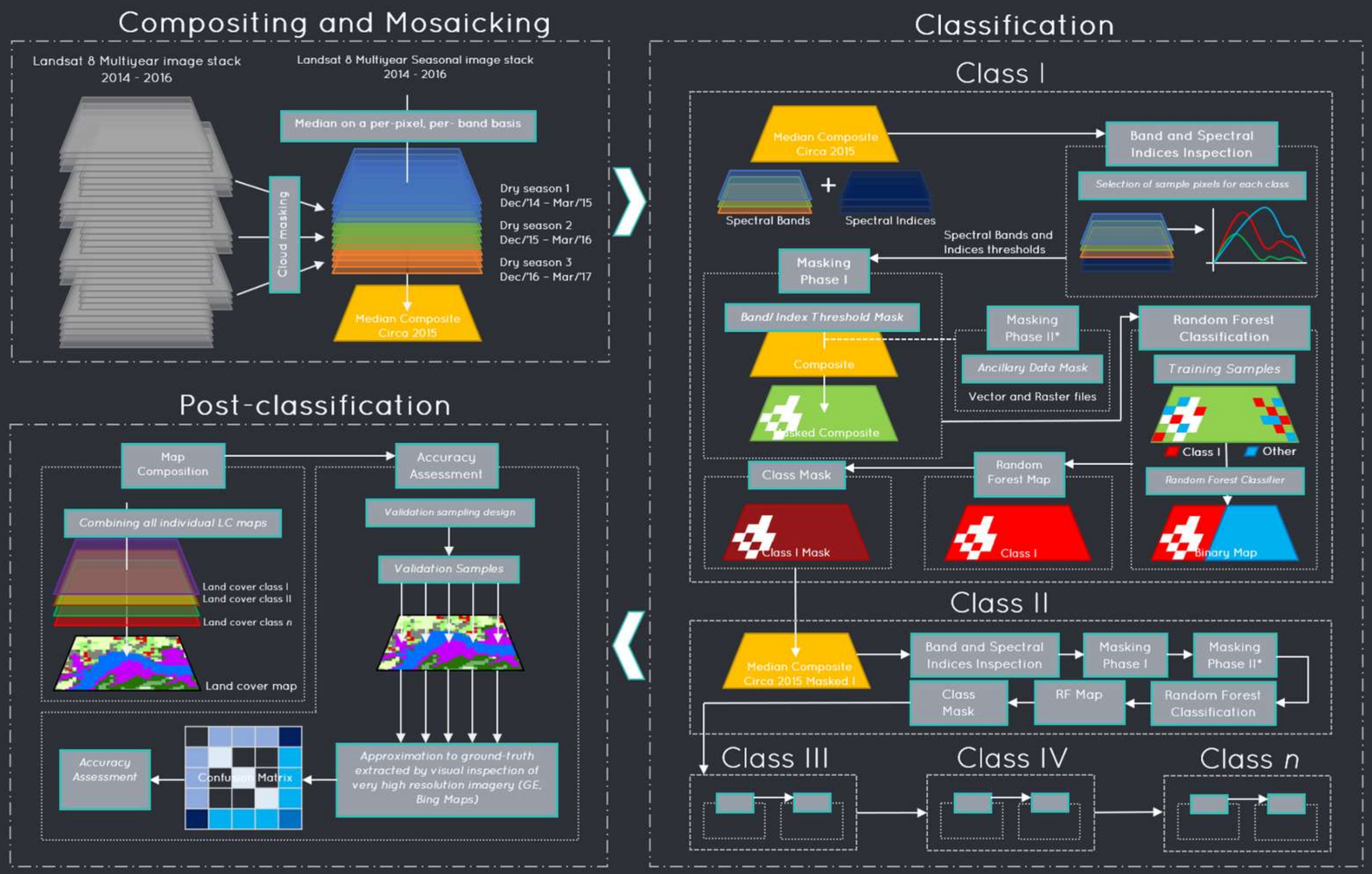


LAND COVER MAPPING

APPROACH

3 Steps

- Data preparation
- Binary classification
- Map composition



NASA TEAM

Why Google Earth Engine™?

- Relatively "unlimited" computational power;
- Easily reproducible by any user with a computer and access to the internet;
- Ultimately transfer this methodology to empower nations to maintain and monitor their natural capital resources.

"With great powers comes great responsability."

Our goal is to develop an approach that yields great quality products.

Robustness and repeatability

Quality of the final product

LIBERIA

Land cover classes

- Literature review.
- 10 initial land cover/ land use classes.

Primary Forest

All areas dominated[1] by broadleaved trees[a] relatively intact or no clear visible indication of human activity.

Grasslands

All areas dominated[1] by hearbaceous type of cover.

Secondary Forest

All areas dominated[1] by broadleaved trees[a] with evidence of human disturbance and or logging history.

Croplands

All areas dominated[1] by non-natural vegetation. Usually followed by harvest and baresoil and/or grasslands.

Mixed Vegetation

All areas dominated[1] by broadleaved trees[a], shrubs, bushes and herbaceous vegetation.

Ecosystem Complex

All areas of sand beaches and intertidal zones.

Water bodies

Water bodies are all areas of open water.

Barren land

All areas characterized by bare rock and/or exposed soil with little or no "green" vegetation.

Mangroves & Wetlands

All areas of vegetative cover where the soil is saturated with or covered with water.

Artificial Surfaces

All areas dominated[1] by buildings and other man-made structures.

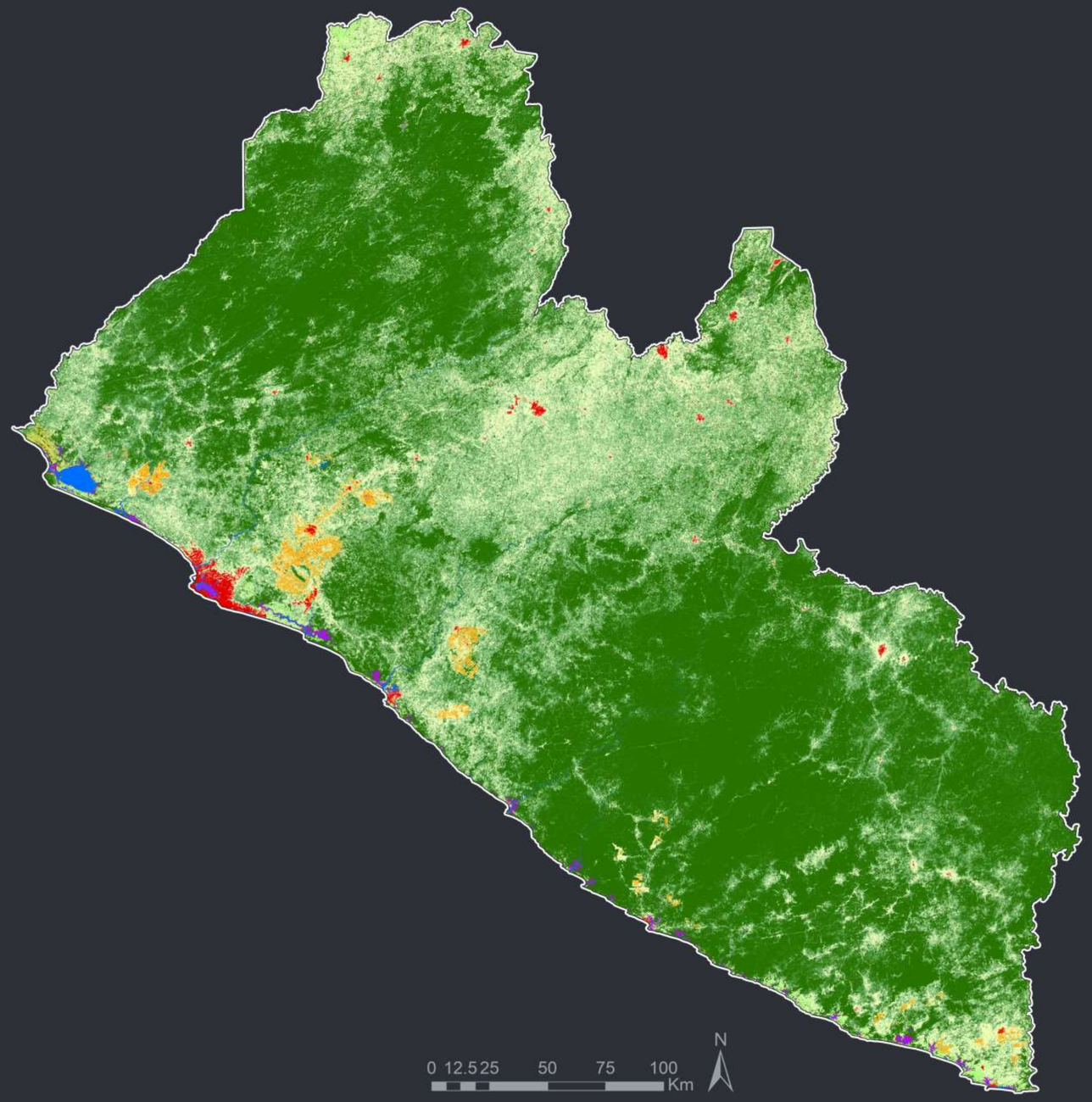
[1] Presence equal or greater than 50% within a 30-m pixel (900 m^2).

[a] Woody vegetation with height equal or greater than 5 meters.

LIBERIA

Land cover classes

- Water bodies
- Mangroves and Wetlands
- Artificial Surfaces
- Barren Land
- Ecosystem Complex
- Croplands
- Grasslands
- Primary Forest
- Secondary Forest
- Mixed Vegetation



Monrovia, Liberia
September 2018

Attendees were part of the Environmental Protection Agency (EPA), Conservation International Liberia (CI – Liberia), Forestry Development Authority (FDA), Ministry of Agriculture, Ministry of Finance and Developing Planning, Liberia Institute of Statistics and Geo-Information Systems (LISGIS), National Fisheries and Aquaculture Authority, University of Liberia, Flora and Fauna International, Society for the Conservation of Nature of Liberia, among others.

GABON

NASA - AGEOS

- NASA and the Agence Gabonaise d'Études et d'Observations Spatiales;
- Remote sensing analysists from AGEOS visited Goddard on June 2018;
- Training and capacity building;
- Test the repeatability of our approach;
- Land cover map for Gabon;

GABON

Land cover classes

- Literature review.
- 9 initial land cover/ land use classes:

1 class was subdiveded into 2 sub-classes based on seasonal occurrence.

Flooded Forests

All areas dominated[1] by broadleaved trees[a] along rivers and streams subject to dramatic water fluctuations and seasonal flooding.

Primary Forest

All areas dominated[1] by broadleaved trees[a] relatively intact or no clear visible indication of human activity.

Grasslands

All areas dominated[1] by hearbaceous type of cover.

Secondary Forest

All areas dominated[1] by broadleaved trees[a] with evidence of human disturbance and or logging history.

Croplands

All areas dominated[1] by non-natural vegetation. Usually followed by harvest and baresoil and/or grasslands.

Water bodies

Water bodies are all areas of open water.

Barren land

All areas characterized by bare rock and/or exposed soil with little or no "green" vegetation.

Mangroves & Wetlands

All areas of vegetative cover where the soil is saturated with or covered with water.

Artificial Surfaces

All areas dominated[1] by buildings and other man-made structures.

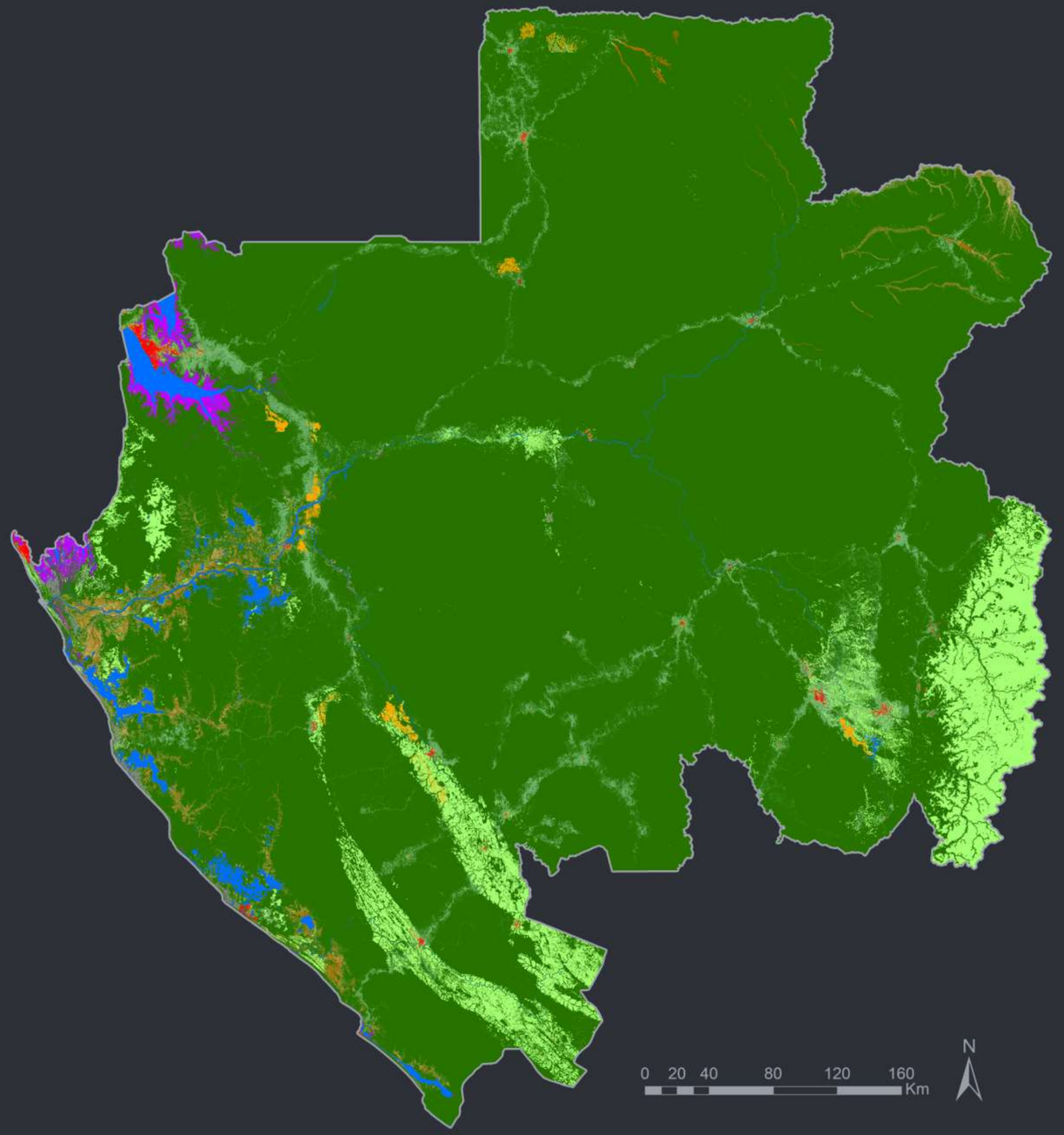
[1] Presence equal or greater than 50% within a 30-m pixel (900 m^2).

[a] Woody vegetation with height equal or greater than 5 meters.

GABON

Land cover classes

- Water bodies
- Mangroves and Wetlands
- Artificial Surfaces
- Barren Land
- Croplands
- Grasslands/Savanna
- Flooded Forests (Permanent)
- Flooded Forests (Seasonal)
- Primary Forests
- Secondary Forests



Libreville, Gabon
March 2019

The GDSA Secretariat held a workshop in Libreville to meet with stakeholders and understand the in-country priorities for implementing the GDSA. The workshop consisted of several presentations by Conservation International, NASA, AGEOS and the GDSA Secretariat. Our visit to Gabon also included meetings with the Managing Director from the ANPN (National Agency for National Parks) - Professor Lee White - and the Minister of Industry, Carmen Ndaot. We also visited AGEOS facilities and included a field component at Pongara National Park. Photos: Miroslav Honzak and Celio Sousa

BOTSWANA

Land cover classes

- Literature review.
- 8 initial land cover/ land use classes:

2 classes were subdivided into 2 sub-classes based on density of cover and seasonal occurrence.

Open Water

All areas of open water (permanent and seasonal)

Wetlands

All areas of vegetative cover where the soil is saturated with or covered with water.

Grasslands

All areas dominated[1] by hearbaceous type of cover.

Salt pans

All areas dominated[1] by flat expanses of ground covered with salt.

Open Shrublands

All areas covered[2] by vegetation including shrubs[a] and grasses.

Artificial Surfaces

All areas dominated[1] by buildings and other man-made structures.

Closed Shrublands

All areas dominated[1] by vegetation including shrubs[a] and grasses.

Croplands

All areas dominated[1] by non-natural vegetation. Usually followed by harvest and baresoil and/or grasslands.

Open Woodlands

All areas covered[2] by low density tree[b] cover.

Closed Woodlands

All areas dominated[1] by low density tree[b] cover.

[1] Presence equal or greater than 50% within a 30-m pixel (900 m^2).

[2] Presence equal or lower than 50% within a 30-m pixel (900 m^2).

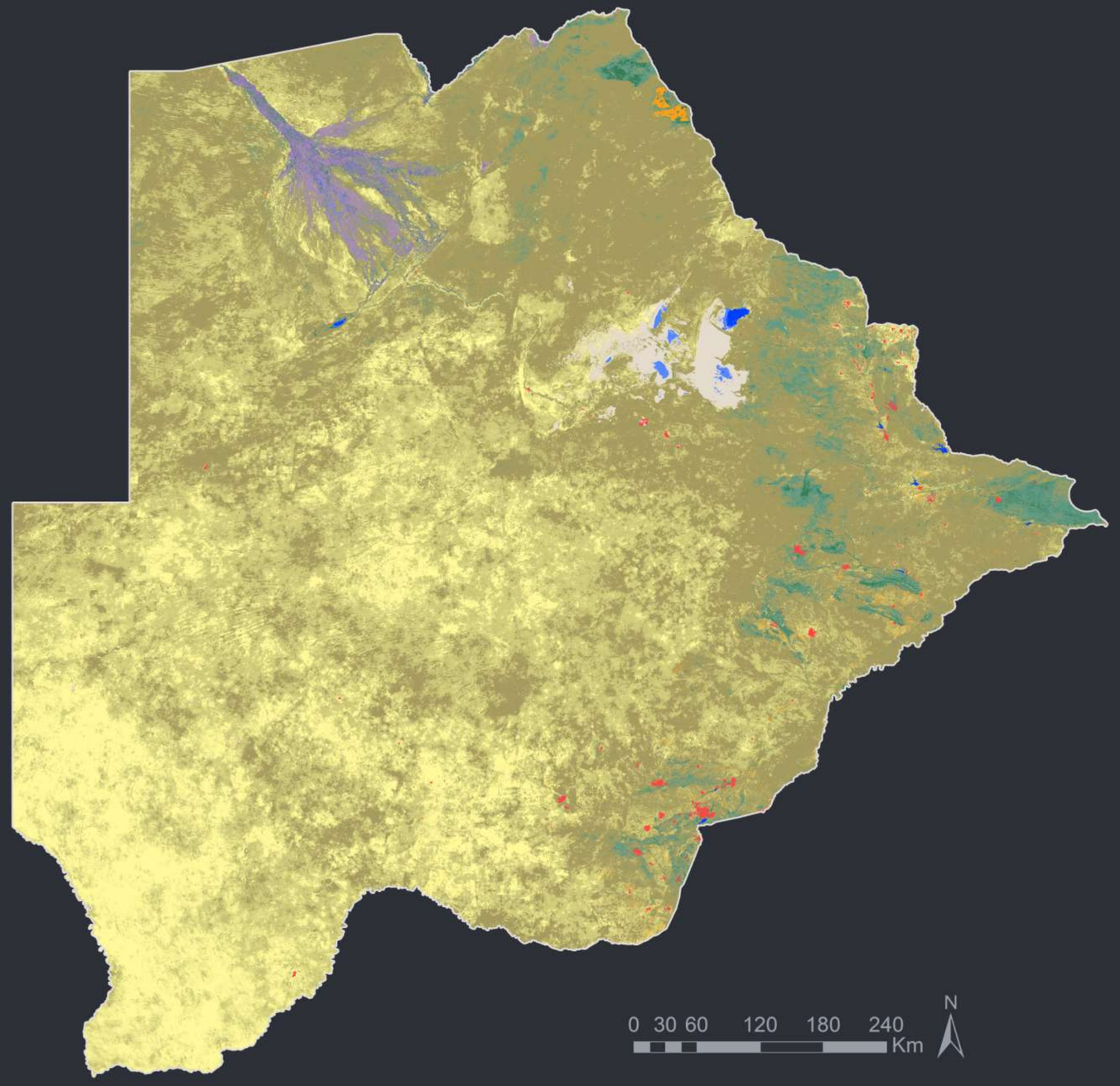
[a] Small- to medium-sized woody plants.

[b] Woody vegetation with height equal or greater than 5 meters.

BOTSWANA

Land cover classes

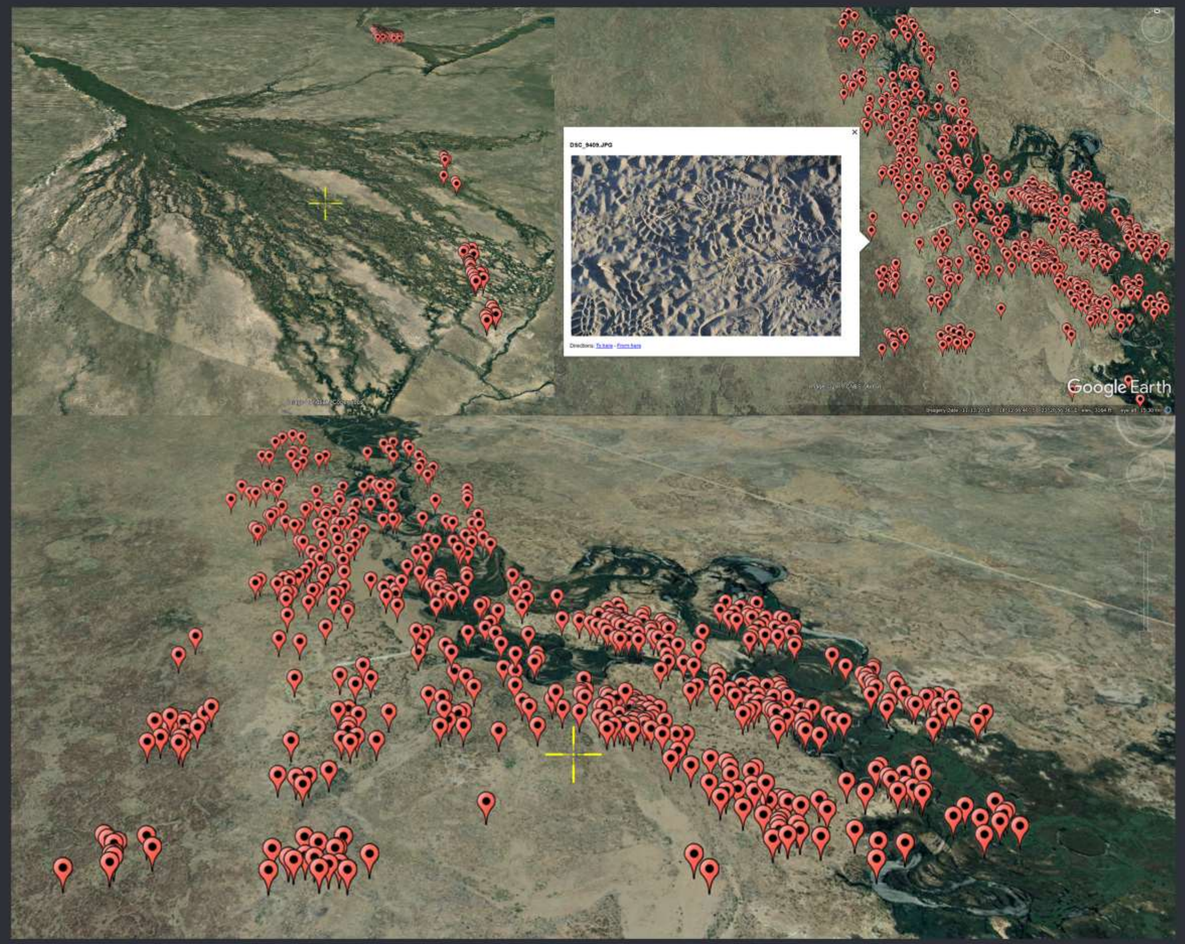
- Open water (Permanent)
- Open water (Seasonal)
- Wetlands (Permanent)
- Wetlands (Seasonal)
- Salt Pans
- Artificial surfaces
- Croplands
- Closed woodlands
- Open woodlands
- Closed shrublands
- Open shrublands
- Grasslands



Gaborone & The Okavango Delta, Botswana
July 2019

NASA and Conservation International Teams in Botswana. The proximity of Kwando Lagoon Camp todifferent types of vegetation and ecosystems allowed the teams to collect a vast amount of ground data. In Gaborone, all the members from NASA-CI teams presented on their role in the partnership.

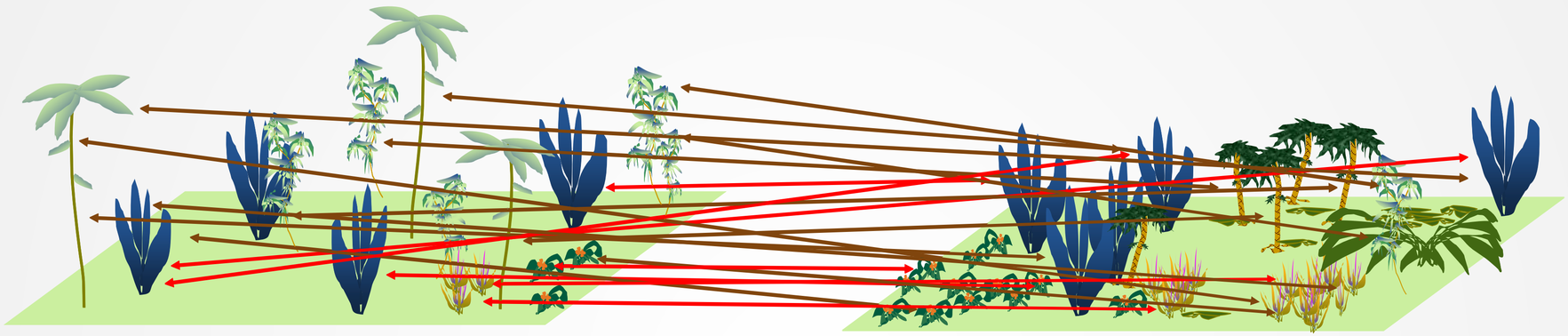
Gaborone & The Okavango Delta, Botswana
July 2019



One hour long low altitude flight from Maun to the airstrip serving the camp. The teams took advantage of this flight to collect aerial photographs along the flight line. Also, the team was able to take advantage of the game drives offered by the camp tovisit different vegetation types. Ground photographs as well as GPS points were collected in every location

GENERALIZED DISSIMILARITY MODELING

GENERALIZED DISSIMILARITY MODEL

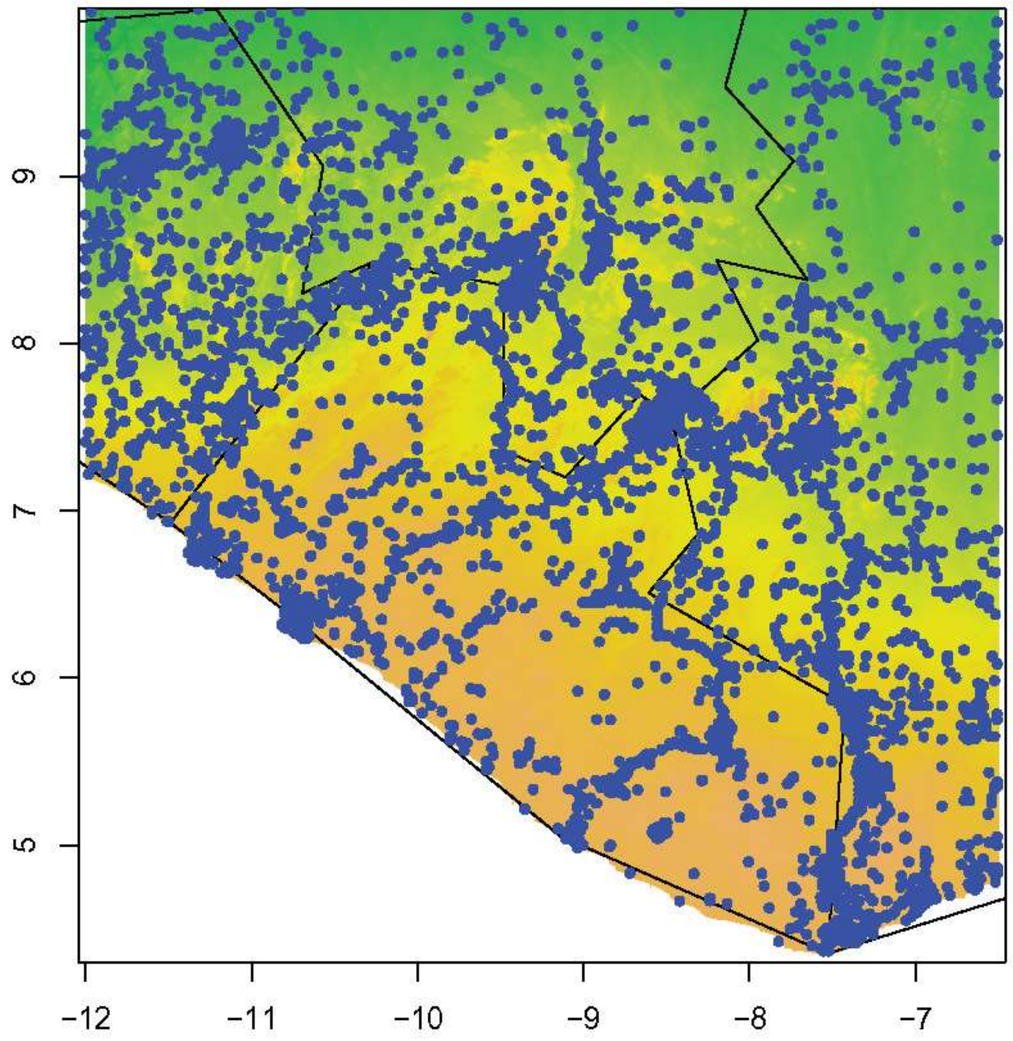


- GDM is a statistical technique for modelling compositional dissimilarity (beta diversity)
- It measures the proportion of species in a given biological group (e.g., reptiles) occurring at one location that do not occur at a second location – as a function of the environmental characteristics of these two locations.
- It is used to predict the compositional dissimilarity between any two locations within the region, regardless of whether biological data are available for these locations.

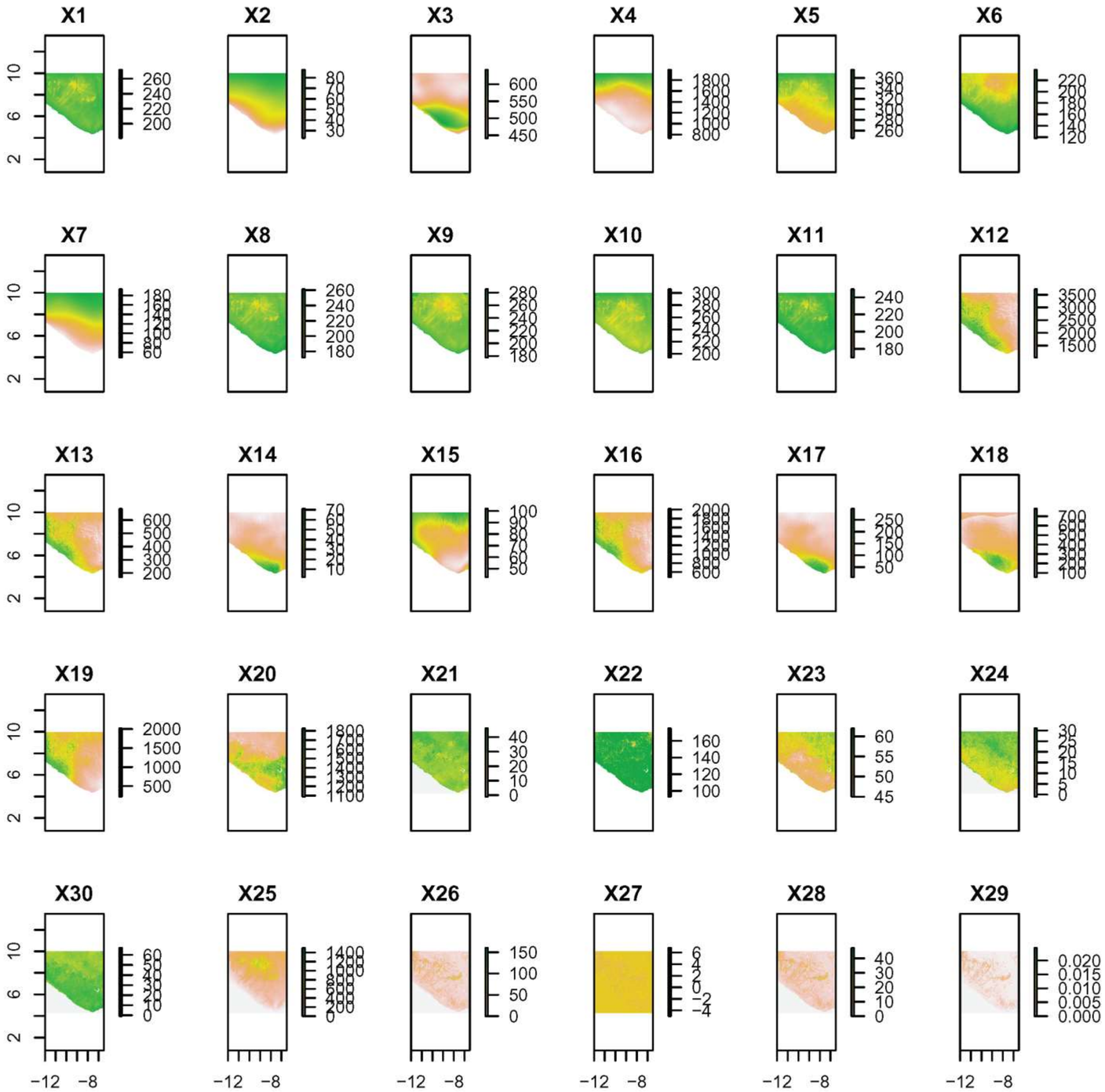
BIEN DATASET FOR LIBERIA

Input species data used (BIEN, V. 4.1):

- 57,452 observations
- 4,166 unique species



X1 = Annual Mean Temperature
X2 = Mean Diurnal Range
X3 = Isothermality
X4 = Temperature Seasonality
X5 = Max Temperature of Warmest Month
X6 = Min Temperature of Coldest Month
X7 = Temperature Annual Range
X8 = Mean Temperature of Wettest Quarter
X9 = Mean Temperature of Driest Quarter
X10 = Mean Temperature of Warmest Quarter
X11 = Mean Temperature of Coldest Quarter
X12 = Annual Precipitation
X13 = Precipitation of Wettest Month
X14 = Precipitation of Driest Month
X15 = Precipitation Seasonality
X16 = Precipitation of Wettest Quarter
X17 = Precipitation of Driest Quarter
X18 = Precipitation of Warmest Quarter
X19 = Precipitation of Coldest Quarter
X20 = Soil bulk density
X21 = Soil clay content
X22 = Soil depth
X23 = Soil Ph
X24 = Soil silt content
X30 = Soil sand content
X25 = Elevation
X26 = Roughness
X27 = Topographic Position Index (TPI)
X28 = Terrain Ruggedness Index (TRI)
X29 = Vector Ruggedness Measure (VRM)



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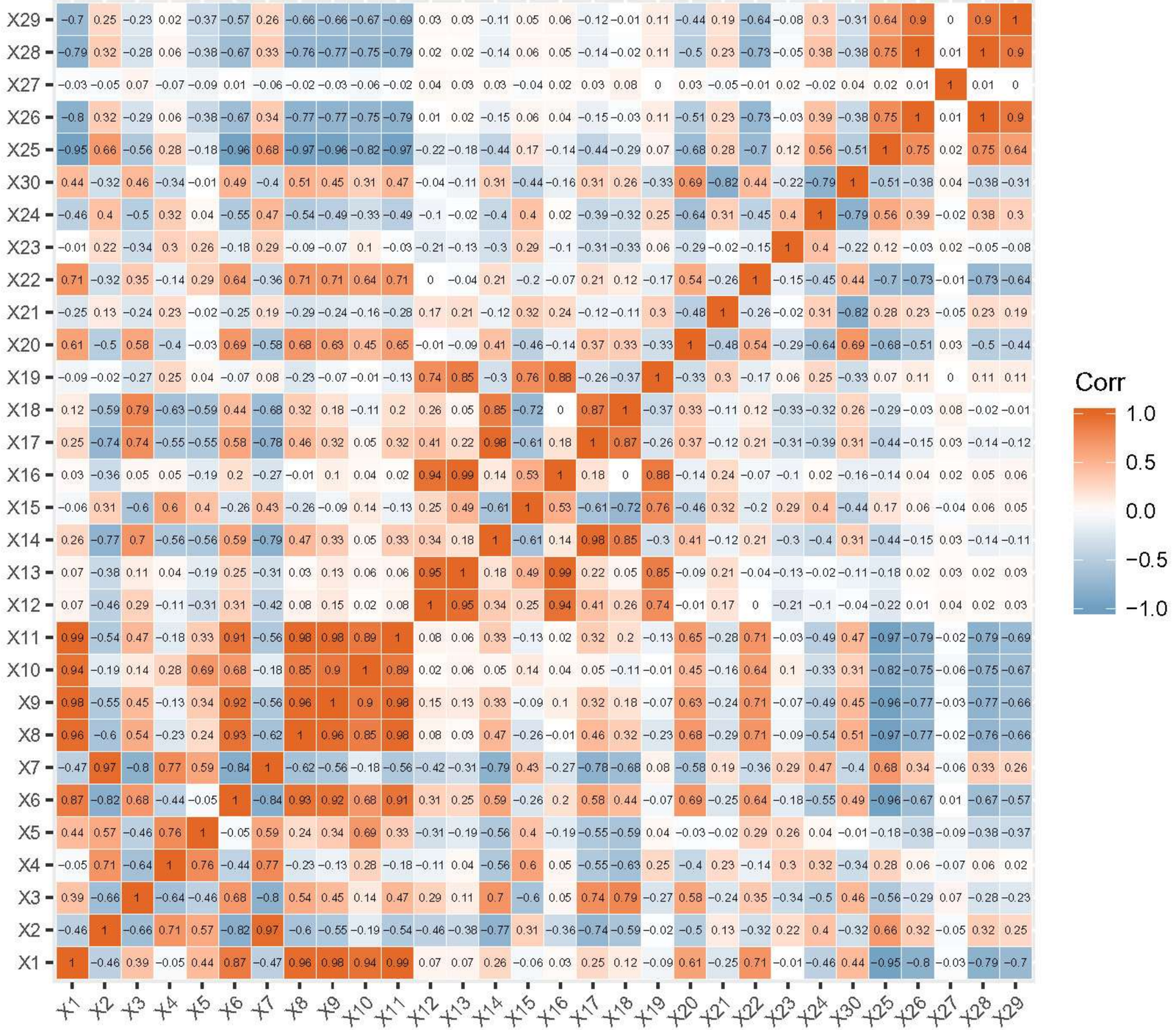
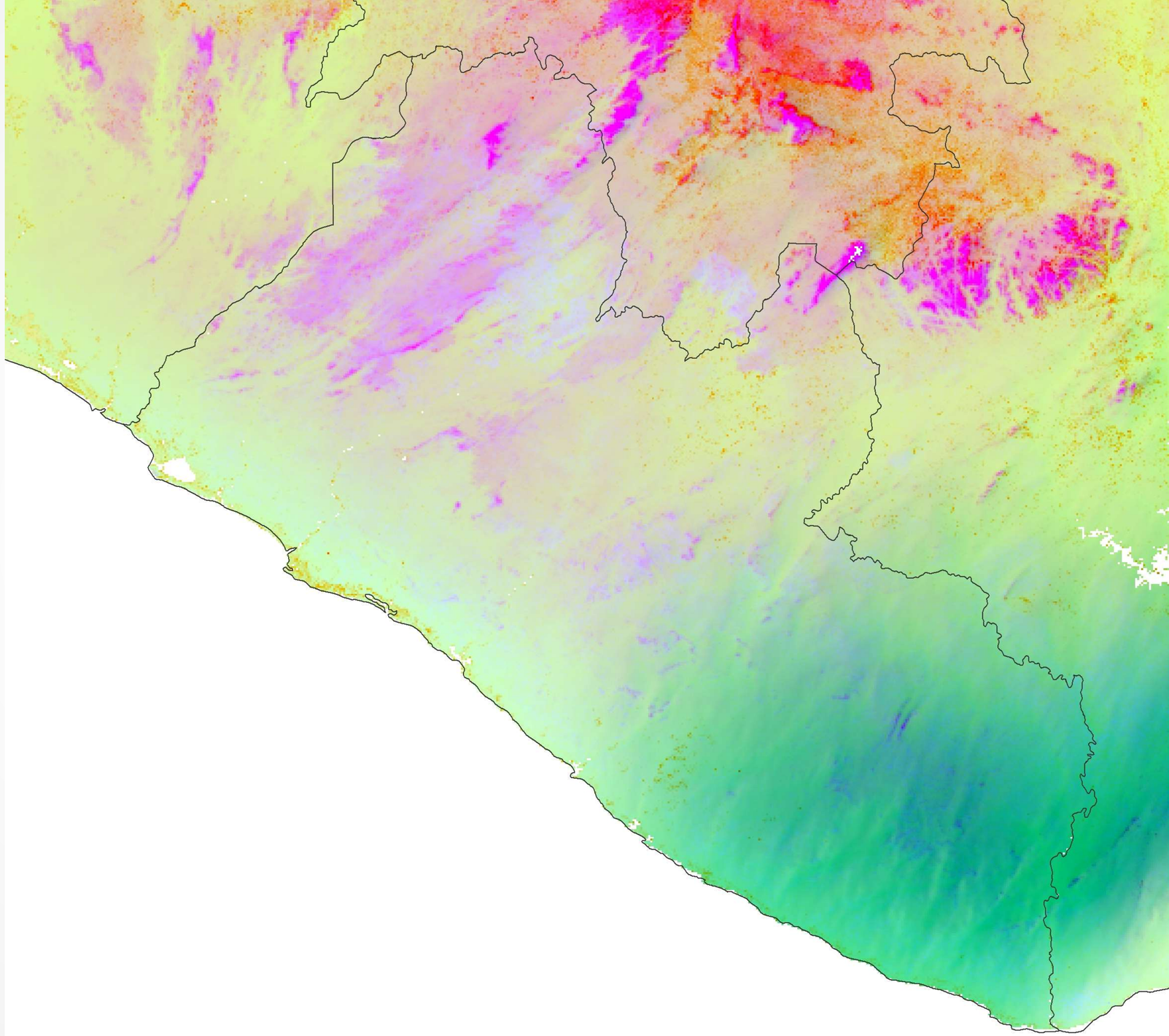
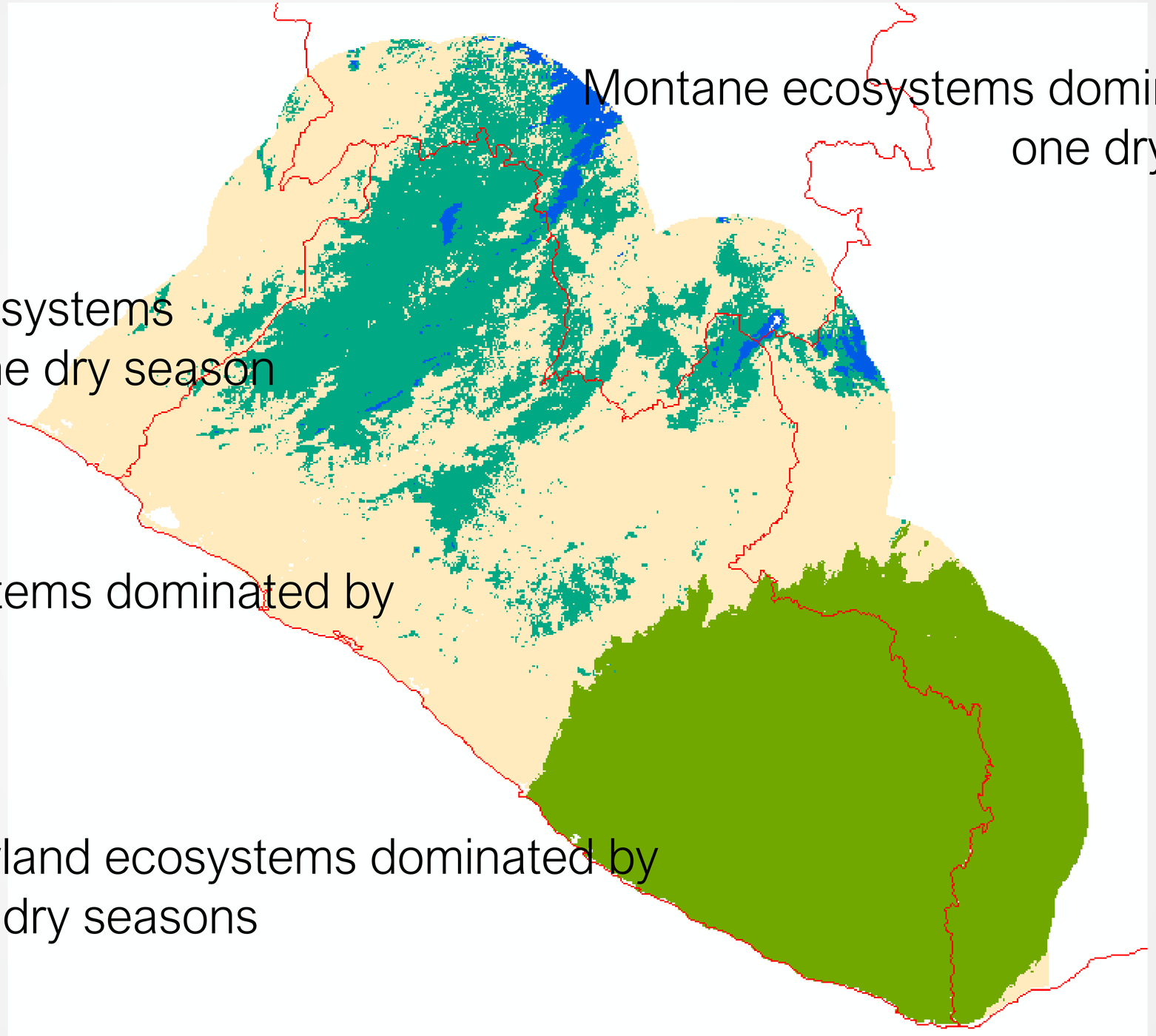


RESULTS (RAW OUTPUT)

- False color composite of the first three principal components (PCA)



ASSIGNING LABELS



COMBINING THE TWO PRODUCTS

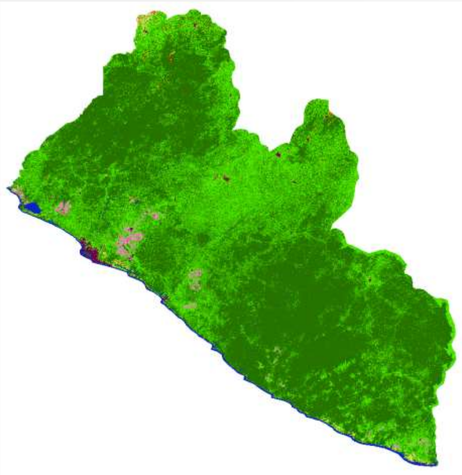
OVERLAY ANALYSIS

Inputs:

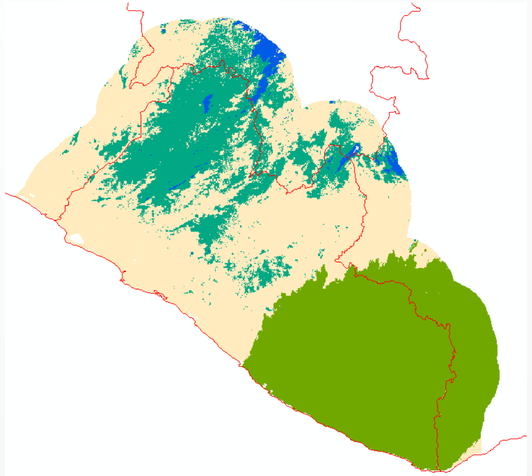
- Land cover map (13 classes)
- Map of potential distribution of ecosystems (4 classes)

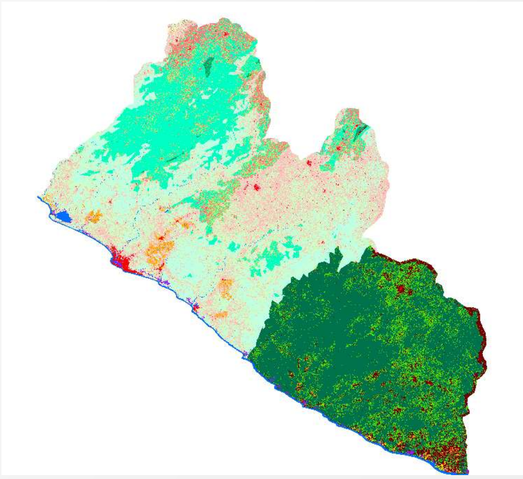
Output:

- Combined map (23 classes)

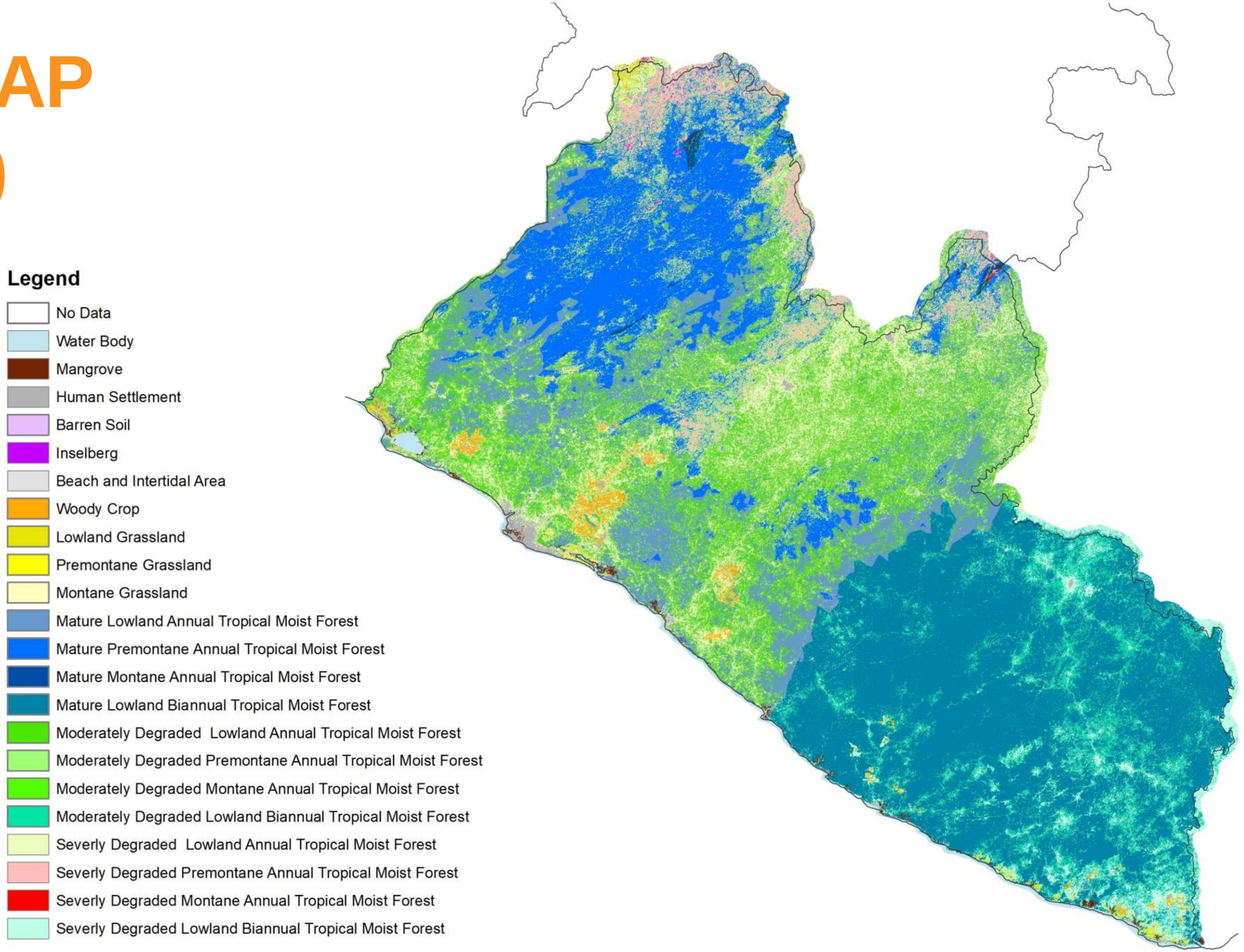


Overlay matrix





COMBINED MAP (23 CLASSES)



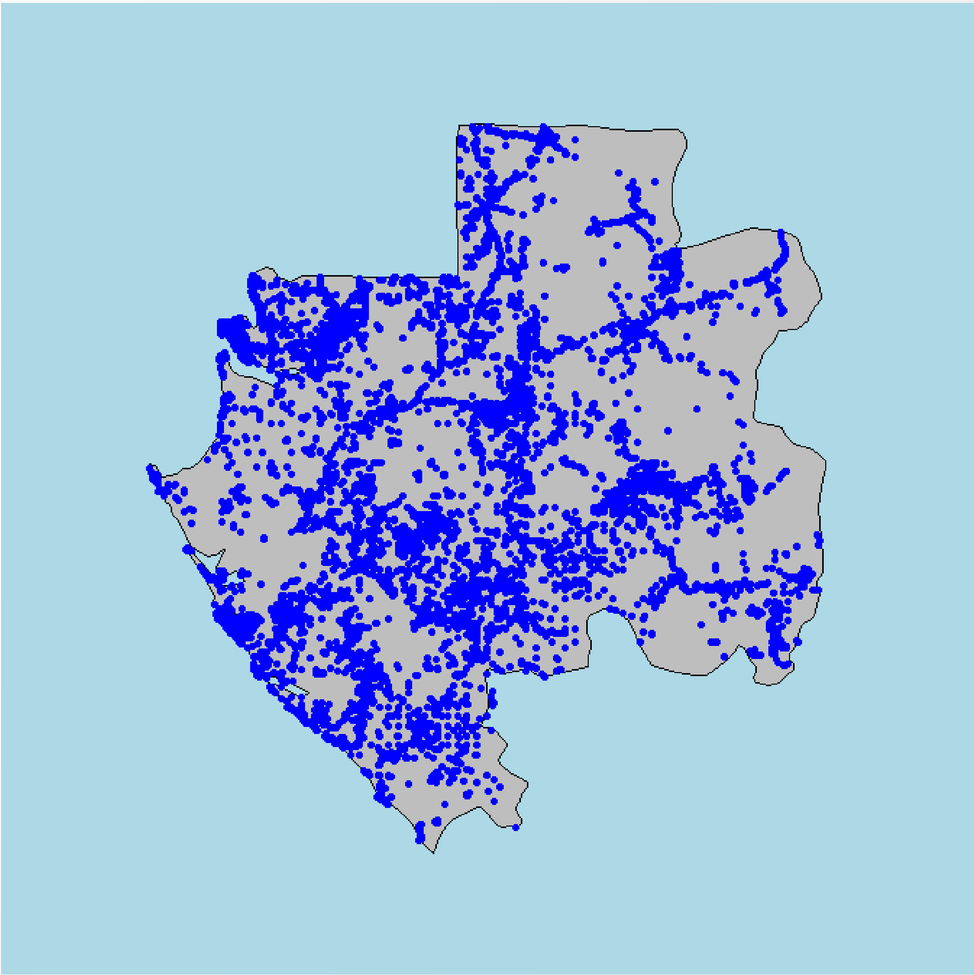
SUMMARY

- The method developed in Liberia is a compromise between state of the art and easy-to-implement methodologies.
- We hope it will be applicable for other countries with minimal modifications; we plan to test it in Gabon and Botswana).
- Ground-truthing data and involvement of in-country experts is essential.

GABON – SNEAK PREVIEW

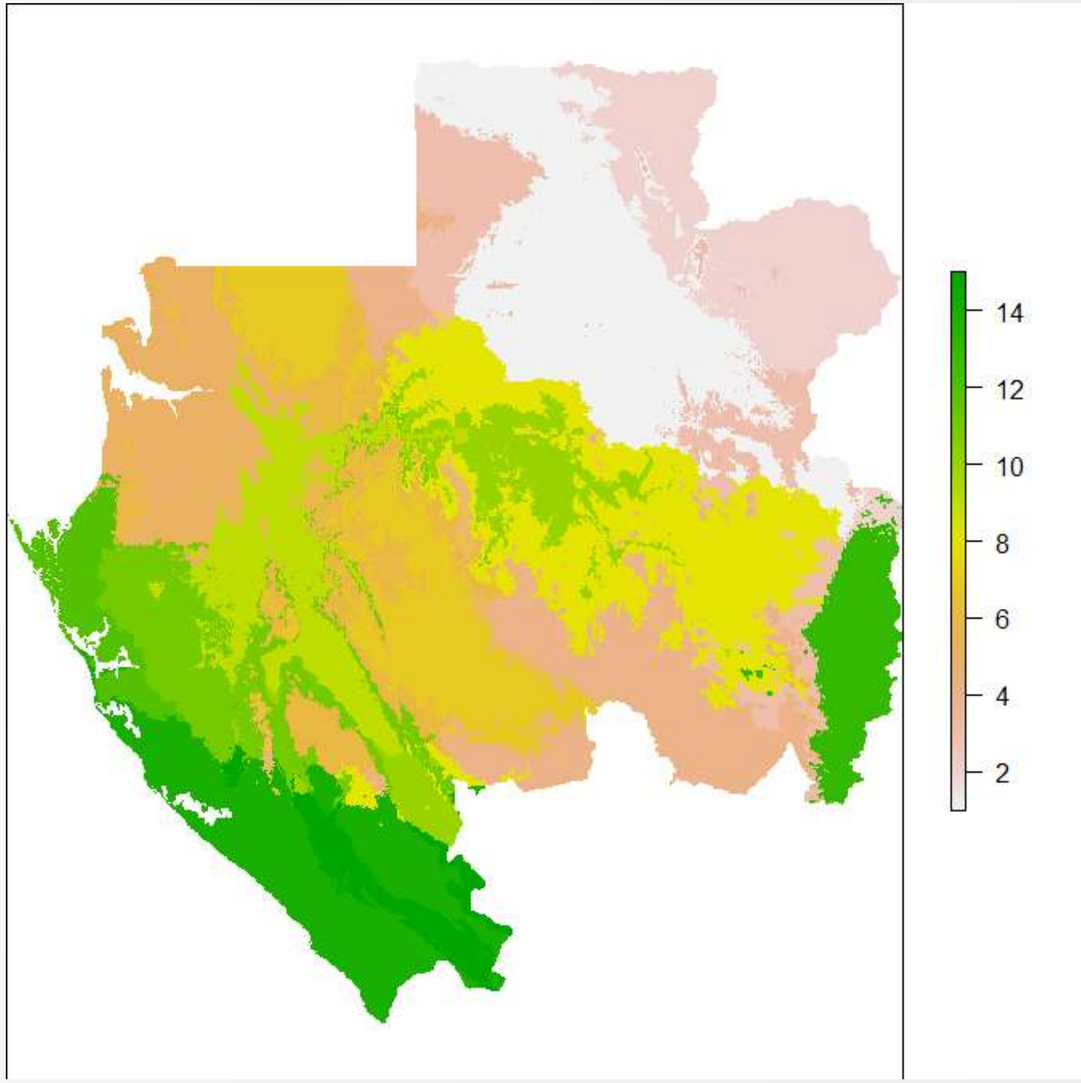
Input data (BIEN V 4.1):

- 109,722 observations
- 5,525 unique species



INITIAL GDM OUTPUT

- Unsupervised classification (n=15) of a GDM output based on spp. Records from public-access-BIEN, WorldClim bioclimatic variables, Africa Soils Atlas soil types map and NASA’s SRTM terrain data



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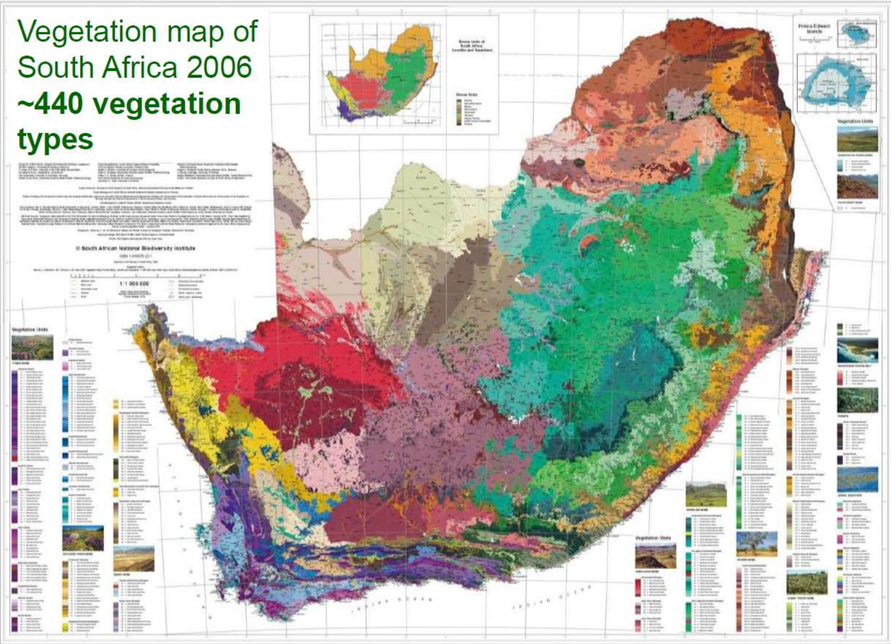

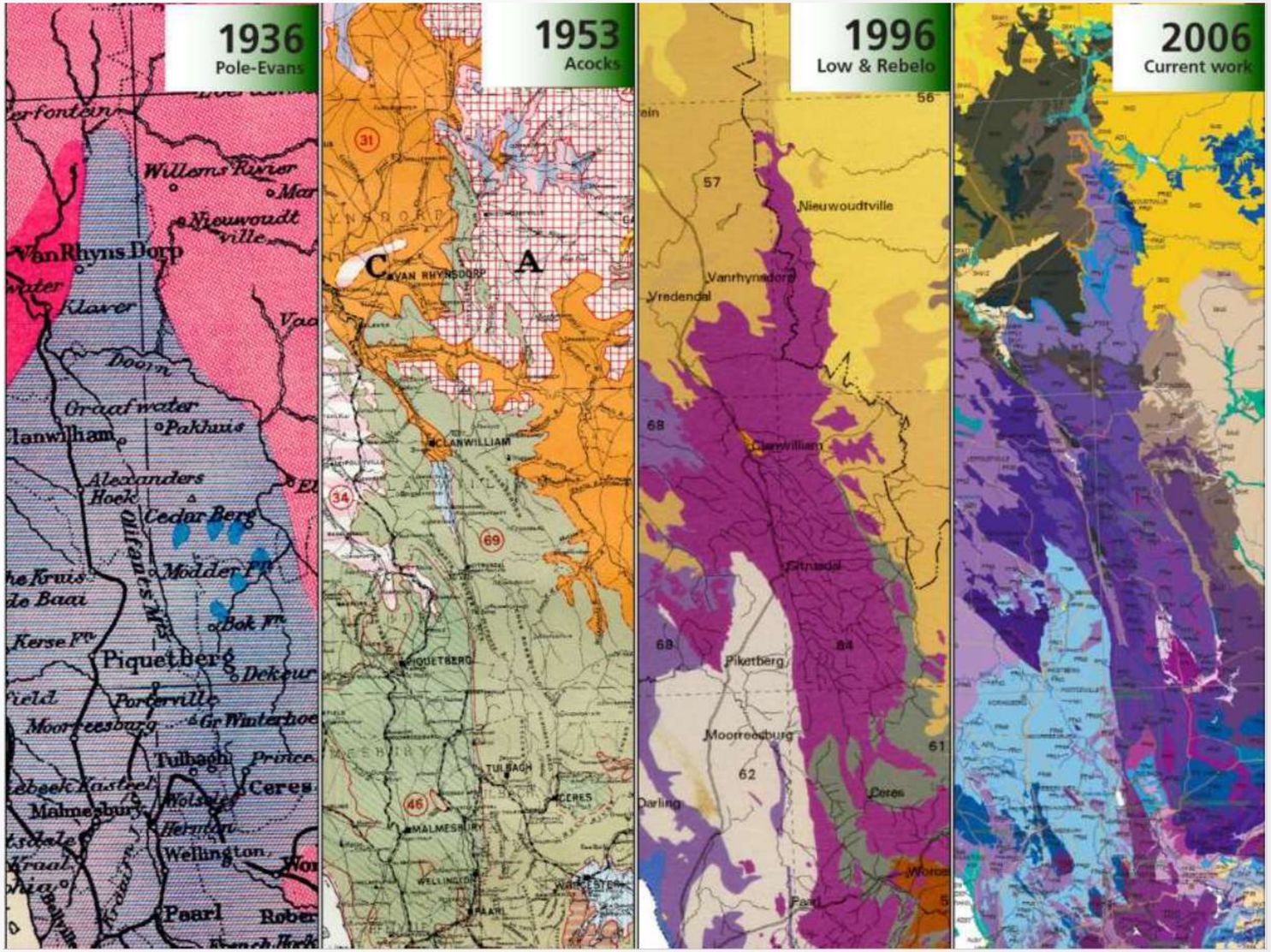

It took seven decades to refine it .


THANK YOU!
CONSERVATION
INTERNATIONAL
NASA