



**A new analytical framework for the classification
of tropical forests and woodlands by taking into
account their ecological diversity and
degradation**

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EUROPEAN UNION DEFORESTATION REGULATION

EN

Official Journal of the European Union

**REGULATION (EU) 2023/1115 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 31 May 2023**

on the making available on the Union market and the export from the Union of certain commodities and products associated with deforestation and forest degradation and repealing Regulation (EU) No 995/2010



EUROPEAN UNION DEFORESTATION REGULATION (EUDR)

Article 2 - Definitions

'forest' means land spanning more than **0,5 hectares with trees higher than 5 meters and a canopy cover of more than 10 %**, or trees able to reach those thresholds in situ, excluding land that is predominantly under agricultural or urban land use;

>> FAO (2001). Global Forest Resources Assessment 2000

>> Wide range of ecosystems

LIMITATIONS OF A SINGLE FOREST DEFINITION

Limitations for implementing the regulation in different **ecological contexts**

Disregard of **degradation level**

Conflict with **national definitions**



???

LIMITATIONS OF A SINGLE FOREST DEFINITION

AMAZON FORESTS



↑Tree cover
↑Vegetation height

LIMITATIONS OF A SINGLE FOREST DEFINITION

AMAZON FORESTS



preserved

degraded

LIMITATIONS OF A SINGLE FOREST DEFINITION

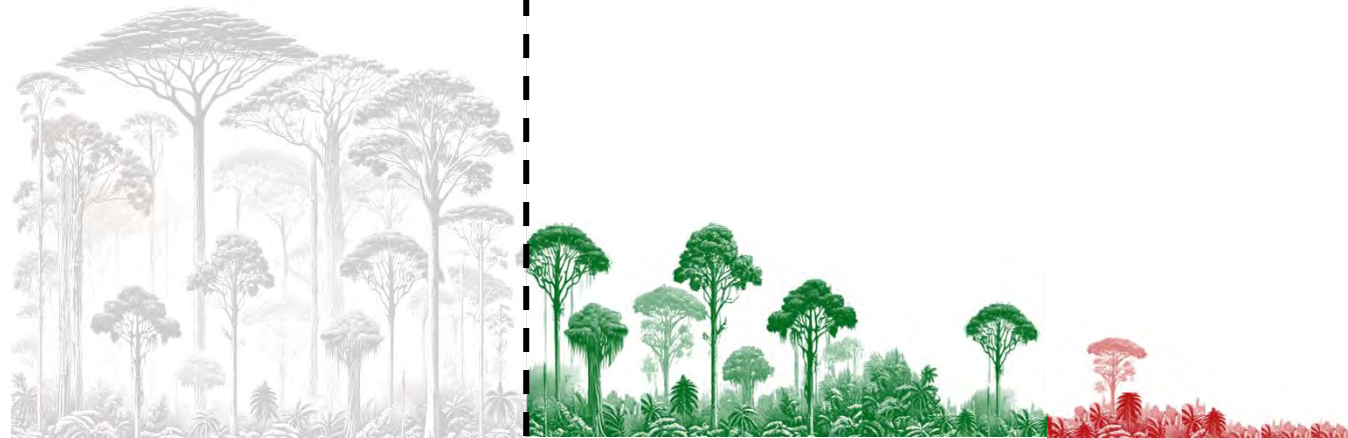
CAATINGA FORESTS



↓ Tree cover
↓ Vegetation height

LIMITATIONS OF A SINGLE FOREST DEFINITION

CAATINGA FORESTS



preserved

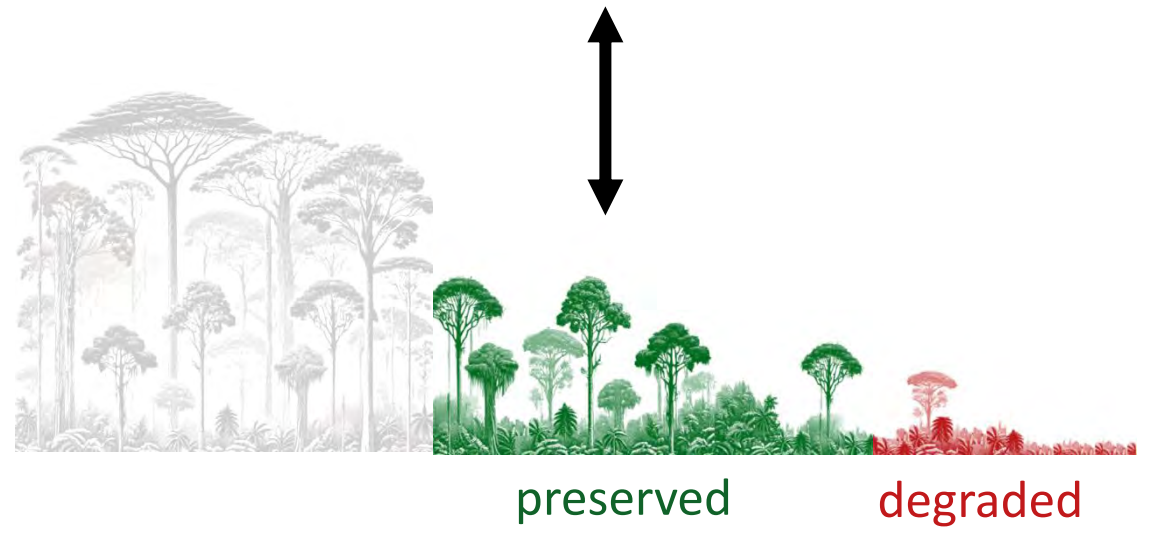
degraded

LIMITATIONS OF A SINGLE FOREST DEFINITION

AMAZON FORESTS



CAATINGA FORESTS





STUDY OBJECTIVE

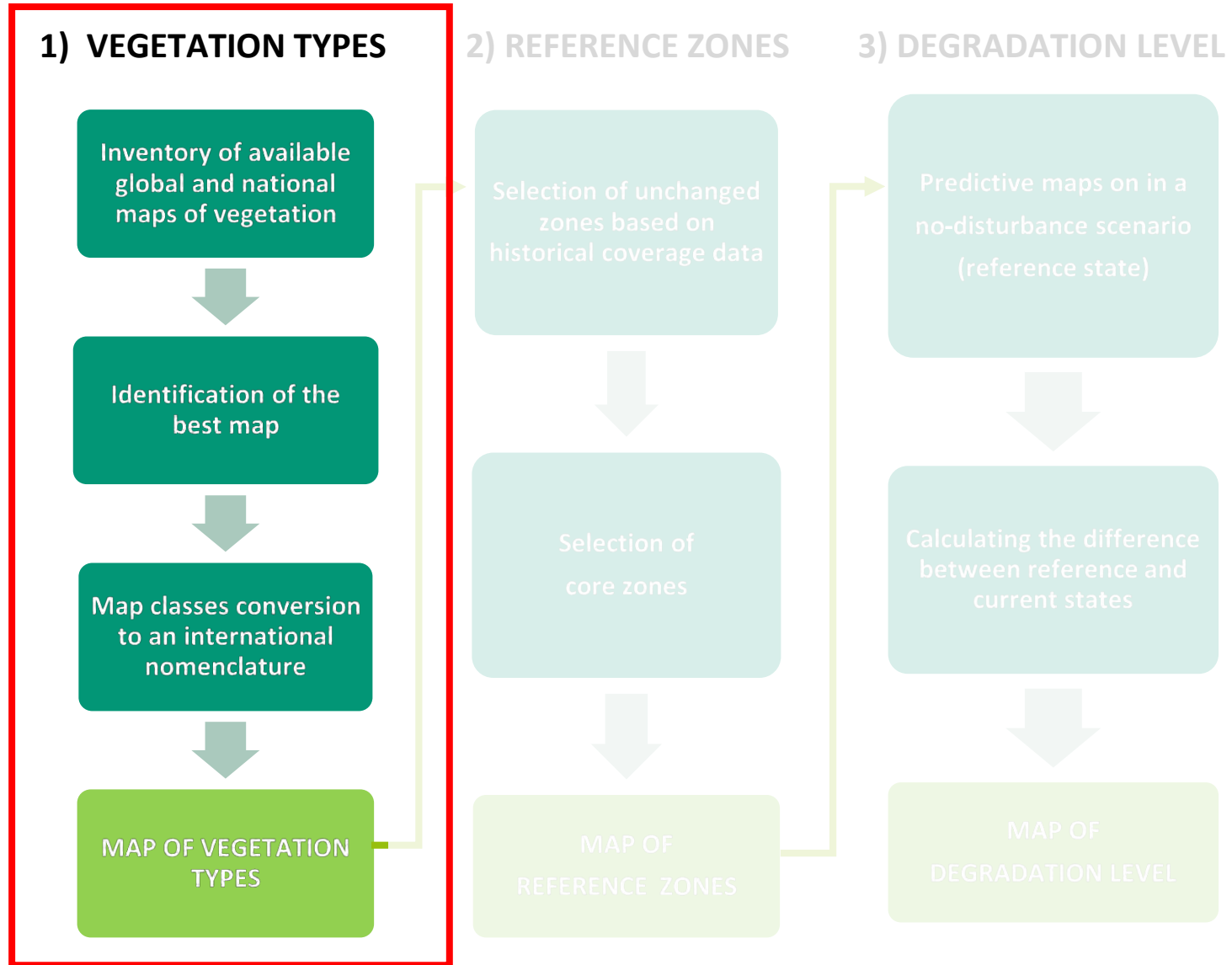
Propose a classification system for tropical forests and woodlands taking into account ecosystems diversity and their degradation level

Study areas: Brazil and Cameroon

Specific targets:

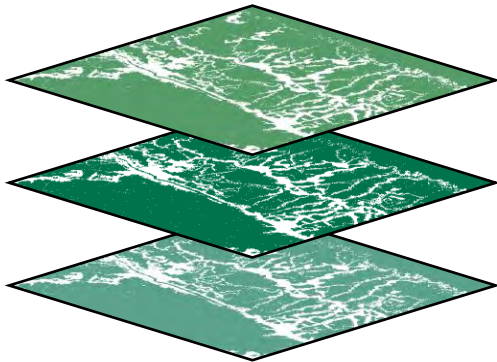
1. Produce a map of **vegetation types** based on a international classification system
2. For forests and woodlands:
 - Identify **reference zones**
 - Analyze **degradation level**

PROPOSED ANALYTICAL FRAMEWORK



1) VEGETATION TYPES – METHODS OVERVIEW

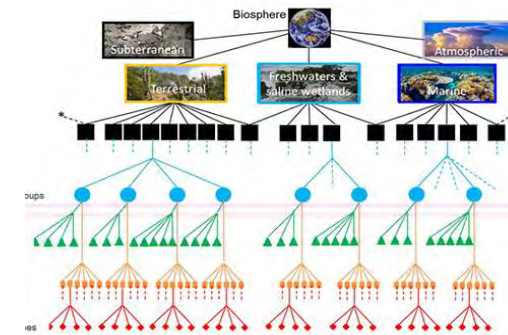
Data collection:
Available vegetation maps



Data selection:
Best map

- Scale
- Class detail
- Quality of sources
- Date
- Validation

Classes Conversion:
IUCN Ecosystem Classification (Keith, 2020)



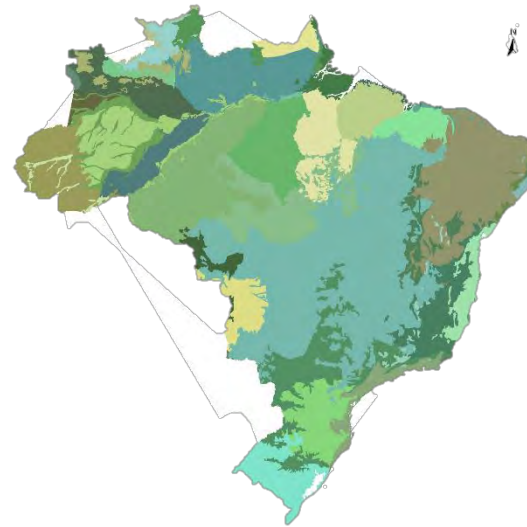
1) VEGETATION TYPES – AVAILABLE MAPS FOR BRAZIL



**FAO, 2012
GLOBAL ECOZONES**

Ecofloristic zones maps
(Lavenu 1988 ; Sharma 1988)
Expert meetings

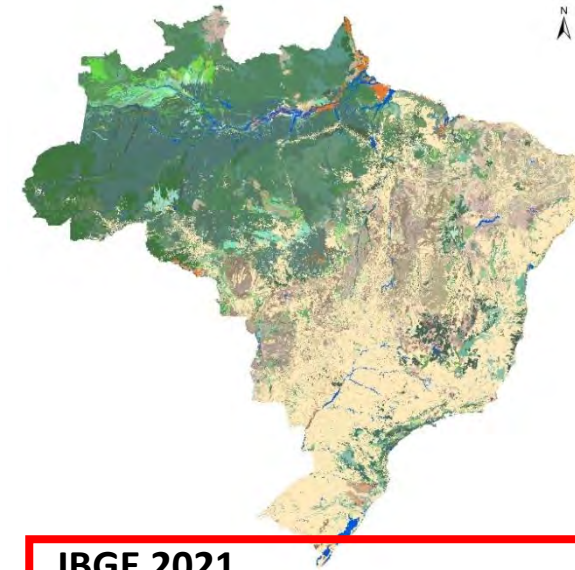
- Pros and Cons (+/-)
- Scale 1:5.000.000
 - Few classes
 - + International nomenclature



**WWF/RESOLVE 2017
ECOREGIONS**

Global biomes and climate maps
(1960s - 1990s)
Regional data (IBGE, 1993)
Expert meetings

- Pros and Cons (+/-)
- + Widely Used
 - Scale?
 - Local nomenclature

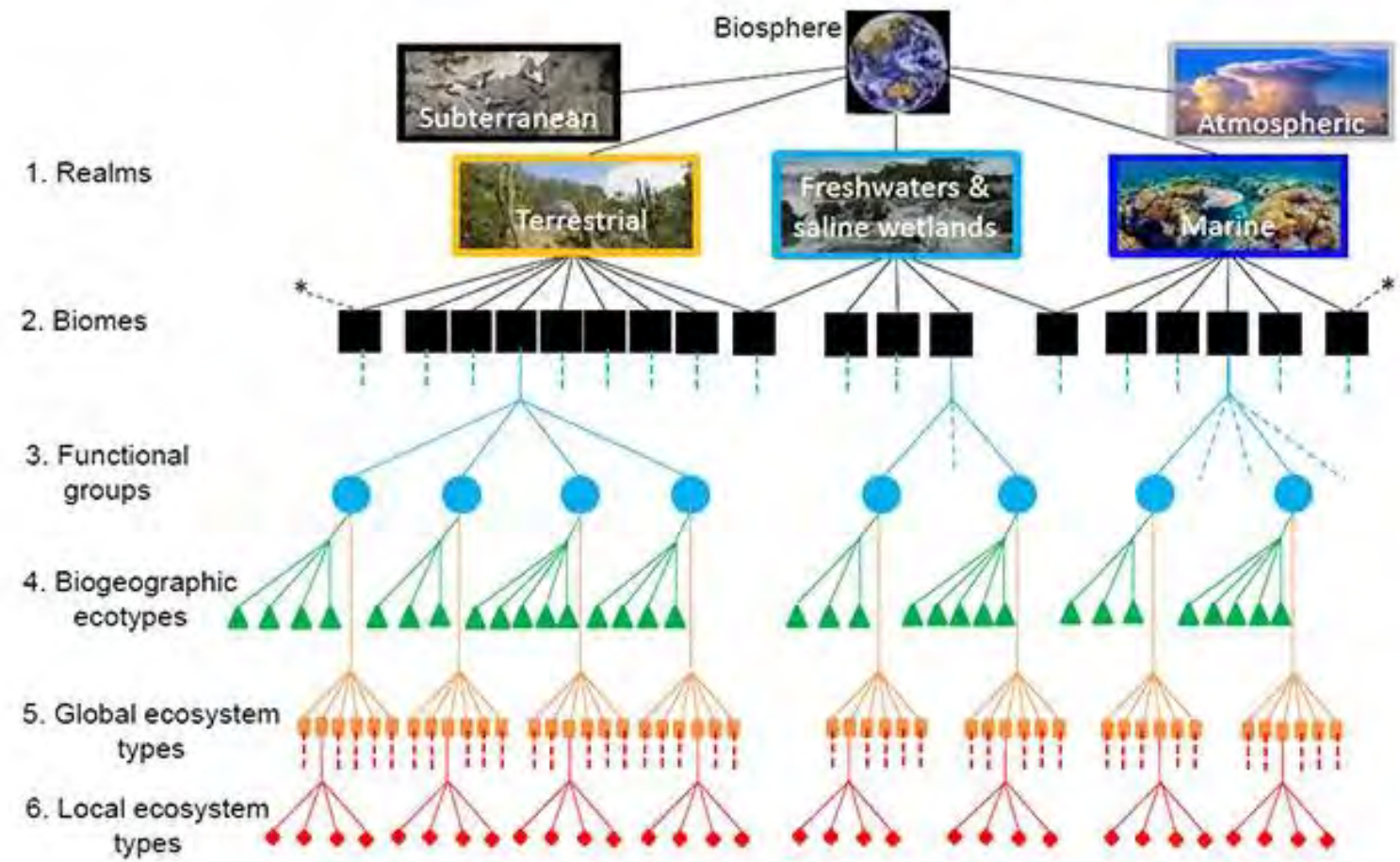


**IBGE 2021
MAP OF VEGETATION**

Interpretation of LANDSAT images
>8500 field points
Support bases (SRTM, Geology, Pedology,
Geomorphology and Climate)
Expert meetings

- Pros and Cons (+/-)
- + Best Scale (1:250,000)
 - + Detailed Classes
 - National nomenclature

1) VEGETATION TYPES - IUCN ECOSYSTEM CLASSIFICATION



1) VEGETATION TYPES - IUCN ECOSYSTEM CLASSIFICATION

Realm

T Terrestrial ×

Also see the 6 transitional realms for related biomes

Select a Biome

T1 Tropical-subtropical forests biome

T2 Temperate-boreal forests and woodlands biome

T3 Shrublands and shrubby woodlands biome

T4 Savannas and grasslands biome

T5 Deserts and semi-deserts biome

T6 Polar/alpine (cryogenic) biome

T7 Intensive land-use biome

Biome

T1 Tropical-subtropical forests biome

Select a Functional Group

T1.1 Tropical/Subtropical lowland rainforests

T1.2 Tropical/Subtropical dry forests and thickets

T1.3 Tropical/Subtropical montane rainforests

T1.4 Tropical heath forests

1) VEGETATION TYPES – INTERNATIONAL NOMENCLATURE

Keyword matrix



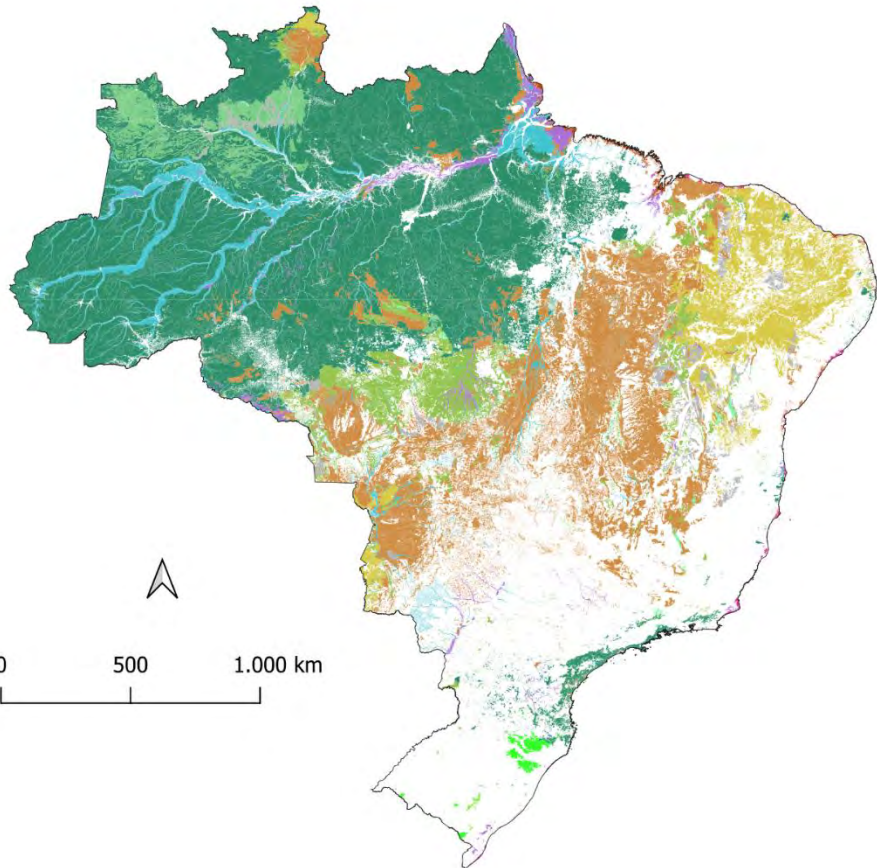
Matrices comparison

- Realm
- Predominant vegetation
- Climate
- Rain Seasonality
- Water Deficit
- Phenology
- Particularity

**Ranking
based on
similarity
score**



1) VEGETATION TYPES - RESULTS



Vegetation classes

- MFT1.2 Intertidal forests and shrublands
- MT2.1 Coastal shrublands and grasslands
- T1.1 Tropical/Subtropical lowland rainforests
- T1.2 Tropical/Subtropical dry forests and thickets
- T1.3 Tropical/Subtropical montane rainforests
- T1.4 Tropical heath forests
- T2.4 Warm temperate laurophyll forests
- T3.1 Seasonally dry tropical shrublands
- T4.2 Pyric tussock savannas
- T4.4 Temperate woodlands
- T4.5 Temperate subhumid grasslands
- T6.5 Tropical alpine grasslands and herbfields
- TF1.1 Tropical flooded forests and peat forests
- TF1.3 Permanent marshes
- Contact zones

14 vegetation types

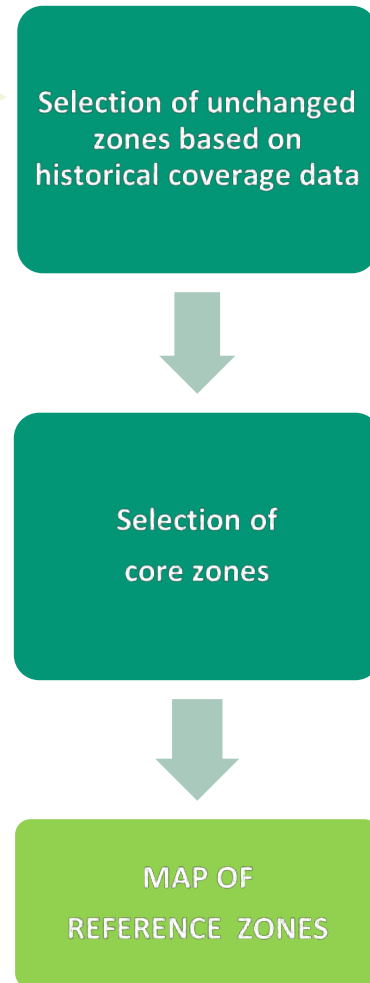
9 contact zones

PROPOSED ANALYTICAL FRAMEWORK

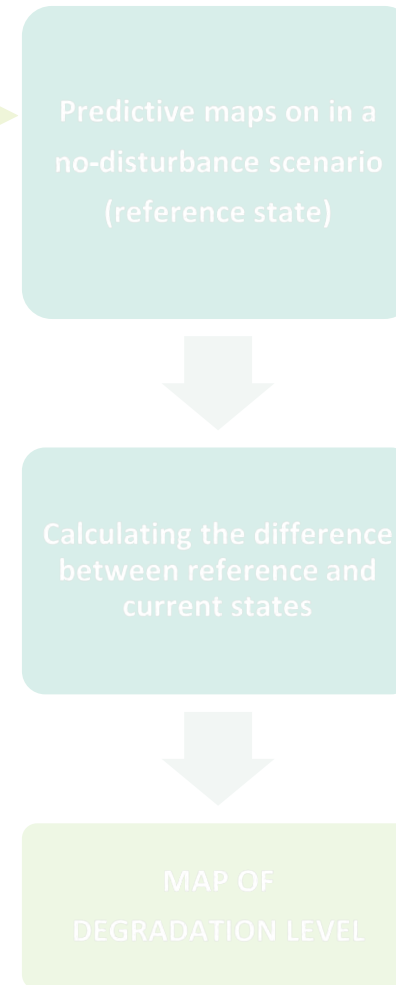
1) VEGETATION TYPES



2) REFERENCE ZONES



3) DEGRADATION LEVEL



2) REFERENCE ZONES – HISTORIC DATA FOR MOIST ZONES

Tropical Moist Forest

Time series of forest cover change
(1982 – 2023)

Selected areas:

Not deforested or degraded since 1982



Vancutsem et al., 2021

2) REFERENCE ZONES – HISTORIC DATA FOR DRY ZONES

Mapbiomas

Time series of forest cover change
(1985 – 2023)

Selected areas:

Not deforested since 1985



Mapbiomas Collection 9

2) REFERENCE ZONES – CORE ZONES

Core zones

Distance to currently anthropized surfaces
>> pasture, agriculture, urban areas, roads,
mining and other artificial surfaces

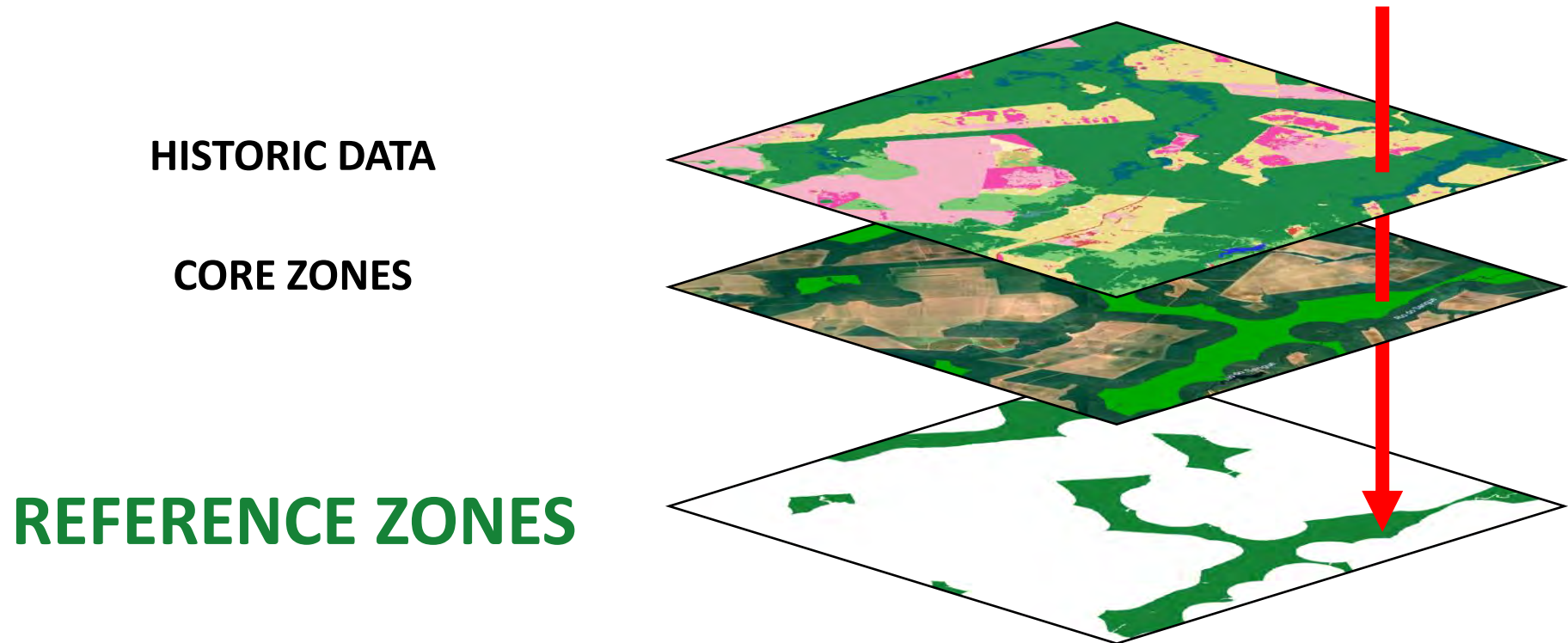
Selected areas:

1km buffer from currently anthropized classes

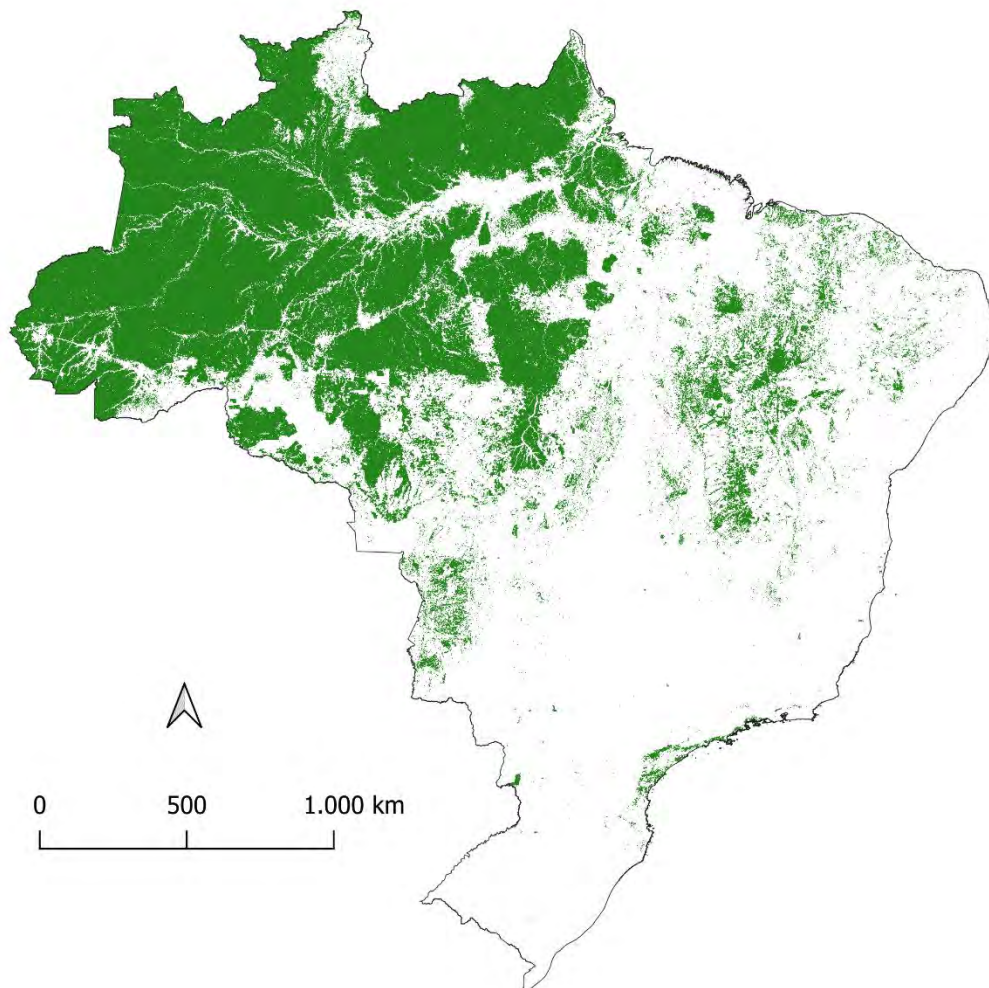


2) REFERENCE ZONES – DATA INTERSECTION

Common Pixel Selection



2) REFERENCE ZONES – RESULTS



Class	Total pixels	Reference pixels	
T1.1 Tropical/Subtropical lowland rainforests (Amazon)	2,976,364,799	2,277,139,301	77%
T1.1 Tropical/Subtropical lowland rainforests (Atlantic Forest)	50,934,622	12,772,608	25%
T4.2 Pyric tussock savannas	1,260,755,116	371,891,980	29%
T3.1 Seasonally dry tropical shrublands	431,480,461	73,400,317	17%
TF1.1 Tropical flooded forests and peat forests	383,581,805	222,097,884	58%
T1.2 Tropical/Subtropical dry forests and thickets	382,969,003	154,231,758	40%
T1.4 Tropical heath forests	204,837,995	183,994,222	90%
MFT1.2 Intertidal forests and shrublands	21,918,598	8,399,498	38%
T2.4 Warm temperate laurophyll forests	16,795,296	704,874	4%
T4.4 Temperate woodlands	2,040,029	123,069	6%
T1.3 Tropical/Subtropical montane rainforests	2,005,310	207,761	10%
Contact T1.1/T1.2	841,254	368,387	44%
Contact T1.4/T1.1	18,631,190	18,408,069	99%
Contact T3.1/T1.2	33,489,424	7,958,719	24%
Contact T4.2/T1.1	5,246,665	3,634,569	69%
Contact T4.2/T1.2	24,522,348	6,119,572	25%
Contact T4.2/T3.1	23,356,117	7,892,963	34%
Contact T4.2/T3.1/T1.2	8,624,756	2,359,595	27%

PROPOSED ANALYTICAL FRAMEWORK

1) VEGETATION TYPES

Inventory of available global and national maps of vegetation



Identification of the best map



Map classes conversion to an international nomenclature



MAP OF VEGETATION TYPES

2) REFERENCE ZONES

Selection of unchanged zones based on historical coverage data



Selection of core zones



MAP OF REFERENCE ZONES

3) DEGRADATION LEVEL

Predictive maps on in a no-disturbance scenario (reference state)



Calculating the difference between reference and current states



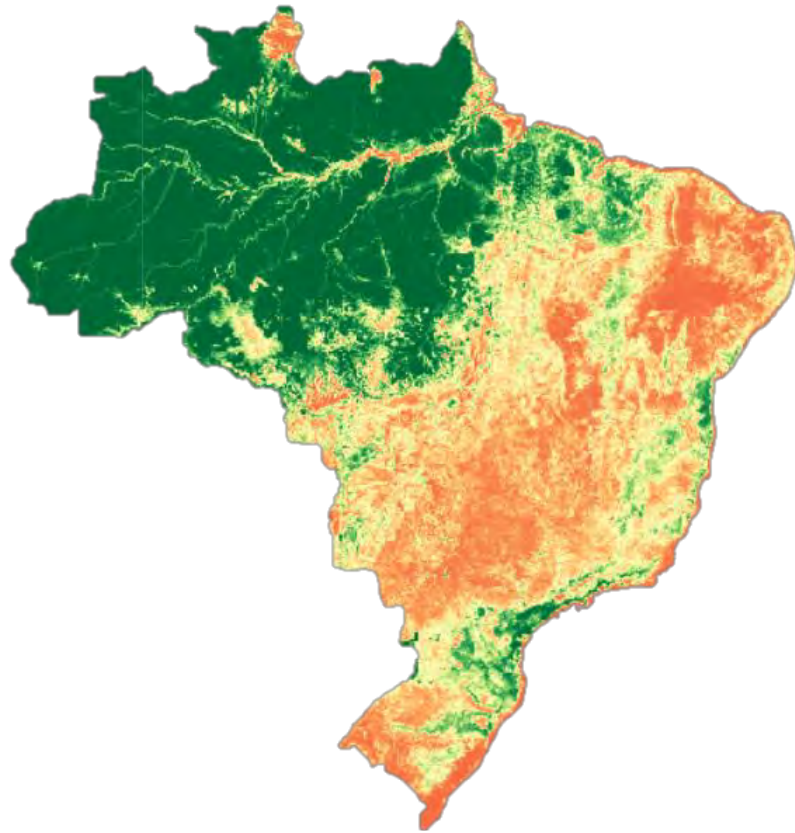
MAP OF DEGRADATION LEVEL



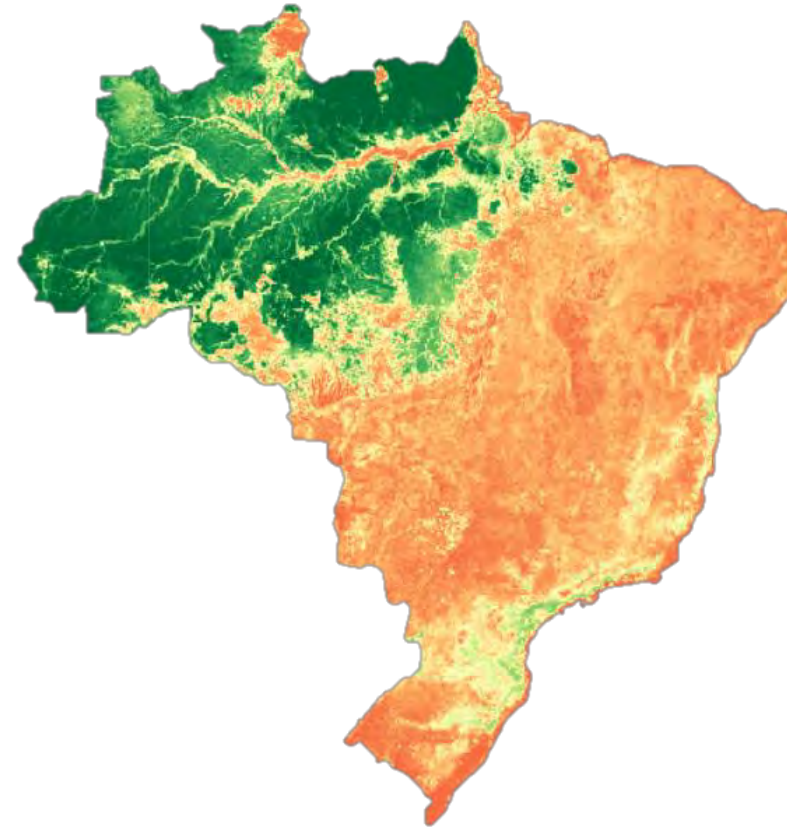
3) DEGRADATION MODELLING – PARAMETERS



3) DEGRADATION MODELLING – PARAMETERS



Tree Cover
(Brandt et al., 2022) + GFW



Vegetation Height
(Lang et al., 2023)

3) DEGRADATION MODELLING – 66 ABIOTIC VARIABLES

RELIEF

NASADEM
(NASA, 2020)

- Elevation
- Slope
- Aspect
- TPI

HYDROLOGY

MERIT
(Yamazaki et al., 2019)

- Distance to rivers
- Hand Index

CLIMATE

CHELSEA
(Karger et al., 2017)

- BIO 1 - BIO19
 - CLT *
 - CMI *
 - HURS *
 - PET *
 - RSDS *
 - SFCWIND *
 - VPD *
 - SWB
- *min/max/mean/range

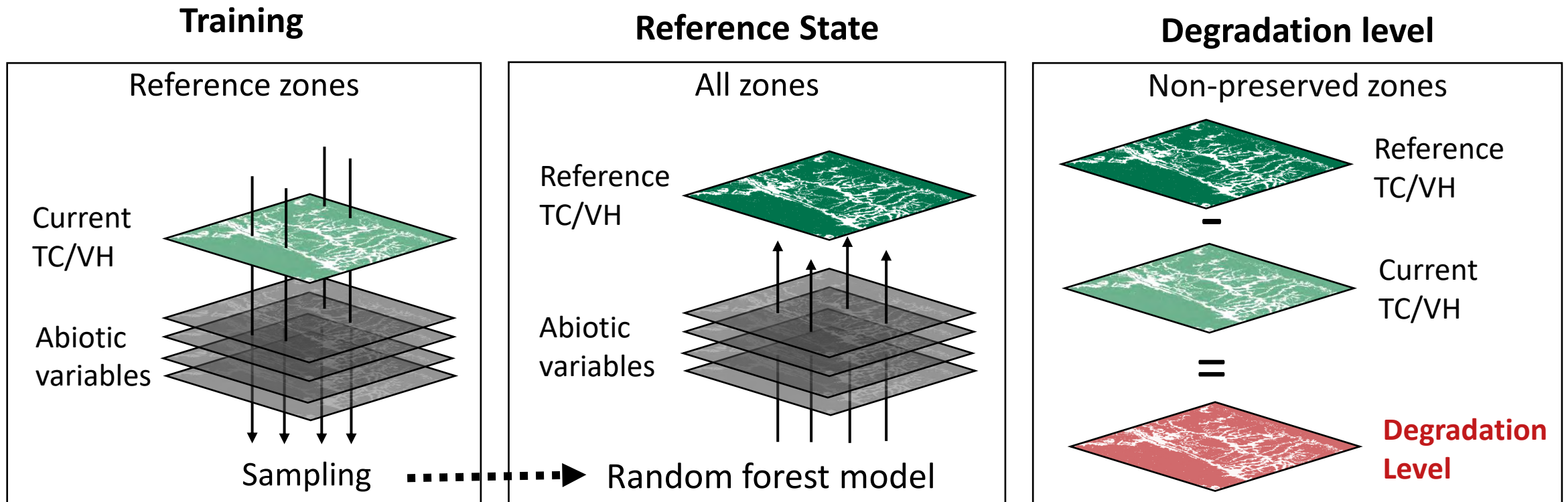
SOIL

SOILGRIDS 2.0
(Poggio et al., 2021; Turek et al., 2023)

- Bulk density
- Cation exchange capacity
- Clay
- Coarse fragments
- pH in water
- Sand
- Silt
- Organic carbon
- Nitrogen
- Water volume
10/33/1500 kPa

3) DEGRADATION MODELLING – METHODS OVERVIEW

For each type of vegetation



3) DEGRADATION MODELLING – RESULTS (DIFFERENCE MAPS)

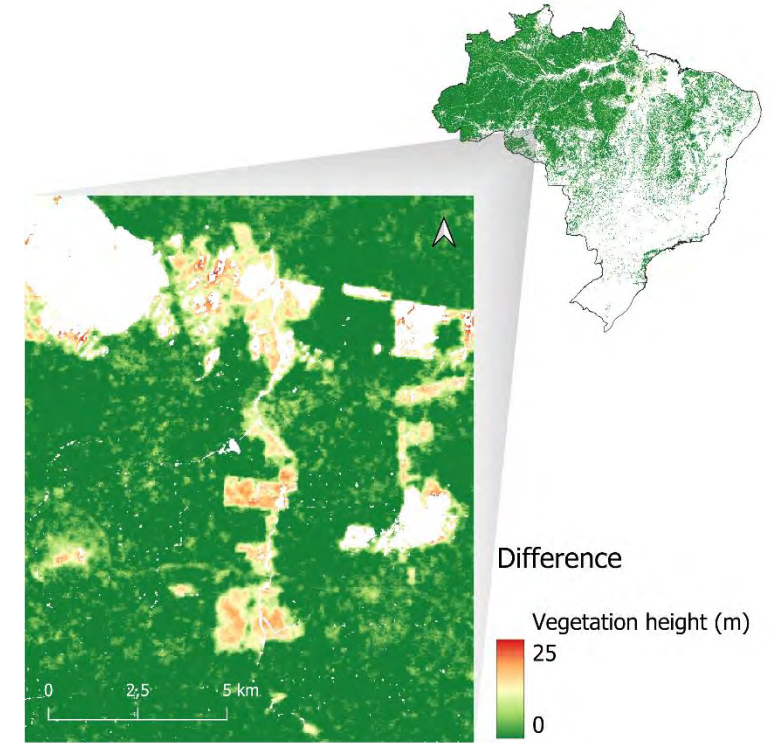
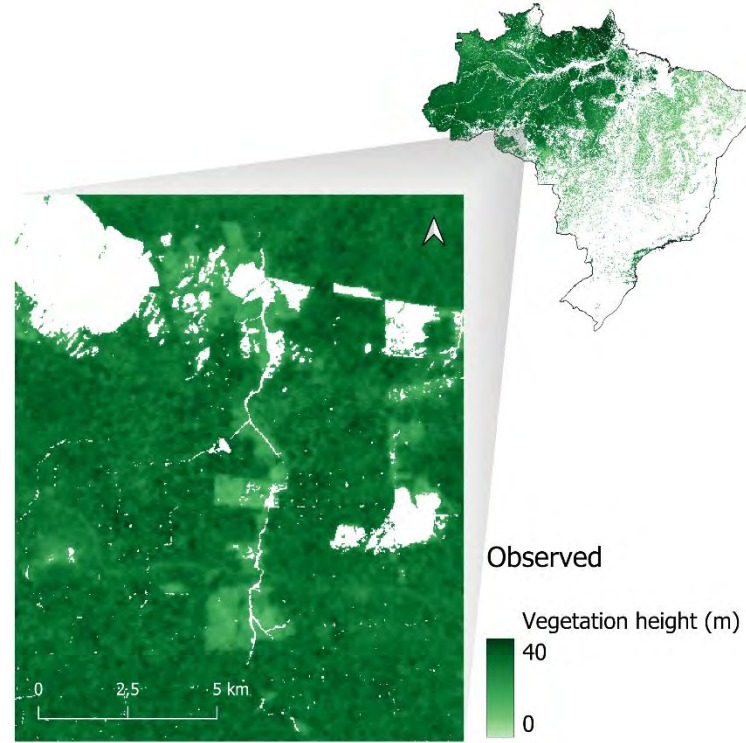
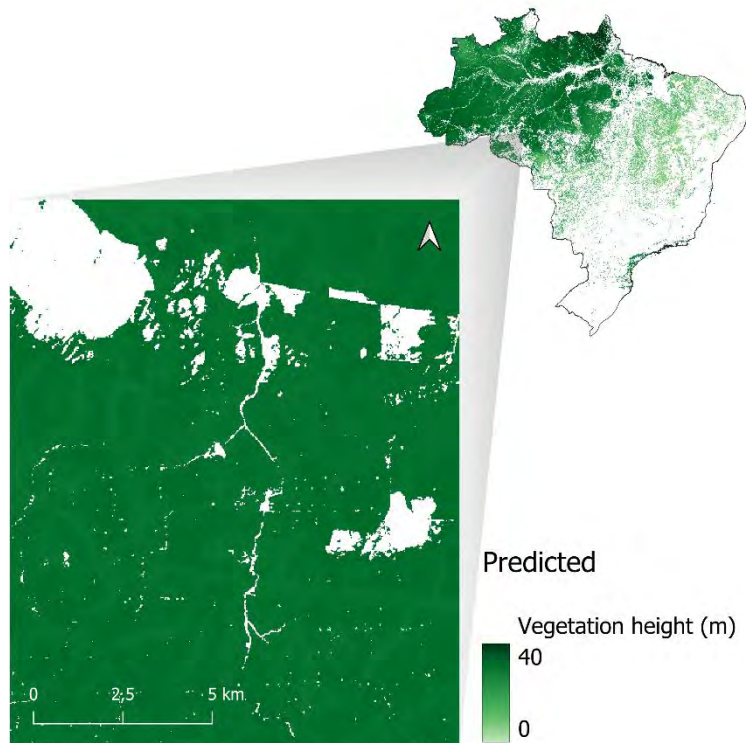
REFERENCE STATE

–

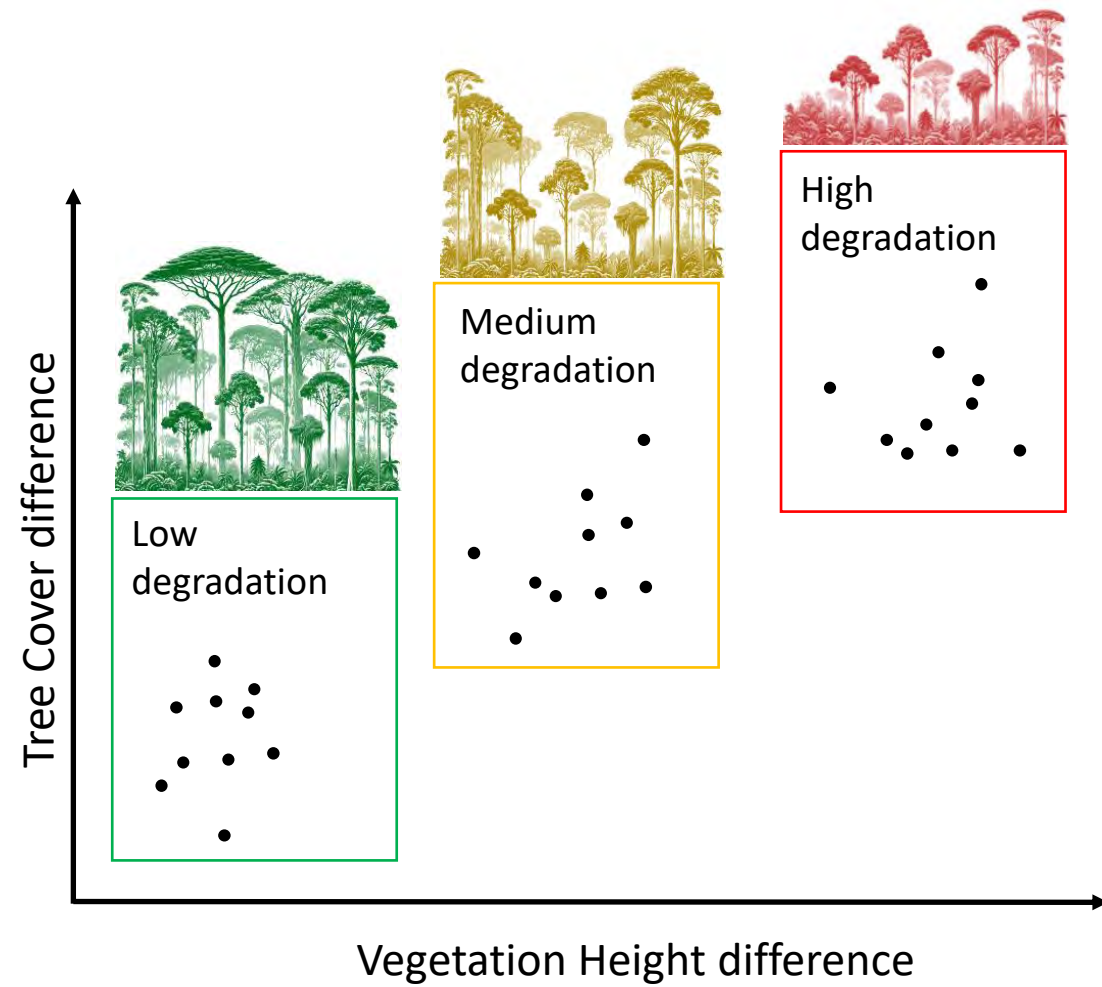
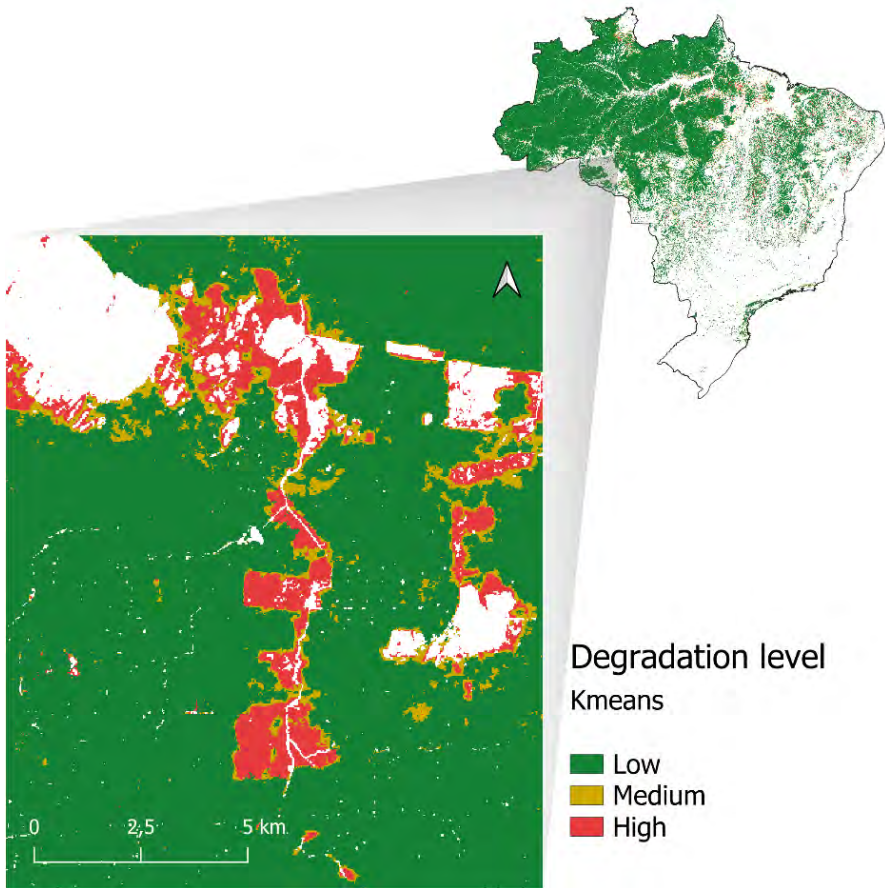
CURRENT STATE

=

DEGRADATION LEVEL

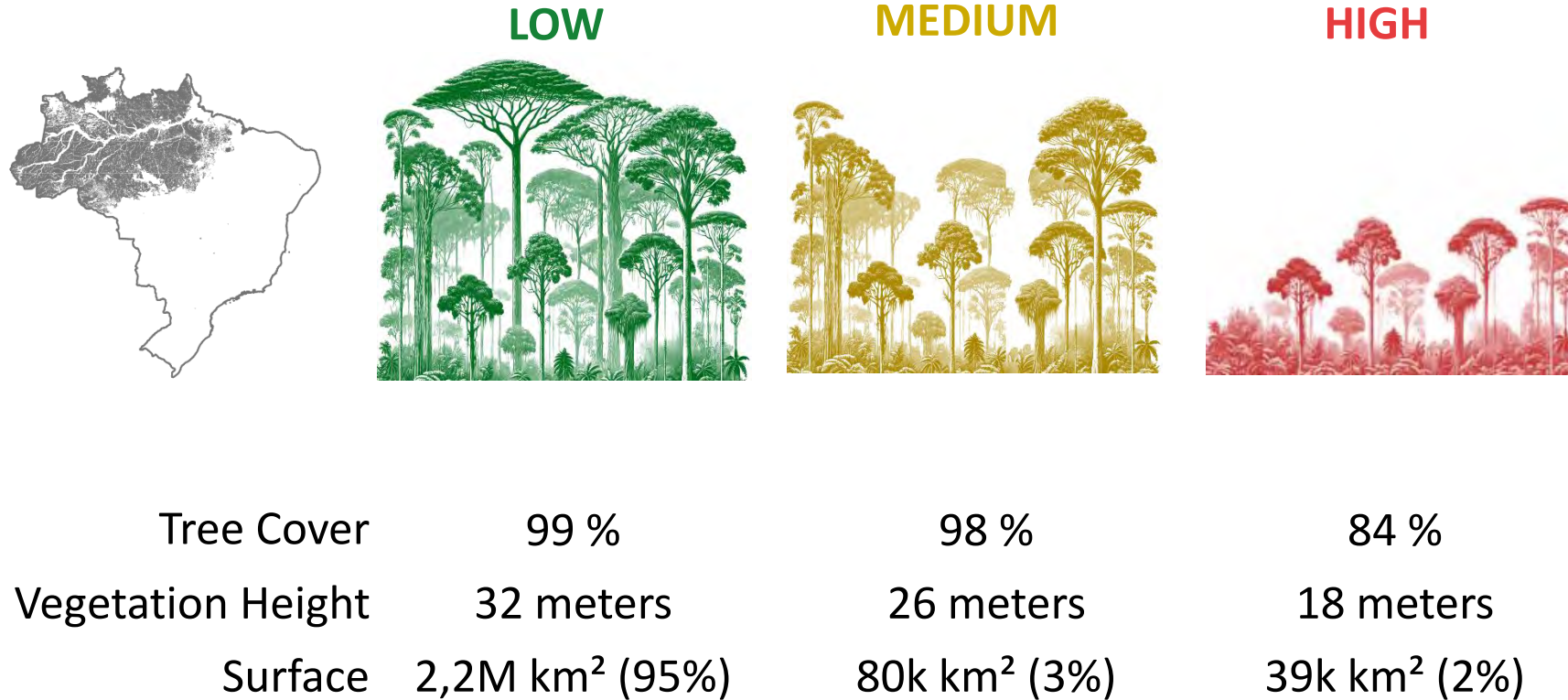


3) DEGRADATION MODELLING – RESULTS (GROUPING)



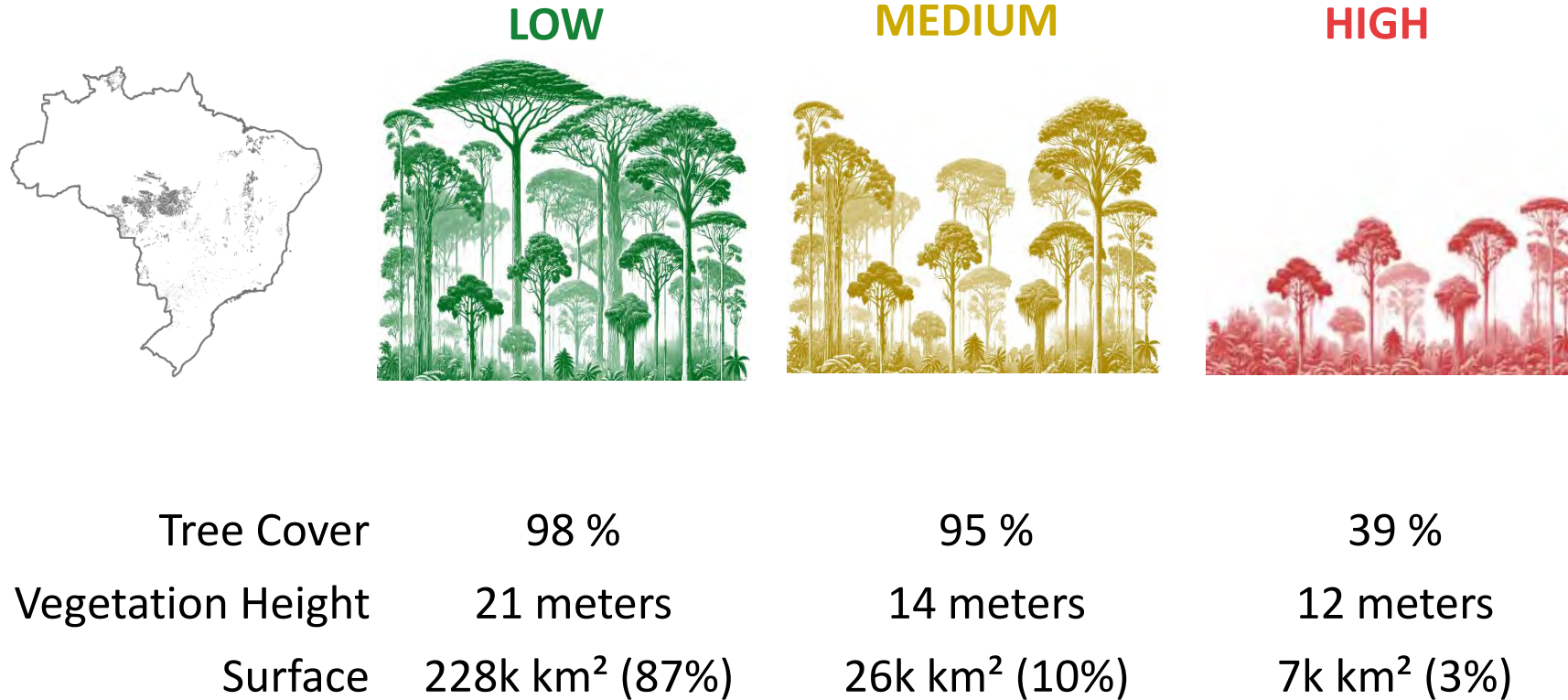
3) DEGRADATION MODELLING – DEGRADATION LEVEL

T1.1 Tropical/Subtropical Lowland Forests (Amazon)



3) DEGRADATION MODELLING – DEGRADATION LEVEL

T1.2 Tropical/Subtropical dry forests and thickets



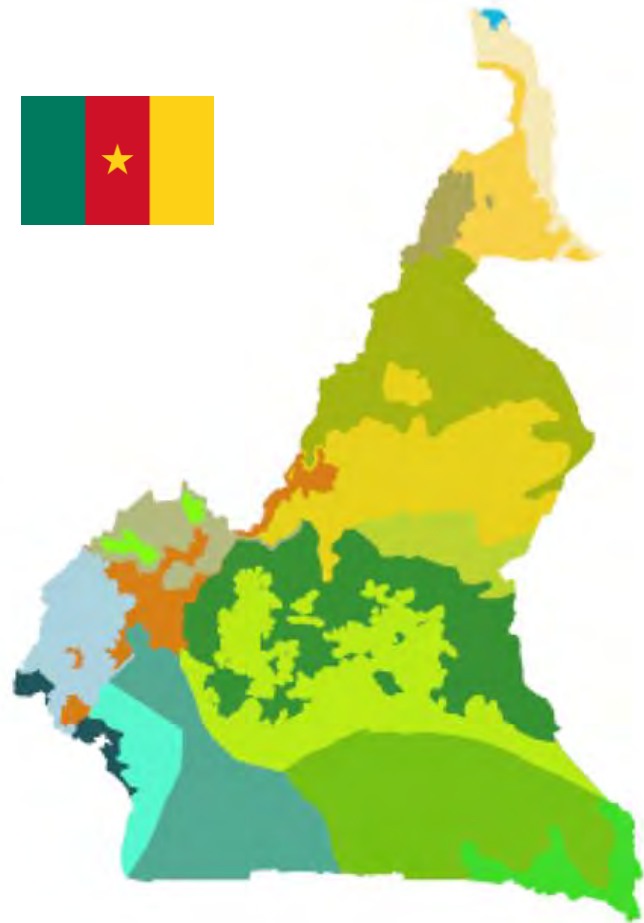
FINAL SYNTHESIS AND OUTLOOK

Next steps:

- Evaluation of the methodology in Cameroon
- Analyze the complementarity to other products on degradation (ex. JRC Products)

Challenges:

Datasets availability



Cameroon Vegetation Map
(Letouzey, 1985)

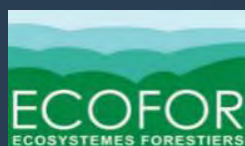


FINAL SYNTHESIS AND OUTLOOK

Development of an **operational, replicable and adaptable** methodology

- >> Identification of consistent boundaries for different vegetation types
- >> Assessment of degradation levels based on vegetation structure
- >> Consideration of different vegetation types including open and dry ecosystems

New insights can support the future discussions on **EUDR revision**



Thank you for your attention

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