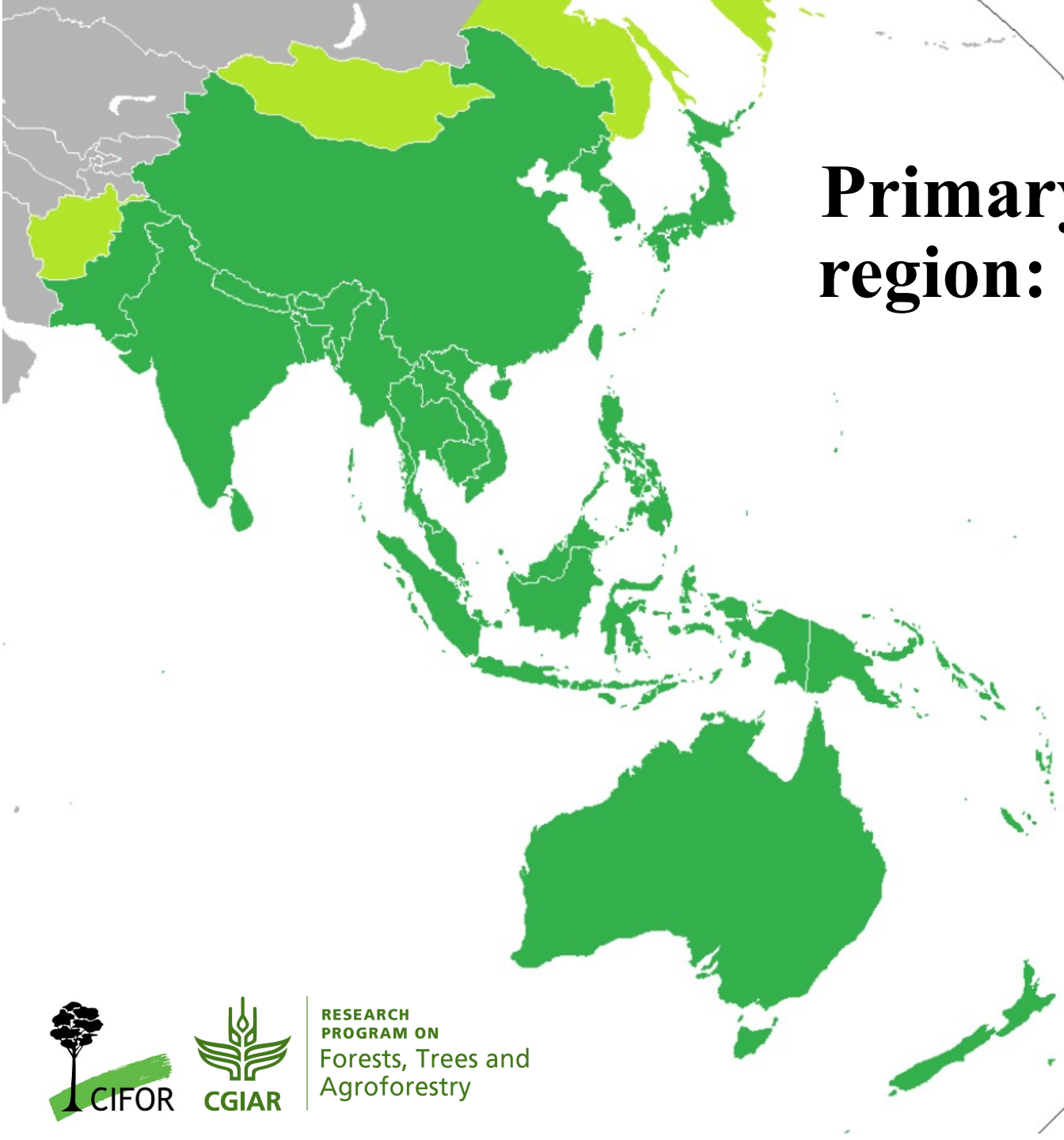

Primary forests in the Asia-Pacific region: status, extent and diversity

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Asia-Pacific Forest Sector Outlook:
Roadmap for primary forests conservation.
Online expert workshop

23-25 March 2021

CIFOR
CGIAR
RESEARCH PROGRAM ON Forests, Trees and Agroforestry

Background

Primary forests…

Gibson, L. (2011) Primary forests are irreplaceable for sustaining tropical biodiversity.

Watson, J. E. et al. (2018). The exceptional value of intact forest ecosystems

Potapov et al. 2017 Intact Forest Landscape

Krogh, A. 2019. State of the tropical rainforest. Rainforest Foundation Norway "One third of the original tropical rainforest is still intact, one third is degraded.

Recent development of an "Forest Landscape Integrity" index (Gantham et al. 2020) or assessment of "Deforestation Fronts" (Pacheco et al. 2021)

Background

- Of the Asia Pacific region's 723 million hectares of forest, only 19 percent (140 million hectares) is primary, much lower than the global average (32 percent) (APFSOS III: FAO, 2019)

- Reversing this trend must be a priority for all countries in the region now and in the next decade to ensure our survival, notably in the face of climate change

Historical trends 2000 – 2020 of natural forest cover

Data
- Landsat 5 TM, 7 ETM, 8 OLI 30m
  - Image selection for non-tropical zones: summer time
- NASA SRTM Digital

Pre-processing and image enhancement
- Cloud masking
- Image correction and composition
- Indices generation: NDVI and NDII

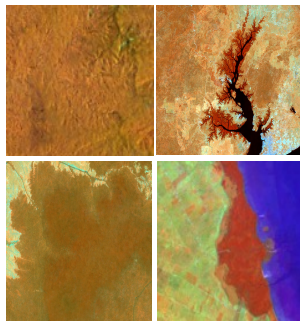
Sample collection
- Stratified random sampling
- Visual interpretation
- Sample references: forest maps from AP countries

Classification
- Band: near infra red, short wave infrared 1, short wave infrared 2, NDVI, NDII
- Grid is used to divide area into smaller parts: 182 grids
- Support Vector Machine

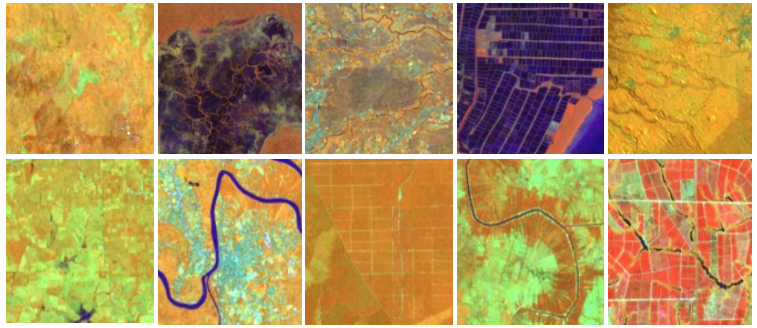
Sample collection

Landsat composite NIR, SWIR1, SWIR2
Location: Indonesia
Ecozone: tropical rainforest, tropical mountain system

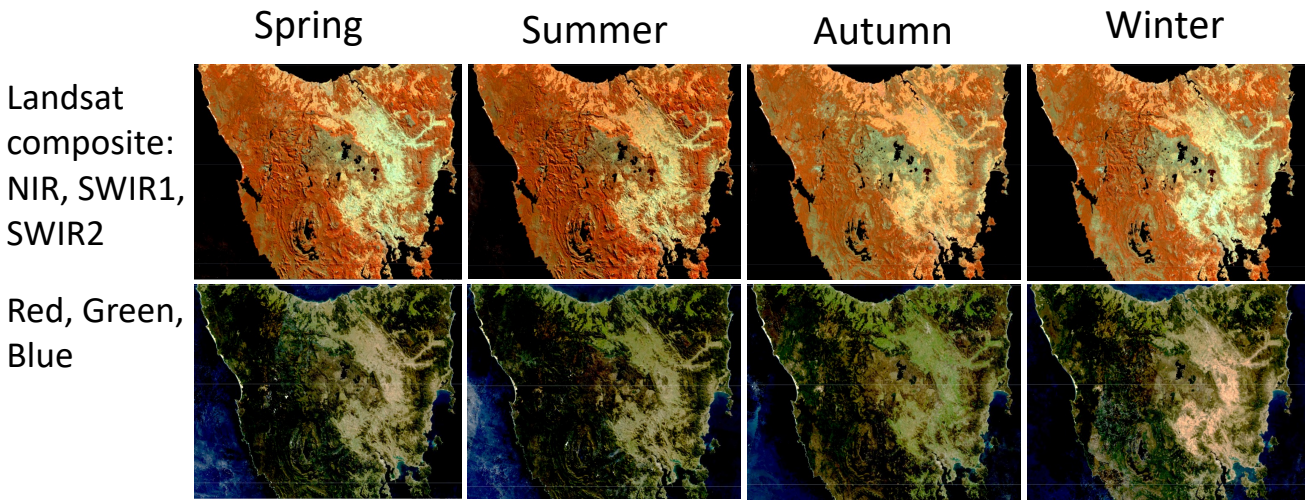
Forest



Non-forest

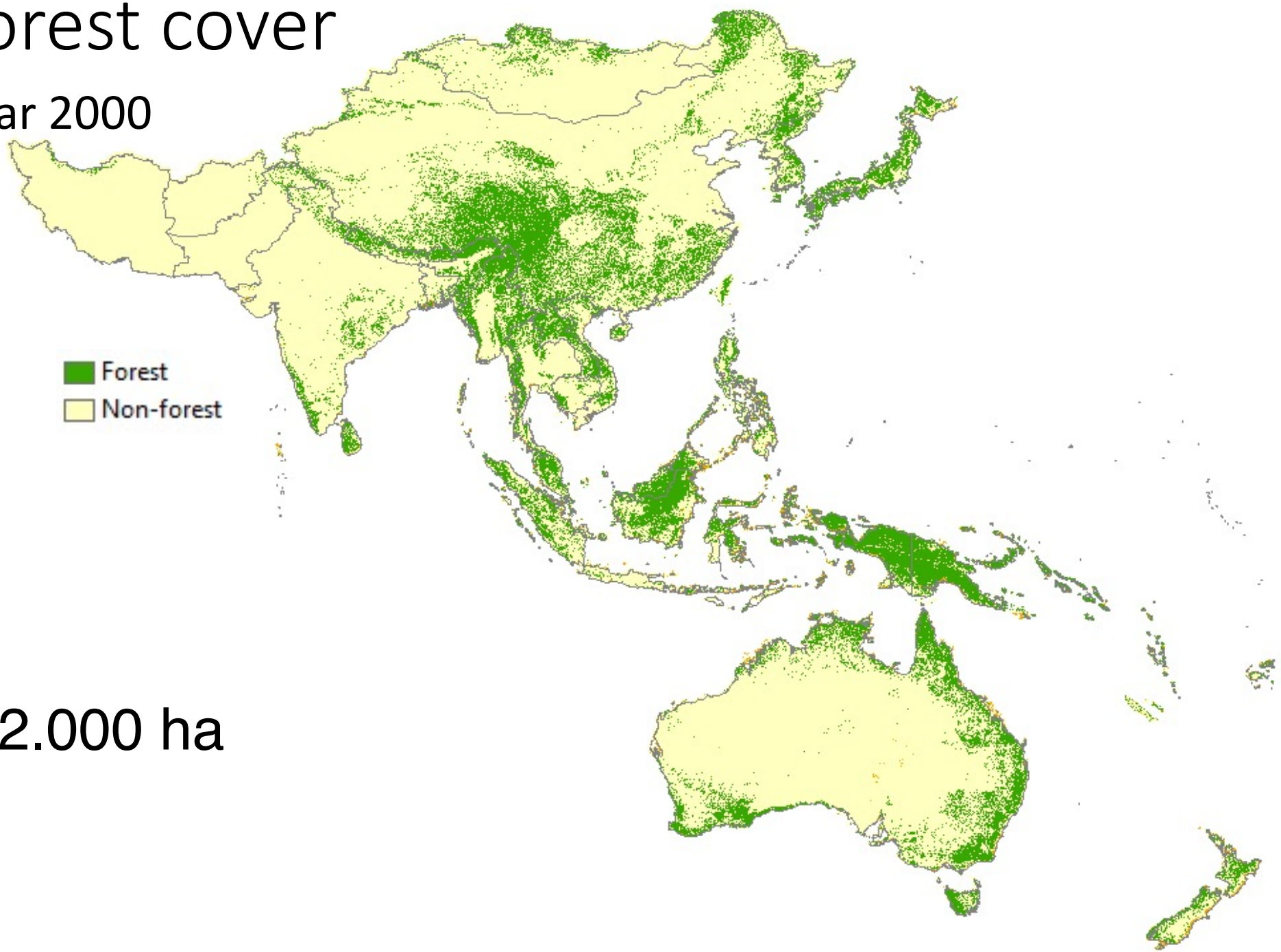


Location: Tasmania, Australia
Ecozone: temperate oceanic forest, temperate mountain system



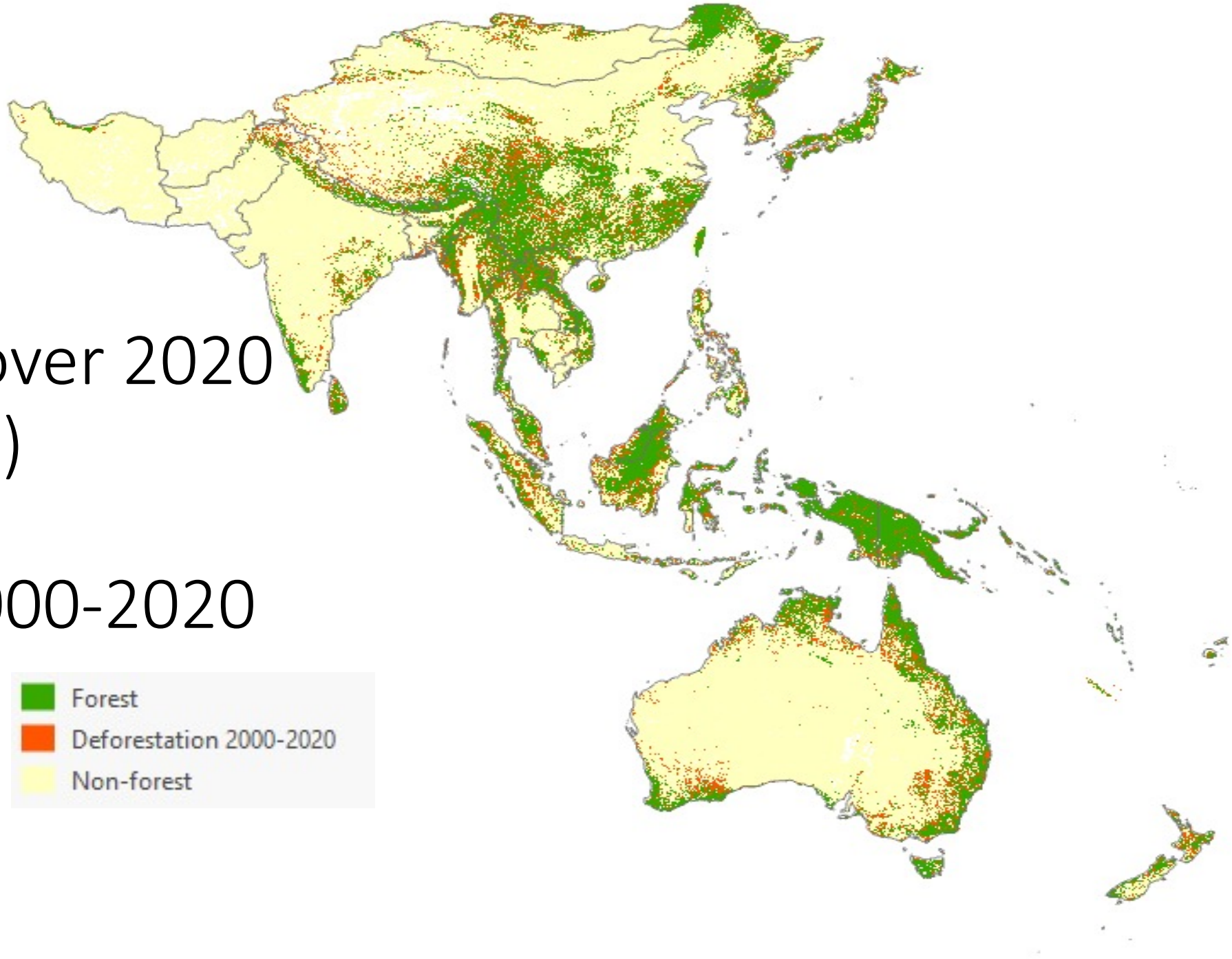
Natural forest cover

Asia Pacific year 2000

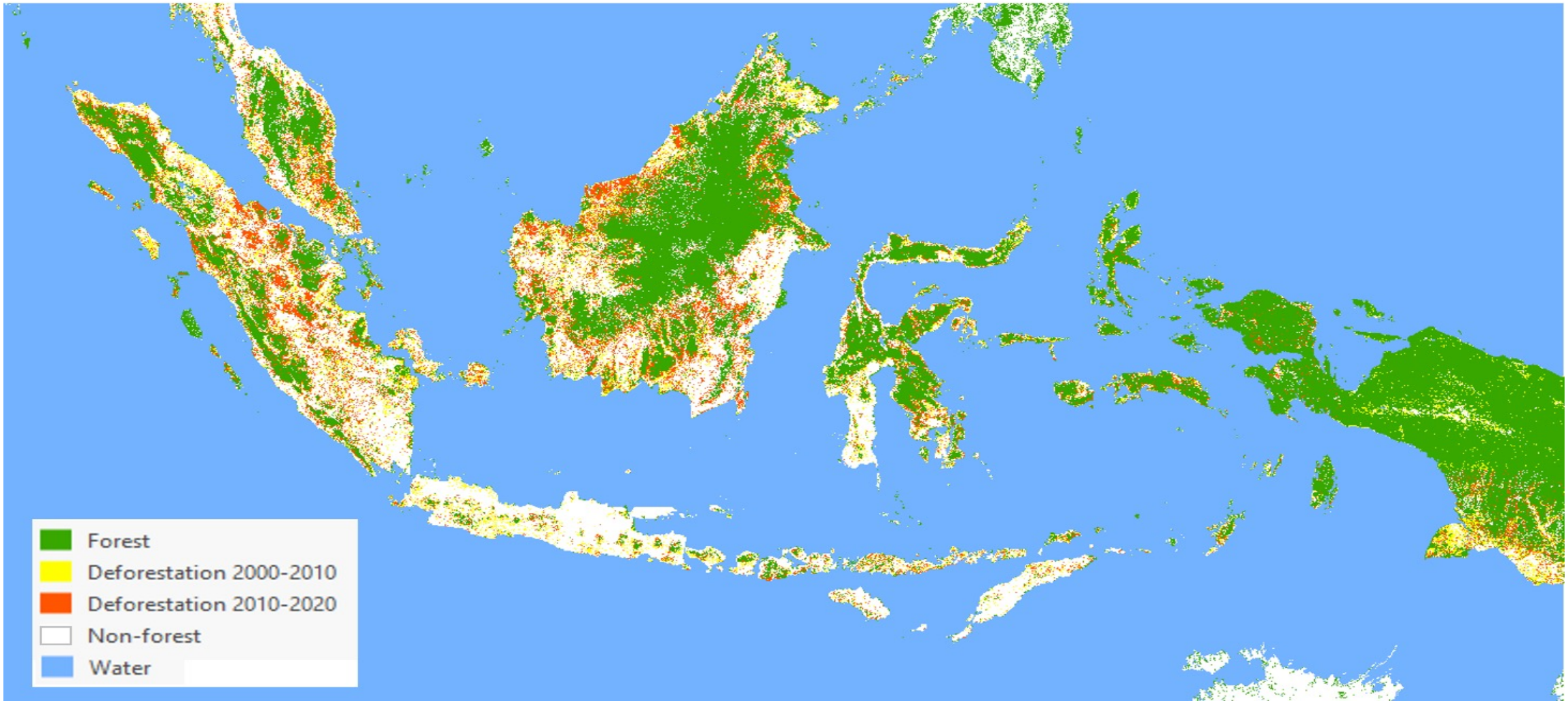


771.142.000 ha

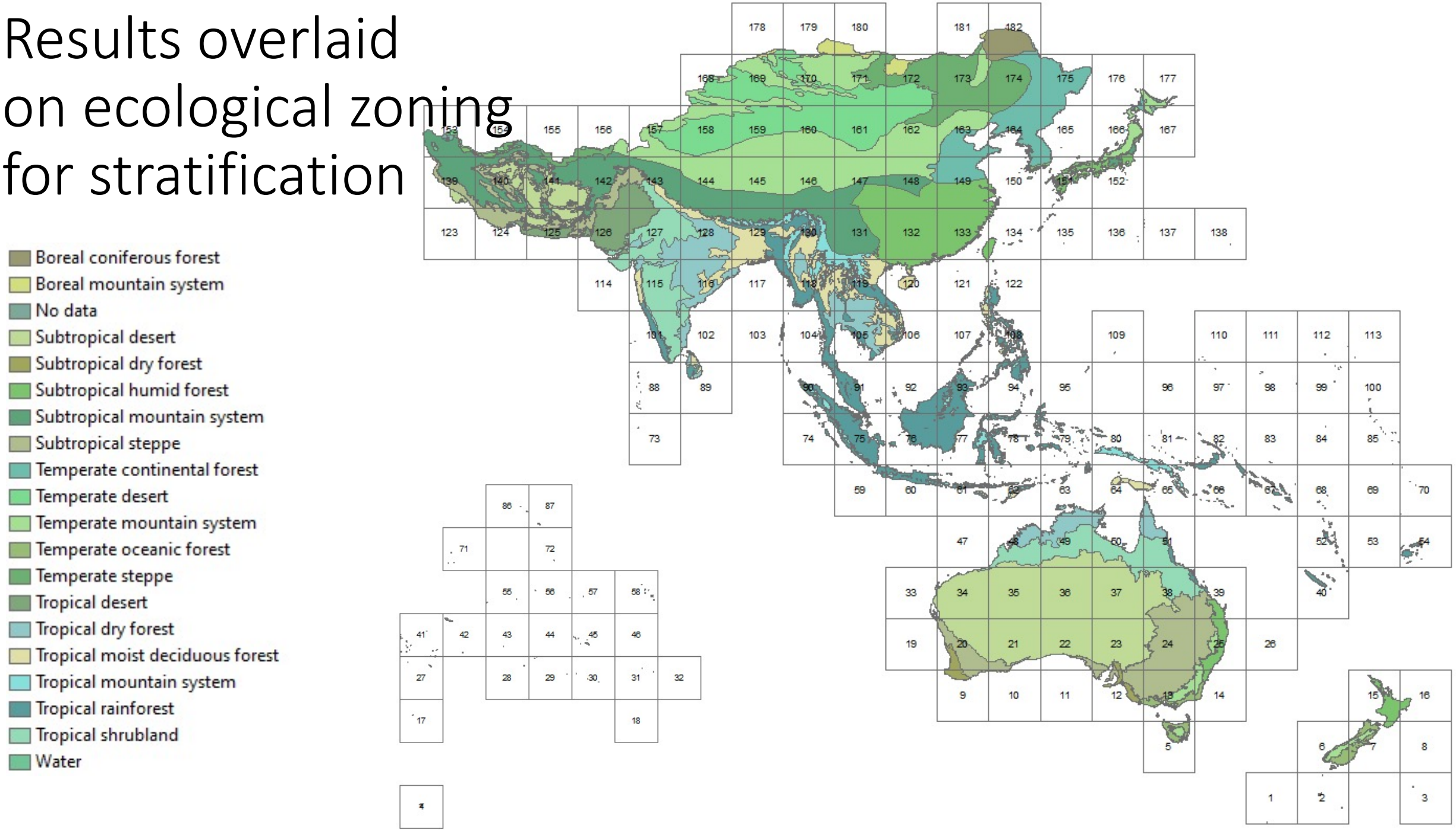
Natural forest cover 2020 (732.264.000 ha) and deforestation 2000-2020

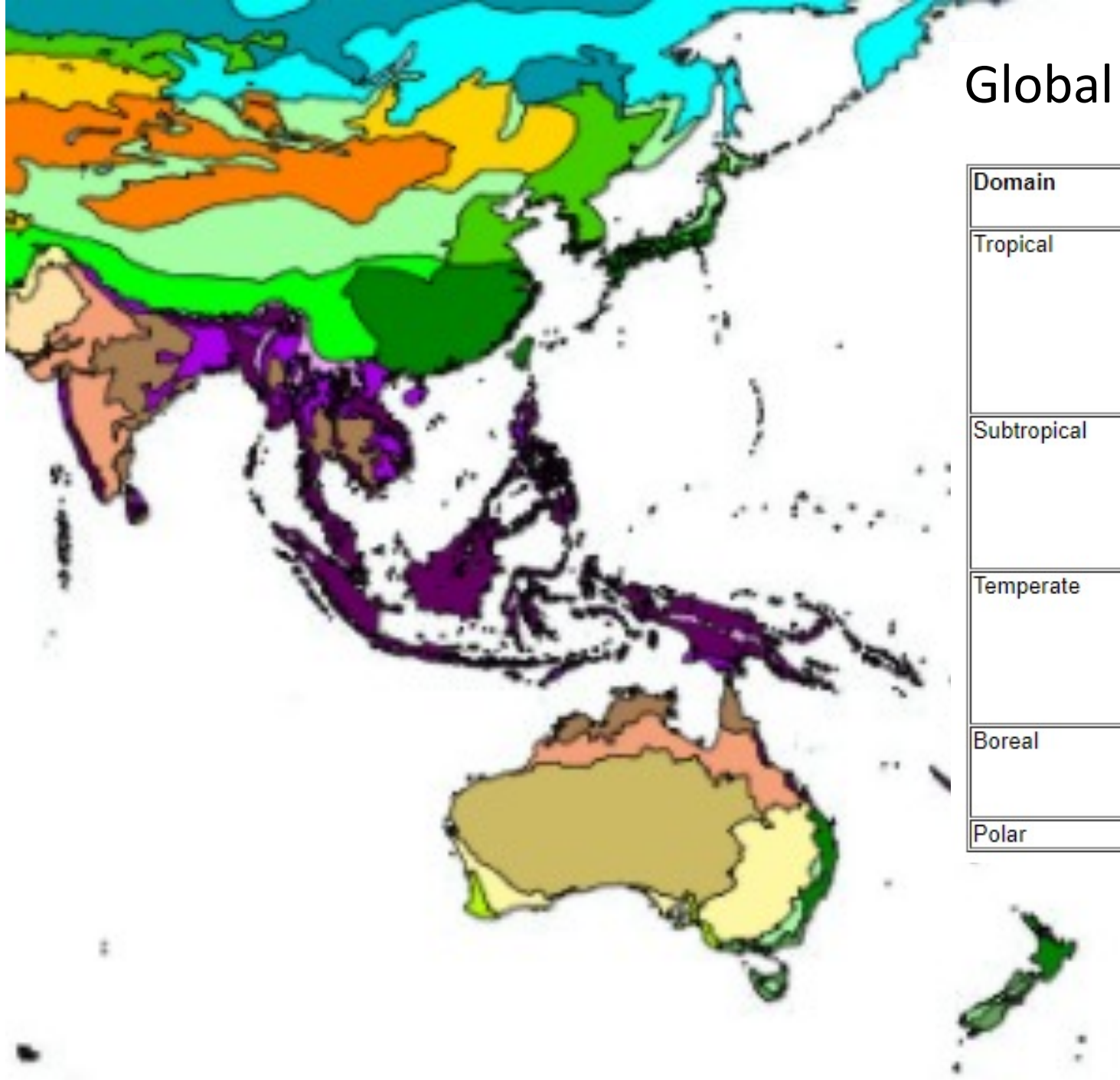


Indonesia: Deforestation 2000-2010 (yellow), 2010-2020 (red)



Results overlaid on ecological zoning for stratification





Global Ecological Zone, FAO

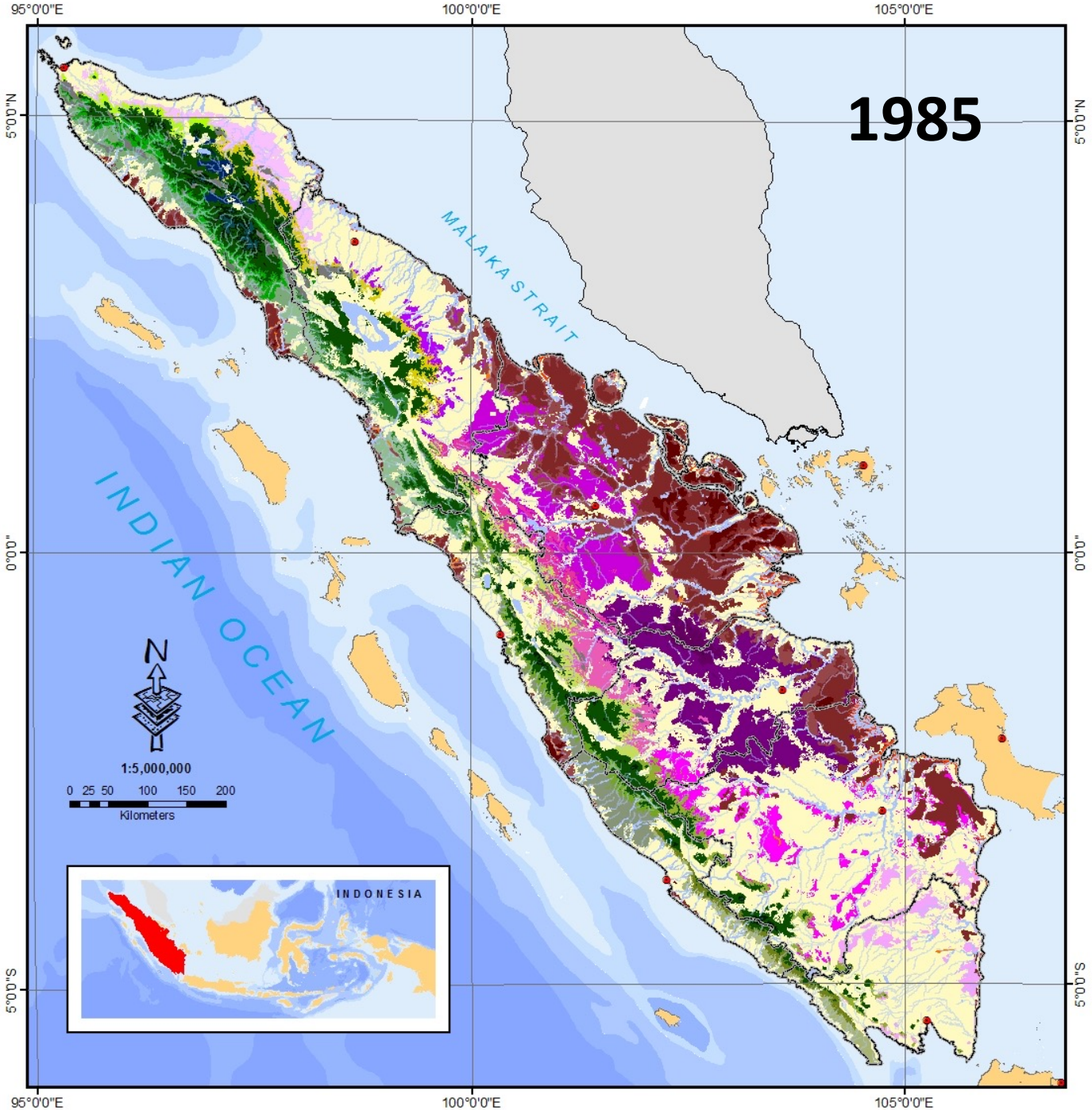
Domain	Global Ecological Zone (GEZ)	
	Code	Name
Tropical	TAr	Tropical rain forest
	TAwa	Tropical moist deciduous forest
	TAwb	Tropical dry forest
	TBSh	Tropical shrubland
	TBWh	Tropical desert
	TM	Tropical mountain systems
Subtropical	SCf	Subtropical humid forest
	SCs	Subtropical dry forest
	SBSh	Subtropical steppe
	SBWh	Subtropical desert
	SM	Subtropical mountain systems
Temperate	TeDo	Temperate oceanic forest
	TeDc	Temperate continental forest
	TeBSk	Temperate steppe
	TeBWk	Temperate desert
	TeM	Temperate mountain systems
Boreal	Ba	Boreal coniferous forest
	Bb	Boreal tundra woodland
	BM	Boreal mountain systems
Polar	P	Polar

//www.fao.org/geonetwork/

Classification of forest types in the region (Champion & Seth 1968, Paijmans 1973, Thai Van Trung 1978, Whitmore 1984, Blasco et al. 1996, Laumonier 1997, Corlett 2014, Roy et al. 2015, Guo et al. 2018, Su et al. 2020 etc…), existing vegetation maps for each country… **Develop a concordance matrix of the various forest types in the region**

Global Ecological Zones FAO		**Eco-floristic zoning and ecological mapping**	
	Bioclimatic division (including altitudinal zonation)		*Edaphic types (including wetlands)*
Tropical	Tropical rain forest	Lowlands	Kerangas
		Hill	Ultramafic
		Submontane	Karst
	Tropical mountain systems	Lower montane	
		Upper montane	Riparian
			Freshwater swamp
			Mixed peat swamp
			Peat swamp forest
			Mangroves
			back-mangroves and nipa vegetation

Global Ecological Zones		Eco-floristic zoning and ecological mapping	
	Bioclimatic division (including altitudinal zonation)		*Edaphic types (including wetlands)*
Tropical seasonal		Tropical seasonal evergreen	Limestones/karst
	Tropical moist deciduous forest	Tropical moist deciduous	
	Tropical dry forest	Tropical dry deciduous	
Subtropical	Subtropical humid forest	Subtropical evergreen broadleaved	
	Subtropical dry forest		
	Subtropical mountain systems		
Temperate	Temperate continental forest	Temperate deciduous broadleaves	
	Temperate mountain systems		



Forest and Eco-floristic Sectors

Legend

- Province Boundary
- River

Natural Forest Cover in Eco-Floristic Sectors

West Coast

- Tapaktuan-Banda Aceh Block (< 500 m)
- Airbangis-Bakongan Block (< 500 m)
- Pesisir-Talamau Block (< 500 m)
- Bengkulu Block (< 500 m)

Western Hill

- Tapaktuan-Banda Aceh Block (500 - 1000 m)
- Airbangis-Bakongan Block (500 - 1000 m)
- Pesisir-Talamau Block (500 - 1000 m)
- Bengkulu Block (500 - 1000 m)

Submontane

- Submontane North (1000 - 2000 m)
- Submontane Central (1000 - 2000 m)
- Submontane South (1000 - 2000 m)

Montane

- Montane North (2000 - 2500 m)
- Montane Central (2000 - 2500 m)
- Montane South (2000 - 2500 m)
- Low Forest and Thickets of the Ericaceous Zone (> 2500 m)

Eastern Hill

- Langsa-Banda Aceh Block (500 - 1000 m)
- Asahan-Langsa Block (500 - 1000 m)
- Tembesi-Tapanuli Block (500 - 1000 m)
- Semangka-Tembesi Block (500 - 1000 m)

Eastern Lowland

- Langsa Block (< 500 m)
- Asahan Block (< 500 m)
- Riau Block Kwantan to Barumun (< 150 m)
- Upper Batang Hari-Upper Barumun (150 - 500 m)
- Upper Rawas-Upper Batang Hari (150 - 500 m)
- Jambi Block South of Kwantan (< 150 m)
- Tigapuluh Mountains Block (150 - 500 m)
- Tigapuluh Mountains Block (500 - 1000 m)
- Palembang Block, South of Musi (< 500 m)
- Lampung Block (< 500 m)

Swamp

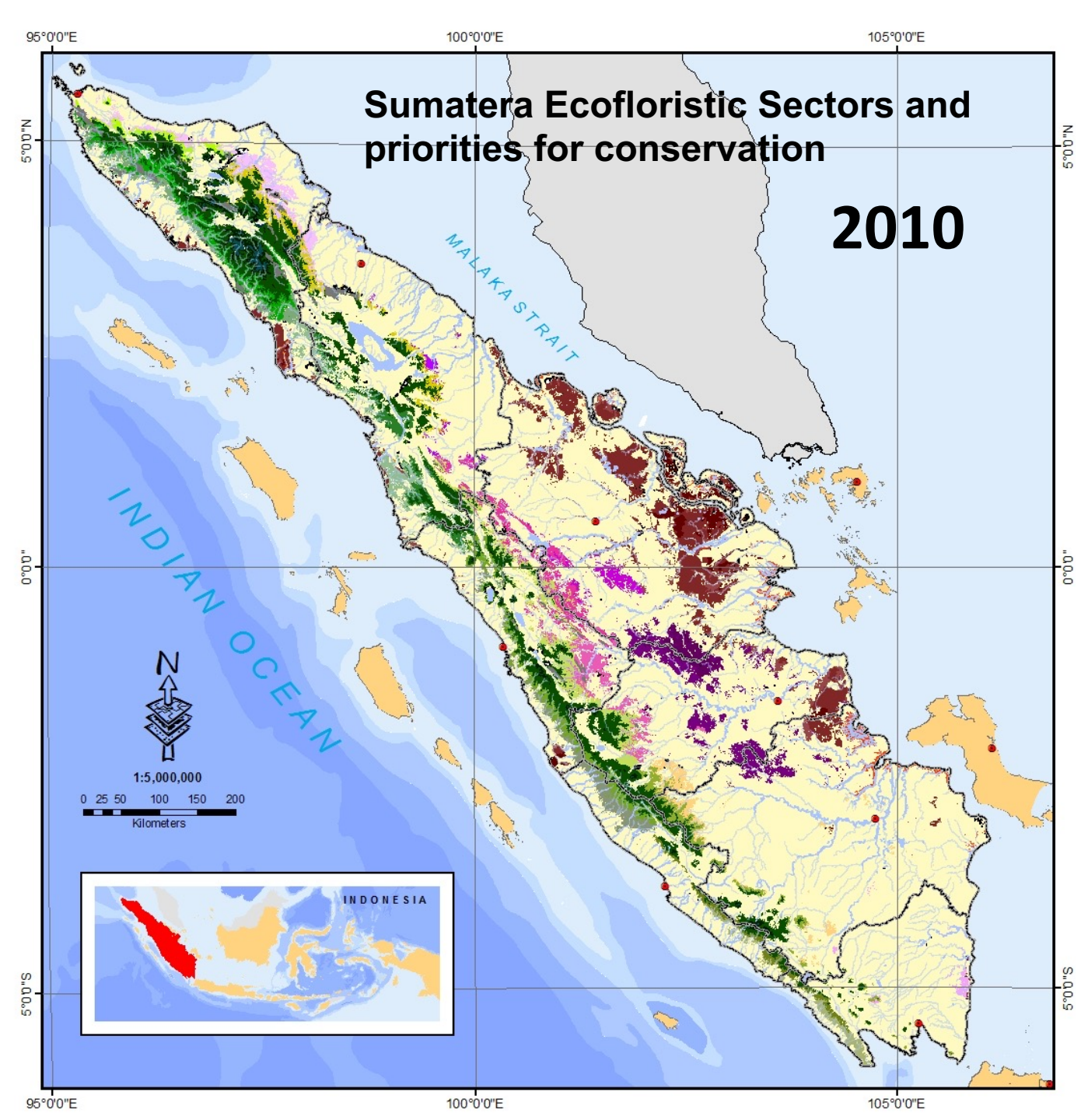
- Fresh Water Swamp on Alluvium (Shallow Peat)
- Mixed Peat Swamp
- Peat Swamp Forest on Deep Peat Layer
- Brackish Swamps (Mangroves)
- Montane Swamp Vegetation
- Riparian Forest

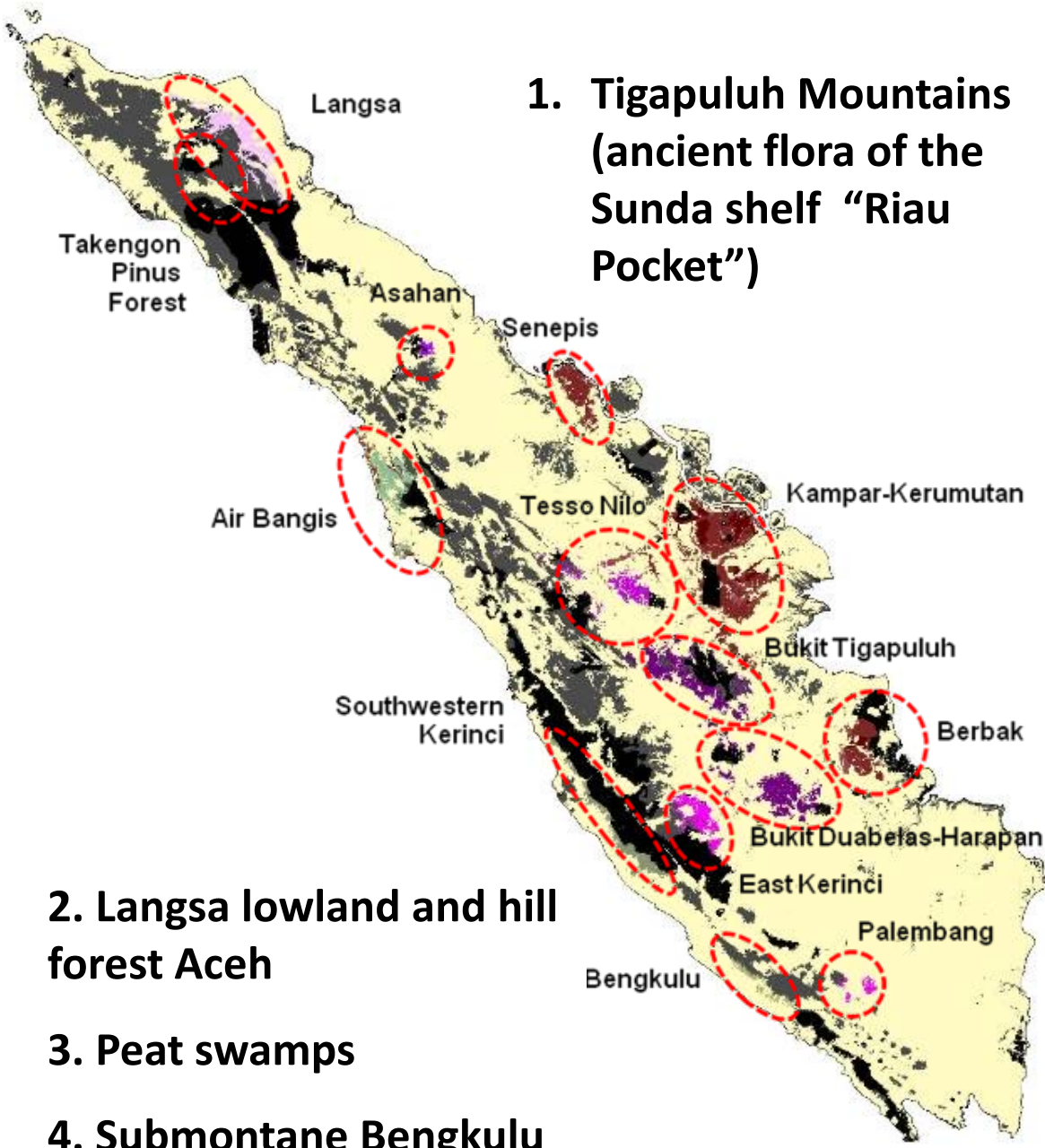
Other

- Coastal Forest Formations
- Formations on limestone
- Takengon Pinus Forest

Non Natural Forest Cover

- Non Forest
- Water body
- Cloud





1. Tigapuluh Mountains (ancient flora of the Sunda shelf "Riau Pocket")

2. Langsa lowland and hill forest Aceh

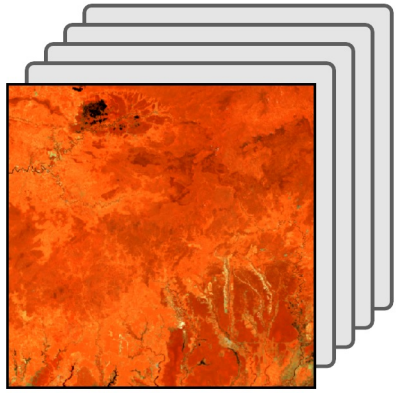
3. Peat swamps

4. Submontane Bengkulu

Looking for Primary Forest
1st Approach K-Means Clustering

- K-Means clustering with proper input bands can be powerful enough to differentiate intact and degraded forest in classification.
- Can then be used as basis to select intact and degraded forest samples in supervised classification
- Principal Component Analysis (PCA) or Supervised Classification can be used to identify correlation between classes and input bands

- How far is it efficient in detecting degradation criteria?



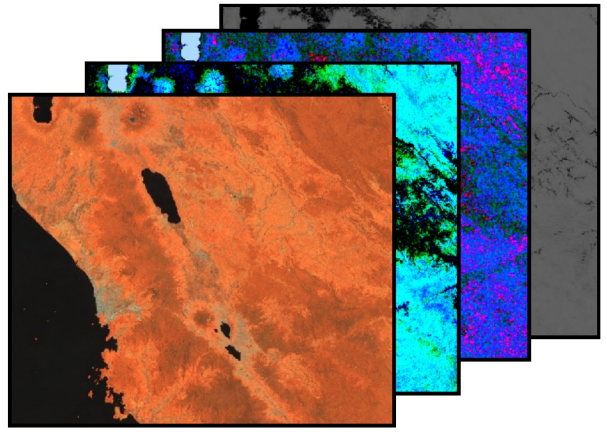
Landsat archives

- Cloud-masking
- Topographic correction
- BRDF correction
- Median composite using 3 years-window

Pre-processing

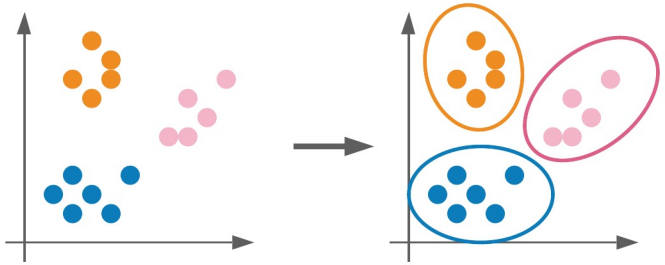
- Create NDs: NDVI, NDWI, NDBI, EVI, SAVI, SLAVI
- Create PCA of NDs
- Create 7 Haralick's texture: con, corr, savg, idm, asm, ent, var
- Create PCA of Textures
- Add band: Tree cover masked with loss

Feature processing



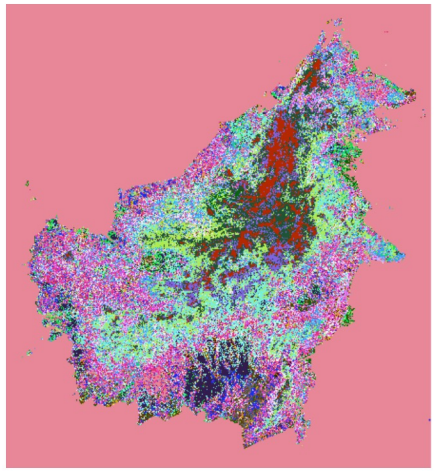
- Six Landsat bands
- 3 first bands of PCA NDs
- 2 first bands of PCA NDs
- Tree cover

Data ready for processing

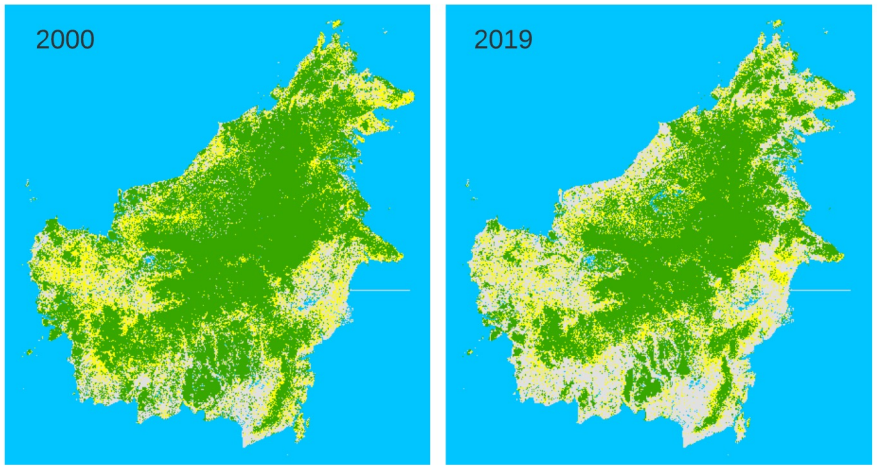


K-Means Clustering Analysis using k=20

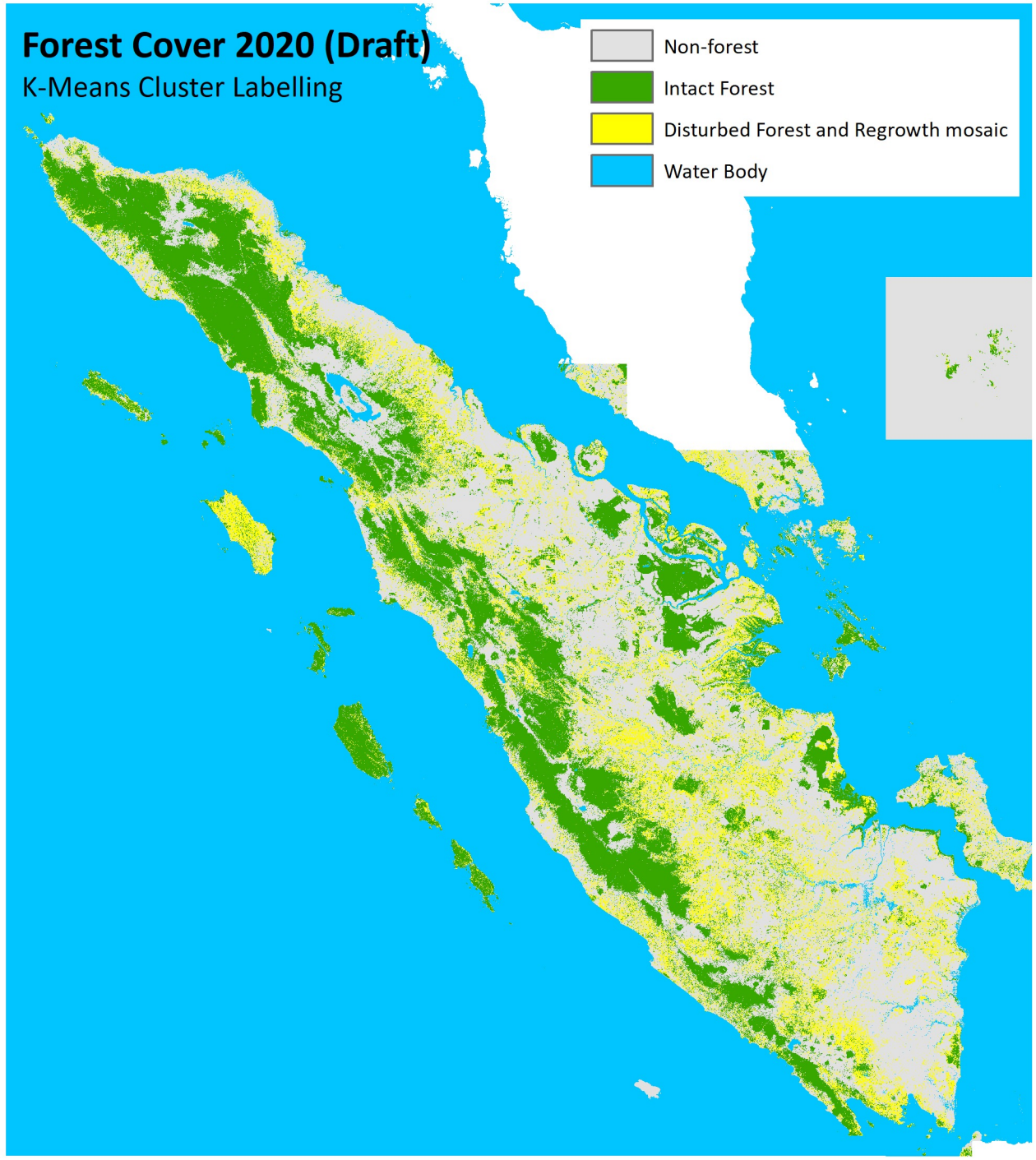
Clustering Analysis

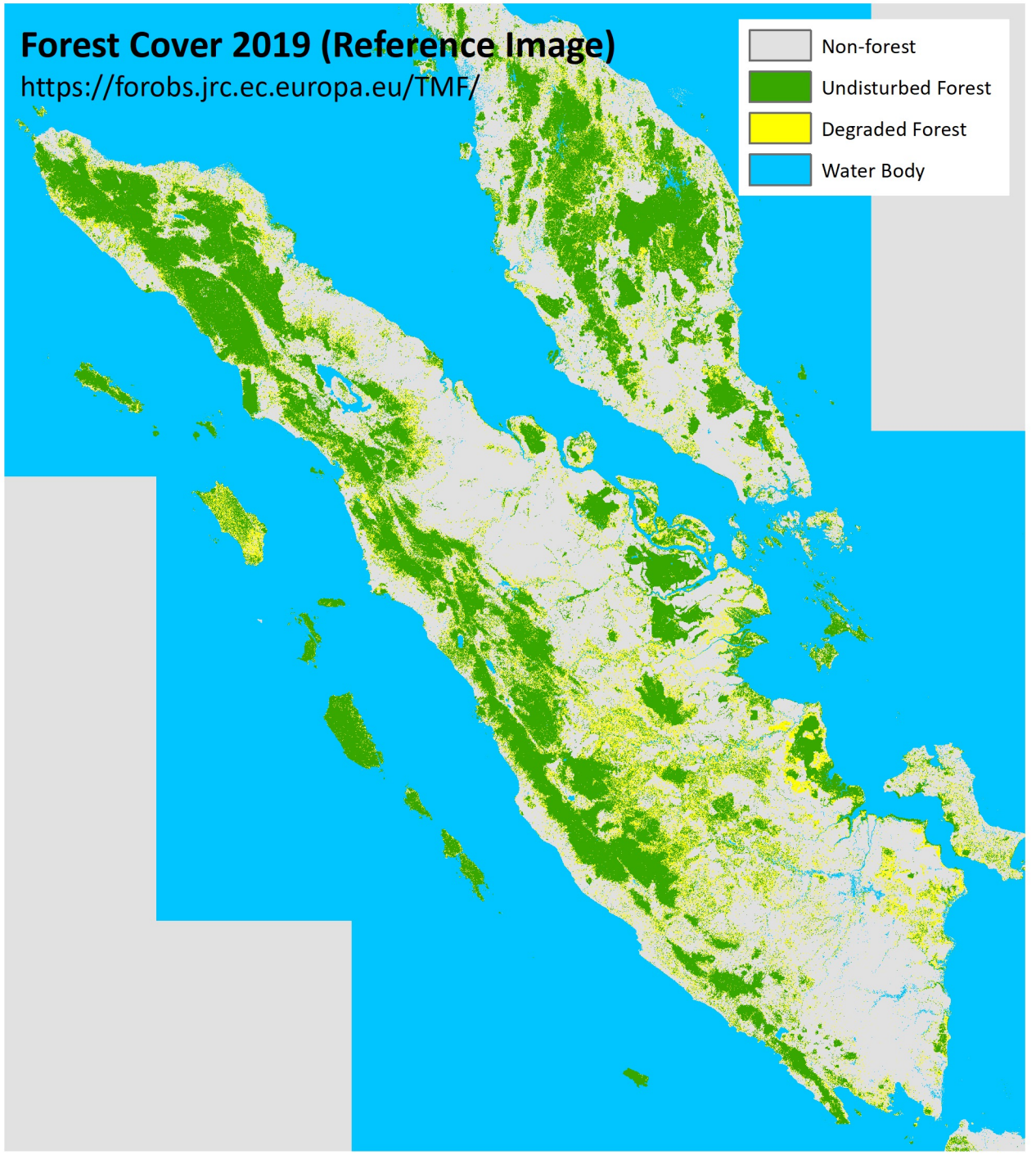


Un-labelled clusters

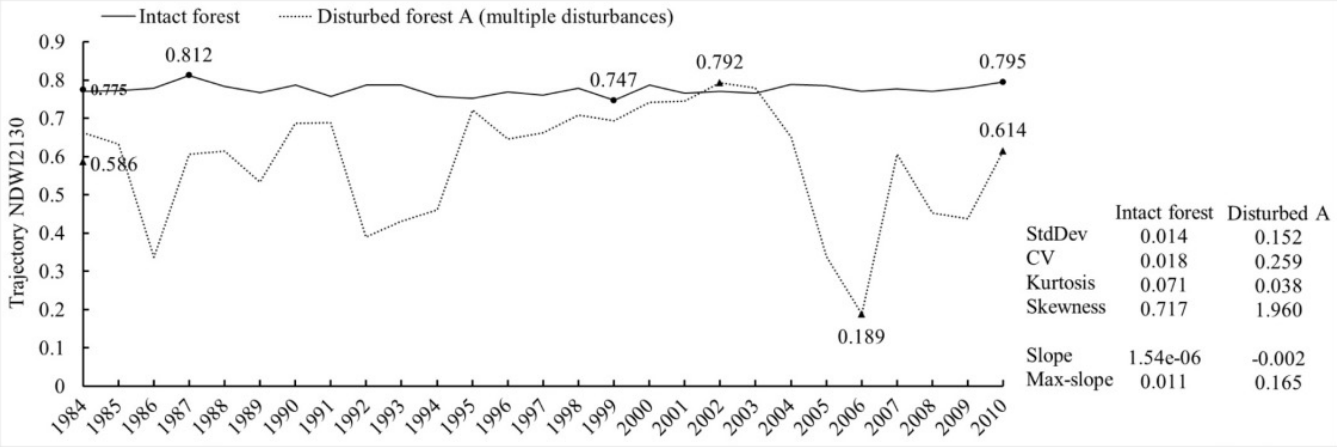


Labelled clusters: tentative forest cover 2000 & 2019

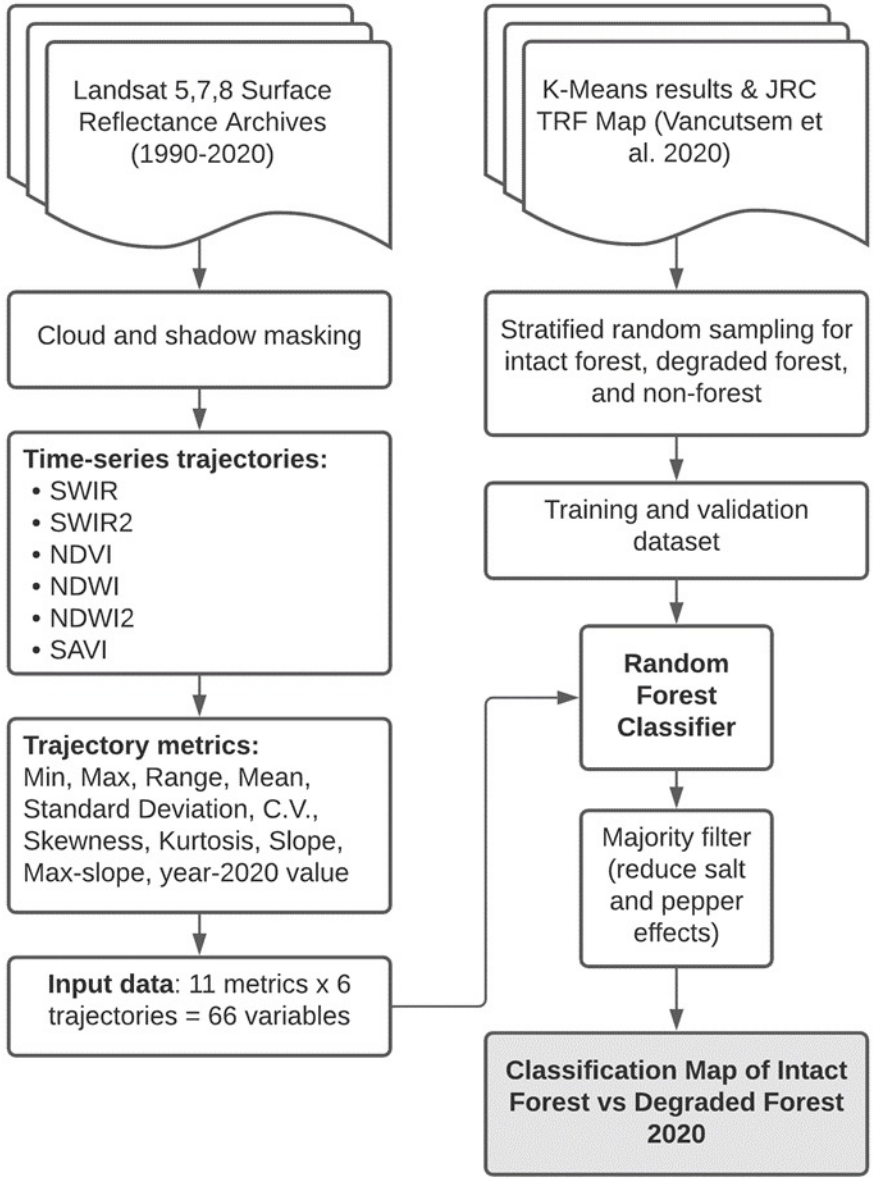

Forest Cover 2020 (Draft)
K-Means Cluster Labelling
Non-forest
Intact Forest
Disturbed Forest and Regrowth mosaic
Water Body

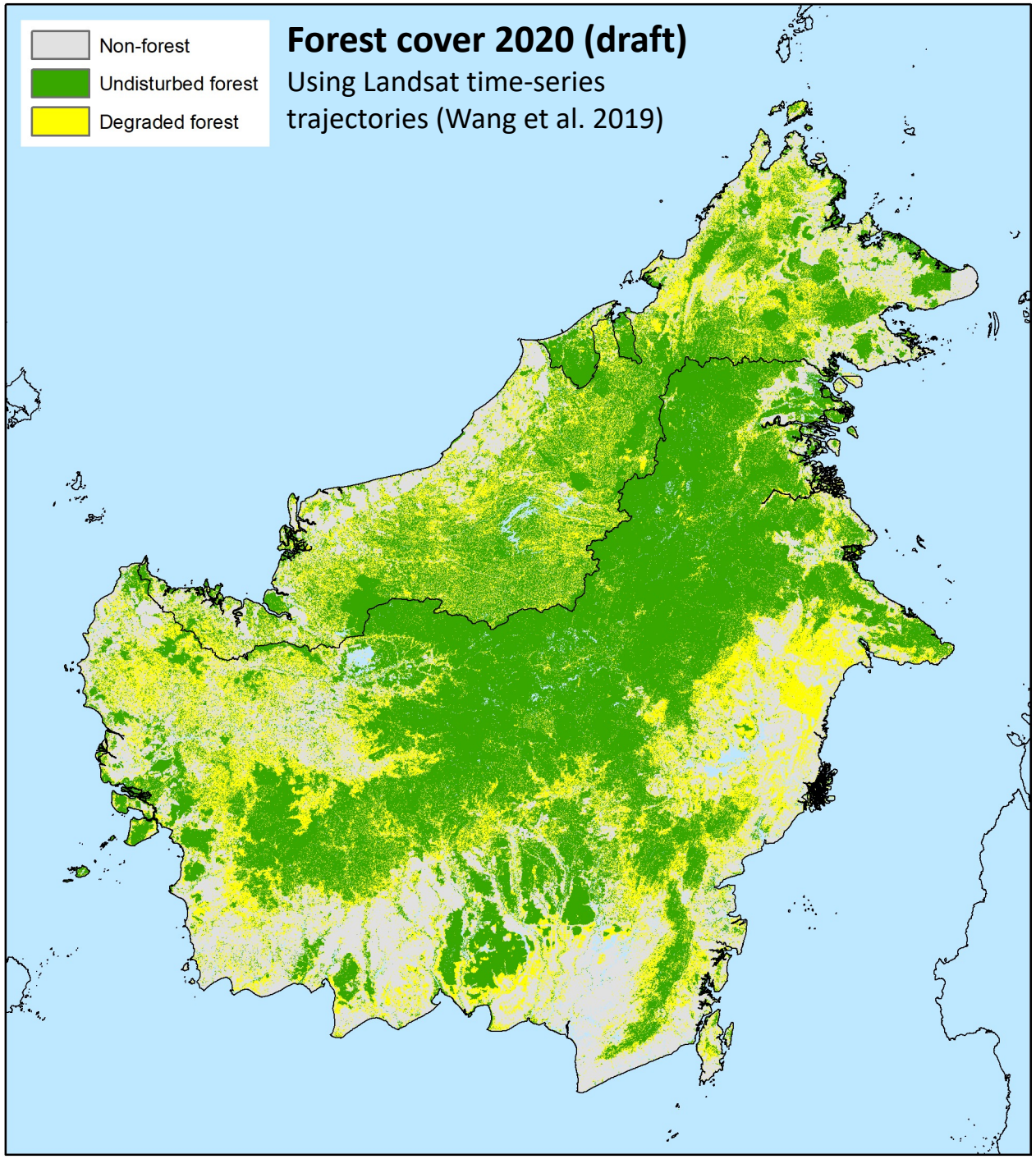

Forest Cover 2019 (Reference Image)
https://forobs.jrc.ec.europa.eu/TMF/
Non-forest
Undisturbed Forest
Degraded Forest
Water Body

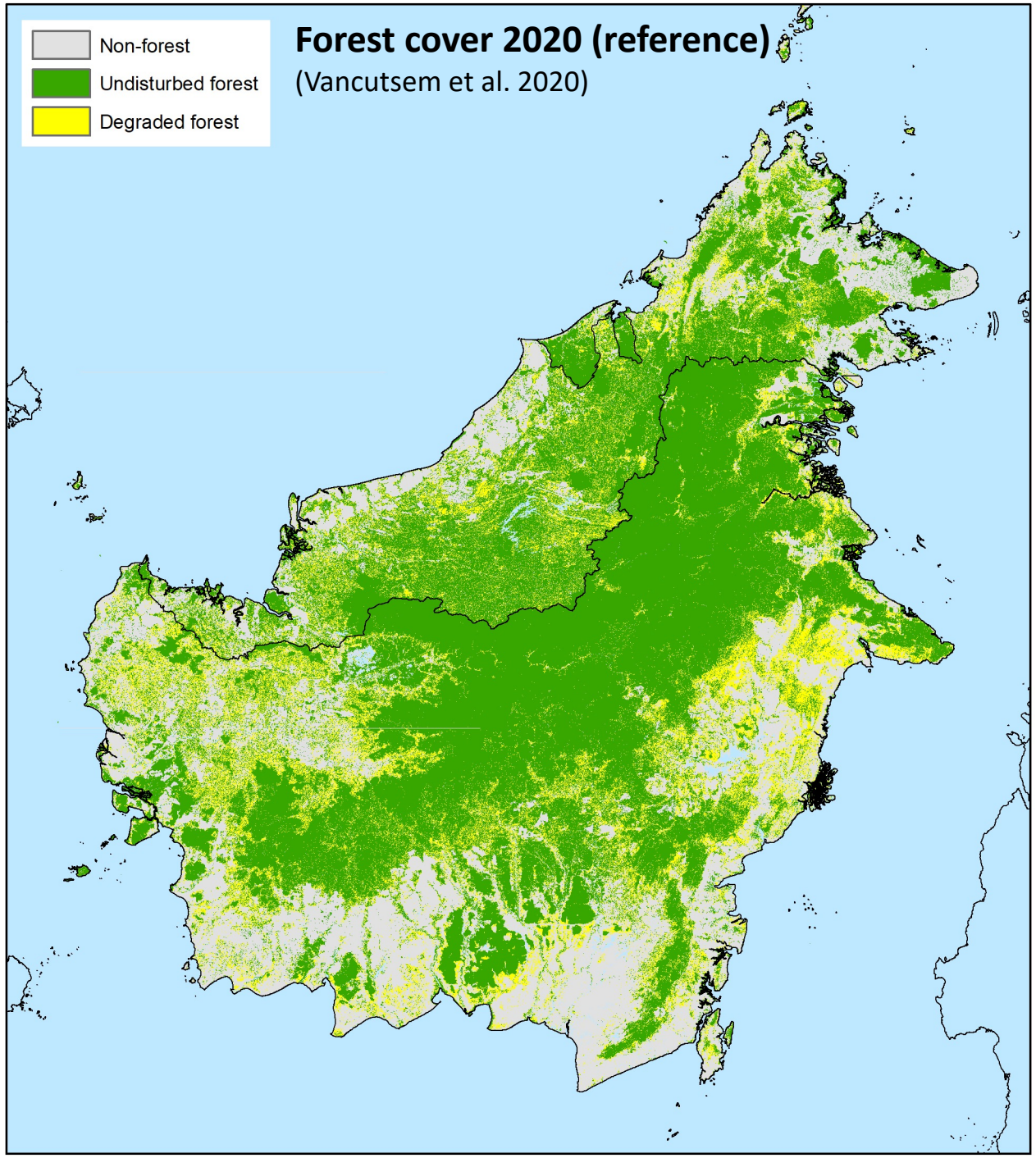
2nd tested approach: **Intact forest classification using Landsat time-series trajectories** (adapted from Wang et al. 2019)



- Intact/undisturbed forest tend to have very low slope of regression and very low standard deviation.
- Forest which have experienced large disturbances would be expected to have higher CV than undisturbed forests.

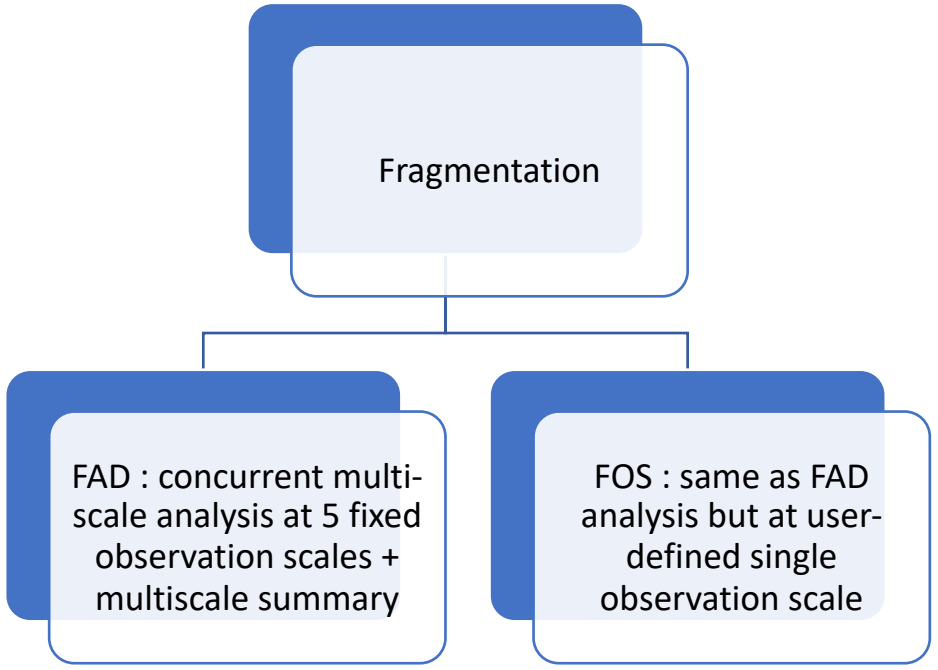


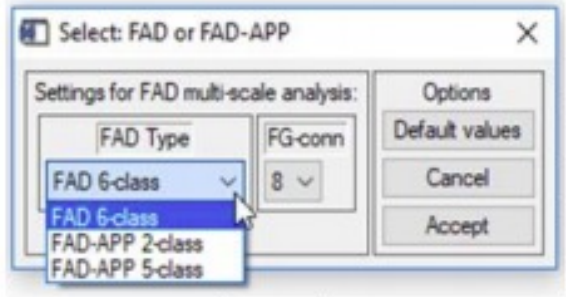

Non-forest
Undisturbed forest
Degraded forest
Forest cover 2020 (draft)
Using Landsat time-series trajectories (Wang et al. 2019)


Non-forest
Undisturbed forest
Degraded forest
Forest cover 2020 (reference)
(Vancutsem et al. 2020)

3rd Approach, using Forest Area Density (FAD) tool and technics, GUIDOS Toolbox, Vogt et al. 2017, 2019 (FAO)

Fragmentation: measuring the spatial density of forest cover, Forest Area Density (FAD, Riitters et al. 2002), at five observation scales using a moving window analysis with square neighborhood areas of length 7, 13, 27, 81, 243 pixels.

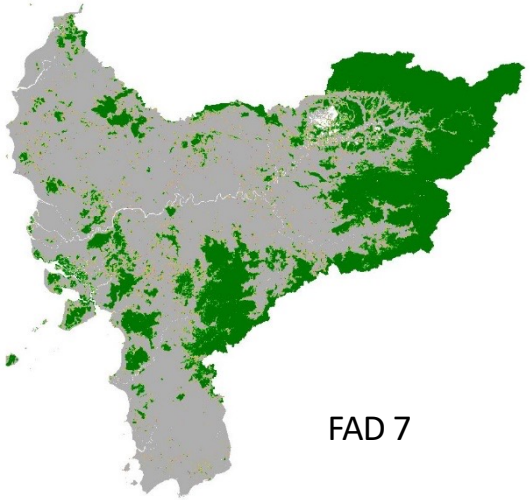




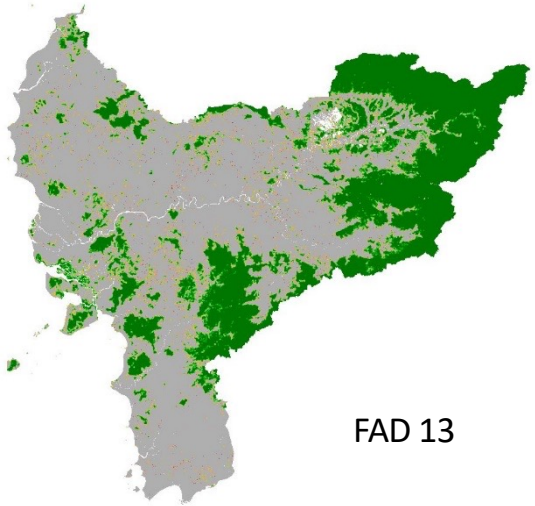
FAD-APP 5-class	Color	FAD range
1-Rare		FAD < 10%
2-Patchy		10% ≤ FAD < 40%
3-Transitional		40% ≤ FAD < 60%
4-Dominant		60% ≤ FAD < 90%
5-Interior		90% ≤ FAD ≤ 100%

FAD 6-class	Color	FAD range
1-Rare		FAD < 10%
2-Patchy		10% ≤ FAD < 40%
3-Transitional		40% ≤ FAD < 60%
4-Dominant		60% ≤ FAD < 90%
5-Interior		90% ≤ FAD < 100%
6-Intact		FAD = 100%

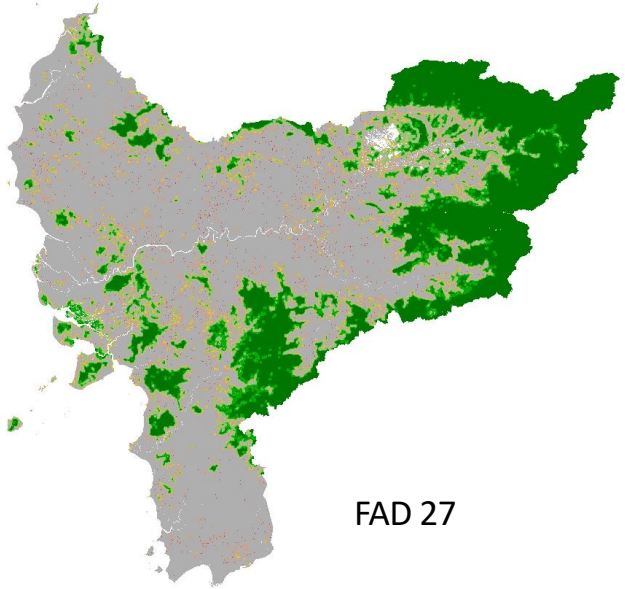
FAD-APP 2-class	Color	FAD range
1-Separated		FAD < 40%
2-Continuous		40% ≤ FAD ≤ 100%



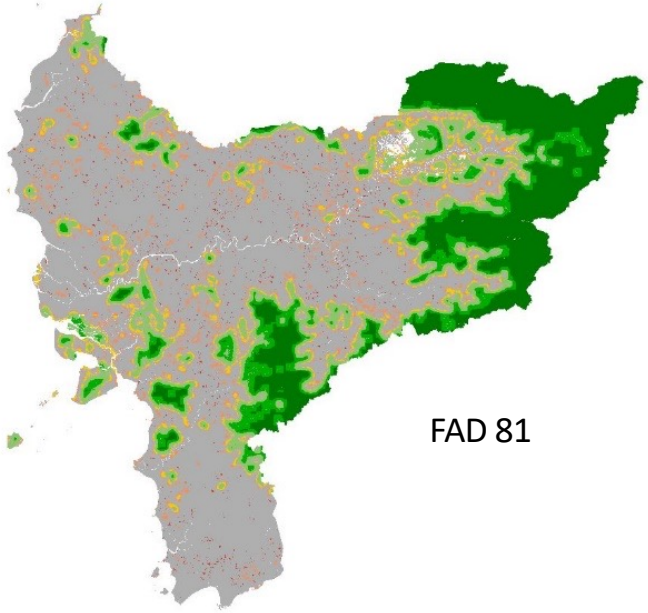
FAD 7



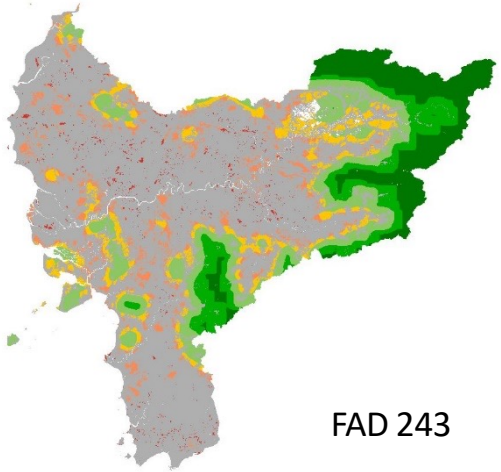
FAD 13



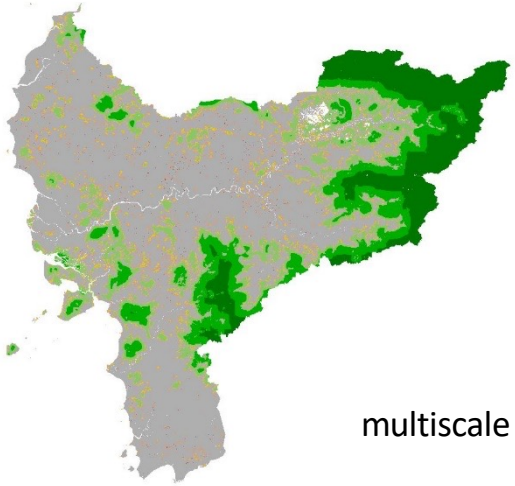
FAD 27



FAD 81



FAD 243



multiscale

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