Monitoring Deforestation and Forest Degradation on National and Local Level in Indonesia

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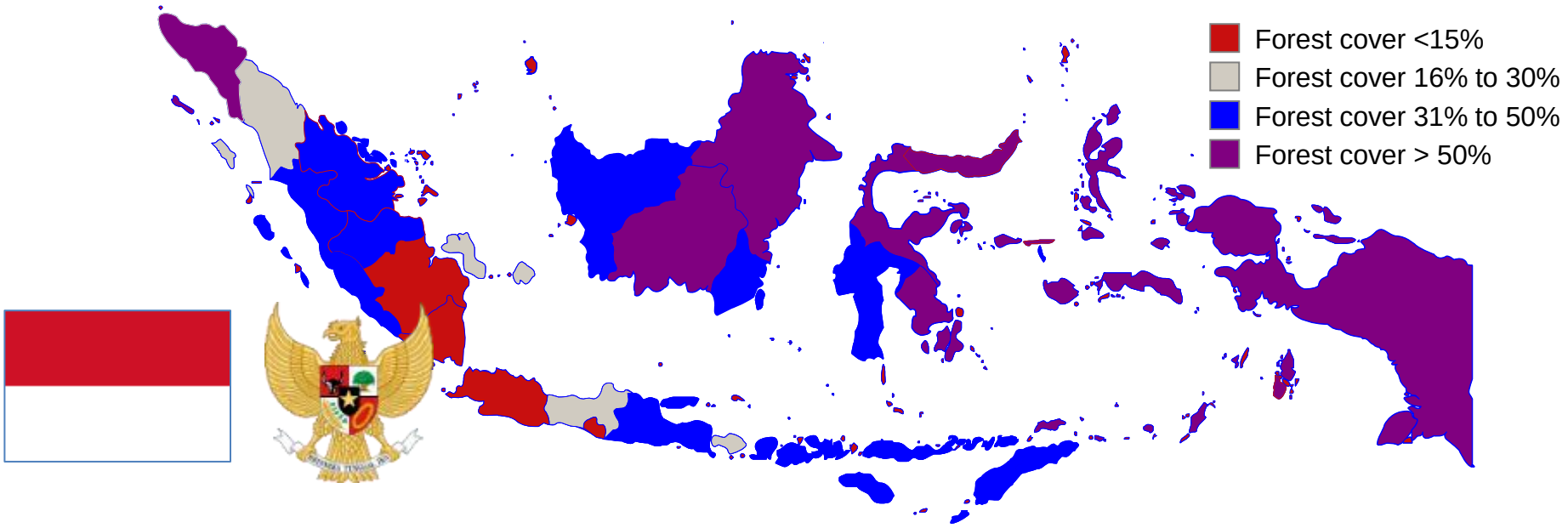
Outline

- The context – Indonesia
  - ✓ Indonesia quick facts
  - ✓ The forest sector in Indonesia

- Monitoring of deforestation and forest degradation
  - ✓ Multi-level mapping approach
  - ✓ National Level – General approach
  - ✓ National Level – Identification of degraded forests
  - ✓ Local Level - LiDAR derived emission factors, logging roads as proxy and degradation in LiDAR data

Indonesia is a rapidly developing country, the world's 3rd largest democracy and home to the 3rd largest tropical forest



Republic of Indonesia

- Archipelago of 17,000 islands, 3,500 miles wide
- World's fourth most populous country
  - Labor force: 94 million
- Economy based on NR and commodities (oil, coal, oil palm)
- World's largest Muslim population – Muslim 87%, Protestant 7%, Roman Catholic 3%, Hindu 2%, Buddhist 1%
- Literacy rate: 93%
- World's third largest democracy

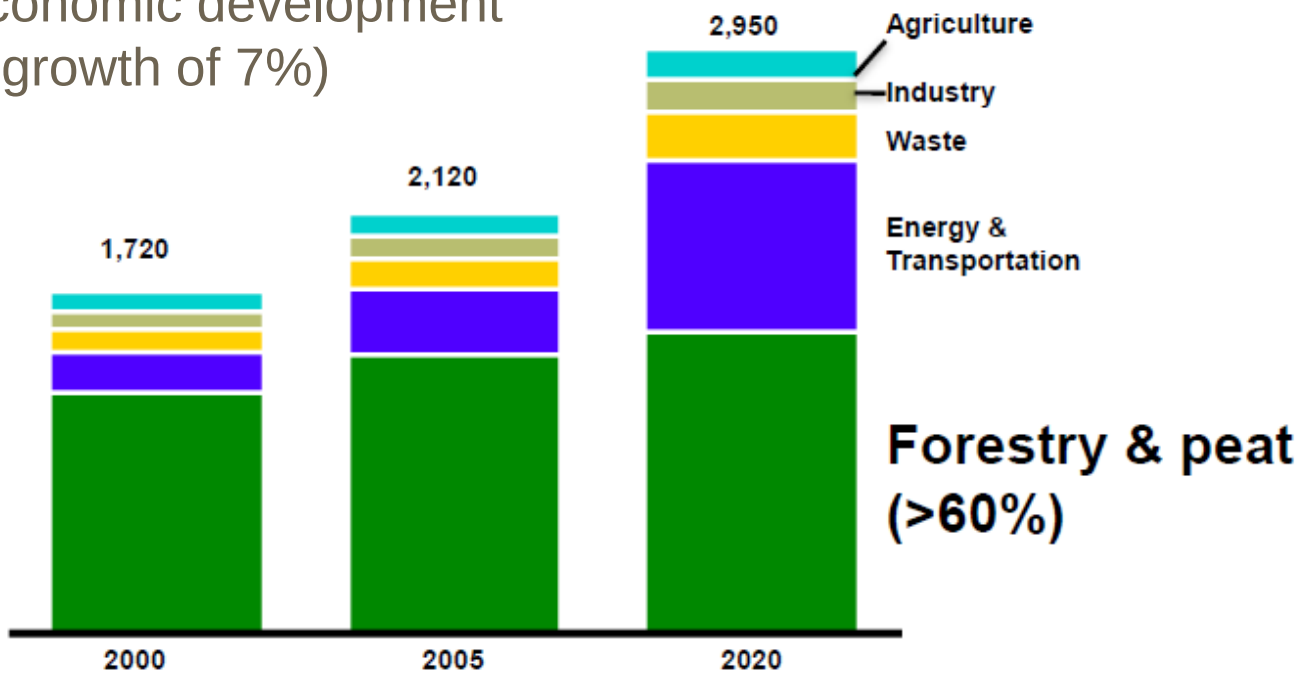
Key figures

- Population: 255 million
- Nominal GDP: USD 878 billion
- GDP per capita: USD 3500
- Population below poverty line: 16.7%

SOURCE: Worldbank, IMF (2014)

Indonesia

- 3rd largest forest cover (approx. 100 M ha)
- 3rd largest emitter of GHG worldwide (approx 2 GT CO2) with over **67%** from deforestation (e.g. palm oil plantations, mining, etc)
- National GHG emission reduction target
- (-26/-41%) vs economic development
- target (economic growth of 7%)



Source: Indonesia's Second National Communication under the UNFCCC, MoE, Indonesia, November 2010

Drivers of Deforestation & Degradation in Indonesia

Deforestation:

Rapid and abrupt land cover transformation e.g. for

- **Palm oil plantations**
- **Mining**

- **Land development (Infrastructure)**
- **Slash and burn**
- **Un-well management of existing degraded forest**

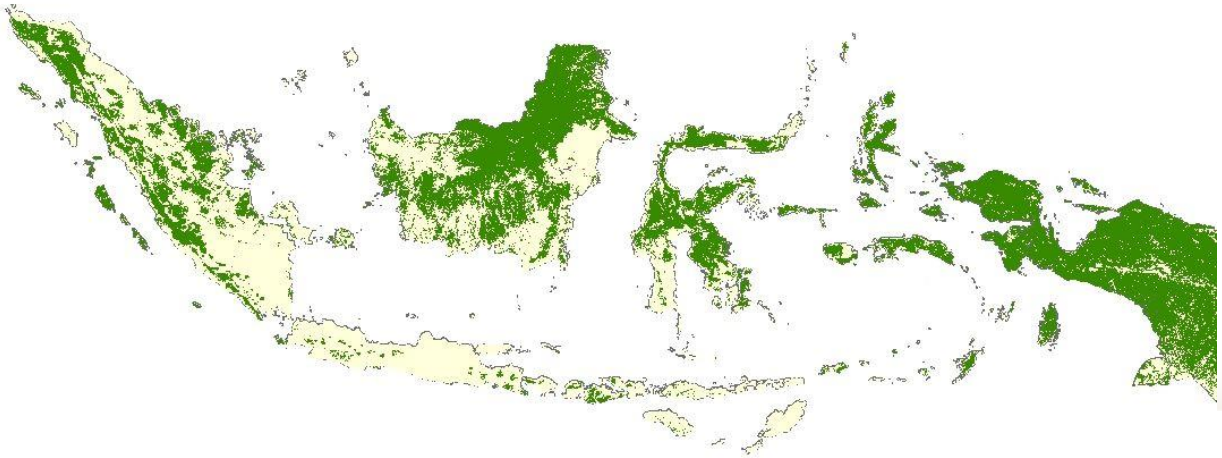
Forest Degradation:

Slow and subtle change in forest cover through

- **Legal selective logging (concessions)**
- **Illegal logging**
- **Fire**
- **Un-well management of existing degraded forest**

Definition: Forest

Formal definition	Working definition
Permenhut 14/2004 on A/R CDM : “Land spanning more than 0.25 hectares with trees higher than 5 meters at maturity and a canopy cover of more than 30 percent, or trees able to reach these thresholds in situ”	**SNI 8033:2014** defines forest based on satellite data features including color, texture and brightness **SNI 7645:2010** elaborates land cover classes definition (23 classes)

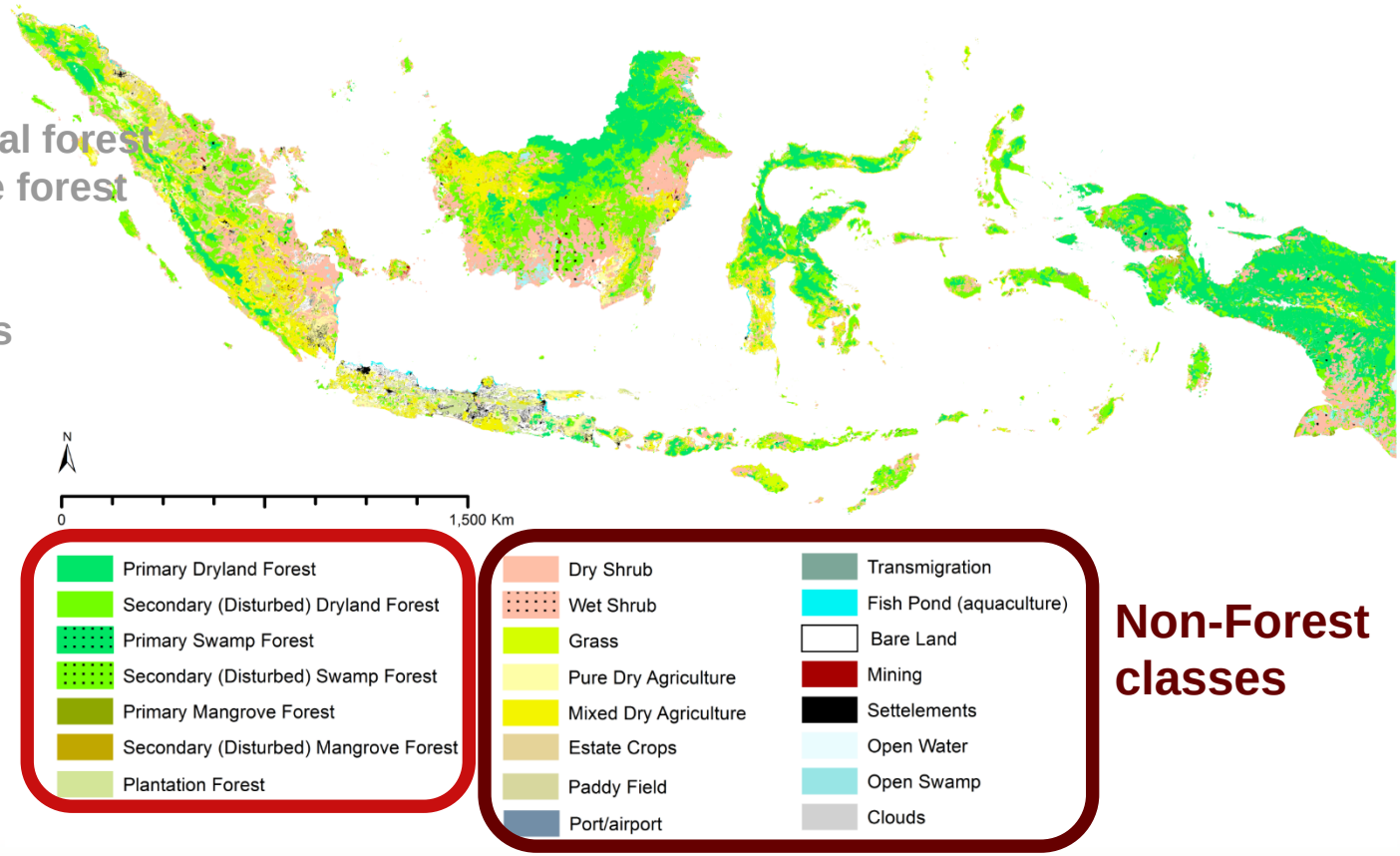


Activity Data: NFMS (National Forest Monitoring System) - 23 land cover classes – KLHK – SNI 7645-2010

7 **Forest** classes:

- 6 classes of natural forest
- 1 class man-made forest (plantation)

16 **Non-Forest** classes, including no data/clouds



Forest classes

Non-Forest classes

Definitions – cont.

Deforestation: Conversion of natural forest categories into other land-cover categories that has only occurred once in a particular area

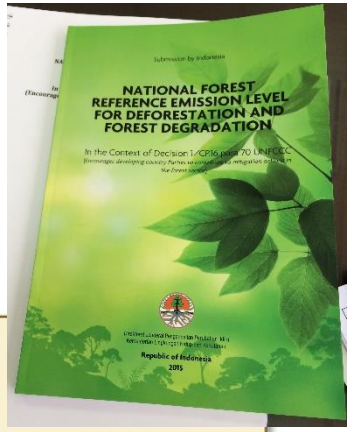
Permenhut No. 30/2009: permanent alteration from forested area into a non-forested area as a result of human activities.

Forest degradation: change of primary forest classes to secondary forest classes or logged-over forests

Permenhut No. 30/2009: deterioration of forest cover quantity and carbon stock during a certain period of time as a result of human activities

Main causes for forest degradation: unsustainable logging, agriculture (shifting cultivations), fires, fuelwood collection, livestock grazing

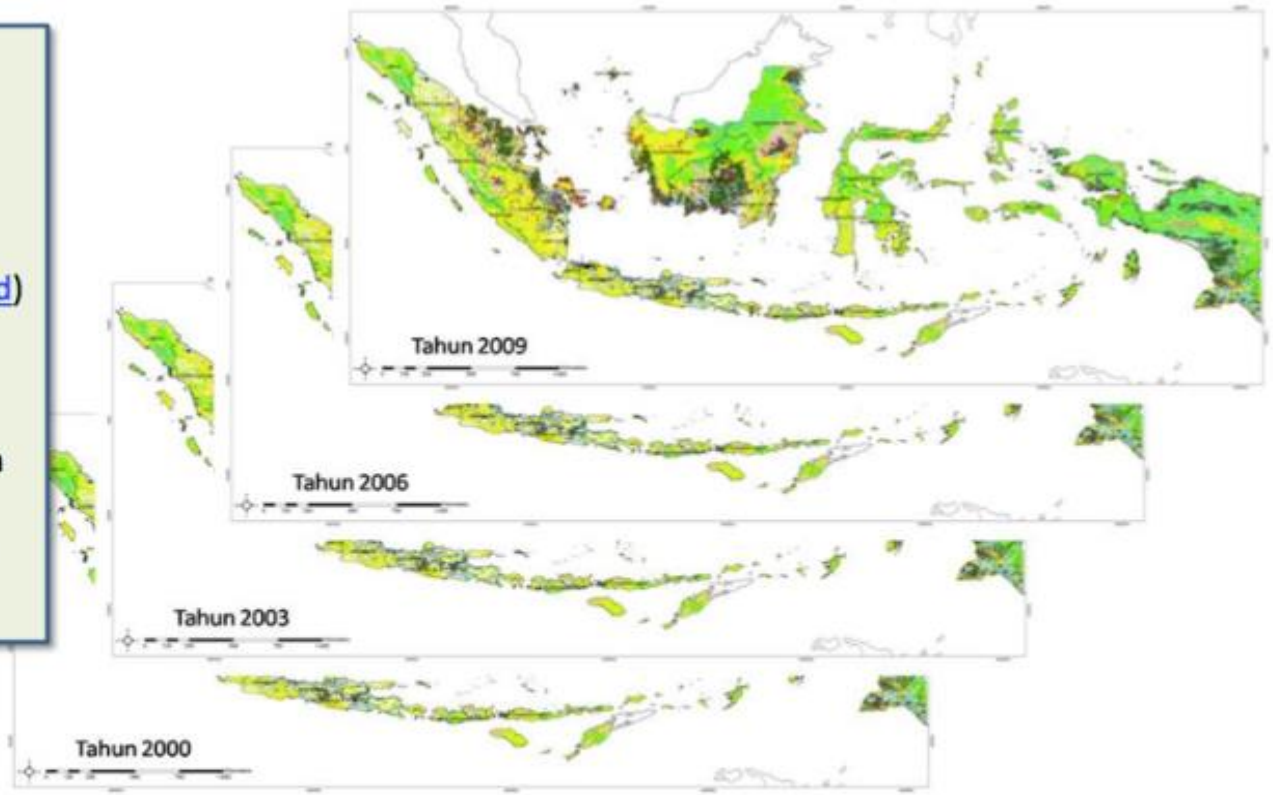
National FREL Indonesia



Reference period	**1990 - 2012**
Reasons	(1) Availability of land-cover data that transparent, accurate, complete and consistent (2) Reflect the general condition of the forest transition in Indonesia, and (3) The length of time that describes the national circumstances and policy dynamics that may affect it (biophysical, social, economic growth, political and spatial planning).
Reference emission calculation	Historical emission from deforestation and forest degradation, i.e. **average annual emission** from 1990 to 2012
Emission calculation method	• Deforestation : carbon stock different (gross deforestation) • Degradation : carbon stock different • Peat emission : emission from peat decomposition (adopted from IPCC, 2013) where deforestation or degradation occurred

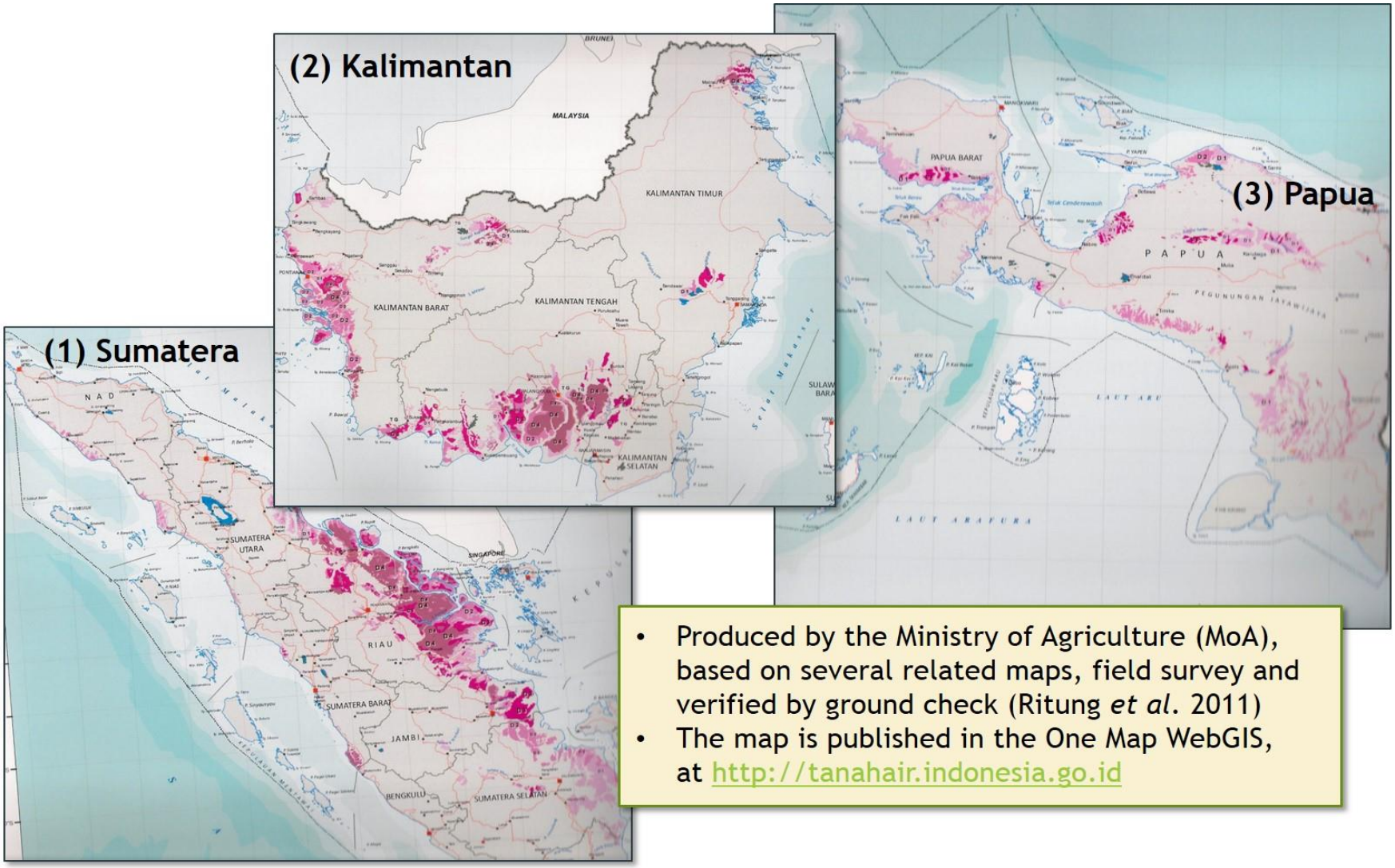
Land Cover Data based on Landsat imagery

- This data is part of the National Forest Monitoring System (NFMS) and has been stored in NFMS website (http://nfms.dephut.go.id) .
- The maps have been checked for consistency with other source of data i.e. LAPAN's forest/non-forest data and Margono *et al.* (2014).



- Land-cover data set from MoFor (23 classes) refer to SNI 8033:2013, time-series from 2000 – 2012.
- Landsat satellite images manual interpretation (visual) with minimum mapping unit 6.25 ha

National Peatland Data (Ministry of Agriculture)

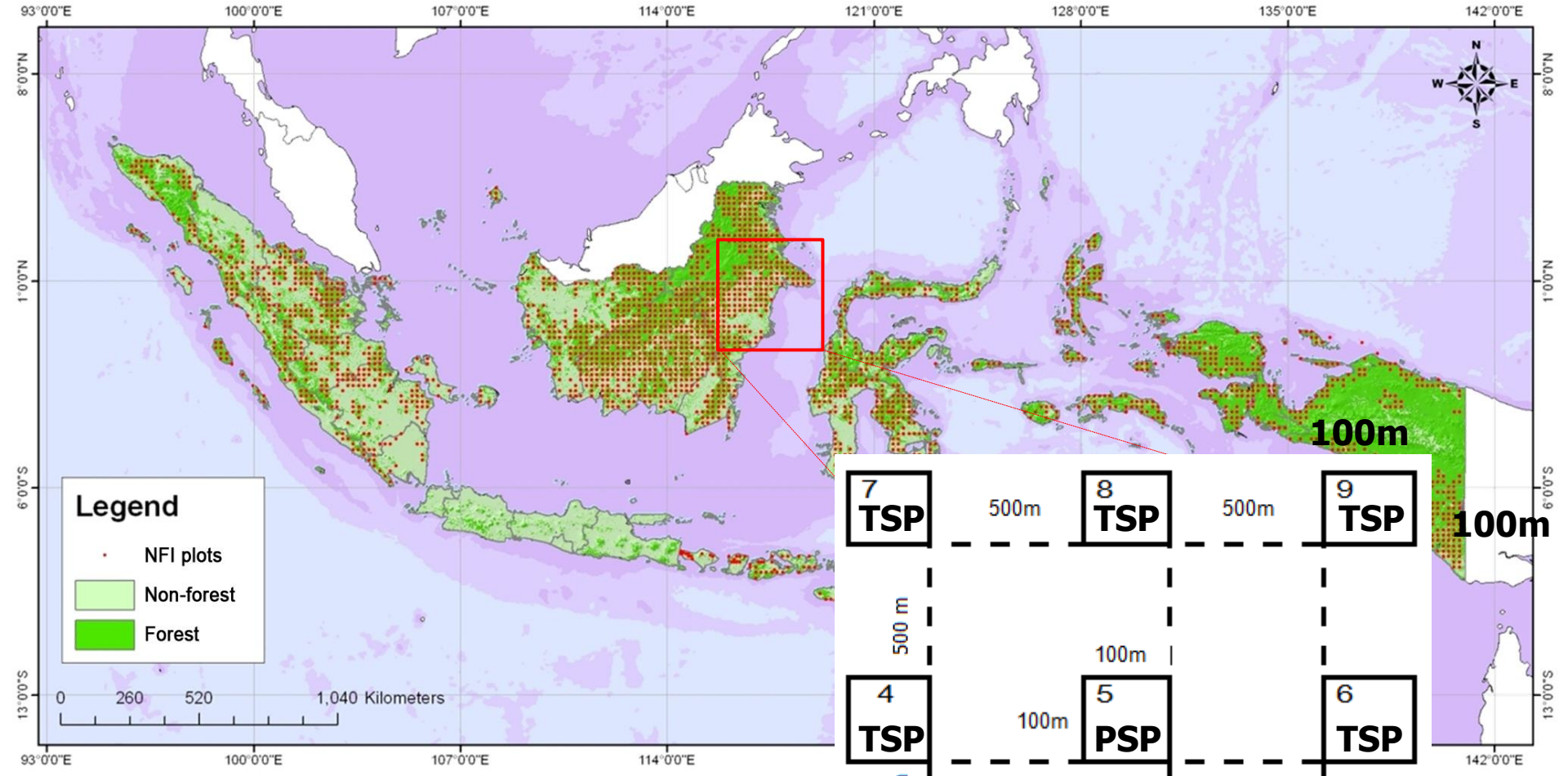


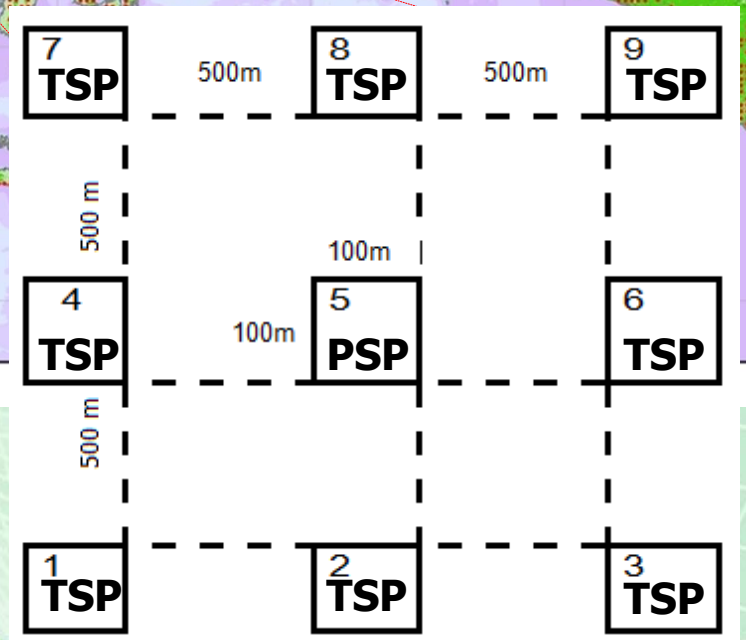
- Produced by the Ministry of Agriculture (MoA), based on several related maps, field survey and verified by ground check (Ritung *et al*. 2011)
- The map is published in the One Map WebGIS, at http://tanahair.indonesia.go.id

National Forest Inventory (NFI)

- Programme initiated in 1989, support by FAO and Worldbank
- 1989-2013: > 3,900 plots developed, distributed on a 20x20km grid
- Total of 4,450 measurements of Permanent Sample Plots
- 74% (>2,600 measurements) used for FREL
- No sample plots in mangrove forests available → forest research data used for these forest types

NFI-Cluster Plot Distribution





- Systematic Stratified Sampling 20 km x 20 km
- Grid UTM
- Forest state area
- Seven (7) forest classifications

KEMENTERIAN LINGKUNGAN HIDUP DAN KEHUTANAN

National Forest Monitoring System

[Sistem Monitoring Hutan Nasional]

SIMONTANA

Maskot: **Si Bino**

Importance of class of “forest degradation” (for Indonesia)

- For the period of 1990-2012, the annual rate of forest degradation in Indonesia was 507,486 hectares (FREL, 2015).
- 90% of natural forest loss in Indonesia occurred within degraded forests (Margono *et al.*, 2014), meaning that logging (either managed or un-managed) preceded clearing.
- The Indonesian bio-georegion diversity and topography creates a wide variation of forest types and forest formations, which is linking to difficulties in classifying the different level of forest degradation.
- Different levels of forest degradation is greatly required for sustainable management purposes

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FORCLIME Forests and Climate Change Programme in a nutshell

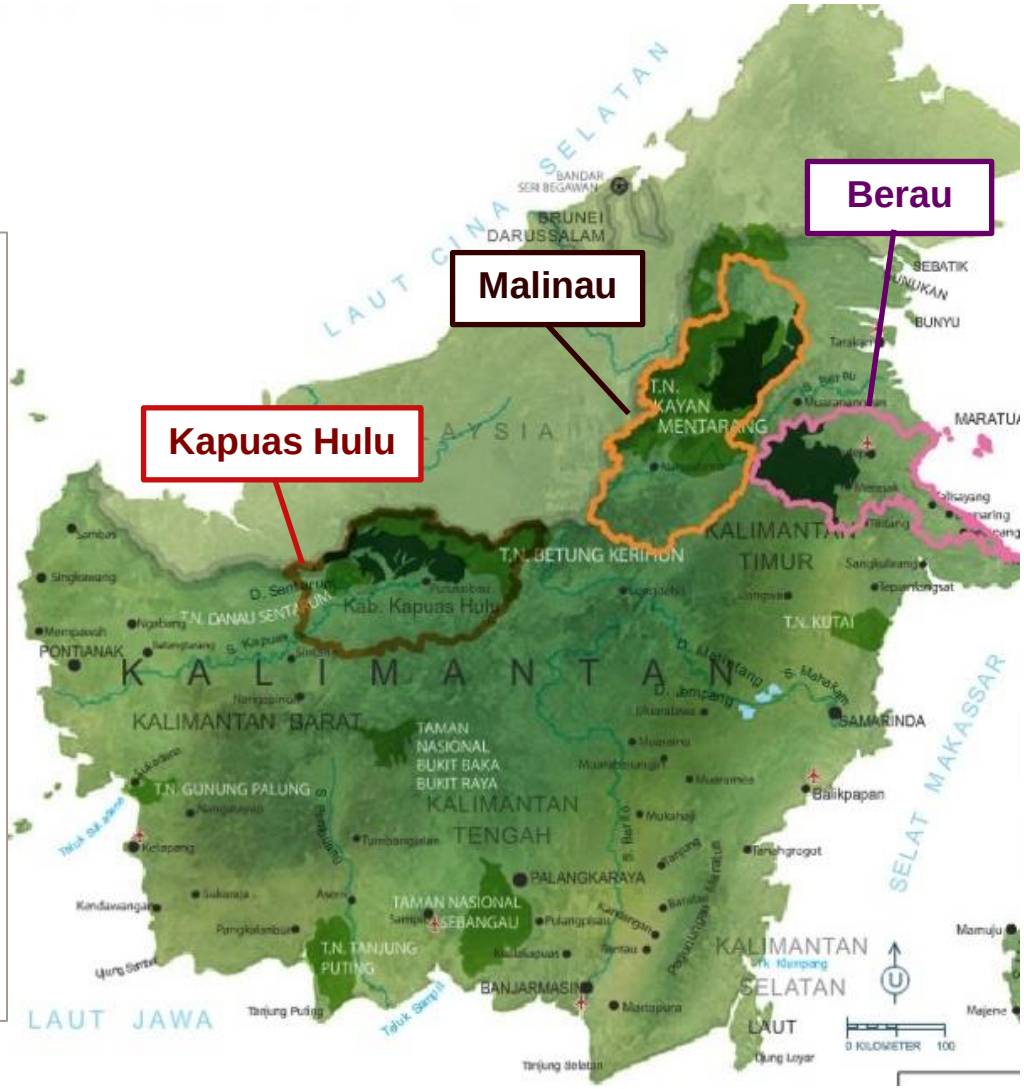
Programme Objective

- implement sustainable forest management for the benefit of the people.
- reduce greenhouse gas emissions from the forestry sector,
- conserve forest biodiversity within the regional Heart of Borneo Initiative and

Main Partner: Ministry of Environment & Forestry (MoEF)

Programme Duration: 2009-2020

Funded by: BMZ (German Ministry for Economic Cooperation and Development)

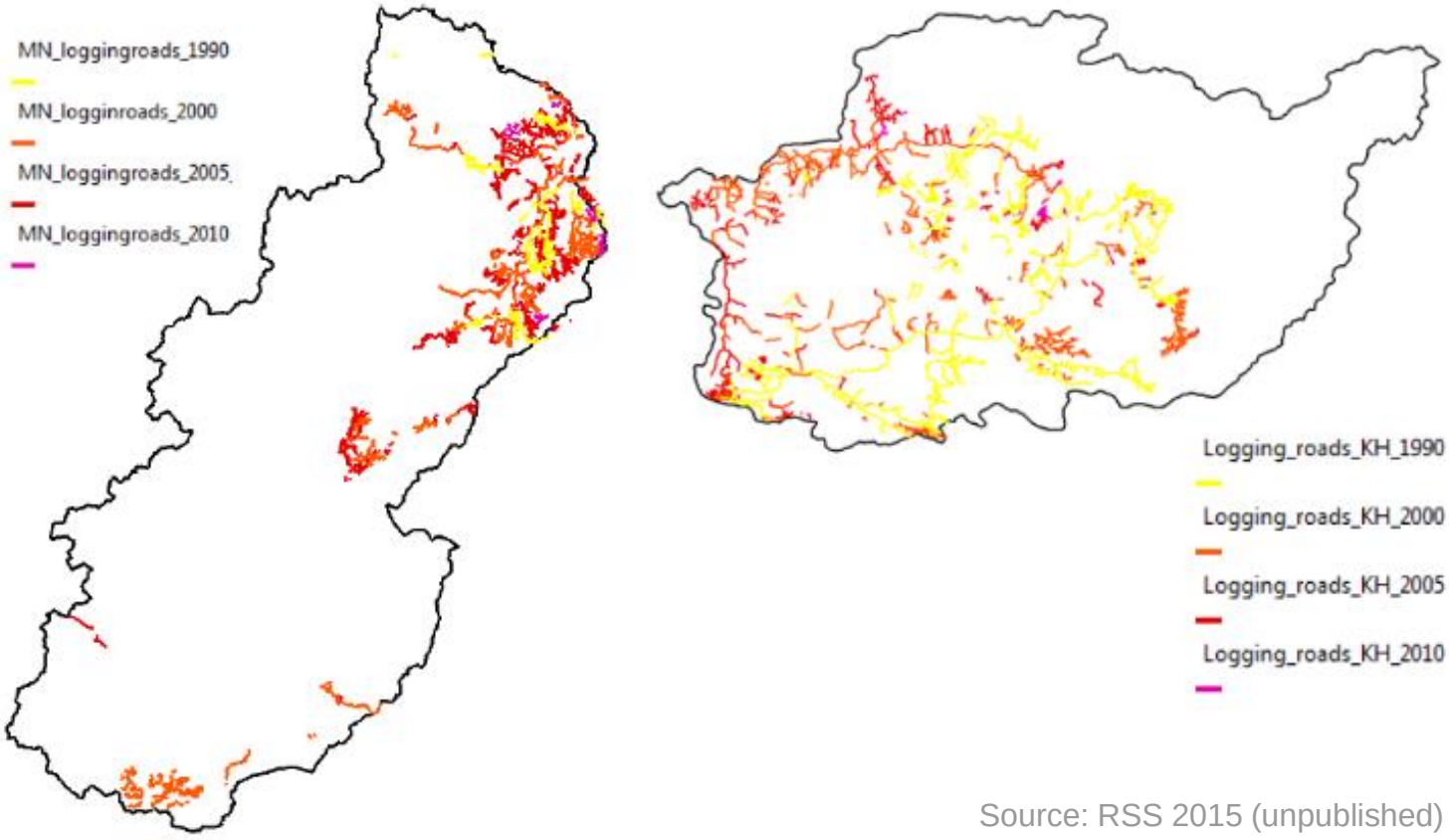


Forest degradation in Landsat imagery

- Difficult to automatically distinguish primary and logged over secondary forests due to spatial resolution
- Use of proxy: logging roads
- Buffer of 300 m around logging roads (based on visible impact) → assumed logging impact → degraded (secondary) forest

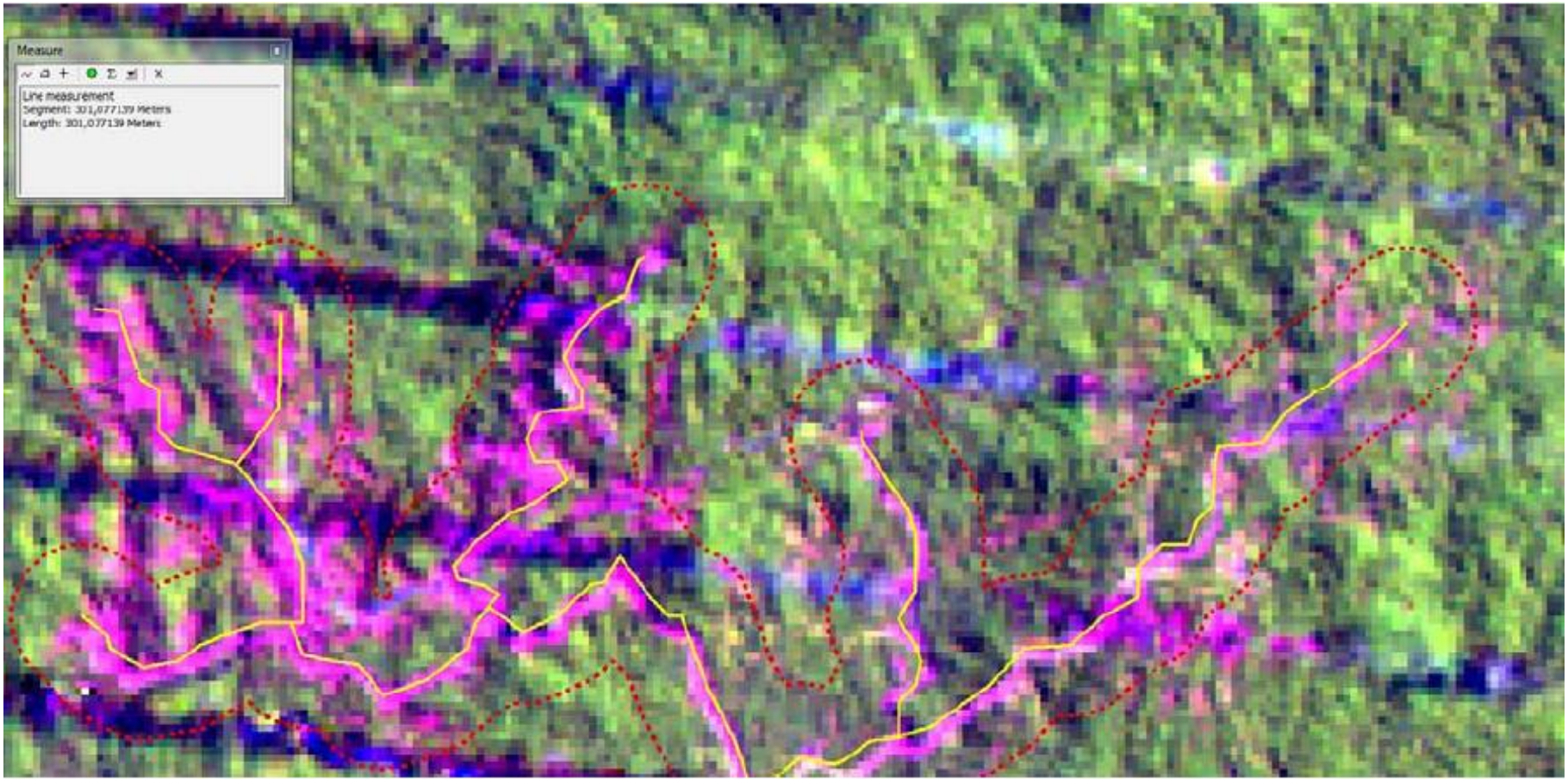
Forest degradation in Landsat imagery – cont.

Logging road network for 2 districts, evolving over time



Source: RSS 2015 (unpublished)

Forest degradation in Landsat imagery – cont.



Source: RSS 2015 (unpublished)

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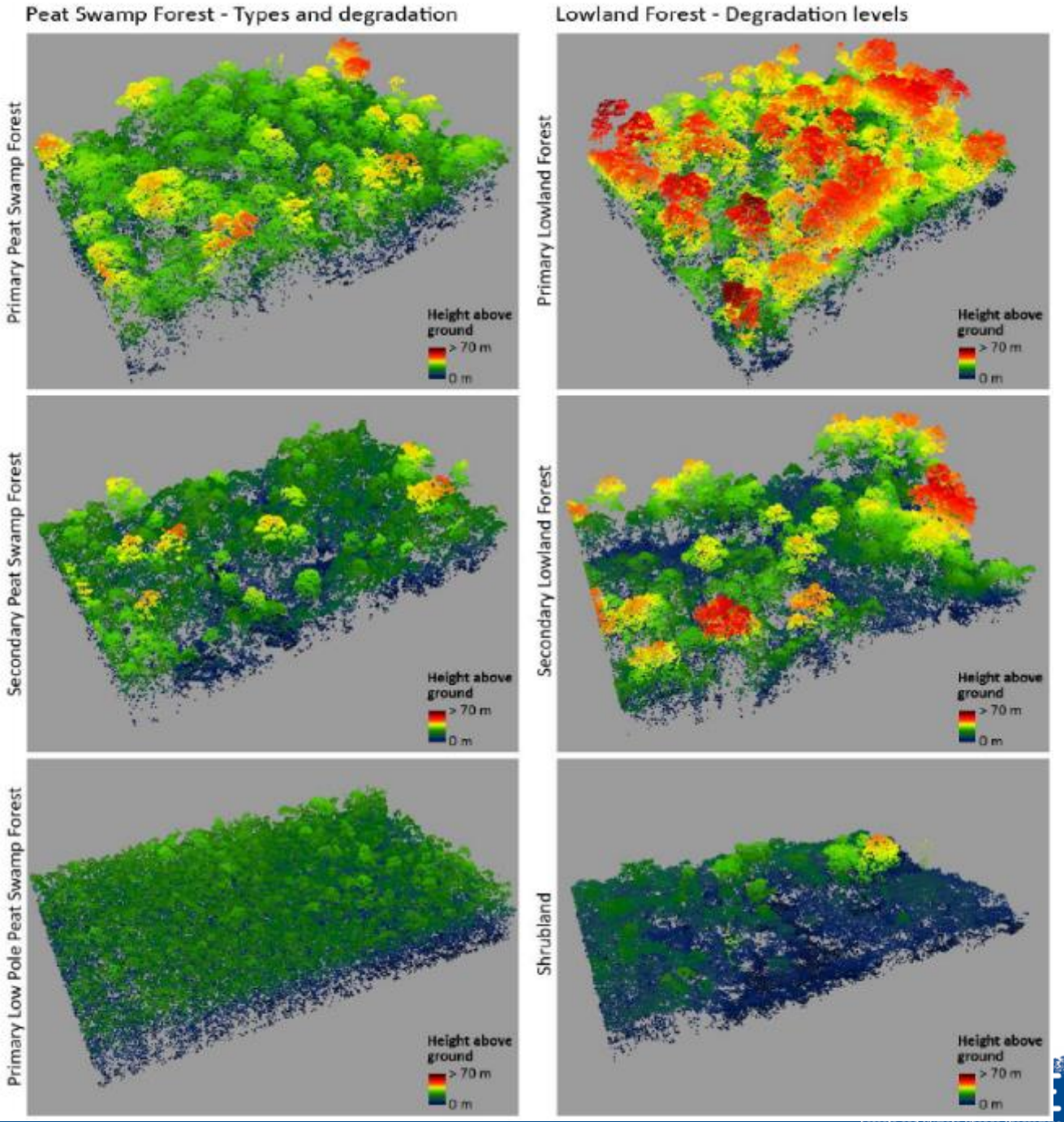
Forest degradation in LiDAR data

- Degradation levels can be easily distinguished
- Only for small sample areas reasonable



Source: RSS 2015 (unpublished)

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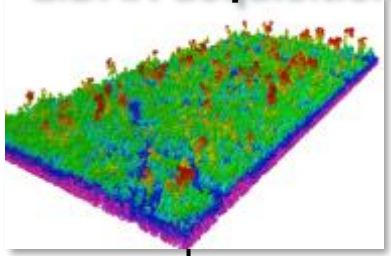
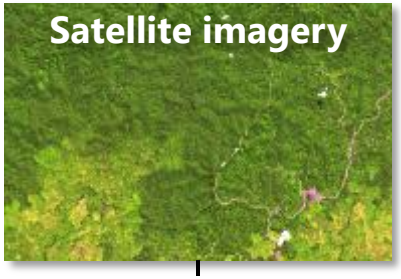
FORCLIME Aboveground Biomass

- Based on LiDAR biomass models and forest inventories
- 3 districts in Kalimantan (results for 2 already available)

Forest Inventory

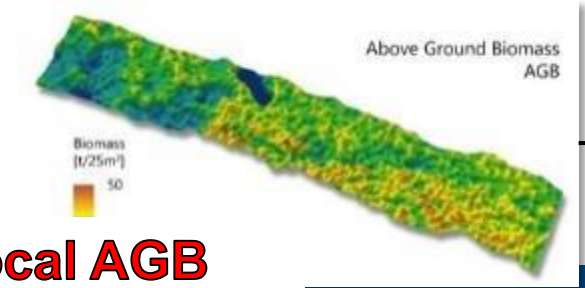
LiDAR acquisition





Land cover classification

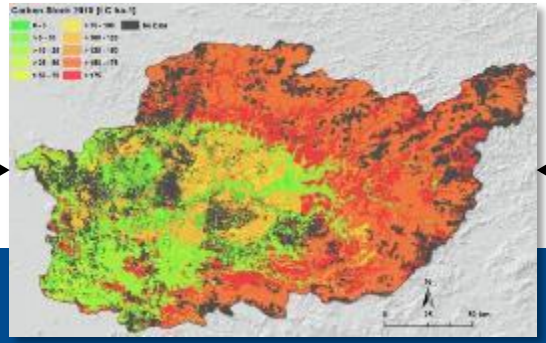
Modeling



Local AGB values

Upscaling

Carbon stock map

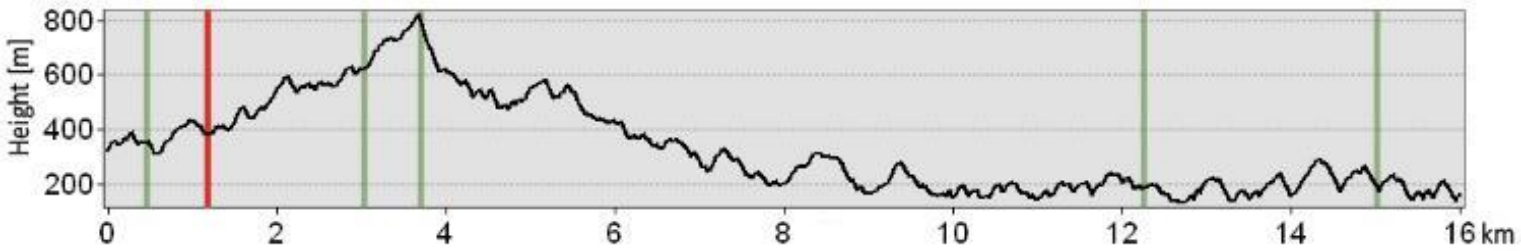


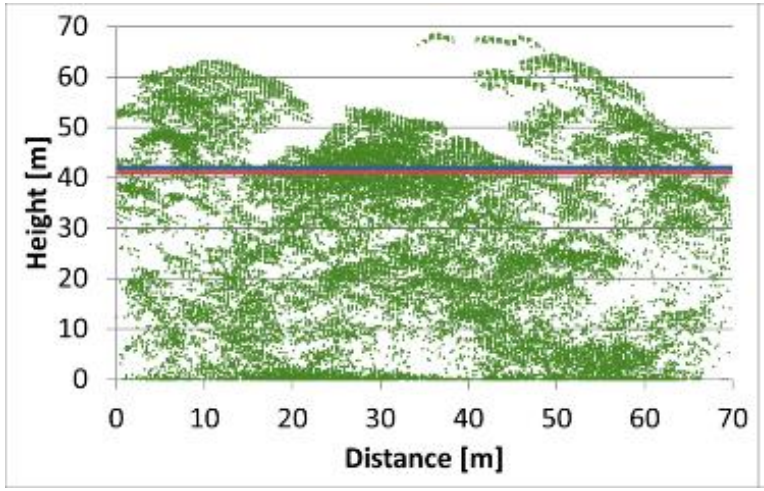
Primary Hill and Sub-montane Dipterocarp Forest (300-<900 m a.s.l.)

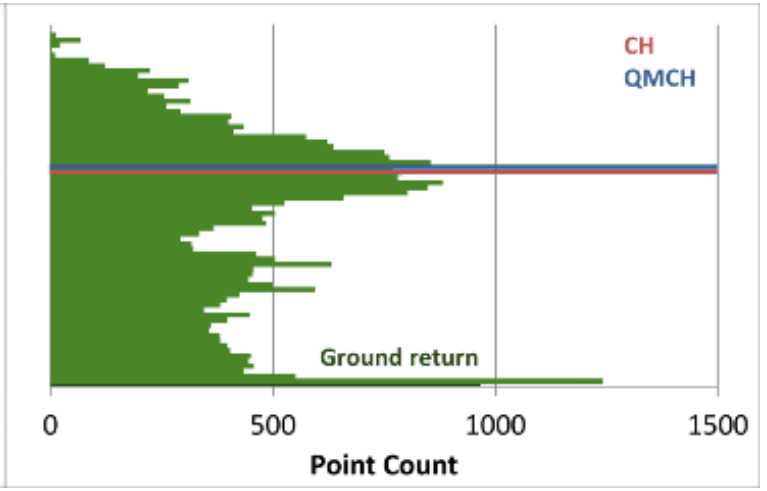
Plot ID:
01_02

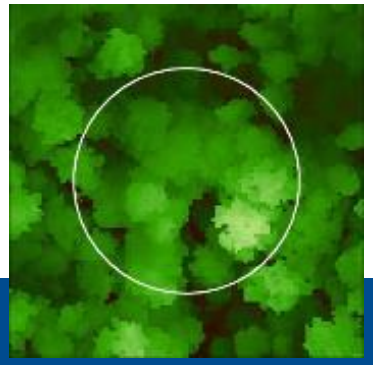
Ø Terrain Height:
634.2 m

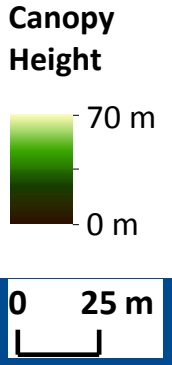
AGB:
374.8 t/ha











Forests and Climate Change Programme

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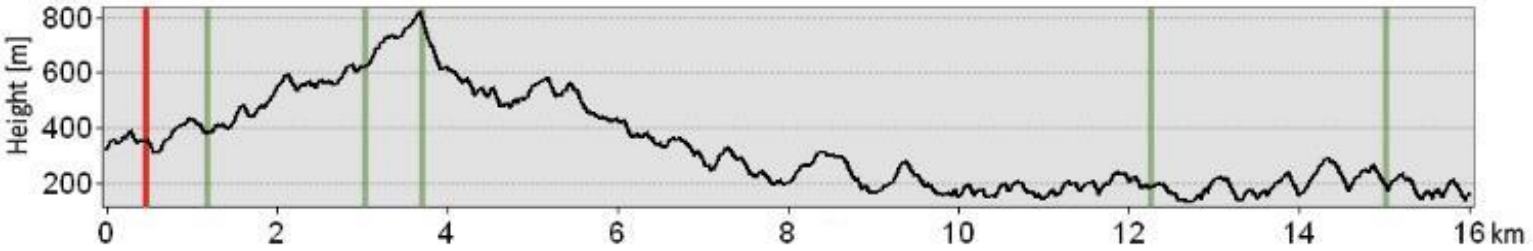
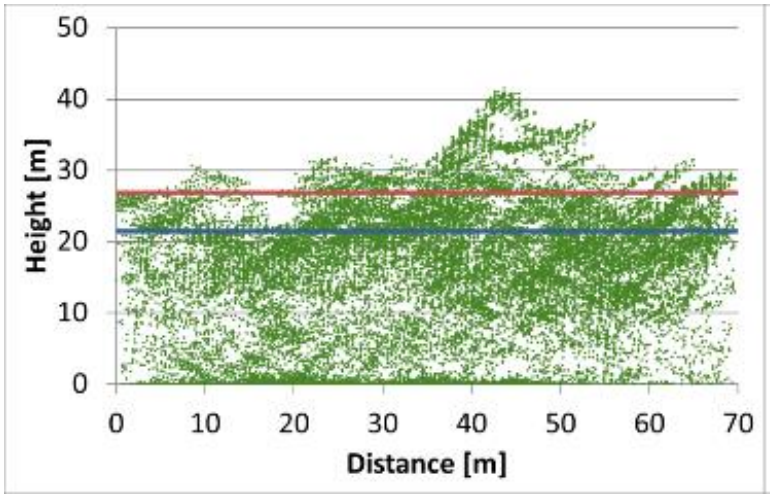
Secondary Hill and Sub-montane Dipterocarp Forest (300-<900 m a.s.l.)

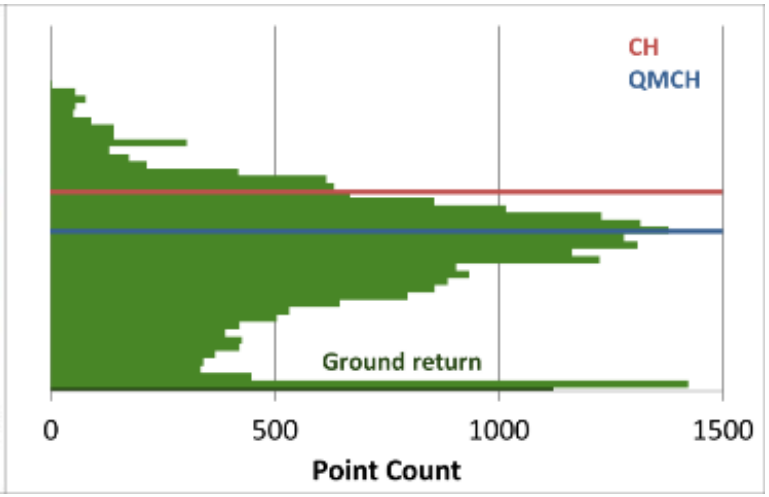
Plot ID:
01_01

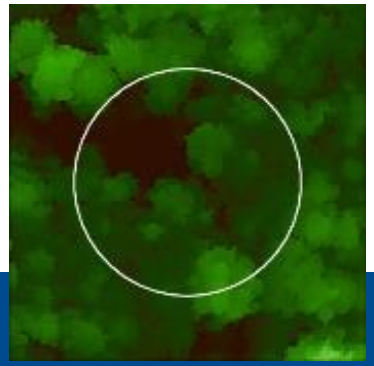
Ø Terrain Height:
325.6 m

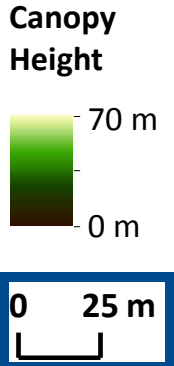
AGB:
166.3 t/ha

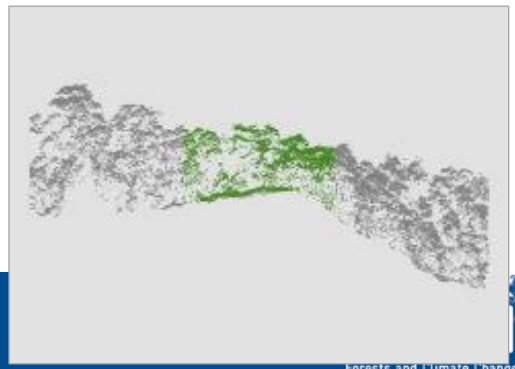












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FORCLIME Aboveground Biomass

	AGB (t ha^{-1}) NFI Indonesia*	AGB (t ha-1) NFI Kalimantan*	AGB (t ha^{-1}) FORCLIME Kapuas Hulu	AGB (t ha^{-1}) FORCLIME Berau
Primary dryland forest	266.0	269.4	512.9	332.9
Secondary dryland forest	197.7	203.3	331.8	291.7
Primary sw				Not present in Berau
sw				Not present in Berau

Significant difference between NFI and local AGB and inbetween districts!

→ High biomass variability in Indonesian forests

**National FREL submission by Indonesia, draft version 12/2014*

Costs for LiDAR AGB study

Acquistion and processing of LiDAR data and field inventory for calibration: 4 – 12 US$ per hectare

→ Costs may vary greatly due to:

- Area to be covered
- Accessibility of the area
- Resolution and type of LiDAR data acquired (points per m^2, full wave form vs. single return)
- Local conditions (biodiversity, biomass)
- Evaluation procedure (full wave form vs. single return)

Discussion

- High importance to assess forest degradation but difficulty to do it in a cost-effective way on national level
- Wide variety of forest degradation types requires advanced methodology and field verification as well as experienced analysts with local knowledge
- National level uses Landsat data, sub-national level can use other data (higher resolution, RADAR, LiDAR, etc.)
- How can national and sub-national level be linked?

  → sub-national level should use national data as basis which can be improved with local data (top-down approach)?

  → up-scaling of local data into national data?