Assessing C-stock dynamics at the landscape level

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• Upscaling issues: from plot to landscape

• Study area – forest transition

• Information resolution – C-stock dynamics

• Spatial resolution – land use/cover

• Temporal resolution – C-stock dynamics
Upscaling C-stock change assessment

- Plot level C-stock
- Time averaged C-stock of Land use systems
- Look-up table
  - Field
  - Map
- Land use/cover changes
  - Satellite
  - Analyst
  - Reality
- Landscape level C-stock changes

Field Map

Reality Analyst Satellite

Reality Analyst Satellite
Sources of uncertainties

- **Technical:** Data (satellite imageries) quality and resolution, pre-processing error (georeferencing, atmospheric correction), interpretation error (inconsistency, semantic extraction, information recognition), classification method, extrapolation

- **Operational:** lack of budget for ground truthing, monitoring, purchasing data with proper resolution & powerful software, lack of time & capacity, lack of coordination …

- **Political:** definition of forest, scope of REDD, gaps between expectation and reality, …
Resolution

- **Information** resolution: different level of details in the information to be discriminated in classifying *land use/cover*

- **Spatial** resolution: size of *area* on the earth surface that is represented by one value in the map/pixel

- **Temporal** resolution: *frequency* of assessment conducted during one period of time
Forest transition

C-stocks (t/ha)

Time

Undisturbed forest

Forest frontier

Forest/agricultural mosaics

Forest/plantation/agricultural mosaics
Case study area

Scatterplot of population density vs forest fraction at district level

Case study area and previous studies conducted in the area
EAST KALIMANTAN
- Tree based: 13%
- Forest: 78%
- Non tree: 3%
- Non vegetation: 6%

JAMBI
- Tree based: 46%
- Forest: 35%
- Non tree: 8%
- Non vegetation: 11%

LAMPUNG
- Tree based: 49%
- Forest: 8%
- Non tree: 31%
- Non vegetation: 12%
Main Land use/cover changes 1990 to 2005

- East Kalimantan: Area of forest declined from 89.5% to 79.4%; area of undisturbed forest declined from 73.8% to 51.7%; area of logged over forest increases from 13.7% to 27.7%

- Jambi: Area of forest declined from 54% to 34%; currently rubber area (agroforest and monoculture) > forest; oil palm increased from 3% to 11%

- Lampung: Area of forest declined from 14% to 8%, under national park; coffee cultivation dominates
Resolution

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Information resolution

- 3 levels of **forest classification**: general (I), ecozone specific (II), and management (III), are combined with:
- 2 sublevels of **non-forest classification**: woody (**tree**) vs non-woody (**non-tree**) vegetation differentiation (A) and type of woody vegetation (B)
- Subsets of the combination explored: I, II, IIA, III, IIIA, IIIB
• Changes from level I and II to III (discrimination of logged over forest from undisturbed forest) make a big jump in terms of carbon emission estimate (at level III is 2.6 times from level IIA)
• C emission assessment should include forest degradation especially in areas like East Kalimantan where main proximate driver of carbon emission is forest degradation
Compared to East Kalimantan, differences in carbon emission estimates are more marked among sublevels at the same level than among levels, i.e., tree-based differentiation is important in the classification.

Main proximate driver in Jambi is tree-based system development.
- Similar to Jambi, but flatter, in Lampung differences among sublevels are more significant than among levels but less evident.
- When tree-based systems were discriminated based on vegetation type (IIIB), C-emission estimates declines slightly.
- In Lampung, dominating tree-based systems is coffee agroforest which does not sequester carbon as much as many other tree-based systems.
Information Resolution: Summary

- In early FT, when forest degradation is more marked than forest conversion, discriminating forest based on types, quality and management are inevitable in assessing C-stock changes at landscape level.

- In the intermediate FT, when forest conversion and plantation development take place, discriminating between tree-based systems with other non-forest areas is important.

- In the advanced FT, when agricultural intensification is active and there are conversion from one tree-based systems to others and also to croplands and others, differentiating vegetation type within the tree-based systems leads to a noticeable difference.
Resolution

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Spatial resolution

- TREES 2000 from SPOT Vegetation (1 km x 1 km)
- Our land use/cover maps of 2000 derived from Landsat ETM (30 x 30 m)
- No time series data for TREES
- Comparison is only conducted on 2000 land use/cover and not on lucc nor C-stock changes
TRESS 2000  LANDSAT 2000

Jambi
Spatial resolution: Summary

• In landscapes with fragmented forest (usually correlate with advances in FT) higher spatial resolution is required to get higher classification accuracy at a proper information resolution
Resolution

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- Temporal resolution: frequency of assessment conducted during one period of time
Temporal resolution

• Time period - 1990-2005: 1990 – 2000 (period 1), and 2000 – 2005 (period 2)

• With decentralization started to take place in 2000, access to forests and forest management changed a lot

• East Kalimantan, being the most forested province among the 3 case study areas, gave small scale logging permit for several years since 2000
Which baseline?
Temporal resolution: Summary

- Reference period matters when setting reference level.
- In the most advanced stage of FT, having more frequent assessment does not really make a different since annual emission has been stabilized.
- In the intermediate stage of FT, where annual emissions have declined from period 1 to period 2, rate of declines matters in setting up how much further declines of annual emissions are eligible for compensation compared to BAU rate of decline, otherwise the reduction of emission in the future will be overestimated.
- In the early stage of FT, annual emissions have increased from period 1 to period 2; in setting reference line one has to consider the reduction of rate of increase from BAU rate for compensation, otherwise the emission reduction will be underestimated.
Conclusion

- **Information resolution**: early FT stage needs to differentiate natural forest ecozone and quality, intermediate FT stage needs to differentiate tree-based systems from other non-forest area.

- **Spatial resolution**: more fragmented landscape needs higher resolution. The later the FT stage is, the fragmentation tends to be higher.

- **Temporal resolution**: there is a need to calculate the rate of change in annual C emission in different periods in addition to the annual C emission only; landscape with different FT stages might be affected differently if the reference period and temporal is not determined properly. Those in early FT stages will be disadvantaged.
Conclusion

• **Stages of FT** is an important factor to consider **in determining resolution** to be applied in the assessment of C-stock dynamics at landscape level

• **Implication for REDD mechanism:** **subnational level monitoring system is necessary**
Thank you!