Estimation of Forest Carbon Using LiDAR-Assisted Multi-source Programme (LAMP) in Nepal

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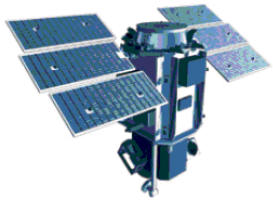
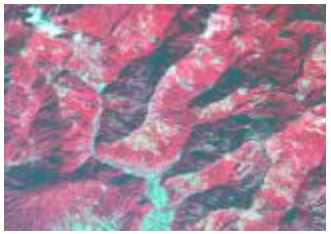
Framework: LiDAR-assisted Sampling

"Wall-to-wall" satellite data - medium to high resolution





Maps with variable or unknown accuracy

Sample of laser data (LiDAR)

Statistical data on forest and land cover and forest statistics of inaccessible areas

Ground measurements (regular plots, detailed plots)

Regular plots:
Reliable statistical data, many variables,accessible areas

Detailed plots:
PSPs, Growth, Biomass, Health
NTFPs

Maps with known accuracy, reliability vary according to accessibility

Statistical data with reduced field sampling rate, many variables, Including biomass

Maps with known accuracy, many variables

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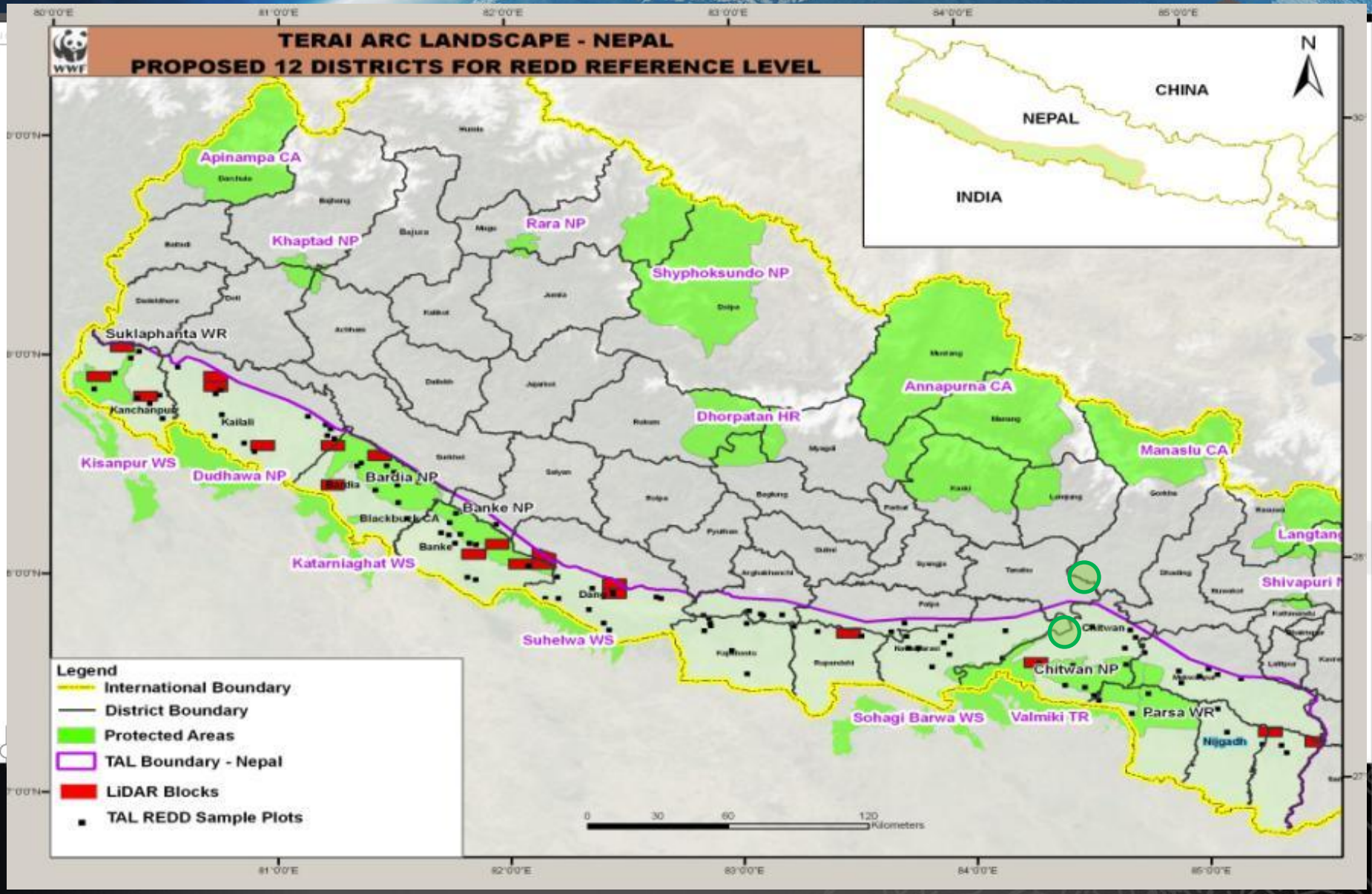
Study Area



How the LiDAR blocks were designed?

- Stratification from a **Landsat based forest classification**.

- **Weight calculated for every block** as a product of the importance of the forest types and the inverse of the forest types area.

$$w_i = \frac{ew_i}{A_i / A},$$

where *ew* is the expert weight and A is the area

- The forest classification was used as a priori information to calculate weighting function for systematic plot assignment and random block assignment within each block.

- 5 km x 10 km systematic grid over Terai Arc Landscape.

Stratification

High density mixed
Low density mixed
} Mixed forest

Low density sal
high density sal
} Sal forest

Short grass
Tall grass
} Grass

Chir pine forest
Degraded forest
Hill sal
Riverine

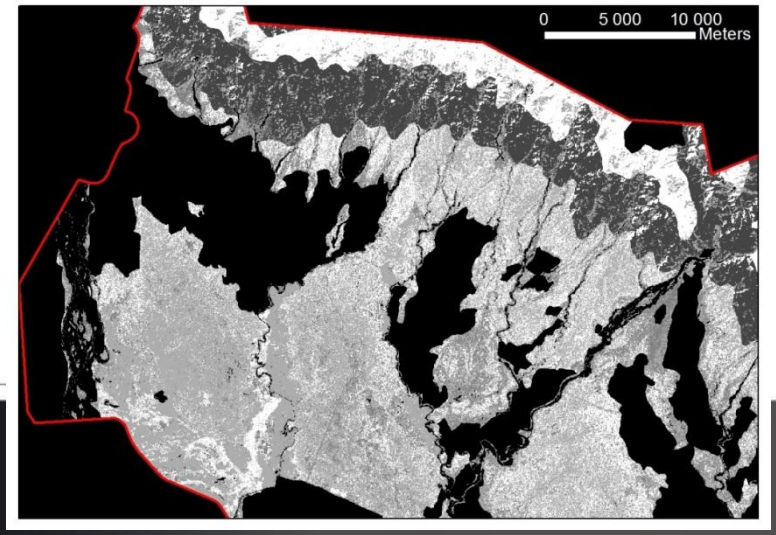
Shadow

Exposed surface
Settlements
Water bodies
} Non-forest

After reclassification there were total 9 classes: 7 “forest” classes, “shadow” and “non-forest”.

The used forest type weights

Forest type	Area, km^2	Expert weight	Area-normalized weight
Hill-sal	3625	100	541
Sal	3458	200	1135
Mixed	1299	200	3020
Riverine	180	100	10880
Grass	873	50	1124
Degraded forest	1098	50	893
Chir pine	442	100	4436
Shadow	598	100	3283
Non-forest	8043	0	0



Forest type map with forest type weights. The larger weights are with brighter tones in gray-scale. Black = zero weight (non-forest).

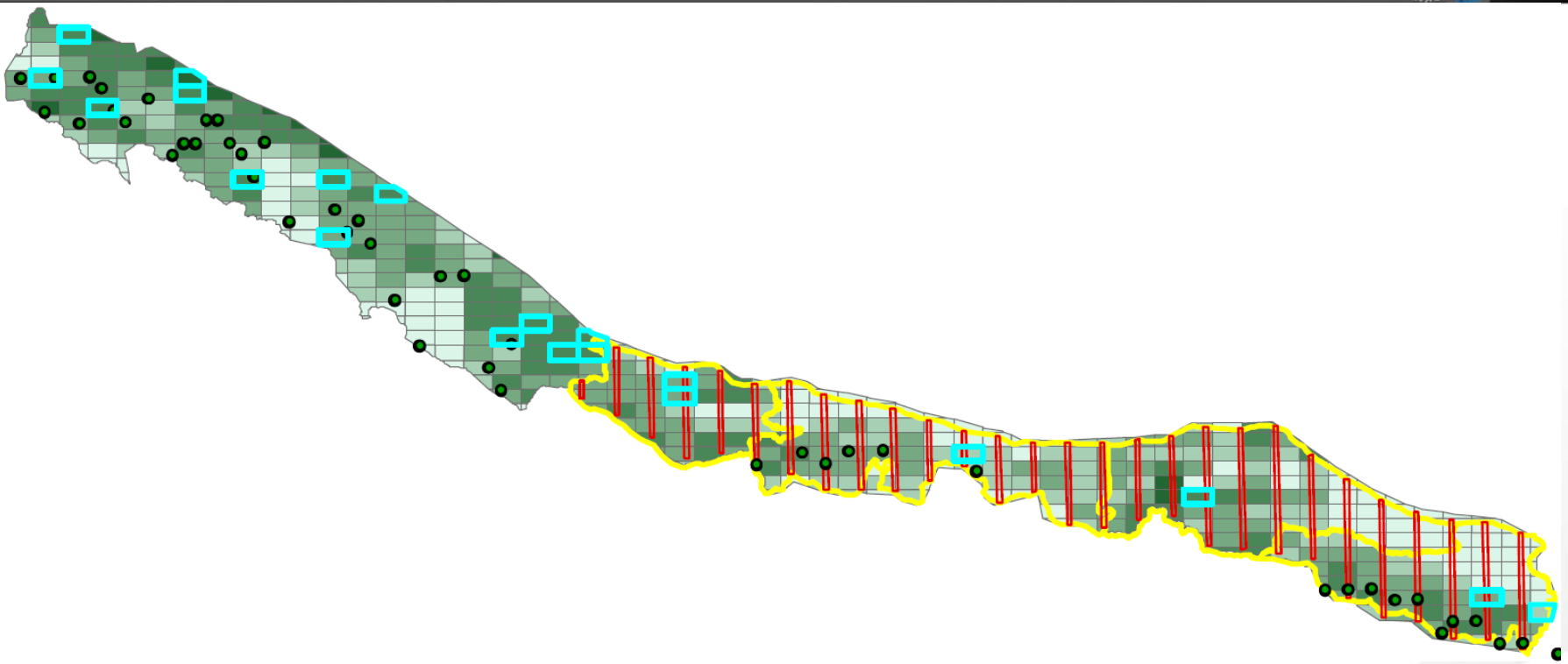
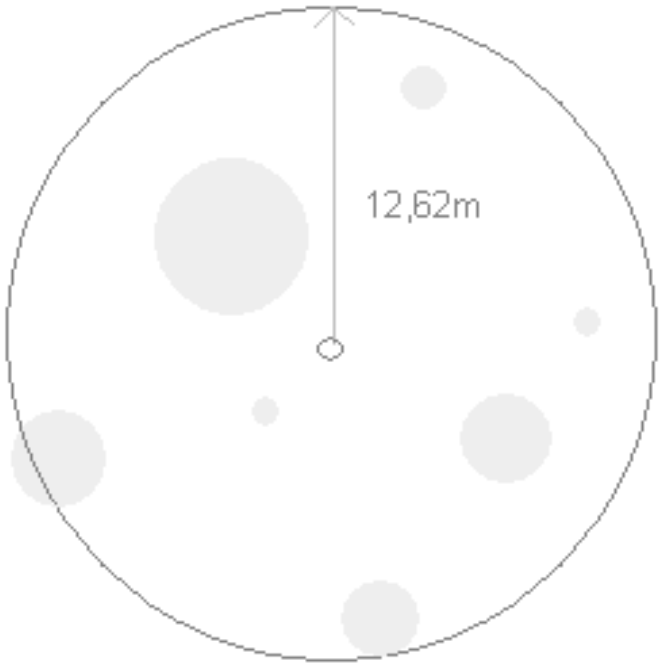


Fig: Comparison of blocks and systematic strips, and selected blocks

Collection of field data

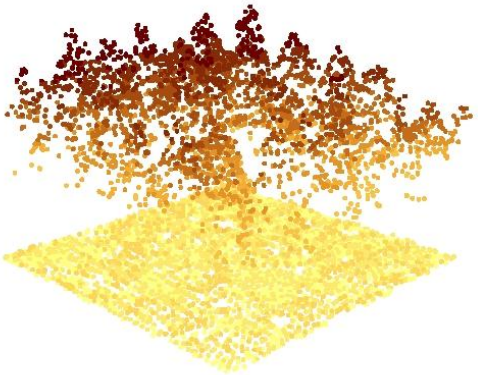


- Circular plots with radius of 12.62 meters.
- Tree tallying started always from the magnetic North in the clockwise order.

Collection of field data...

- All trees and shrub above the diameter of 5 cm were measured.
- DBH (1.3 m) was measured using D-tape.
- Height was measured using Vertex.
- Height was measured for sample trees (every 5th tree), additional sample trees (not included in the sample tree of that spp), top broken trees and standing dead trees.

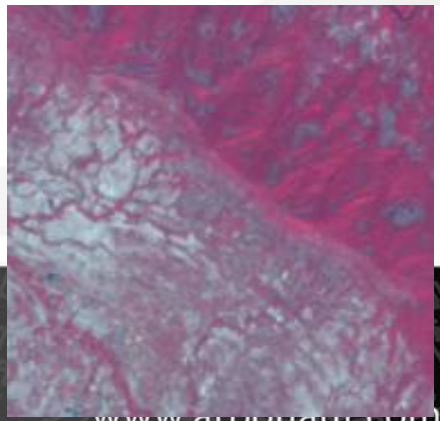
Materials



- Samples (5%) of LiDAR data to calibrate **satellite models**;

- Reference **field sample plots** to calibrate **LiDAR models**;

- Medium (e.g.Landsat) to high resolution (e.g.Rapideye) satellite imagery for **wall-to-wall biomass** map.



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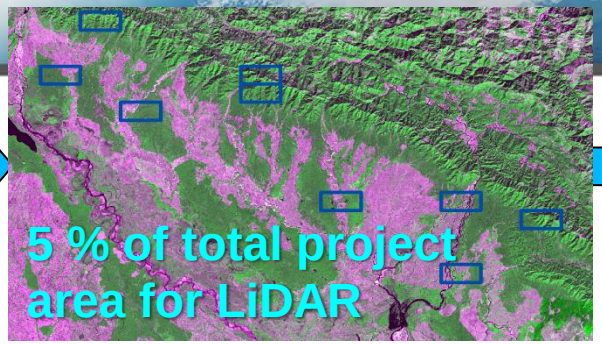
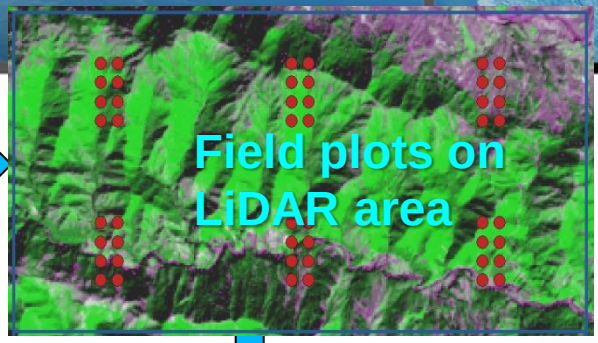
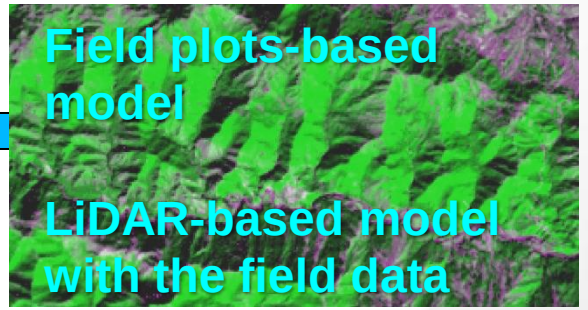
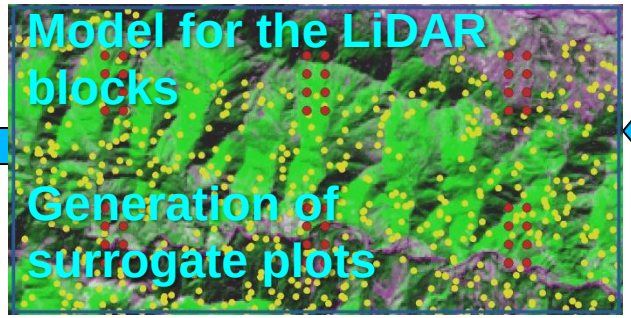
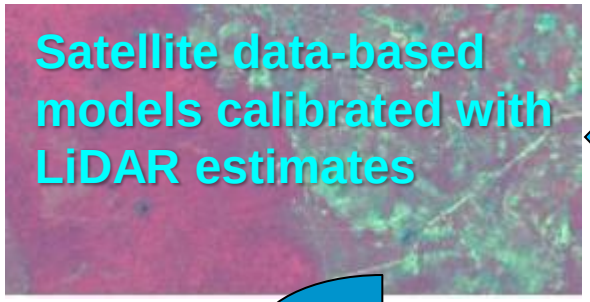
Methods: Work Flow



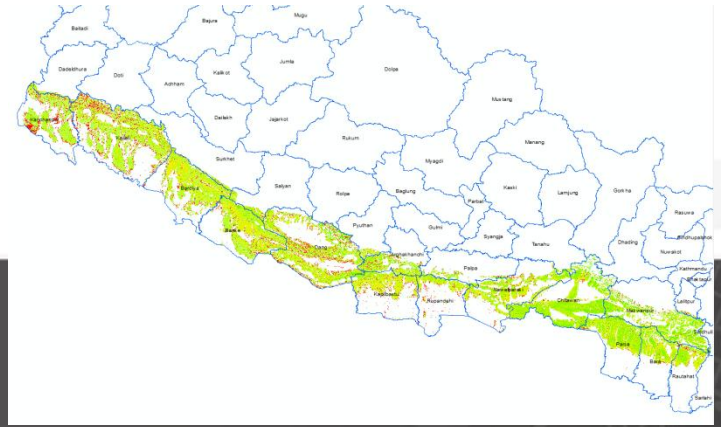


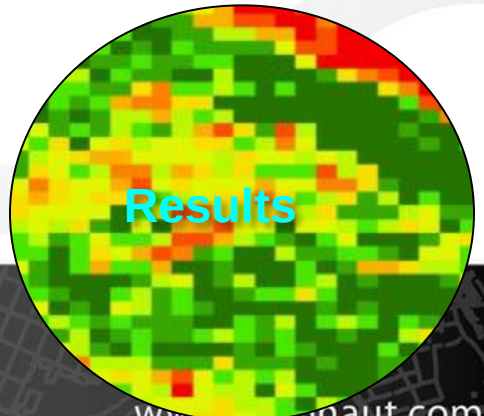




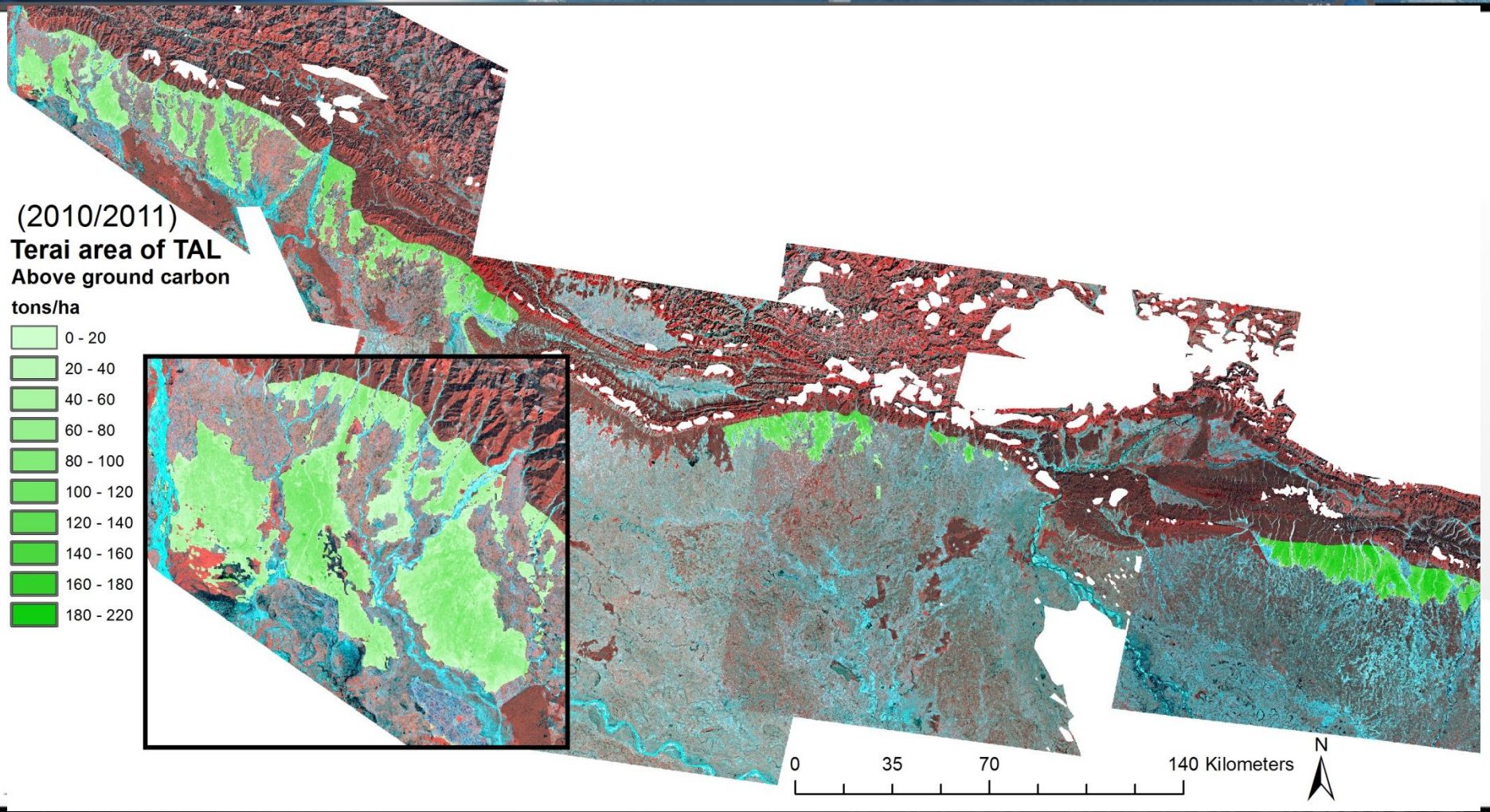


Estimate all variable of interest for a grid using LiDAR treated satellite models

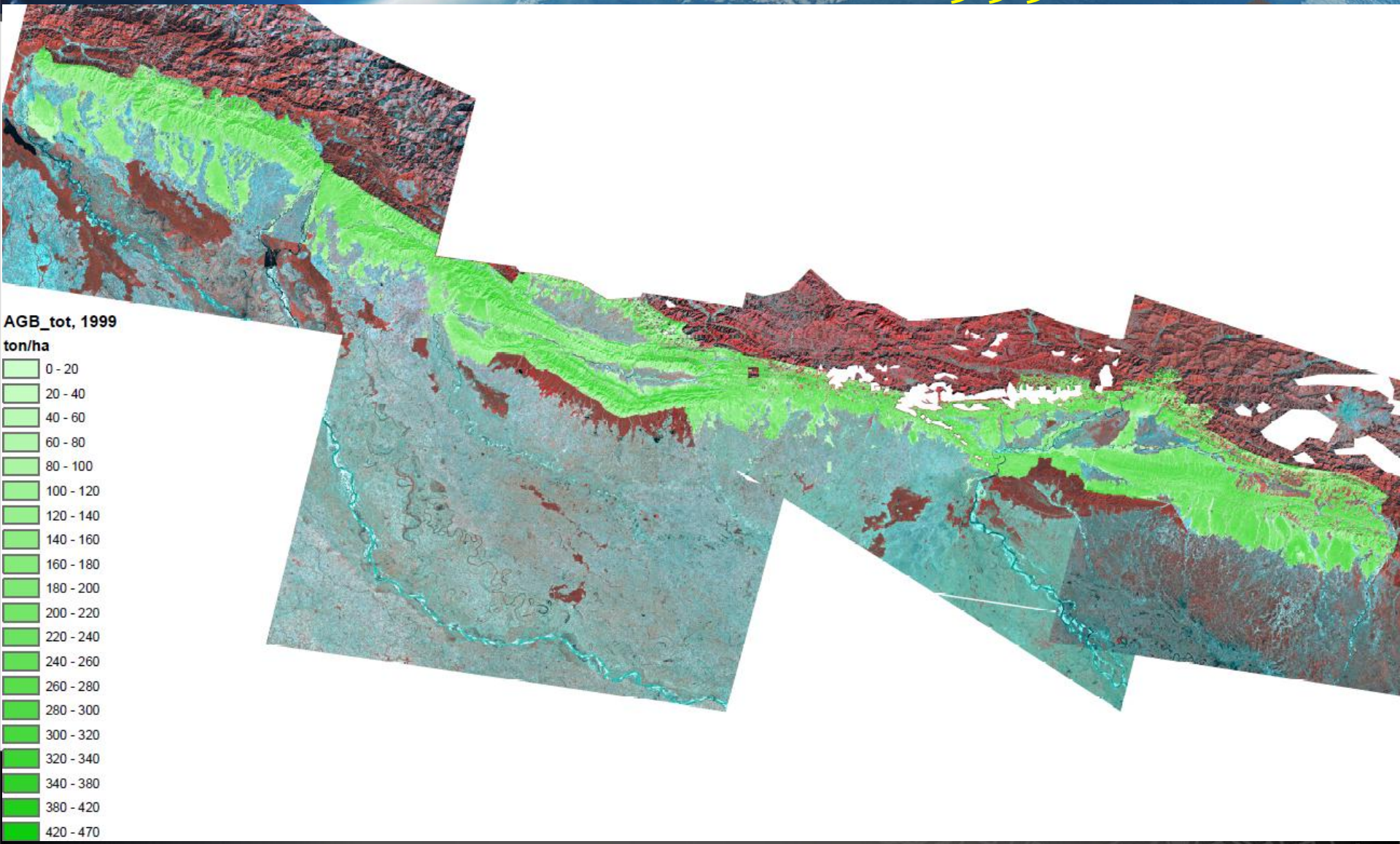




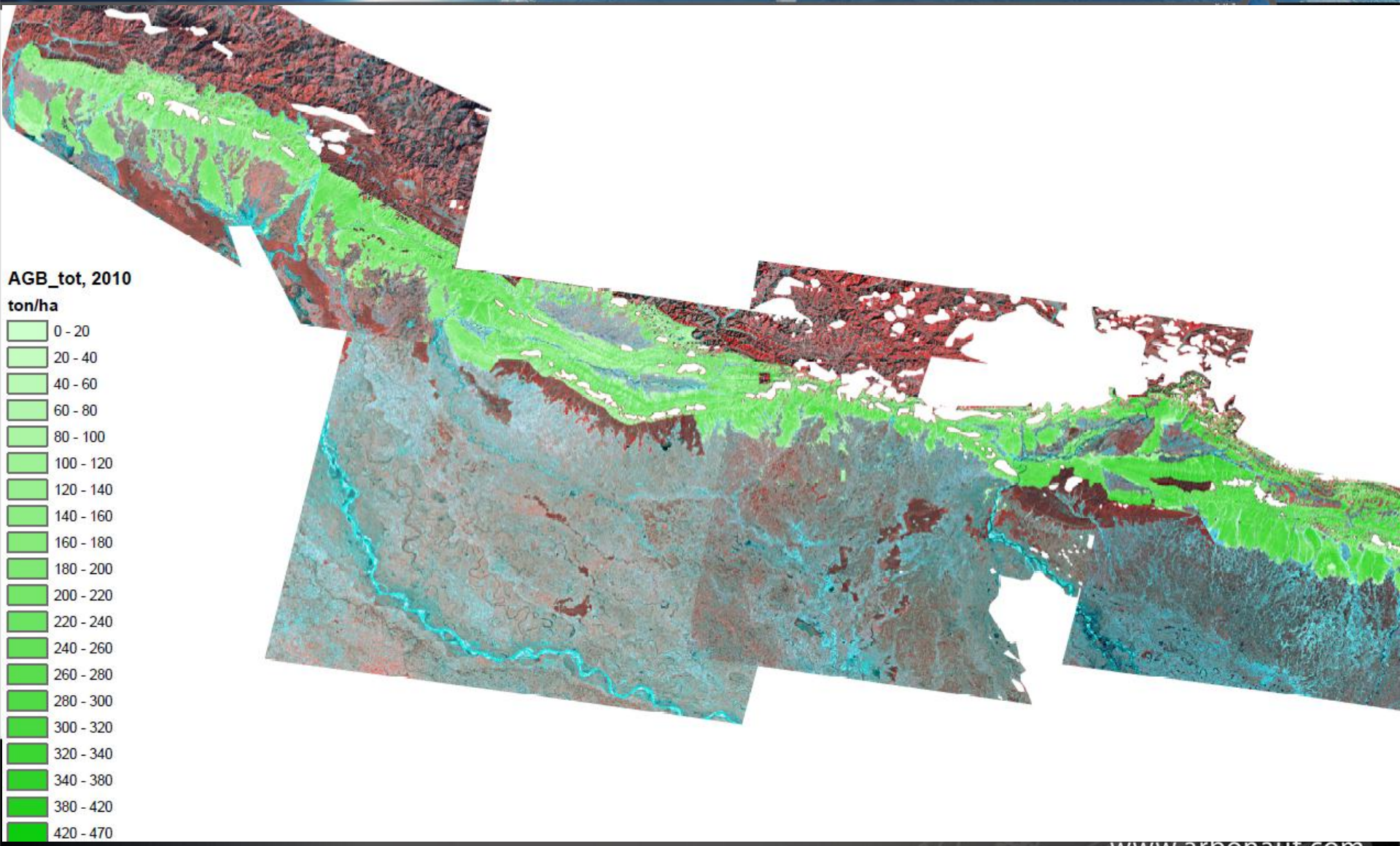
Preliminary Result



Test result: AGB in 1999



Test result: AGB in 2010



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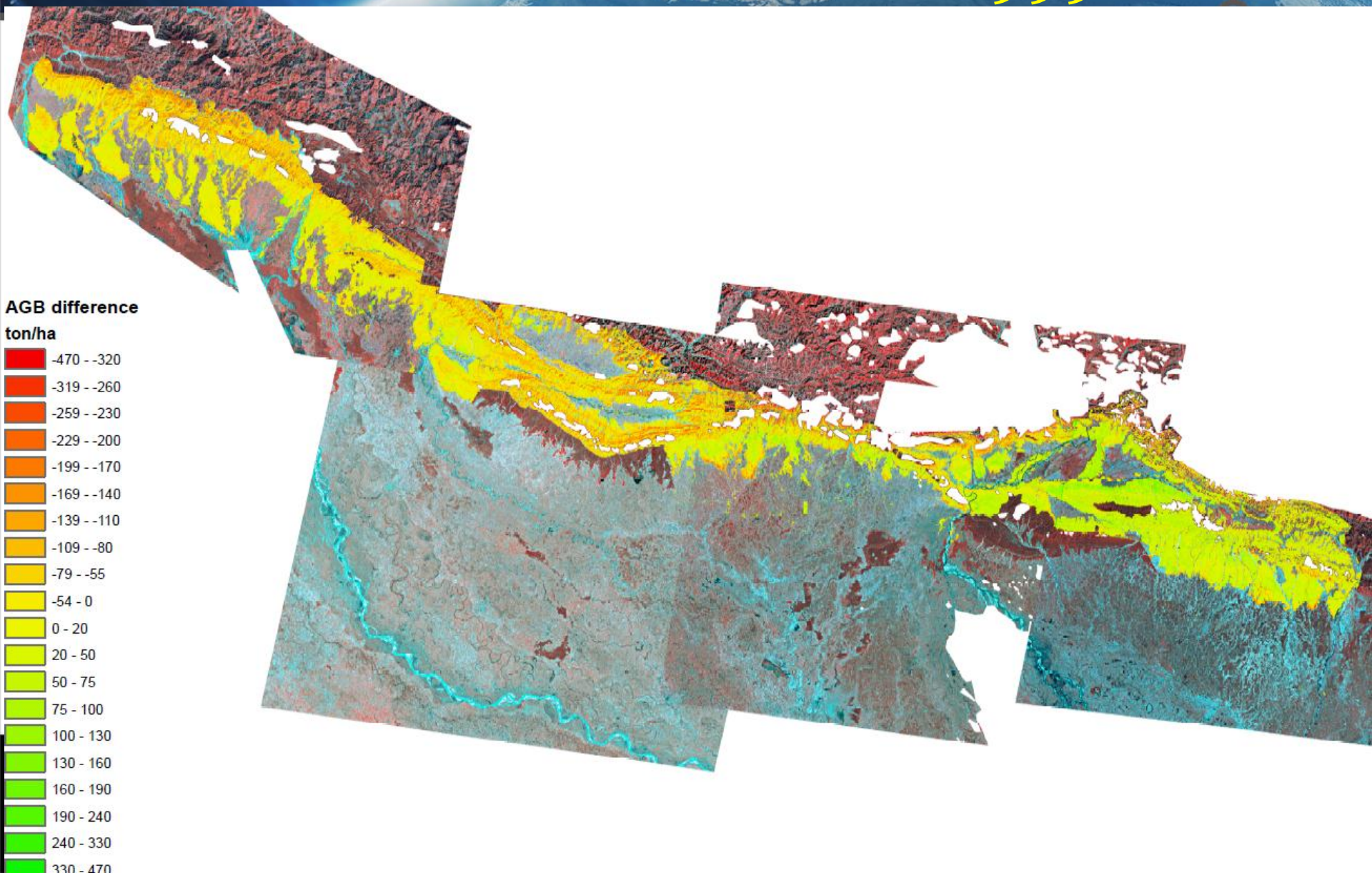
Test result: difference in AGB 1999 - 2010



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Thank you!