ROUNDTABLE MEETING ON SUSTAINABLE PALM OIL

Use of Satellite and UAV (Drone) Data for High Carbon Stock Assessment

Niels Wielaard

SarVision
Applications in remote sensing

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SUSTAINABILITY WHAT'S NEXT?

SarVision introduction

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- SarVision: remote sensing spin-off from Wageningen University, the Netherlands.

  Develops semi-automated agriculture, forest and land cover, carbon stock and hydrological change monitoring systems, providing updates on a regular basis (weekly to annually);
- Remote sensing cooperation with government agencies e.g. Indonesia, Colombia, Brazil;
- Strongly involved in RSPO since 2005: e.g. invited member of the RSPO Working Group on Greenhouse Gas Emissions I. Advisor to European Commission on satellite monitoring EC Renewable Energy Directive.
- Cooperation with WRI on project POTICO and IFC BACP, assignment ESA-WorldBank and palm oil industry PNG.
- European Space Agency project 'PalmOilVision' with four leading palm oil companies

New remote sensing techniques

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- Rapid growth of availability and application of LiDAR surveys and Unmanned Aerial Vehicles (UAVs), drones, increasingly advanced low cost, light weight, compact cameras;
- Improved image quality and availability of (radar) satellite sensors that can see through clouds (ALOS PALSAR, Sentinel-1);
- Availability of free to low cost high resolution (10-20m detail) satellite imagery with more frequent updates (up to weekly as from 2015/16);
- New semi-automatic ‘big data’ image processing techniques enable quick overview of very large areas and evolution to near real-time systematic monitoring;
- Access to mapping results is made easy and available to everyone through tools such as Google Earth and Global Forest Watch.

How to assess carbon stocks?

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- Stratification of vegetation types using satellite imagery or maps;
- Quantification of carbon requires measuring vegetation in the field for each stratum:
  - Measure diameter (DBH) and height of trees in plots of e.g. 1 hectare;
  - Use established allometric equations (relating wood volume to DBH and/or height) to calculate above ground biomass.
- Airborne LiDAR (Light Detection and Ranging - uses emitted laser pulses to measure distance between objects) to measure ground surface and vegetation height.
- LiDAR is typically sample-based: develop laser point cloud-to-carbon model and apply it to satellite imagery to cover larger areas

What are current problems?

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- Satellite imagery for stratification: outdated, too cloudy, not available for specific dates needed;

- Field measurement: hard to replicate or keep consistent, too many plots needed and very labor-intensive (3-4 days/ha), therefore often considered too costly;

Studies show that airborne LiDAR can achieve accuracy very similar to field measurement, however:

- Logistics of manned aircraft LiDAR surveys in remote regions can be difficult (lack of small readily available Cessna-type aircraft, fuel), and cost-prohibitive for use over large areas.

Approach using latest techniques (1)

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1. UAV application with advanced camera and processing techniques

UAV with consumer-grade camera (photogrammetry) or even UAV with LiDAR camera can generate point clouds: GPS points to produce tree counts and 3D height models.

UAV below clouds, less logistical challenge, higher point density, semi-automated process

How many plots are necessary to accurately quantify carbon?

- Without LiDAR/UAV: > 100s or even 1000 plots
- Using LiDAR/UAV: < 100 plots

-> **UAV can provide a significant cost reduction over traditional ground survey**

Approach using latest techniques (1)

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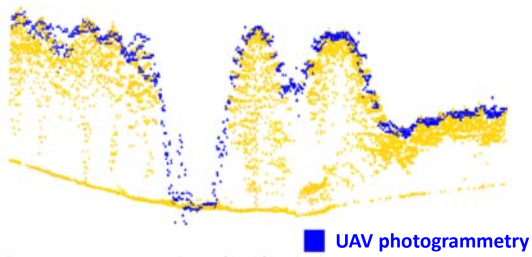
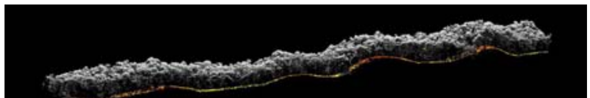
1. UAV application with advanced camera and processing techniques



Forest canopy point cloud
Courtesy Lisein et al 2013

Left: UAV with consumer-grade camera

Right: UAV with LiDAR camera



Courtesy Carbomap, L'Avion Jaune ,IRD, CIRAD

Approach using latest techniques (2)

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2. Multi-source satellite image analysis

It is not about data, but about information: who cares what satellites are used?

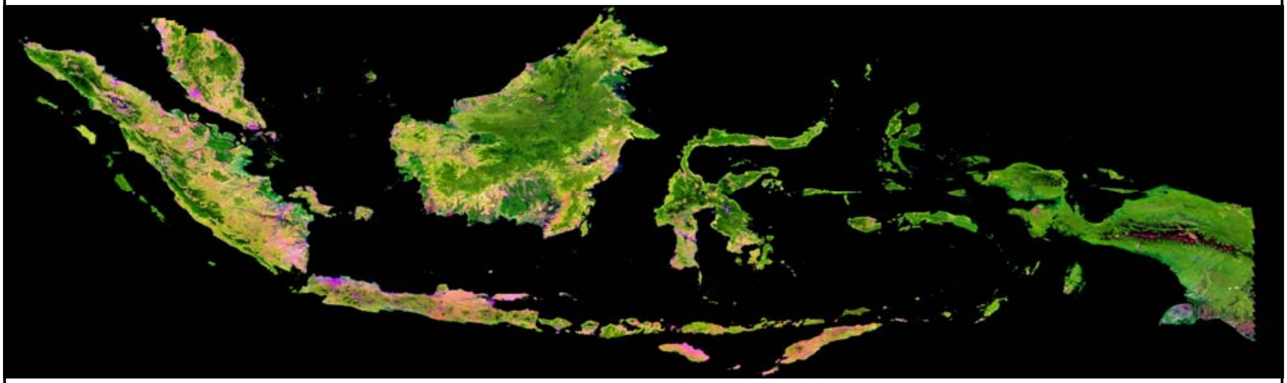
Satellite imagery needed for:

- for pre-stratification of airborne sampling
- scaling up from field/airborne sampling areas to larger landscapes
- update changes and emissions.

-> Know what is happening NOW

ESA Sentinel satellites: freely available 10-20m data updated weekly

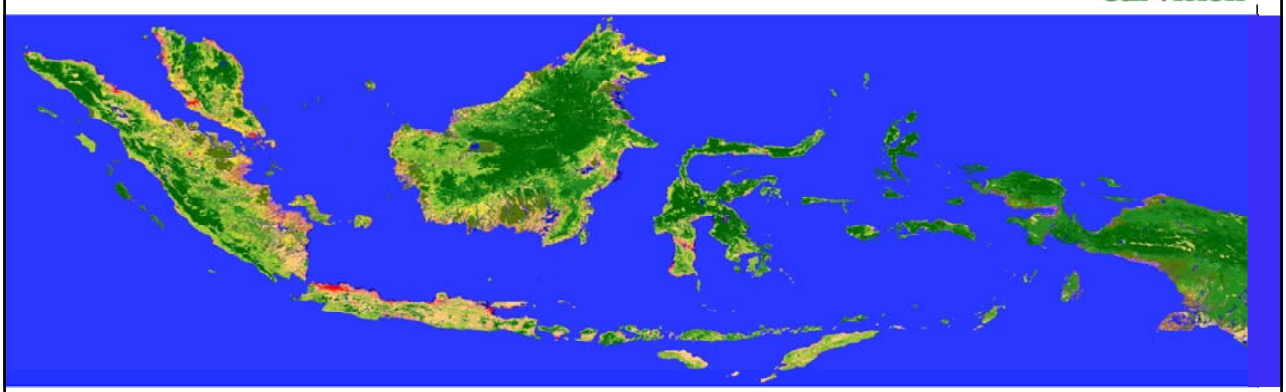
Approach using latest techniques (2)



Example of detailed cloud free image coverage 2010

Created using a new powerful method for automated analysis of hundreds of satellite images

Approach using latest techniques (2)



Example of land use / cover image classification 2010

Created using a new powerful method for automated analysis of hundreds of satellite images

Approach using latest techniques (2)

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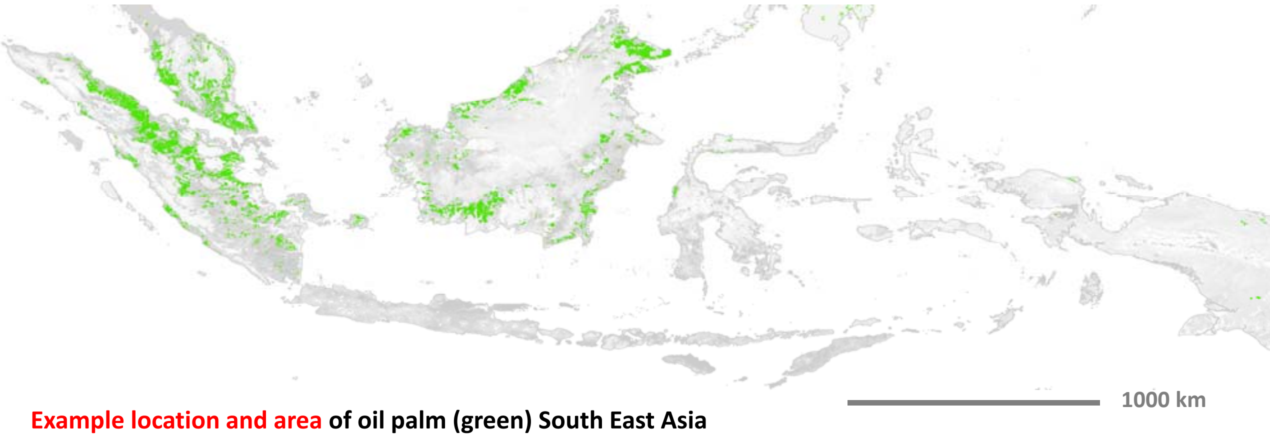

Example location and area of oil palm (green) South East Asia

Mapped using a new powerful method for automated analysis of hundreds of satellite images

Approach using latest techniques (2)

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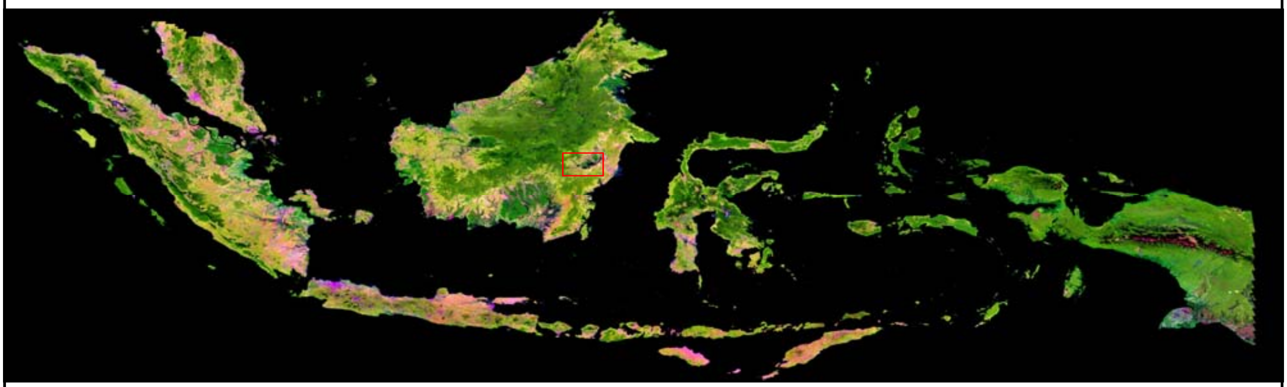
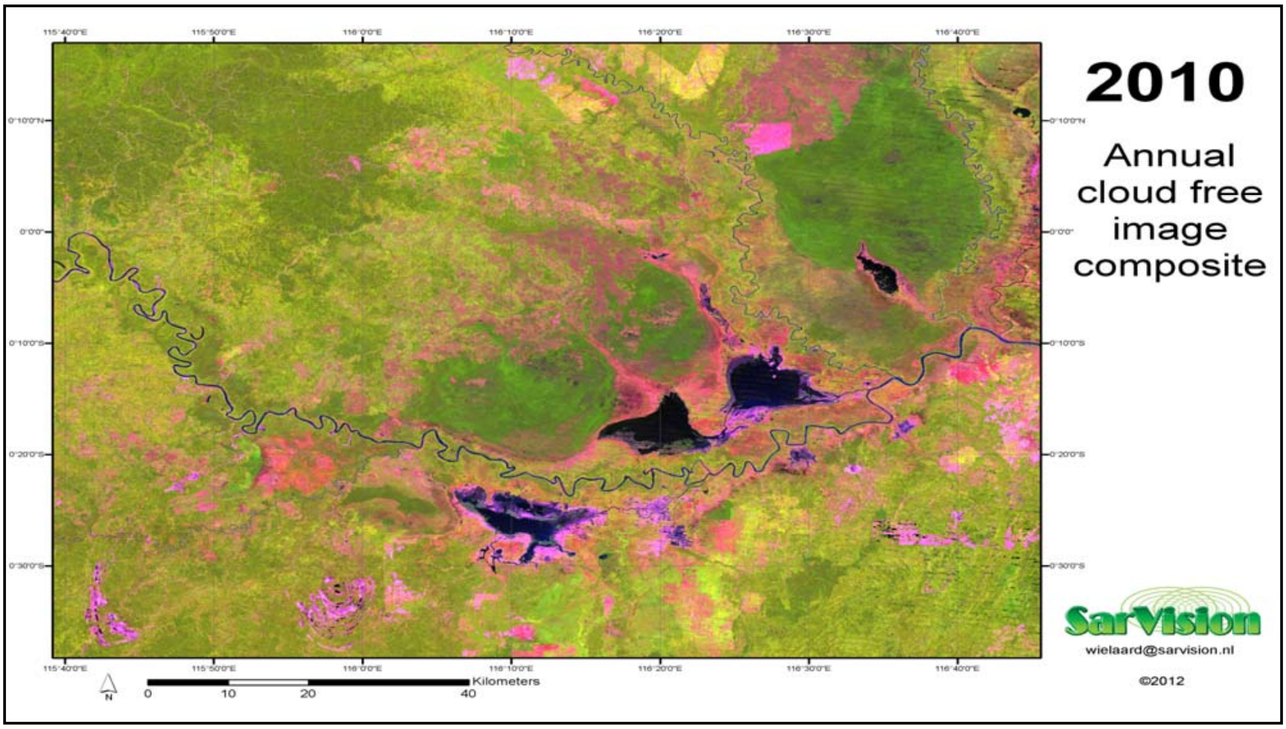


Example cloud free image coverage for up-scaling UAV carbon stock to landscape scale

Created using a new powerful method for automated analysis of hundreds of satellite images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cloud free
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composite
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©2012
Kilometers
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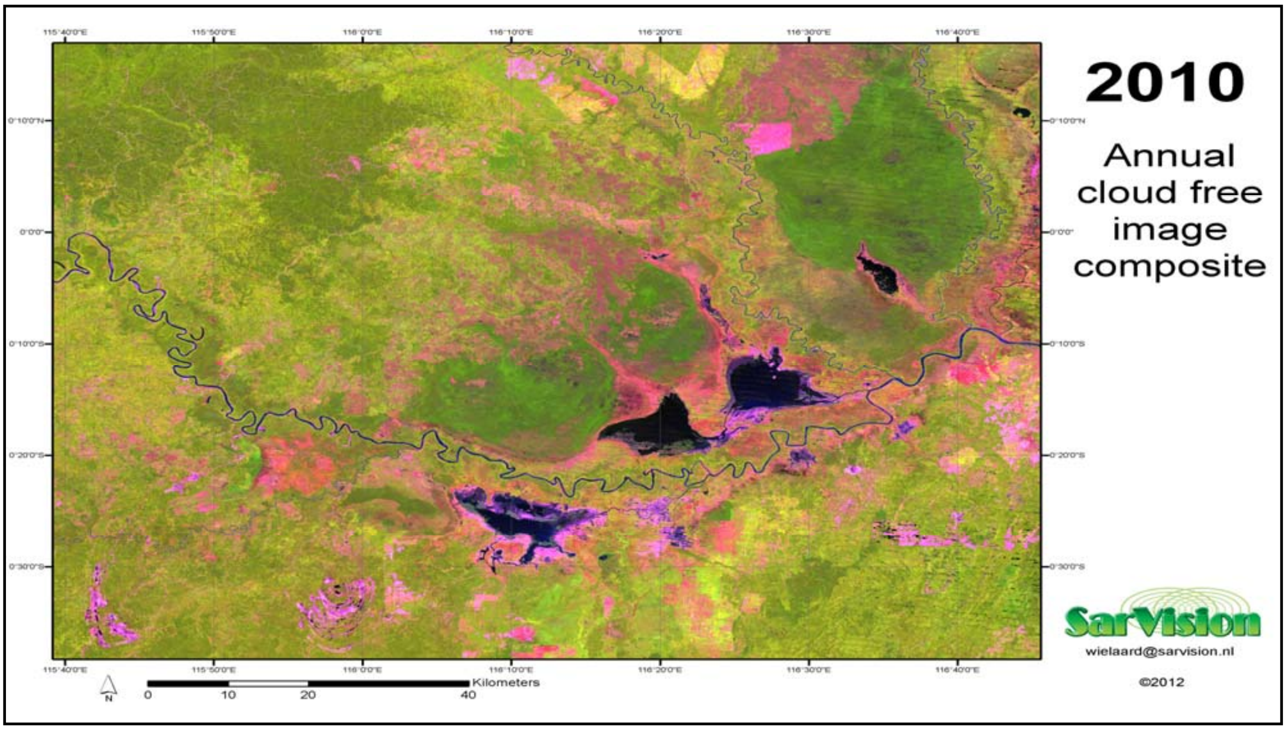
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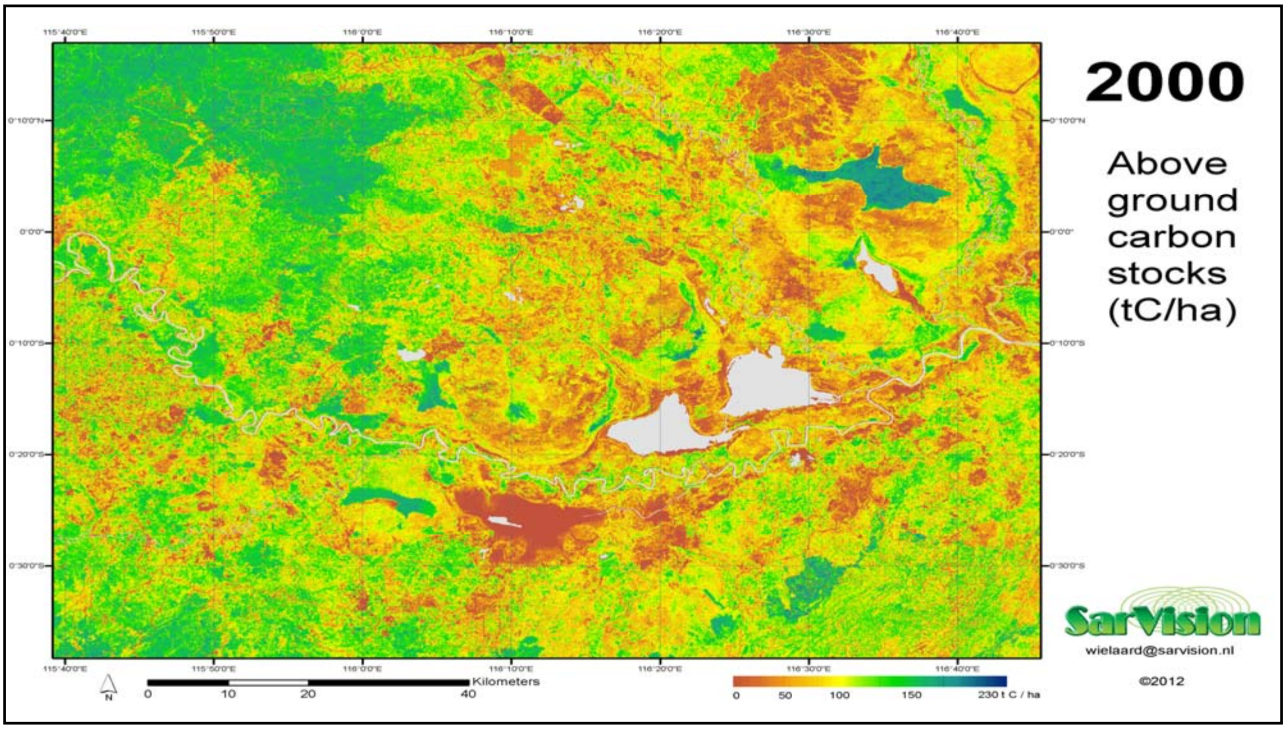
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Above ground carbon stocks (tC/ha)
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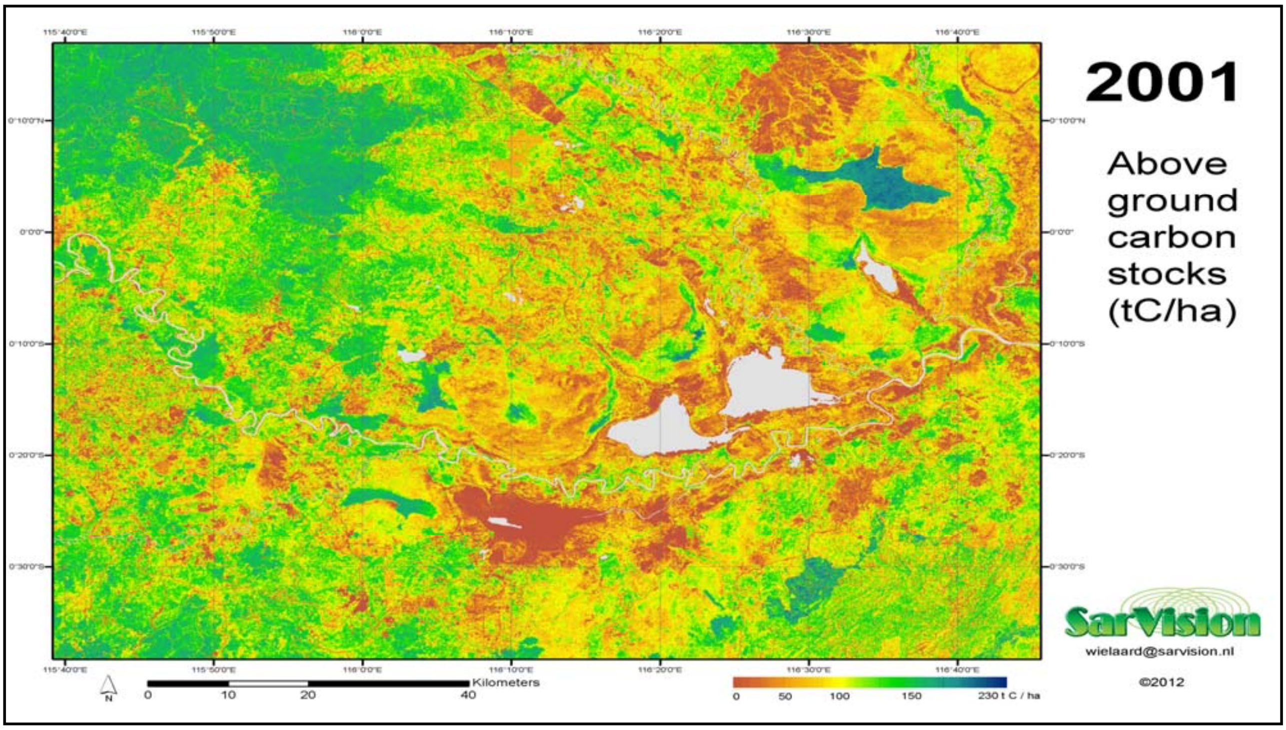
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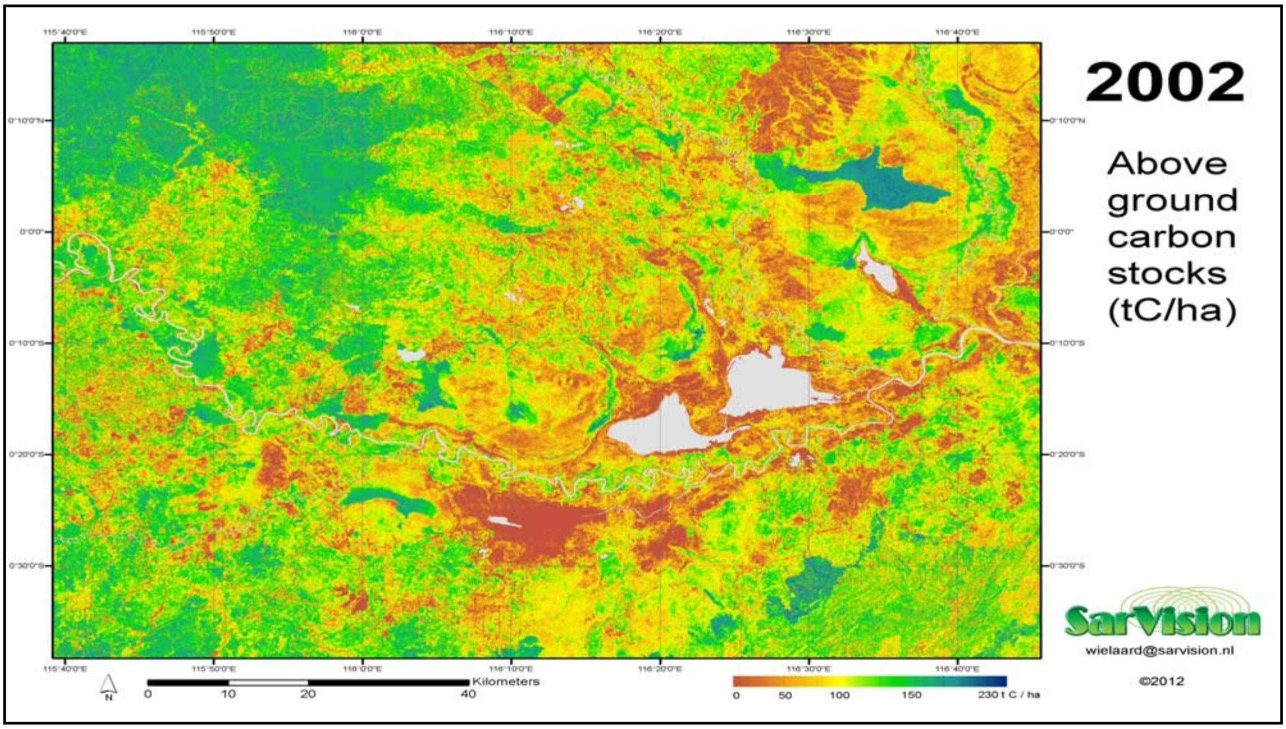
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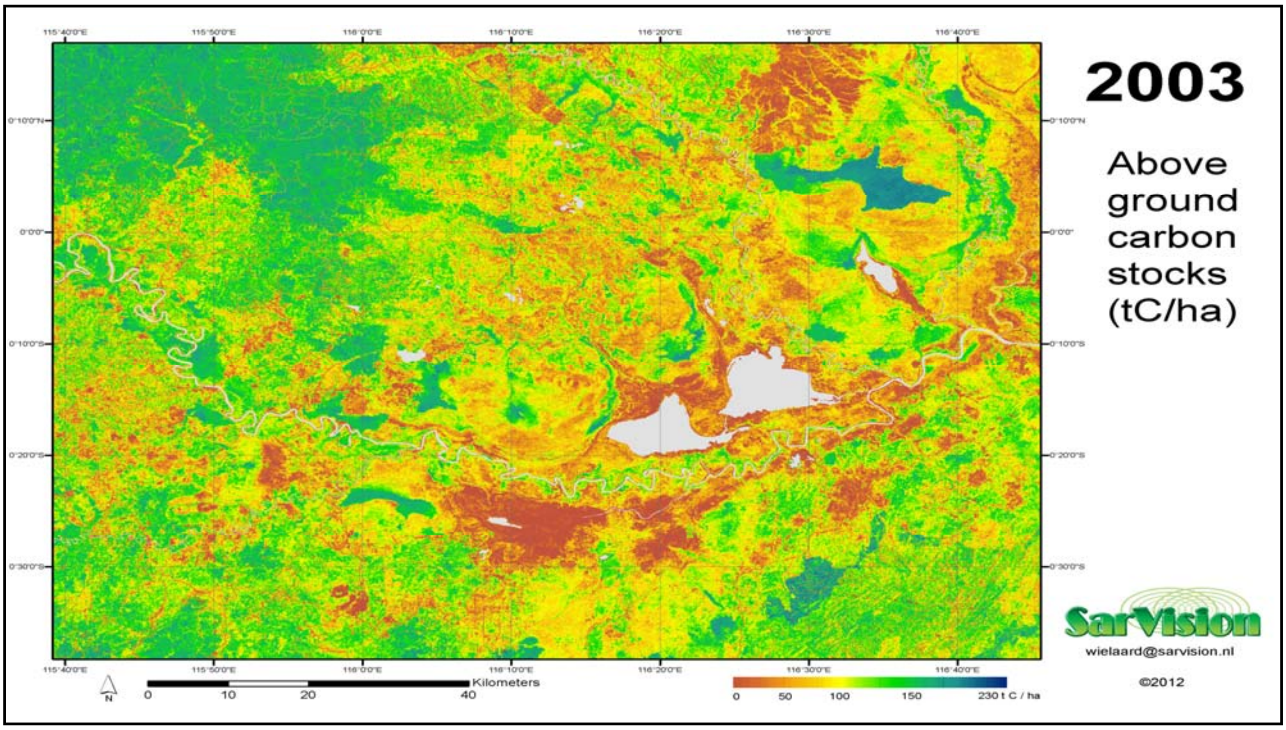
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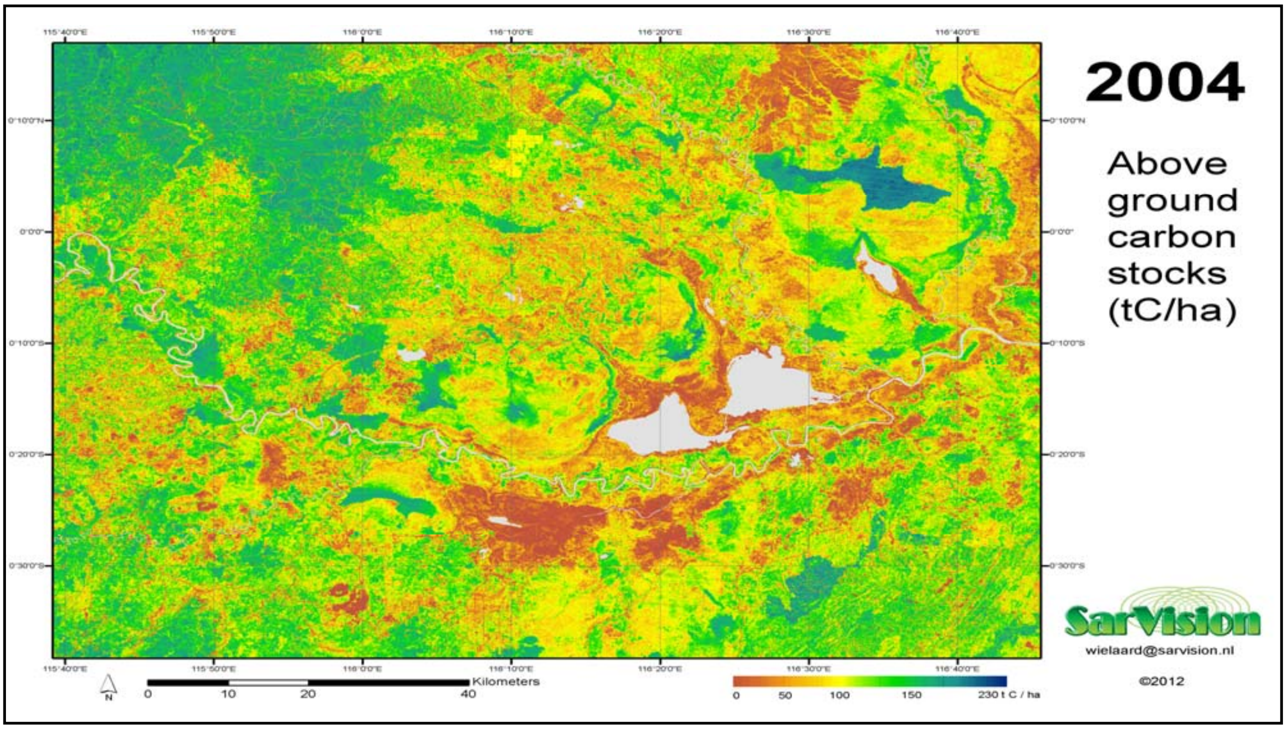
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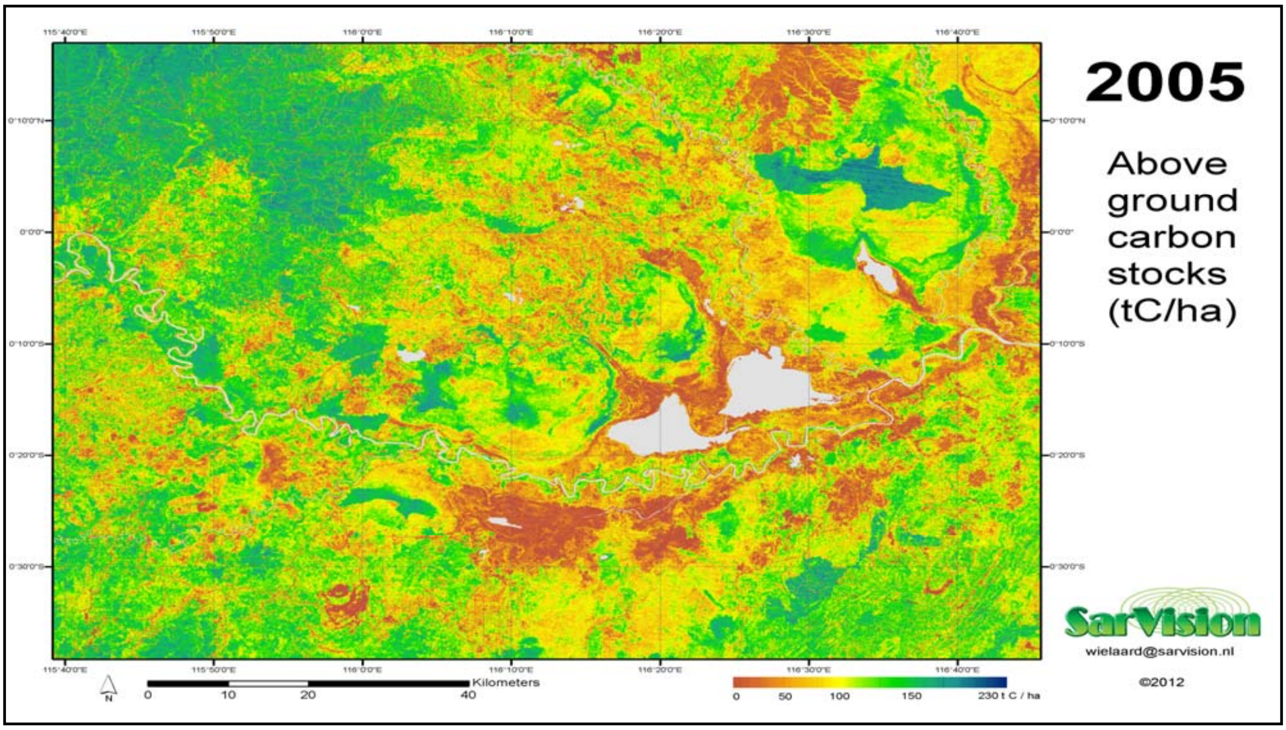
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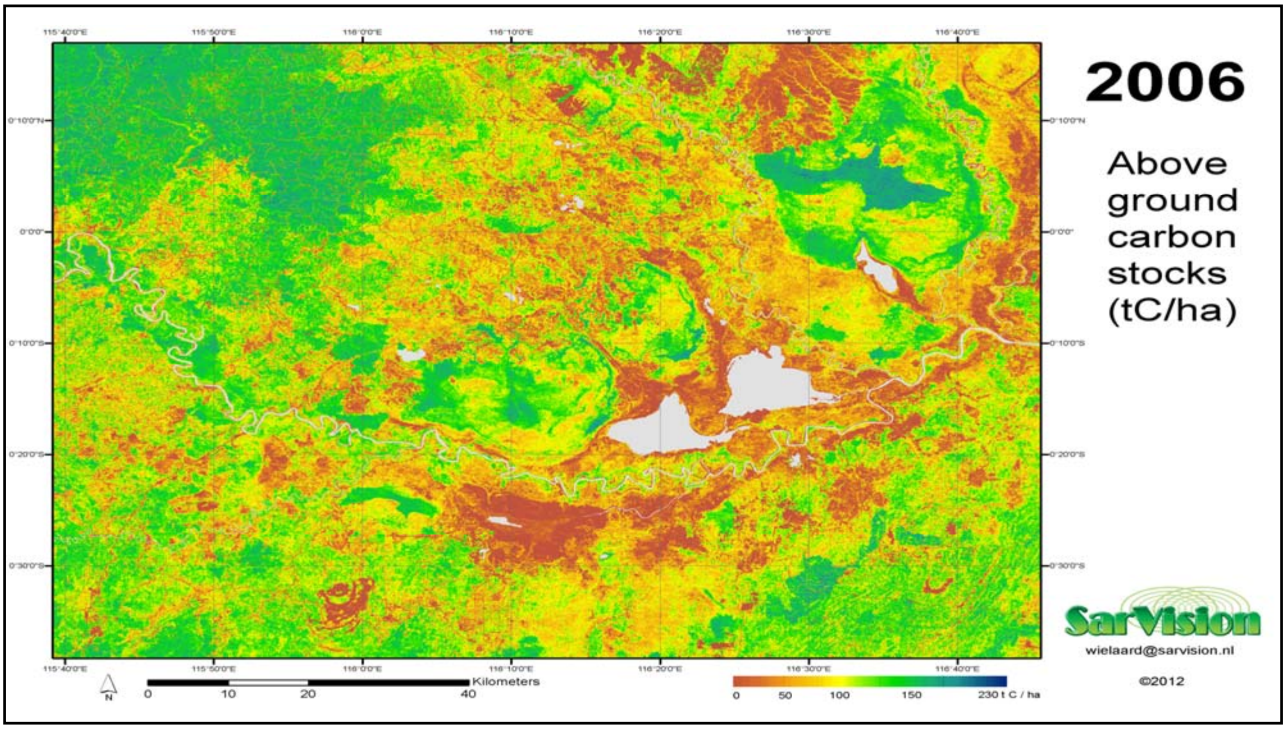
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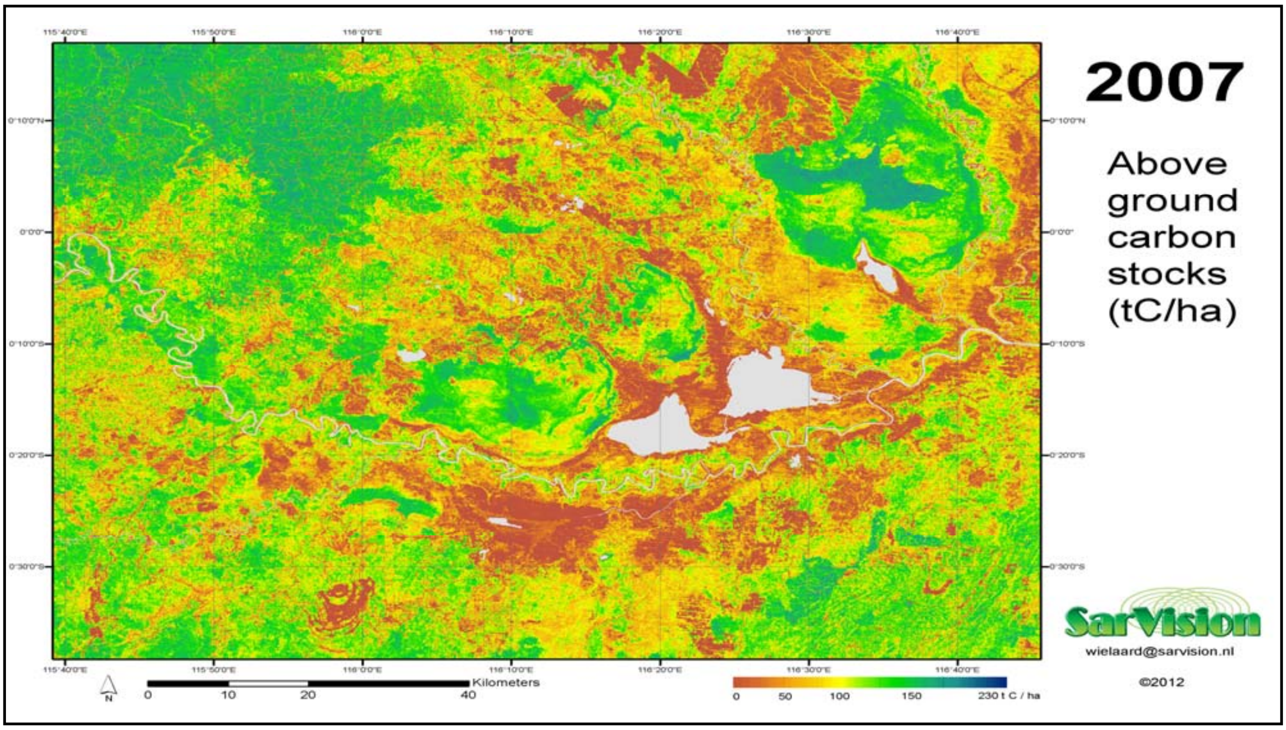
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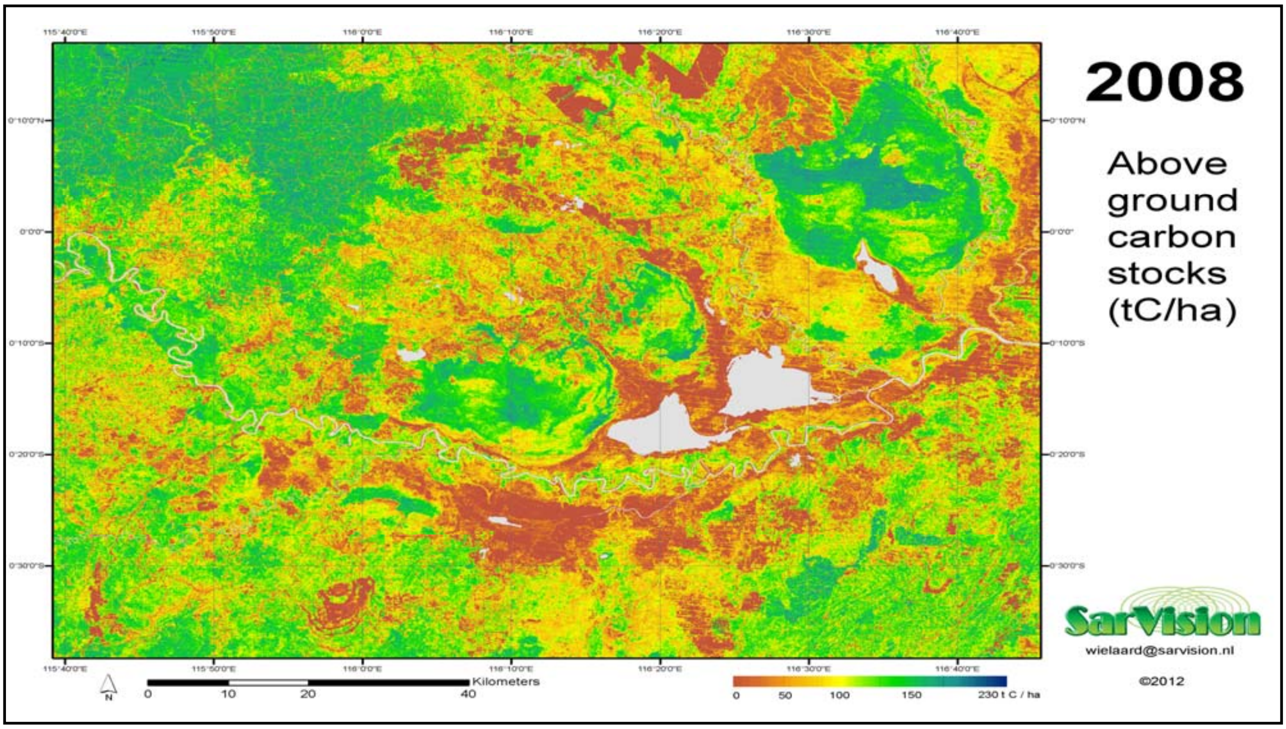
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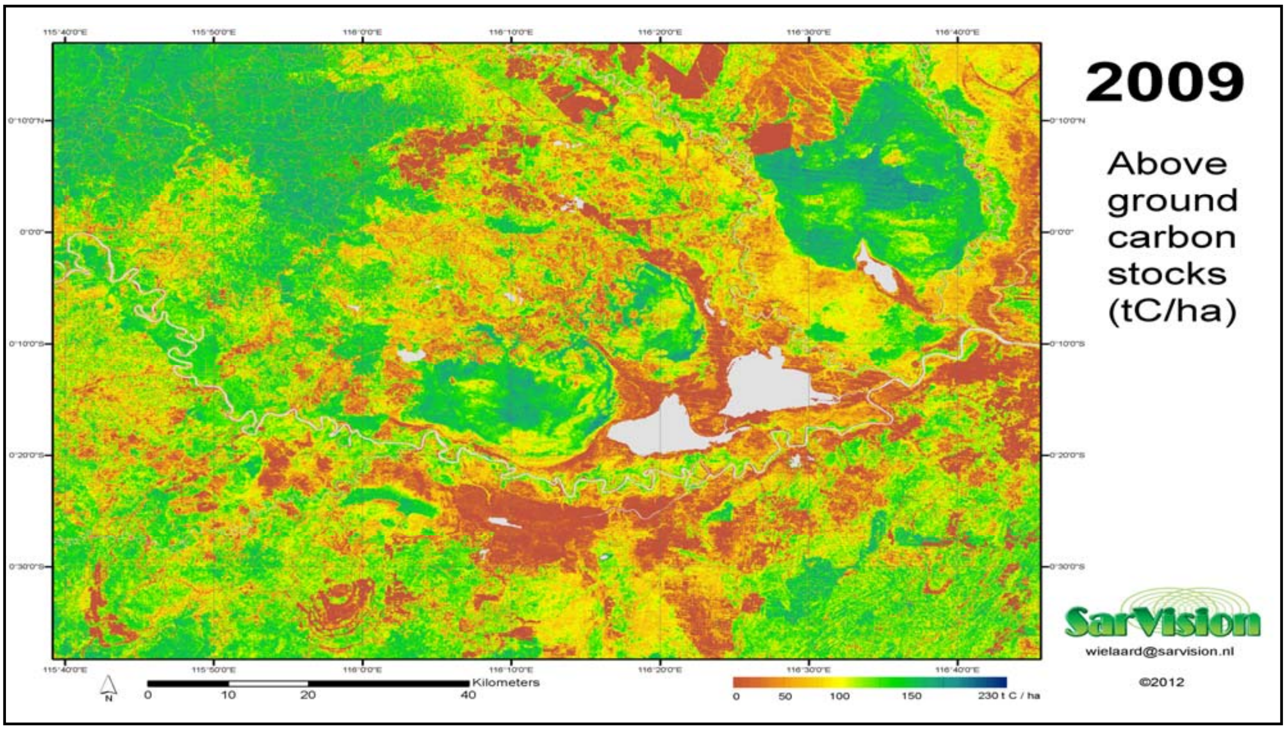
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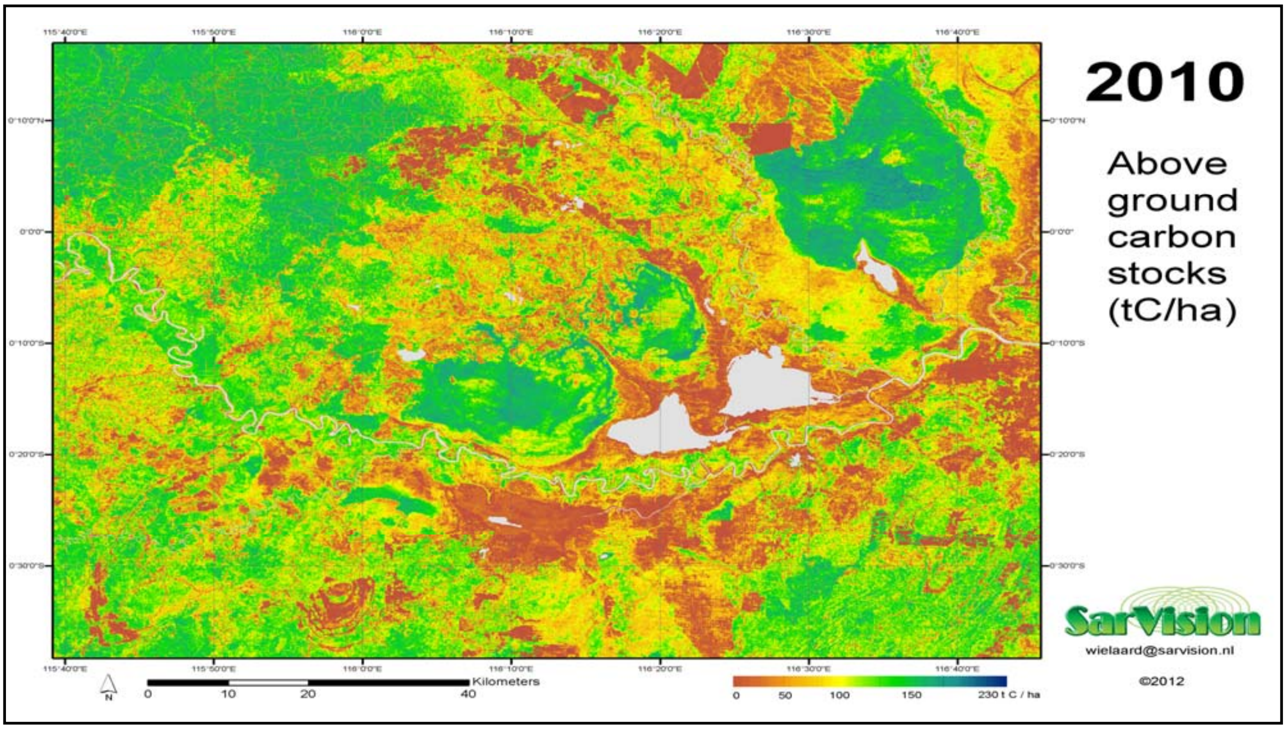
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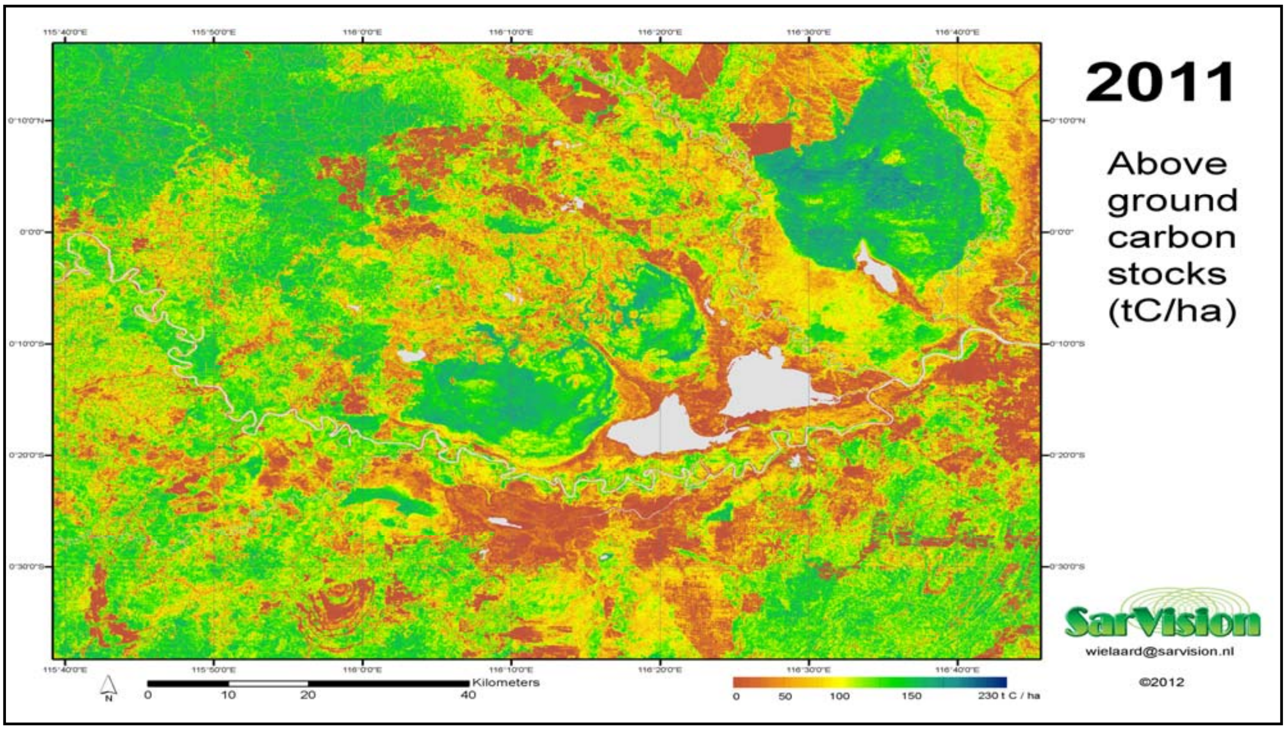
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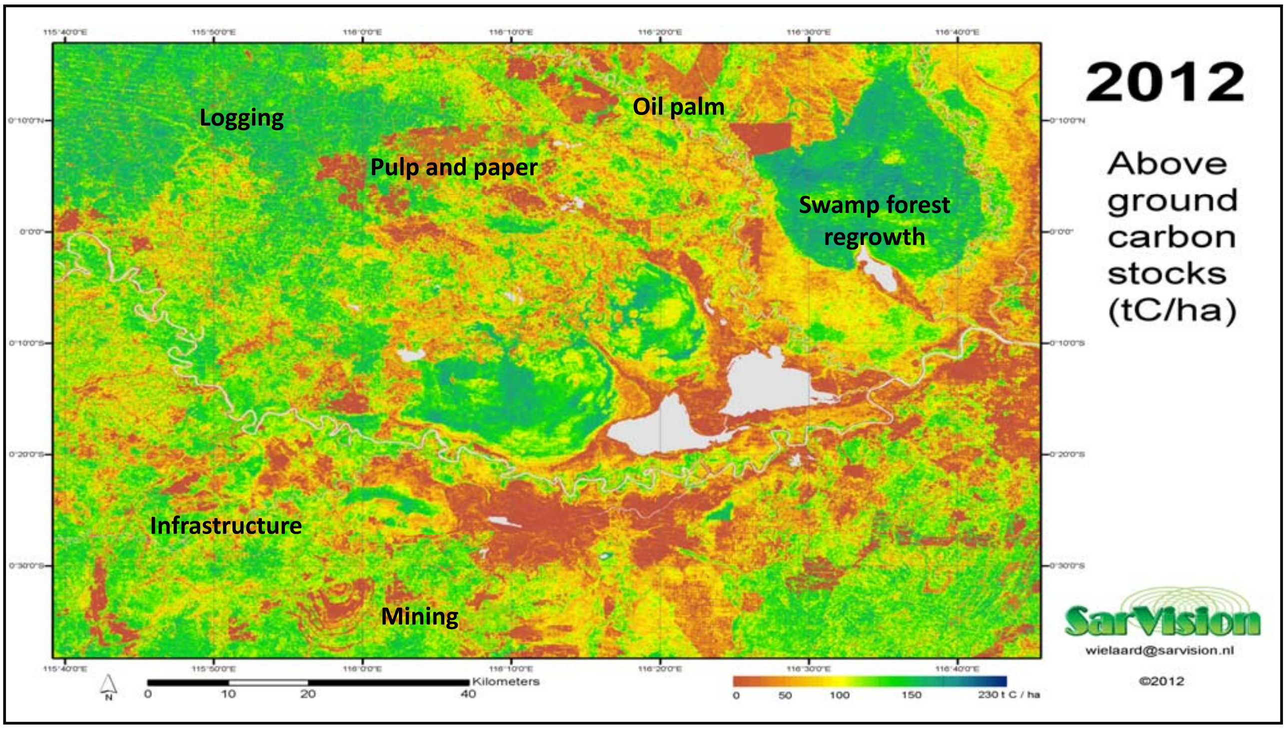
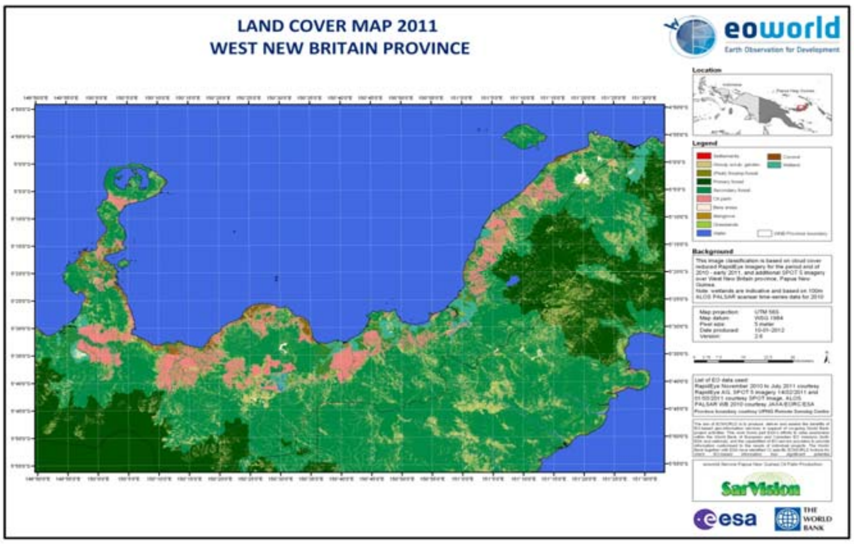


What about smallholders?



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Put smallholders on the map as well

Using 5-10m resolution satellite imagery

At landscape level

Example PNG: 3,500,000 ha mapped at 5m resolution

What about smallholders?

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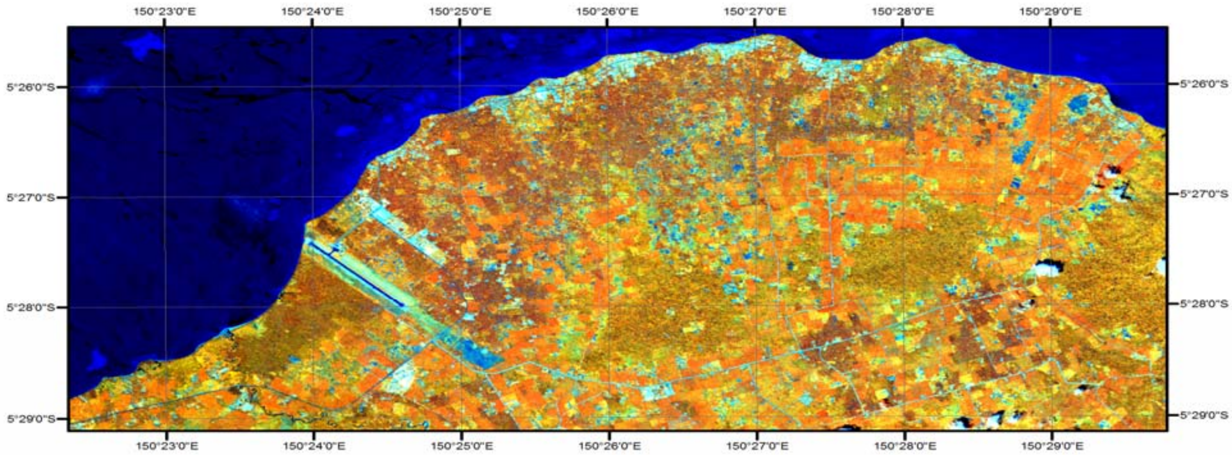
Example 5m RapidEye Papua New Guinea: coconut (brown) vs oil palm (orange)



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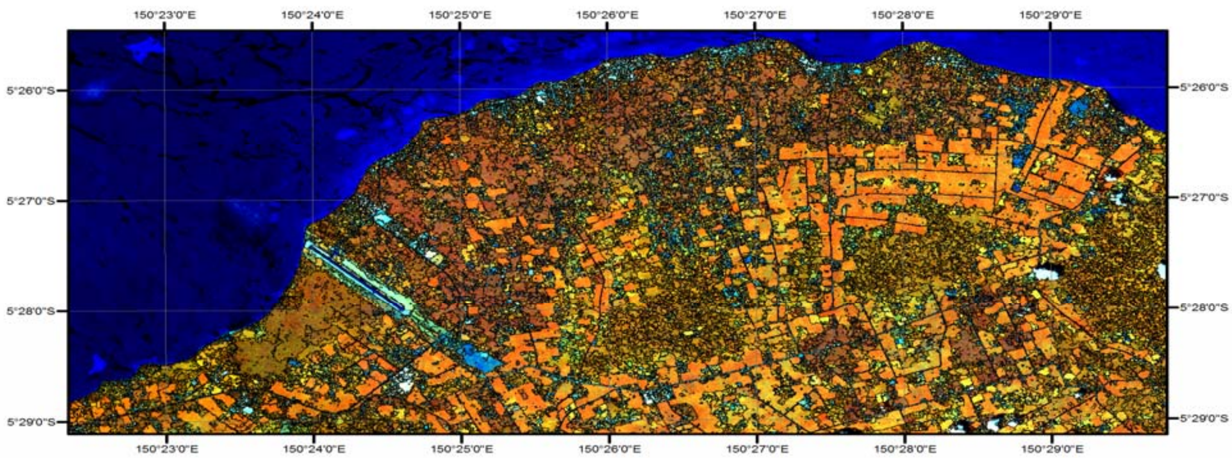
Example 5m RapidEye Papua New Guinea: coconut (brown) vs oil palm (orange)



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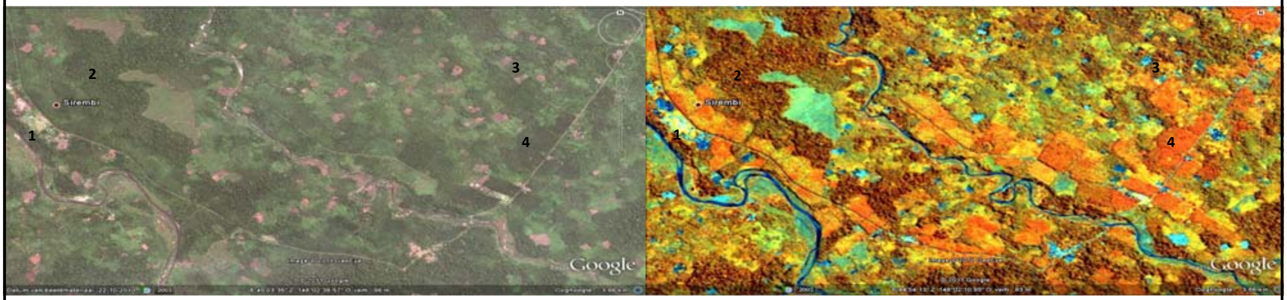

Results show potential for large area monitoring of location, area size, condition, fertiliser need

Yellow : Recently established and poor production
Orange : Mature and good production

To conclude

Problems: satellite imagery too cloudy, not available, field measurement too many plots needed and often considered too costly;

Possible solutions:

- New UAV/drones with consumer-grade camera or laser scanner can be an innovative and low cost tool for carbon assessments;
- New satellite data processing techniques can provide near real-time updates of changes and emissions.

- Questions: What about current problems and cost considerations?
  What about feasibility for smallholders?
  Other concerns that can be addressed?

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