K&C Phase 3 – Brief project essentials

Application of PALSAR for regional assessments of forest disturbance, rice agriculture and wetland habitats.

William Salas
Applied GeoSolutions (AGS)
Durham, NH USA, wsalas@agsemail.com

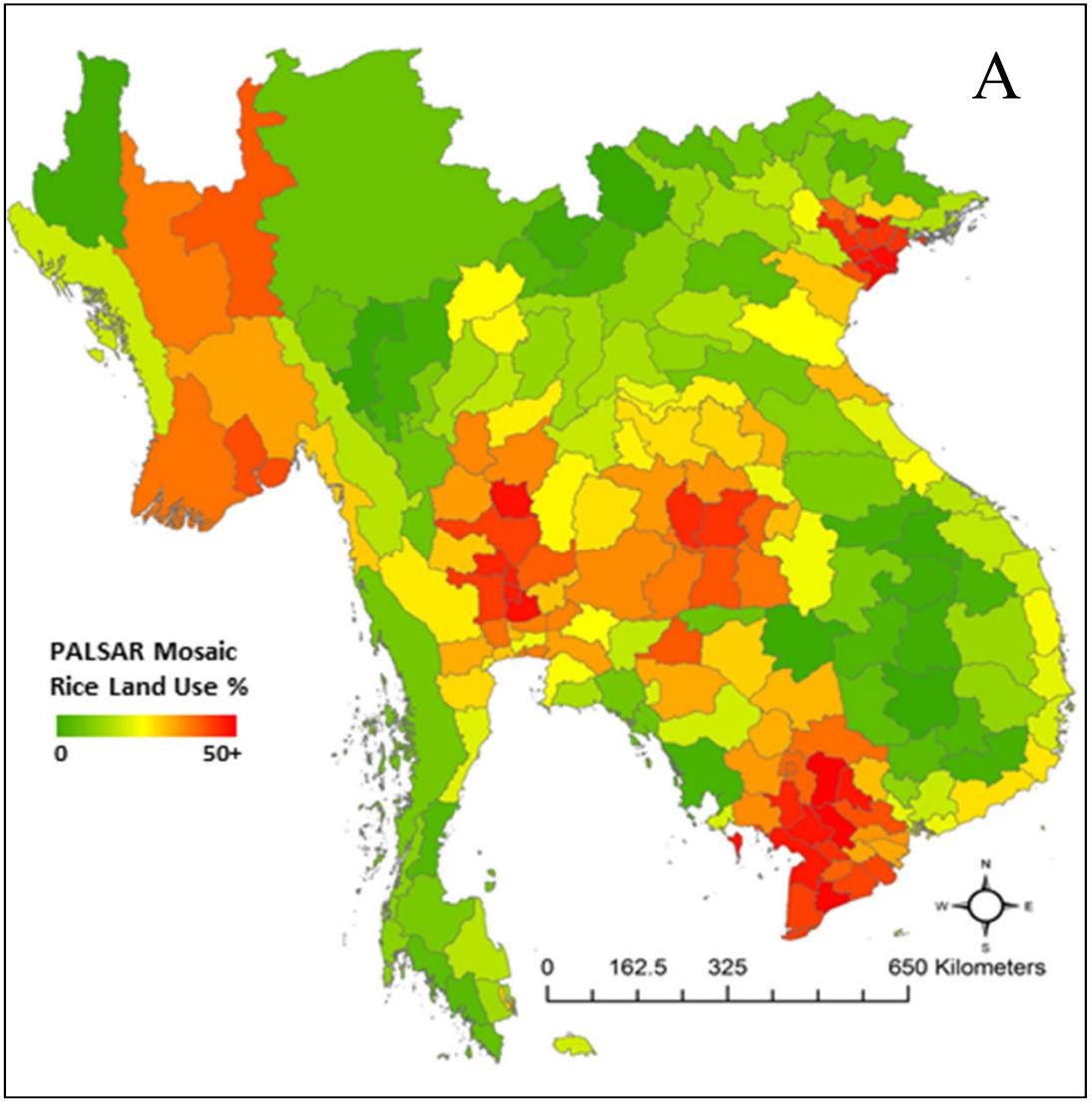
Team includes:

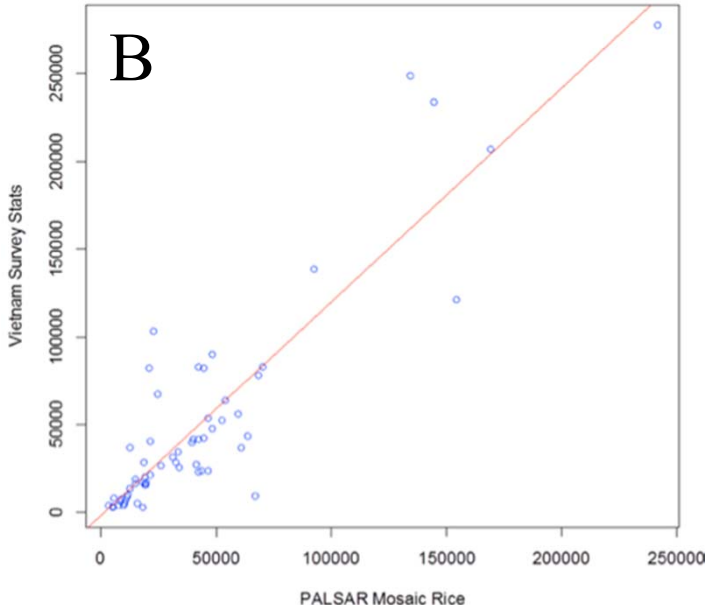
- Nathan Torbick, Steve Hagen and Rob Braswell (AGS)
- Sandra Brown and Nancy Harriss (Winrock International)
- Jiaguo Qi (MSU)
- Xiangming Xiao (OU)

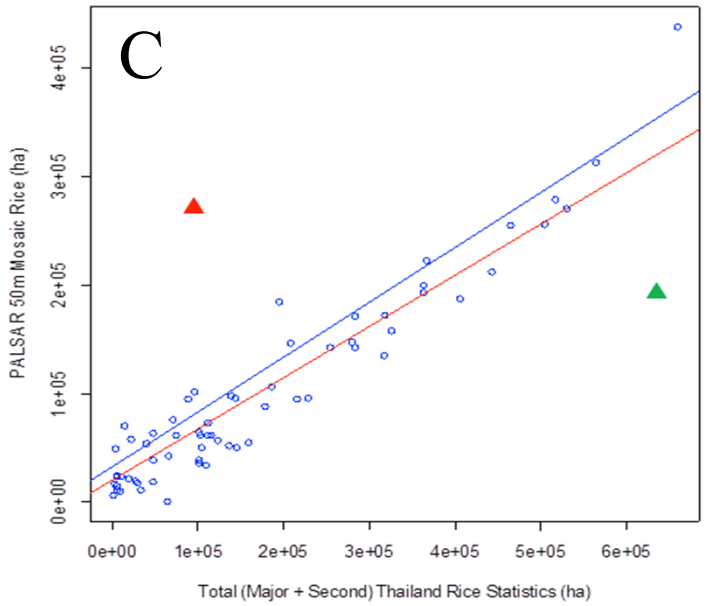
Phase 3 Objective: Move to GHG MRV & Decision Support Applications

- Map rice agricultural intensification across Monsoon Asia
- Develop rice GHG MRV prototype for in Vietnam
- Implement greenhouse gas (GHG) emission reduction offset verification system rice offset protocols
- Evaluate remote sensing tools (PALSAR and optical) for mapping forest structure and degradation in India and Guyana
- Provide geofield photo database to support JAXA cal / val

Operational rice products across Monsoon Asia

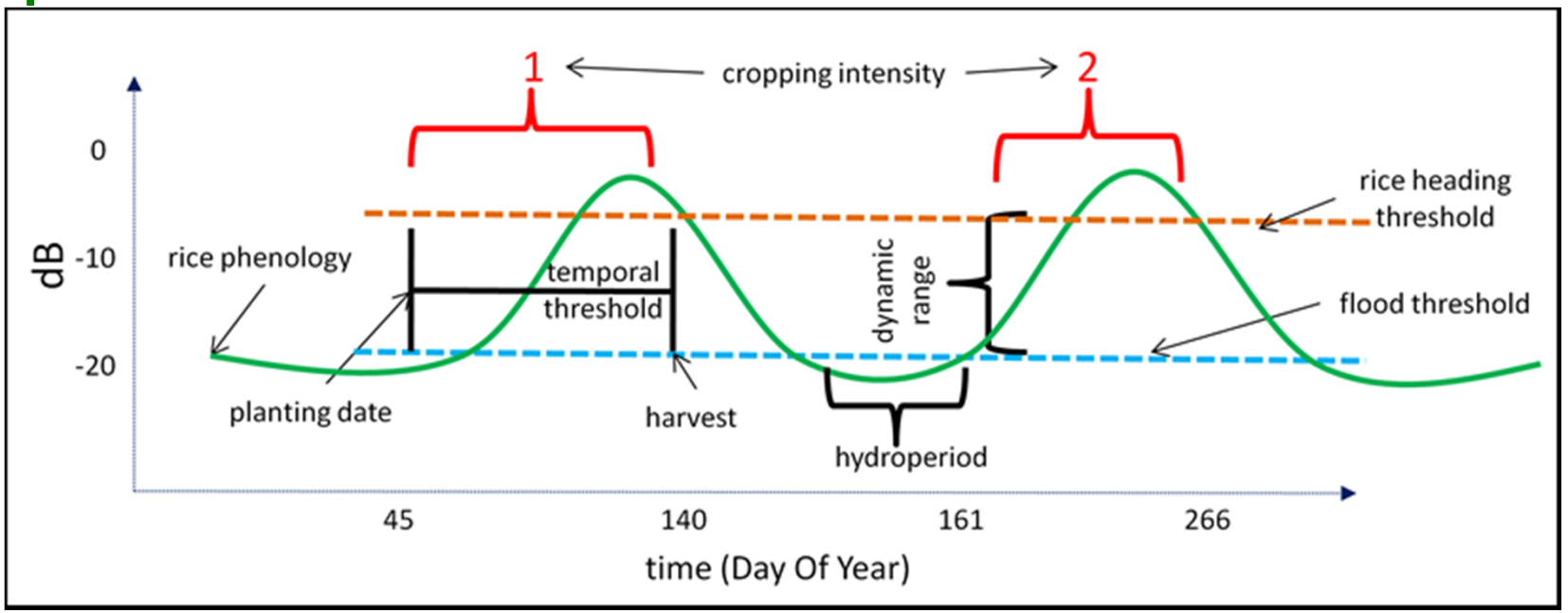






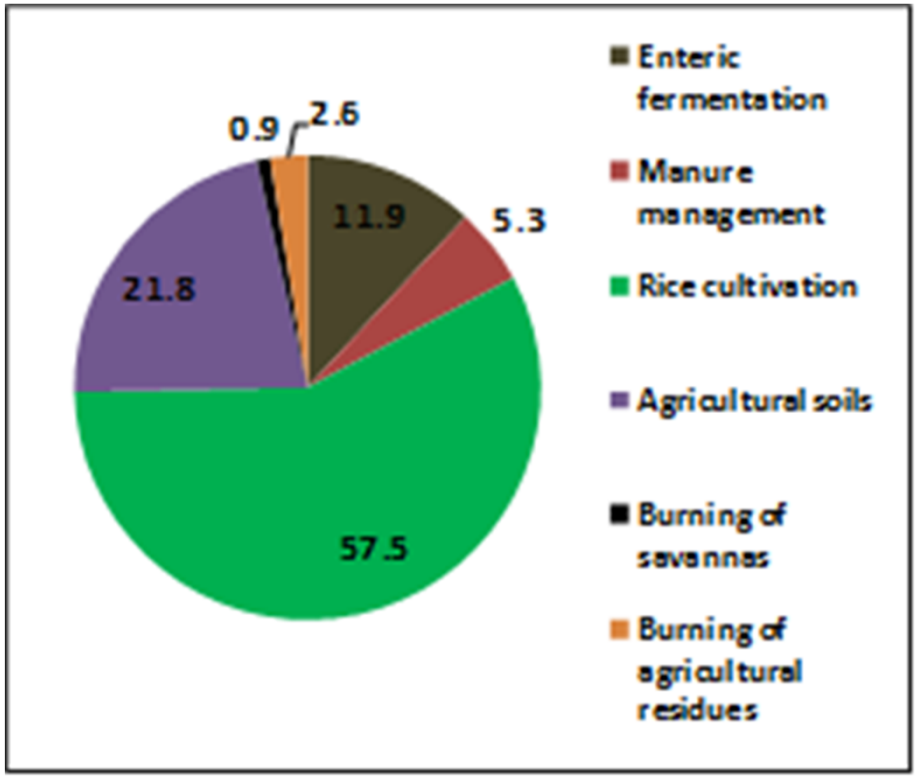
Regional Rice Mapping: Next Steps

- Status: Once ScanSAR mosaics are complete will refine previous maps of rice extent.
- Integrate 25m mosaics with time series ScanSAR mosaics
- New regional products on crop intensity, growing season length and plant/harvest date estimates: timeline: first products for K&C 20.



Vietnam Rice GHG MRV

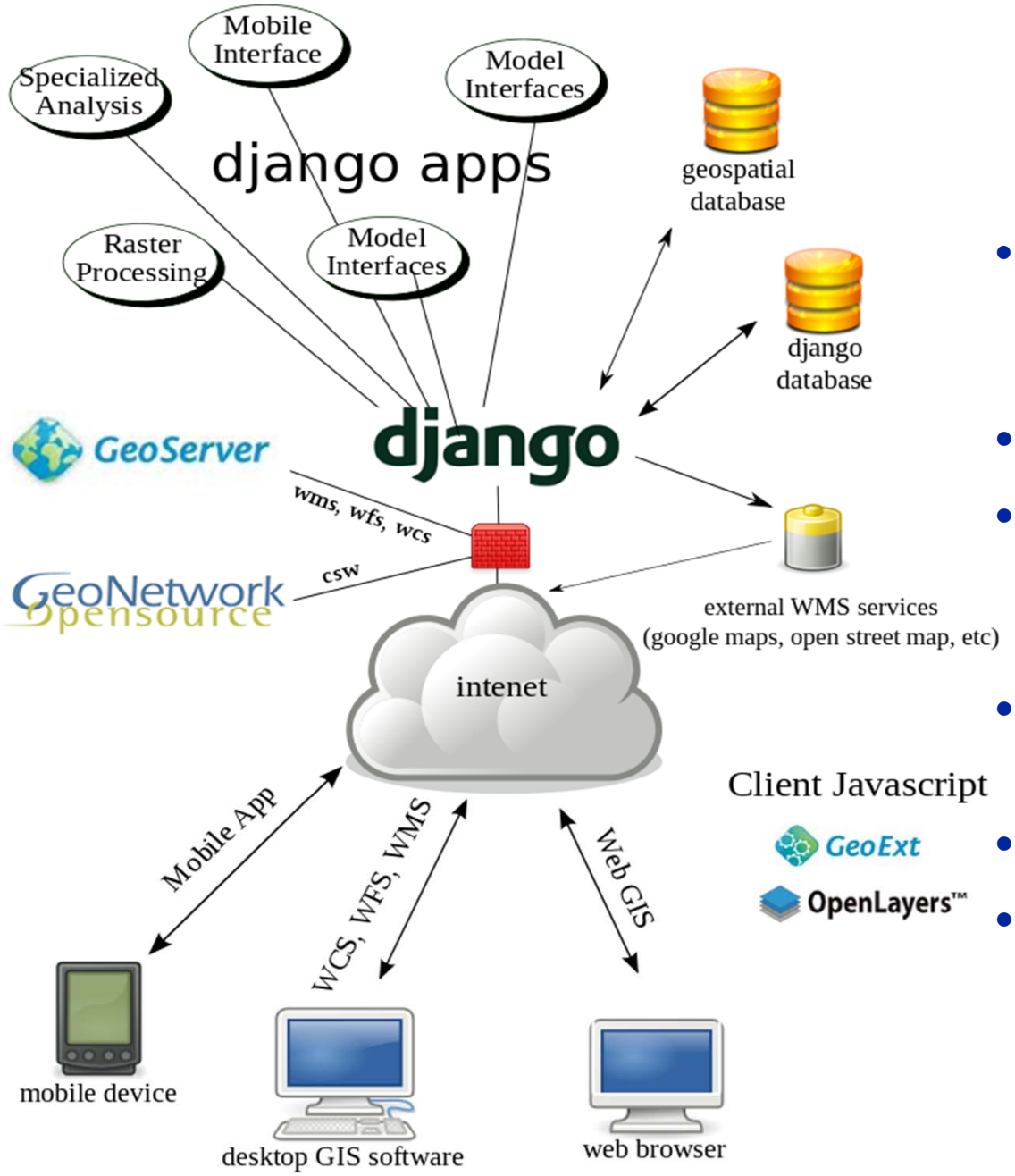
- Goals: Pilot Rice GHG MRV system for 2 Provinces: An Giang and Thai Binh.
- Background: National strategy for Low Emissions Development
- Funding USAID AILEG program
- Collaborators:
  - MARD IAE Vietnam
  - Can Tho University in Vietnam
  - EDF
  - Abt Associates in US
  - IFPRI.



Source: Vietnam 2nd National Communication to the UNFCCC

Vietnam Rice GHG MRV

- Components of Rice GHG MRV
  - Rice observatory (multi-sensor: PALSAR, Radarsat, Sentinel, Landsat 8, etc)
    - Spatial information on extent, cropping cycles, development to drive DNDC
  - Field sites for measurement of rice GHG (CH4 and N2O): Set up benchmark sites in Red River and Mekong Deltas for baseline and mitigation assessment.
  - Field survey system on rice management (modeling) and reference data for validation of RS products (gps mobile device apps). Interviewing ~200 farmers march/April 2013
  - GIS database server (data on soils, weather, topography, field survey)
  - Modeling system: DNDC model cal/val, includes uncertainty system.
  - WebGIS Decision Support Tool: data dissemination & visualization
- Longer term implementation goal: scale up to national and regional scales. On-going discussions with international donor agencies and World Bank



MRV System Framework (open source tools)

- GeoNode - A spatial data infrastructure combining several technologies:
- PostGIS - GeoSpatial Database
- Django - web framework for building website and applications
- GeoServer - Map rendering service
- GeoNetwork – Metadata catalog
- GeoExt / OpenLayers / Leaflet
  - Client javascript tools for visualization and analysis
  - Full-screen web-GIS

Building a Rice Management Observatory

- Multi-sensor system (PALSAR, Landsat, MODIS, Sentinel, etc)
- Goal: operational monitoring at field to regional scales
- Support for:
  - GEO-The Global Agricultural Monitoring (GLAM) Project
  - National GHG reporting
  - Rice GHG Offset Protocols

Rice GHG Offset Protocols

Verification System for Rice Offset Protocols

- GHG offset potential for agriculture is large in aggregate, small on a per hectare basis (0.5 to 3.0 tCO2eq/ha).
- Need to keep project development and verification costs at a minimum to be viable (aka the farmers see the $)
- Key role for remote sensing for cost effective information on eligibility and verification of management changes.
- Transparency is key, need to keep project development and verification costs down for a successful ag offsets program (transaction costs must be low otherwise there will not be a market).
- Demonstration project: Landsat, MODIS, PALSAR, other data
  - RS based rice extent, wet versus dry seeded system, winter flooding, baling rice straw

Mapping Water Management: Key Driver for Methane Landsat and PALSAR

Example CART Error Matrix

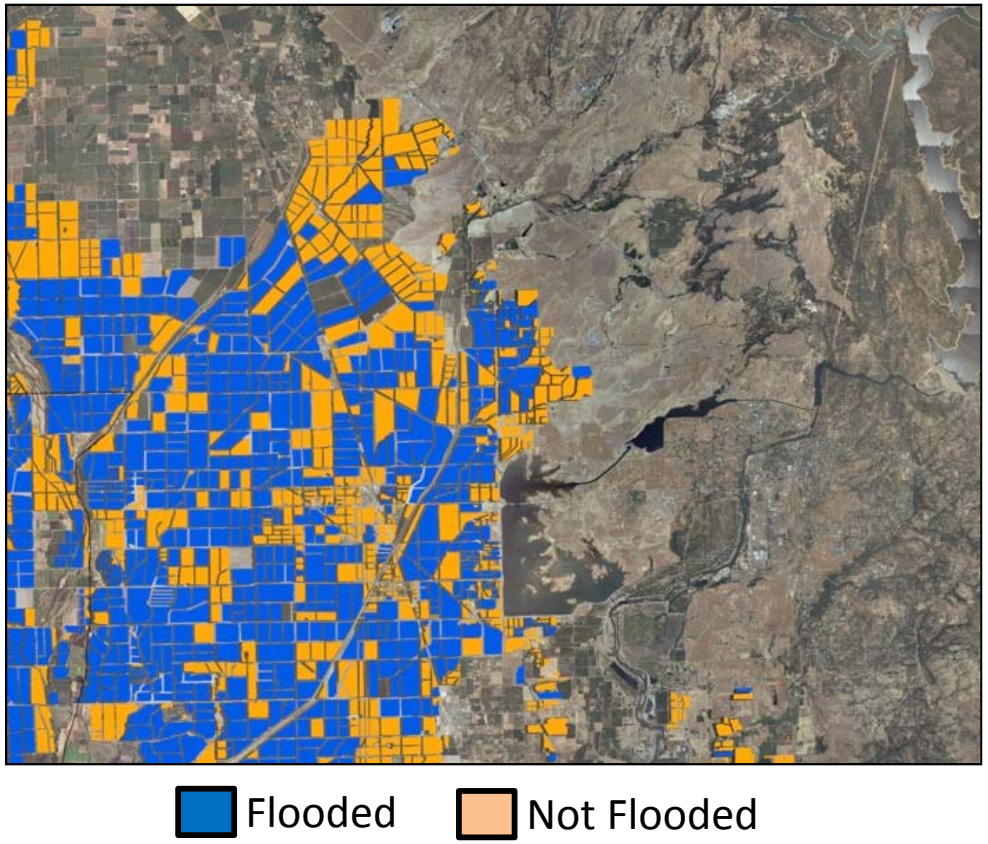
		Winter Flooding	
		WF	NF
Winter Flooding	WF	2545	98
	NF	200	2647

Overall Accuracy	94.57
95% CI	93.94-95.16
P-value	<0.0001
Kappa	89.14

Example CART Model Results

Class	Total (acres)	%
WF	222810.4	48.8%
NWF	233398.8	51.2%

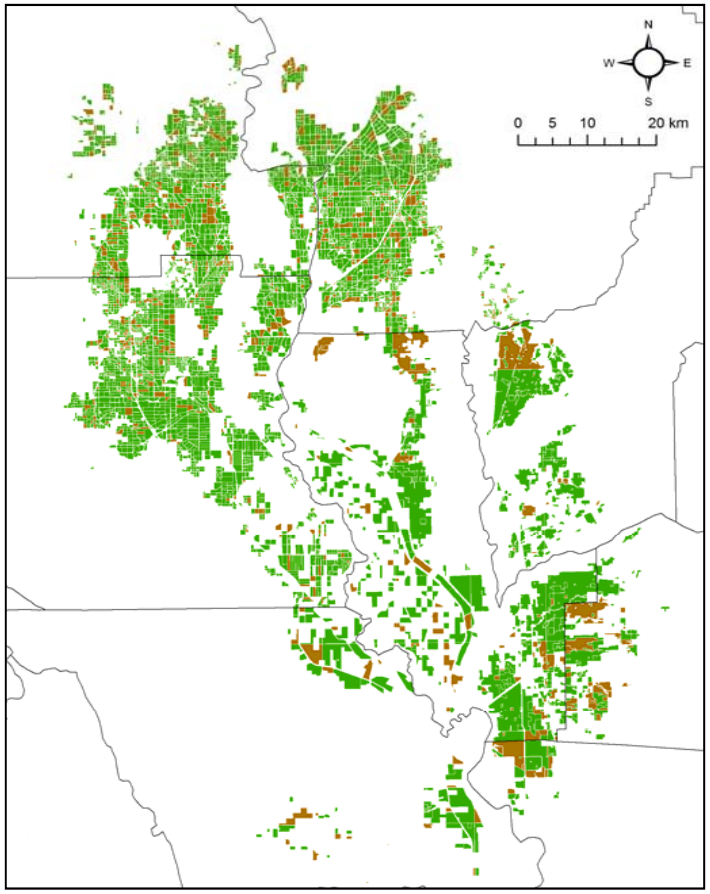
Winter Flood vs. No Winter Flood



*Now comparing to multiple independent datasets and dynamic index approach

Farm field-scale monitoring products to support MRV protocol
Monitoring over 6000 separate fields annually

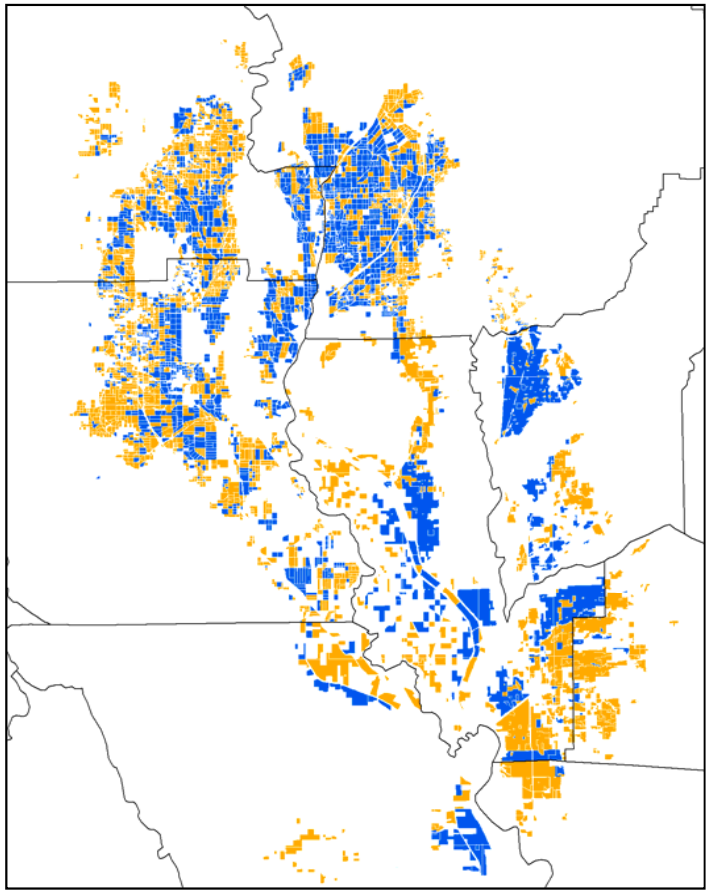
Active 2012-2013 paddies



Active Dormant

Derived from NDVI dynamic range

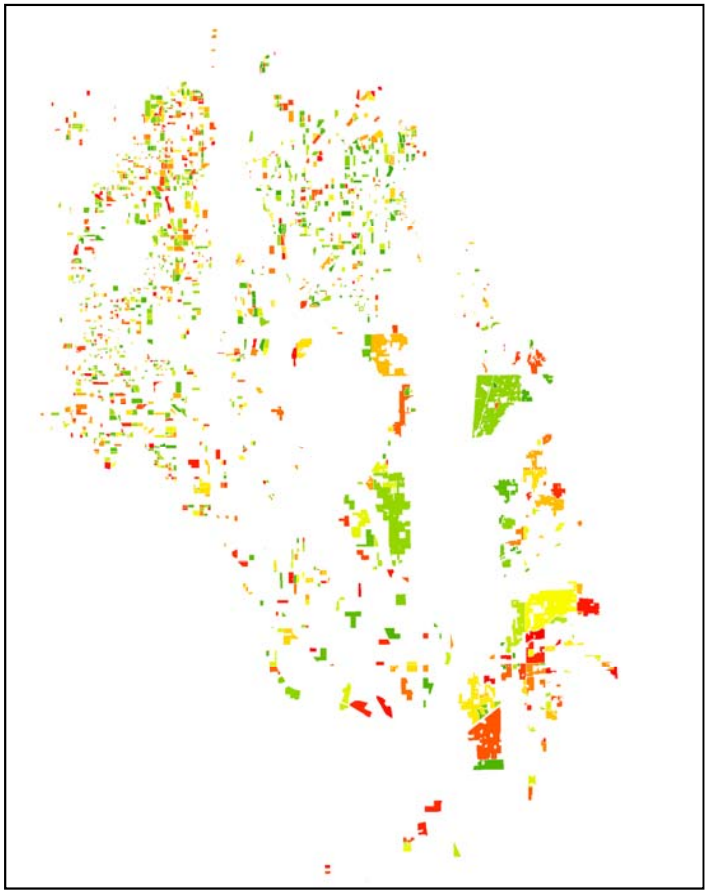
Winter Flood vs. No Winter Flood



Flooded Not Flooded

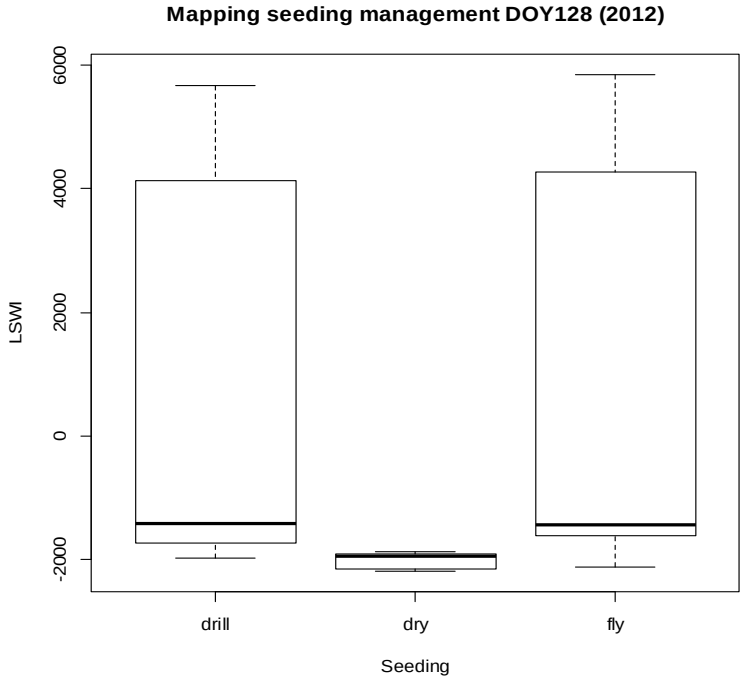
CART driven by indices

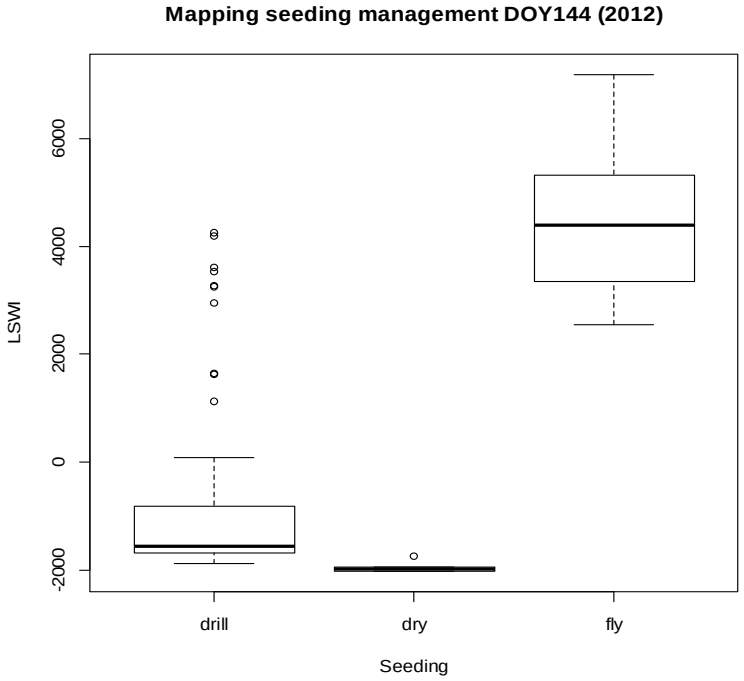
Winter Flood Uncertainty

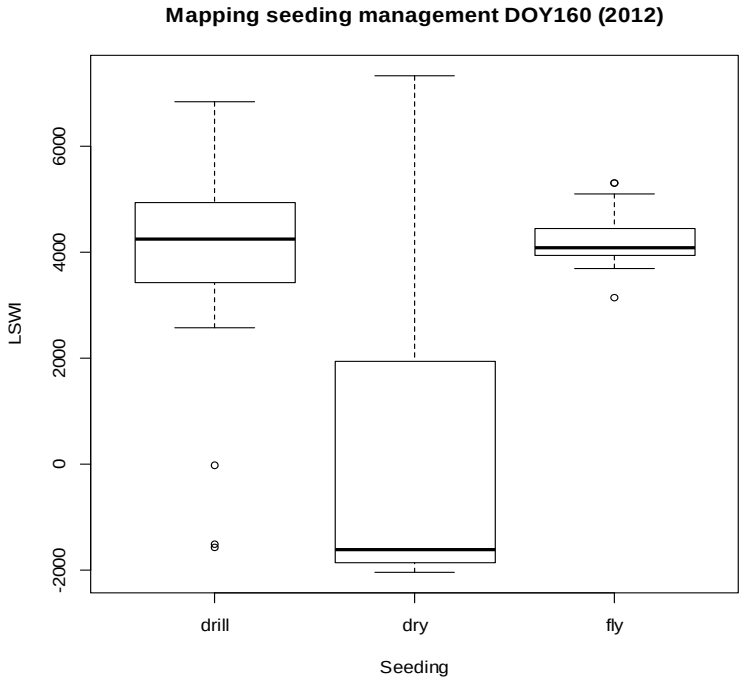


Low High

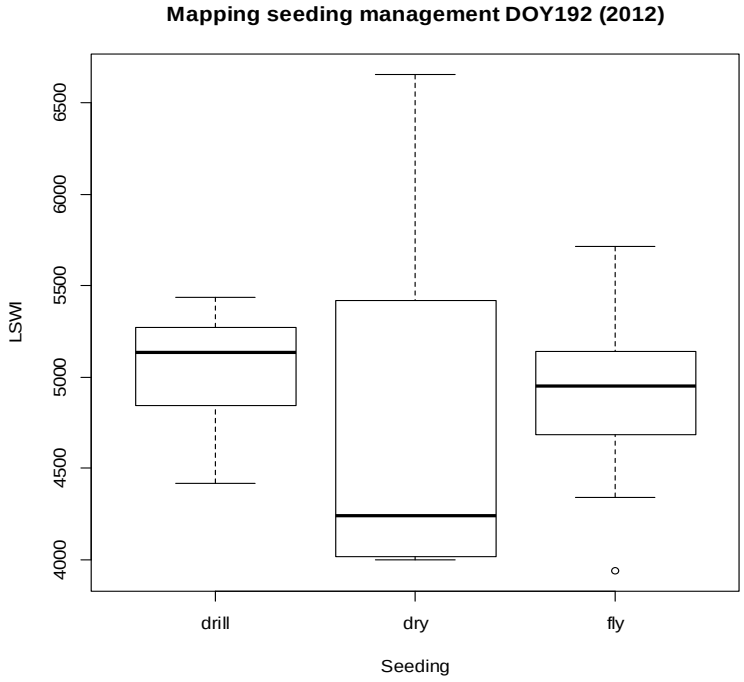
Bootstrap out of sample

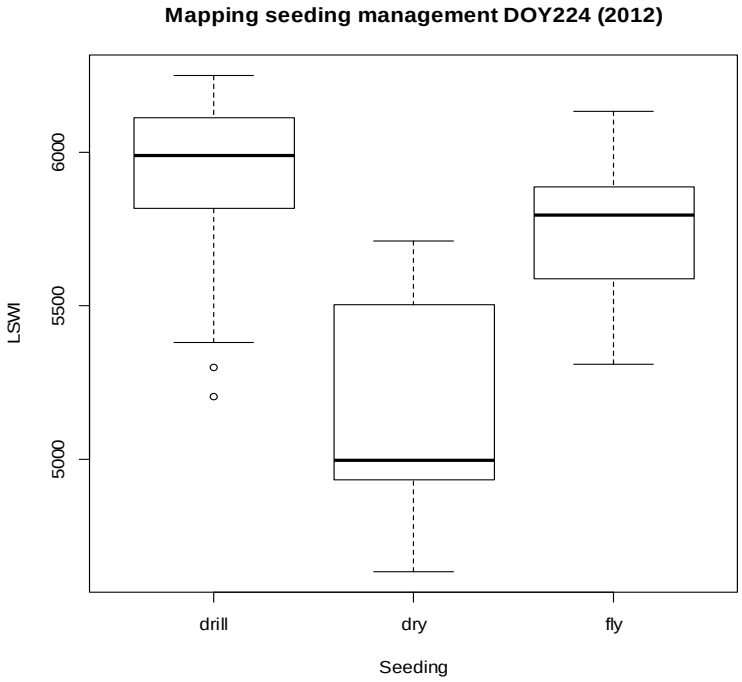


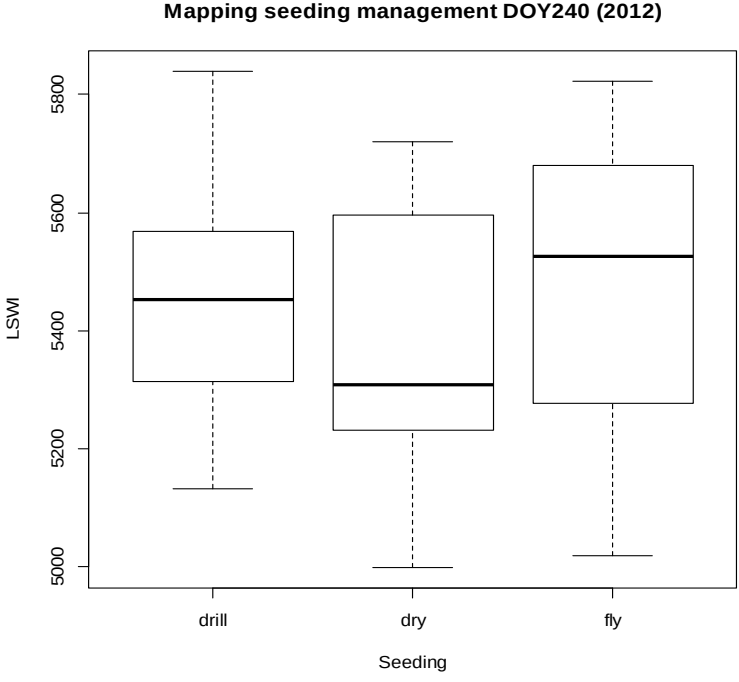




Mapping seeding techniques: Dry versus wet seeded rice

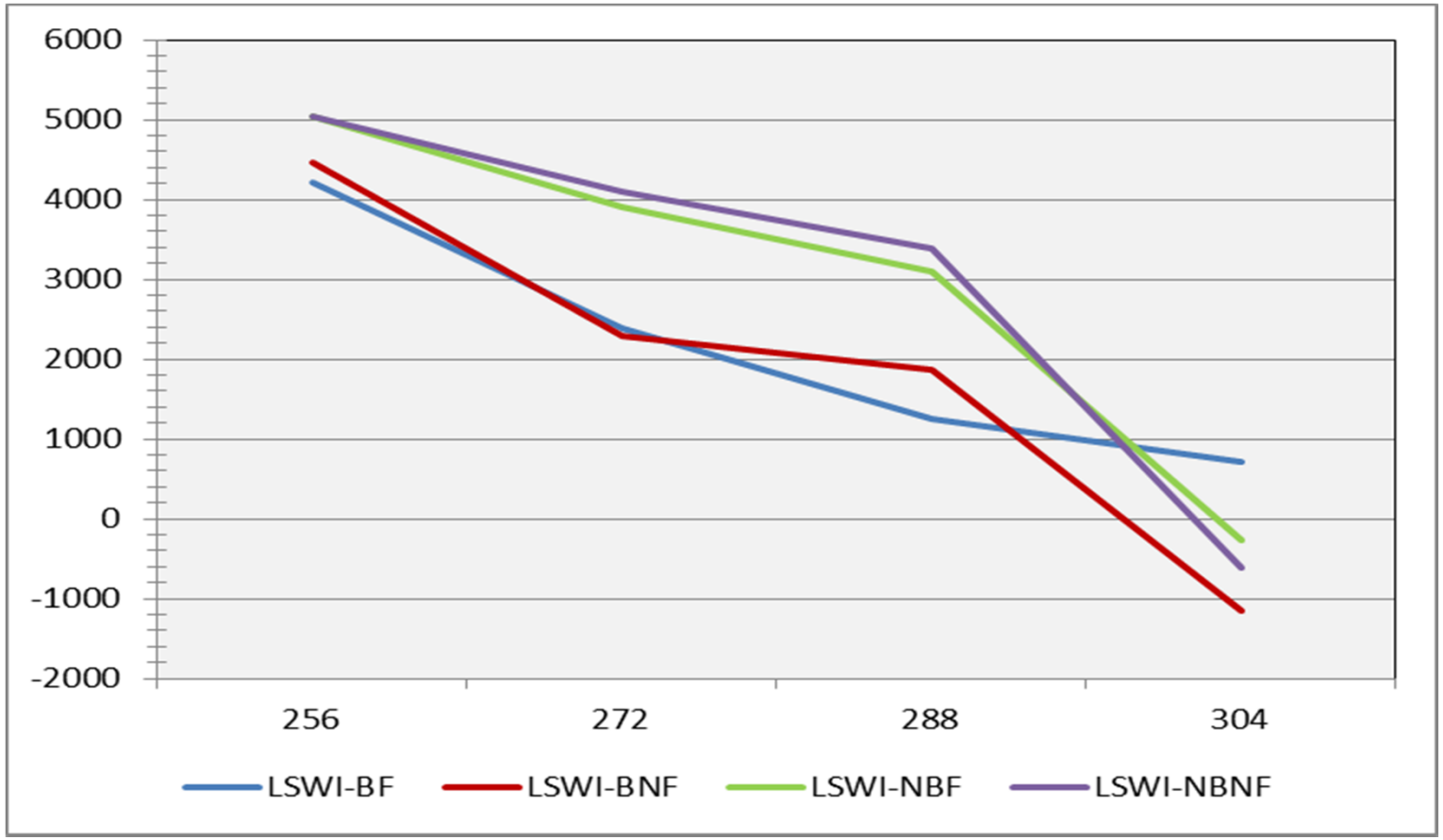






Mapping Rice Straw Management

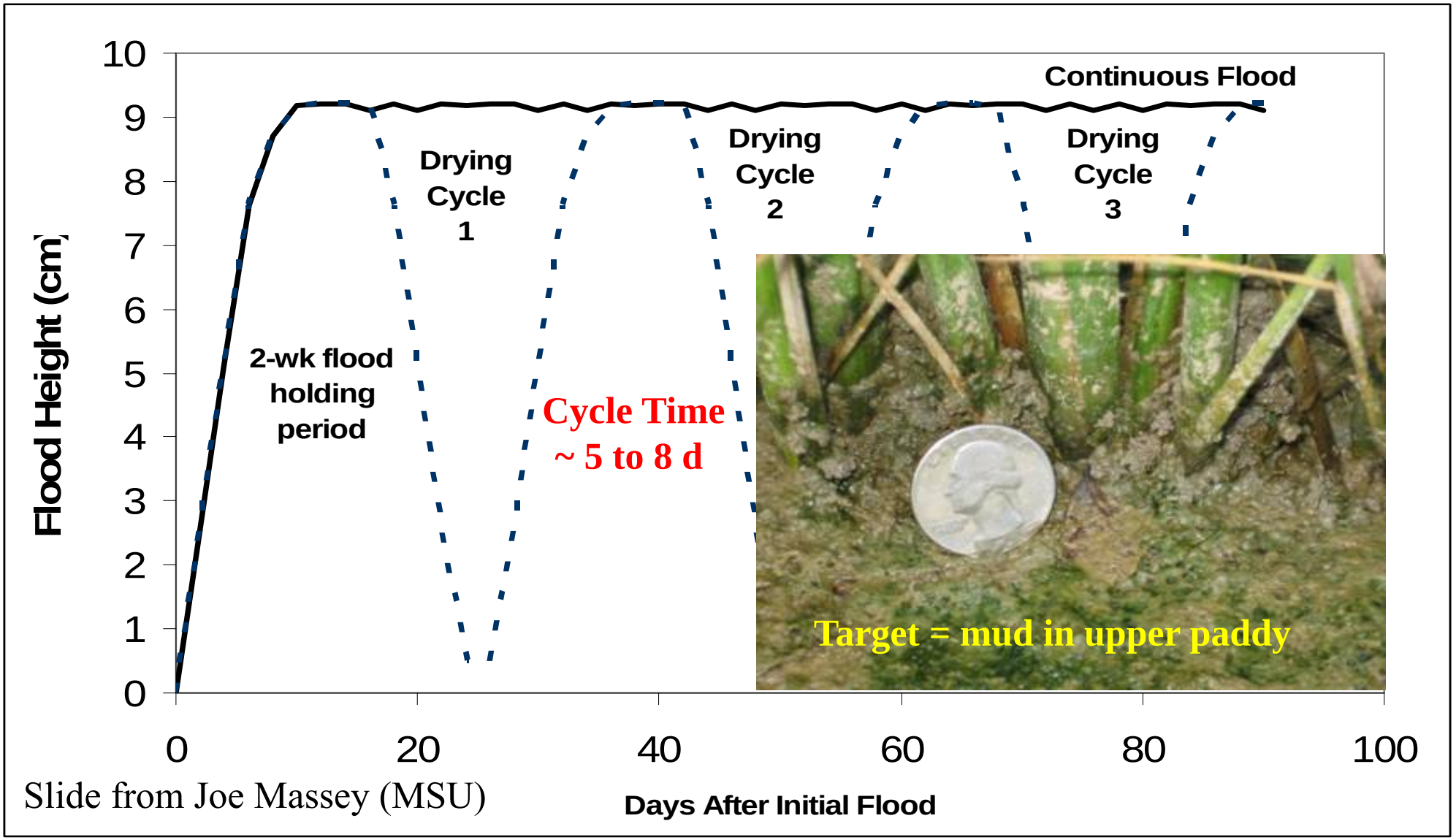
- Post harvest rice straw management has significant impact on methane emissions.
- Need for monitoring straw management for verification and regional estimates of rice GHG emission



Outcome

- Prototype Rice Management Observatory
- Key information on water management, seeding practices and rice straw management: important management drivers of rice methane production
- Next steps:
  - Continued testing in new regions: Vietnam next
  - Develop techniques for mapping water management during rice growth: mid-season drain and AWD.

Continuous vs. Intermittent Flood Management



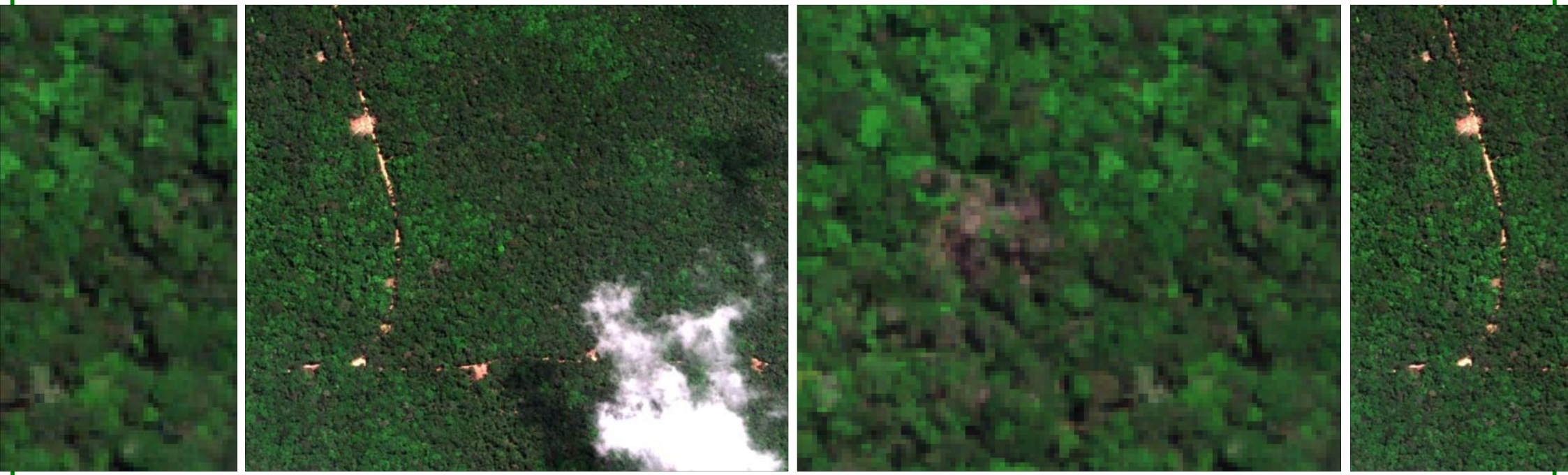
Slide from Joe Massey (MSU)

ALOS

K&C Initiative

An international science collaboration led by JAXA

A Pilot Study to Assess Forest Degradation in Guyana



Bobby H. Braswell (Rob), Steve Hagen and William Salas*
Applied Geosolutions (*wsalas@appliedgeosolutions.com)

Felipe Casarim, Sandra Brown and Nancy Harris
Winrock International

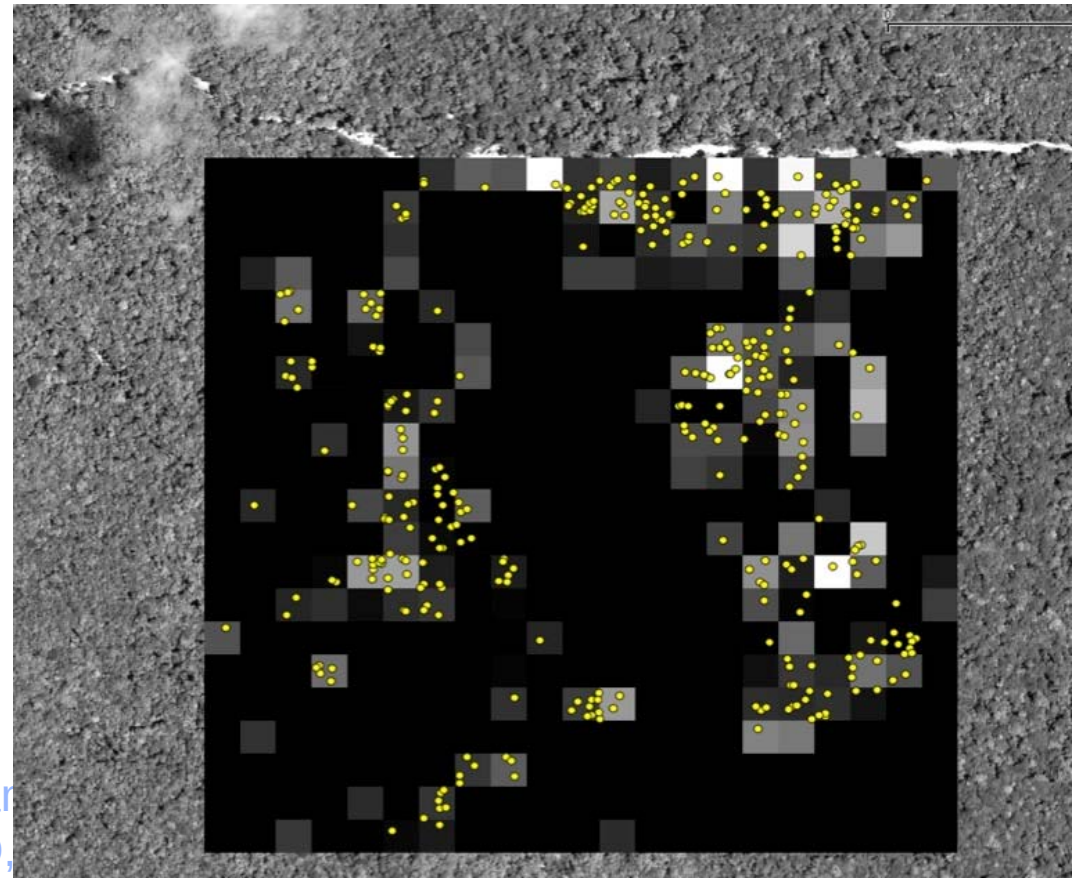
Michael Palace, University of New Hampshire

Guyana Degradation Pilot

- **Objective: can RS be used to identify degradation, coupled with field surveys (Winrock, GFC)**

RS Approaches

- Crown tracing
- Gap fraction unmixing
- VIs
- PALSAR



Background for the Pilot Study

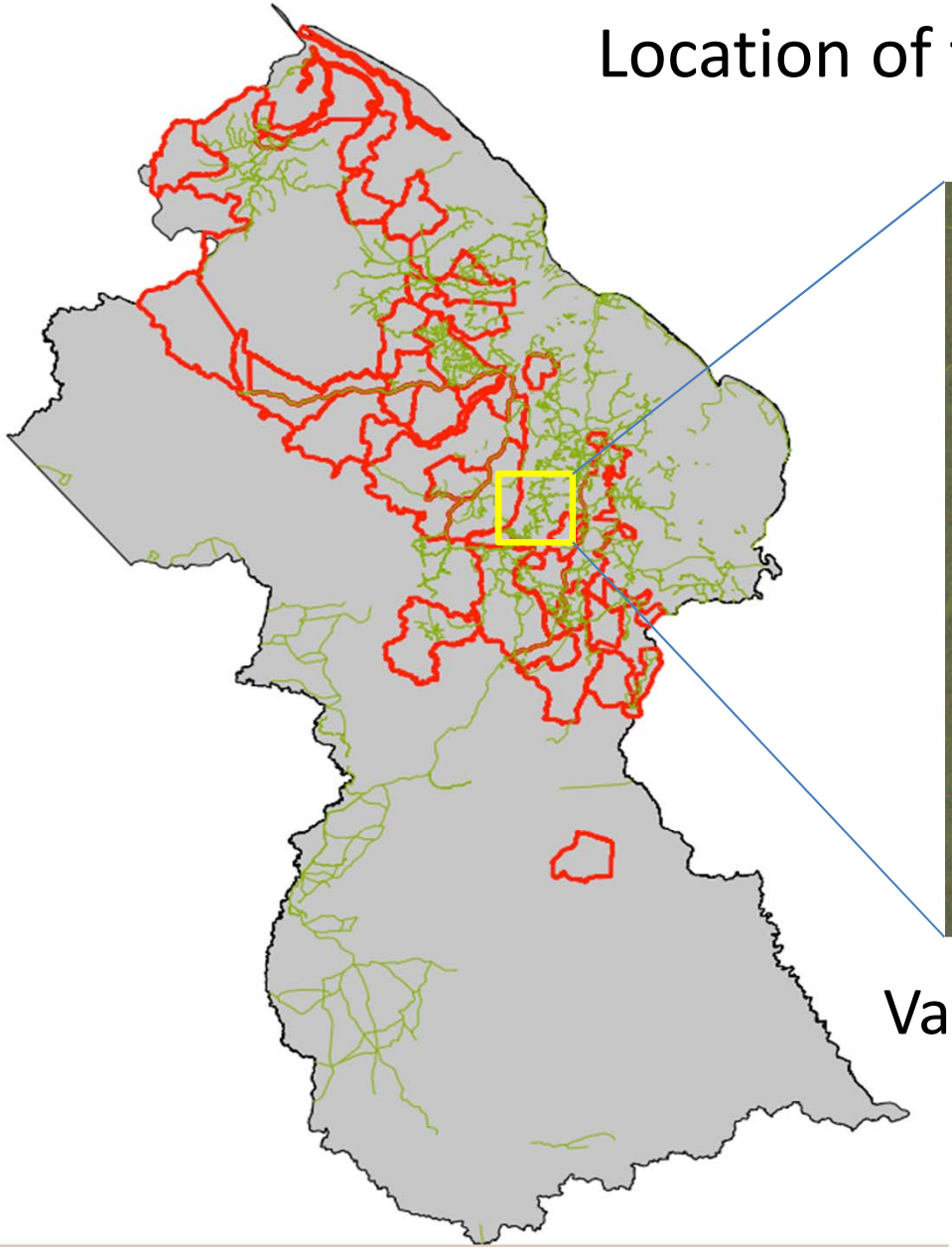
From the Joint Concept Note on REDD+ cooperation between Guyana and Norway carbon loss as indirect effect of new infrastructure is addressed as follows:

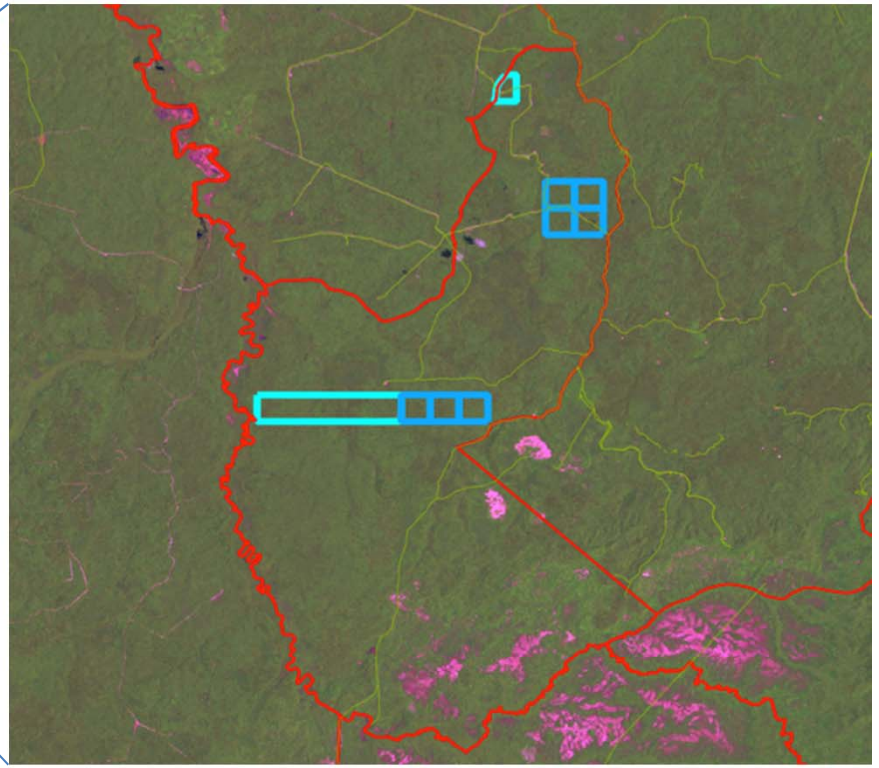
"The establishment of new infrastructure in forest areas often contributes to forest carbon loss outside the areas directly affected by construction. Unless a larger or smaller area or greenhouse gas emission impact can be documented through remote sensing or field observations, **the area within a distance extending 500 meters from the new infrastructure (incl. mining sites, roads, pipelines, reservoirs) shall be accounted with a 50% annual carbon loss through forest degradation**."

A Pilot Study to Assess Forest Degradation Surrounding New Infrastructure

- Background and Objectives of this Pilot Project
- **Task 1.** Evaluate the Use of High Resolution (<1m) Imagery for Mapping Changes in Canopy Gap Fraction and Crown Size Distribution
- **Task 2.** Application of Spectral Unmixing of Moderate Resolution Optical Data for Assessing Forest Degradation
- **Task 3.** Degradation Analysis in Buffers around New Infrastructure
- **Task 4.** Comparison of High Resolution Optical Data, Landsat and PALSAR for Detecting Logging

Location of the Pilot Study





Variety Woods and Greenheart Ltd.

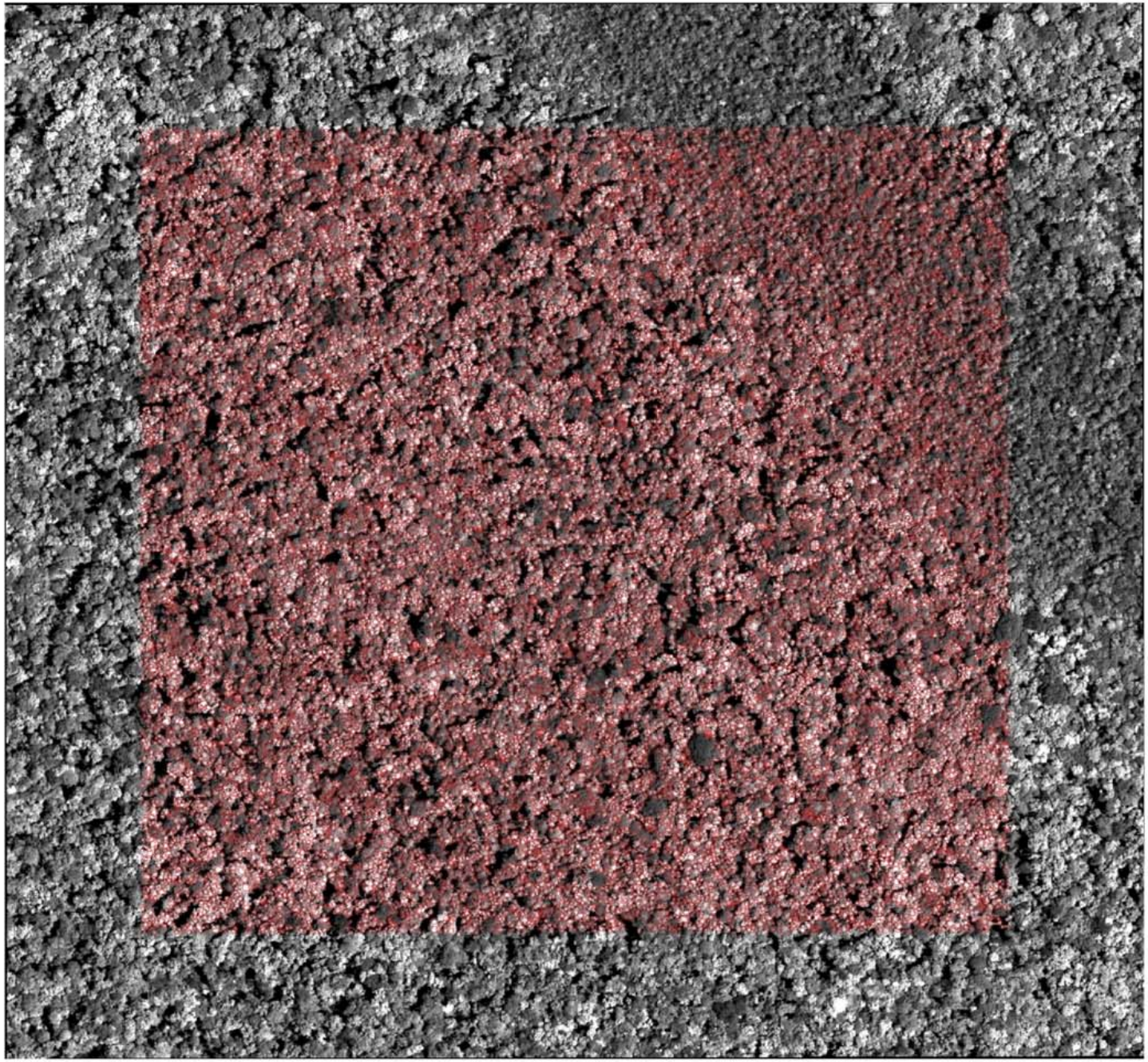
Optical (visible to near-infrared) satellite imagery:

1. Two Landsat-5 Thematic Mapper (TM) Scenes (30 meter resolution)
   - October 2005
   - August 2011
2. Two High-Resolution Panchromatic Scenes (~0.5 meter resolution)
   - GeoEye, November 2010
   - QuickBird, November 2011

PALSAR imagery: 25m mosaics and FBD

A Pilot Study to Assess Forest Degradation Surrounding New Infrastructure

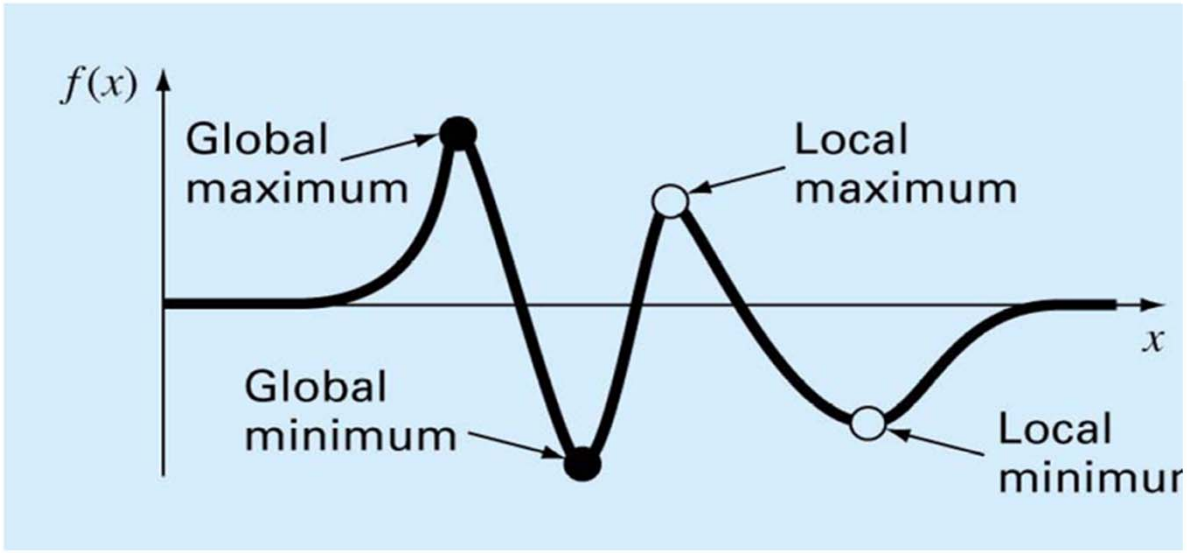
Task 1: Evaluate the Use of High Resolution (<1m) Optical Data for Mapping Changes in Canopy Gap Fraction and Crown Size Distribution

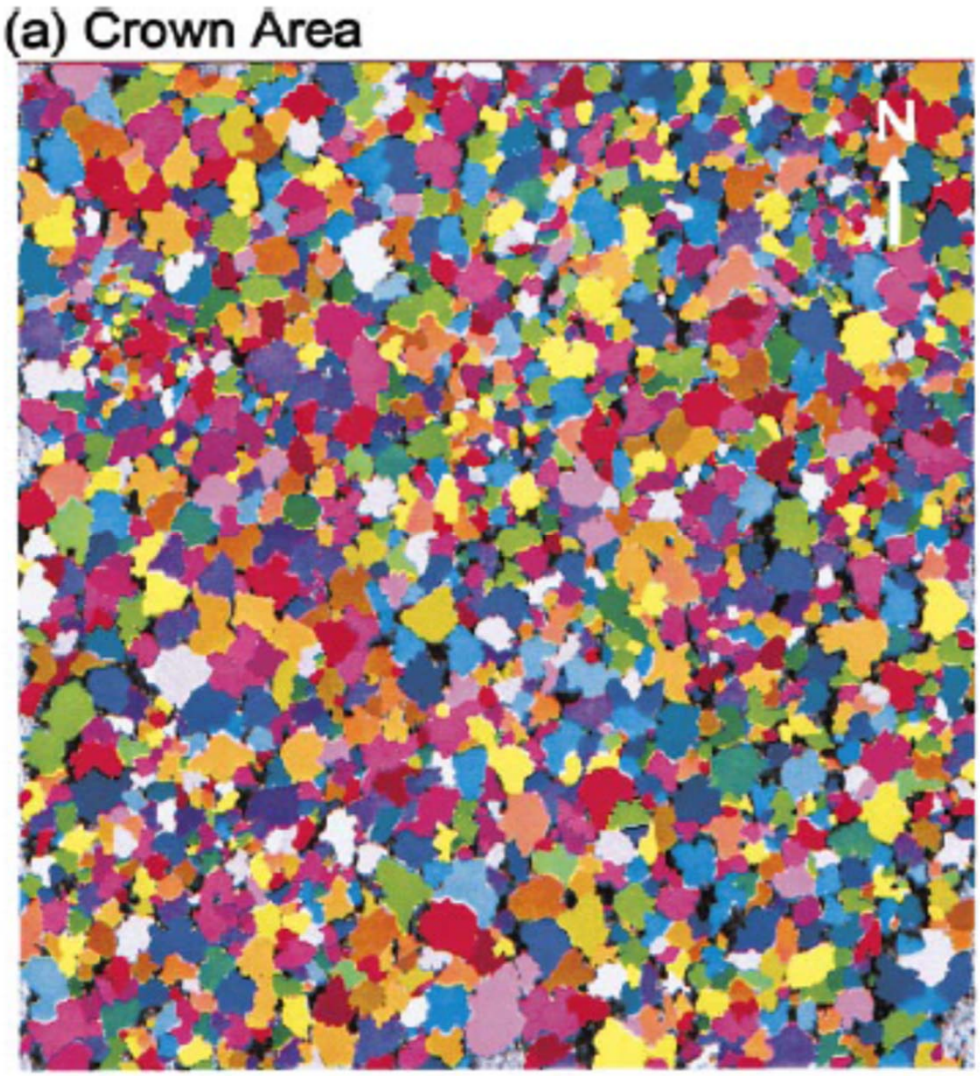


Space Forester over Quickbird image – Block 7

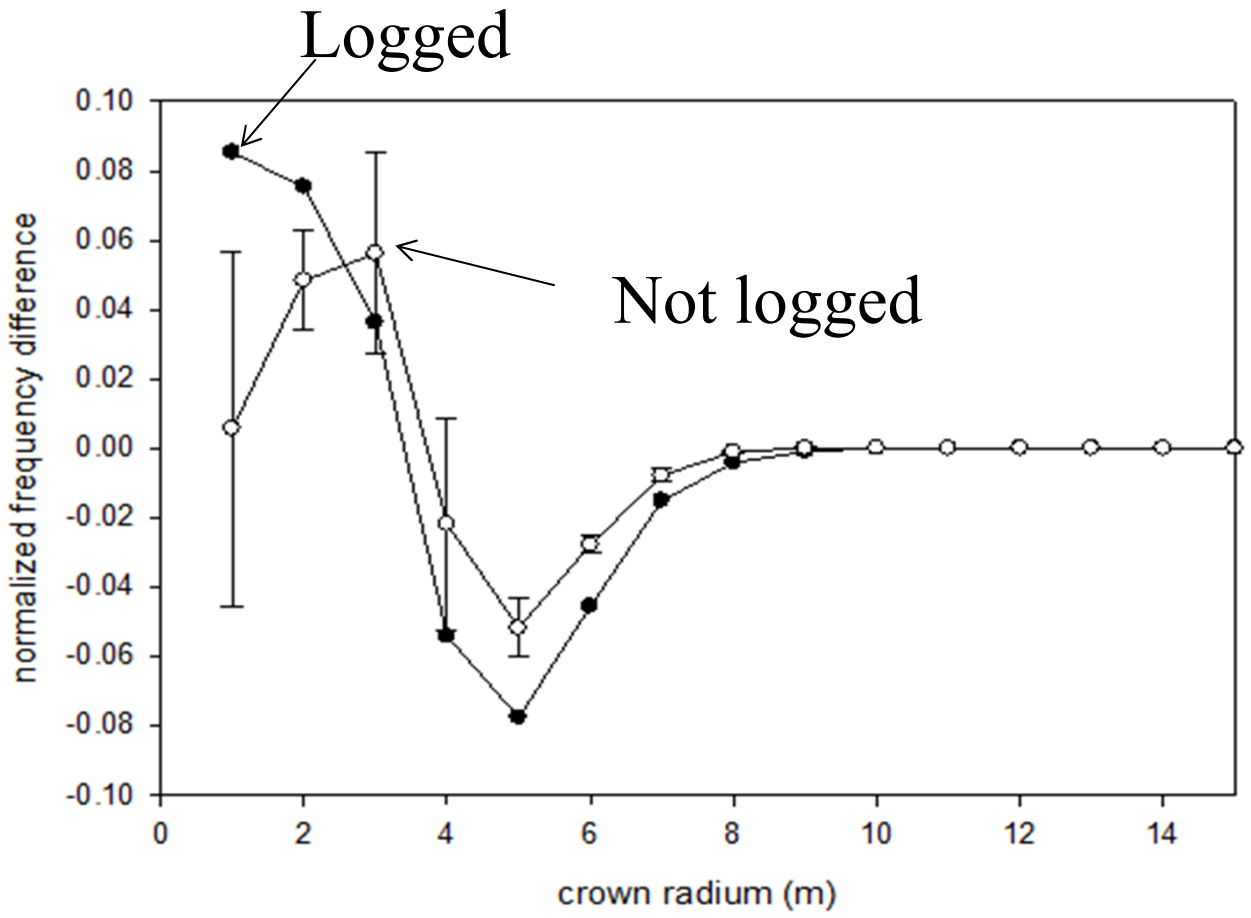
High Resolution Analysis of Logging: Mapping Tree Crowns

- **Applied an automated crown tracing algorithm to map changes in crown size distribution before and after logging.**





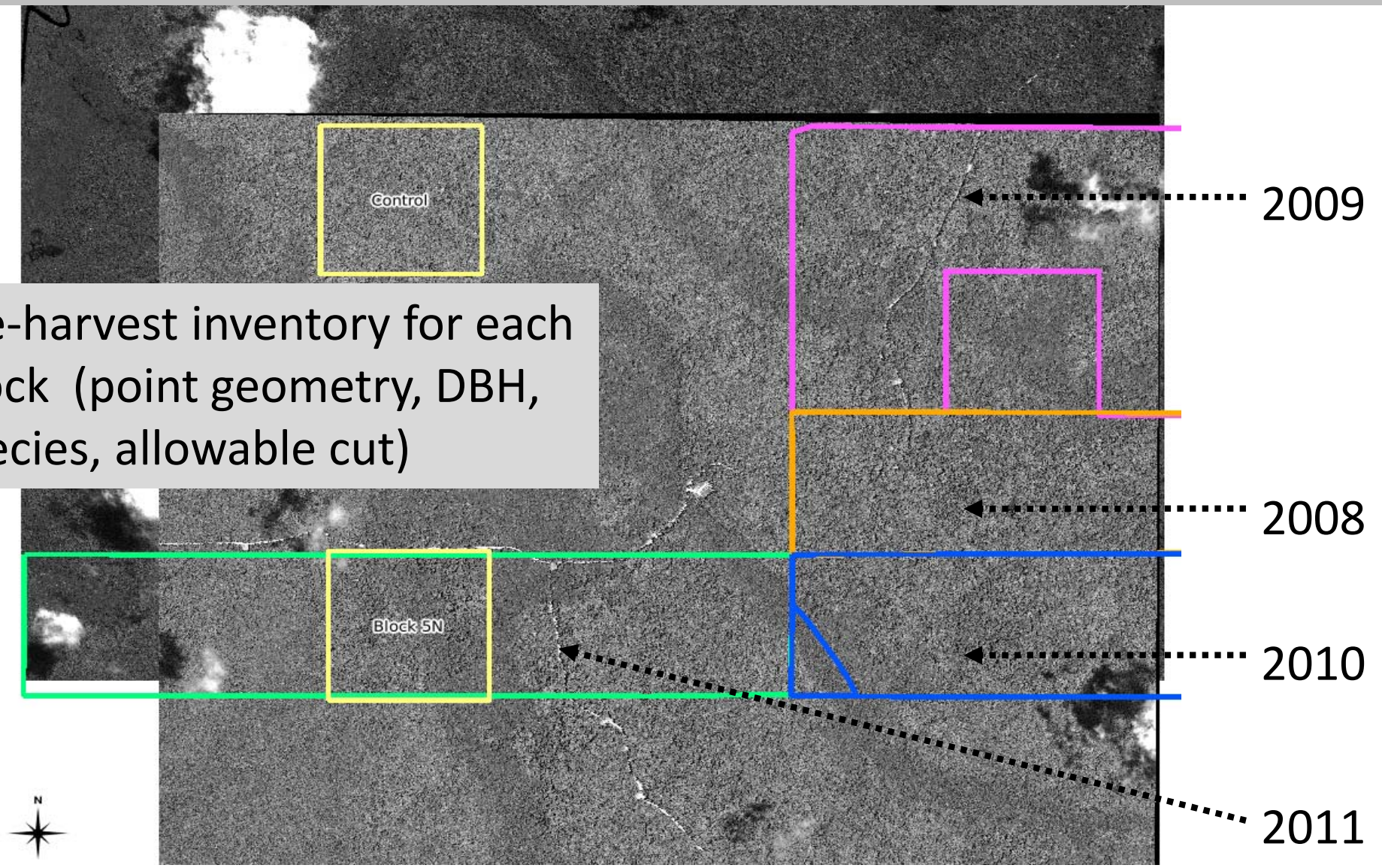
Mapping Tree Crowns:
Difference in crown size distribution pre- and post-logging



Mean crown radius metric decreased 0.7 m in the logged area and 0.3 m in the control areas. Error bars are not provided for the logged results because there was only one logged block for comparison.

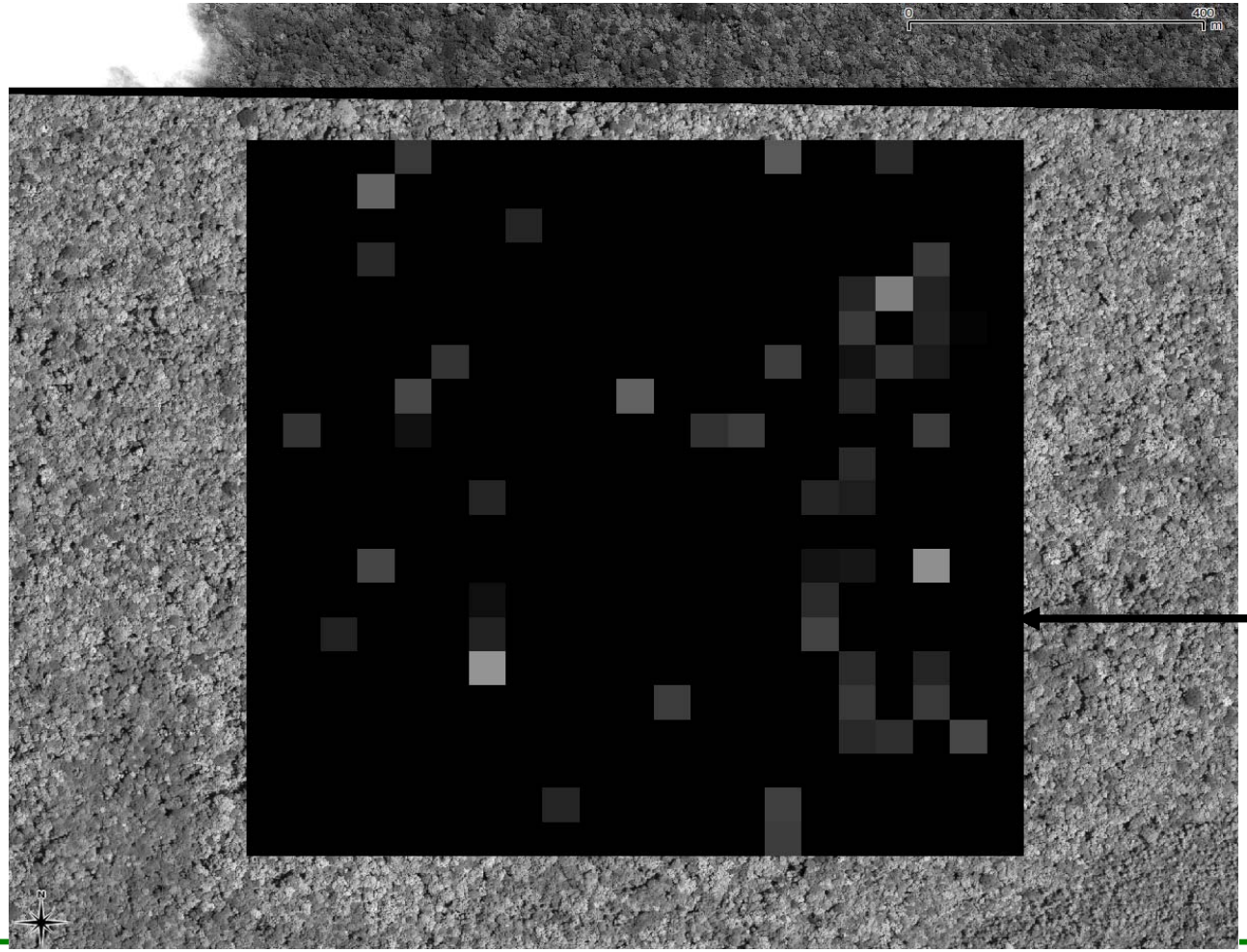
High Resolution Analysis of Logging: Mapping Change in Gap Fraction

1. Pre-harvest inventory for each Block (point geometry, DBH, species, allowable cut)

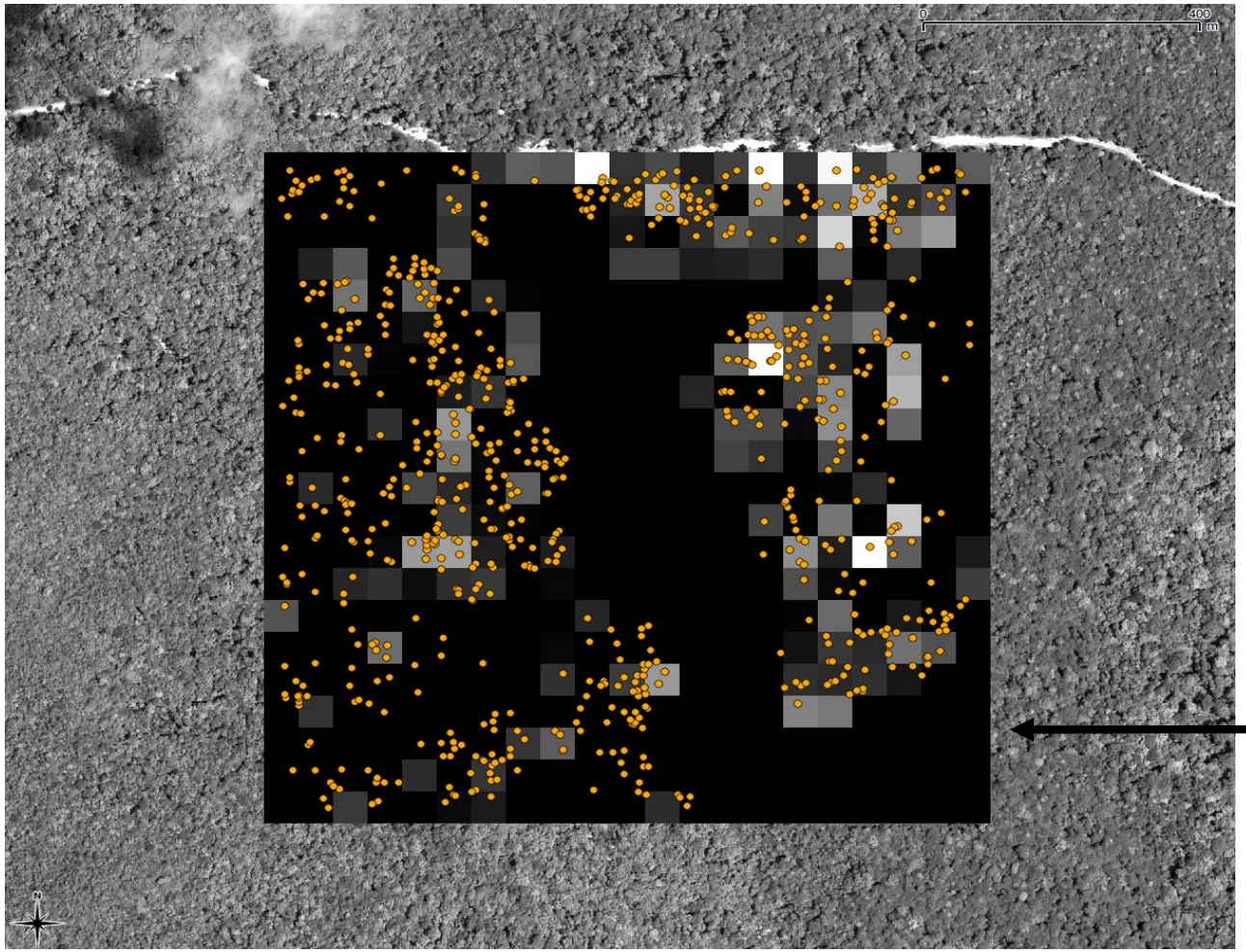


High Resolution Analysis of Logging: Control Plot

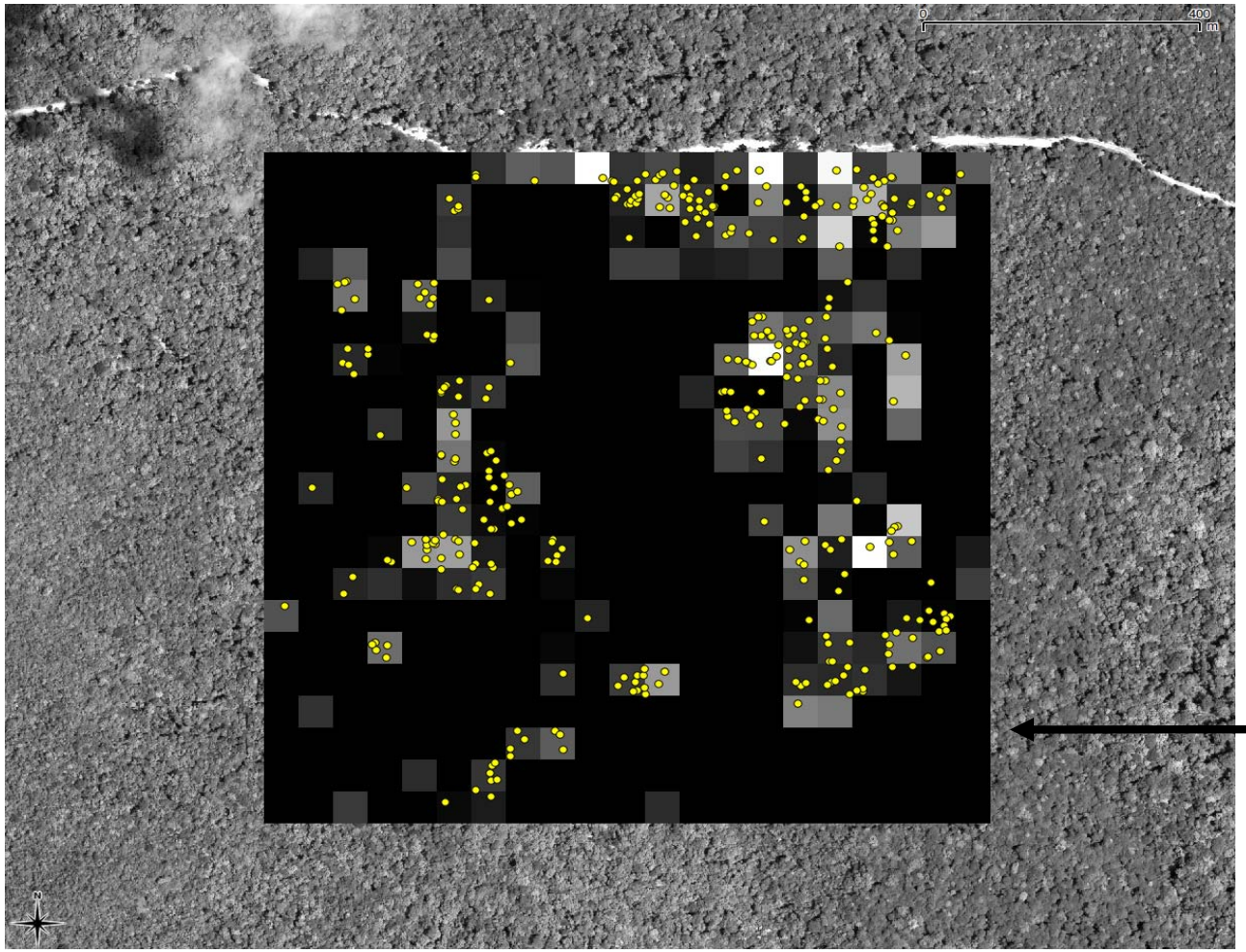
Gap Area Result (50 m)
For Area without Recorded Logging



Gap Area Result (50 m)
With Pre-harvest Inventory Points

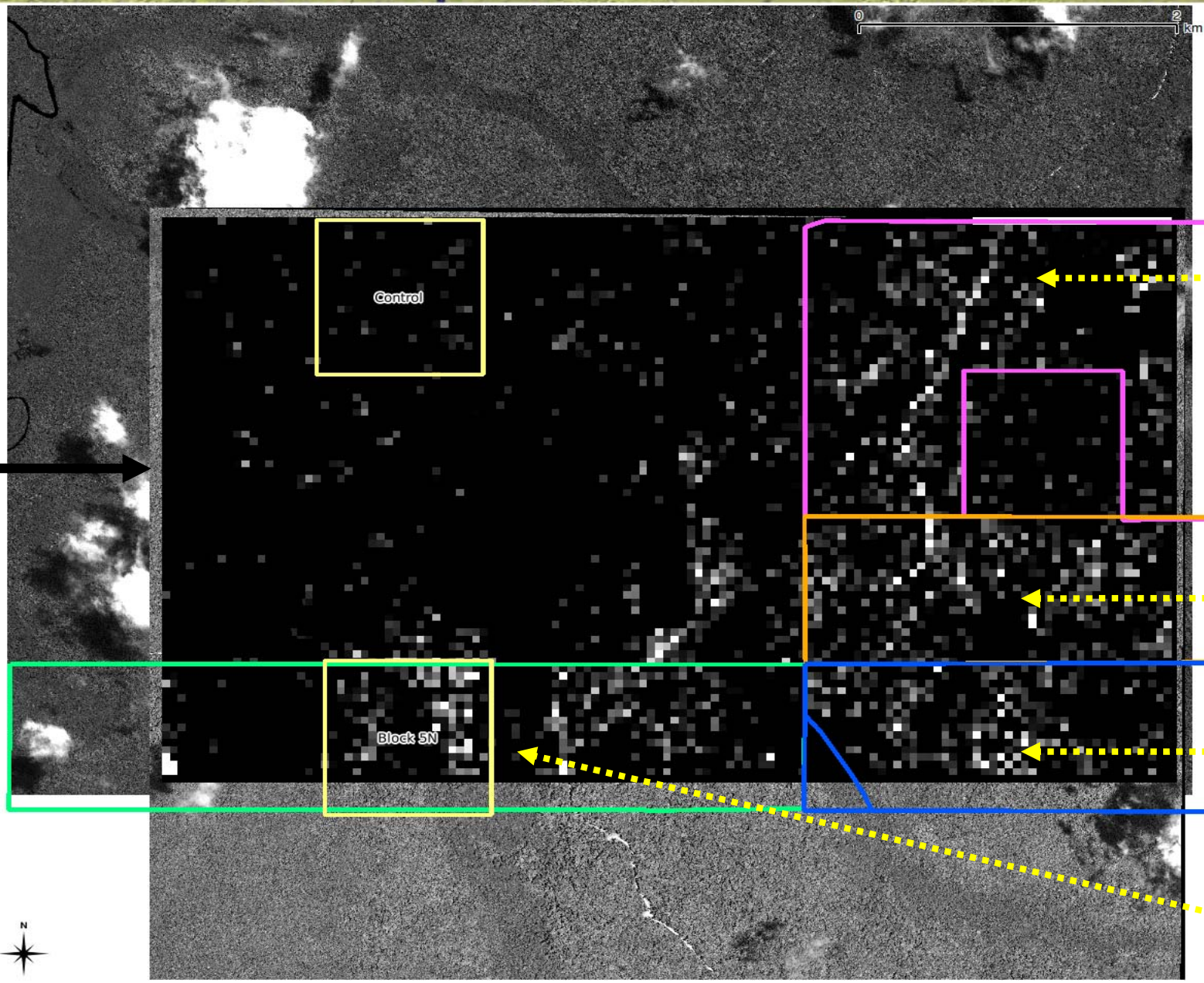


Gap Area Result (50 m)
With Filtered Pre-harvest Inventory Points



ALOS High Resolution Analysis of Logging

K&C Initiative
An international science collaboration led by JAXA



SCENE OVERLAP

High Resolution Analysis of Logging: Mapping gap fraction

Results: Block 5N

1.New gap area = 10,636m^2 from pre- to post-logging (note: changes in gap fraction at reserve site was ~20%)

2. Range in size of new gaps: 37 - 211m^2

3. Used Winrock/GFC derived gap-carbon ratio of 0.106tCm^{-2} to estimate total C removal of 1,127tC (Block 5N)

GFC visited the site post-logging to collect stump data to estimate logging removals

Comparison of the High Res, Landsat and PALSAR Approaches

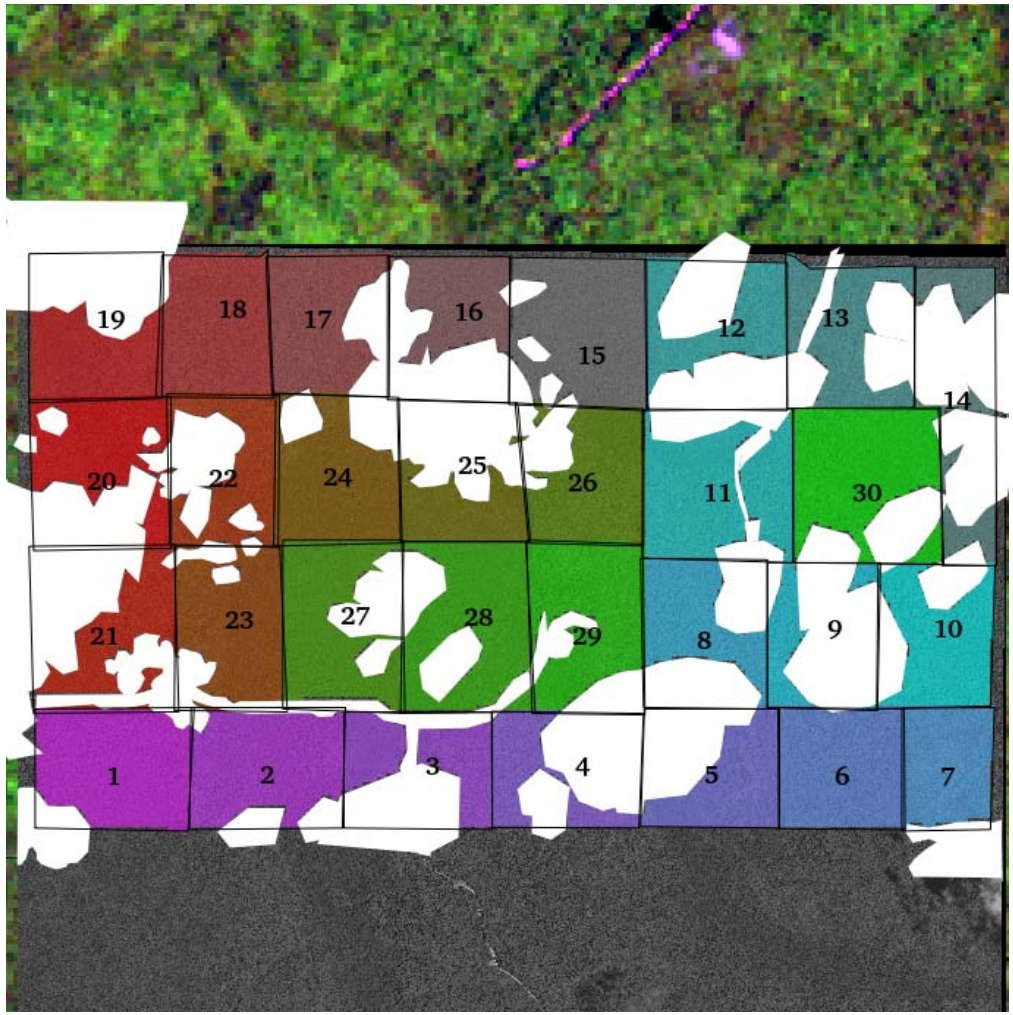
Logged in 2011: (#1, 2, 3, 4),

Logged in 2010: (#5, 6, 7)

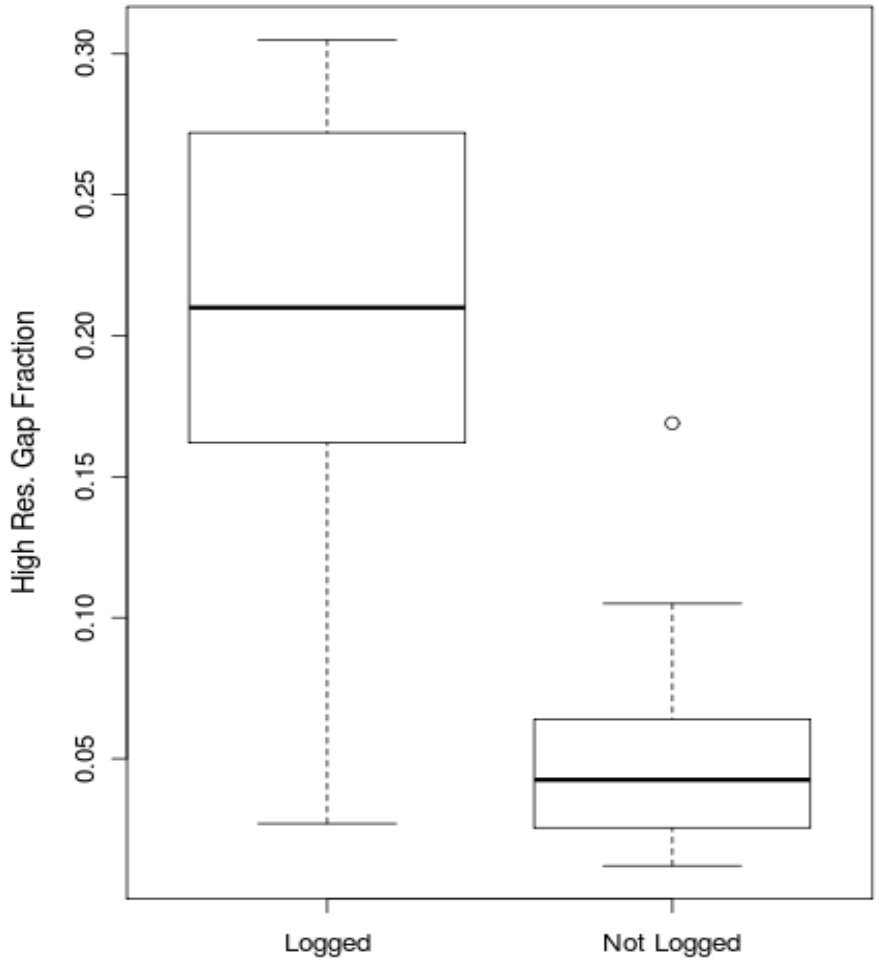
Logged in 2009: (#11, 12, 13, 14)

Logged in 2008: (#8, 9, 10)

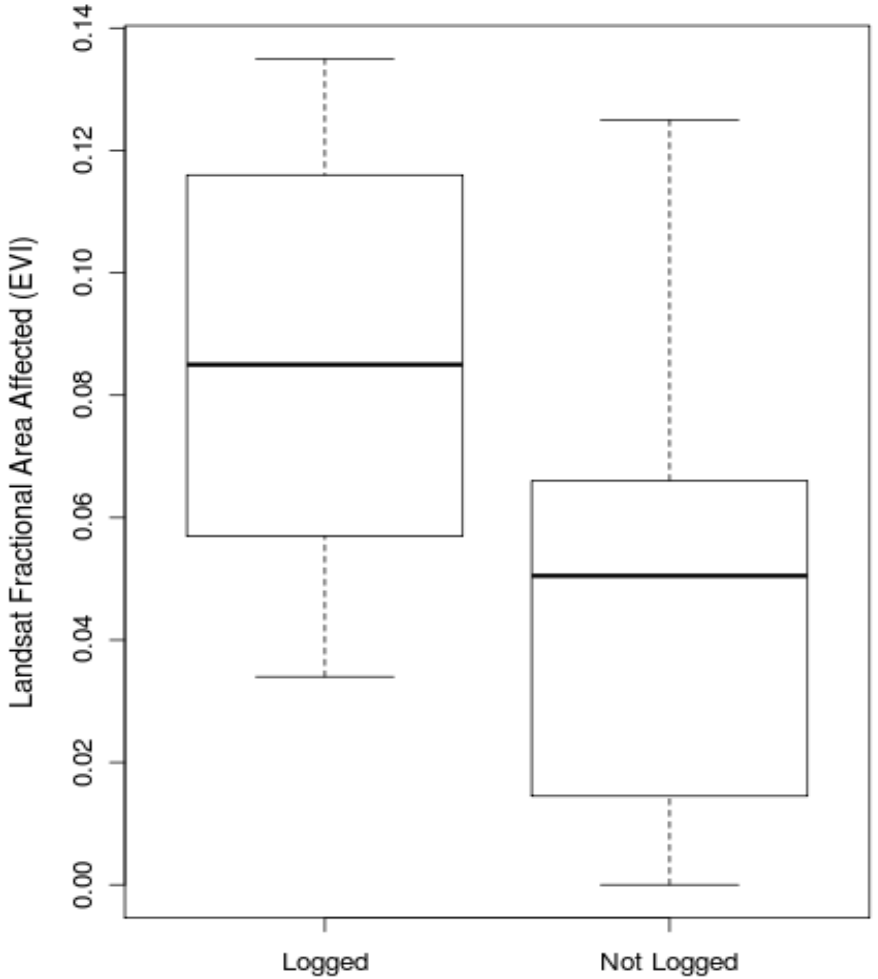
The other sixteen regions were never officially logged (#15 - 30)



High-resolution



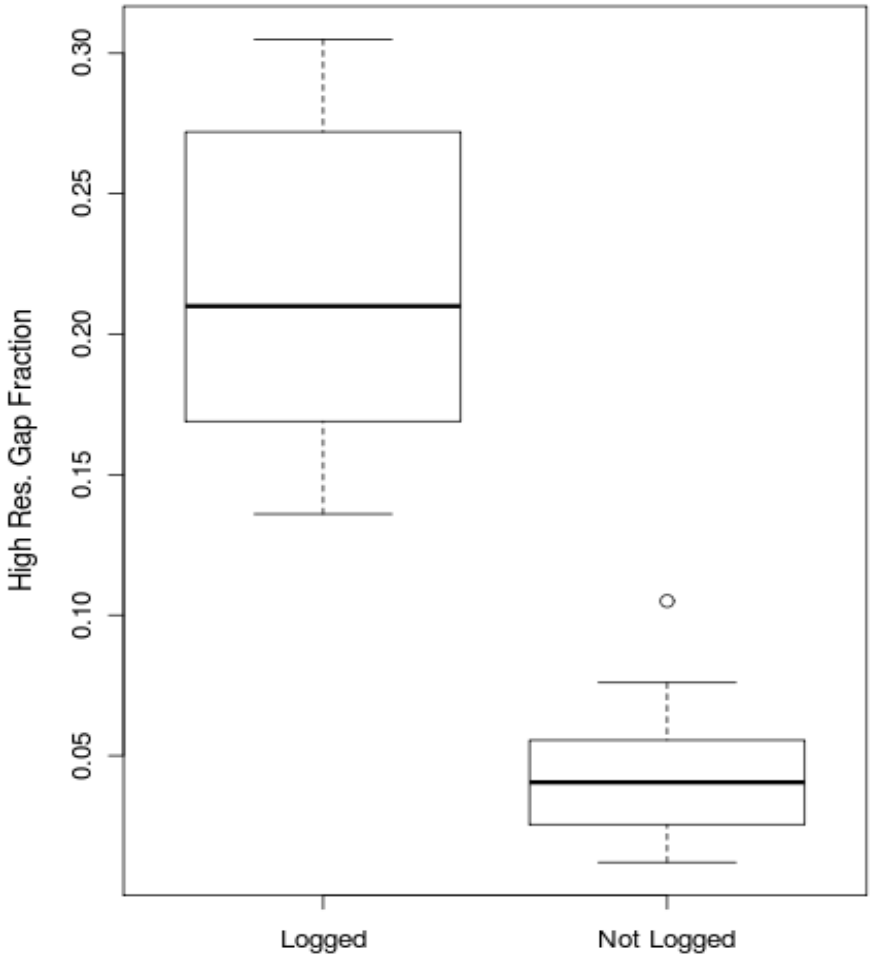
Landsat



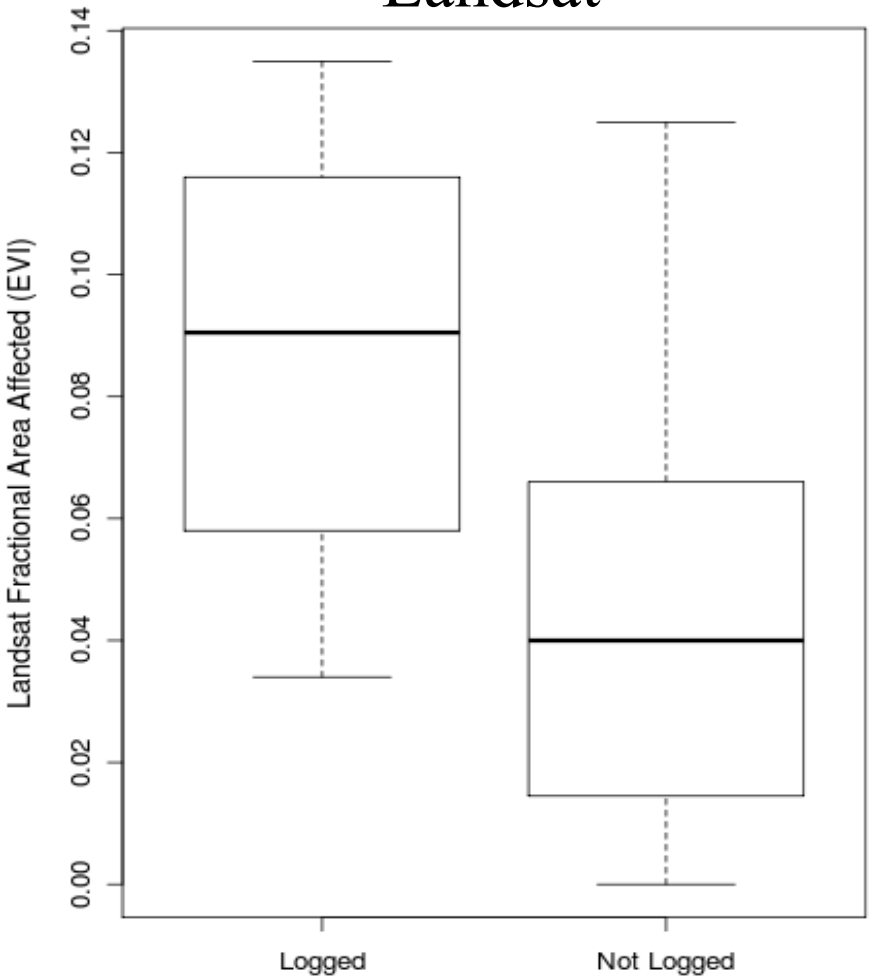
Comparison of the Two Approaches
Adjusted for Outliers

#1 from 2011 → Not Logged; #29 Not logged → Logged

High-resolution

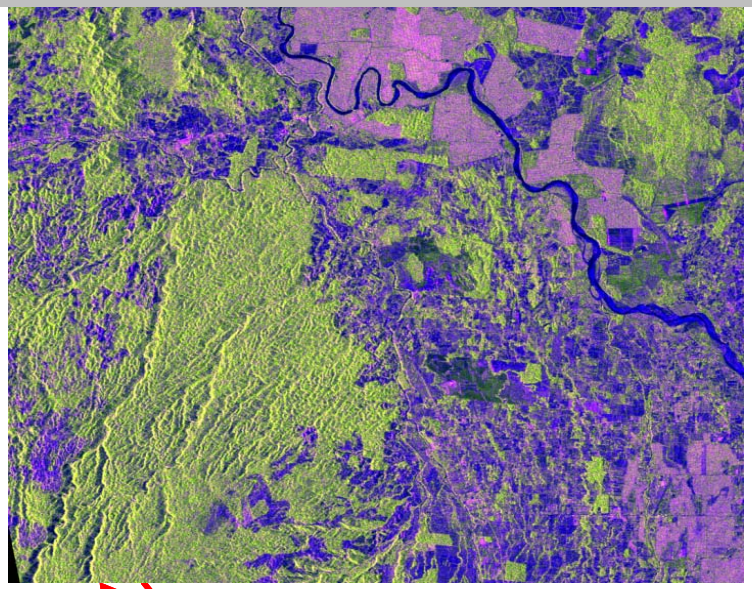


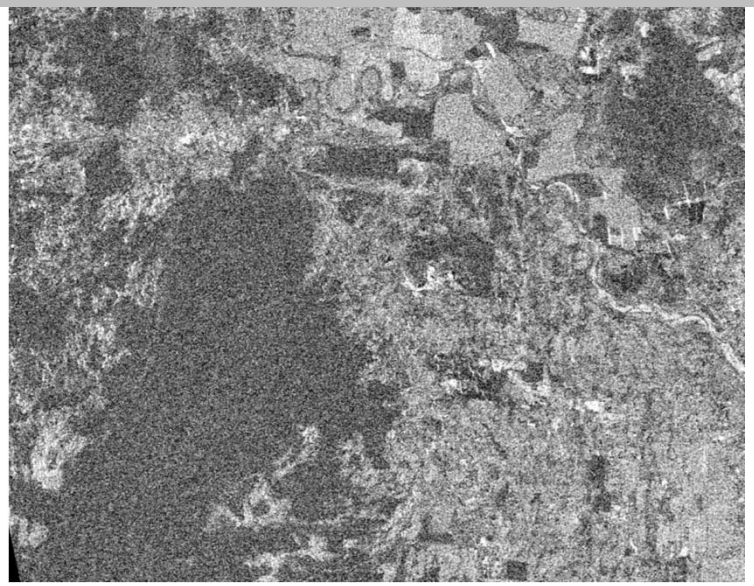
Landsat



Next: PALSAR Radar Forest Degradation Index: Results at K&C20

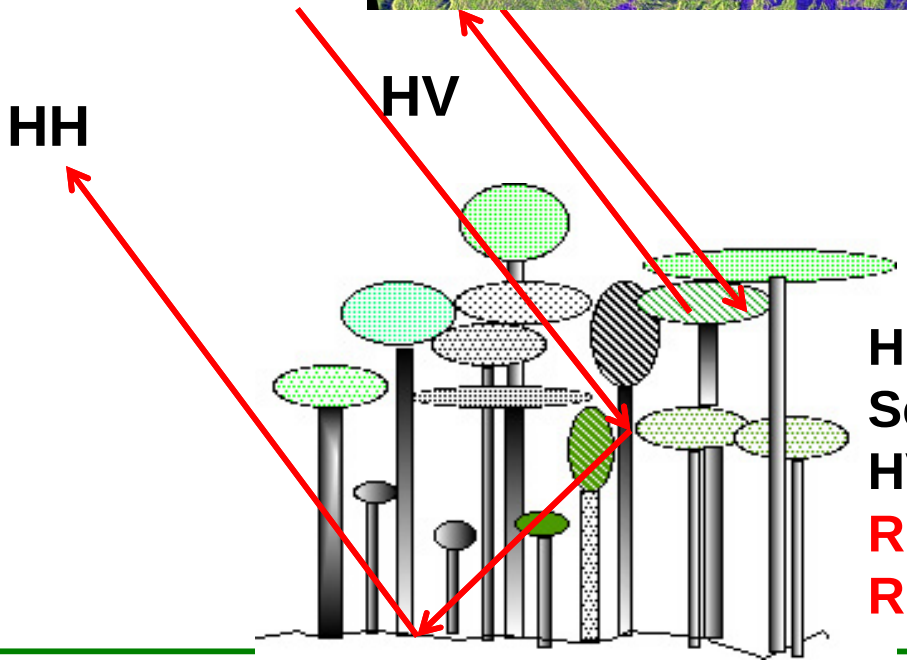
ALOS
La Selva
Costa Rica





RFDI

$$RFDI = \frac{HH - HV}{HH + HV}$$



HH: Dominated by volume & volume-surface Scattering

HV: Dominated by volume scattering

RFDI Sensitivity to calibration is small

RFDI Sensitivity to topography and slope is small

Slide from S. Saatchi

New Opportunity: India Forest Plus

- Partnership for Land Use Science (FOREST-PLUS)
- USAID funded (~15 million USD, 5 year project)
- Team: TetraTech ARD, Applied Geosolutions and MSU
- AGS/MSU Goals: Develop MRV system; demonstration of RS, GIS and field sampling at 4 landscape sites; and training
- Stakeholders in India: MOEF and FSI

India Forest Plus: Initial Scoping Indicates

- FSI desire for SAR capabilities to:
  - support forest carbon,
  - forest loss and degradation mapping and
  - design of field sample plot stratification.
- Opportunity for 4 new landscape sites: different forest types (gradient S to N), FSI field plots
  - Additional field data for validation of JAXA FNF products.
  - Additional field data on forest structure and biomass
  - Demonstration sites for application of PALSAR for REDD+
  - Integration of PALSAR into the MRV system for GOI/FSI
- Additional 25m mosaics to cover 4 landscape demonstration sites India?
- Focus on Phase 4 proposal

Speaking of Phase 4…

- RED to REDD to REDD+ to Landscapes
- Should K&C shift focus from separate topical areas (Forests, Wetlands, rice) to support Landscape GHG Accounting?
- Linking REDD+ and Agriculture]
- UNFCC discussions heading in this direction
- International donors are interested in approaches and tools for landscape level accounting.
- Modeling community moving in this direction….