Beyond Forest Monitoring: New and Emerging Technologies

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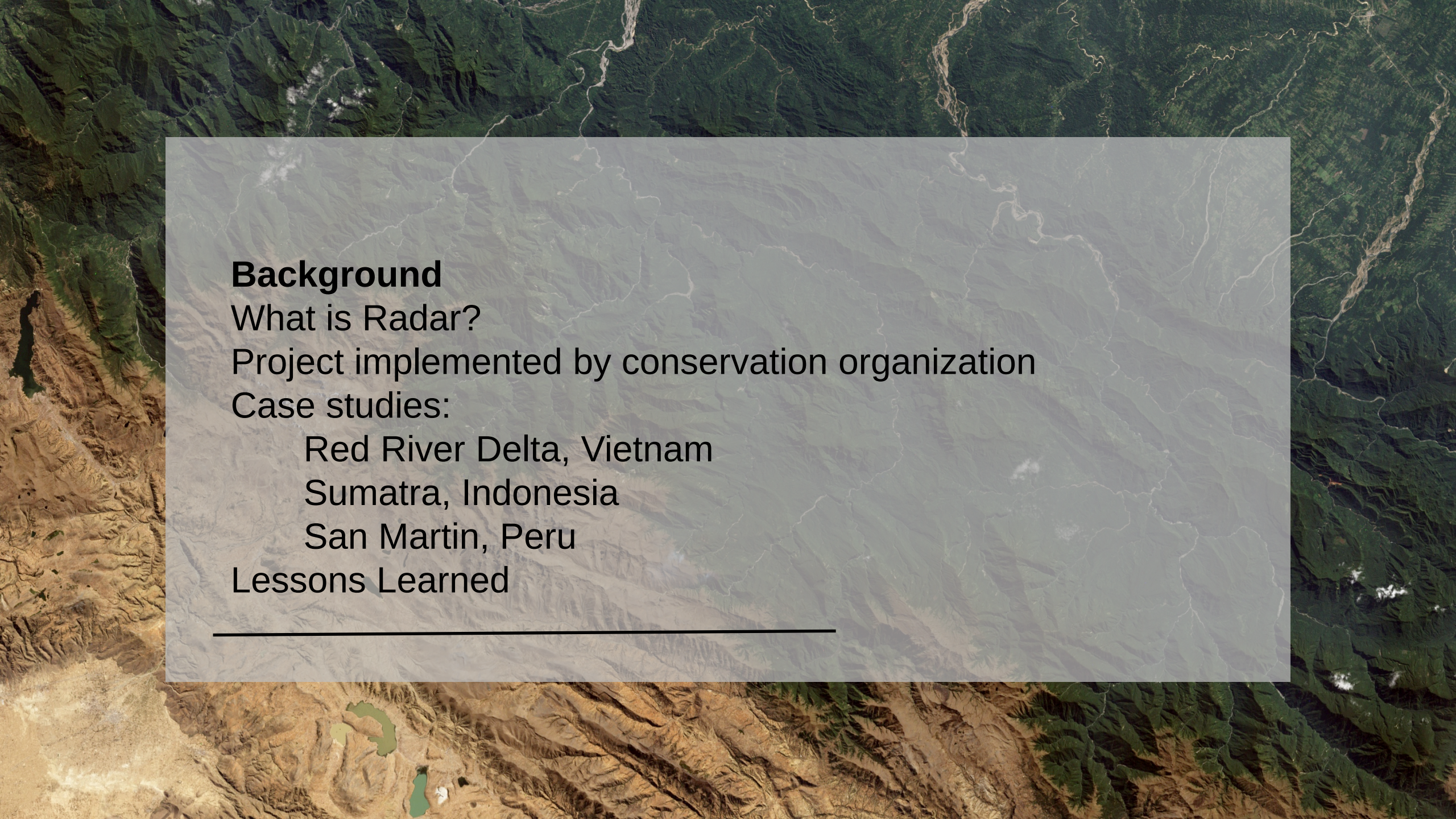


Background

What is Radar?

Project implemented by conservation organization

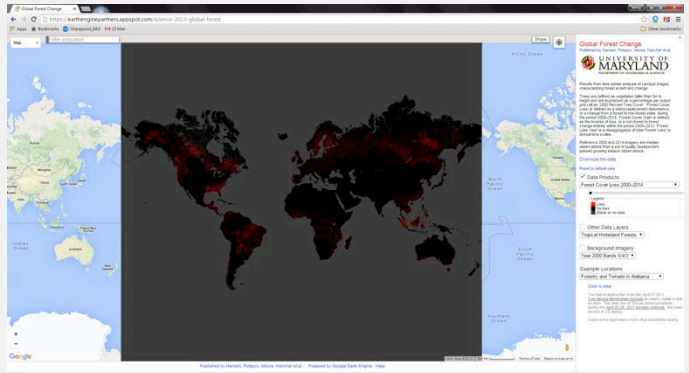
Case studies:

- Red River Delta, Vietnam
- Sumatra, Indonesia
- San Martin, Peru

Lessons Learned

Background

- Operational global products increasingly available
  - Produced systematically
  - Repeatedly
  - Over multiple years (2000-2014)
  - Not an answer to all…a good option



- Flexibility for groups to explore other needs
- Expanding ability to monitor both forest and nonforest habitats
- Standing on the edge of a new frontier in satellite data monitoring

- *Revolutionary time!*

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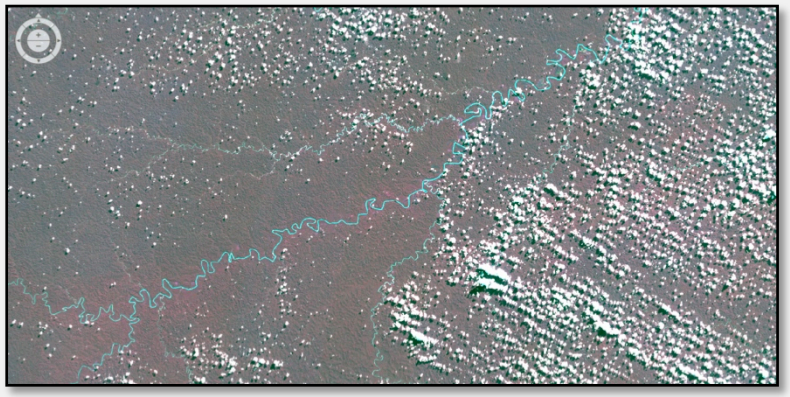
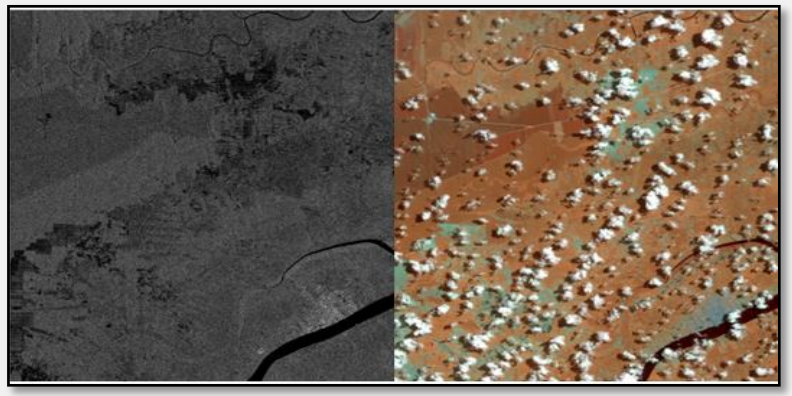
Why not use the same processes/techniques?

- Characteristics of data used for forest monitoring not readily suited to all habitats
- Satellites *see* things on the ground differently
- Clouds – need a way to deal with them
- Continuity of data – need more now
- New satellite recently launched that (1) *sees* things on the ground differently & (2) data are free





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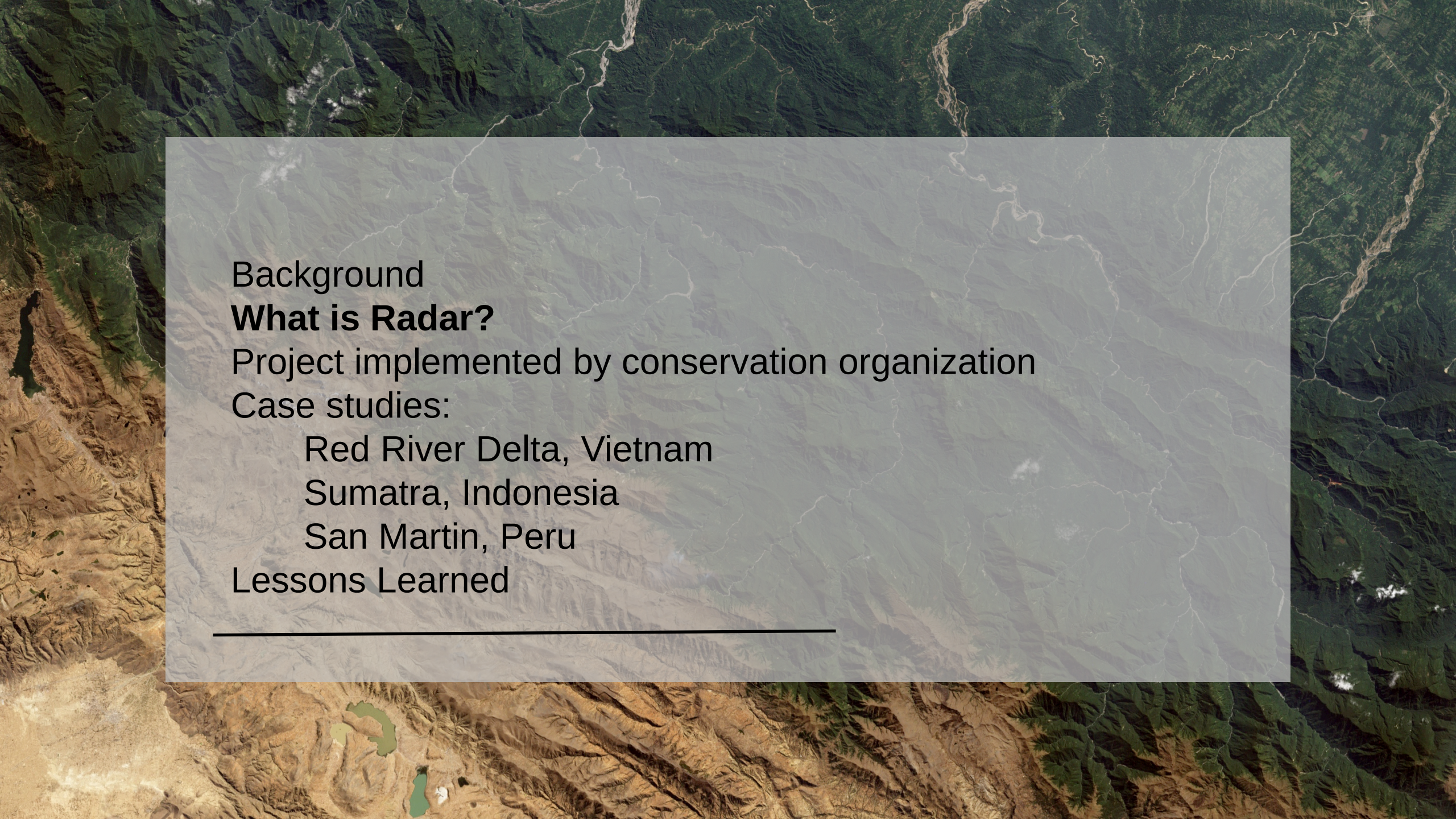

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What is Radar?

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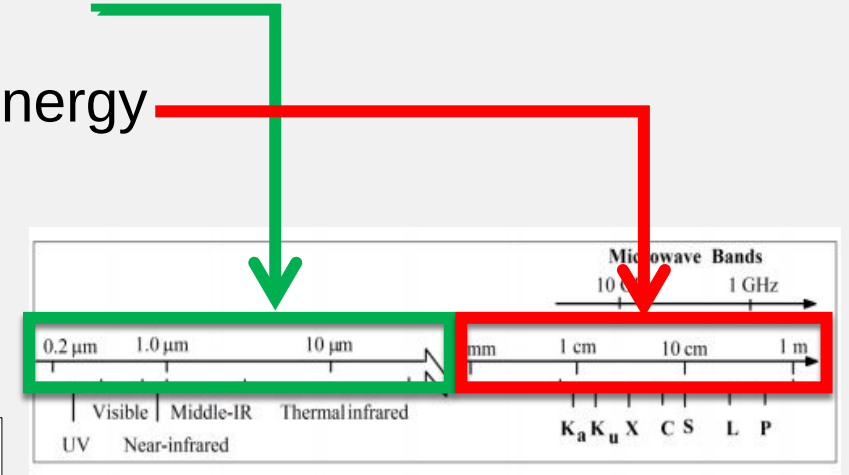
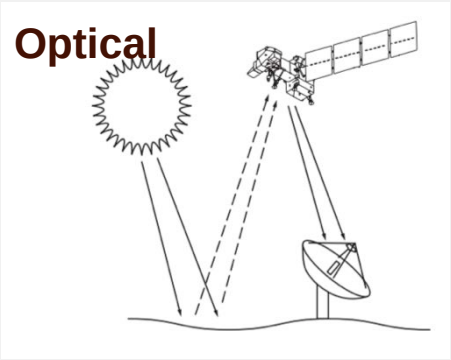
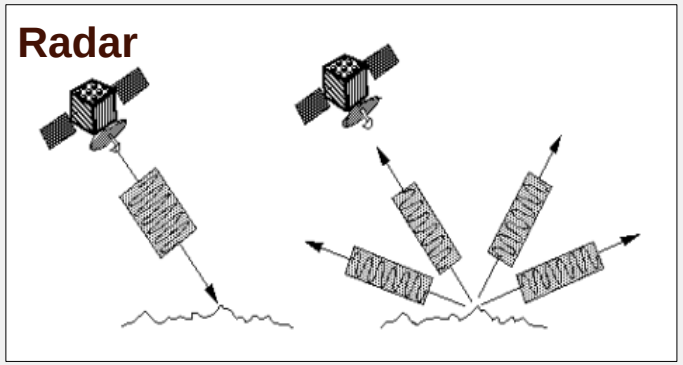
Lessons Learned

What is RADAR?

- “Sees” things on the ground differently
- Optical sensors are passive and ‘collect’ reflected sunlight
- Radar sensors are active → send pulse out, receive pulse back at antenna
- Optical sensors use visible/infrared light
- Radar sensors operate using microwave energy
- NOT a new technology
- April 2014: ESA launched radar satellite
  - First time, data available at NO COST!







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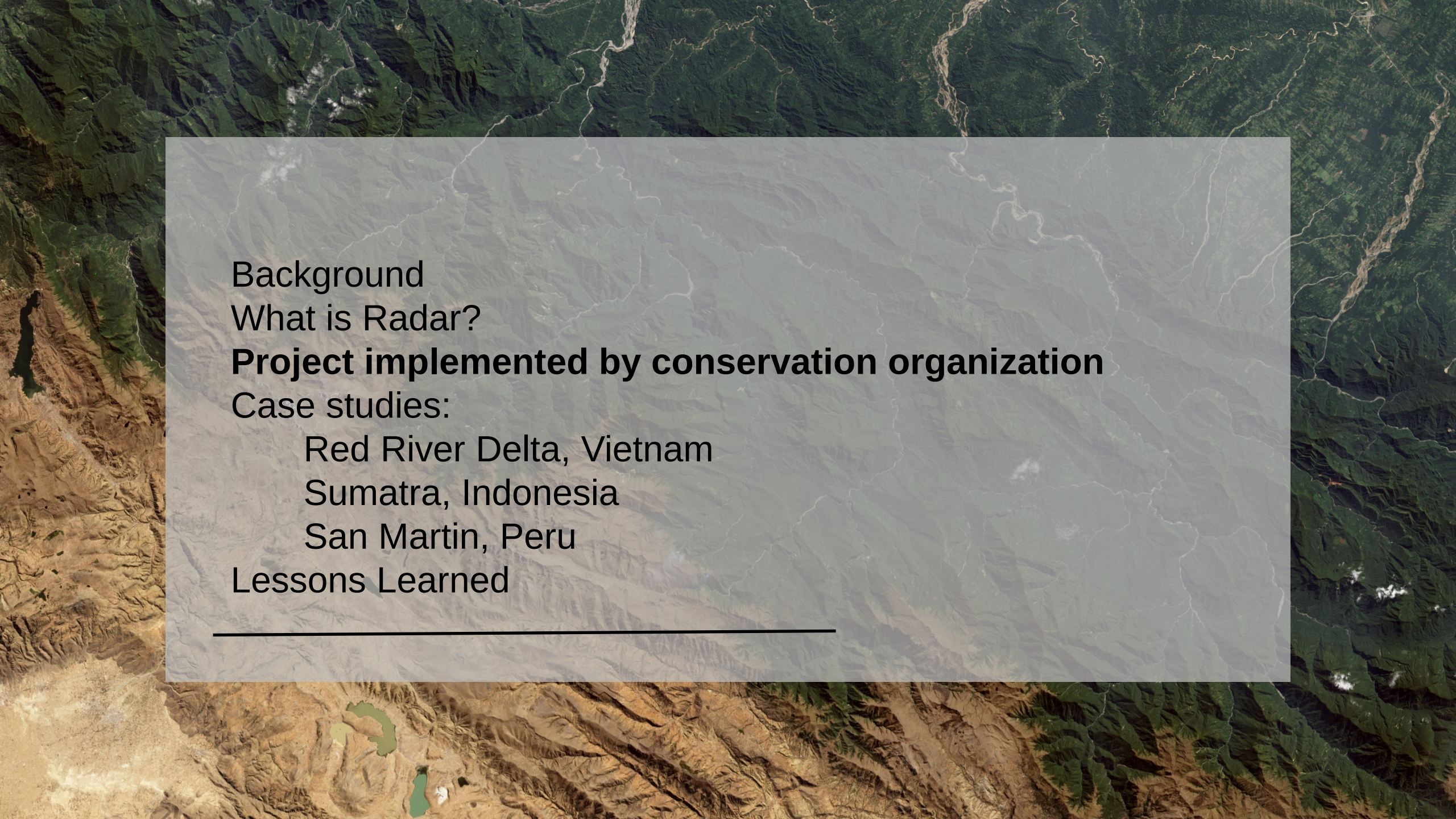

Background
What is Radar?
Project implemented by conservation organization
Case studies:
- Red River Delta, Vietnam
- Sumatra, Indonesia
- San Martin, Peru

Lessons Learned

Project implemented by one conservation organization

- Enlisted expertise of radar partner
- Received capacity building
- Identified a series of case studies
  - All located in key geographies of interest for organization
  - Theme of interest
  - We, or partner, had expertise in area
  - Landscape dynamics → landcover/user characteristics problematic for optical → could be suited to radar
  - Data available
- Explored techniques and methods

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Where were the case studies located?

Location:
Red River Delta, Vietnam
Objective:
Rice mapping/monitoring

Location:
San Martin, Peru
Objective:
LC/U characterization

Location:
E. Sumatra, Indonesia
Objective:
LC/U characterization

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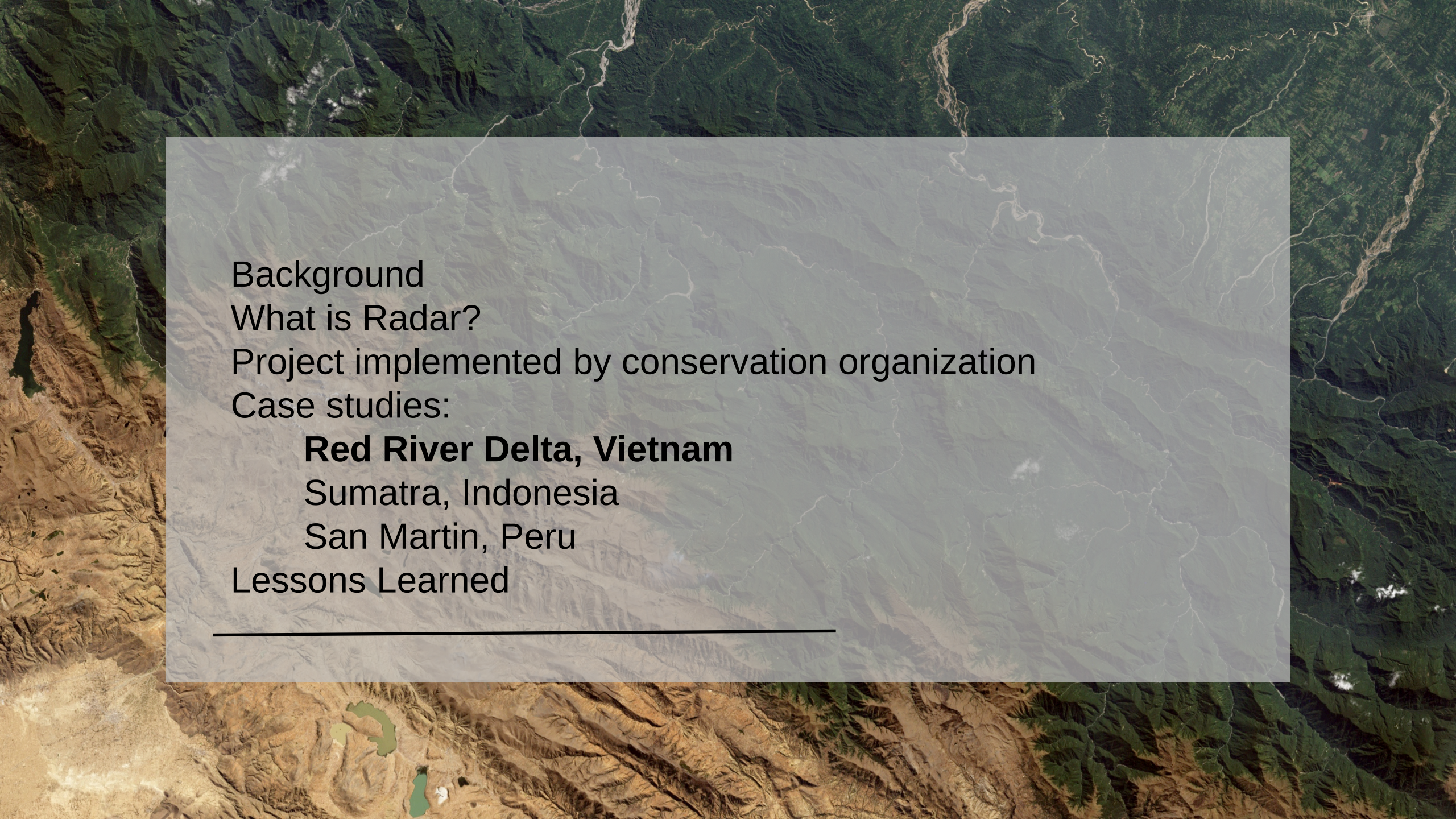

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Lessons Learned

Red River Delta, Vietnam

Objective: Assess rice mapping and monitoring – key to ecosystem service assessments and forecasting rice production to meet demands

Method: Thresholding analysis to separate wet areas from dry areas

- Wet areas in radar images have very low values and are easy to separate
- Frequent imagery (every 2 weeks) in the growing season
- Cloud-free observations
- Rapid analysis for early warning

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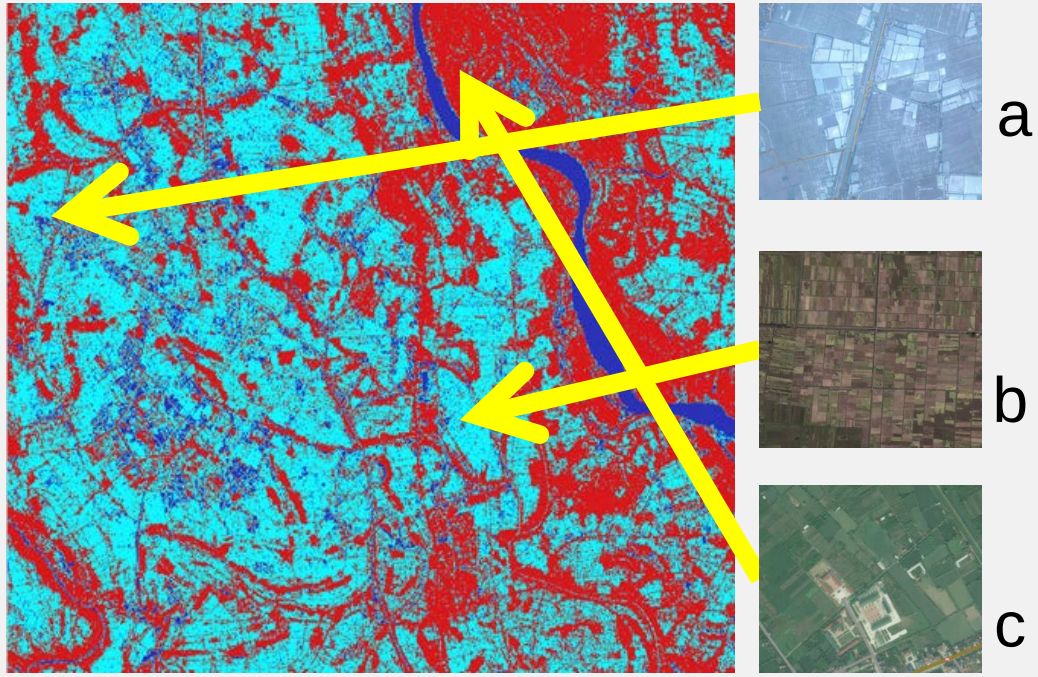
Red River Delta, Vietnam

Results

- Maps of inundation for seven different dates in the wet season (March – July)
- Classified image of inundation duration

Demonstrated quick and easy method for mapping

- Visual check of results with high resolution imagery
- Data can be used as inputs into higher level models



a) Water bodies and flooded rice paddies (5-7 x)
b) Agriculture (3-4 x)
c) Urban, natural vegetation, and plantations (1-2 x)

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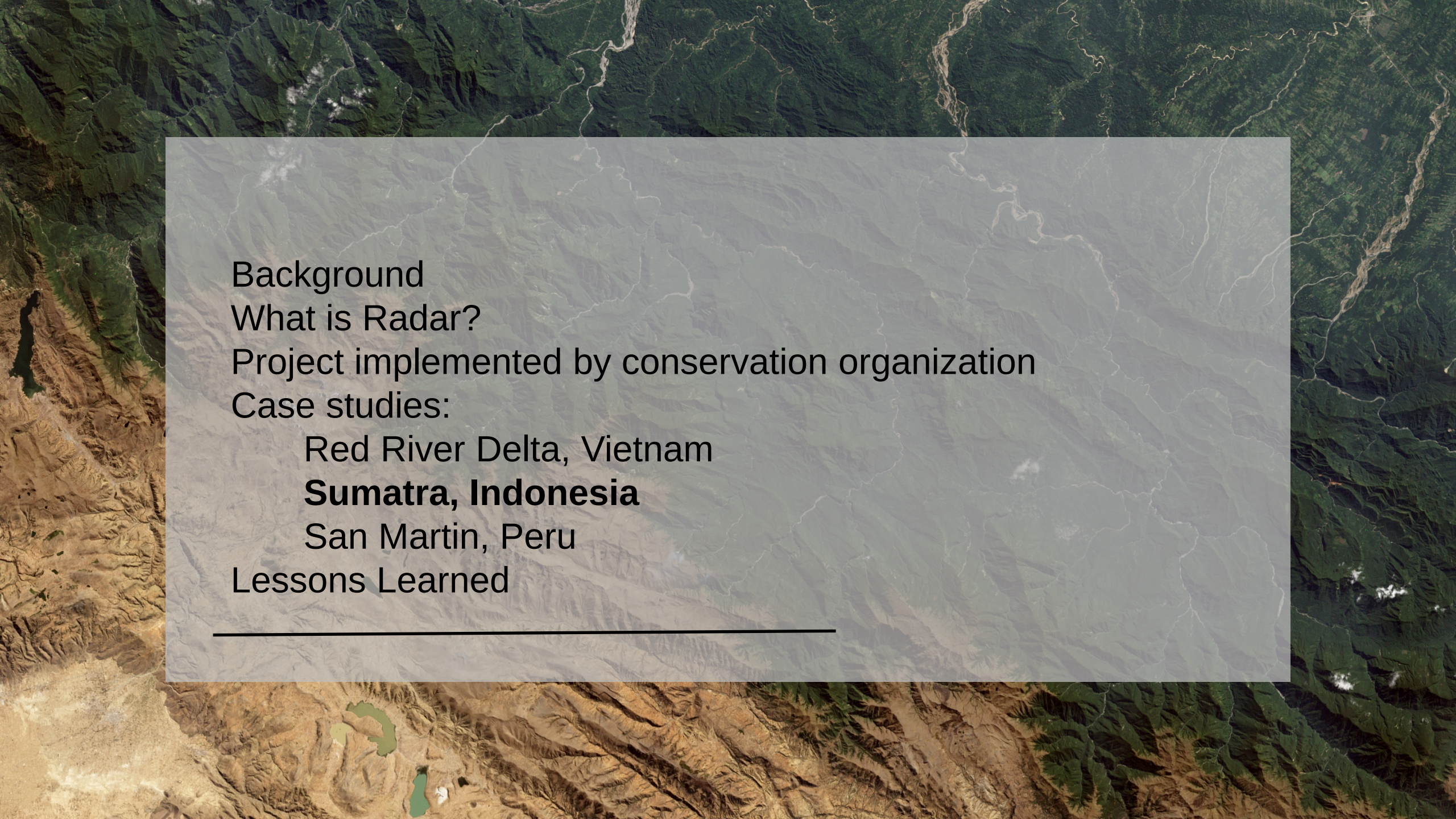

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Lessons Learned

East Sumatra, Indonesia

Objective: to inform land cover/use characterization and facilitate the identification of natural forest, mangrove forest, and oil palm plantations at different growth cycle stages, areas of agriculture, and urban centers

Method: Optical-radar infused classifications

- Natural forest and mature plantations → readily separable using radar
- Mangroves and plantations → readily separable using radar
- Forests and mangroves → readily separable selected optical bands
- Cleared areas → readily separable using radar (appearing very dark)
- Exploiting and combining optical/radar characteristics may yield enhanced land cover/use classification

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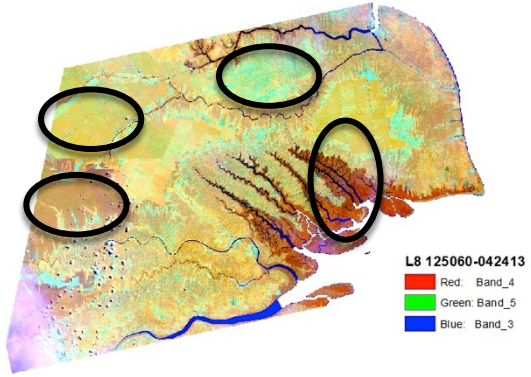
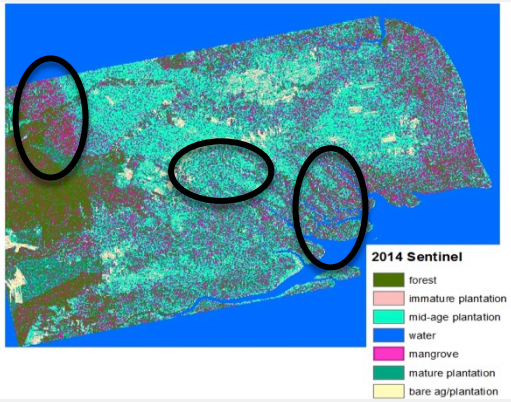
East Sumatra, Indonesia

Results

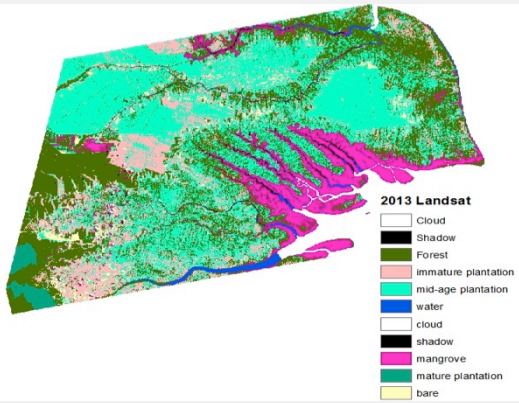
- Combination of radar and optical data improved differentiation of land cover/use classes
- Separation of oil palm plantations at different growth cycle stages (immature, mid-age, and mature)
- Separation of mature plantation and mangroves
- Captured deforestation, plantation clearance, agricultural rotation



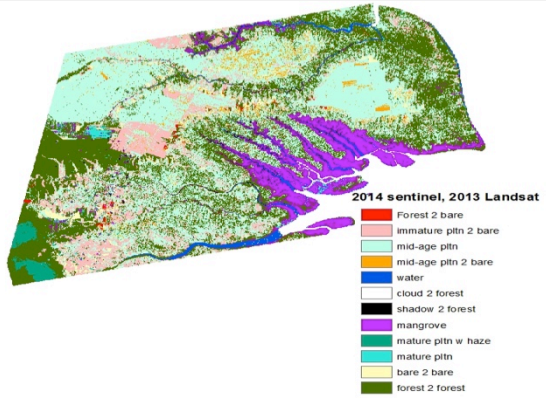
Optical image, 2013



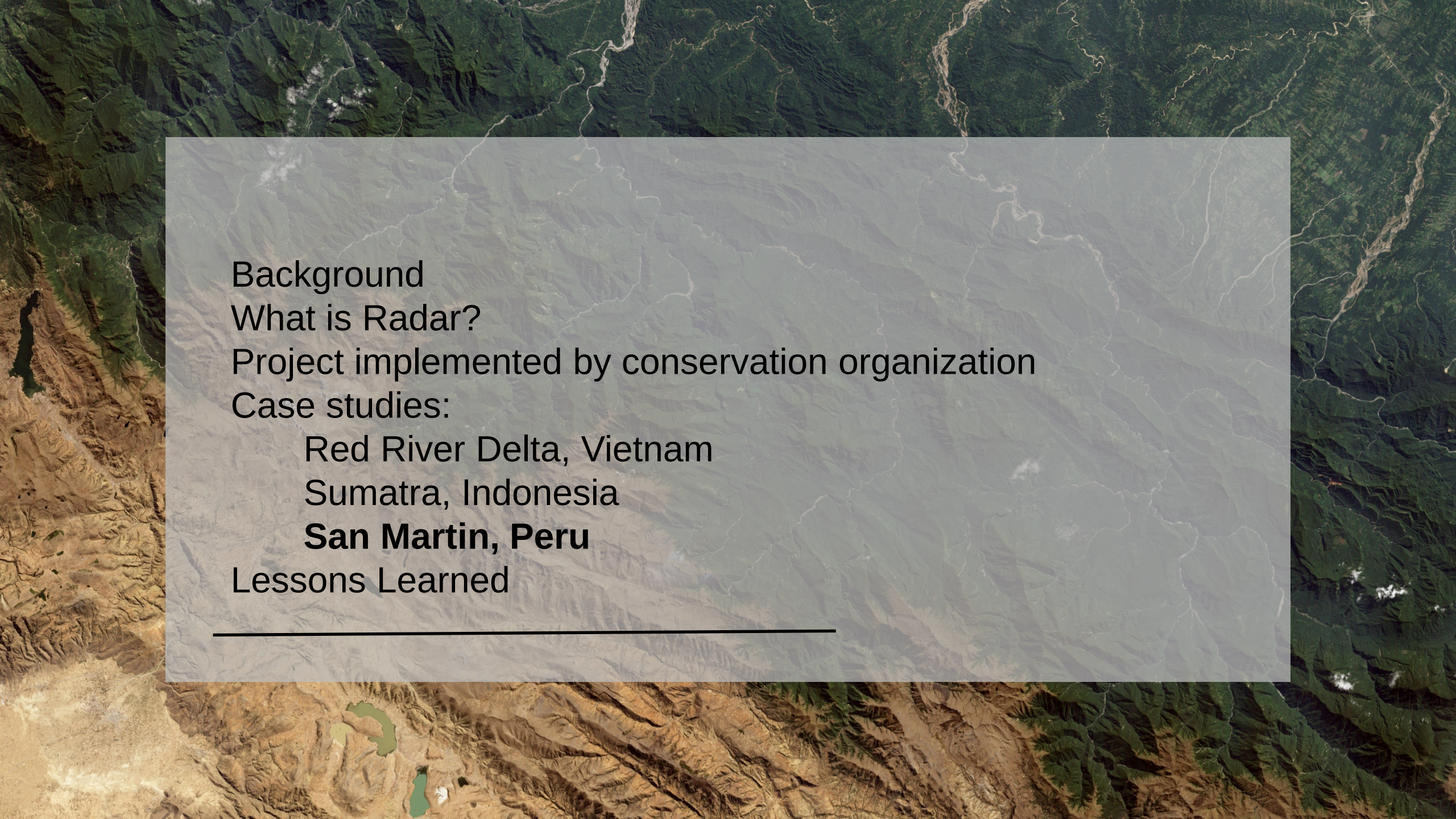
Radar-only
Misclassification of mangrove, plantation, forest



Optical-only
Improvement over radar-only but…confusion:
mangrove → mature plantation,
natural forest → mature plantation



Radar-optical infused
Most improvement:
mature plantation and mangroves separated; deforestation, plantation clearance, agricultural rotation captured



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Lessons Learned

San Martin Region, Perú

Objective: to assess how much information can be derived from specific radar images for mapping diverse land-uses in rapidly changing geographies with limited optical imagery available

Method: Radar data mining techniques

- Multi-image time series → 11 images from 2015
- Batch processing → models to pre-process large data volumes
- Image smoothing → leveraged time series to reduce image *noise*
- Texture analysis → exploits relationship between neighboring pixel measurements
- Principal Component Analysis (PCA) → statistical procedure; convert potentially correlated variables into uncorrelated variables (PCs)

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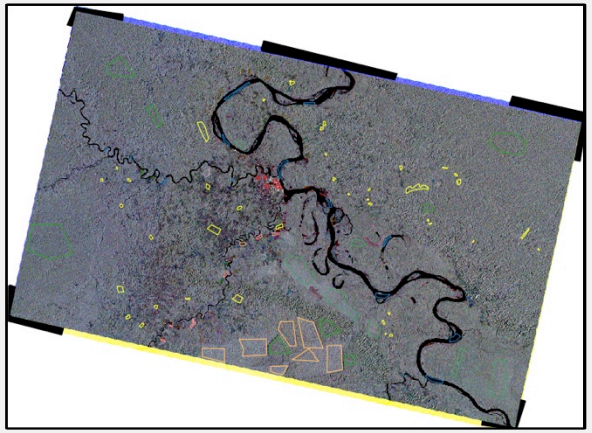
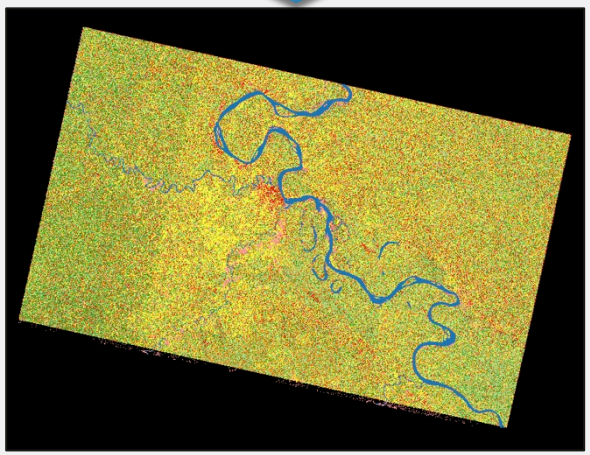
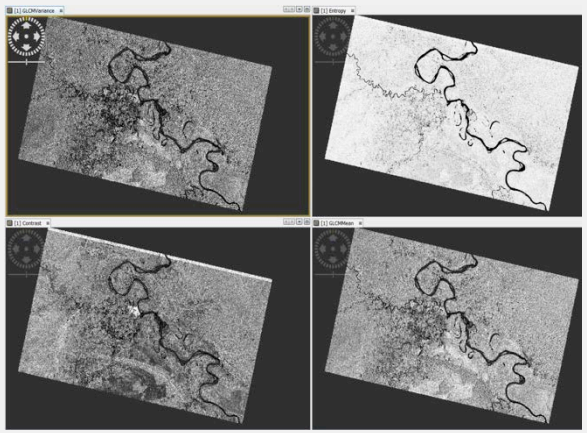
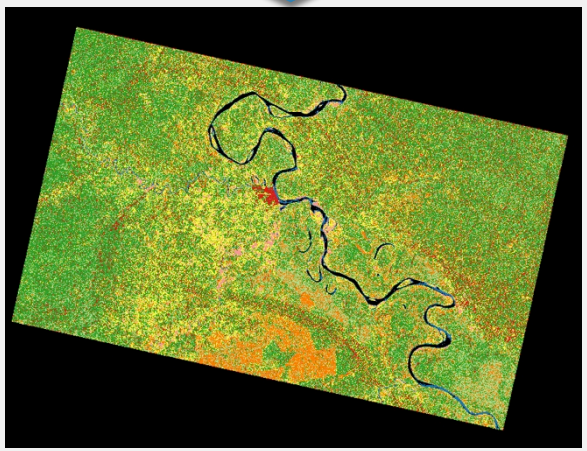
San Martin Region, Perú



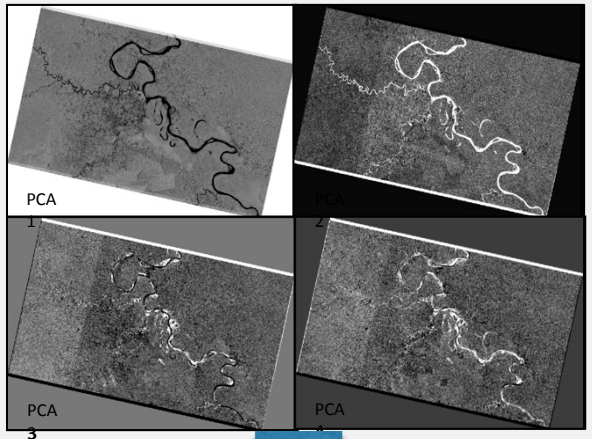


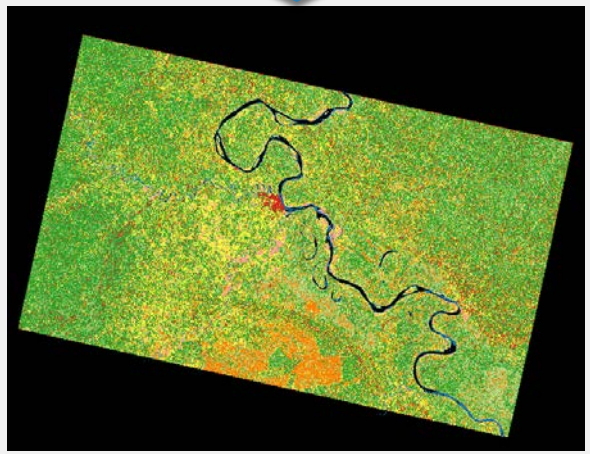
Training data overlaid on 11 image stack, 2015



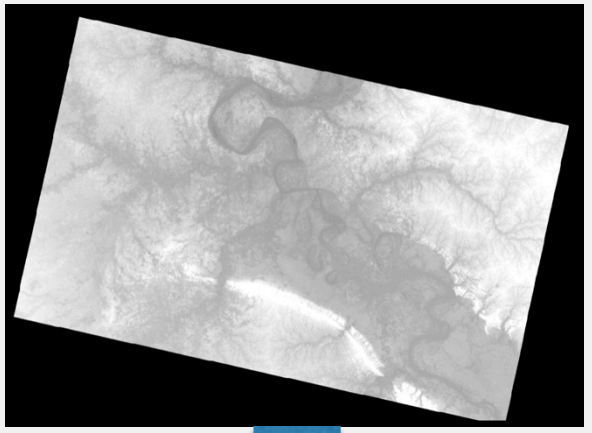


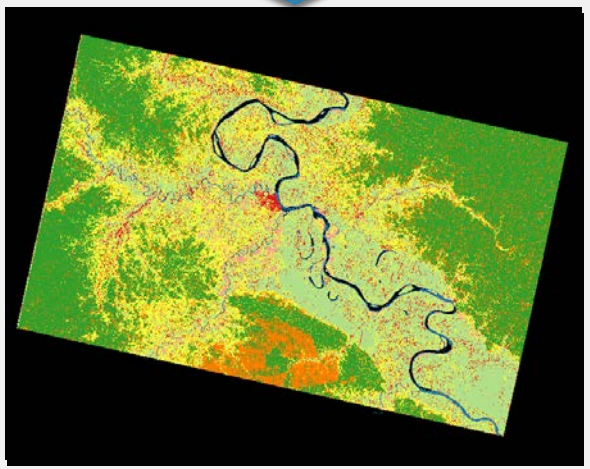
Radar images with texture anal ysis- improved differentiation b etween classes



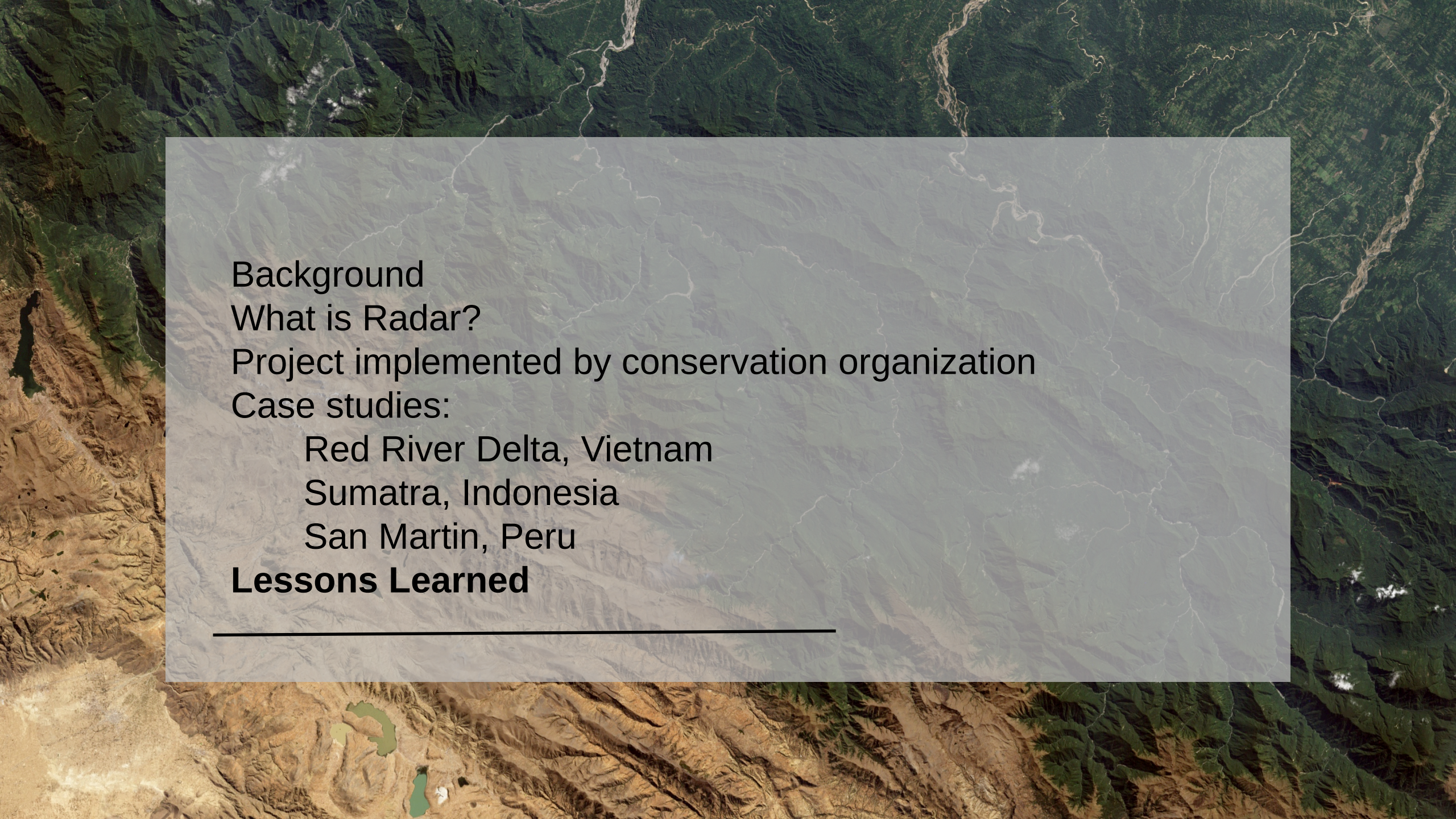


Radar mages with texture analy sis and PCA –PCA provides limited additional information





Radar mages with texture analy sis, PCA and elevation. Promis ing results



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Lessons Learned

Lessons Learned

- Radar improved land use discrimination
- Frequent image collection means many more *looks*
- Particularly helpful in cloudy areas

Limitations…

- Requires intensive data preprocessing
- Learning curve to work with radar imagery
- Implications in terms of hardware and software
- Some limitations exist

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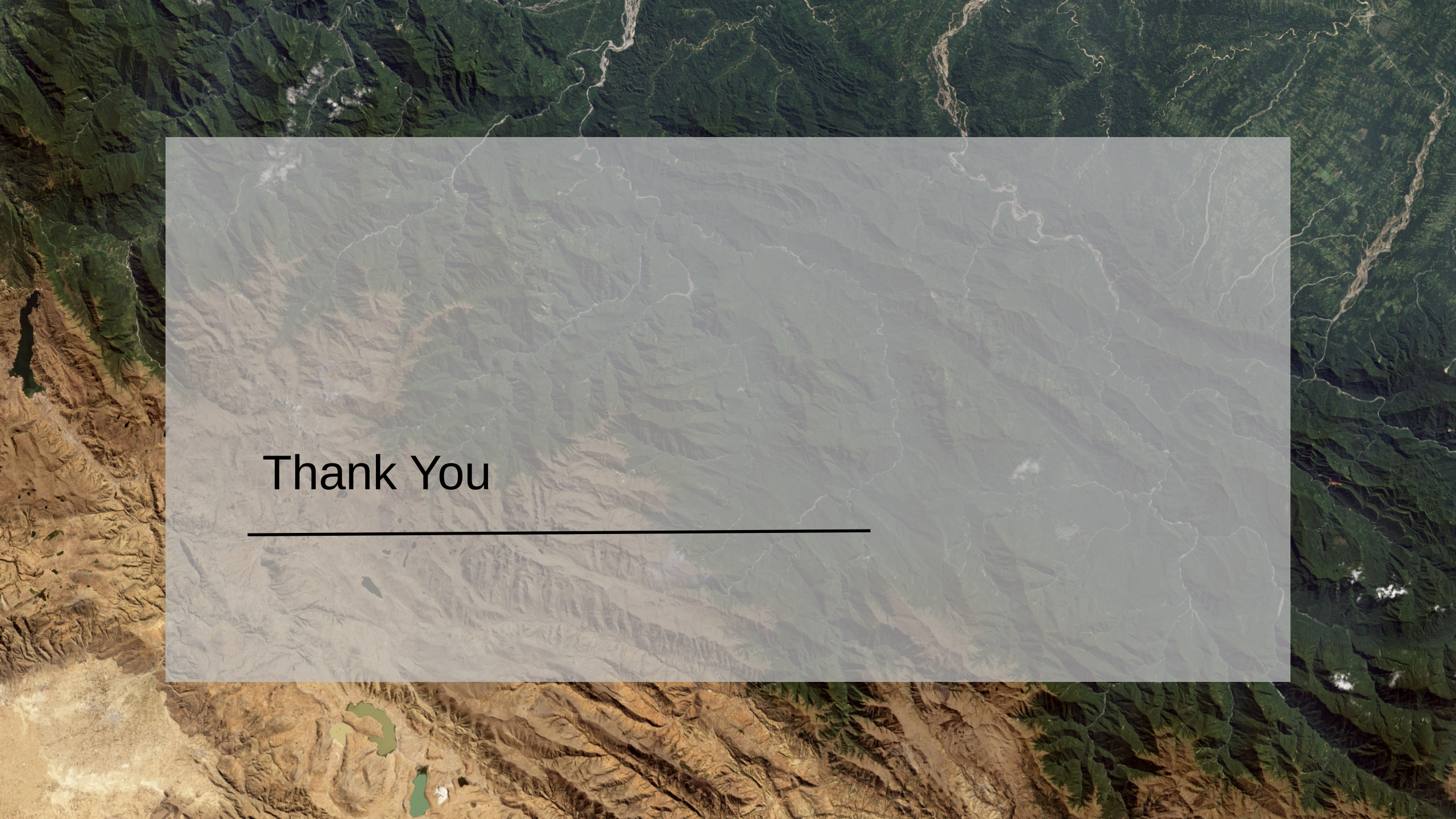
Thank You