

Beyond Forest Monitoring: New and Emerging Technologies

- Last edited: August 31st, 2016

An aerial photograph of a mountainous region. The terrain is rugged with deep valleys and ridges. A prominent river valley runs through the center, with a river visible. The mountains are covered in dense green forest, while the lower elevations and valleys are more brownish and appear to be less vegetated. A semi-transparent grey rectangular box is overlaid on the center of the image, containing text.

Background

What is Radar?

Project implemented by conservation organization

Case studies:

Red River Delta, Vietnam

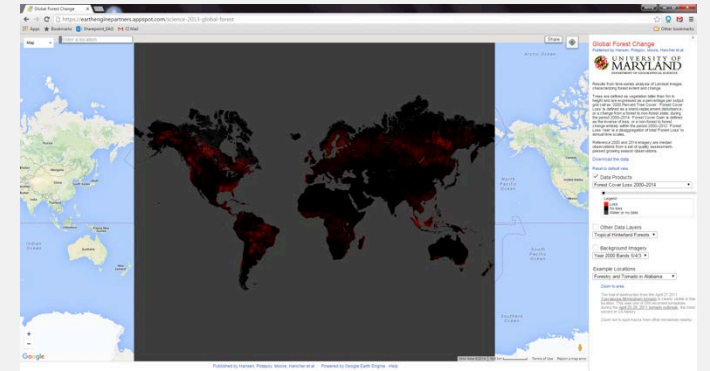
Sumatra, Indonesia

San Martin, Peru

Lessons Learned

Background

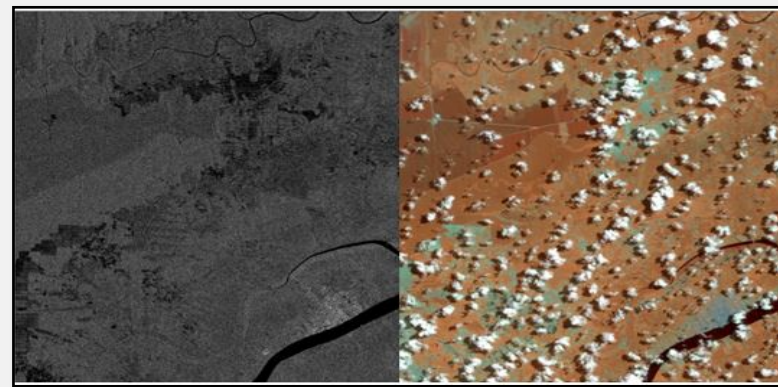
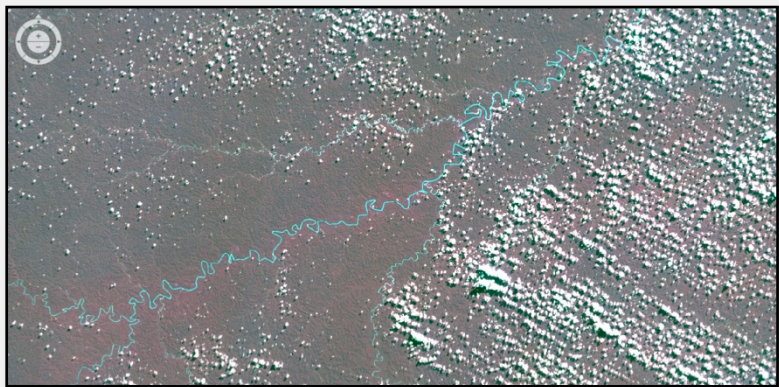
- Operational global products increasingly available
 - Produced systematically
 - Repeatedly
 - Over multiple years (2000-2014)
 - Not an answer to all...a good option



- 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!*

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



An aerial photograph of a mountain range, showing a mix of green forested peaks and brown, rocky terrain. A semi-transparent grey rectangular box is overlaid on the center of the image, containing text. The text is in a clean, black, sans-serif font. The background image shows a complex network of ridges and valleys, with some snow-capped peaks visible in the distance.

Background

What is Radar?

Project implemented by conservation organization

Case studies:

Red River Delta, Vietnam

Sumatra, Indonesia

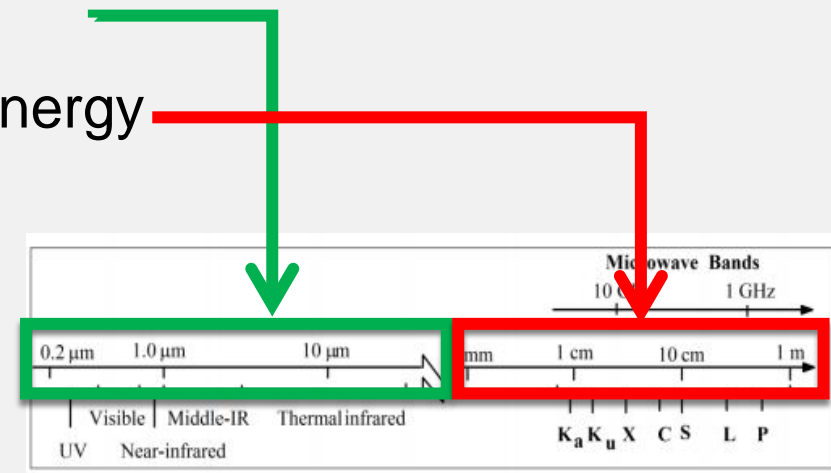
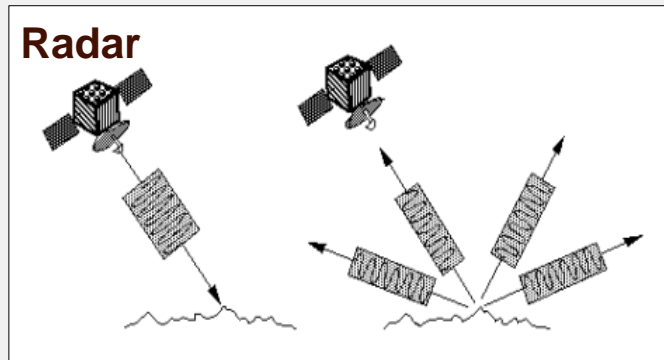
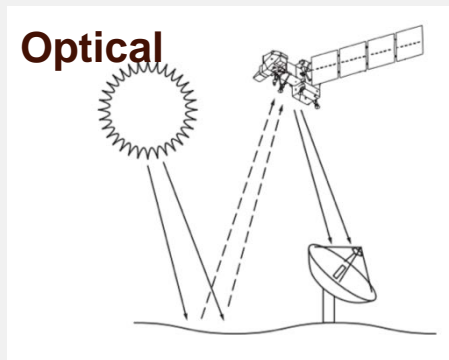
San Martin, Peru

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!



An aerial photograph of a mountainous region. The top half shows lush green mountains with a river valley. The bottom half shows brown, eroded mountains with small green lakes. A semi-transparent grey box is overlaid on the center, containing text.

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

Where were the case studies located?



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

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

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



An aerial photograph of a mountainous region. The terrain is rugged with deep valleys and ridges. A river valley is visible on the right side, with a river winding through it. The mountains are covered in dense green forest. In the lower-left corner, there is a brownish, rocky area with some small green ponds. A semi-transparent grey rectangular box is overlaid on the center of the image, containing text.

Background

What is Radar?

Project implemented by conservation organization

Case studies:

Red River Delta, Vietnam

Sumatra, Indonesia

San Martin, Peru

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



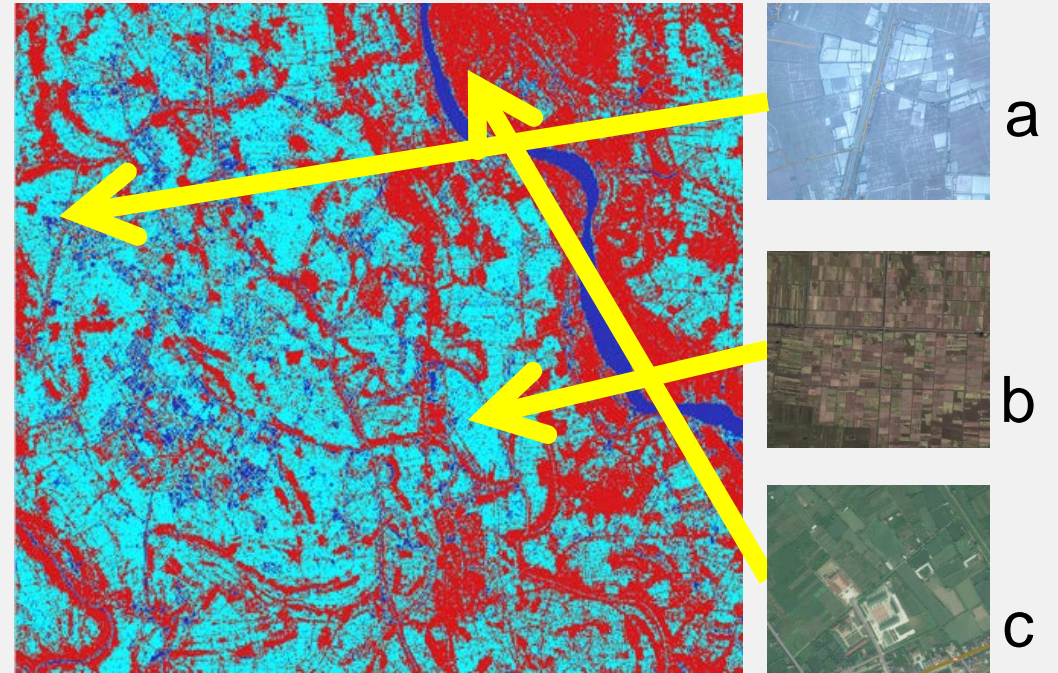
Red River Delta, Vietnam

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)

An aerial photograph of a mountainous landscape. The foreground shows a brown, eroded hillside with a small green pond. The middle ground is a semi-transparent grey box containing text. The background is a vast, green mountain range with a winding river valley.

Background

What is Radar?

Project implemented by conservation organization

Case studies:

Red River Delta, Vietnam

Sumatra, Indonesia

San Martin, Peru

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

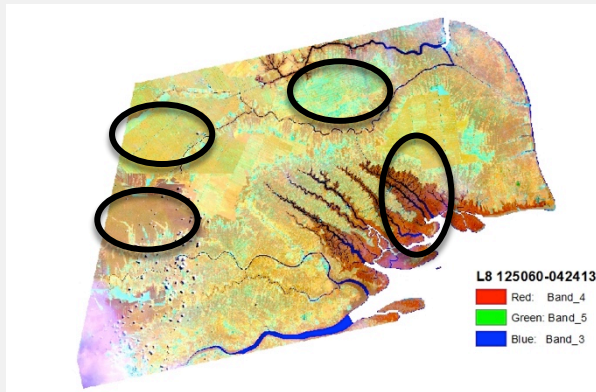
Method: Optical-radar infused classifications

- 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

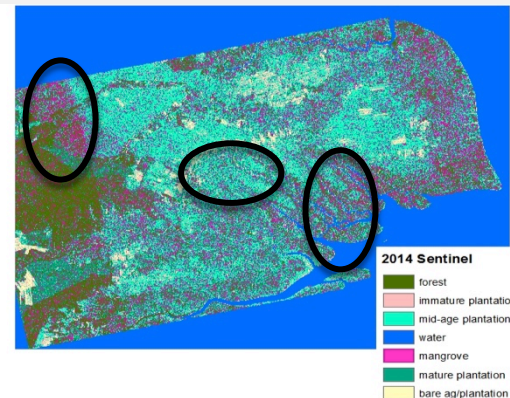
East Sumatra, Indonesia

Results

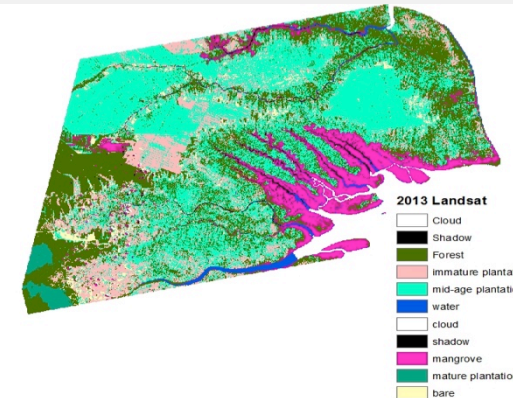
- Combination of radar and optical data improved differentiation of land cover/use classes
- Separation of oil palm plantations at different growth cycle stages (immature, mid-age, and mature)
- Separation of mature plantation and mangroves
- Captured deforestation, plantation clearance, agricultural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



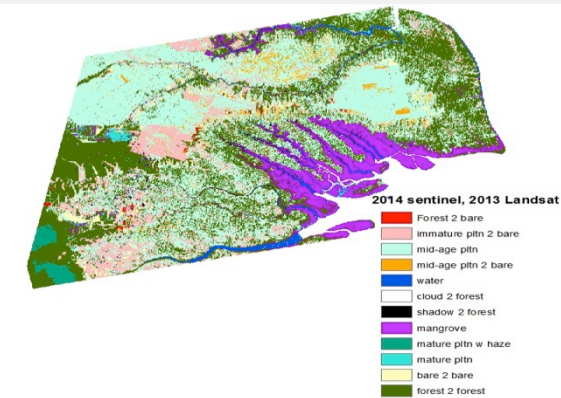
Optical image, 2013



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

An aerial photograph of a mountain range, showing rugged terrain with green vegetation on the peaks and brownish soil in the valleys. A semi-transparent grey rectangular box is overlaid on the center of the image, containing a list of topics. The text is in a clean, black, sans-serif font.

Background

What is Radar?

Project implemented by conservation organization

Case studies:

Red River Delta, Vietnam

Sumatra, Indonesia

San Martin, Peru

Lessons Learned



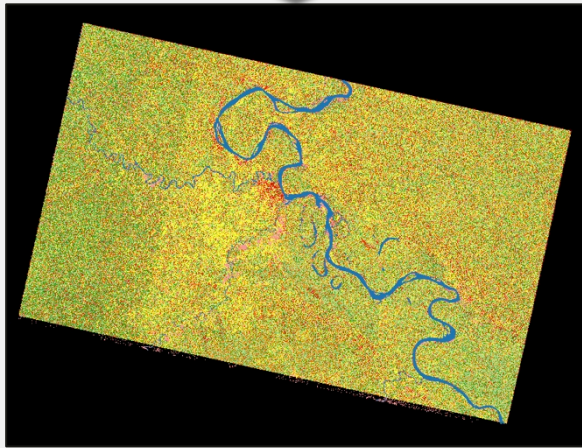
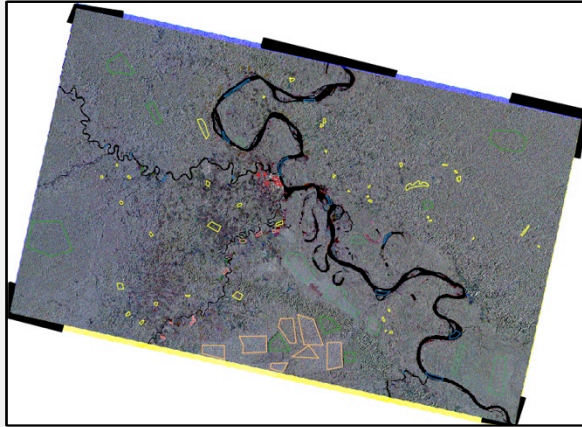
San Martin Region, Perú

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

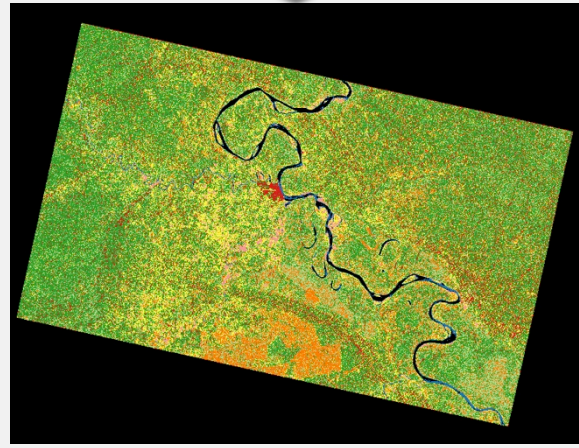
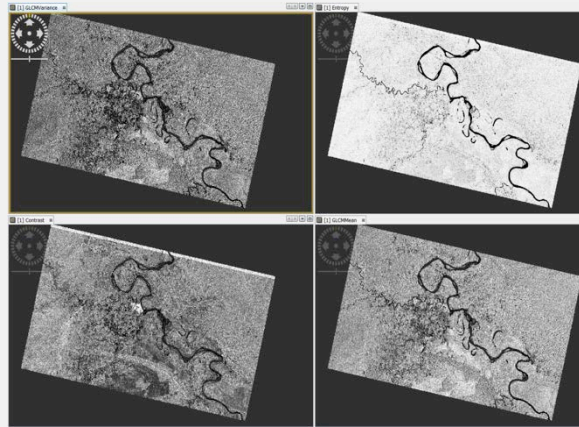
Method: Radar data mining techniques

- 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)

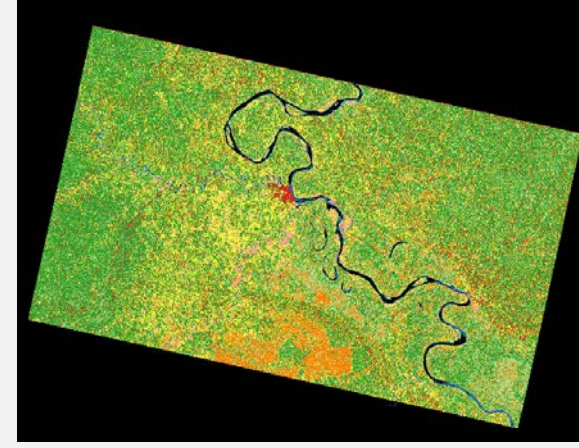
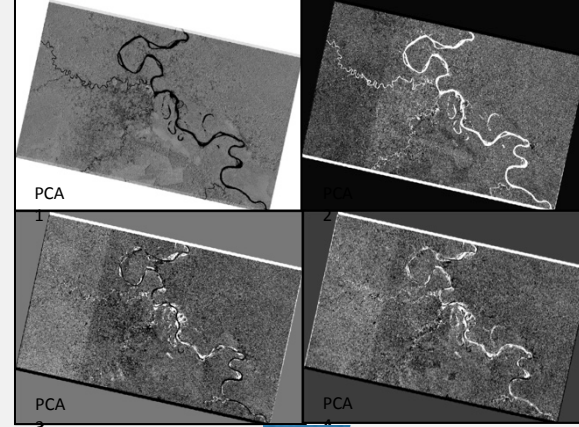
San Martin Region, Perú



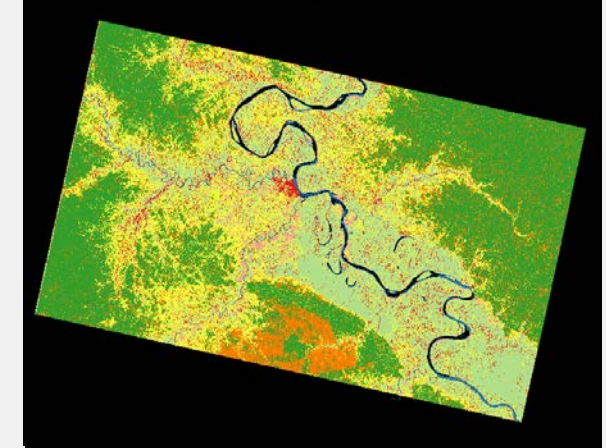
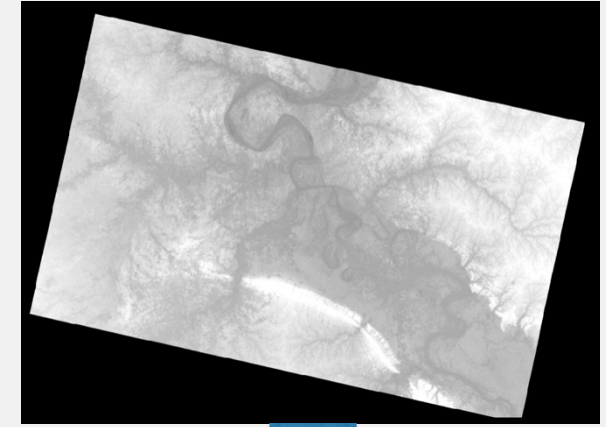
Training data overlaid on 11 image stack, 2015



Radar images with texture analysis- improved differentiation between classes



Radar images with texture analysis and PCA –PCA provides limited additional information



Radar images with texture analysis, PCA and elevation. Promising results

An aerial photograph of a mountainous region. The top half shows lush green mountains with a river valley. The bottom half shows brown, eroded mountains with small green lakes. A semi-transparent grey text box is overlaid on the center.

Background

What is Radar?

Project implemented by conservation organization

Case studies:

Red River Delta, Vietnam

Sumatra, Indonesia

San Martin, Peru

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

An aerial photograph of a mountain range. The foreground shows rugged, brownish-tan terrain with some small green lakes. The middle ground is dominated by a large, semi-transparent grey rectangular overlay that covers most of the mountain range. The background shows lush green forested mountains with winding rivers and some snow patches.

Thank You
