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AI-ForestWatch: AI-based Forest Monitoring and Change Detection

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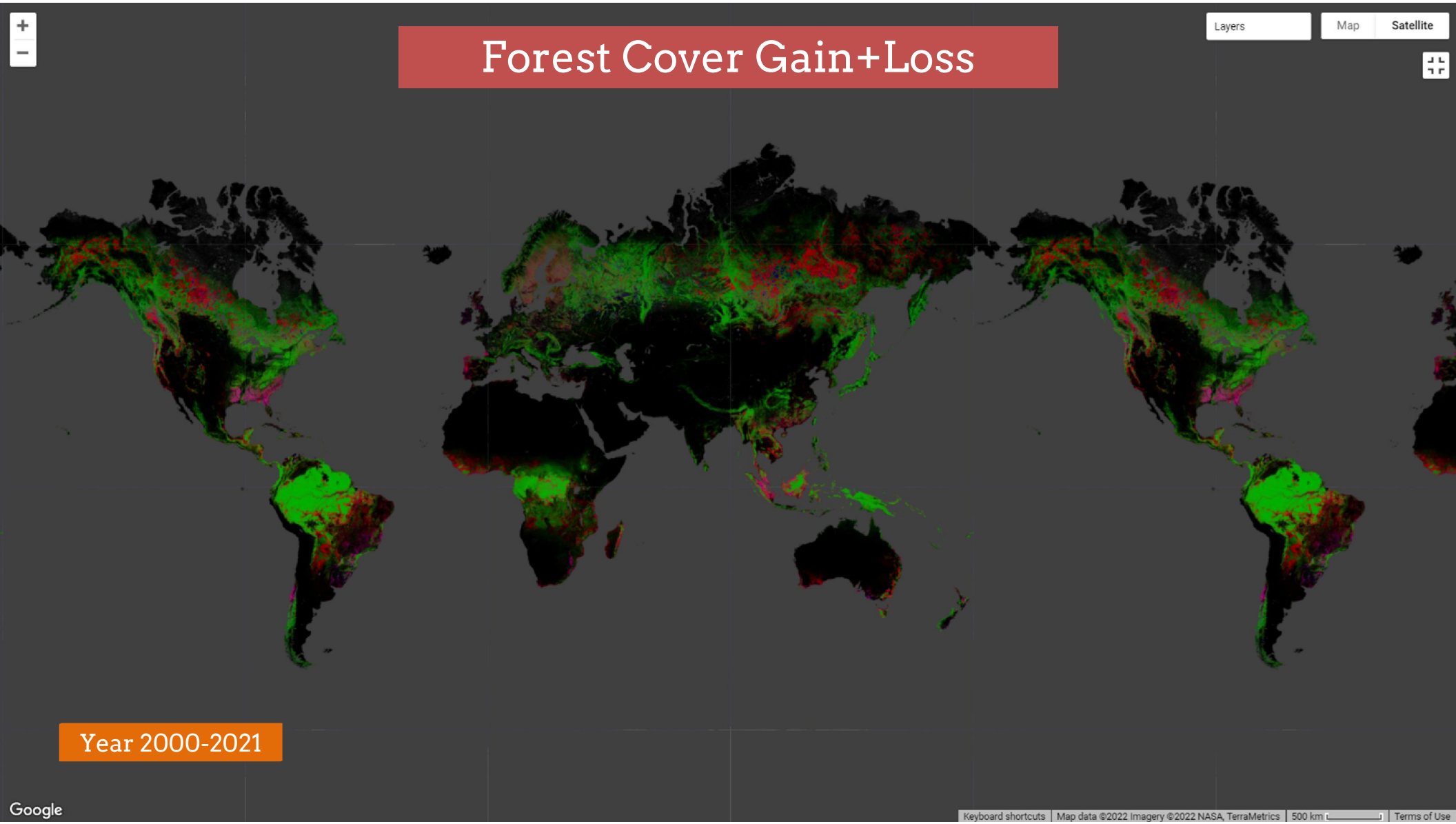
Presentation Outline

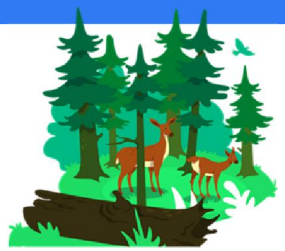
TOPICS FOR TODAY

- ➔ **Introduction**
- ➔ AI-ForestWatch
- ➔ Results
- ➔ Conclusion


Forest Cover Gain+Loss
Layers
Map
Satellite
Year 2000-2021
Google
Keyboard shortcuts
Map data ©2022 Imagery ©2022 NASA, TerraMetrics
500 km
Terms of Use

Increased Wildfires

Loss of Biodiversity



Increased Flooding

Deforestation

Natural Calamities

Global Warming

Expected Droughts

Negative Impacts of Deforestation

From 2001 to 2023, Pakistan lost **9.94 kha** of tree cover, equivalent to a **1.0% decrease in tree cover** since 2000. **4.1%** of tree cover loss has resulted in **Deforestation**

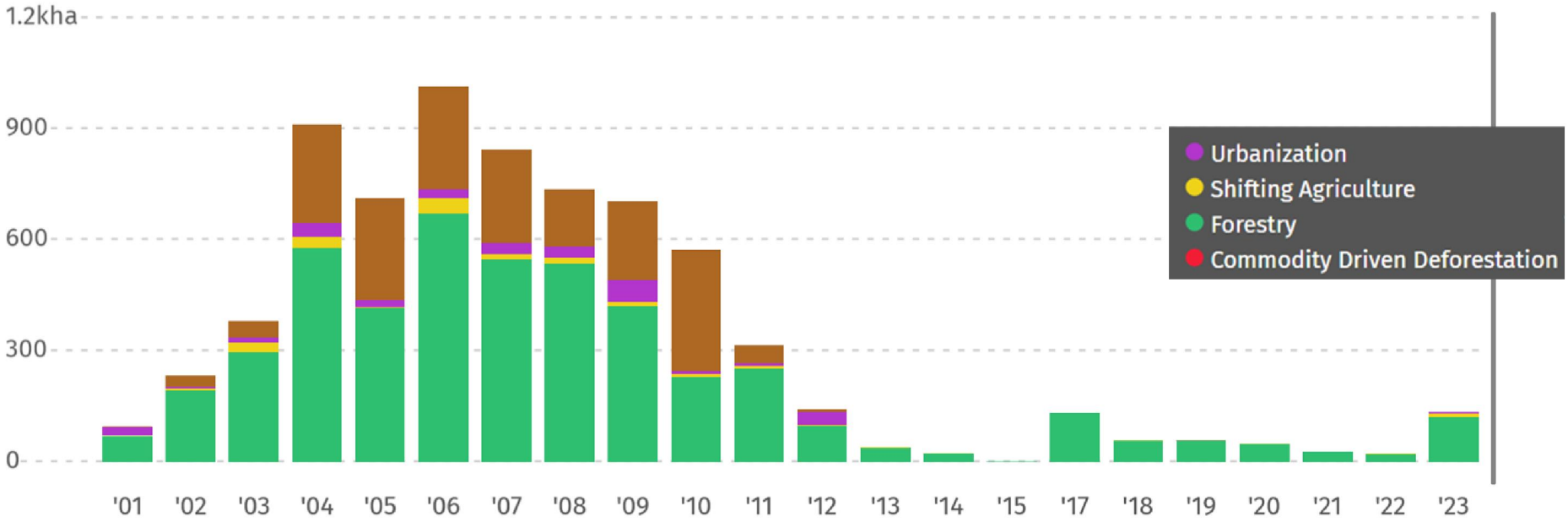


Figure 1. ***Distribution represents ANNUAL TREE COVER LOSS from year 2001 to 2023***

Source: [Pakistan Deforestation Rates & Statistics | GFW (globalforestwatch.org)]

Afforestation Efforts in Pakistan:

BTAP Project

- Government of Khyber Pakhtunkhwa launched the **Billion Tree Afforestation Project (BTAP)** in 2014 under the Bonn Challenge.
- The key goals of this project were:
  - **Increase area** of forests by two percent.
  - **Increase density** of degraded forests by closure against grazing and fire.
  - **Enhancement** of forest resource base, **rehabilitation** and **improvement** of existing **forest ecosystems**.

Primary BTAP Regions

Dera Ismail Khan
Bannu
Kohat
Peshawar
Mardan
Haripur
Gallies
Kaghan

Hazara Tribal
Malakand
Buner
Lower Dir
SwatKalam
Upper Dir
Dir Kohistan
Chitral

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Existing Monitoring Frameworks:

Global Forest Watch

- **Initiative** for **Forest Change Monitoring**.
- Latest data, technology and tools that empower people everywhere **to protect forests better.**
- **Analyze** forest change and investigate **trends** in tree **cover loss.**

Existing Monitoring Frameworks:

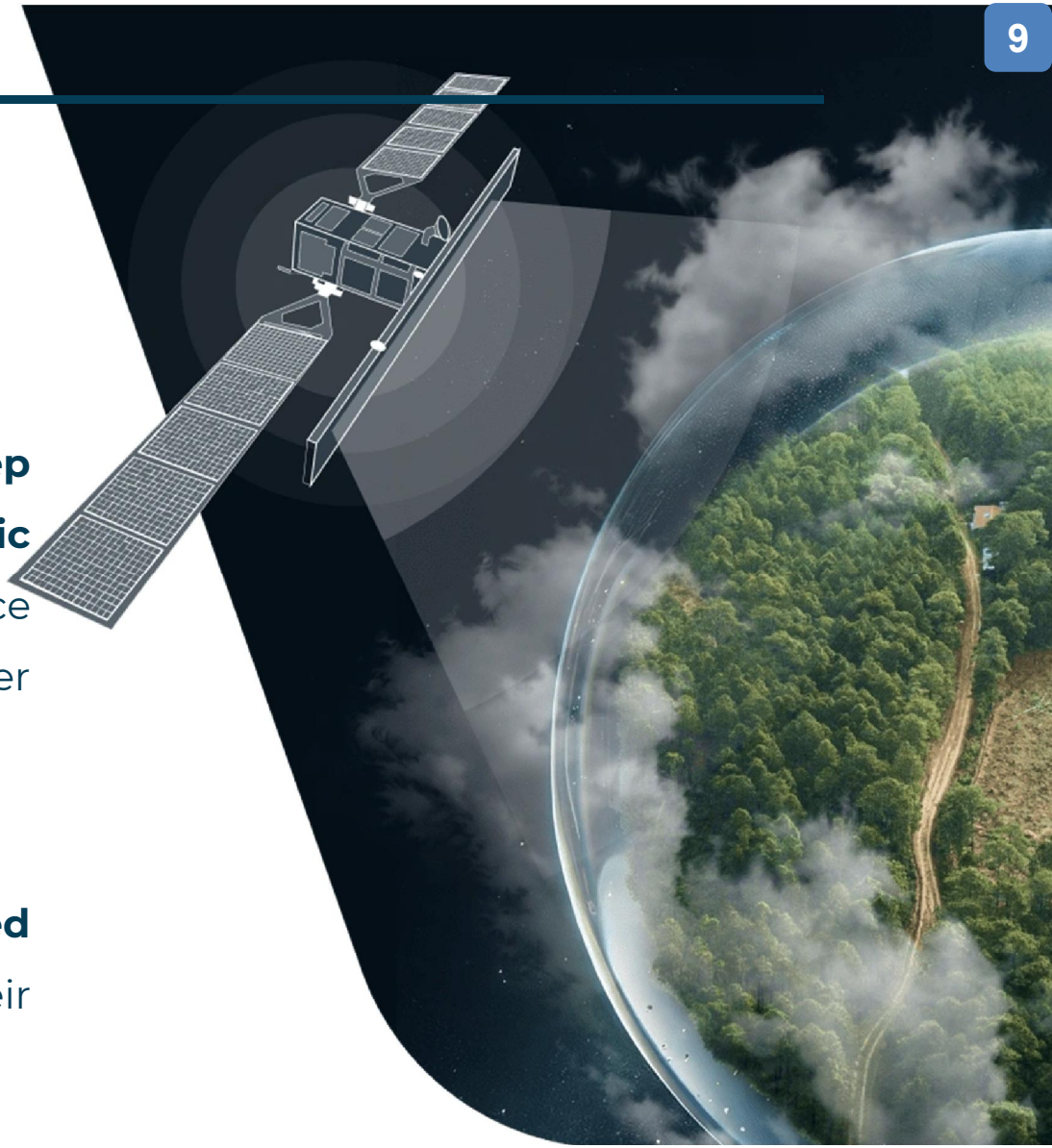
Drawbacks: Global Forest Watch

- Lies heavily on **thresholding techniques.**
- Doesn't cater for **afforestation efforts** made globally.
- Surveys are **time-consuming** and require **a lot** of **resources**.
- Need to develop an approach that can **automatically monitor** the **change** in forest area.

Solution: AI-Forest Watch

- The proposed approach uses **deep convolution neural network-based semantic segmentation** to process multi-spectral space borne images to monitor the forest cover change patterns quantitatively.

- The solution also caters for **newly planted trees** under BTAP project regardless of their height and canopy area.



Study Regions - the BTAP land

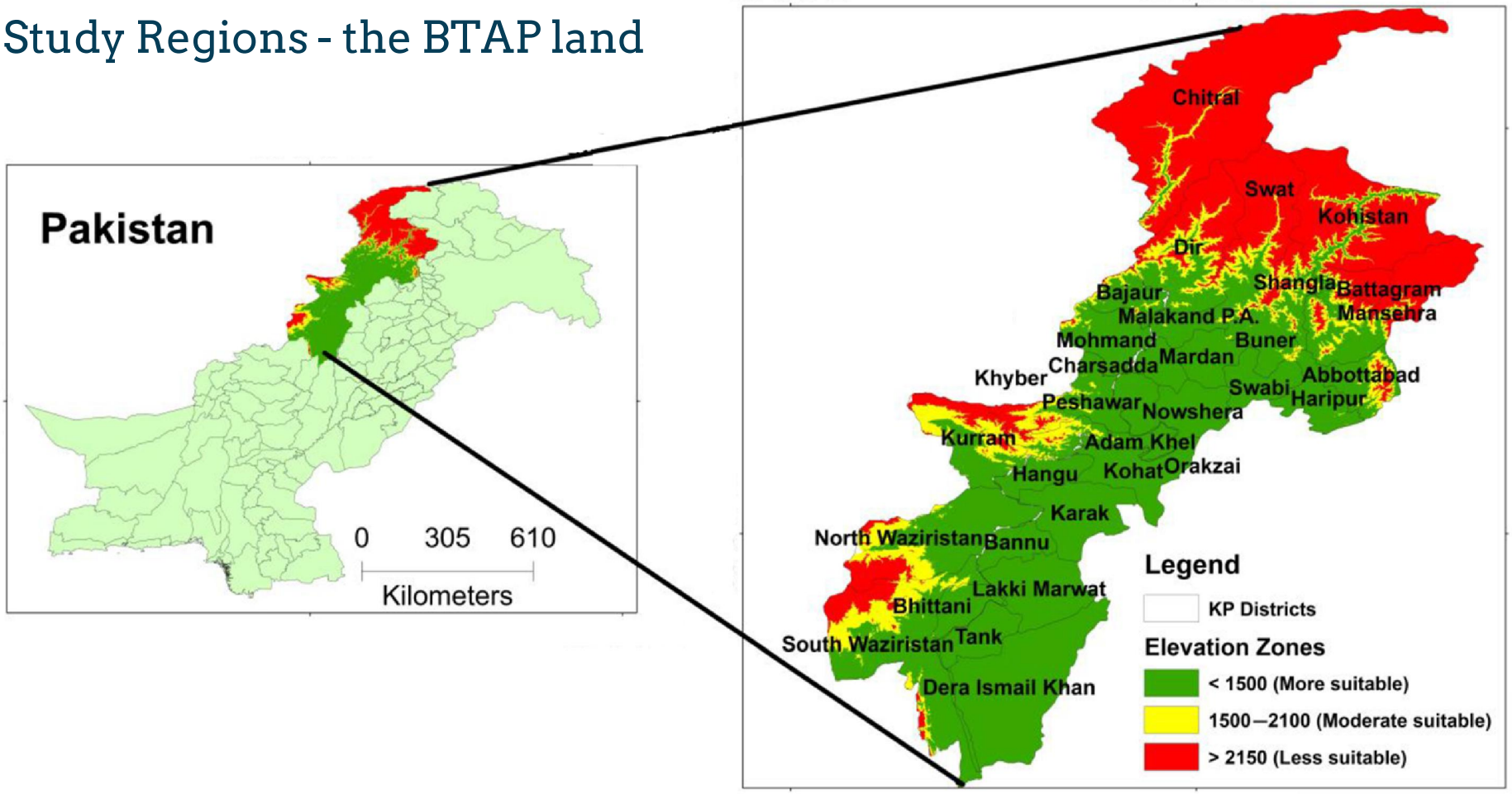
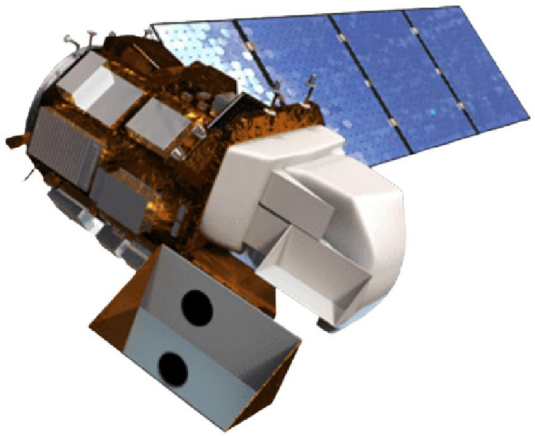


Figure 2. ***Geographic location of the districts of BTAP regions under study.***

About the Dataset

Landsat program provides the longest continuous coverage of the whole world.

- Landsat-8 top of atmosphere imagery available from 2013.
- Selected images for each year:
  - With <10% cloud cover.
  - Temporal resolution of 16 days.
  - Spatial resolution of 30 m per pixel.
- Used geo-referencing technique to digitize these maps.



Band	Percentage (%)	Number of images
Training	80	2700
Validation	10	338
Test	10	337
Overall	100	3375

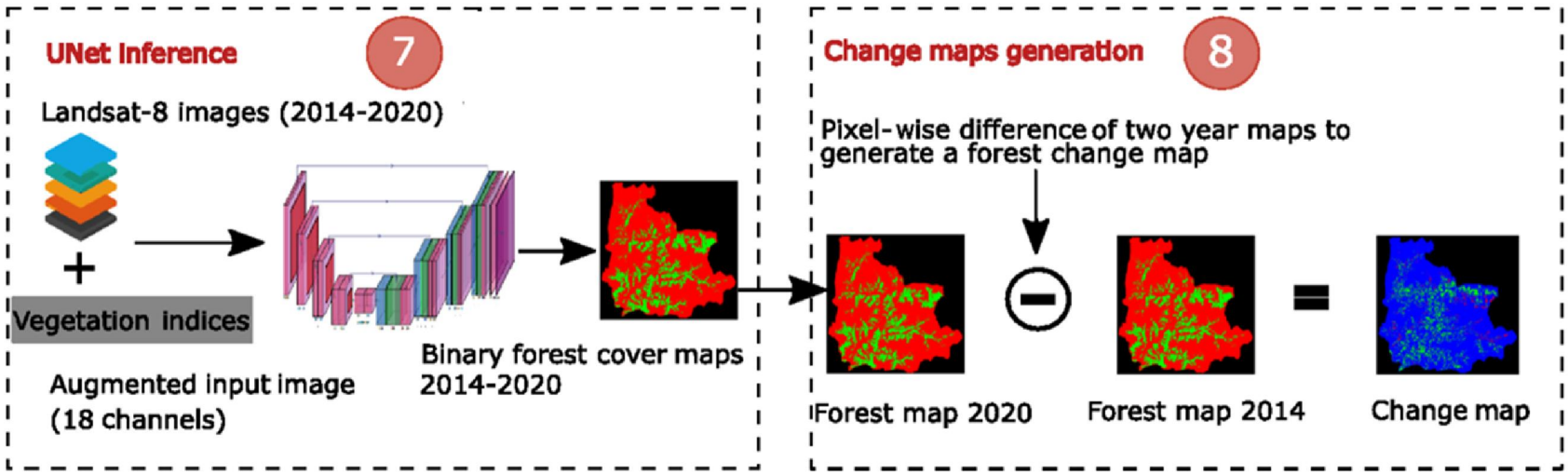
Table 1. ***Distribution of dataset (splitwise)***

AI-Forest Watch Framework

Multi-spectral data augmentation with indices

- Normalized Difference Vegetation Index (NDVI)
- Enhanced Vegetation Index (EVI)
- Soil Adjusted Vegetation Index (SAVI)
- Modified Soil Adjusted Vegetation Index (MSAVI)
- Normalized Difference Moisture Index (NDMI)
- Normalized Burn Ratio (NBR)
- Normalized Burn Ratio-2 (NBR-2)

Forest Estimation and Change Detection



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Comparison of the baseline ML-based Land Cover Classification Algorithms with UNet-based Semantic Segmentation Approach for RGB channels

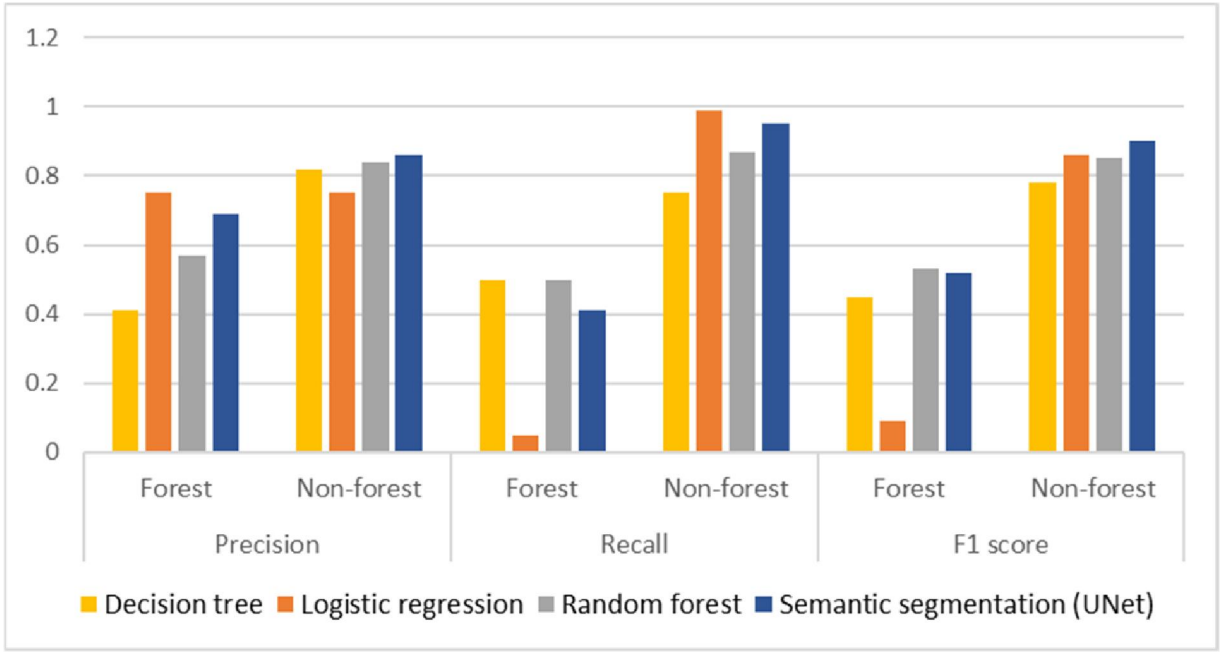


Figure 4. ***Per-class F1 scores comparisons***

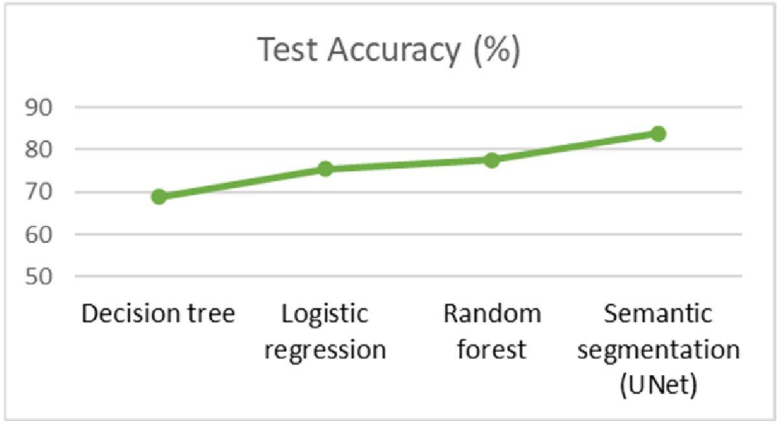


Figure 5. ***Test accuracy comparisons***

Comparison of the baseline ML-based Land Cover Classification Algorithms with UNet-based Semantic Segmentation Approach for Full-spectrum Input Image

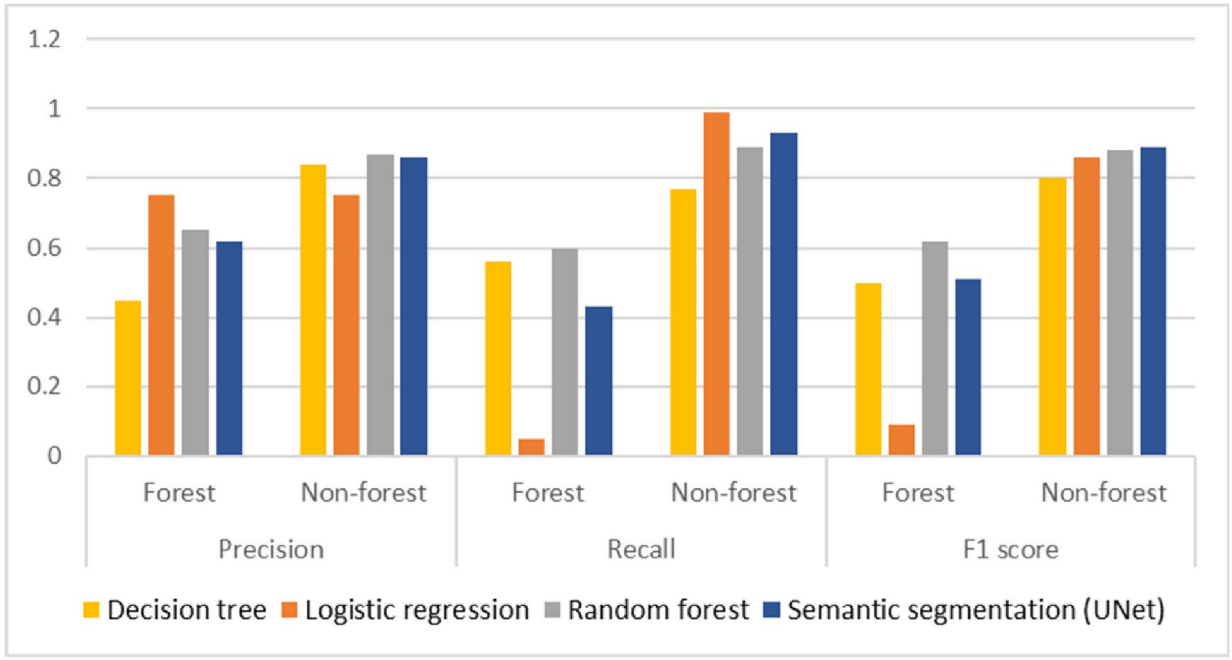


Figure 6. ***Per-class F1 scores comparisons***

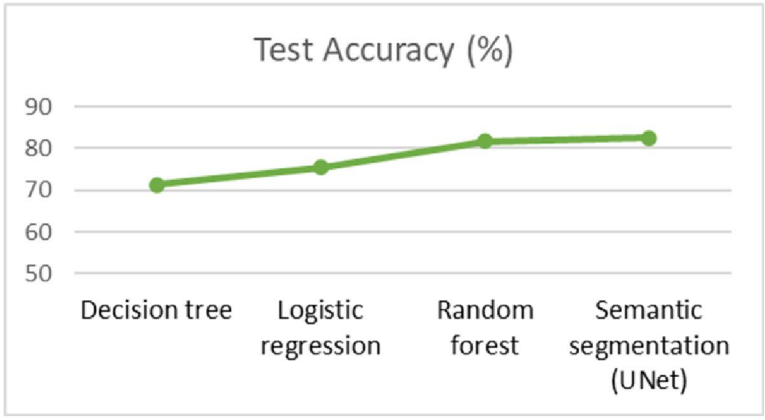


Figure 7. ***Test accuracy comparisons***

Comparison of the baseline ML-based Land Cover Classification Algorithms with UNet-based Semantic Segmentation Approach for Vegetation Indices

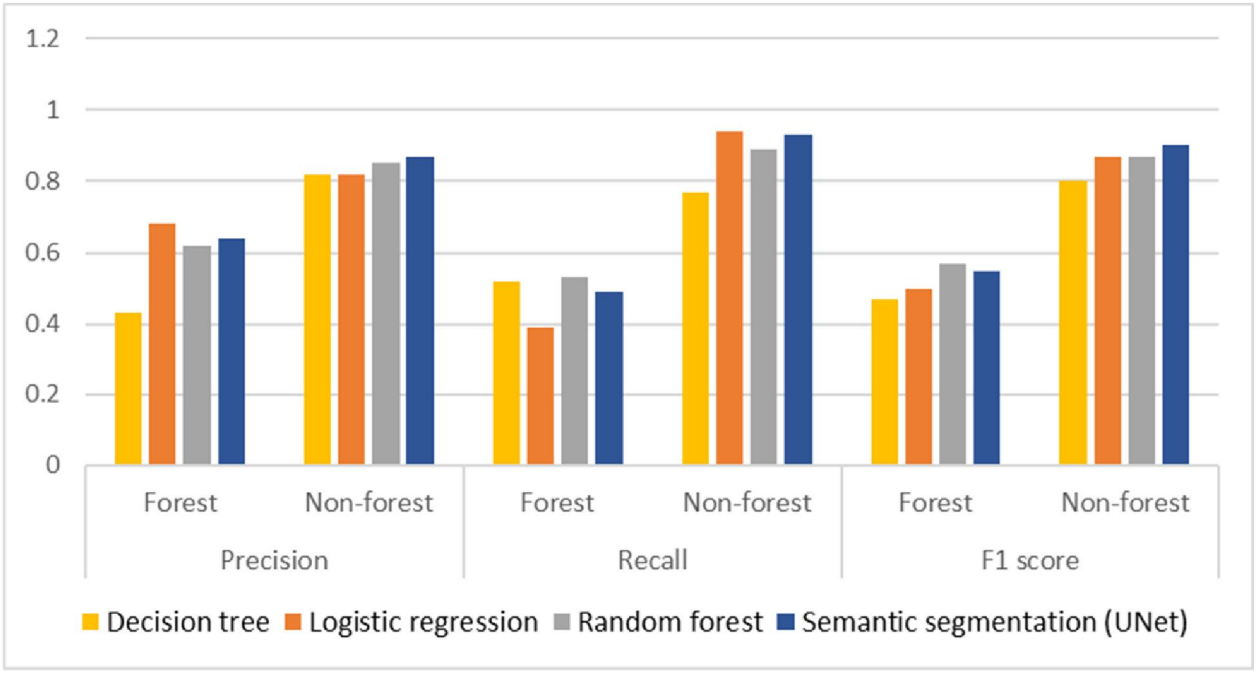


Figure 8. ***Per-class F1 scores comparisons***

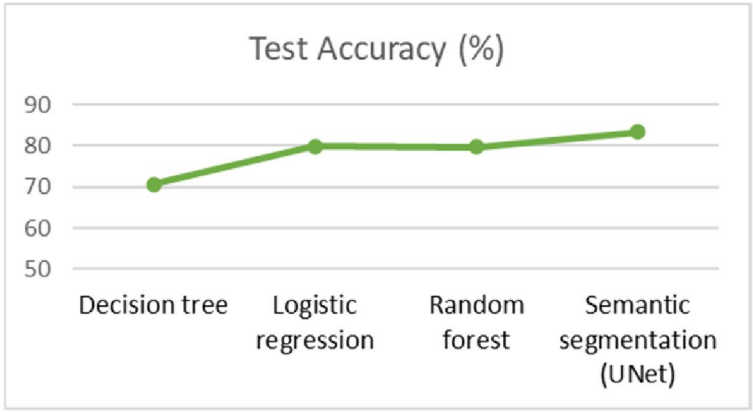


Figure 9. ***Test accuracy comparisons***

Comparison of the baseline ML-based Land Cover Classification Algorithms with UNet-based Semantic Segmentation Approach for Augmented Configuration

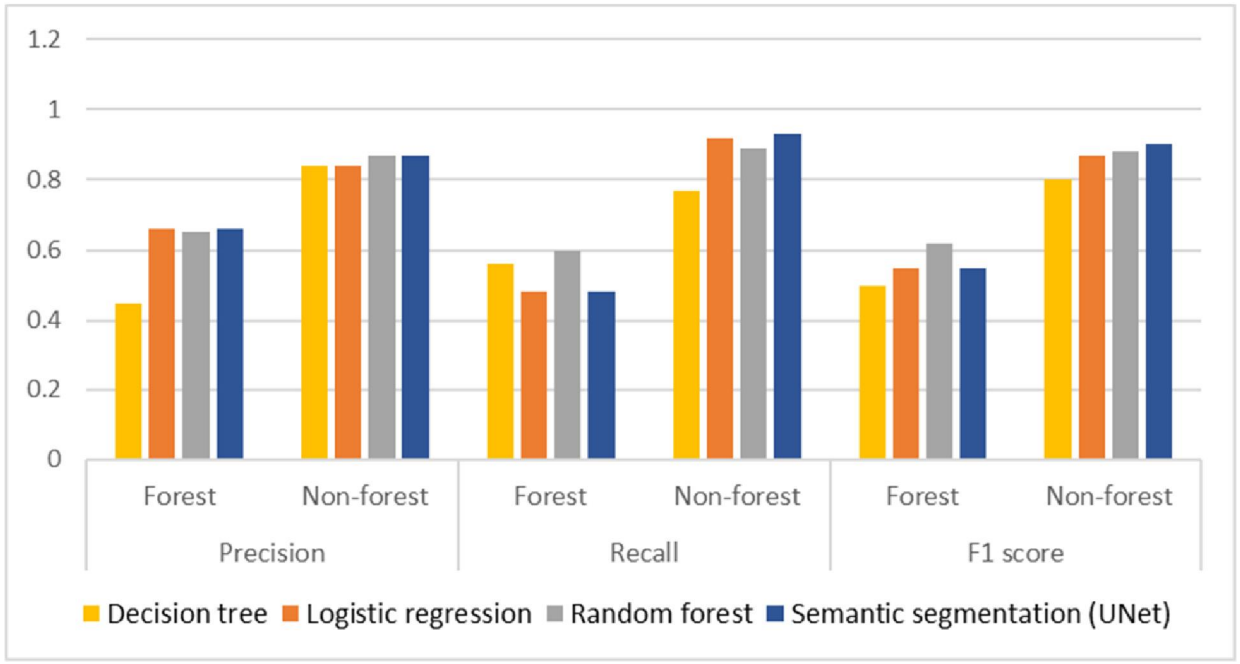


Figure 10. ***Per-class F1 scores comparisons***

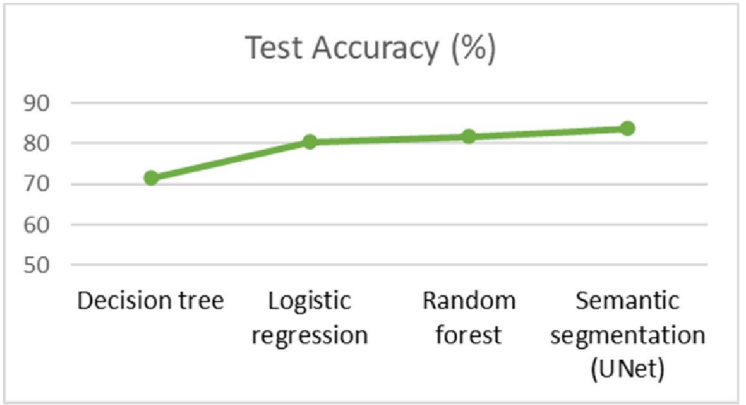
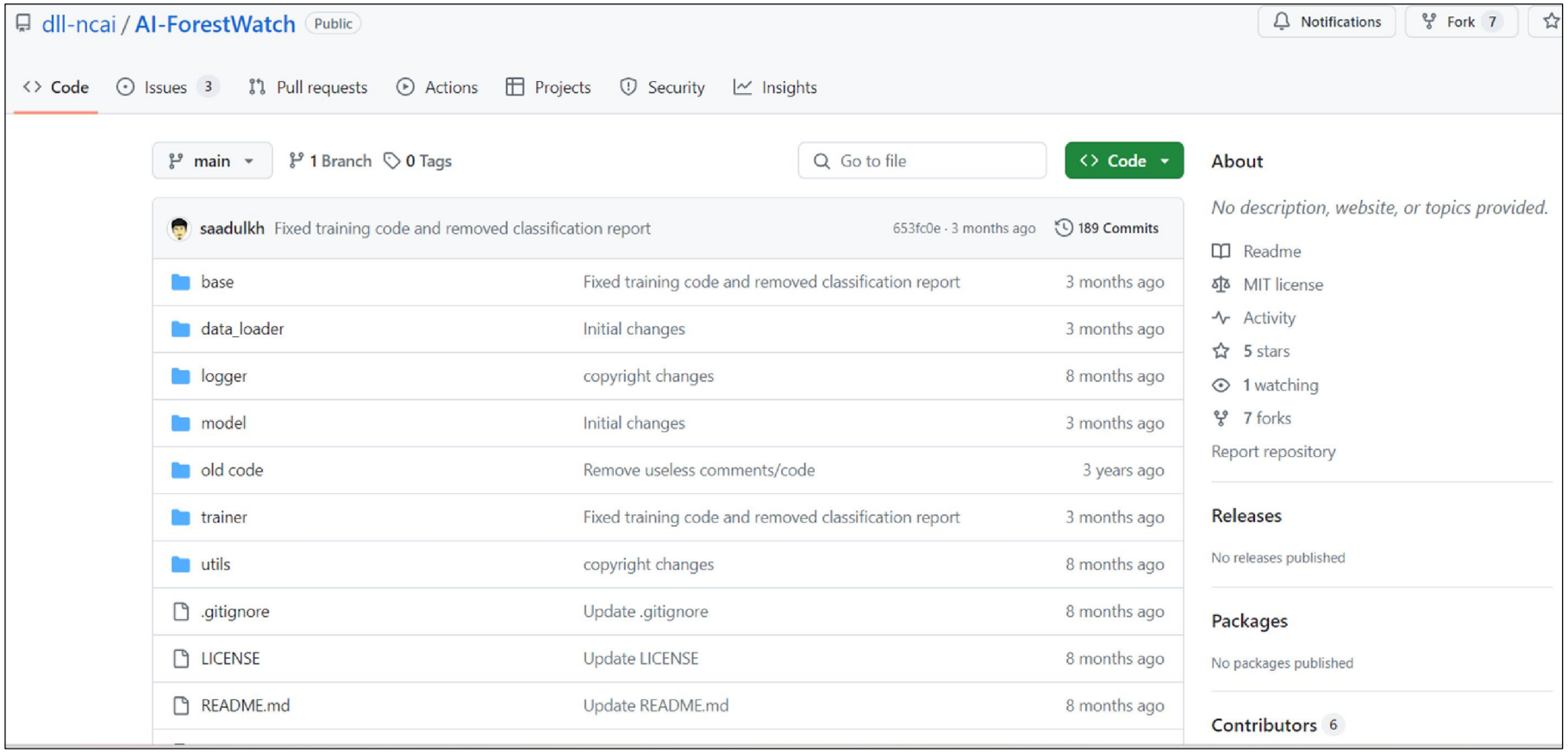


Figure 11. ***Test accuracy comparisons***

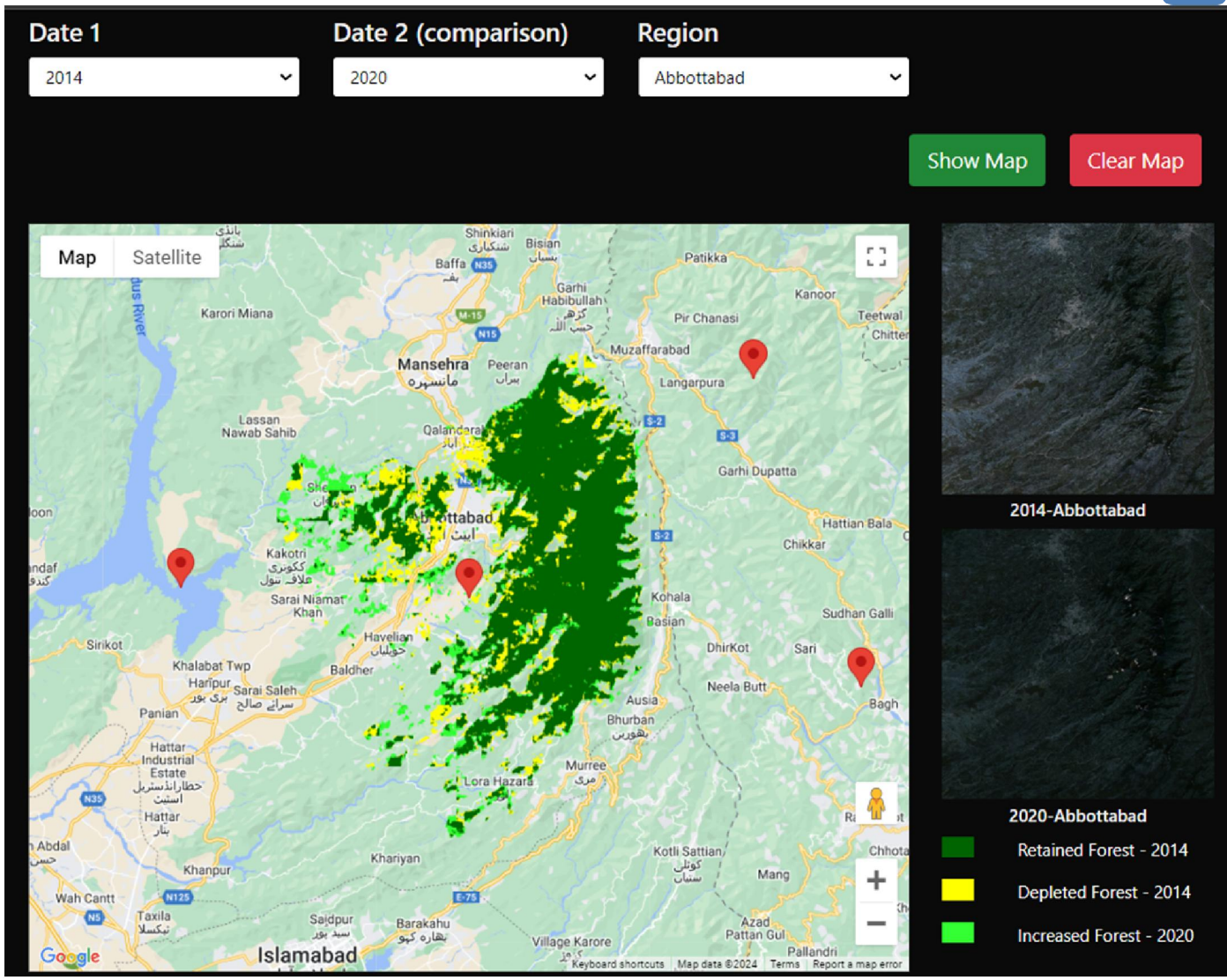
The code is open source and is available at the following link:

https://github.com/dll-ncai/AI-ForestWatch

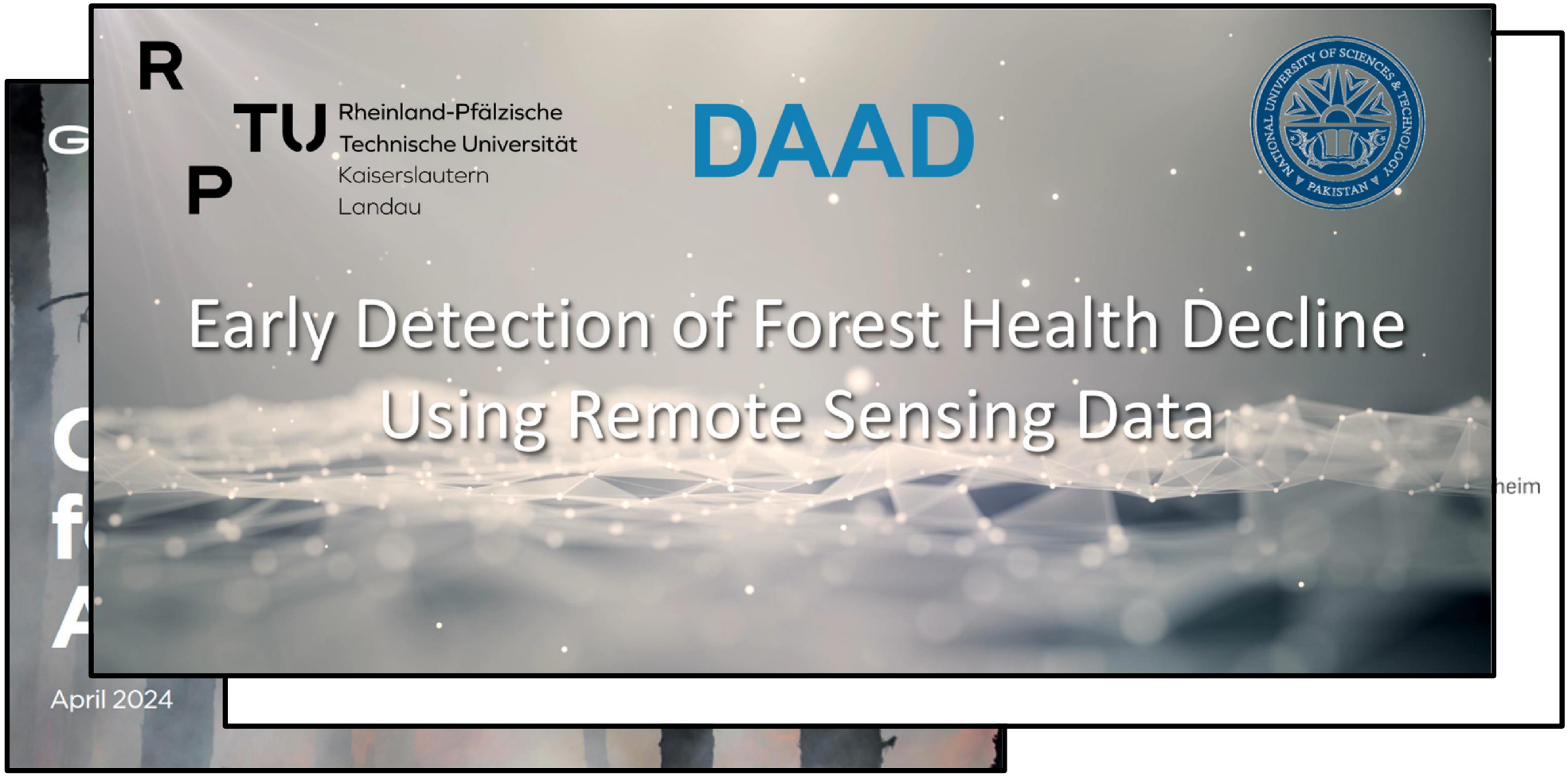


We have also developed a public portal for AI ForestWatch which can be visited at:

https://tukl.seecs.nust.edu.pk/forest_monitoring_and_change_detection_using_remote_sensing_data.html



Other Initiatives



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Conclusion

- **Enhanced Detection:** Advanced algorithms improve the detection of subtle changes, aiding in early intervention for deforestation, disease, and climate impact.
- **Sustainability Goals:** Efficient forest management and conservation efforts are bolstered, contributing significantly to global environmental sustainability targets.
- **Collaborative Efforts:** Integration with local and global conservation initiatives enhances data utility and fosters cooperative preservation strategies.