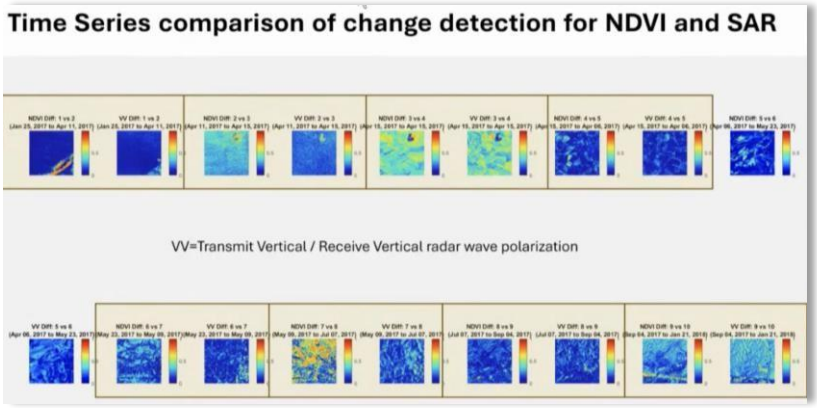
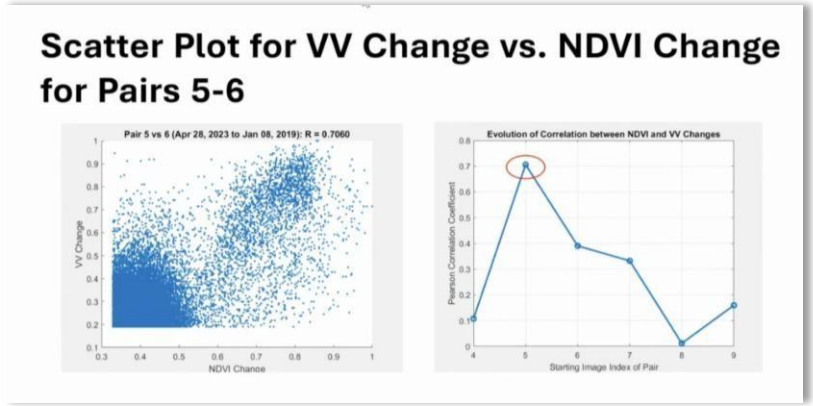
Early Warning for Deforestation and Biodiversity Loss

The University of Missouri-Columbia, in collaboration with Through Sensing LLC, Indiana University of Pennsylvania, and TGI consortium universities, is developing an AI system to monitor deforestation and biodiversity change in the Amazon areas.





Predicting Forest Degradation Before It Spreads

Uses multispectral and SAR satellite imagery with hybrid AI models to identify early indicators of deforestation and wildfire outbreaks.

AI for Conservation Across the Amazon Biome

Combines ResNet and temporal models (TCNs/LSTMs) to track forest loss and biodiversity shifts across all nine Amazon nations.

Key Features

- **Hybrid AI Architecture:** Merges spatial and temporal models to deliver both real-time and predictive insights.
- **Multi-Sensor Satellite Integration:** Leverages Sentinel, Landsat, and Copernicus Land Cover datasets for robust, multi-angle analysis.
- **Scalable, Region-Wide Monitoring:** Covers the full Amazon biome with spatially detailed outputs.

Applications

- **Conservation Planning**: Equips forest managers and NGOs with timely data for proactive intervention.
- **Wildfire Risk Management**: Detects early signs of forest degradation before fire hazards emerge.
- **Policy and Biodiversity Monitoring**: Informs national and international efforts to preserve critical habitats.

Team:
University of Missouri-Columbia (Dr. Dong Xu, Joe Soundararajan);
Through Sensing LLC (Andrew Kalukin);
Indiana University of Pennsylvania (Soundararajan Ezekiel)

Technical Challenges

The primary challenges during the process consisted of the following elements:

- **AWS learning curve:** Generates the EC2 instance and other details for setup of the AWS environment require training. Though training is available for free online, it is time consuming. The team ended up engaging professional services to carry out these tasks.
- **Integration of AWS with Python and MATLAB:** The workflow processes are embodied in Python and MATLAB scripts which can be run from the team's own computers. Working out how to do this task and other AWS tasks took more time than the scientific problems they were trying to solve.
- **Access to multi-sensor data through AWS:** AWS provides access to some image data. For their purposes which required data fusion of multiple sensors and ground truth, the team found it more convenient to gather their own data and upload it to AWS.
- **Decisions about which AWS models to use:** AWS has its own geospatial and satellite data processing models. After evaluating these options, the team found it more convenient to use their own AI models and geospatial processing scripts.
- **Availability of ground truth data and investigation of using multi-polarization SAR as ground truth:** Ground truth datasets for deforestation exist for some important regions of the world like the Amazon, but there are no global ground truth datasets. Data fusion of SAR and EO/IR was investigated in this research, and the idea appeared to be at least partially successful. If this idea could be developed successfully, it could enable detecting deforestation at a larger geospatial scale.

Observations and Lessons Learned

The GenAI algorithms demonstrated a good ability to distinguish deforested areas. Some of the technology used by other teams, for example, looking for fire hazard conditions, could be a useful complement to this work.

Lessons learned:

- AWS used fewer resources for processing algorithms than the team expected, though the storage of data can generate costs that build up quickly.
- Multiscale geospatial approach helped improve the accuracy of detecting deforestation.
- Data fusion of SAR and EO/IR seems promising.

Next Steps

The team has been exchanging notes with some of the other teams from the Challenge doing complementary projects, to see if their processes might fit into the other teams' workflow. The possibility of using multi-polarization SAR as ground truth for EO/IR could enable them to scale the approach by avoiding some of the need for human annotation of ground truth, which is generally the bottleneck for AI. A paper is planned for publication, most likely at the Applied Imagery Pattern Recognition Workshop in October 2025.

Customers/Operations

Some of the knowledge gained from this effort, for example, the value of data fusion of multi-polarization SAR and EO/IR image data, has applications for ongoing work being done for the US government.