Improving near real-time tropical forest cover loss monitoring with multiple data sources

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Introduction

Tropical countries need reliable and timely measurements of the extent of forest disturbances to prevent and reduce unsustainable and illegal activities, such as illegal logging and mining. Time series-based forest monitoring at near real-time (NRT) has the capacity to detect forest cover loss once new satellite images become available.

Current NRT forest monitoring methods mainly identify changes at pixel level, neglecting what happens in neighboring pixels[1]. However, land changes are correlated in space and time. For example, a pixel adjacent to a pixel classified as deforested is more likely of being deforested than one that is surrounded by forested pixels.
With the recent launch of the Copernicus Sentinel-1 satellites, dense and regular C-band SAR data is for the first time available free of charge and with global coverage.
There is an increasing availability of frequently updated spatial data, e.g. roads networks from OpenStreeMap and real-time active fire data. Combining satellite time series and spatial data in NRT has the potential to improve the spatial accuracy and timeliness to detect forest cover loss, but approaches are lacking. The main objective of this study is to develop such a multi-source approach.
The study site is located in the province of Madre de Dios, Peru.

Methods I

Sentinel-1 VV time series and dynamic road network data (major roads and logging roads) were combined to detect forest cover loss in NRT. To do so, we further developed the probabilistic machine learning approach developed by Reiche et al. (2018)[2] to accommodate multi-source data streams.

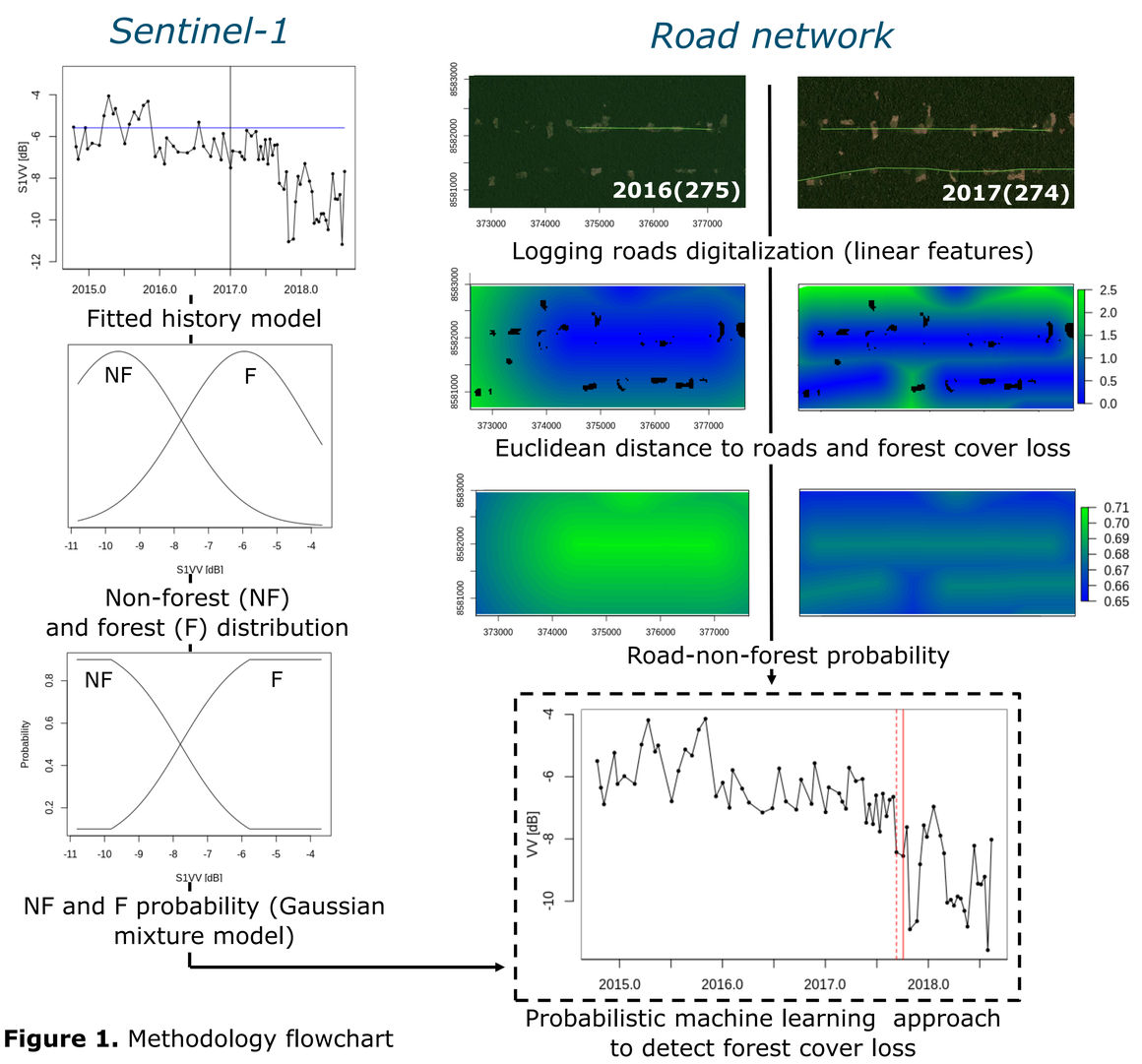

Figure 1. Methodology flowchart

Methods II

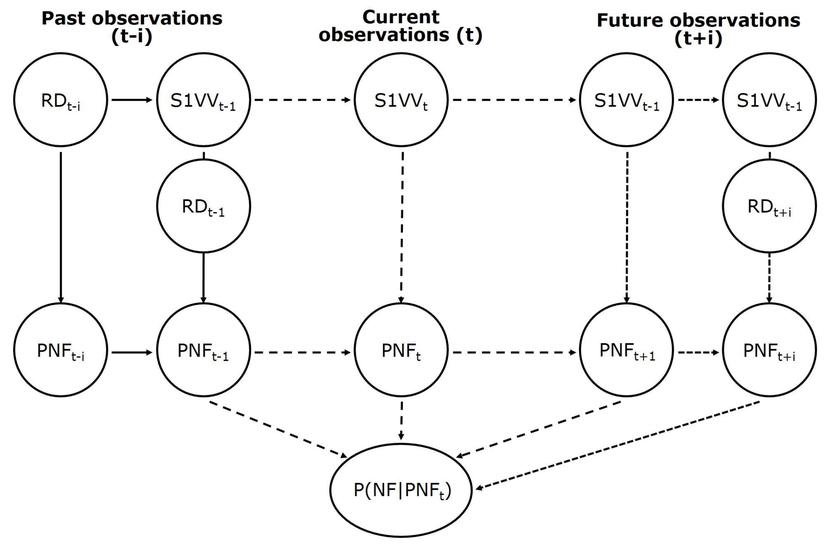

Figure 2. Multi-source probabilistic machine learning approach to detect forest cover loss. Euclidean distance to roads (RD), Sentinel-1 VV time series (S1VV), Non-forest probability PNF)

Preliminary results – NRT forest cover loss detection

Single pixel example of NRT forest cover loss detection with single-source (Sentinel-1 only) and multi-source (Sentinel-1 + roads) probabilistic machine learning approach.

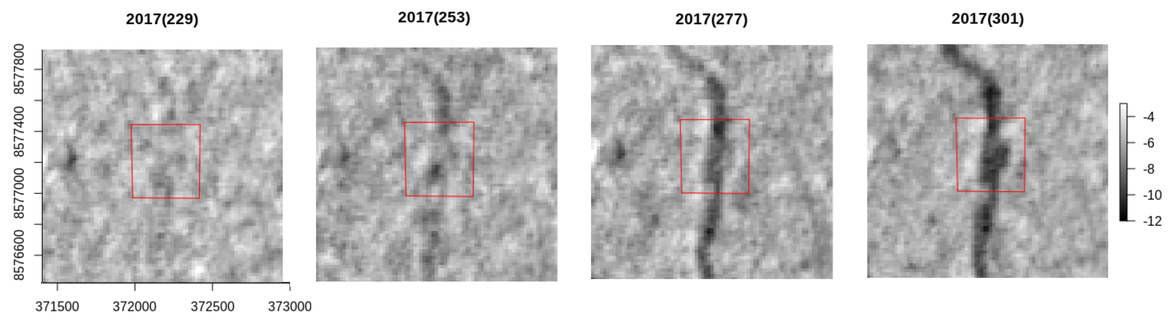

Figure 3. Sentinel-1 VV time series. Central pixel sample (red polygon)

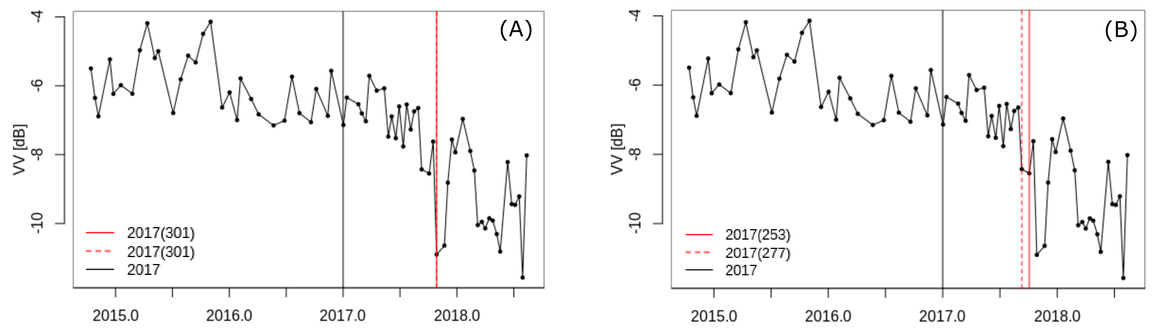

Figure 4. (A)Single-source (Sentinel-1 only) forest cover loss detection. (B)Multi-source (Sentinel-1 + roads) forest cover loss detection. Start of the monitoring period (black line), time flagged (red dotted line), time confirmed (red line)

- Dense Sentinel-1 time series in combination with spatial data, road networks, improved the timing of forest cover loss detection

Future research

- Assess results for Madre de Dios province
- Explore methods to derive spatial-non-forest probabilities
- Inclusion of other spatial datasets (e.g. fire, water bodies) and sensors (e.g. Sentinel-2)

References

[1]Reiche, J et al. 2018a; Remote Sens. 2018, 10(5):777. [2]Reiche, J et al. 2018b; Remote Sensing of Environment 204(4):147–61.

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