Assessing Land-Use Following Deforestation at the Pantropical and National Scale Using Remote Sensing Time Series and Deep Learning

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Why this important?

Motivation

- Assessing post-deforestation land-use to support sustainable forest management
- Improve information on drivers and land use after forest change by using open-source datasets and methods

Challenges

- Identify/Interpret land-use
- Spatial heterogeneity
- Spatially/temporal explicit information

Remote sensing

- Data, resolution, and computing power
- Method/framework to detect land uses

Monitoring of land-use following deforestation

- **Project goal**
  1. develop and test reproducible open-source method for assessing direct drivers of forest loss for the pan-tropical countries

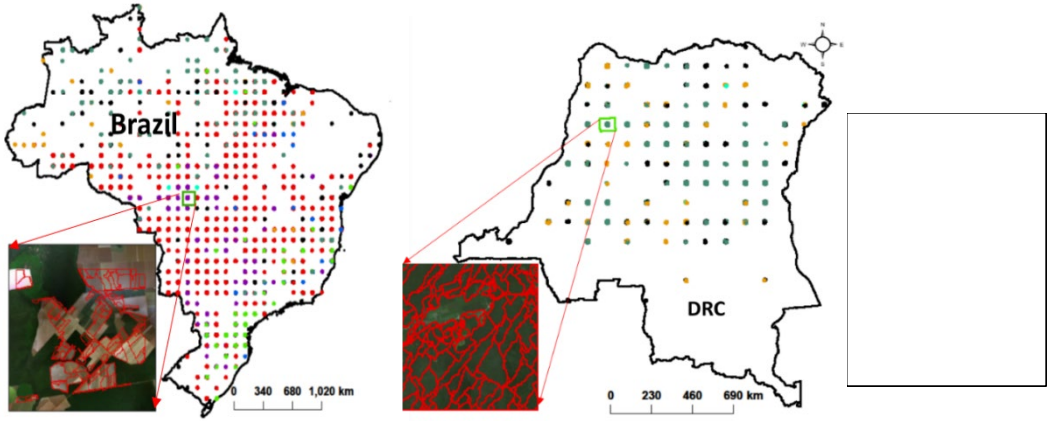
- **Case studies**
  1. Spatial and temporal deep learning methods for deriving land-use following deforestation: *A pan-tropical case study* using Landsat time series

  2. Using High-Resolution Imagery and Deep Learning to Classify Land-Use Following Deforestation: A Case Study in Ethiopia *(wall to wall)*

Case study 1: Sample-based land use change monitoring (Pan-tropical)

Background

- Sample based approach
- Landsat time-series to predict land use activities driving deforestation
- Six deep learning models
  - 2D-CNN
  - LSTM
  - 3DCNN
  - ConvLSTM
  - 2DCNN+LSTM
  - 2DCNN+Multi-head soft attention
- Continental and pan-tropical models

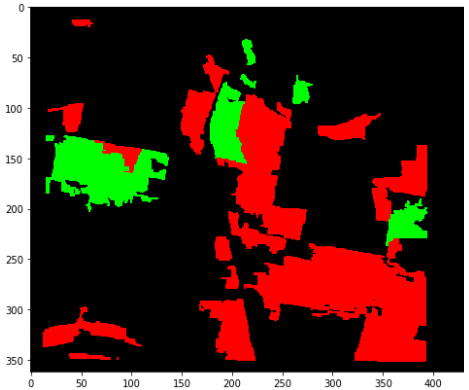


FAO, (2010)

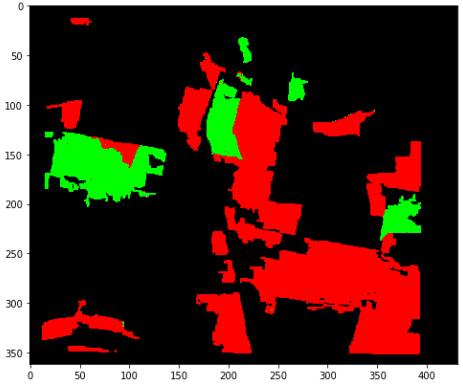
Case study 1: Example land-use prediction vs ground truth

Time series images

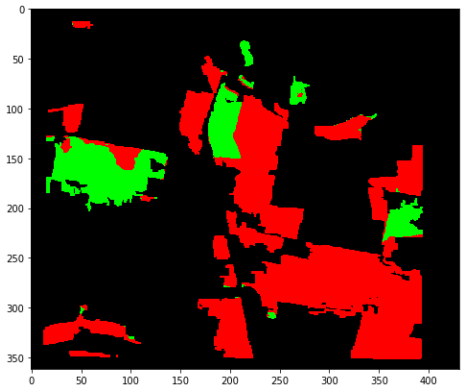
Ground truth polygons



Prediction CNN+MHSA



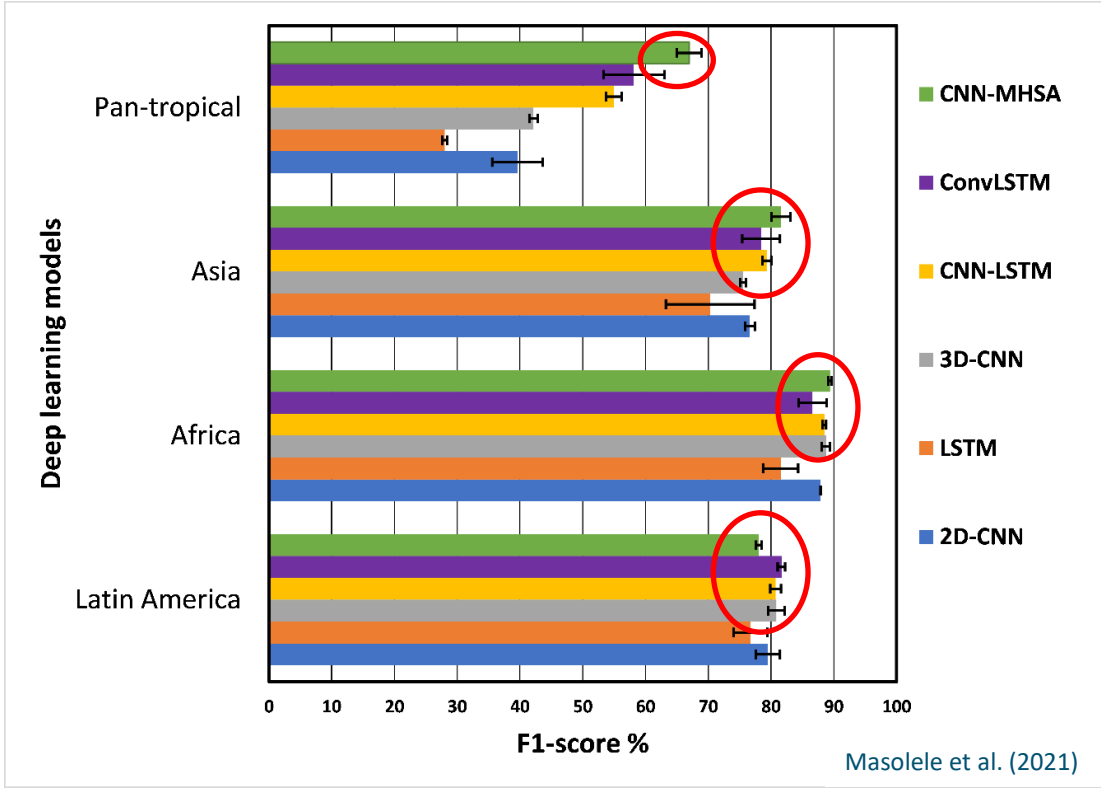
Prediction CNN+LSTM



Case study 1: Land use change monitoring (accuracies)

Accuracies of six DL methods for continental and pan-tropical scale for predicting land use following deforestation using Landsat time series for following classes:

- large-scale/commercial cropland
- Pasture
- Mining
- small-scale cropland
- Other land with tree cover
- Tree crops



Masolele et al. (2021)

Case study 2: Wall to wall land use change monitoring (Ethiopia)

Motivation

- Improve information on drivers and land use after forest change by using open-source datasets and methods

Data

- Planet data, Sentinel-2 & Landsat-8
  - Single date and Multi-temporal
- Hansen forest loss 2010 – 2014
- 9 land use classes for 2016

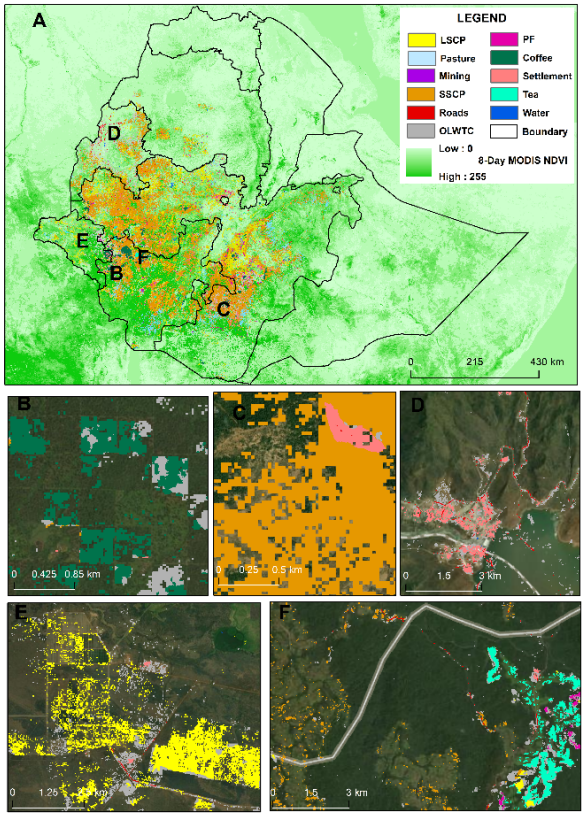
Method

- Attention U-Net

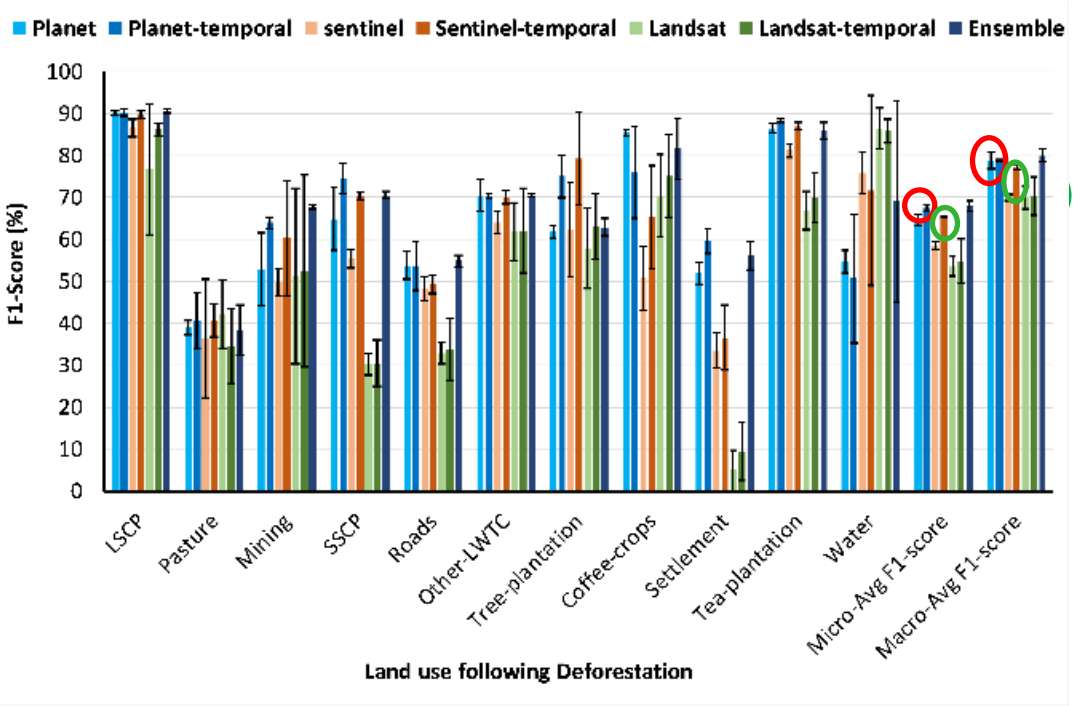
Output

- Best model
- Wall to wall map

Case study 2: Land use change after forest loss (Ethiopia)



- Planet-NICFI vs Sentinel-2 vs Landsat-8 vs Ensemble



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Conclusion

- Case study 1: Pantropical
  - We can use deep learning predict land-use with good quality
  - Continental models performed better compared to the pan-tropical model.
  - Spatio-temporal model improved the accuracy in classifying the FLU by a significant margin.

Conclusion

- Case study 2: Ethiopia
  - We can use deep learning for wall-to-wall mapping of land-use after deforestation with good quality
  - Optimal results need high spatial (Planet-NICFI) or temporal (Sentinel-2) resolution
  - The deep learning model and related land-use following deforestation product generated in this research are readily available.
  - The whole case study is implemented in FAO SEPAL

Ongoing activities in Ivory coast, Africa

- Characterising land use change after deforestation and regrowth (deep learning, Ivory coast)
- Increasing detail in monitoring drivers of forest loss – (deep learning, Africa)
- Transferability

Acknowledgements

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Thank you

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