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TAKING THE PULSE OF OUR PLANET FROM SPACE

EUMETSAT ECMWF EUSPA

Temporal deep learning for mapping temperate forest tree species in Flanders using Sentinel-2 time series

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GEO.INFORMED project

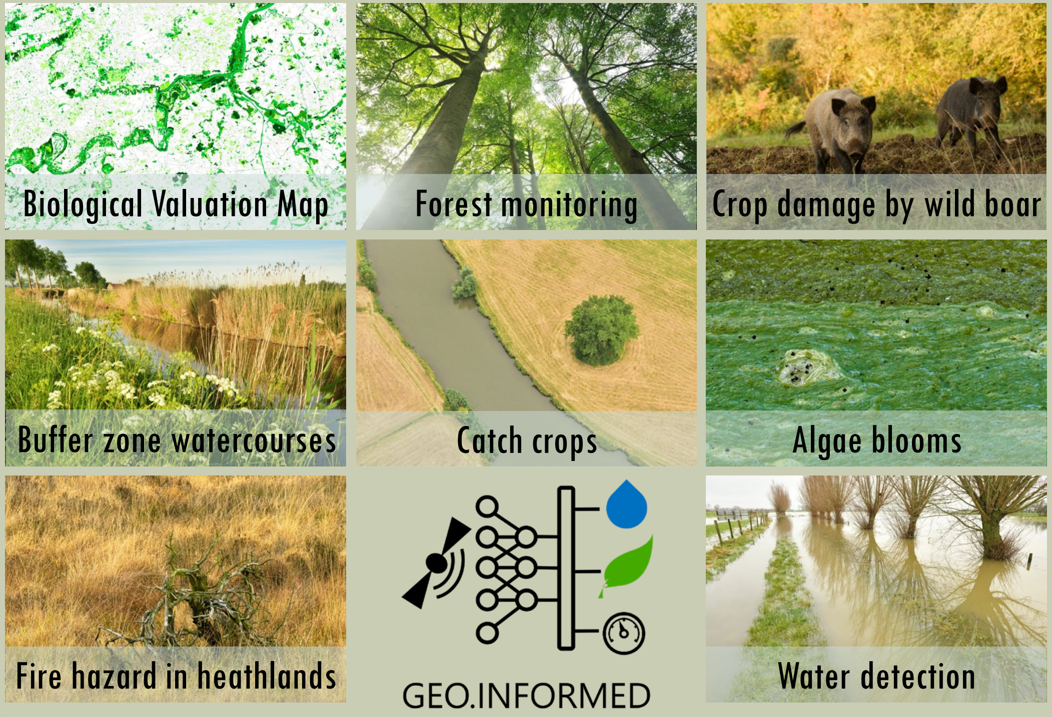
CONCEPT

- Ground reference data
- Sentinel data
- Deep learning models
- Geo-data for environmental policy in Flanders

PROJECT WORKFLOW

- End user needs
- Use case selection
- Model specification
- Model development

USE CASES



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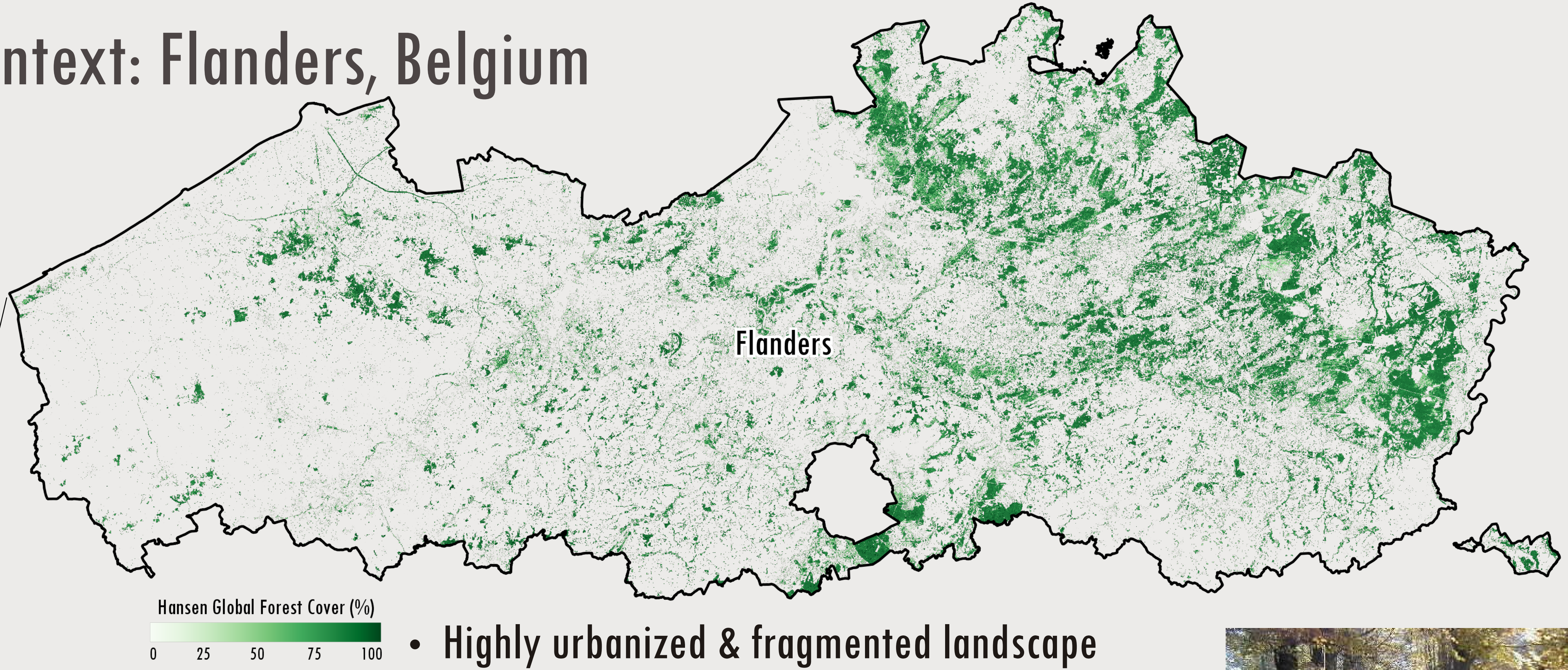
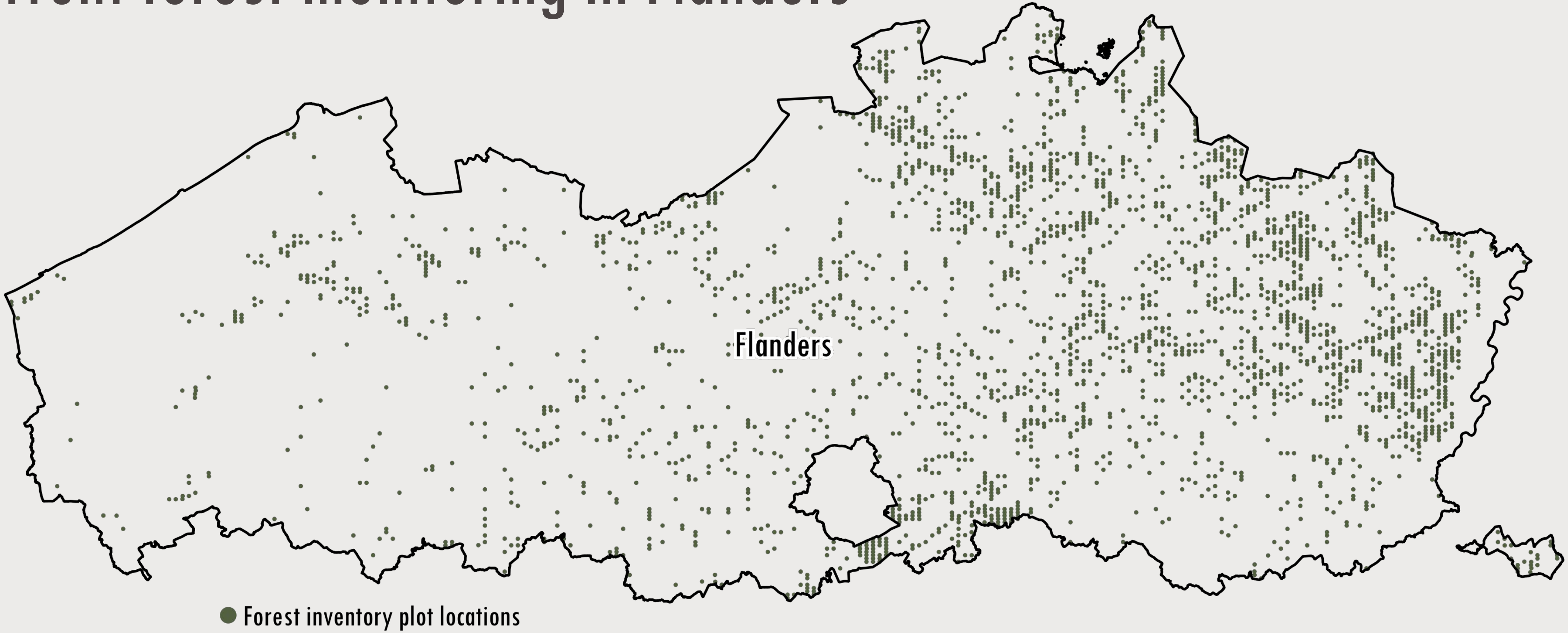
Context: Flanders, Belgium



- Highly urbanized & fragmented landscape
- Forest cover percentage ~10 % of area
- Shift in policy focus
  - Wood production → multifunctionality
  - Increase average stand age & structural diversity

Current forest monitoring in Flanders



- National forest inventory → Tree characteristics (diameter, height), presence native/exotic species, dead wood
- But only allows for statistical evaluation on regional level over decadal time period
- Need for information: frequent updates and spatially-explicit

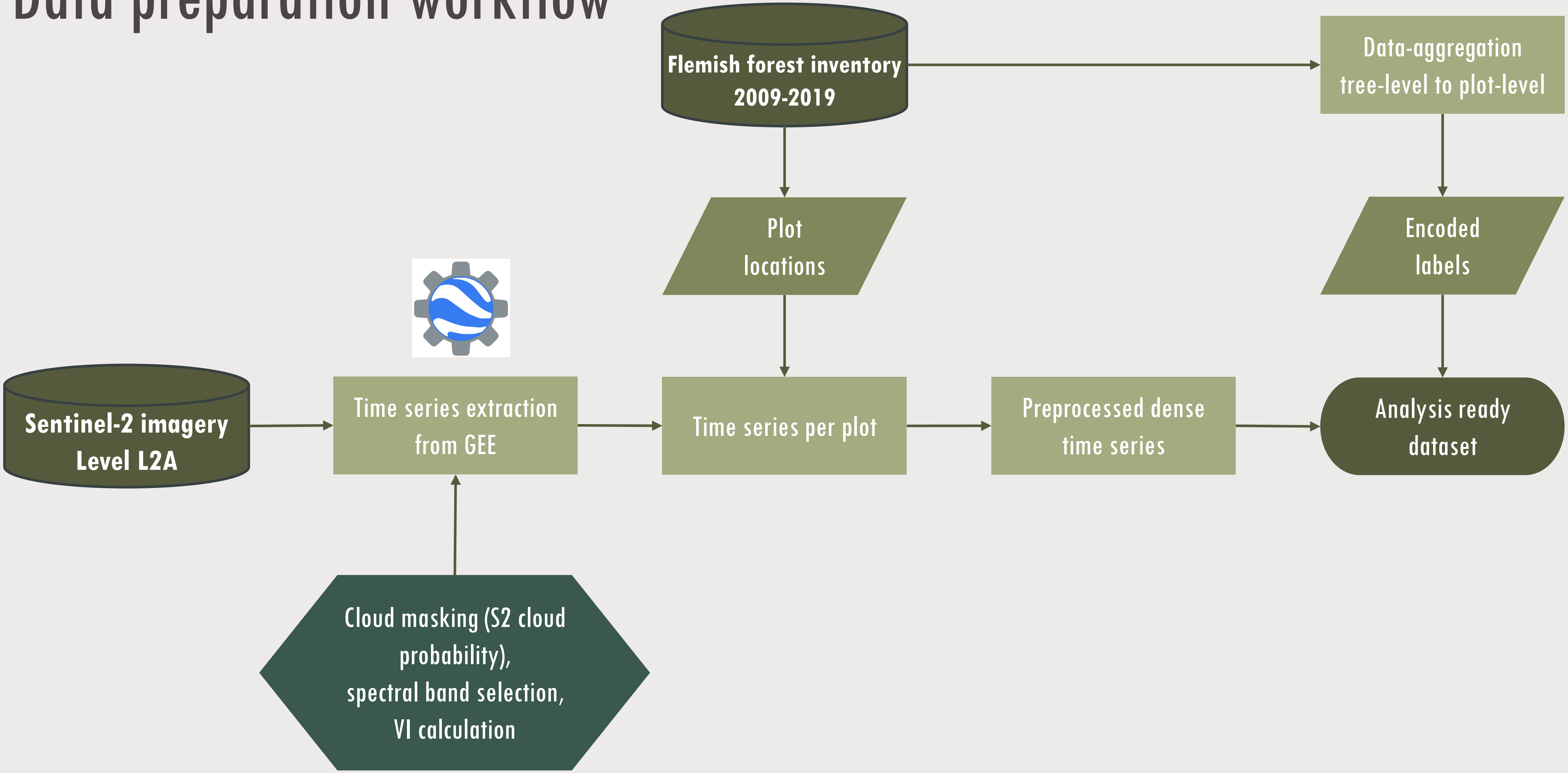
Objectives and challenges

- Can we use national forest inventory data in Flanders to train supervised ML/DL algorithms?

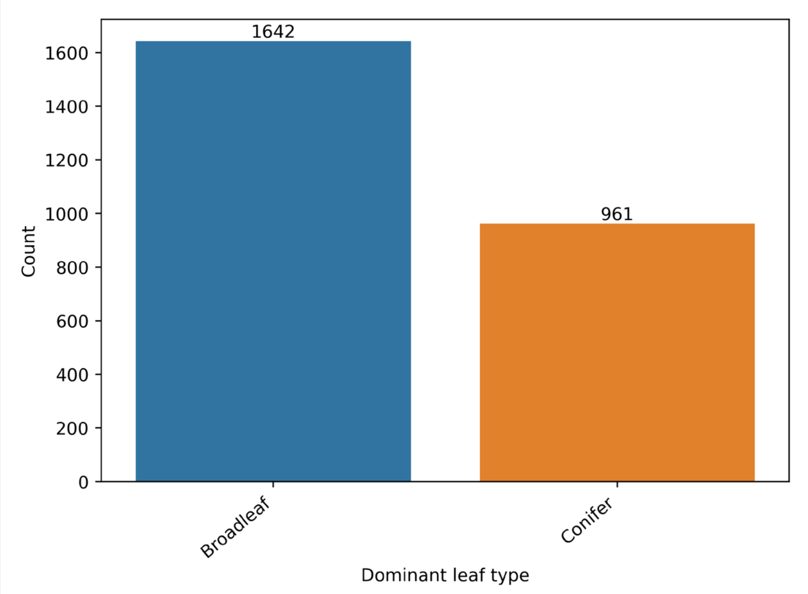
Challenges

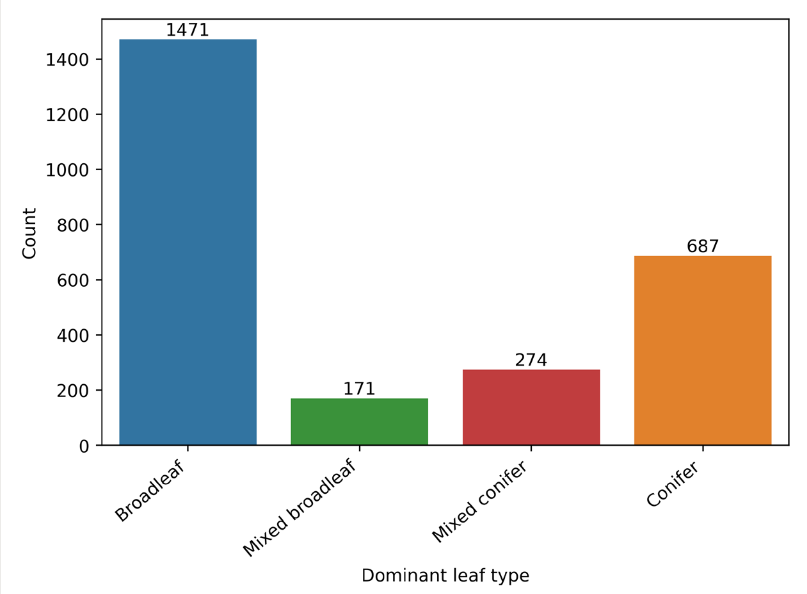
- Temporal mismatch between data collection and Sentinel-2 data
- Limited size of inventory (~2600 plots in one measurement cycle)
- Highly imbalanced datasets

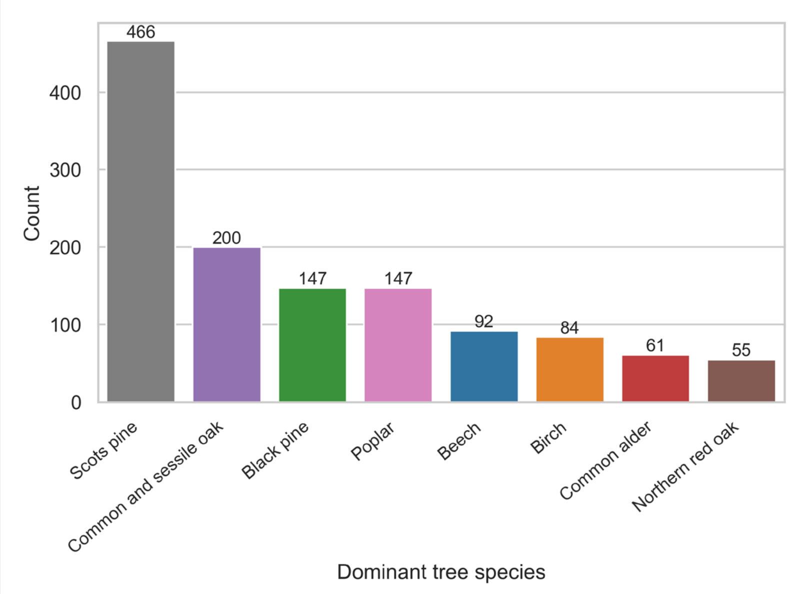
Data preparation workflow

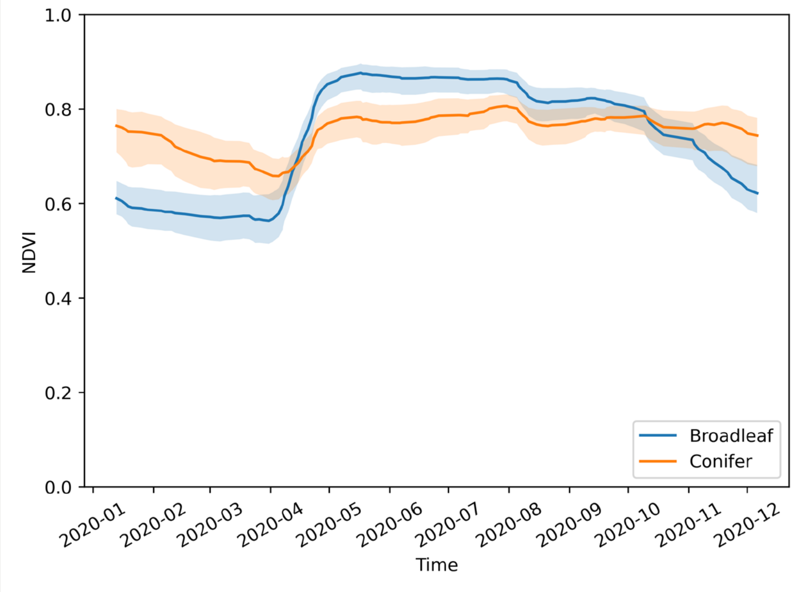


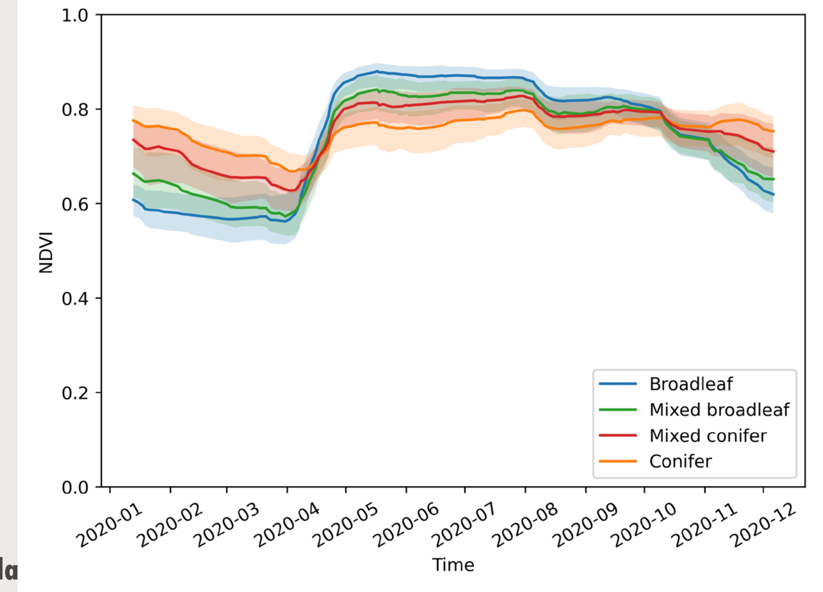
Datasets

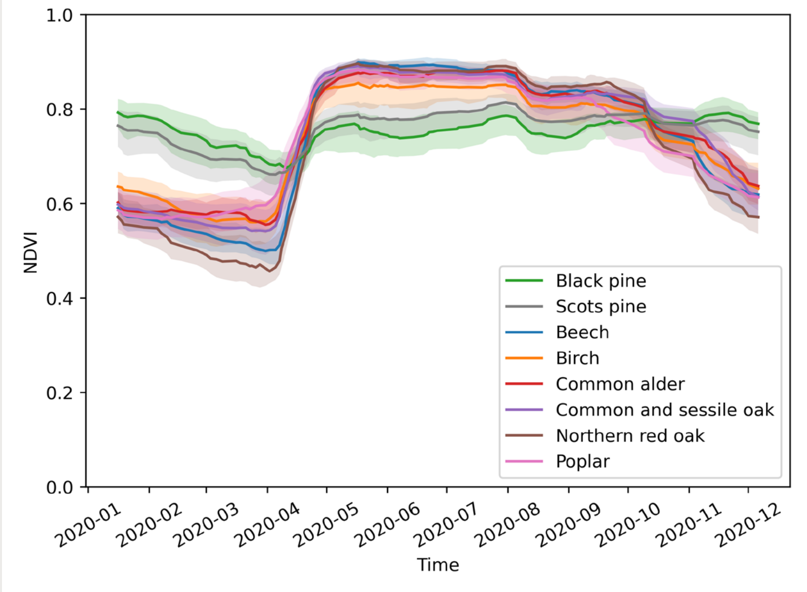

1642
961
Count
Broadleaf
Conifer
Dominant leaf type


1471
171
274
687
Count
Broadleaf
Mixed broadleaf
Mixed conifer
Conifer
Dominant leaf type

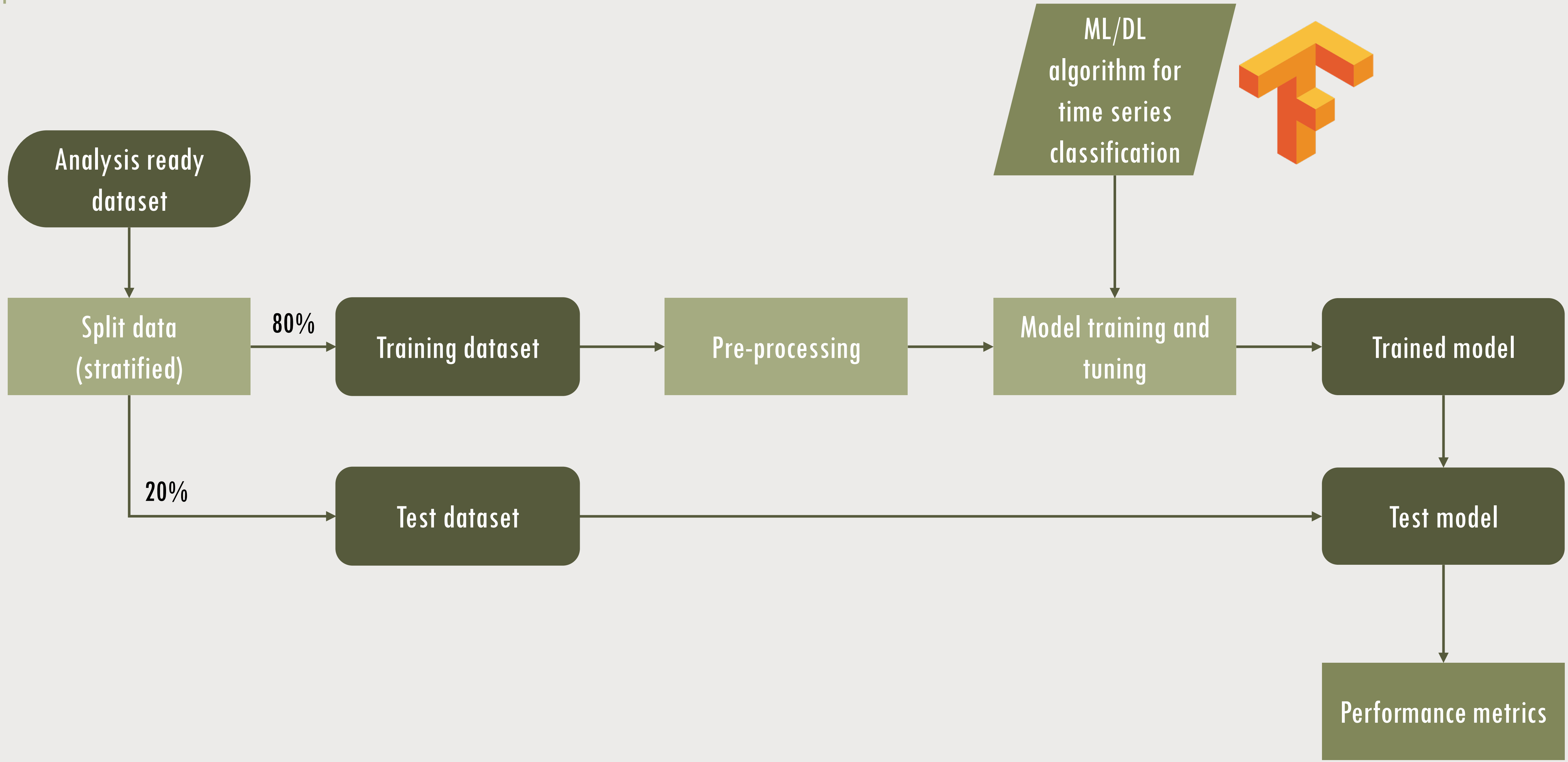

466
200
147
147
92
84
61
55
Count
Scots pine
Common and sessile oak
Black pine
Poplar
Beech
Birch
Common alder
Northern red oak
Dominant tree species


NDVI
Time
Broadleaf
Conifer

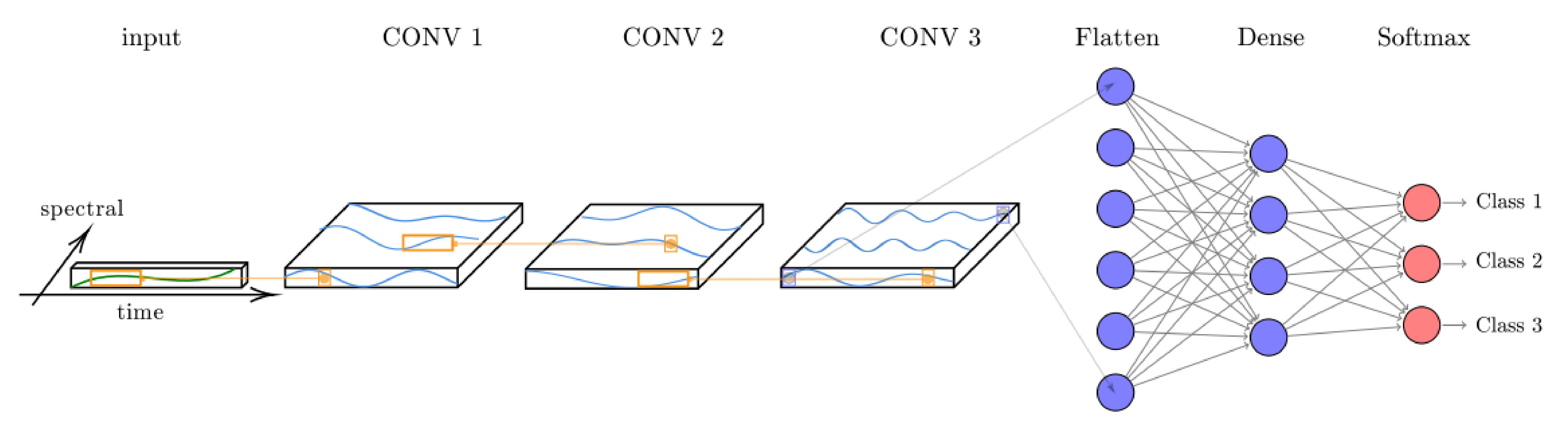

NDVI
Time
Broadleaf
Mixed broadleaf
Mixed conifer
Conifer


NDVI
Time
Black pine
Scots pine
Beech
Birch
Common alder
Common and sessile oak
Northern red oak
Poplar

Model training workflow

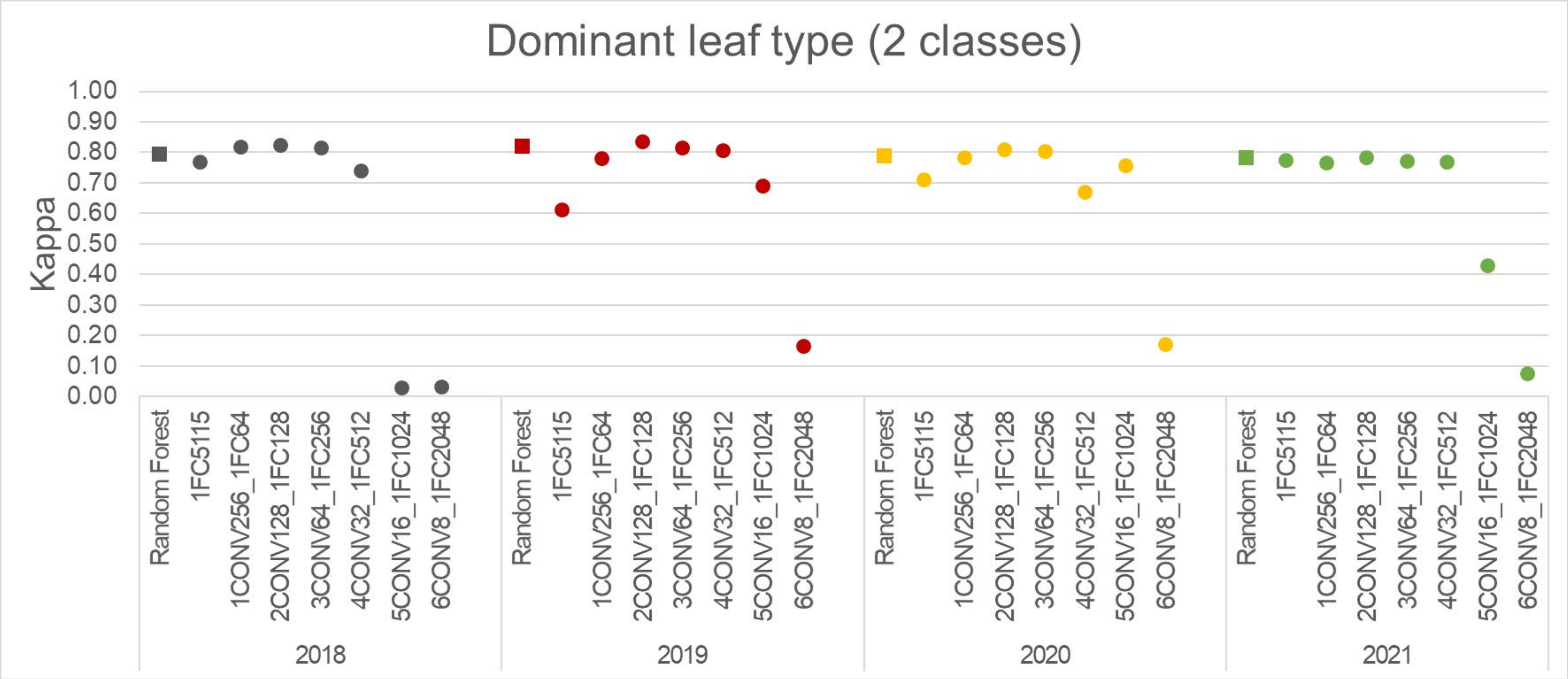


Temporal convolutional neural network (tempCNN)



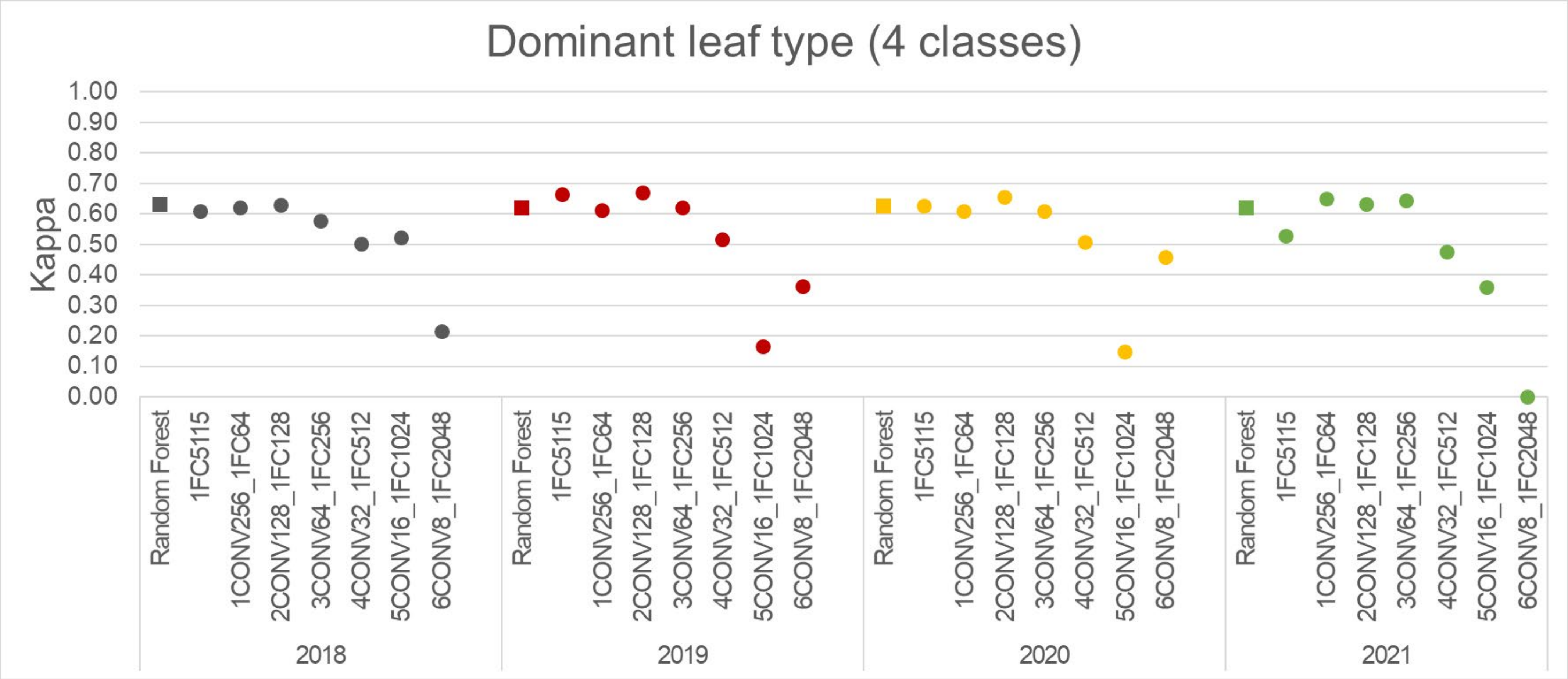
- Architecture proposed by Pelletier et al. (2019)
- Applies the idea of temporal convolutions
- Previously applied to crop type mapping
- Compare with random forest

Results



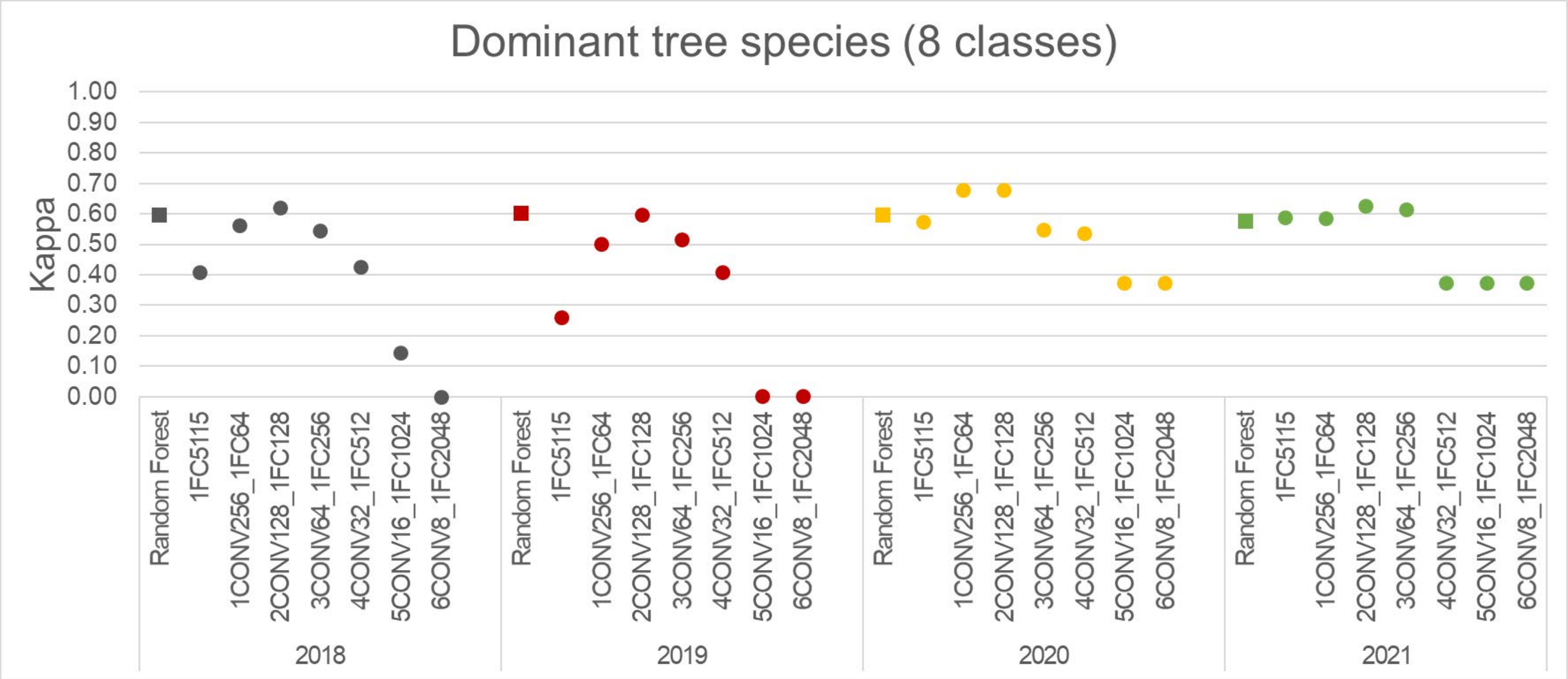
Highest overall accuracy 92%

Results



Highest overall accuracy 82%

Results



Highest overall accuracy 70%

Findings

- Optimal number of convolutional layers: 2 or 3
  - Certain configurations with too many layers may lead to under-performance
- TempCNN vs RF
  - RF performance is often on similar level as best-performing TempCNN configuration
  - Training and testing time
- Performance across years seems similar
  - Transferability across years?

Next steps

- Run additional experiments with TempCNN
- Repeat experiments to check robustness of accuracies
- Class imbalance
- Move towards prediction of percentages of classes

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