TreeView

Precision Forestry to Tackle Climate Change

www.precision-forestry.org

Why do we want to monitor trees?

Trees: pillars of nature-based solutions to climate change

Trees are the conduits for natural carbon transfer out of the atmosphere

Tree-planting is a central tenet of policy responses from governments and organisations

Tree are ‘fundamental units’ of ecosystems and plantings; require studies at the scale of individual trees

Increasing value is being placed on the role of trees in urban areas for climate, health and well-being roles

UK Treescape is valued at £130 billion

Valuations of trees and woodlands

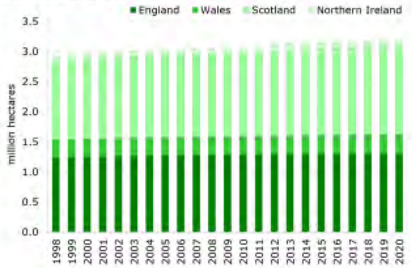
- Asset value of woodlands (2017) = £130 billion
  -Timber - £8.9 billion (6.9%)
- 475 million visits to Woodland areas and 718 million hours (2017)
- 269 thousand tonnes pollutants removed - £938 million saved in health costs (2017)
- 18 million tonnes carbon sequestered - £1.2 billion (2017)
  - 4% of UK greenhouse gas emissions
- Urban woodlands cooled 11 city regions to save £229.2 million in labour productivity and avoided air conditioning costs (2018)

ONS 2020 – Woodland Natural Capital Accounts

Current distribution and trends

- Total tree and woodland cover: 3.7 million hectares
- Tree outside woodlands: 14 %

Figure 1 Area of woodland, 1998 to 2020



Source: Forestry England, Forestry Commission, Forestry and Land Scotland, Scottish Forestry, Welsh Government, Natural Resources Wales, Forest Service, National Forest Inventory.

GOAL: 12% land coverage by 2060 (180,000 ha in the next 20 years)

Threats

- Non-natives, pest and diseases
  - Non-native species cost to forestry £109 million (Williams et al. 2010)
    - Phytophora spp = £600,000 annually
    - Green spruce aphid = £3.6 million annually
  - Ash dieback – total cost to Britain £15 billion over next 100 years (Hill et al. 2019)
    - 955 ash-associated species – 71 at high risk from declines in Ash (Broome & Mitchell, 2017
- Climate change (Morison & Matthews, 2016)
  - Increasing range of pests and diseases
  - Greater frequency of drought, heat stress and waterlogging
  - Shifting tree species suitability ranges
- Increasing woodland fires (ONS, 2020)

TreeView: Precision Forestry for a Nature-Based Solution to Climate Change

Through the UKSA National Space Innovation Programme, the OU has led a feasibility study for a new Earth Observation mission for tree-level studies from Space

A ‘Newspace’ mission:

we aim to fly a SmallSat for 5 years, for a total cost of £15m

For reference:

- ESA Scout “Newspace” missions are up to 30 M euro
- ESA Earth Explorers are ~ 100s M euro
- ESA Sentinels and Copernicus programme ~ 300 – 500 M euro

Environment, Earth and Ecosystem Sciences
Physical Sciences
Computing and Communications

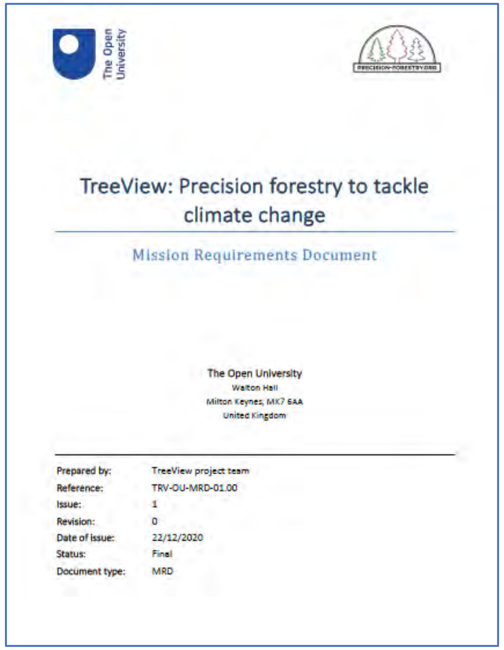
Primary Mission Objectives

Possibly the first fully UK-funded and developed science satellite mission

- To map and characterise the UK treescape
- To monitor the green infrastructure of the cities and large towns across the UK
- To provide early warning of pest, disease, and climate stress on tree populations
- To provide space-based observation of large field-based climate change experiments (e.g. BIFoR FACE) and forest monitoring sites (e.g. Alice Holt)
- To image other countries of interest such as China, Australia, Brazil and cities such as Hong Kong, Singapore, Auckland when UK is under cloud cover

Mission requirements

- Precision forestry: 'the use of advanced technologies for a more granular data capture and management'



TreeView: Precision forestry to tackle climate change

Mission Requirements Document

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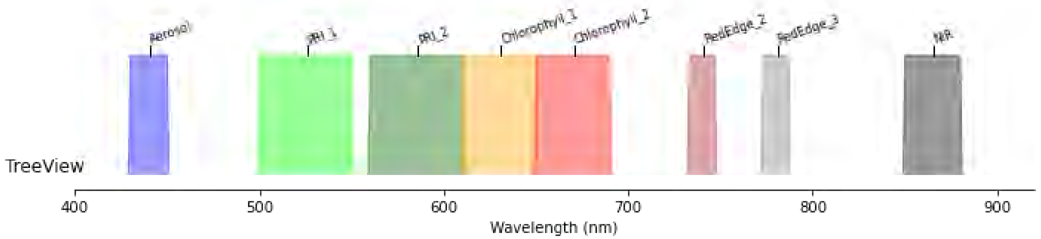
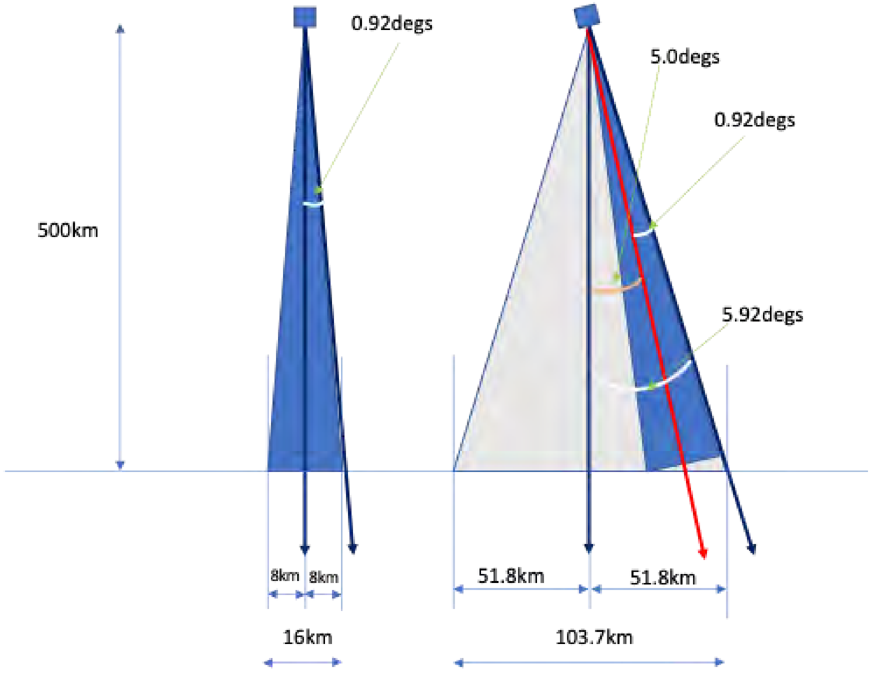


Requirement	Target	Outcome
Ground Sample Distance	2 m	2 m
No. of spectral bands	6 - 10	8
Bandwidths	10 – 40 nm	15 – 50 nm
Swath	> 40 km	> 16 km (104 km)
Full UK Coverage	1 per year	Every 6 weeks
Repeat Coverage (spring – summer)	10 x for target locations	15
SNR	> 100	> 100

Orbit

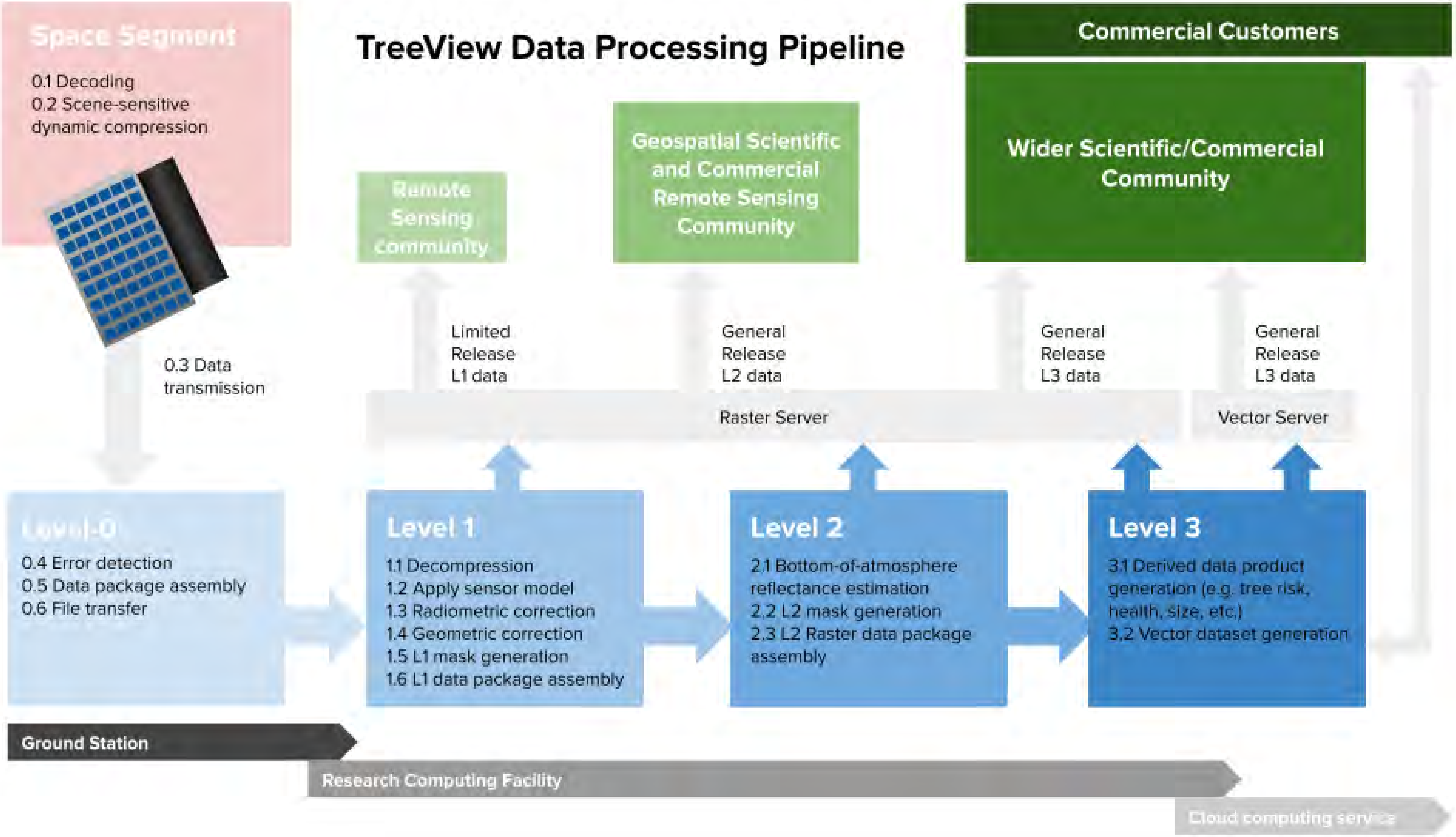


Orbit selected: Sun Synchronous, 501km, 11:00 LTAN, Local pass time over UK ~10.25am

Assumed off-nadir pointing capability of 5 degrees from nadir with a 16km swath on the ground.

For more details of the spacecraft and payload, refer to https://ceoi.ac.uk/wp-content/uploads/2021/April_2021_Challenge_Workshop/2-TreeView-CEOI-Presentation-April-2021_final_Kadmiel-Maseyk.pdf

Data Processing

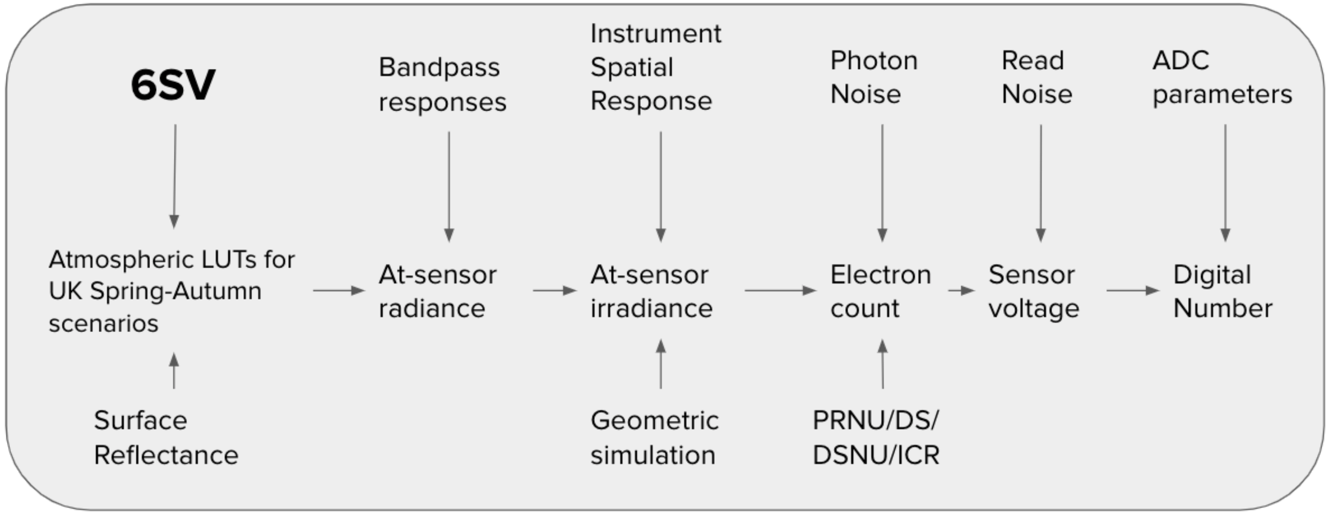


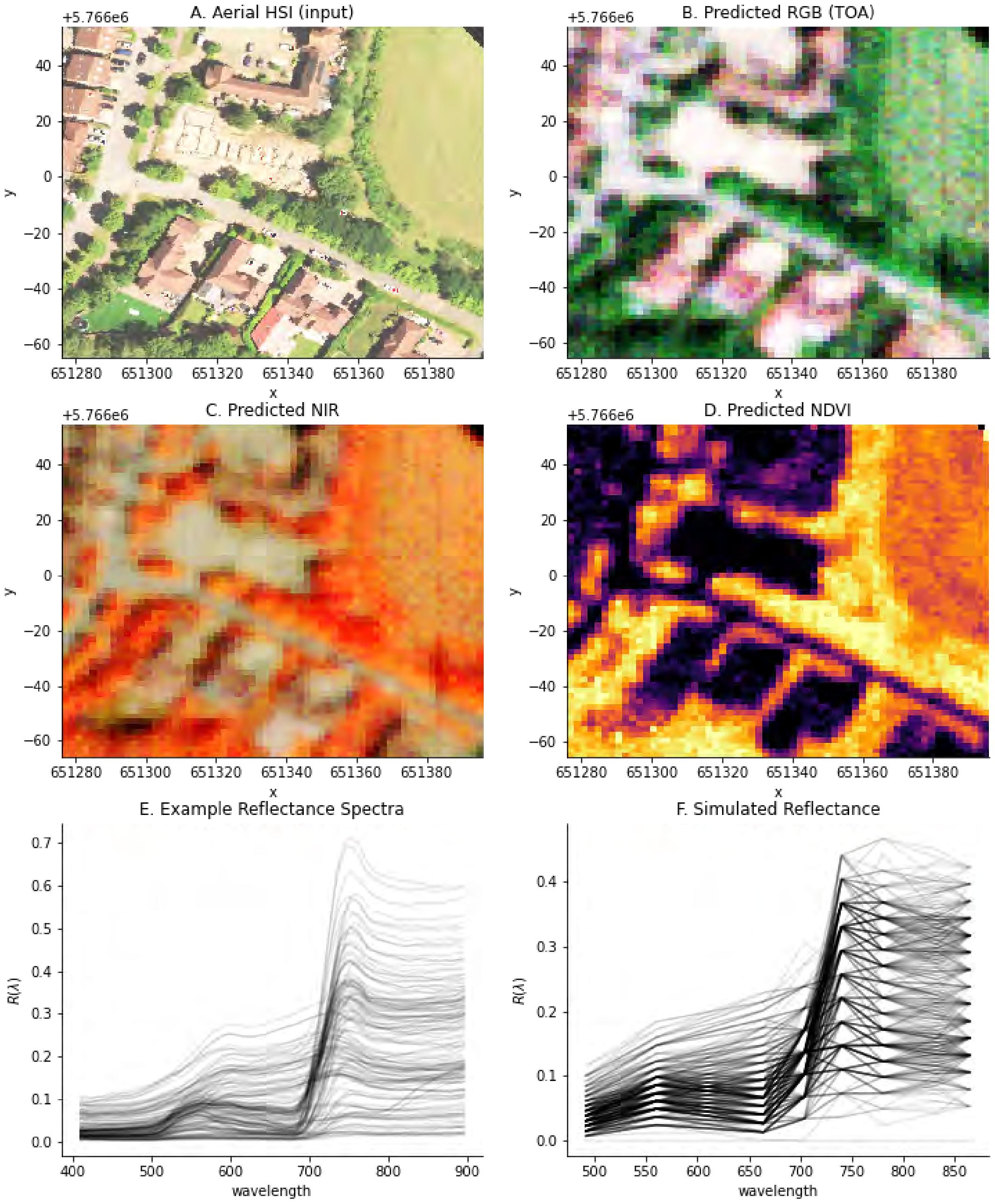
TreeView simulation work

Joseph Fennell (OU)

Simulation pipeline based on real-world scenarios; scene reflectance from hyperspectral airborne data (2Excel-geo)

Urban areas and rural woodland





Vegetation indices at 2 m GSD

We have simulated data from Milton Keynes, and compared to equivalent 10 m simulations (Sentinel-2)

TreeView won't produce RGB images; these are for comparison

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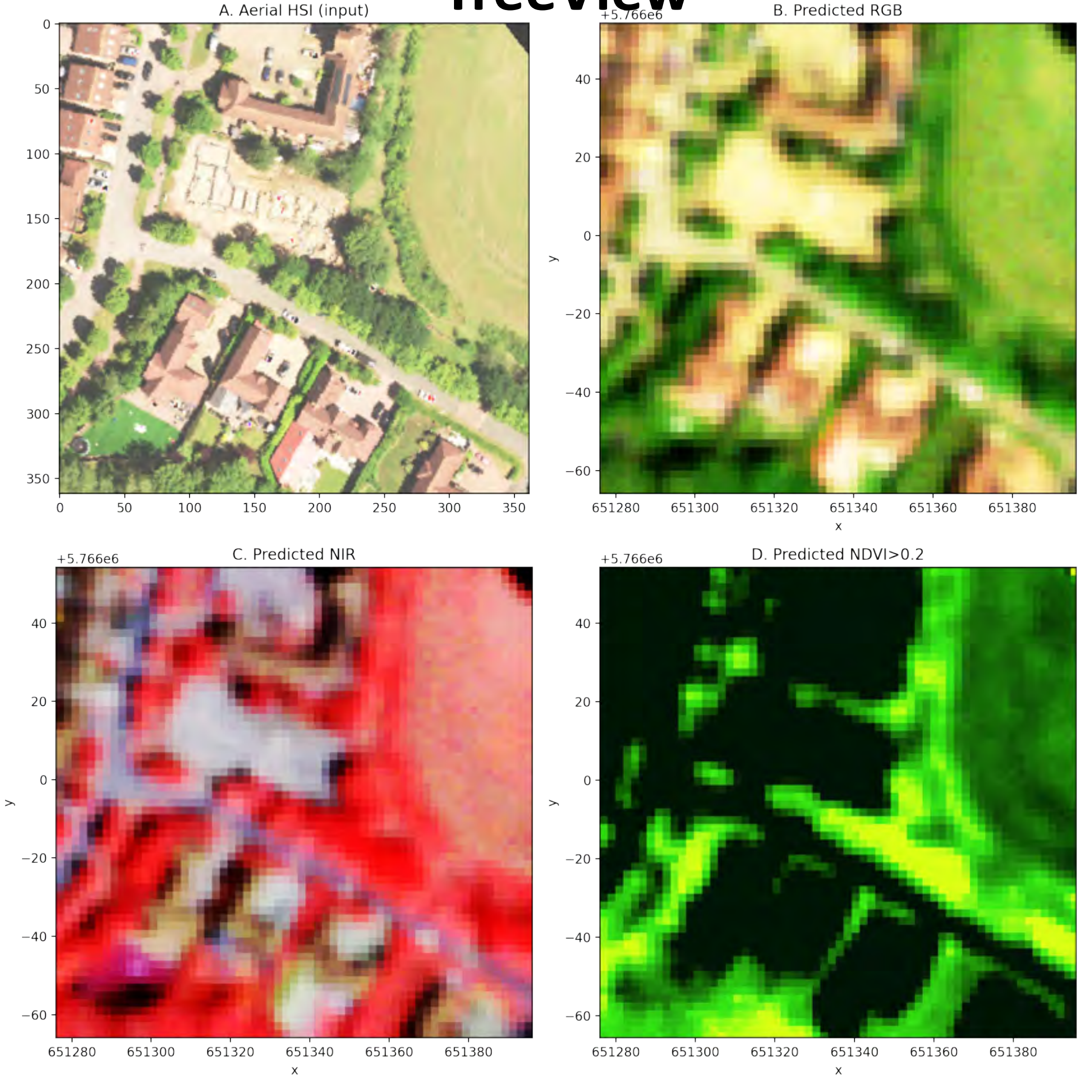
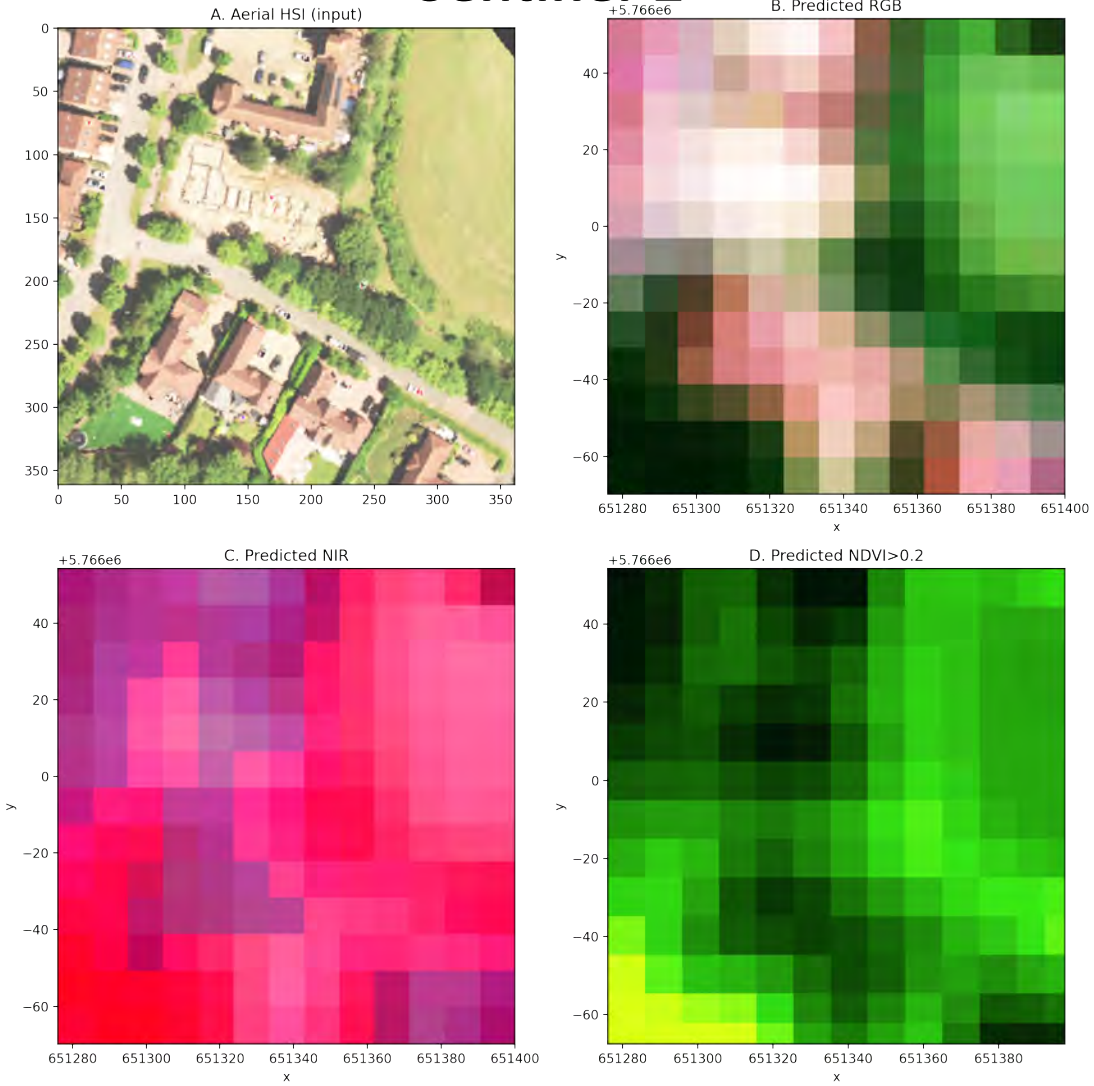
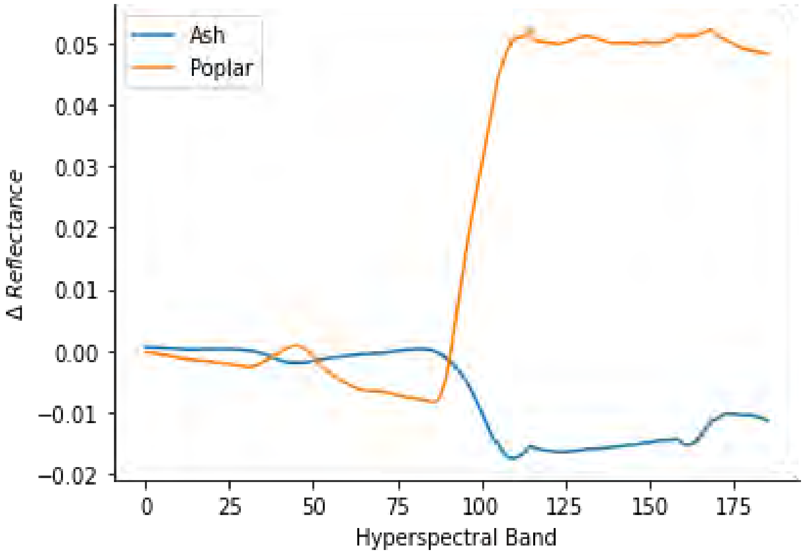


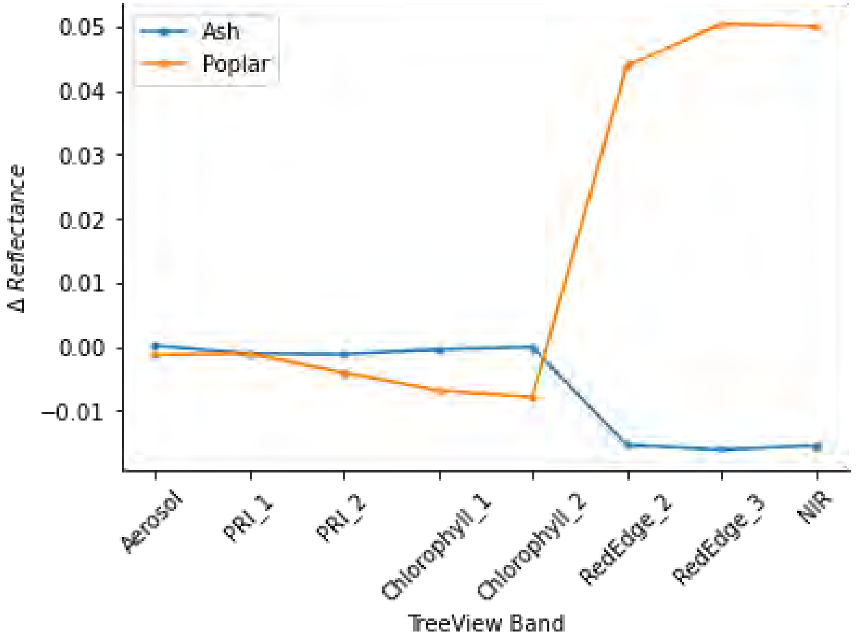
Sentinel-2



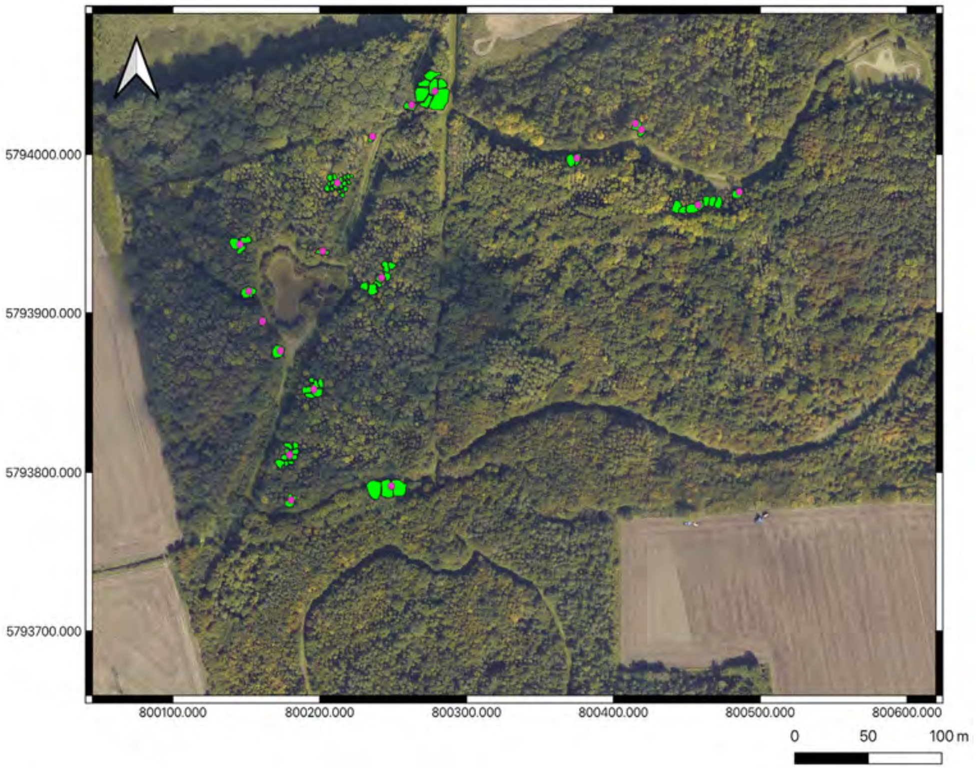
Discriminating between species

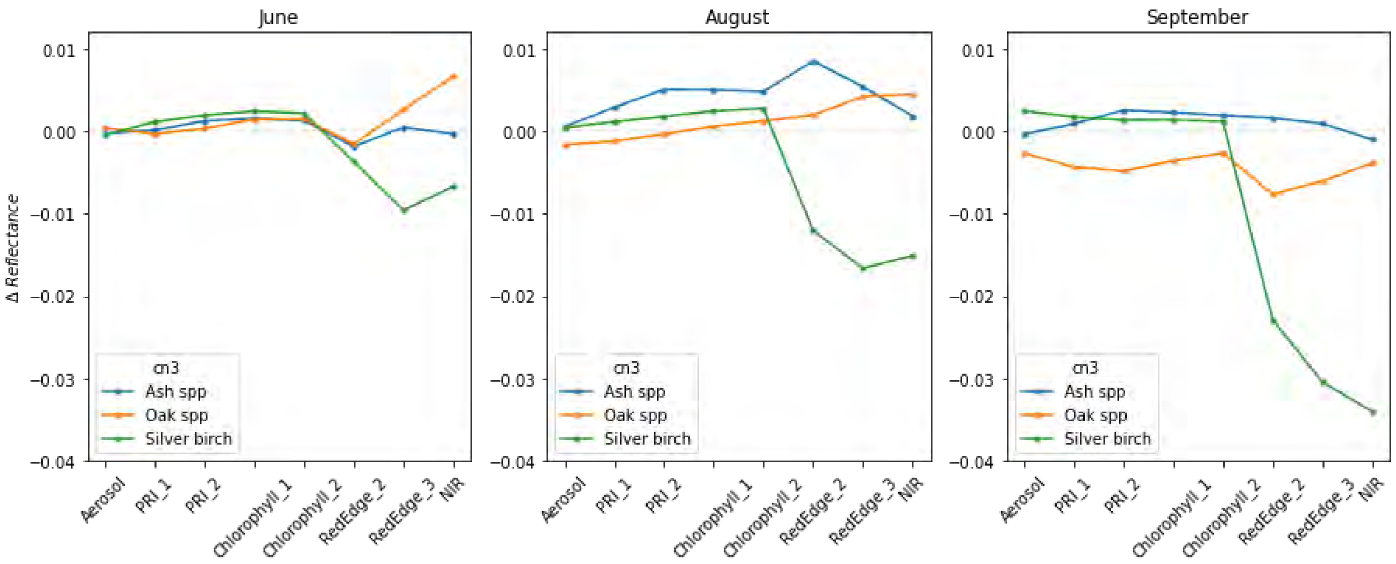
Location of tree species, Treezilla citizen science database

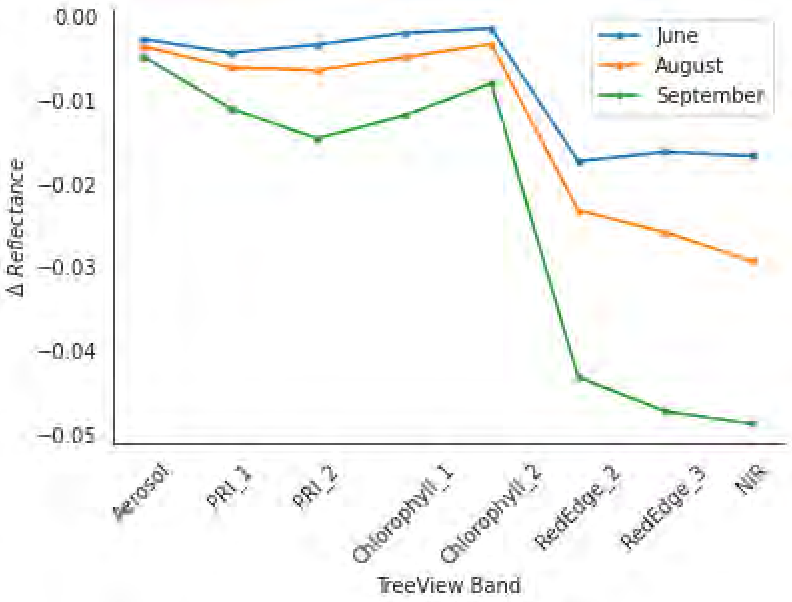




Temporal information and disease impacts







Trees experiencing ash dieback

Progress since April 2021

- SPIN (Space Placements in Industry) intern, Ben Kanda, Machine Learning for Urban Tree Monitoring
- Applied for phase 2 funding to progress to PDR – Preliminary Design Review
- Partner to a UK-Australia Spacebridge call application – investigation of agritech (tree crops) applications and partnering in ecosystem restoration management Southern Australia
- Working with a wider range of partners and stakeholders in the UK

Summary

- TreeView is a tool for measuring, monitoring and management of treescapes to assess the impacts of climate change and to quantify their role in carbon capture

- There are potential applications in other ecosystems such as wetlands, peatlands, and in monitoring the health of orchards

- TreeView represents a very affordable route to large scale precision forestry

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