INTEGRATION OF SPATIAL BIG DATA FOR IMPROVED LONG TERM FOREST RESOURCE PLANNING

IRISH RESEARCH COUNCIL
An Chomhairle um Thaighde in Éirinn

Dylan Walshe[1,2], Daniel McInerney[1], and Kenneth A. Byrne[2]
[1]Coillte Forest, Castletroy Business Park, Plassey Road, Limerick.
[2]Department of Biological Sciences, University of Limerick.

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Abstract

Ireland's forestry sector delivers key economic, environmental, and social services to the public. The sector is expected to play a key role in the transition to a carbon free society and aid in mitigating the effects of climate change. Achieving this requires the development of scientifically robust tools to underpin forest management decisions across short to long term times scales.

This project will use remote sensing datasets to estimate forest parameters such as tree height, stem diameter, standing volume, and stocking. The outputs from the models will then inform the second objective which is to investigate the impact of increased storm frequency, the impact of biomass removal, and changes in silviculture due to encroachment of invasive species on sustainability.

The growing importance of the forestry sector, particularly the increased demand for wood as biomass, and the impacts of increased storm frequency makes this project timely and essential as the results of the evaluation of models will be crucial in analysing timber supply, management decisions, and future planning as well as providing novel contributions to Coillte's operational forest resource planning work flows.

Objectives:

1. To develop and optimise statistical models for the spatial estimation of forest parameters at individual forest stand level using multi-temporal airborne laser scanning (LiDAR) data, optical satellite imagery and field inventory data.

2. Investigate the impact of future modelling scenarios on timber production, sustained yield, and ecosystem services. The specific scenarios will relate to the impact of increased storm frequency, biomass removal, and encroachment of invasive species.

Study Area

The Slieve Blooms has been chosen as the project site because two LiDAR campaigns have been flown (2013 and 2018). The study area also has a historical archive of cloud-free satellite imagery from Copernicus' Sentinel 2 and NASA's Landsat 8. Sentinel 2 will be used as a primary source of imagery due to its spectral resolution and revisit time of ~5 days. It is used for intensive timber production, and provides a range of eco-system services e.g. amenity, landscape, and biodiversity. The total forest area is 11,240 ha and is made up of Sitka Spruce (8,620 ha), Lodge Pole Pine (1,234 ha), Norway Spruce (323 ha) and the remainder is other broad leaved species.

Study Area

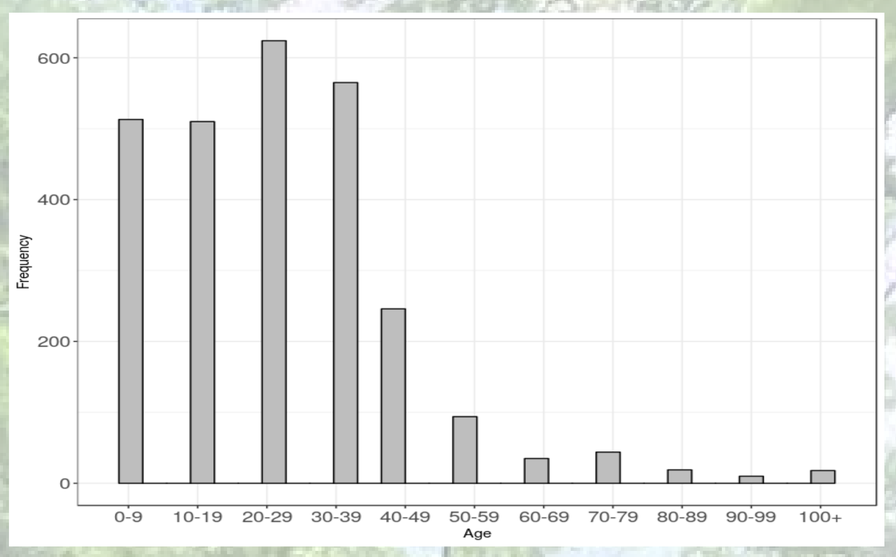

Figure 1: Age class distribution of Coillte forests in the Slieve Blooms Study Area

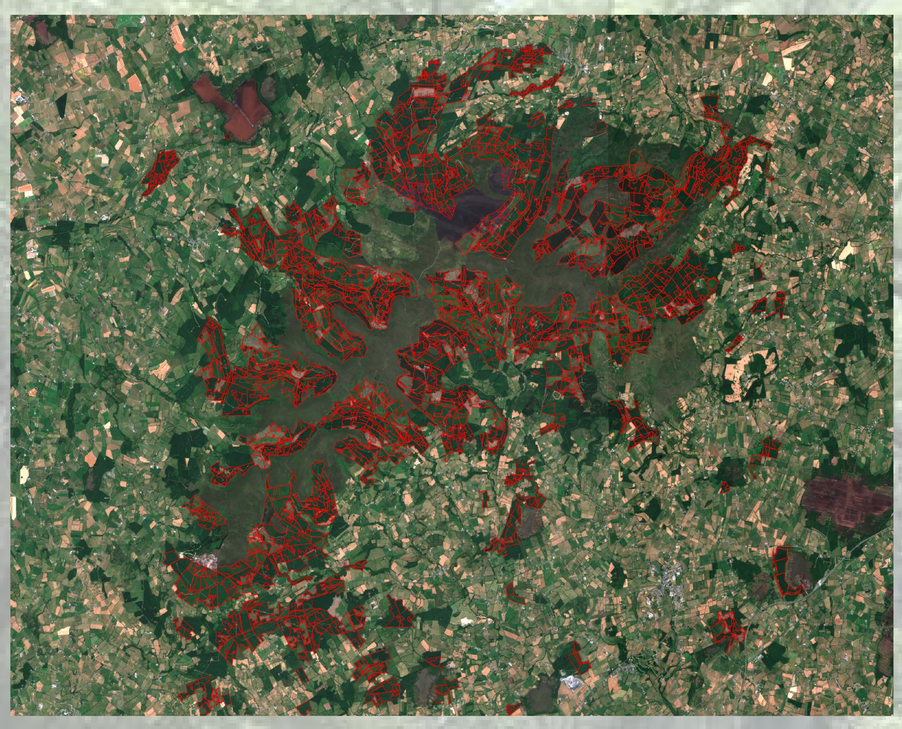

Figure 2: Sentinel 2 RGB image of the Slieve Blooms (red) taken on 10/07/2018

Methods

Work Package 1

Data	Modelling	Uncertainty
• Acquire • Consolidate • Validate	• Height • DBH • Volume • Stocking	• Accuracy • Precision • Bias

Work Package 2

Storm Frequency	Biomass Removal	Invasive Species
• Decisions • Production • Profile	• Nutrient availability • Bio-economy	• Birch • Rhododendron

A variety of models will be created and tested e.g. multinomial, RandomForest, k-nn, and SVM.

Software

This project will involve processing spatial Big Data and so will be completed using a GNU/Linux distribution operating system (e.g. Ubuntu) as it facilitates parallel processing and offers efficiencies in data processing. All of the images used will be processed by free and open source software such as GDAL, QGIS, Orfeo Toolbox, R, pktools, ARCSI, SNAP, FUSION. The scripts written as part of this project will be made available online (Github) and allow for replication of results.

Remsoft is an optimised operational and scheduling software that is used in Coillte to plan harvesting in tactical (3-5 years) and strategic (20-30 years) time frames. The results from the modelling will feed into this software and be used to alter harvesting plans.

Expected Results

- A model capable of estimating forest parameters at stand level using field inventory report measurements.
- A multi-temporal LiDAR dataset which estimates change at the stand level.
- A profile of site characteristics for storm susceptible forests which will be used to identify at future risk areas.
- An impact assessment report on nutrient availability due to the removal of biomass on subsequent forest rotations.
- An impact assessment on the effects of encroachment of invasive species has on timber production and sustained yield.

Conclusion

Using remote sensing, LiDAR, and field inventory datasets, a model for estimating forest parameters will be produced in order to update stand level inventory in the Slieve Blooms. Three scenarios pertaining to the impact of storms, biomass removal, and encroachment of invasive species will then be modelled in relation to timber production, sustained yield, and ecosystem services for state forests managed by Coillte. All three scenarios will be modelled on two time scales, tactical and then strategic.

Acknowledgements

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