**Creation of a Digital Twin of the Forest of Dean in South England for precision forestry applications**

Digital Twins (DT) are virtual representations of physical objects, systems, or processes, designed to simulate, analyse, and predict their behaviours in the real world. These digital models are created using data collected from sensors and other sources, which can include real-time data, to mirror the physical counterpart as closely as possible. This allows for in-depth analysis, monitoring, and optimization of performance, as well as the ability to test scenarios and solutions in a virtual environment before applying them in reality.

The application of DF to forestry involves creating a virtual model of a forest that can simulate its physical characteristics, processes, and dynamics. This model can be updated in real time or at regular intervals with data from various sources, including satellite imagery, drones, ground sensors, and manual surveys.

A DT has been created for a forest district in South England. The Forest of Dean stands are characterised by a complex structure with a mix of species and ages on a progression to natural forests. As a result, current stand models are very limited to forecast production, test different management alternatives or gauge the impact of disturbances. The aggregated nature of the baseline data embedded in the Forestry England Subcompartment Database incorporates considerable uncertainty in any model predictions. Therefore, better alternatives have been sought by realigning the subject of all the analysis to individual trees.

Tree lists have been created using a combination of Airborne LiDAR (ALS) and high-resolution satellite imagery such as Planescope. Whereas trees are being delineated using normalised pointclouds, species labelling has been achieved using time-series of satellite imagery that looks at the particular phenological cycles for each vegetation type. Mobile Laserscanning has been captured in plots of 30x30 m to calibrate allometric relationships to define stem properties, which cannot be seen directly from ALS. The reconstruction of stem profiles is being done using 3DFin, developed by the University of Oviedo and CETEMAS in Spain. This application also creates a tree list with height and DBH. As pointclouds were registered to the OSGB National Grid, then DBH extracted from the ground could be added seamlessly to tree lists generated to the tree lists created by ALS. As a result, allometric models were created to link species, tree height, canopy width, depth and volume to DBH. So, it was possible to upscale the estimations of DBH to all the area being covered by ALS, totally 80 km2.

The final tree list has been used as baseline data to run production forecast models and calculating the probability of wind damage using ForestGALES. Different management options such as clearfelling, thinning intensities, or transitions to Continuous Cover Forestry have been tested to evaluate the long-term effects on timber production, changes in the probability of wind damage or the recruitment intensity for natural regeneration.

This presentation will show examples of the advantages of using precision forestry methods for implementing the best possible alternatives in terms of adding volume increments and minimising the risk of wind damage.