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| **Assessing spatio-temporal disturbance in Australian softwood plantations with multi-resolution satellite sensors.** |
| Current methods in Australia for detection of poorly performing softwood plantations range from irregular ground inspection, through annual expert observations from helicopter or aircraft to occasional use of spaceborne multi-spectral sensors. The cost of aerial observations over large extents is substantial. However, regular image acquisitions from satellites provide the potential for more timely and cheaper assessments of plantation condition.  The aim of this nationally funded two-year research project is to assess the cost effectiveness of using differing resolution multi-spectral satellite sensors to detect symptoms of plantation disturbance.  The geographical focus for this project is a large section of southeastern and eastern Australia covering approximately 370,000 ha of non-contiguous pines. Whilst species vary slightly from *Pinus radiata* to *P. elliottii*, the climate, topography, damage agents and silvicultural management practices vary substantially across the study area.  Satellites sensors of differing resolutions have been selected. These are Sentinel 2 (10-20-60m), PlanetScope (3m), SkySAT (2m) and Pleiades Neo (1.24m). The latter two satellites are pan-sharpened to 0.5m and 0.3m respectively. Using cloud computing, the Forest Disturbance Index (FDI) using Tasselled Cap Coefficients (TCC) (at ground reflectance) for six of the Sentinel 2 bands, is applied to seasonal geo-medians. Processing is restricted to plantation estates using GIS supplied by foresters. Atypical FDI values both spatially and temporally (seasonally and annually) are detected using statistics. Atypical pixels are compared with ground truth established at six 10km x 10km sites where high spatial resolution aerial CIR imagery is captured. Machine learning (ML), using extensive training from forest experts, is applied to this imagery to detect disturbed individual trees. In addition, near simultaneous PlanetScope and Pleaides Neo imagery is captured, analysed and compared with the ground truth.  Ground truth was successfully established from ML applied to aerial imagery and enabled the health of individual crowns to be classified. When pan-sharpened Pleiades Neo satellite imagery using standard spectral indices is compared with ground truth, individual infected trees can be detected with variable accuracy. However, gaps in the forest canopy lead to false positives. Currently we are developing a non-canopy mask to reduce these errors. At the lower resolution of Sentinel 2, the application of the spatio-temporal FDI shows that individual discoloured/infected trees cannot be detected. When atypical trees cluster at three or more, FDI can detect them. Again, gaps in the forest canopy lead to false positives; we are currently trialling two methods to remove these effects. Additionally, we are currently experimenting with the derivation of species specific TCC for all 11 Sentinel 2 bands. This should provide increased sensitivity in unhealthy tree detection.  Whilst this project is 50% complete, early findings demonstrate that Sentinel 2 imagery can be processed over large extents, at low cost, to detect plantation disturbance. This is not successful at the individual tree level. As the resolution of the satellite sensor increases, as does the cost, unhealthy individual trees are able to be detected. Finding the optimum balance between resolution and cost is the challenge that this research will answer by June 2025. |