NATIONAL INSTITUTE FOR
FOREST PRODUCTS INNOVATION

NIFPI Mount Gambier Centre Project Progress Summary Reports - Summary reports as of 10 June 2020

NS020 / NT001 Solutions for the optimal use of dense, remotely acquired data by forest growers

Lead organisation
NSW DPI Forestry/ University of South Australia

Principal researcher
Dr Christine Stone, NSW DPI Forestry / Dr Jim O'Hehir, University of South Australia

Start date 1/11/2018
Completion date 15/6/2020

Project description
Rapidly advancing remote sensors on UAV, airborne and satellite platforms are providing high fidelity data in terms of spatial, spectral and temporal resolution. A trans-Tasman team of remote sensing specialists, data scientists and forest industry service providers will ensure the delivery of multiple task specifications and procedures for the operational implementation of these technologies by the forestry sector.

Summary of progress
Plantation resource managers are increasingly attracted to the use of remote sensing systems for obtaining tree measurements and assessments due to increasing sensor and platform capability and availability, reducing deployment costs and increasing costs and risks associated with the current manual systems. This project is developing and adapting new cutting-edge sensor and platform technology for use in forestry applications. The project is comprised of several sub-projects which are actively involved in developing solutions for applications using a range or sensors and platforms in different situations across Australia. The project is benefitting from a high level of collaboration between industry and researchers to make multiple data sets available with knowledge sharing on solutions.

Ultra high-resolution imaging from Unmanned Aerial Systems (UAS) for detection of weeds and tree health assessment represents the sub project being undertaken by the University of Tasmania. Data has been collected at three pine plantation sites in Northern Tasmania using a range of sensors: hyperspectral; multispectral, visible and thermal, with the aim of testing which sensors are best at detecting weeds. Data processing is now complete, and the results are being summarised.

A second sub project; hyperspectral detection of nutrient deficiencies in radiata pine undertaken by Scion (New Zealand) has demonstrated that generalised field predictions of photosynthetic capacity can be made using only remote sensed reflectance data. This will benefit the industry by improving the assessment of plantation nutrient status at a fraction of the cost and complexity of manually collected and analysed methods.
The University of South Australia (UniSA) is undertaking a sub project: monitoring Forest Properties at the Individual Tree Level using UAV-borne Sensors. Two approaches have

been developed to undertake survival counts of young radiata pine plantations from pre-processed Hyperspectral and Phantom UAV images. Both methods work but the second approach has been found to be more accurate and cost-effective in terms of estimating tree survival counts. Most plantation companies already have the equipment to capture the necessary data and allow the companies to estimate replanting costs to make more informed decisions.

The automation of forest inventory sub-project undertaken by the University of Sydney, has progressed development of workflows and algorithms for tree-level census using point clouds, deep learning and human-machine interaction. Recent research indicates tree detection methods developed for high resolution Airborne Laser Scanning (ALS) data based on deep learning object detection could also be applied effectively to low resolution ALS data. The implication for forest companies is that using this method, cheaper data can be used to obtain more tree attribute information.

UniSA are undertaking a sub project: Growth and Yield Modelling for the Future. The sub project has incorporated ground truth data into plot imputation models and shown that potential to increase the efficiency, and lower the costs, of ALS surveys by reusing calibration plot data both spatially and temporally. The UniSA sub project: Investigation of data management and processing options for forest industry has resulted in the development of a report which draws on the literature to compare options for forestry data management with an emphasis on large data sets.

Interpine have continued working on Ultra-Dense Point Clouds for Inventory implementing forest inventory using a backpack LiDAR scanner. The resulting scans are being incorporated in a virtual reality application (VRForest) and these results are then available for use in forest resource planning software.

NS021 Future Proofing SA Blue Gum Plantations through improved detection of koalas in early planning and forestry operations.

Lead organisation
University of South Australia

Principal researcher
Assoc Prof Delene Weber, University of South Australia

Start date 12/11/2018
Completion date 27/8/2021

Project description
The project will undertake a systematic evaluation of traditional methods and emerging technologies for detecting koalas in blue gum plantations. Results of the evaluation will be used to develop and further test the successful technology.

Summary of progress
The plantation forest industry has invested in systems and equipment to identify koalas. This project aims to improve on these methods by trialling a range of current and potential technology for identifying koalas. A new method involves deployment of multi spectral sensors on an Unmanned Aerial Vehicle (UAV) and development of a real time processing system. The technology uses an algorithm that maximises the value of the scanning data using a biologically inspired method.

NS023 Wearable sensors for improving occupational health and safety of workers in the forestry industry: a pilot prototype for harvesting and processing operations

Lead organisation
University of South Australia

Principal researcher
Prof. Chris Chow, University of South Australia

Start date 15/1/2019
Completion date 15/12/2020

Project description
This project will evaluate workwear embedded with smart sensors for monitoring workplace health and safety hazards. The potential to provide direct early warning advice to individuals will be evaluated.

Summary of progress
Forestry plantation and processing worksites often involve interaction between workers and machinery posing safety risks. New technology being used in other industries may be able to be adapted to help keep separation and provide warnings where the proximity is too close. Working with two sawmilling companies', prototypes have been developed of an artificial intelligence learning system for detecting people and machinery. A prototype system has been developed and is being trialled with videos taken of sawmill situations in place of being able to trial onsite.

Human body and vehicle detection through image processing are a reasonably mature technology, which does not require complex hardware. However, in low-light and dusty environment, there is a possibility for error. Combining the sound processing as a secondary data input reduces the potential risks and significantly increases detection accuracy. Since most cameras include microphones, there are no additional hardware cost. The core of this solution is a machine learning model which is built based on both image and sound data. Such a combination has not been found in the market previously. This proposed solution does not rely on any network, nor additional cloud hardware to run and can be rapidly deployed in any environment. Therefore, the research team believes that this is a valid and practicable approach to address the participants' safety issues.
The UniSA sub project: Investigation of data management and processing options for forest industry has resulted in the development of a report which draws on the literature to compare options for forestry data management with an emphasis on large data sets.

Interpine have continued working on Ultra-Dense Point Clouds for Inventory implementing forest inventory using a backpack LiDAR scanner. The resulting scans are being incorporated in a virtual reality application (VRForest) and these results are then available for use in forest resource planning software.

NS024 Optimising the management of plantation, water and environmental assets.

Lead organisation
University of South Australia

Principal researcher
Dr Baden Myers, University of South Australia

Start date 1/11/2018
Completion date 20/12/2021

Project description
This project will enable the industry to commercially manage plantation, water and natural wetland assets and be recognised by other licenced water users, the community and water regulator as working within the social licence. The project will develop high spatial resolution (25m) and high temporal frequency (every 8 days) actual evapotranspiration regional estimates for the entire Green Triangle to better close the regional water balance.

Background
This project aims to better understand plantation water use and impacts on wetlands in the South Australian water licencing system. The project aims to develop a scientific basis for improved accounting for plantations whilst ensuring sustainable water resources.

Summary of progress
The first sub project has developed a prototype plantation water use estimator. The system uses blended remote sensing data and user provided dates to estimate water use. This will allow the use of actual plantation water use rather than deemed water rates. The tool currently estimates tree water use (evapotranspiration) for any location within Australia on any day of the year. Comparison of the results with other evapotranspiration tools and datasets, including estimates from plantation owners, indicate water use estimates within the expected range.

Groundwater impact assessment is the subject of a second sub project which is testing assumptions behind forest water accounting in the Lower Limestone Coast of South Australia. These include: documentation of a consistent method to provide a depth to groundwater layer; development of a current depth to groundwater layer; investigation of the specific yield of the aquifer for management areas in the Lower Limestone Coast Water Allocation Plan; investigating the accuracy of estimating peak and trough groundwater levels from manually recorded groundwater well depth data.

A third sub project is considering the management of wetlands in plantation forests. The aim is to ensure buffer policies are well founded to protect environmental assets whilst maximising the productive capacity of the plantation land. To date, effort has been on review of buffers including collation of requirements in Australian states and where available in published literature. Consultation with plantation forest managers has developed an understanding of how wetlands are currently managed, including condition assessment and management actions which have been applied.

NS025 Development of best practice guidance for protective guarding of mobile plant used in Australian forests

Lead organisation
Australian Forest Products Association (AFPA)

Principal researcher
Mark Brown, University of the Sunshine Coast

Start date 1/7/19
Completion date 10/12/19

Project description
The project will identify appropriate standards for the design of operator protective structures for heavy machinery used in the Australian forest industry and develop a Best Practice Guideline for publication.

Summary of progress
Industry best practice document has passed through two rounds of industry partner reviews. Second round of feedback is bow being incorporated before content is transferred to the final Best practice format with a desktop publisher. Once it is in final format it will be circulated with the industry partners for a final review. After this review we will plan a series of workshops or virtual workshops to introduce the final best practice to industry for application as a consistent industry approach to managing safe cab protection in industry operations.

Anticipated time line:

- Final draft circulated with industry by 19 June 2020
- Industry introduction workshops in July-August 2020
- Project conclusion with deployed best practice by September 2020

NS026 Development of a timber industry sector framework for setting carbon emissions targets using the Science Based Targets initiative

Lead organisation
Edge Environment Pty Ltd

Principal researcher
Jonas Bengtsson, Edge Environment

Start date 1/4/19
Completion date 28/2/20

Project description
The project will develop life-cycle greenhouse gas emissions mitigation targets, aligned with International best practice (SBT initiative), for use and adoption by the Australian timber industry to maintain timber's position as a preferential product.

Summary of progress
Carbon in materials is one of the most important and urgent issues to tackle in the transition to a low carbon economy and timber has a natural advantage. However, the process of demonstrating the carbon benefits of timber use is quite technical. Through NIFPI funding, the project team has developed Australia's first easy to use carbon calculator and carbon reduction target-setting tool for the wood product manufacturing sector. The methodology applied in these resources has been tested with Timberlink, who have successfully measured the carbon footprint of their operations and supply chain. With this technical phase nearing completion, the next step is communications, the aim of which is to engage the industry in leading the carbon agenda in the built materials sector, delivering commercial and reputational advantages and increasing the use of timber in construction.

Ultimately this work seeks to: grow awareness of the resources available (developed as part of this project) to help manufactures measure their carbon footprint and set targets;

drive engagement within the timber industry on the importance and value of setting science-based carbon reduction targets; and catalyse change through the increased use of lower carbon materials in construction to decarbonise our built environment.

NS031 University of South Australia Options for Operating Efficiently and Sustainably within Forest Water Licence Rules

Lead organisation
University of South Australia

Principal researchers
Courtney Regan and Jeff Connor, University of South Australia

Start date 1/7/19
Completion date 30/6/20

Project description
The project will report on economic value of water accounting and licencing options industry can propose. The project will develop a spread-sheet application for forest industry to evaluate economics of responses to new water licencing requirements.

Summary of progress
Forest water licencing is unique to the Lower Limestone Coast of South Australia. This project provides forest licence holders with the opportunity to work within the water licencing rules to establish agreed options for ensuring flexible management within State Government management plans. After consultation with plantation growers, a model using stylised data has been built for radiata pine and Tasmanian blue gum that provides a tool for testing alternative management strategies including age of clearfelling, replanting versus land disposal and the price that can be paid for water licences. The tools developed from this project will be made available to the forest water licensees to be incorporated into their own planning, business and analysis systems.

NS032 Characterising softwood sawn products in Australia

Lead organisation
University of South Australia

Principal researcher
Assoc Prof. Rameez Rameezdeen, University of South Australia

Start date 1/8/19
Completion date 30/6/21

Project description
Establish the physical and mechanical properties of a nationally pooled Australian structural softwood timber sample to validate its compliance with the design standards specified in AS1720.1-2010: Timber Structures - Design Methods

Summary of progress
The aim of this project is to capture a representative sample of softwood sawn-timber production from 13 major Australian sawmills. The sampled timber will be tested at the University of South Australia (UniSA) and results analysed to provide feedback to the industry on the structural properties of their sawn timber products; and provide a

benchmark of Machine Graded Pine (MGP) properties that can be compared against the results of previous and future test programs.

A dedicated in-grade timber testing facility is almost complete at the UniSA Mawson Lakes Campus as part of the UniSA's Specialised Testing and Research Unit. The timber testing 'production line' is optimised to process bending, tension, compression and shear tests from timber up to 6m long with associated moisture and density data. Four test machines have been purchased by UniSA with two now installed. Delivery of the third and fourth has been delayed due to current international travel restrictions. Testing of some timber from a trial pack has begun to test the equipment and system.

To undertake the testing and to build capacity, UniSA has recruited a Testing Coordinator for this project and will employ additional technical staff in the coming months. Rigorous data capture and storage software has been developed by UniSA's information technology team to track samples, identify the piece and preparation of the biased and random bending test specimens and ensure the integrity of the project results.

NS033 Development and implementation of forest health and biosecurity systems and protocols based on quantitative pest risk and economic impact assessment

Lead organisation
University of South Australia

Principal researcher
Dr Jim O'Hehir, University of South Australia

Start date 1/7/19
Completion date 30/6/21

Project description
The project will develop a Green Triangle focussed integrated forest health and biosecurity system (including response scenarios) utilising pest spread forecasts and economic impacts to plantation (profitability, control costs and loss of markets).

Summary of progress
Forest health involves the management of existing pests and diseases while biosecurity concentrates on the exclusion and detection of exotic pests and diseases. This project includes designing and implementing a cooperative forest health and biosecurity surveillance system and developing calibrated pest spread and potential economic impact models.

The risk of biological and economic loss due to pest and disease incursion is perceived as high and if uncontrolled, can result in significant plantation loss. The Port of Portland is identified as the region's major risk for pest and disease incursions. The University of South Australia (UniSA) has employed a local forester who is being trained to take on the role of a forest health and biosecurity officer with appropriate training and certifications to operate under legislative authority in South Australia and Victoria.

The project is using Agriculture Victoria expertise to adapt a model developed for metropolitan Melbourne to understand the biological risk of pest incursions in the Green Triangle region. The integrated health and biosecurity monitoring system is being rolled out in the radiata pine and Tasmanian blue gum plantations in the south west of Victoria.

Collaboration at an industry scale allows for increased knowledge transfer to aid in better decision making, cost sharing and better understanding of pest/disease risks and impacts. The group aims to meet to discuss forest health issues, collaboration and the project objectives.

The results from the monitoring system assessments will be integrated into the Australian National Forest Health reporting system to be developed by Plant Health Australia. Individual companies will receive their own report to describe specific risks and the results of incursions, and where appropriate recommendations for control treatments.

NS034 Scoping an Automated Forest Fire Detection and Suppression Framework for the Green Triangle

Lead organisation
University of South Australia

Principal researcher
Dr Jim O'Hehir, University of South Australia

Start date 1/7/19
Completion date 31/3/20

Project description
The project will deliver a feasibility and cost benefit study aimed at innovative forest fire detection technological solutions and optimisation of forest fire controlling decision making processes.

Summary of progress
This project is relevant to the fire detection and suppression system in the Green Triangle region which is reliant on fire towers and other methods for fast fire detection and suppression to protect the plantation and wider community.

One sub project relates to the potential for detection from remote sensing methods and a report provided to industry which provides a clear picture of available fire detection technology and the availability of future innovations. High potential systems have been identified and the most promising trialled by the forest industry partners over the 2019/2020 fire season. OroraTech (https://ororatech.com/) plans to launch cube satellites constellation beginning in 2021 which aims to detect fires within 10 minutes and provide notifications within 20 minutes. Contact has also been made with Airbus who have been trialling the High Altitude Pseudo-Satellite (HAPS) system (https://www.airbus.com/defence/uav/zephyr.html). A presentation has been made to the South Australian Country Fire Service, Victorian Country Fire Authority and Victorian Department of Environment, Land, Water and Planning staff and a submission made to the SmartSat CRC (https://smartsatcrc.com/) incorporating an extension of the project to make use of alternative sensors.

A second sub project has undertaken a 'view shed' analysis of the Green Triangle fire towers and the potential for complementary detection systems such as cameras. A third sub project has modelled alternative suppression scenarios including firefighting resources, deployment relative to forest fire danger, travel times to fires and plantation area and value loss. This all provides the industry with an overview of future options for investments in fire suppression, deployment and detection methods. It is believed to be the first time this combination of modelling has been developed and applied to provide a basis for efficient and effective optimisation of forest plantation fire loss systems.

NS038 Development of state-of-the art genomic resources for pine breeding to enable single-step genomic selection

Lead organisation
Southern Tree Breeding Association Inc.

Principal researcher
Dr Tony McRae, STBA

Start date 1/4/19
Completion date 30/6/21

Project description
The project aims to double the rate of genetic gain in the pine breeding program in Australia via an across industry rollout of a low-cost, high-throughput SNP genotyping assay and modern, single-step genomic selection methods.

Summary of progress
Tree Breeding Australia, based in Mount Gambier, manages softwood and hardwood cooperative tree improvement programs for the Australian industry. The current NIFPI project aims to operationalise single-step genomic prediction into the national breeding program for radiata pine.

Modelling indicates that single-step genomic prediction can double the annual rate of genetic gain in the program primarily by shortening the generation interval and increasing the accuracy of prediction. Such an increase will deliver substantial long term economic and competitive benefits to the Green Triangle and other Australian regions growing softwood plantations.

The project is contributing to the reference assembly (genome map) for radiata pine in partnership with other international efforts. This map will enable tree breeders to make sense of DNA sequence and marker data used in single-step genomic selection. Directly measuring the DNA sequence to identify differences and similarities between individuals (using DNA sequencing and array technologies) enables prediction of genetic value years before field measurements. The DNA data are used to predict the realised relationships among individual trees, and this enables selection based on the DNA measurements when combined with the performance data in the national database. Performance data for growth, form (branch size and stem straightness), wood quality and health traits on more than
560,000 genotypes measured in hundreds of field trials will be used routinely as training populations to develop prediction models for identifying elite trees for use in Australian plantations.

The machinery to run a single-step genomic prediction approach has been developed by Dr Kerr (TBA), Dr Boerner (Animal Genetics and Breeding Unit) and colleagues by developing new algorithms and software systems in partnership with the livestock industries to enable results of the DNA assays to be used in tree breeding and forestry operations. Data to implement it has been collected and used in eucalypts, but getting the required data is a more difficult task in radiata pine due to the conifer genome being 47 times larger.

To investigate options for data generation we have tested a NZ SNP chip, as a DNA assay method, on 192 genotypes and found it to be promising. A further 768 samples have also been sent to the USA for genotyping by Thermo Fisher following extraction of DNA by AGRF in Adelaide.

Dr Tibbits and colleagues at AgriBio are currently genotyping seeds and needle tissue sampled from a key founder collection. This collection aims to capture and sequence founder trees that contribute genes to the advanced generation breeding population of TBA. The current collection captures 59.3% of all genes and ongoing efforts by collaborators is seeking to find more founder trees in arboreta, orchards, trials and archives, with the prospect of the project being able to collect 70% of all genes in the breeding program.

While this project is primarily focused on building foundational data sets to enable long term use of genomics data in the radiata breeding programs we are also planning for the results to be used in a first pilot scale single-step TREEPLAN evaluation for radiata pine and this will be completed later this year – an internationally significant step for the radiata pine industry.

NS052 Development of best-practice fatigue management for the Australian Forestry Industry

Lead organisation
University of South Australia

Principal researcher
A/Prof. Jillian Dorrian, University of South Australia

Start date 30/1/20
Completion date 30/6/21

Project description
The project aims to double the rate of genetic gain in the pine breeding program in Australia via an across industry rollout of a low-cost, high-throughput SNP genotyping assay and modern, single-step genomic selection methods.

Summary of progress
This project aims to provide evidence to tailor the implementation of fatigue management guidelines for different forestry workplace environments (e.g. forests, sawmills), and develop tools to help support worker safety. Like other shiftwork industries, forestry includes workforces that are likely to experience fatigue. A new Fatigue Management Guideline, with risk assessment, tools and
controls, is currently being rolled out for South Australia. At the recent initiation meeting the project partners affirmed the aims of the project to:

1. Examine the current fatigue systems that operators and contractors are using, and the level of uptake of the new fatigue guideline;

2. Develop tools to help support the guideline, tailoring implementation to different forestry workplace environments (e.g. forests, sawmills); and

3. Identify existing best-practice within forestry and in other work domains and propagate and promote these approaches.

COVID-19 restrictions have delayed the initiation of this project and the access to forest industry employees to undertake the initial stages of surveying and information gathering; however, planning is proceeding to reduce the reliance of non-contact methods.