



Erosion: mapping, measuring and mitigating

New Zealand is one of the most erodible countries in the world. Erosion is one of the major challenges that faces our primary industries and is likely to worsen as climate change brings more frequent and intense weather to our shores.

Forestry has a unique role to play in minimising erosion. Established forests are known to stabilise land for long periods and reduce erosion significantly compared to agricultural land uses. However, when the trees are harvested the risk of erosion and debris flows (associated with harvest residues left on site) increases for a period of up to six years until the next crop's canopy is fully established. This period is known as the window of vulnerability and during this time the steep, high erosion risk sites could lose valuable topsoil and incur damage from sediment and woody debris flows either in the forest or on neighbouring lands or water bodies.

Currently, there is no nationally co-ordinated approach to recording and reporting erosion and debris flow events. Without this base of information it is difficult to gauge New Zealand's erosion problem, identify the factors that cause an erosion event (such as rainfall intensity), and to manage the risk of future events.

Scion's Growing Confidence in Forestry's Future research programme, supported by MBIE and Forest Growers, is addressing this gap with a three-pronged research strategy. It aims to develop methods to map erosion sites across New Zealand, measure the size of the problem and share successful mitigation techniques. Once complete, the research will assist forest managers and regulators to customise their approach to managing erosion risk.

(Continued on page 7)

CONTENTS

Erosion: mapping, measuring and mitigating	1
Forestry - sunrise or sunset industry?	2
Zespri's biospife ready for market	3
Weaving mātauranga Māori and Scion science	4
Flexible decision making tactics for climate change	6
Northland Māori Forestry Forum	7
Changes ahead for the Scion nursery	8
Scion goes to town	8
Scion Christchurch office has moved	8

Forestry – sunrise or sunset industry?



When I was approached about the opportunity to lead Scion I read the material provided, talked to Board members and quickly became excited about the opportunity for forestry and New Zealand. Three months into the job, I continue to be excited about forestry's potential to be the vibrant heart of New Zealand's bioeconomy.

Recognising forestry as a sunrise industry is not new thinking here or internationally. Increasingly the thinking is being voiced more loudly and more broadly. Take for example, the World Business Council for Sustainable Development that has a Forest Solutions Group tasked to "emphasise the importance of the forest-based industry as a key part of a low-carbon bio-based economy"¹. The initiatives stemming from this group reach across many countries in a quest to move from an economic reliance on petrochemicals to a renewable, forest-based bioeconomy.

Valuing forestry as a sunrise industry is what drives the Scion team. We know what's possible from our research results and from our innovative technologies that are part of our day-to-day work.

Climate change is a global phenomenon that is changing behaviour and desire

¹ <http://www.wbcsd.org/Projects/Forest-Solutions-Group>

for renewable and sustainable outcomes. Increased forest cover and increased use of forest products as carbon sinks is the way ahead. We need more trees in the ground now because demand is growing and will outstrip supply. We need also to realise the large potential for productivity improvements, such as designing trees specific to the requirements of end products.

Beyond the urban reach, forestry will be at the heart of regional and rural renewal and wellbeing. Forestry will also bring environmental improvements through water quality and erosion control; it will feature in optimal and mixed land use; and it will be relevant to realising iwi aspirations now and for generations to come.

In a transformed New Zealand I envisage trees and other bio sources as a resource replacing fossil fuels. Renewable resources will be powering our economy by providing biomaterials and bioproducts, chemicals, biofuels and bioenergy.

In this New Zealand of the future, engineered lumber products will feature in our homes and work places, and tall timber buildings will no longer be show pieces – they will be standard features of our cityscapes providing safe, comfortable and attractive environments.

Beyond the urban reach, forestry will be at the heart of regional and rural renewal and wellbeing. Forestry will also bring environmental improvements through water quality and erosion control; it will feature in optimal and mixed land use; and it will be relevant

to realising iwi aspirations now and for generations to come.

So, why is forestry still perceived by some to be in its sunset phase? Why is an industry with so much potential to help solve local and global problems struggling to sustain itself? It is tough when log supply and market forces affect those at the 'woodface' of our industry. Closures of sawmills are still happening, such as in Australia recently reported in *Friday Offcuts*, with devastating consequences for communities. Rotation periods are reducing as market forces are not demanding quality; reduction in pruning is occurring for similar reasons. Cumulative reduction in quality will be followed by reduced value and potentially a declining industry.

Today's business environment is challenging. Yet the facts and trends point to a new context for the forestry and forest products industries within the world's carbon cycle.

It is up to us in the forestry sector to make sure we take up the opportunities before us. To do this we need to debate what the future looks like and what New Zealand's position (and particularly our opportunity to have a unique position) can be in the global forestry scene. I see that Scion needs to help shape that thinking to ensure government funding is directed to forestry and to the desired future that will come from discovery and stretchy science. I see a key part for industry too in funding the nearer-term research and working with Scion to make sure that research gets applied in order to attain our desired future.

I welcome your thoughts on this topic and any other matters raised in this issue of *Scion Connections*.

Dr Julian Elder
Chief Executive

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'Masterbatch' developed by Scion, in Rotorua.

Zespri's biospife ready for market

Taking a product from the laboratory to market is a challenging process. But after a long journey, the biobased and industrially compostable version of Zespri's iconic spoon-knife, the biospife, is now ready for use. Following many rounds of testing and development, Zespri has 150,000 biospifes ready for kiwifruit lovers all over the world to cut, scoop and compost.

Commercialisation: a whole new ball game

Innovative projects can bring a wide variety of challenges from the chemical level right through to manufacturing and regulatory considerations. The biospife was no exception. Kiwifruit residue is a wet biomaterial that is rarely included in the kind of hot plastic manufacturing used to create spifes. This created unforeseen challenges for the team.

Scion project leader Dr Dawn Smith oversaw the final steps that brought the

biospife to a commercial scale. "We created an array of different looking prototype biospifes for Zespri to choose from. But we still had to ensure their chosen spife could be made outside the lab, using the manufacturing equipment available, and that was one of the biggest challenges."

The project team settled on a process called masterbatching. Dawn and her team created a 'masterbatch' mixture that acts like a concentrate. The concentrated kiwifruit mixture is then added to a compostable bioplastic before being injected into the spife moulds. Getting the mix right was key to making sure the biospife would have the right qualities and meet food safety standards.

Late last year, the masterbatch mixture was sent to plastic manufacturer, Alto, for a trial run. Dawn says, "It went so smoothly we were in shock. Anyone who's been involved in bioplastics processing knows that is rare."

Alto's Engineering Services Manager, Paul Clemence says, "Here at Alto

Packaging Limited we are passionate about developing innovative and sustainable products. This is often a difficult process, but when all parties involved have a similar philosophy and are determined to succeed, it makes the challenges a lot easier to overcome. This project was a good example of that."

Taking kiwifruit one more step

The biospife is a 'kiwi' project in many ways. The kiwifruit skins in the biospife are a side product from puree processing in Te Puke, and were shipped to Scion's Rotorua campus to be turned into masterbatch. After being added to the bioplastic by Alto in Christchurch, the finished biospifes were sent to Zespri's headquarters in Mount Maunganui. From there, Zespri takes the biospife to the world, sending them to any of the 53 countries they sell kiwifruit to.

As a biomass side stream of kiwifruit horticulture, kiwifruit skins are either sold as animal food or composted. Dawn says, "Adding kiwifruit to the biospifes creates another use for the by-product before it's composted. The kiwifruit component also gives the biospife an organic look, differentiating it from the polystyrene spife".

Zespri's commitment key to success

Zespri's drive to be more sustainable led to the initiation of this project and the company's commitment ensured that it endured the many challenges that come with product innovation.

Dawn says, "It has been a long journey to get the biospife to commercialisation, and Zespri's commitment has been vital to our success. Working with a company keen to improve its sustainability performance was a great experience".

Zespri's Alice Moore, Global Marketing Manager for Organics, says, "Scion and Alto's innovative work has created an excellent, more environmentally-friendly product.

"It is great to be able to offer an alternative bio-degradable spife and we're looking forward to engaging consumers and telling them about the science behind it when they cut, scoop and eat our kiwifruit".

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George Haimona prepares the bioplastic for weaving.

Weaving mātauranga Māori and Scion science

Rotorua iwi Ngāti Whakaue have been working with Scion scientists to deliver a unique educational project that merges our science and innovation with traditional Māori knowledge.

The project was initiated by Te Taumata o Ngāti Whakaue, who run Matakōkiri, a science education programme for rangatahi (young people) between 7 and 14. Their latest project was to build six bilingual science kits.

Eva Tait, one of the Ngāti Whakaue Matakōkiri programme co-ordinators, says, “We wanted a sustainable container to hold our resources, designed and created by iwi and Scion scientists. We spoke to Lou Sherman, Packaging Research Leader from Scion, and together with Lee Warbrick and Caroline Newton we came up with a concept of working with local experts in their field, Te Arawa weavers and local scientists from Scion to create a container combining harakeke and plastic.

“We could’ve easily chosen a fish bin to hold our resources, it’s cheap, versatile and accessible. But most of our items

are traditional tools that our people used, so we wanted to carry them in a traditional manner, and store them in way that showed the authenticity of the locally made material. It was farfetched, but Lou was really interested.”



Developing the harakeke/bioplastic kete prototypes

Over a few months, the team from Te Taumata and Scion co-designed a project, using three different manufacturing technologies, to build three very different harakeke kete (baskets), unlike any you’ve seen before. They applied for and received a grant from MBIE’s Curious Minds fund to do the mahi (work).

The muka was processed at Scion and added to 3D printing filament, sheets of biobased and industrially compostable PLA plastic, and dried as thin strands.

Together, they planned an educational journey for 15 Ngāti Whakaue rangatahi. Starting at Tunohopu marae in Ohinemutu, these rangatahi spent time with their whānau (family) learning about traditional ways to work with harakeke (flax).

The students then spent three sessions at Scion with Lou Sherman, Ben McDonald and Dr Marion Sanglard who each led a group to create a harakeke and polymer kete prototype using a different method.

For Ngāti Whakaue, using harakeke in this way merges mātauranga Māori with new technology. Eva says, “Historically our people used harakeke for everything. We had flax mills here in Rotorua, and it was a big industry. When synthetic materials became available the flax use dwindled because it wasn’t viable as a commercial product”.

3D printed kete, woven bioplastic and harakeke set in resin

Ngāti Whakaue weavers provided Scion with bundles of prepared harakeke fibre known as muka. The muka was processed at Scion and added to 3D printing filament, sheets of biobased and industrially compostable PLA plastic, and dried as thin strands. From there, the materials were used to make prototype kete.

Ben’s group studied and scanned the structure of a traditional harakeke kete. They used computer based CAD modelling to modify the scan so it could be 3D printed using the harakeke-infused filament. Marion’s group took a slightly more traditional approach and cut up sheets of the harakeke/ biopolymer composite, and then wove the strips into kete. Lou’s team dyed the harakeke



fibres in bright colours and set them in resin. They also created some of their own moulds to make uniquely shaped kete. In between kete design and build, staff demonstrated how extrusion was used to make sheets for weaving and the 3D printing filament, and also showcased material characterisation methods using microscopy and tensile testing.

For Ngāti Whakaue, using harakeke in this way merges mātauranga Māori with new technology. Eva says, “Historically our people used harakeke for everything. We had flax mills here in Rotorua, and it was a big industry. When synthetic

materials became available the flax use dwindled because it wasn’t viable as a commercial product. We wanted to revive the use of harakeke and wanted our young people to know that our people used harakeke for everything and anything”.

Rangitahi returned to Tunohopu on 25 May to showcase the kete to their Ngāti Whakaue whānau, peers and the Scion team.

The next steps

Scion and Te Taumata are now investigating other material development projects they can undertake together.

Lou says, “It was great to show the group how we approach innovation. Building on generations of knowledge of harakeke we tried to push the boundaries on ways it can be used.

“Our team really enjoyed working on this project and we learnt a lot. There’s so much potential to share knowledge between us and we’re looking forward to working with Te Taumata again.”



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Flexible decision making tactics for climate change

Preparing New Zealand's primary industries for climate change is an enormous challenge. Uncertainty around the wide range of possible climate change impacts could lead to over-investment in some areas and under-investment in others. To ensure that we can protect our primary industries efficiently, Scion is investigating an analytical tool that gives decision makers the flexibility to plan for a range of climate change scenarios as they unfold.

How to build climate change into infrastructure decision making

Scion is introducing Real Options Analysis (ROA) to New Zealand's climate change armoury. ROA is an analysis tool that has primarily been used in finance, but is increasingly used internationally in climate change adaptation, particularly for infrastructure planning.

ROA presents investments such as new infrastructure projects as a journey. Along the journey, there are a defined number of decision-making points that are presented as the branches of a tree. Climate change modelling data is used to create the possible scenarios/branches that follow through to a measured response. On a 100-year investment, there would be several different decision-making points along the way that allow the investment to be customised to the situation. This is opposed to a one-off irreversible decision that risks costly over-expenditure or under-expenditure if the project needs to be expanded or re-scoped.

A New Zealand based case study

Scion will be investigating water storage options for a catchment in Canterbury, whose primary industries are heavily reliant on a secure water supply. Our team will be using ROA to set decision makers on a path to making more efficient water storage infrastructure investments.

Research programme leader Dr Anita Wreford says that ROA can be used for a wide variety of projects, from roading to flood management. "For example, we know that over time the climate will change, but there is significant uncertainty around how and when. An increase in droughts and variable rainfall may lead to a need for more water storage so that it's available when needed but the amount we'll need to put aside is unknown.

"ROA allows the design to be adjusted or extended through a series of options over time, when the direction and magnitude of climate change has become more apparent. By making careful decisions that allow for a changing climate, this response can help to reduce the pressure on our rivers and aquifers."

Climate change adaptation one step at a time

Using ROA in climate change adaptation has clear advantages. Anita says, "This approach allows us to take climate change one step at a time. People have the opportunity to understand and plan for the most likely effects of climate change as they affect them.

"ROA can reduce some risks when

making decisions in uncertain circumstances and that's an empowering management concept."

The conventional process for analysing a big infrastructure project is cost benefit analysis (CBA). ROA has advantages over CBA in the context of climate change, by considering uncertainty and explicitly placing a value on flexibility.

The benefits and challenges of ROA

It is not just policy makers that benefit from the flexibility of ROA, Anita says. "People naturally use a simplified version of ROA in day to day decisions. Using it on a big scale will ensure that everyone in New Zealand benefits from safeguarding our industries.

"There are a number of challenges to using it here. ROA is extremely data intensive – and the probability analysis hasn't been carried out in this context here before."

This lack of existing data analysis will be a hurdle for Anita's team, but will ultimately benefit New Zealand by finding a way to use the data available.

The project will be run over the next two years, with funding from The Deep South National Science Challenge. Scion will be working with experts from NIWA, Lincoln University and the University of Portland to undertake the study.

FOR FURTHER INFORMATION

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Northland Māori Forestry Forum

Scion science was on display in April at the Northland Māori Forestry Forum. The event was co-hosted with Taitokerau Māori Forests Inc. and demonstrated Scion's wide ranging capability to the Northland Māori forestry community.

Over 80 people made their way to Whangarei for the conference, with forest owners, industry stakeholders and strategic partners among them.

Taitokerau Māori Forestry Inc. is a collective of nine Māori land trusts. They

have a strong strategic direction for their forests in Northland, which includes better access to information and expertise. This conference allowed Scion to talk about our capabilities, research and achievements in manufactured bioproducts derived from wood to nursery development and much in-between.

Dr Russell Burton, General Manager Research and Investments, says, "With \$2 billion in forestry assets that include land, trees and energy options, Māori are set to become key stakeholders in the future of forestry. Events like this are a great way for us to showcase what we think the future might look like and how we can help to develop it with our science".

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Erosion: mapping, measuring and mitigating

(Continued from page 1)

Using citizen science to report erosion

Gathering large amounts of timely data on erosion events is a key part to developing accurate models. Dr Tim Payn, Principal Scientist, and Duncan Harrison, Geospatial Analyst, are leading a citizen science based approach to gather this data through a newly developed mobile app called 'Erode-NZ'.

Tim explains, "Anyone - forest managers, workers, neighbours, the general public - who sees a slip or debris flow can use the app to report the sighting to a national database, accompanied by photos, a description of scale and impact, and GPS co-ordinates. It's a simple tool, but the ability to report sightings as soon as they're discovered will help us build a picture of what led to the event including rainfall, slope and soil type."

The prototype app has been developed on the Thundermaps platform and is currently being user tested. At present, the data uploaded via the app can only be viewed by Scion scientists.

Measuring slips using LiDAR

The Scion team has also begun to use LiDAR to identify past erosion events. By

comparing the point set data from two LiDAR flights conducted five years apart, the Scion team was able to locate slips purely from the data and without the need to visit the forest.

Tim explains, "LiDAR hasn't been used in this way before. It's enabled us to find slips that we can't necessarily see because they're covered in vegetation. It can also give forest managers a better understanding of the terrain they're dealing with, enabling them to take precise and proactive measures where they are most needed and most likely to be effective.

"For example, using LiDAR data and our improved modelling, we can provide advice to a forest manager about changing the planting regime for the site, or pinpointing the best location for a debris trap."

Mitigating erosion

The range of adaptive management techniques used to mitigate erosion, is also lacking a nationally co-ordinated approach, and foresters are using what they know works for them locally. Our team is learning from their experience by surveying forest managers around New Zealand about the methods they use.

Tim says, "We have found that forest managers are using a wide variety of methods including seeding the soil early with grasses, maintaining riparian margins, using debris traps and altering

planting regimes. Through these surveys we'll match the most successful practices with the receptive land types and share those findings with the forestry industry."

Scion is also undertaking a planting trial to see how well willow and radiata pine grow when they are planted side by side on a steep slope. This trial is taking place on the erosion prone East Coast of the North Island. The study is 18 months into a four-year programme.

Trial co-ordinator Marie Heaphy says, "We'll be measuring height, root collars and survival of the plants. If the willow can stabilise the soil faster than the radiata pine without inhibiting its growth, we could have another option to help stabilise high-risk sites and shorten the time that the soil is vulnerable".

Revealing the big picture

Combining these approaches will allow us to get an understanding of New Zealand's forestry related erosion from multiple perspectives. This work will provide evidence that will allow forest managers to better understand the erosion risk present on their land, and how they can make targeted improvements to their management practices.

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Changes ahead for the Scion nursery

A change in strategic focus for the Forest Genetics Team has opened the door to an exciting new direction for the Scion nursery.

In the past, the nursery has undertaken a considerable amount of commercial work, however a strategic decision has been made to make research the ongoing focus of the nursery. Commercial activities

will continue, but first consideration will go to research activities and our capability and capacity to deliver them.

FOR FURTHER INFORMATION about the Scion nursery contact Bob Shula at bob.shula@scionresearch.com

Scion goes to town

As part of our 70th anniversary celebrations, we will be hosting an interactive exhibition in the Rotorua central business district during the winter school holidays. Locals and visitors will get to see some of the cutting edge

science and innovation that takes place just five minutes from the centre of town. Different technologies – from 3D printers to fermenters – will be on display.

Come by and discover how Scion can help New Zealand move from a petrochemical economy to a renewable, forest-based bioeconomy. The exhibition will be open from 10am – 4pm weekdays, 10 – 21 July, 1201 Eruera Street, Rotorua.

Scion Christchurch office has moved



After many years of co-location with the School of Forestry at the University of

Canterbury, Scion's Christchurch based staff have shifted to the NIWA campus in Riccarton. The move was completed in May, giving Scion staff access to more space and facilities, and deepening links with NIWA's expertise in climate, water and meteorological sciences.

There are around 30 staff at our Christchurch office, working in forest ecology, entomology and rural fire research.

Christchurch staff can now be visited at 10 Kyle Street, Riccarton. Telephone 03 363 0910.

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ISSN 2230 - 6137 (print)
ISSN 2230 - 6145 (online)

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Scion Connections is published quarterly, and is also available online at www.scionresearch.com/scion-connections

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