Forest Flows

Issue 2 January 2023

Forest Flow is now entering its 4th year of research!

Intense land use and climate change is increasing concern and pressure on water use worldwide. Understanding how water flows through the land is essential to make the best use of water resources while maintaining environmental health. The 5-yr Forest Flow MBIE Endeavour programme focuses on planted forest's role, mainly radiata pine, in supplying water in the landscape.

By using an integrated series of ground sensors and remote sensing (See Page 2), Forest Flows seeks to quantify planted trees water use, catchment water storage and release, in planted forests. We seek to answer the questions: Where is the water? Where is it going? And who gets to use it.

This newsletter will outline our activities this last year, first results, and what is to come in 2023!

IN THIS ISSUE:

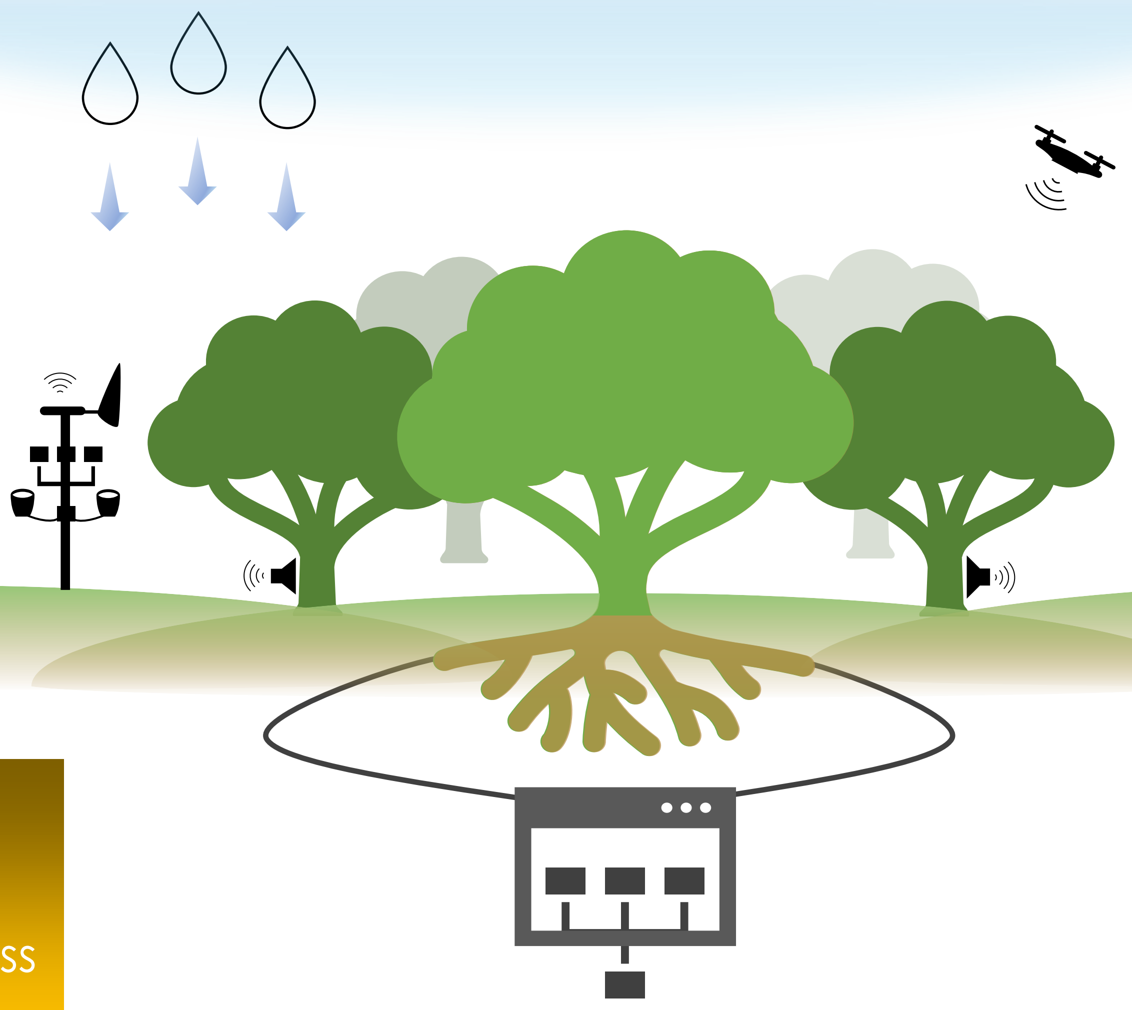
First Results & Observations

Satellite

- Soil moisture
- Tree canopy water stress

Airborne

- SlimSAR L- & P-band radar
- Tree canopy water stress



Above Ground

- Weather station
- Rainfall
- Throughfall
- Tree growth & water use
- Water age
- Streamflow

Below Ground

- Soil moisture
- Groundwater
- Water age
- Soil texture & depth
- Ground penetrating radar

1,717
instruments across seven sites

360,000
observations a day

130 million
observations over the last year

Forest Flows has established 10 research sites throughout the country (Fig. 1). Two wireless sensor networks – Scion's FlowLab and NIWA's LoRA were installed at six sites and they have been running for over a year. The 1,717 sensors across six sites generates over 360,000 observations every 24 hours, which totals 130 million data points in the year! Figures 2 and 3 show examples of the data being collected from the trees and soil, respectively. Few studies in the world have such an intensive set of measurements of forest hydrology.

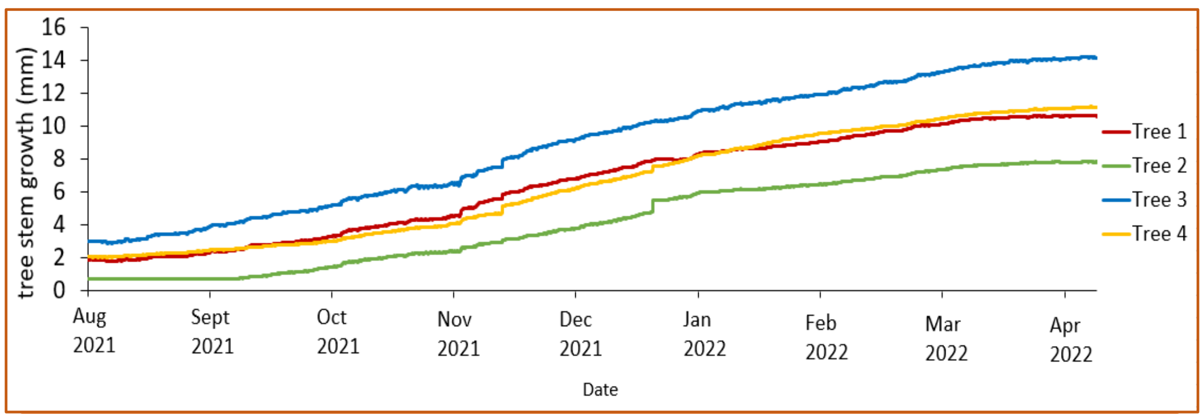


Figure 2: Example of electronic dendrometer tree stem growth data (mm) measured at 5-minute intervals from four trees in one plot over nine months showing a range of growth rates over the period.

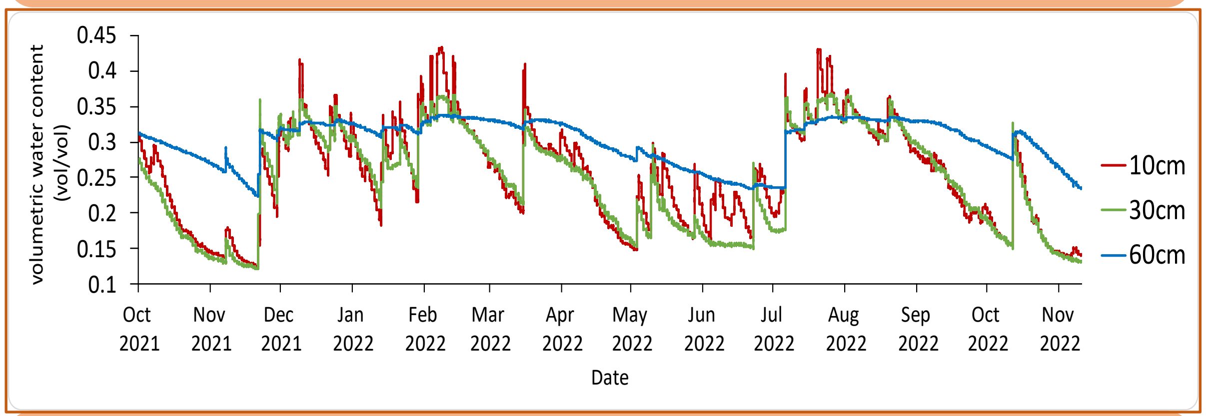


Figure 3: Soil volumetric water content (m³/m³) measured at 5-minute intervals at three different depths from one plot over one year showing the complexity of soil water movement, especially during (peaks) and after rainfall events

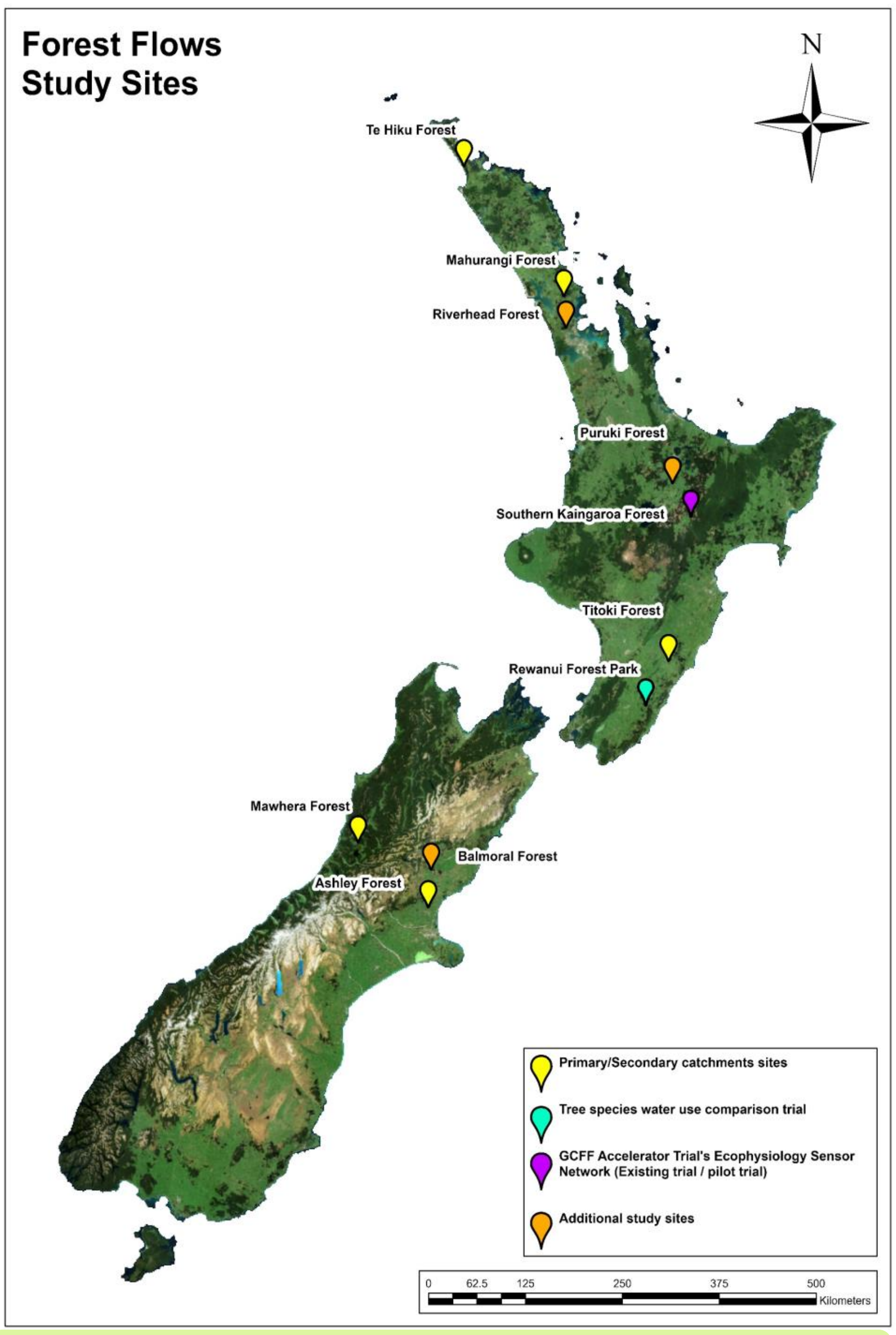


Figure 1: Locations of the Forest Flows research sites

To manage the huge amount of data being transmitted from the forest, Scion built the Kafka Big Data Pipeline (Fig. 4). It enables us to seamlessly stream, clean, store and summarise data arriving in near real-time. The University of Waikato TAIAO programme (Time-Evolving Data Science/Artificial Intelligence for Advance Open Environmental Science) is developing machine learning tools to analyse the data in near real-time and provide early insights into the key hydrological processes in planted forests. This approach can be readily applied to other environmental monitoring projects and large datasets.

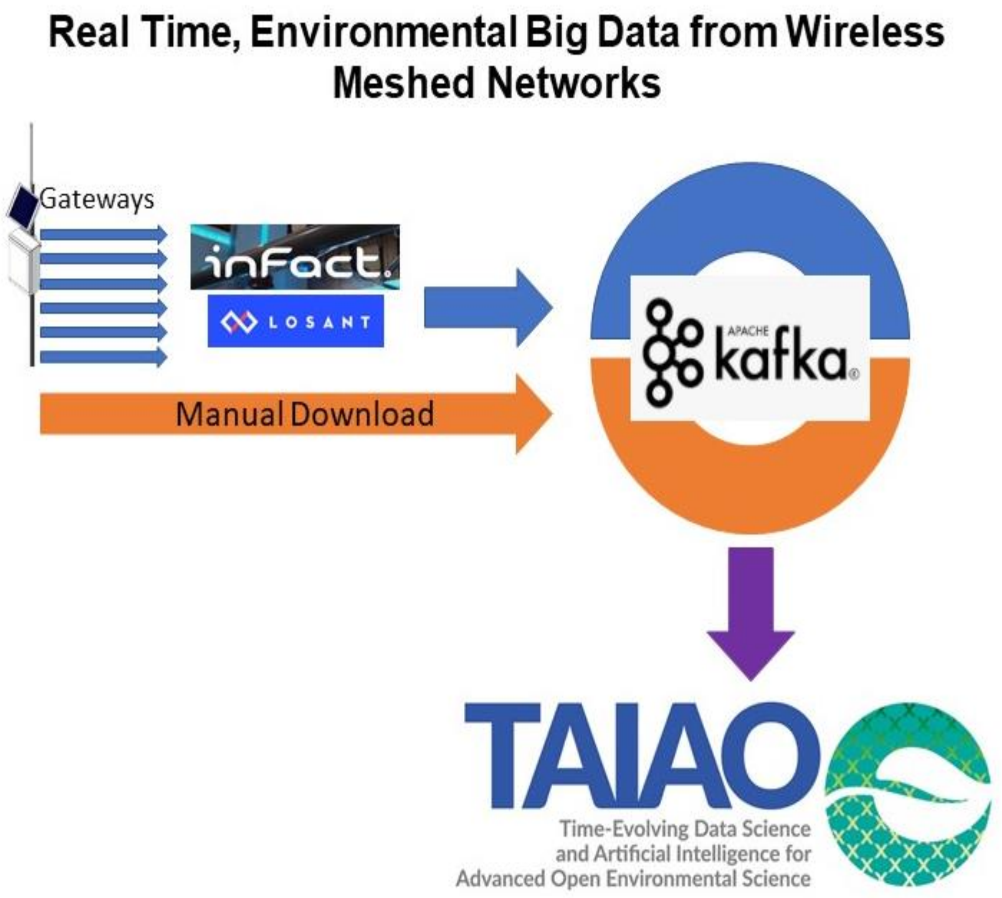


Figure 4: Overview of Forest Flows sensor network data flow

Technological Developments

SlimSAR is the keystone technology for the programme. It is a new type of radar (Fig. 5) from the USA that uses two wavelengths (L- and P-Band) to penetrate the forest canopy and measure soil moisture to a depth of 1m. This technology will help New Zealand to:

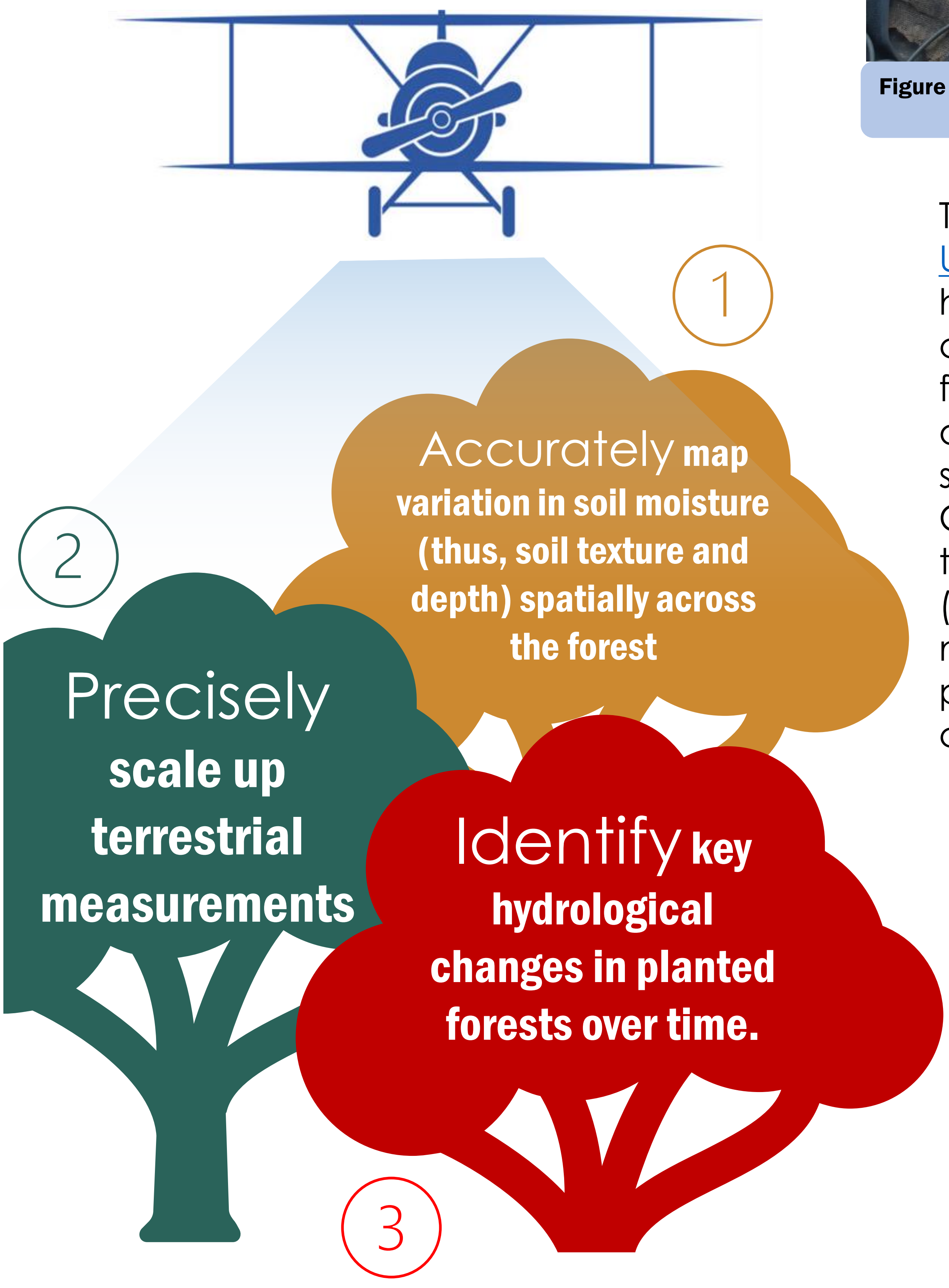


Figure 5: Left – SlimSAR L-and P-Band synthetic aperture radar (SAR). Right – Aircraft

The University of Auckland and University of Southern California have completed two campaigns collecting radar measurements from our main six research sites and are working to create fine-scaled soil moisture maps. Comparing measurements from the first (dry soil) and the second (wet soil) campaigns will give us new insights of soil & hydrological properties and how water storage changes across each catchment.

Stakeholder Engagement

Forest Flows held a series of in-person and virtual workshops in the Tararua and Masterton Districts; two case study sites that are near two research sites. Attendees included famers, foresters, iwi, NGO's, local councils, and other interested parties. From these workshops, we learnt the various views people had about water, trees, and planted forests.

Attendees asked questions on related topics including land use, forestry, carbon forests, water, and central government policy. Learning at the workshops went both ways!

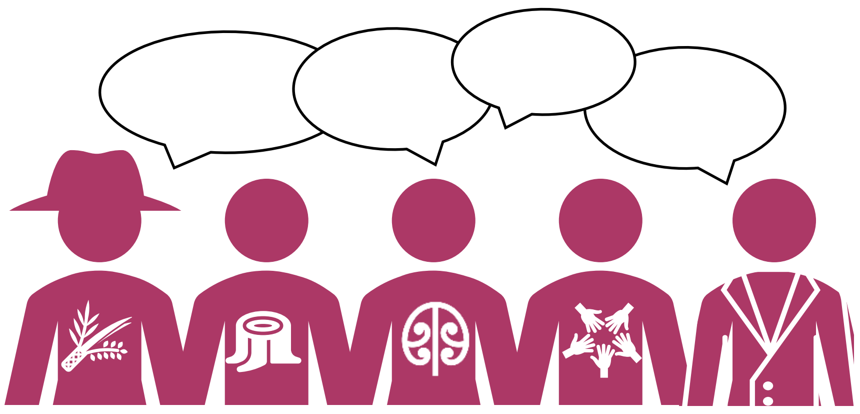


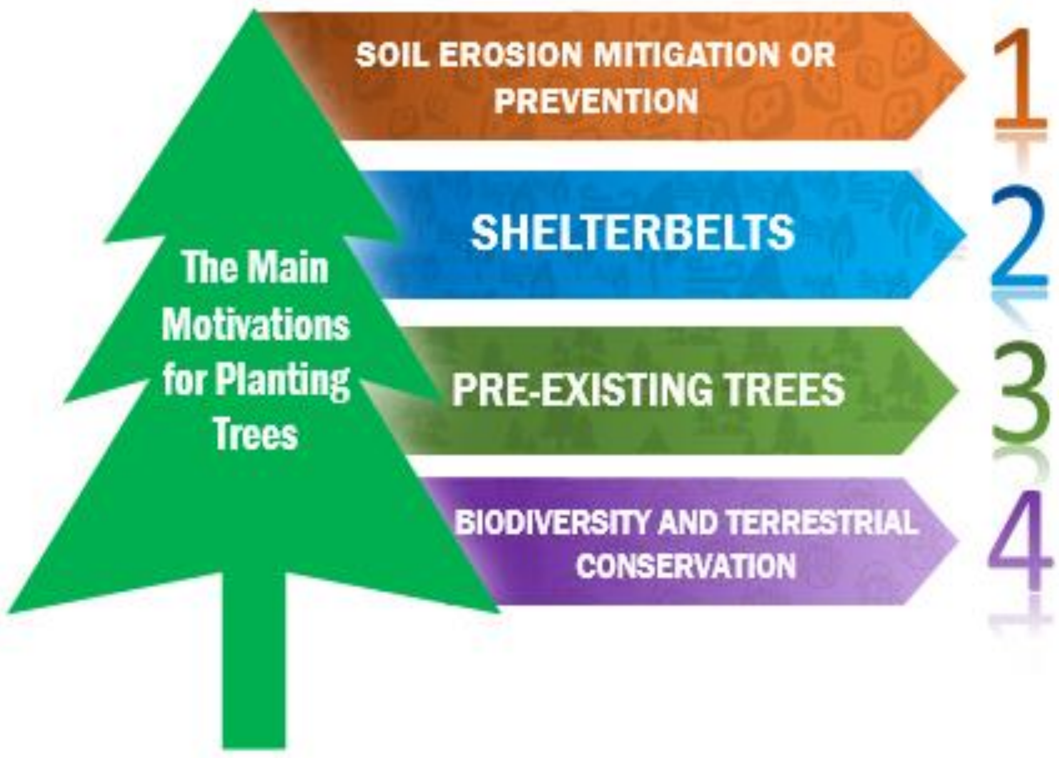
Figure 6: Community workshop held in Dannevirke, Tararua District

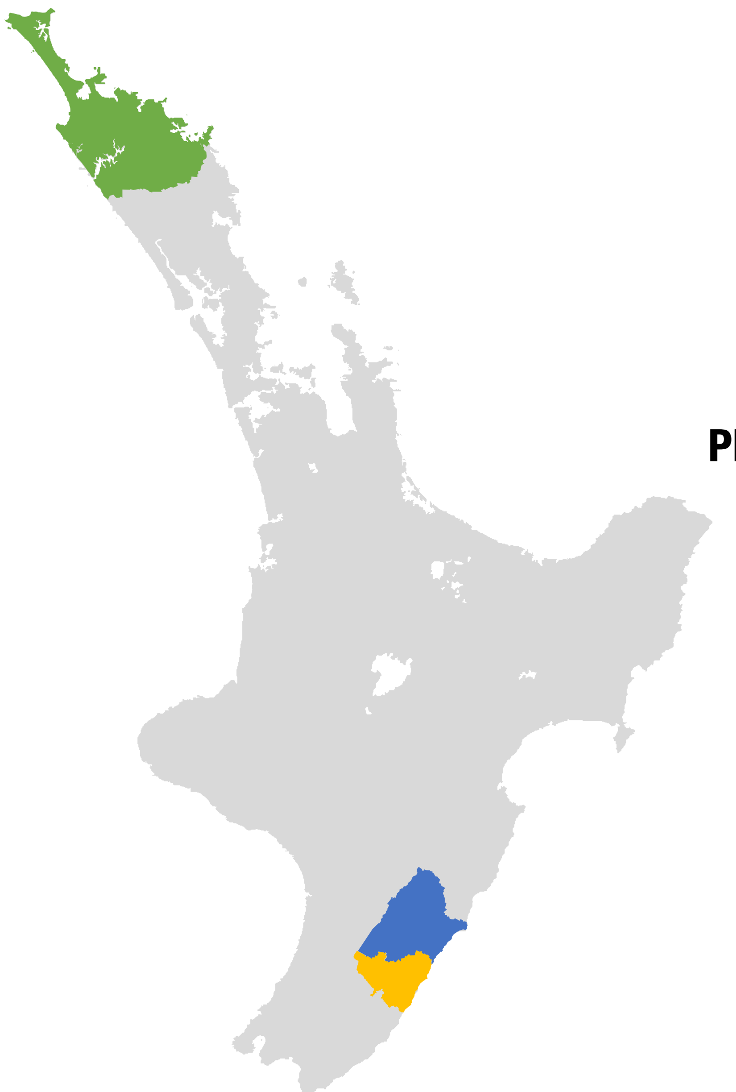
Stakeholders expressed that they wanted science-based management of their natural resources and were looking forward to utilising the results from Forest Flows, especially from the nearby research sites.

Survey Results

To get more information about how local communities viewed water, trees, and planted forests, we conducted a telephone survey in the Tararua and Masterton districts, as well as the Far North/Te Hiku District.

These are some of the initial findings from the survey.





PERCEIVED LIKELIHOOD OF ENVIRONMENTAL RISK BY CASE STUDY SITE

- Drought was perceived to be the main environmental risk in all sites
  - 21.5% = **Far North**
  - 19.9% = **Tararua**
  - 23.6% = **Masterton**

More survey results will be released soon!

What's next?

Forest Flows has data flooding in. With this, science delivery will be our focus in 2023. We will be busy with:

ANALYSING

data we've received from the field and the survey

CONDUCTING

more workshops with stakeholders

SHARING

more results with our stakeholders, on the website, articles, and research papers

In 2022, Forest Flows research was published in three scientific journals:

[Is the reputation of Eucalyptus plantations for using more water than Pinus plantations justified?]

[Evaluation of Multiscale SMAP Soil Moisture Products in Forested Environments]

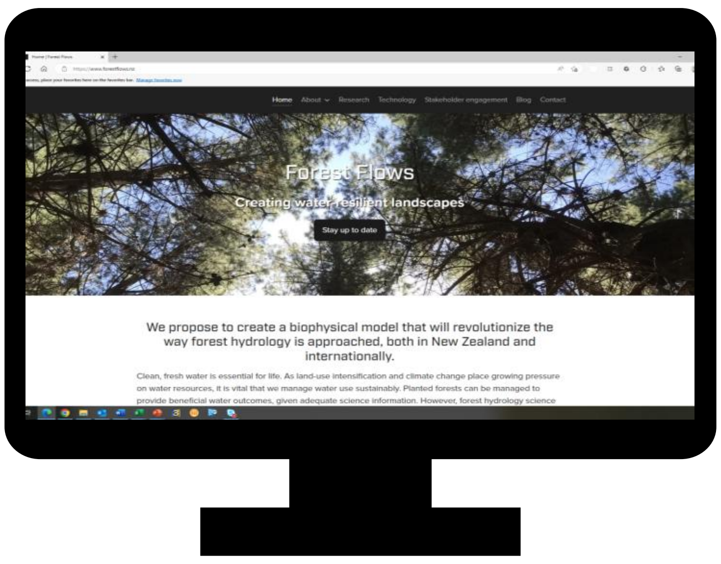
[A systematic review of participatory integrated assessment at the catchment scale]

More can be found on our website: https://www.forestflows.nz/

Thank You!

Forest Flows now has a dedicated website:

https://www.forestflows.nz/



The website will be our main way to share our latest updates, learnings, and publications. New information will added regularly, so keep an eye out!

On behalf of the Forest Flows team, thank you for your interest and support of the programme.

Dr. Dean Meason
Programme Leader
Forest Flows

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