Technology Advancements, Challenges and Opportunities

Artificial Intelligence (Ai)

Case Studies

Forest Measurement, Environmental, and Harvesting Our Forests

David Herries

CTO / Director

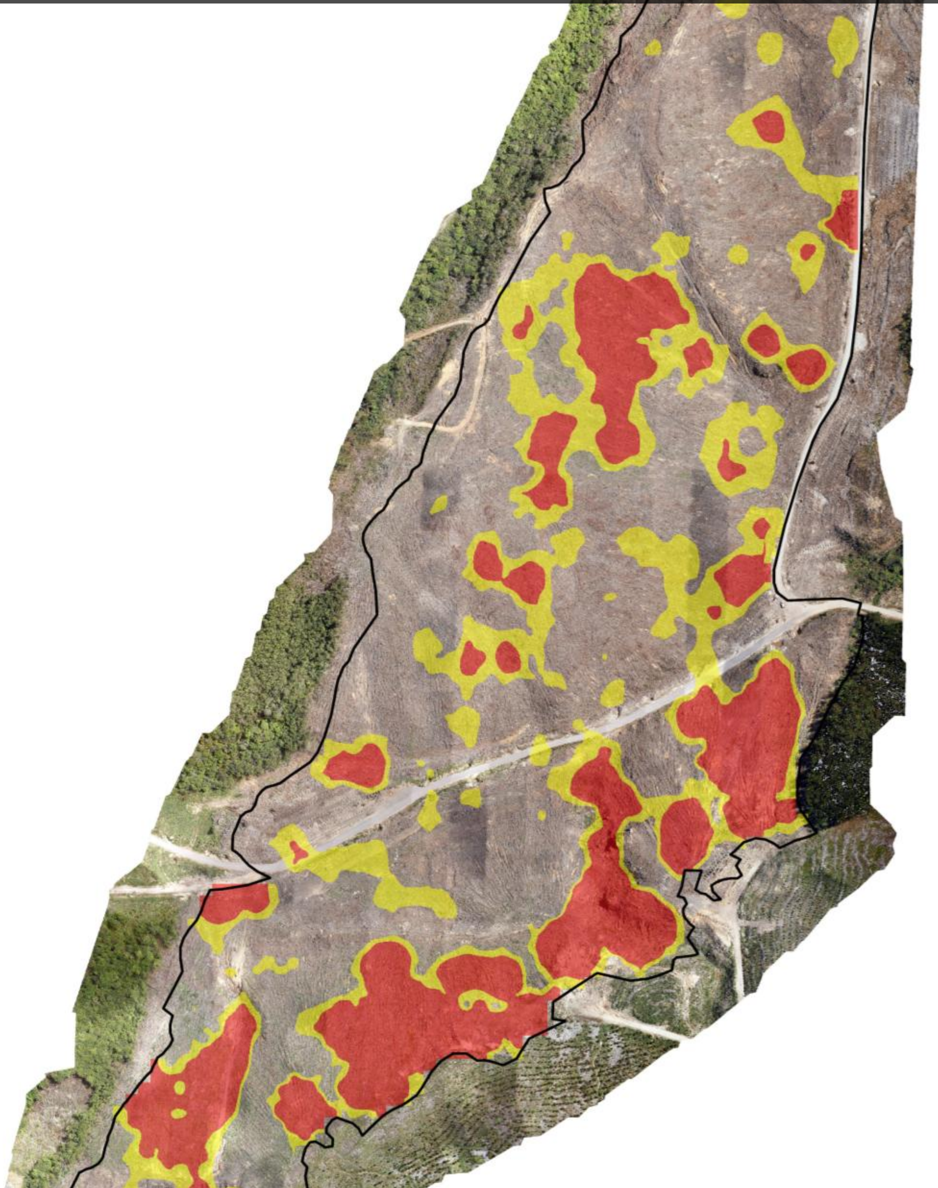
INTERPINE

Bringing innovation to our natural resources

He rangahau tenei ra he hangarau apopo

Case Study:

Woody Debris – Harvest Areas – Analysis using Ai



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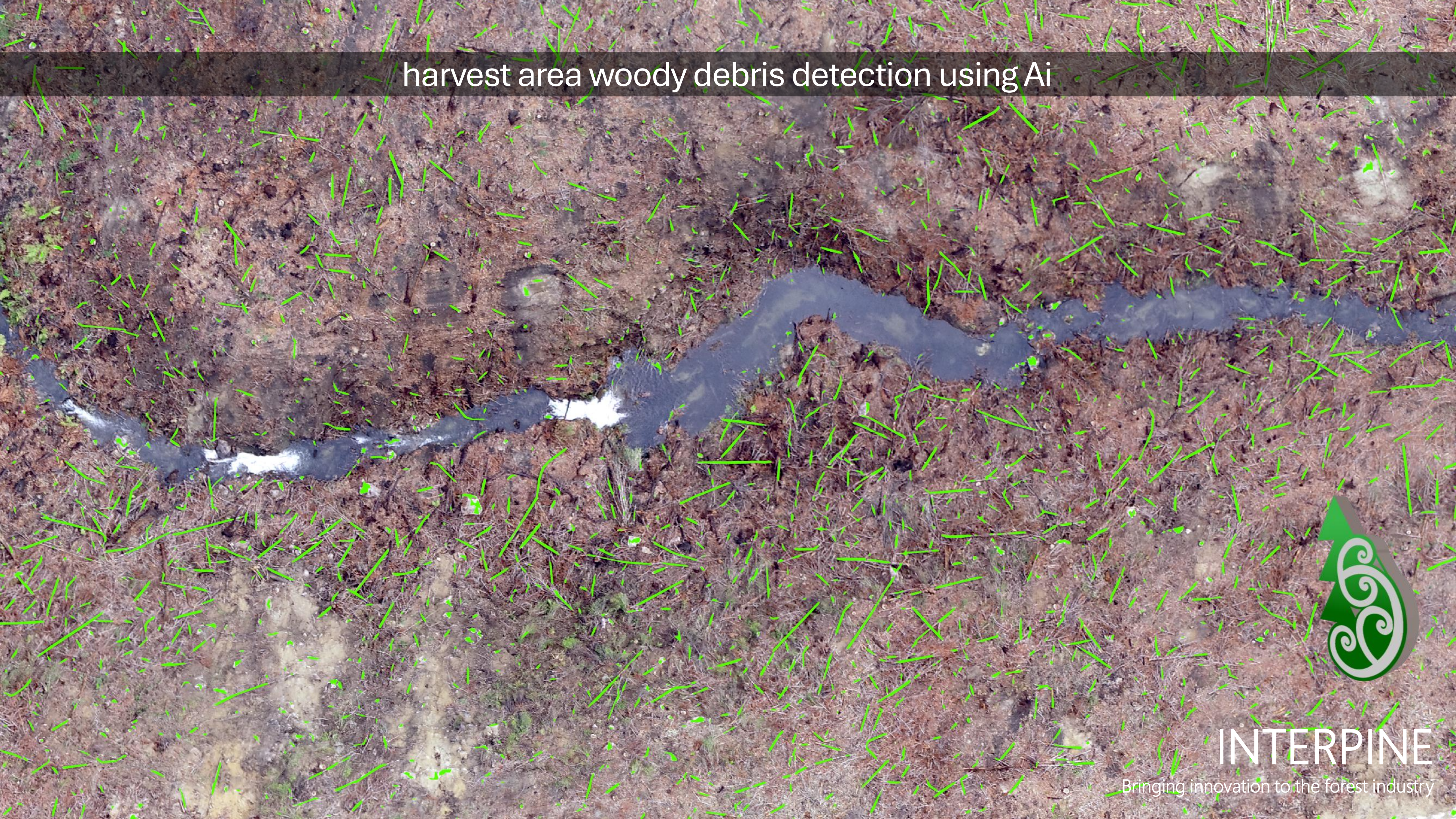

harvest area woody debris detection using Ai
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Woody Debris Detection - Length Class

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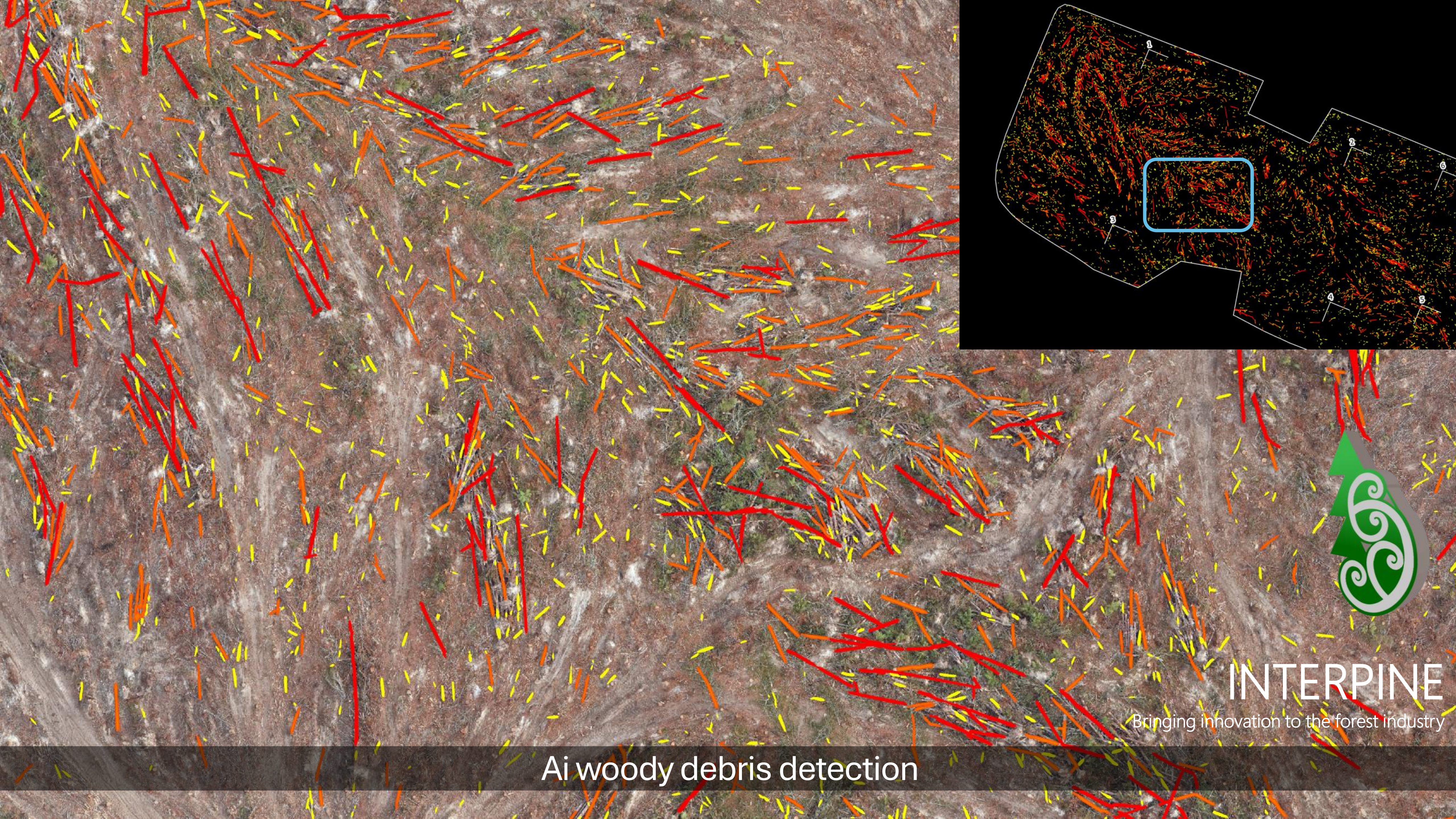
1
2
3
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5
6
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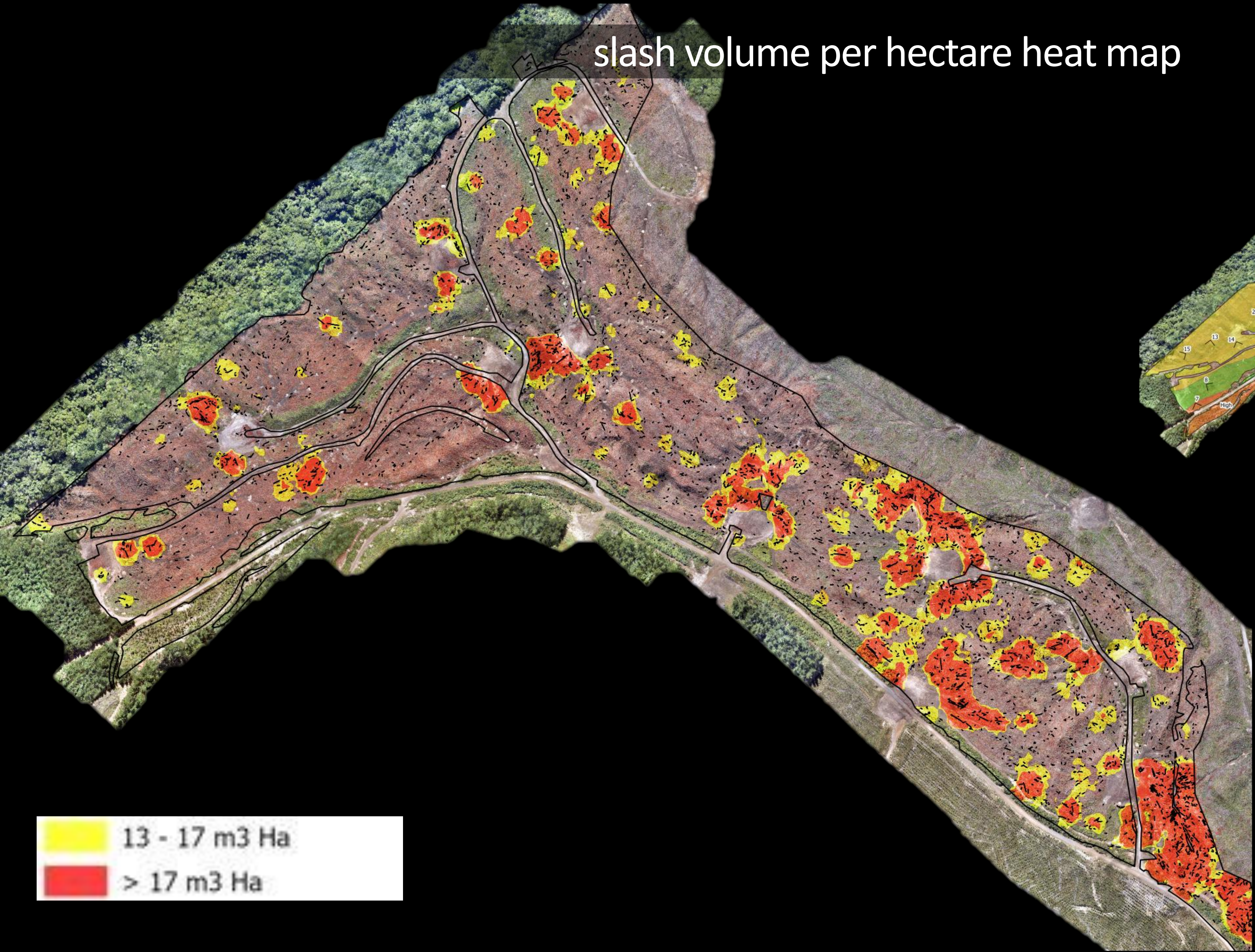
Ai woody debris detection

slash volume per hectare heat map



Erosion Susceptibility Class Map

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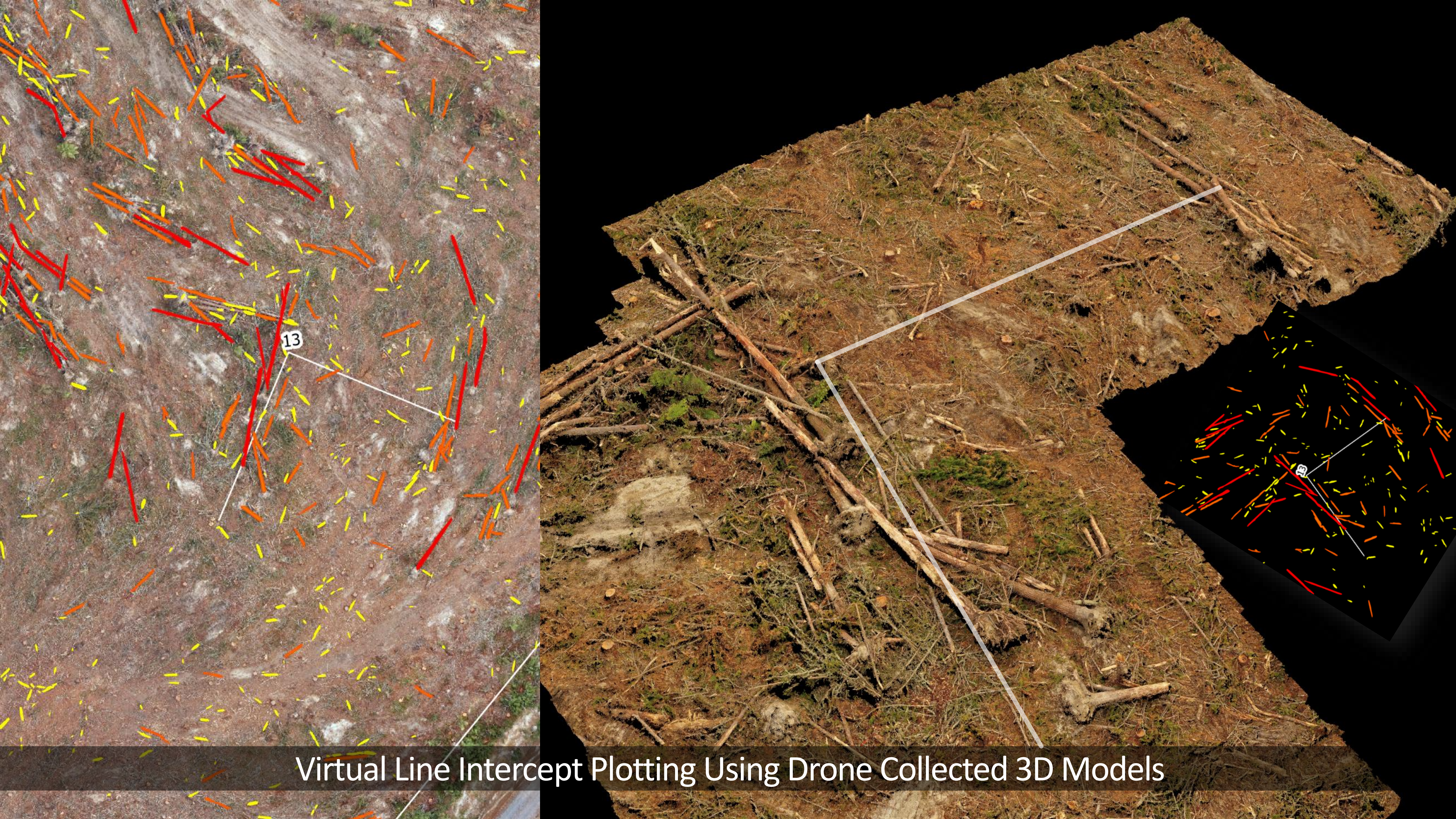
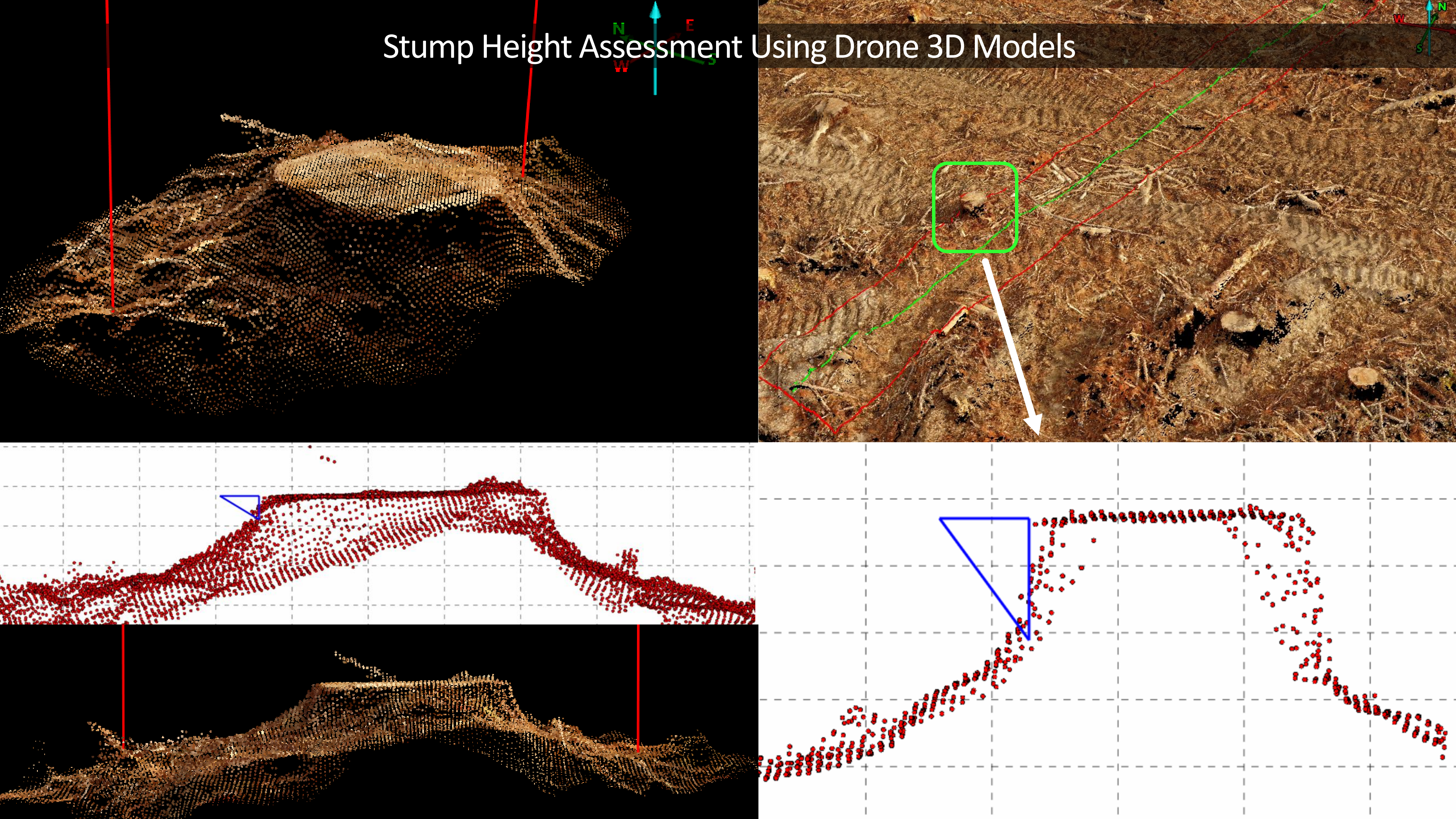
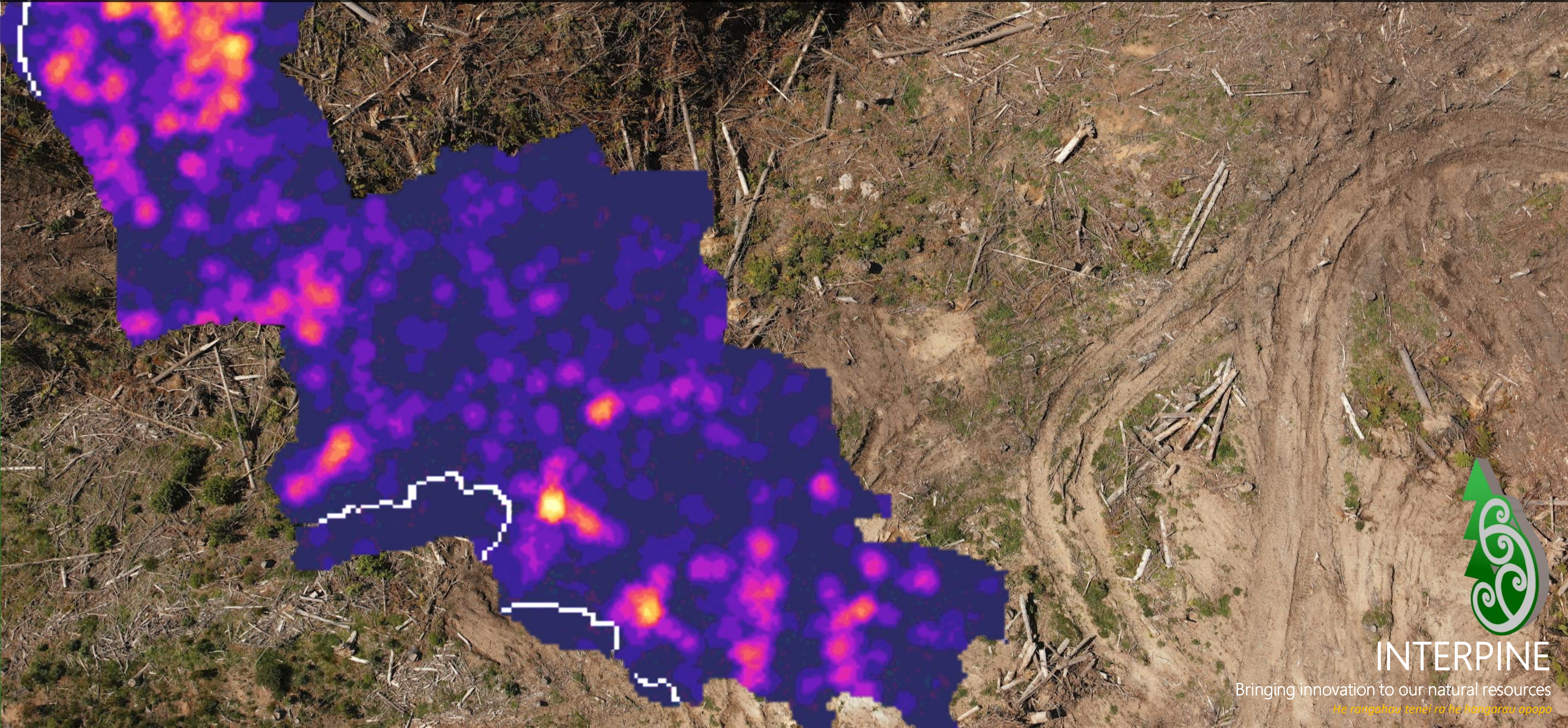

13
Virtual Line Intercept Plotting Using Drone Collected 3D Models

Stump Height Assessment Using Drone 3D Models



Case Study:

Woody Debris - Catchment Level – Analysis using Ai



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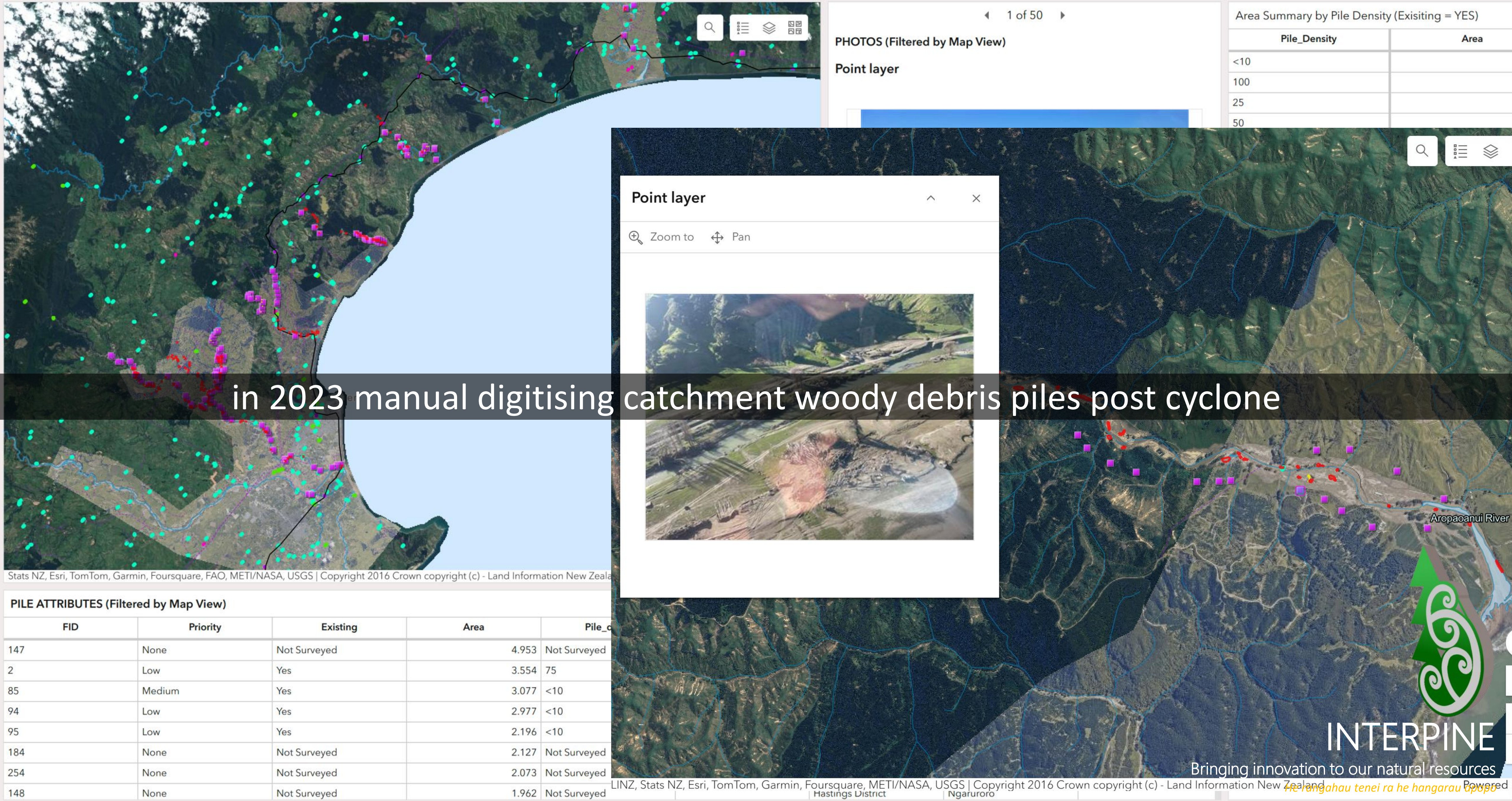

in 2023 manual digitising catchment woody debris piles post cyclone

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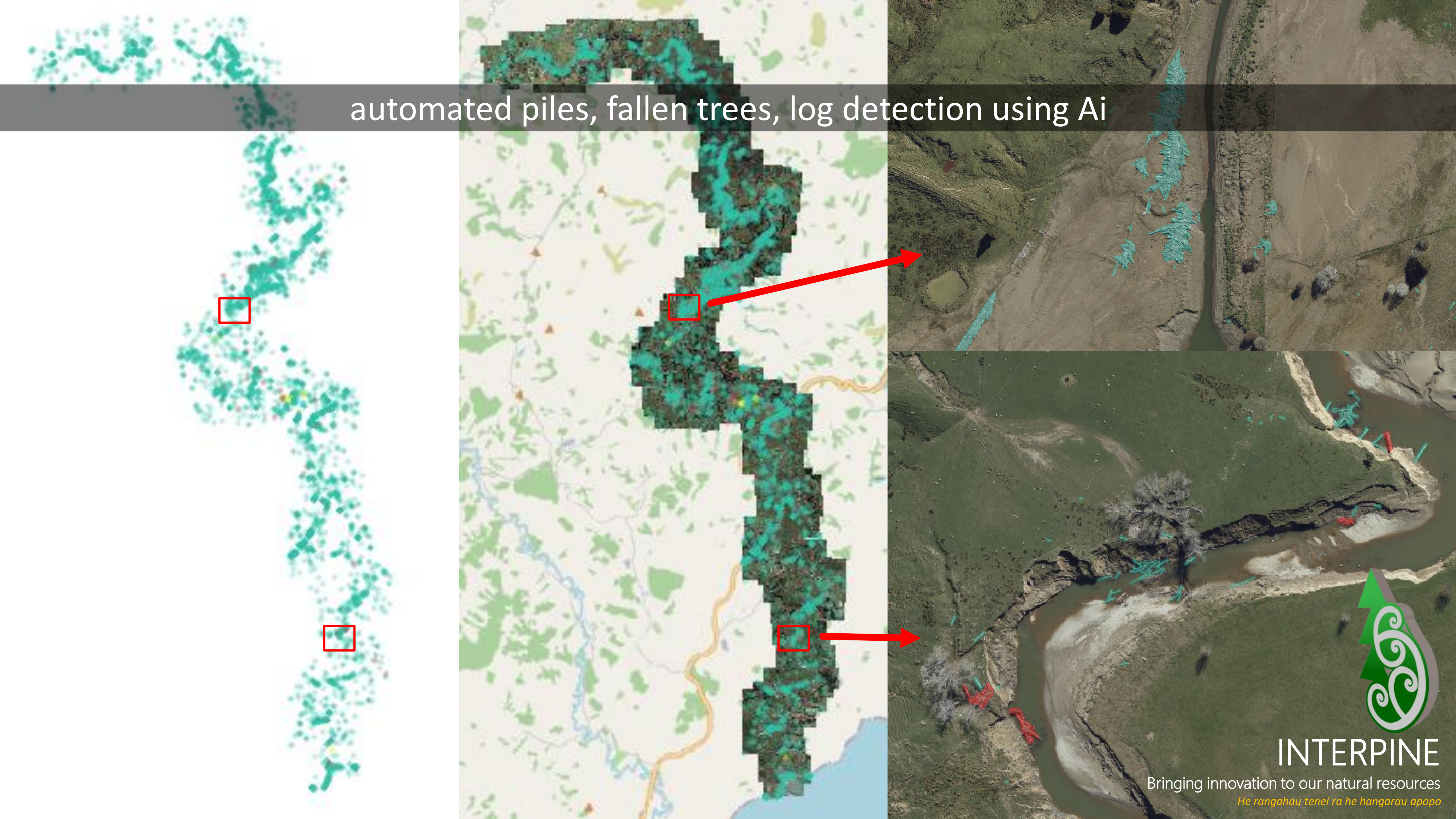
automated piles, fallen trees, log detection using Ai



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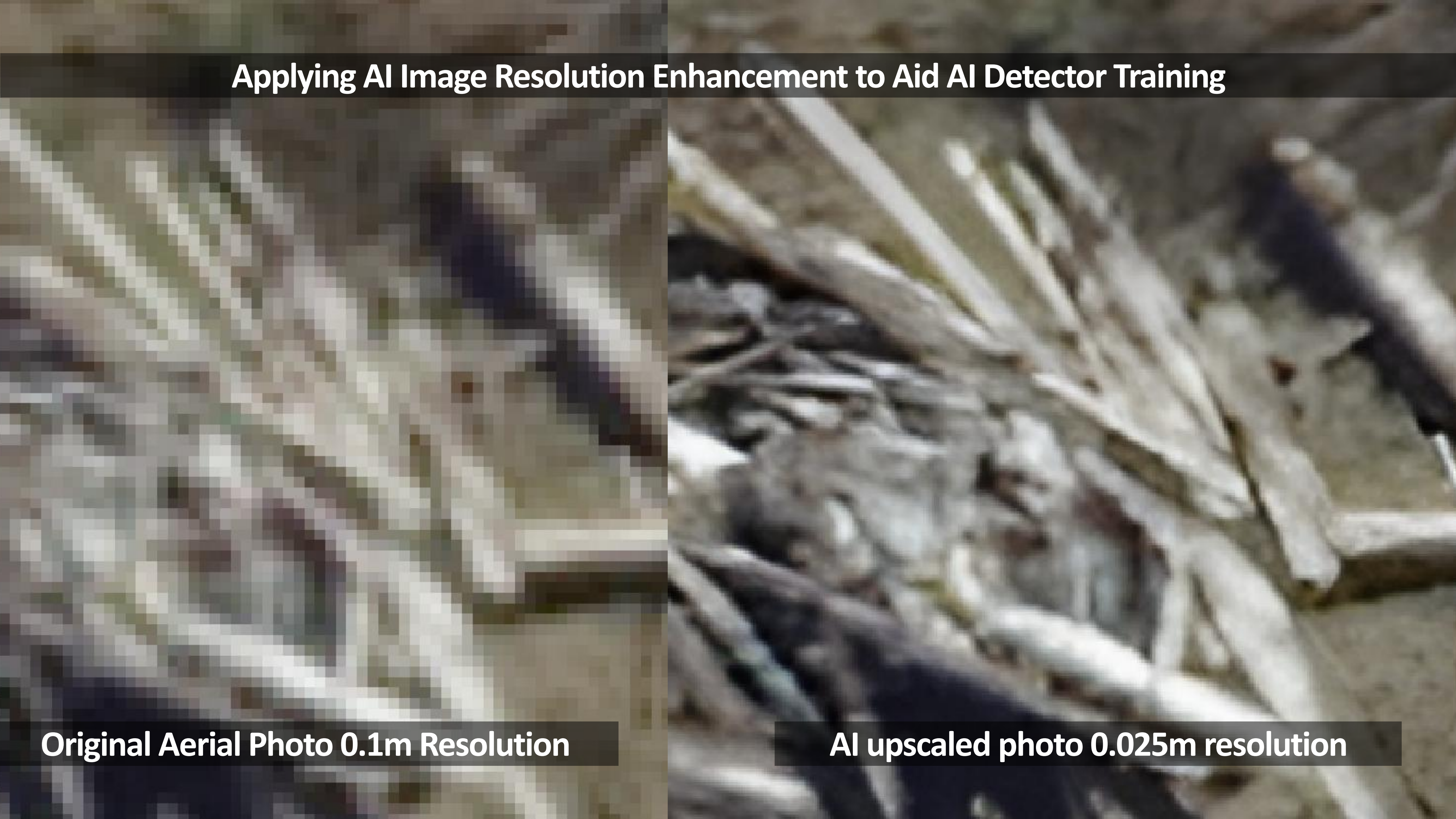
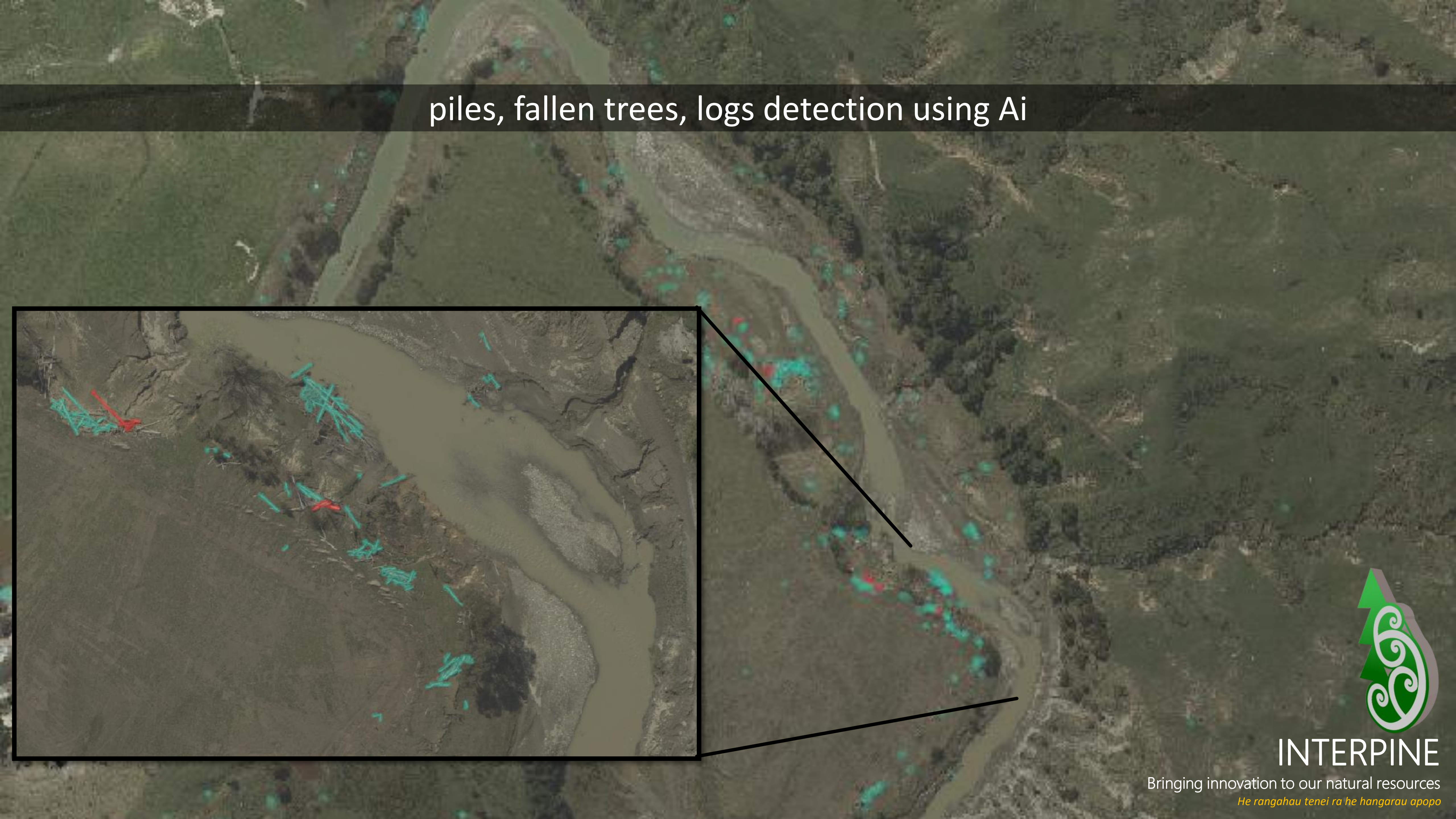
1.5cm
10cm
Comparison


Applying AI Image Resolution Enhancement to Aid AI Detector Training
Original Aerial Photo 0.1m Resolution
AI upscaled photo 0.025m resolution

piles, fallen trees, logs detection using Ai

piles, fallen trees, logs detection using Ai



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piles, fallen trees, logs detection using Ai
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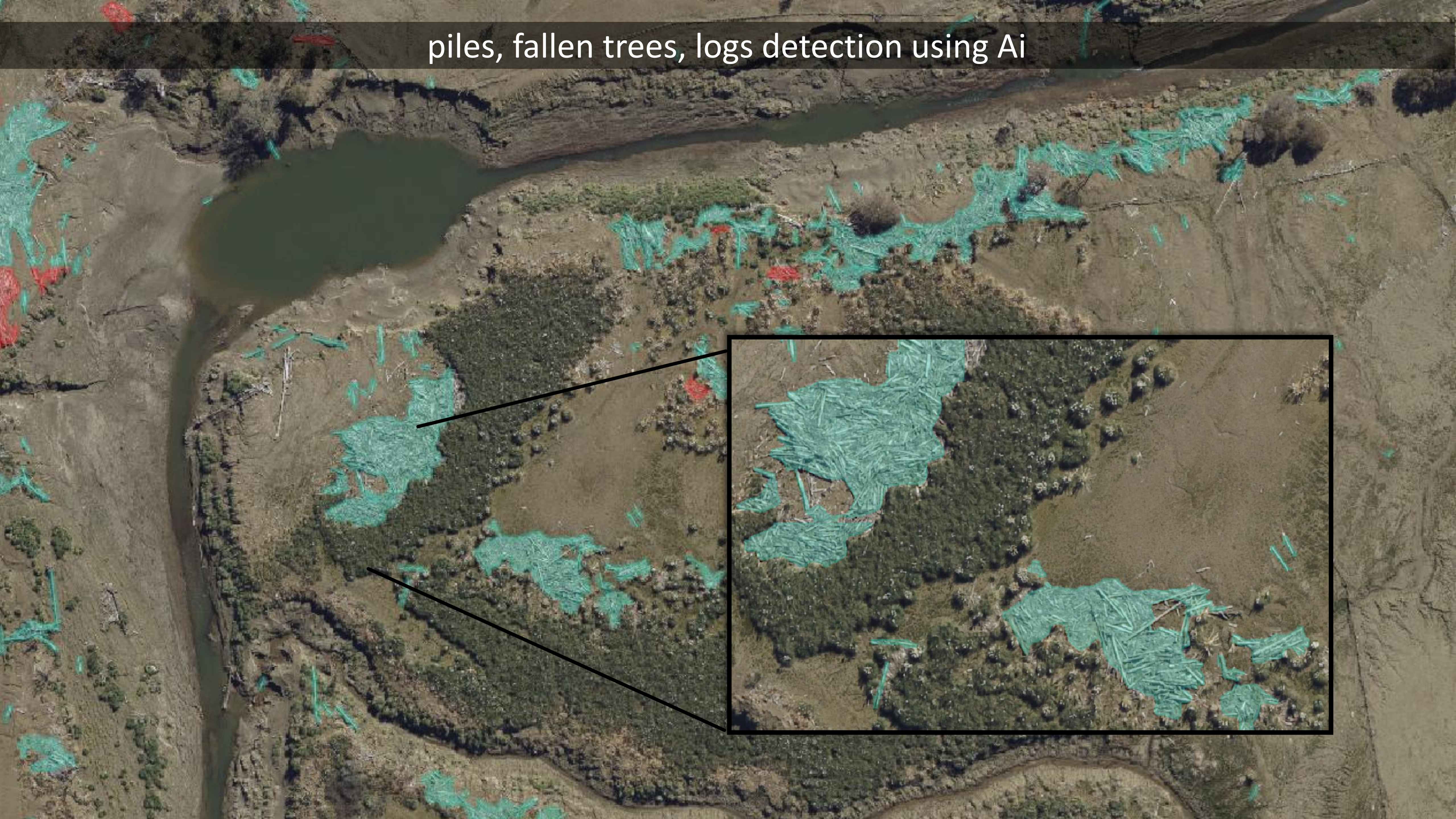
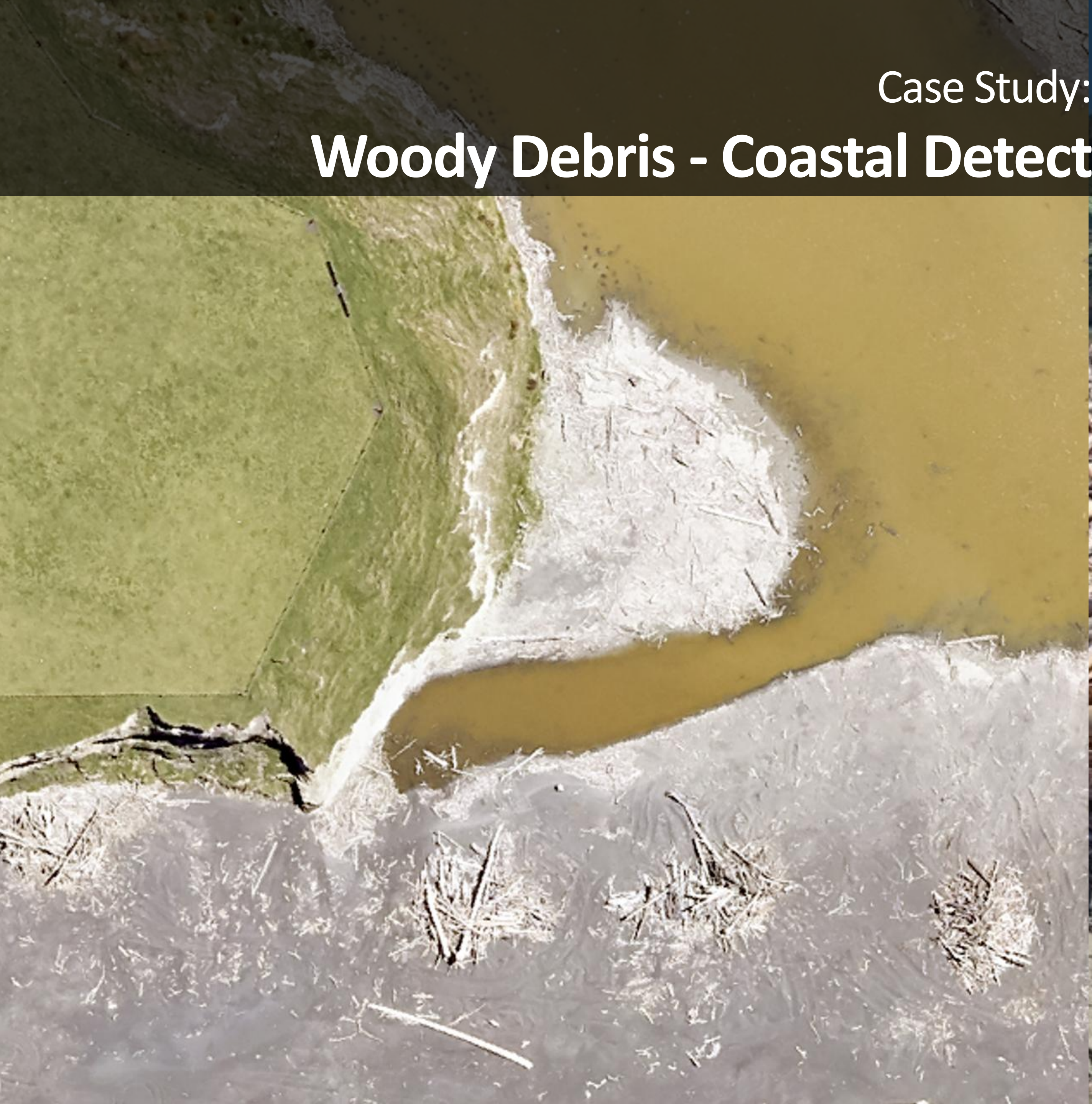
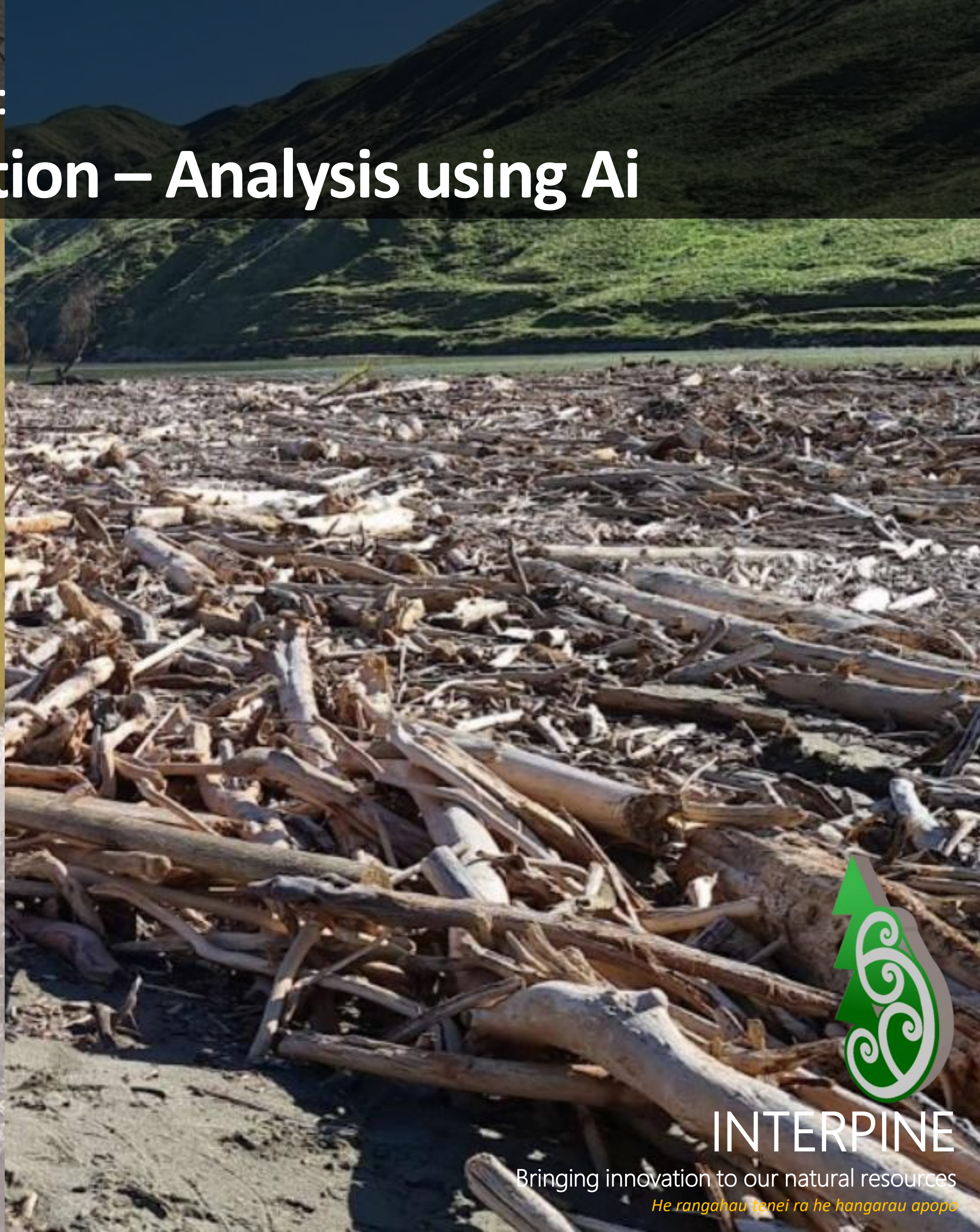
piles, fallen trees, logs detection using Ai



Case Study:

Woody Debris - Coastal Detection – Analysis using Ai





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post Cyclone Gabrielle 241ha of coastal woody debris piles

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in 2023 using daily coverage Planet Monitoring satellites 3-4m resolution

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3-4m daily coastal monitoring – Wairoa river mouth

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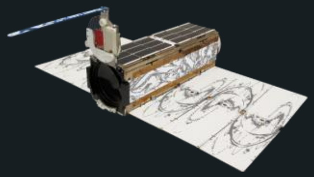
Agile Aerospace

Through our agile aerospace approach, we've created a unique data set

planet.

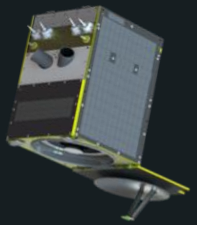
CURRENT CONSTELLATIONS



SuperDove

Always-on Monitoring

- Hundreds of satellites
- Up to 300 million km2 / day
- 8-band
- Unique scanning

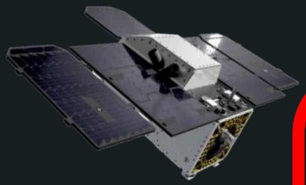


SkySat

High-Resolution Tasking

- ~15 satellites
- **50cm resolution**
- RGB, NIR, and Pan bands
- Sub-daily tasking

LAUNCHING NEW CONSTELLATIONS



Tanager

Hyperspectral Tasking

- Tanager-1 launched
- 400 - 2500 nm
- ~400 5nm bands

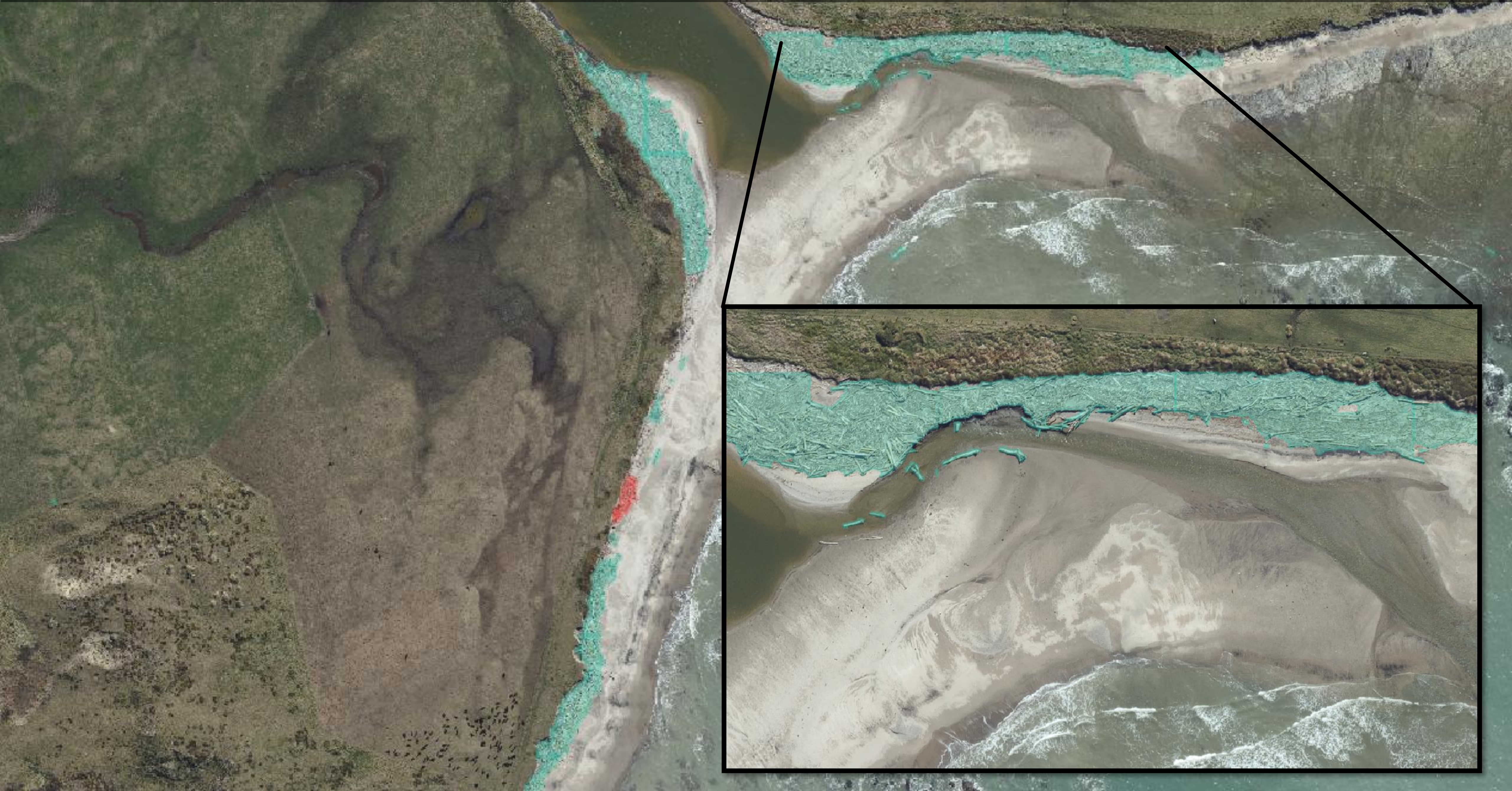
Pelican

Very High Resolution Tasking

- Initial constellation of up to 30 satellites[1]
- **Up to 30cm resolution**
- Pan + 6 RGB+NIR bands
- Up to 30 revisits/day

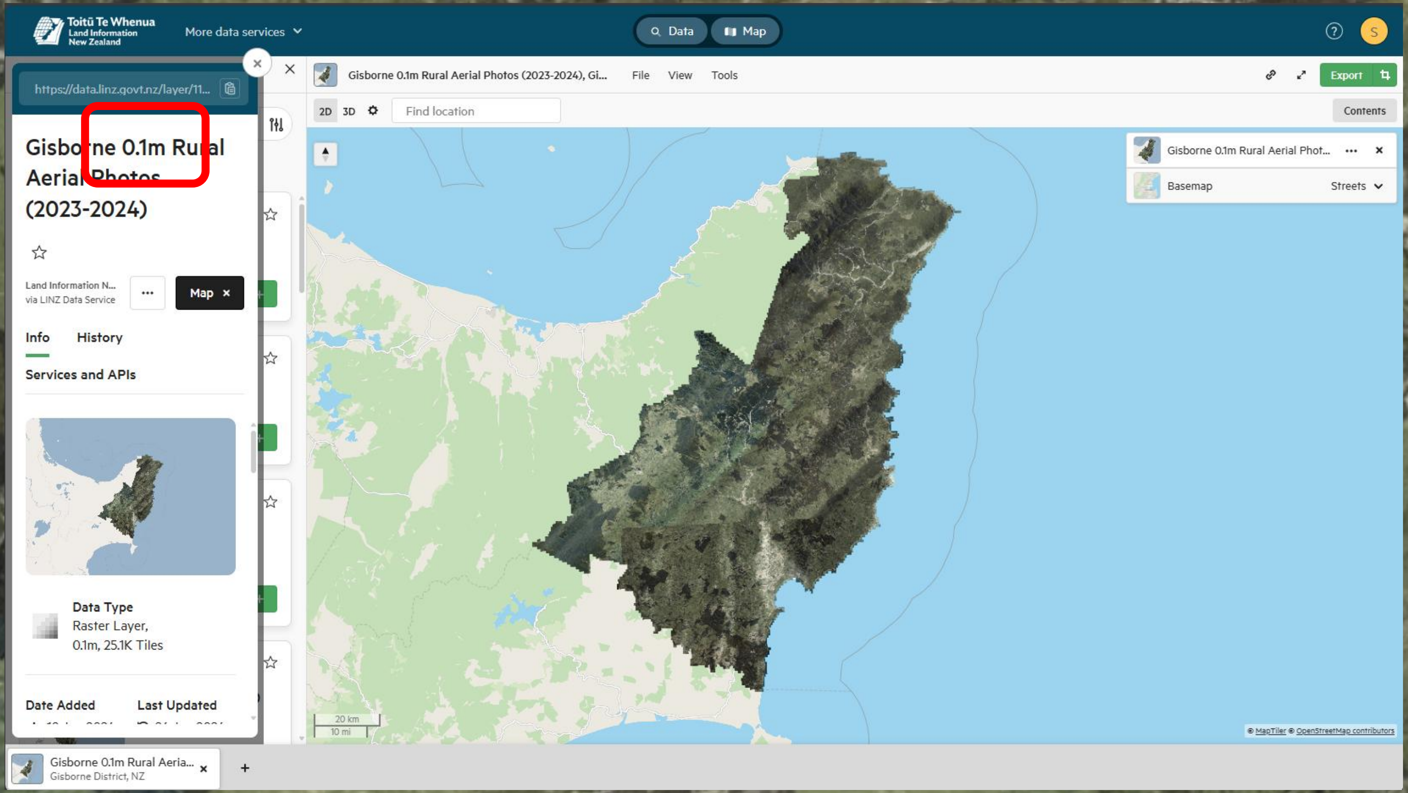
[1] *Does not include initial 2 demonstration satellites planned.*

automated coastal woody debris pile detection using Ai



Case Study:

Woody Debris - Regional Level – Analysis using Ai



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regional woody debris detection

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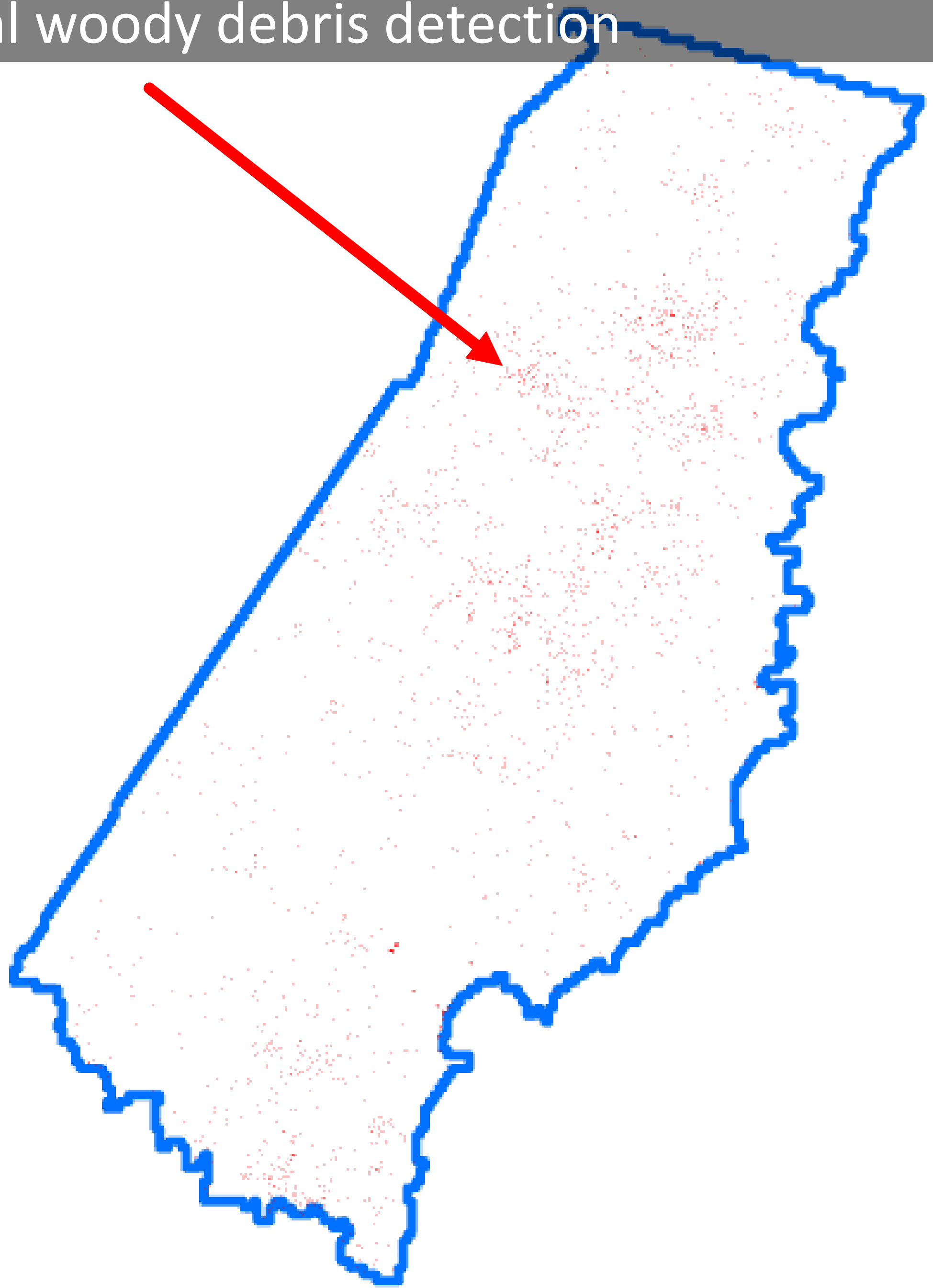
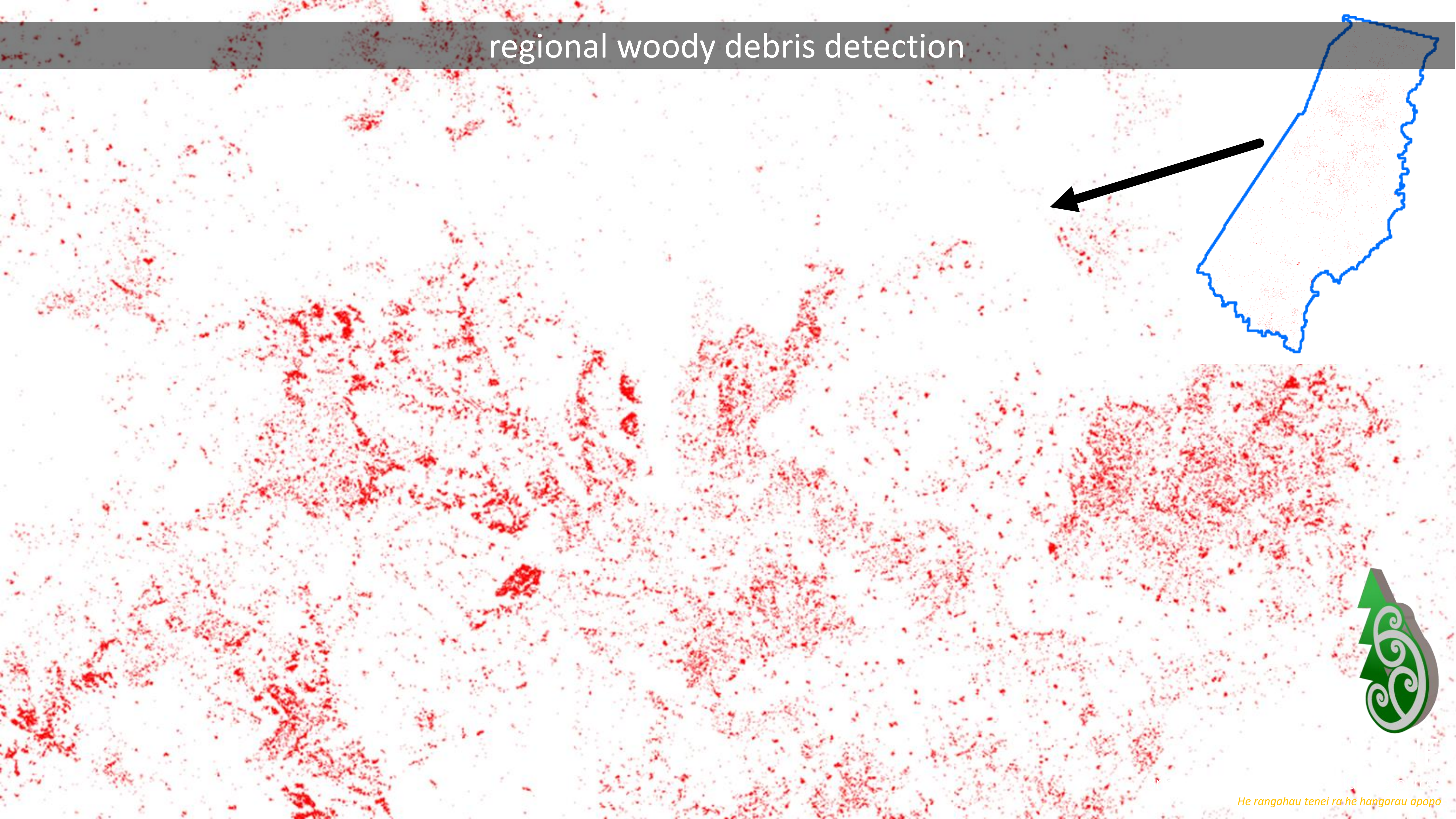
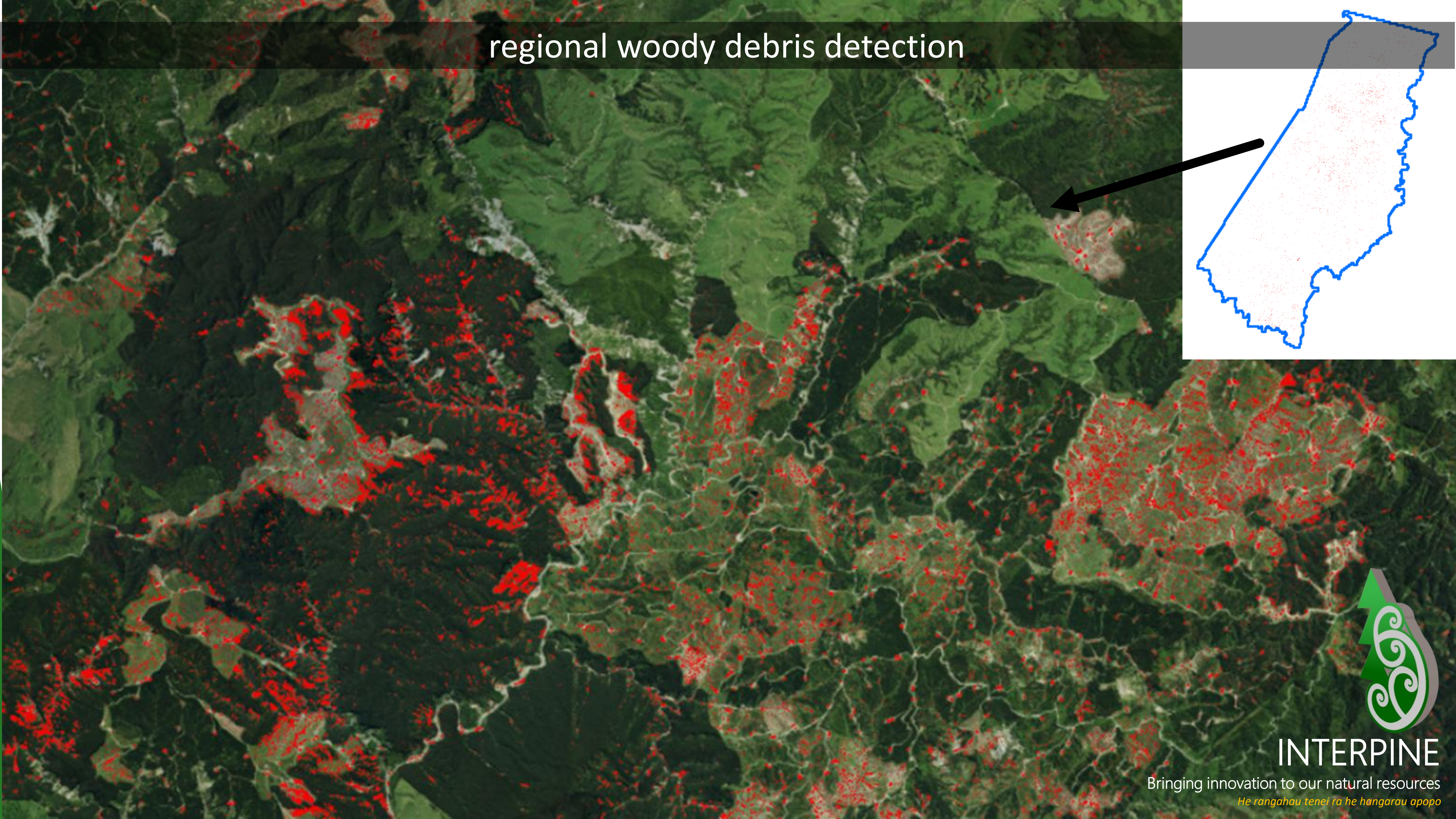
regional woody debris detection



regional woody debris detection



regional woody debris detection



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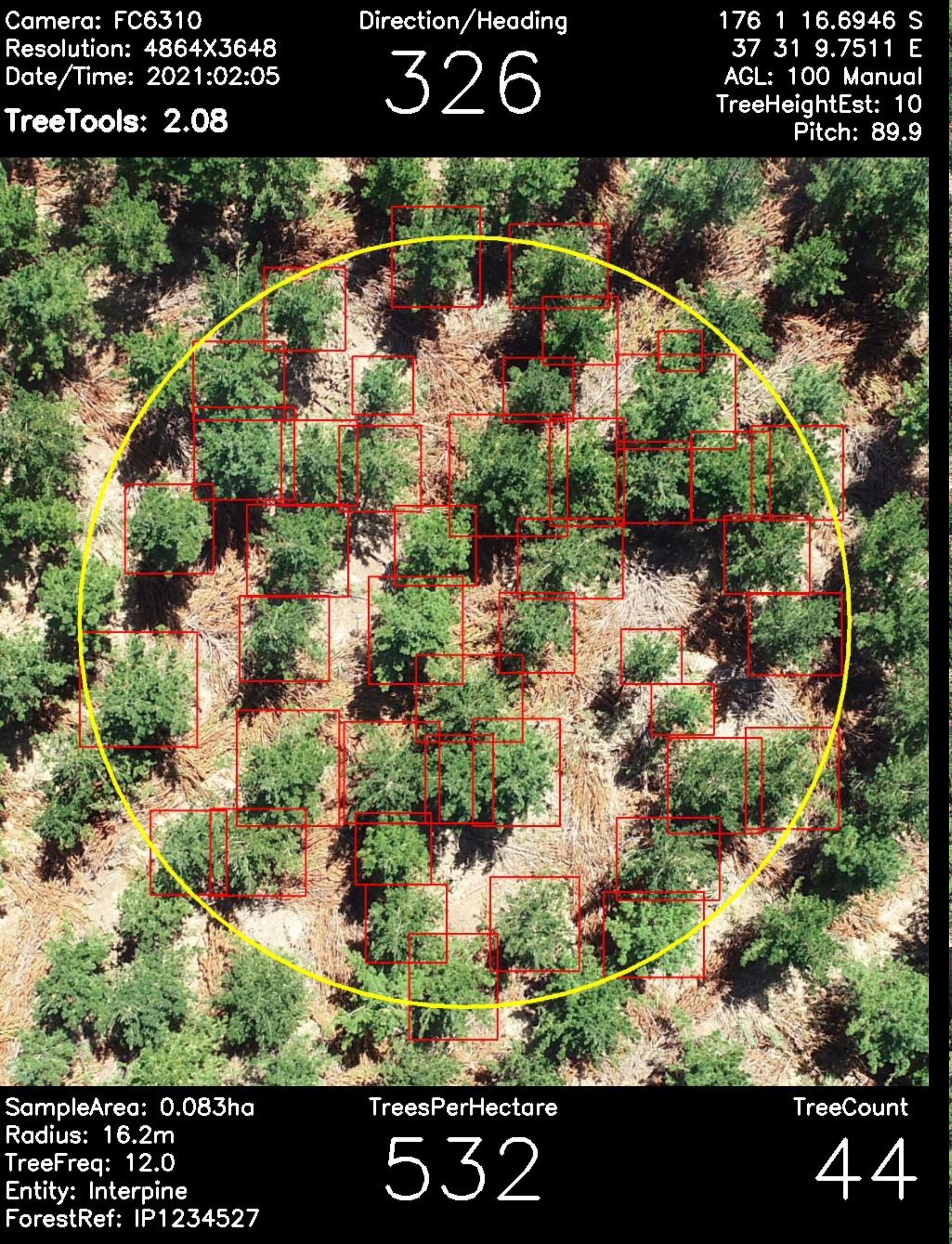
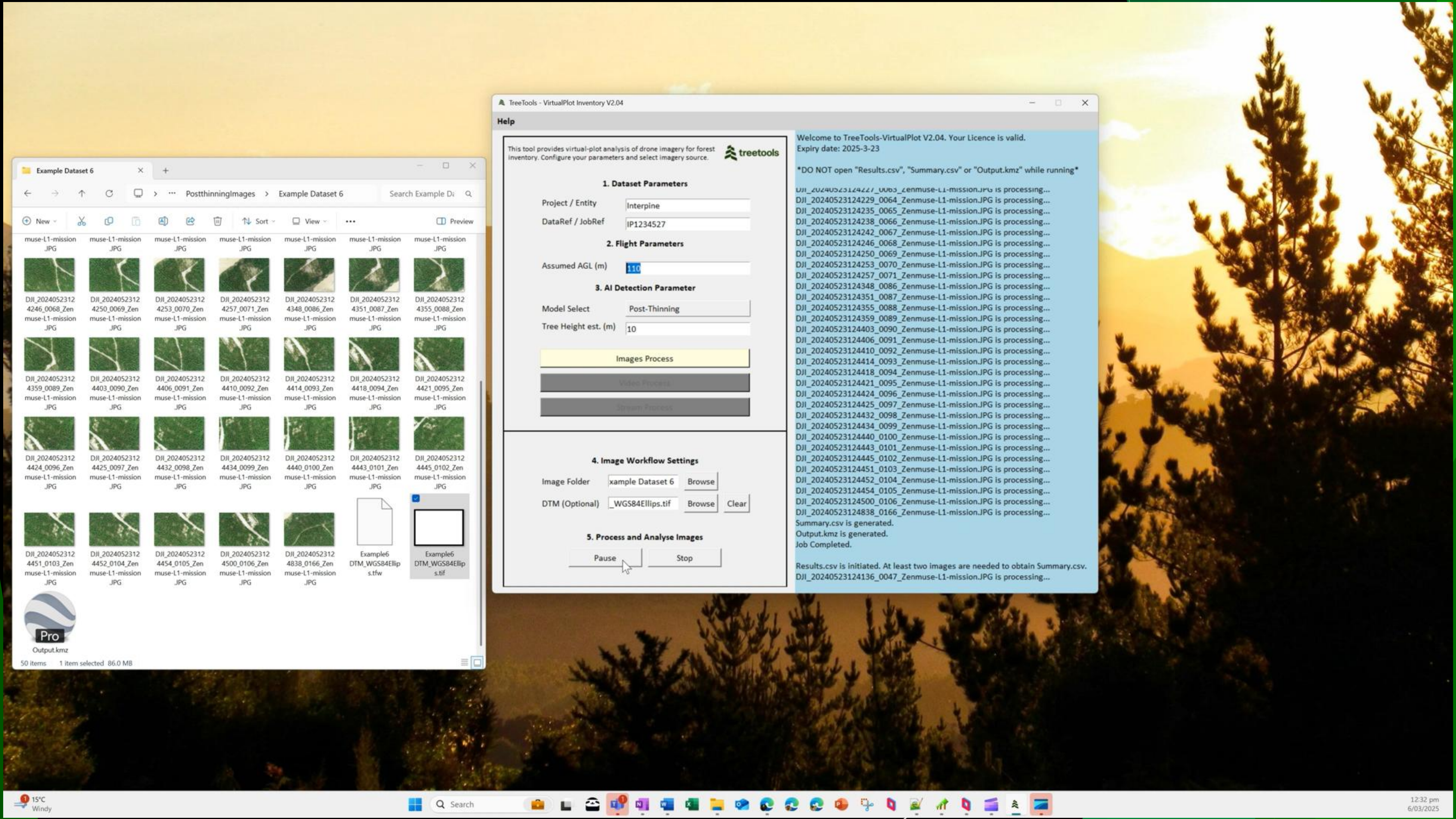
Case Study:

Stocking Survey – Realtime Virtual Plot using Ai


Simplified or use of a lower resolution terrain following flight path
100m AGL
Derived
115m AGL
Derived
90m AGL
Derived
95m AGL
Optimal terrain
flight path against
a 1m DTM
DTM
Elevation
255m
HOME POINT
Derived
120m AGL
Terrain
DTM Elevation
155m
Matrice 4
INTERPINE
INNOVATION


Camera: FC6310
Resolution: 4864X3648
Date/Time: 2021:02:05
TreeTools: 2.08
Direction/Heading
326
176 1 16.6946 S
37 31 9.7511 E
AGL: 100 Manual
TreeHeightEst: 10
Pitch: 89.9
SampleArea: 0.083ha
Radius: 16.2m
TreeFreq: 12.0
Entity: Interpine
ForestRef: IP1234527
TreesPerHectare
532
TreeCount
44

drone based virtual stocking inventory



Example Dataset 6
PostthinningImages > Example Dataset 6
Search Example Da
New
Sort
View
Preview
Example6 DTM_WGS84Ellips.tfw
Example6 DTM_WGS84Ellips.tif
Output.kmz
50 items 1 item selected 86.0 MB
TreeTools - VirtualPlot Inventory V2.04
Help
This tool provides virtual-plot analysis of drone imagery for forest inventory. Configure your parameters and select imagery source.
treetools
1. Dataset Parameters
Project / Entity
Interpine
DataRef / JobRef
IP1234527
2. Flight Parameters
Assumed AGL (m)
110
3. AI Detection Parameter
Model Select
Post-Thinning
Tree Height est. (m)
10
Images Process
4. Image Workflow Settings
Image Folder
xample Dataset 6
Browse
DTM (Optional)
_WGS84Ellips.tif
Browse
Clear
5. Process and Analyse Images
Pause
Stop
Welcome to TreeTools-VirtualPlot V2.04. Your Licence is valid.
Expiry date: 2025-3-23
DO NOT open "Results.csv", "Summary.csv" or "Output.kmz" while running
DJI_20240523124229_0064_Zenmuse-L1-mission.JPG is processing...
DJI_20240523124235_0065_Zenmuse-L1-mission.JPG is processing...
DJI_20240523124238_0066_Zenmuse-L1-mission.JPG is processing...
DJI_20240523124242_0067_Zenmuse-L1-mission.JPG is processing...
DJI_20240523124246_0068_Zenmuse-L1-mission.JPG is processing...
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DJI_20240523124257_0071_Zenmuse-L1-mission.JPG is processing...
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DJI_20240523124351_0087_Zenmuse-L1-mission.JPG is processing...
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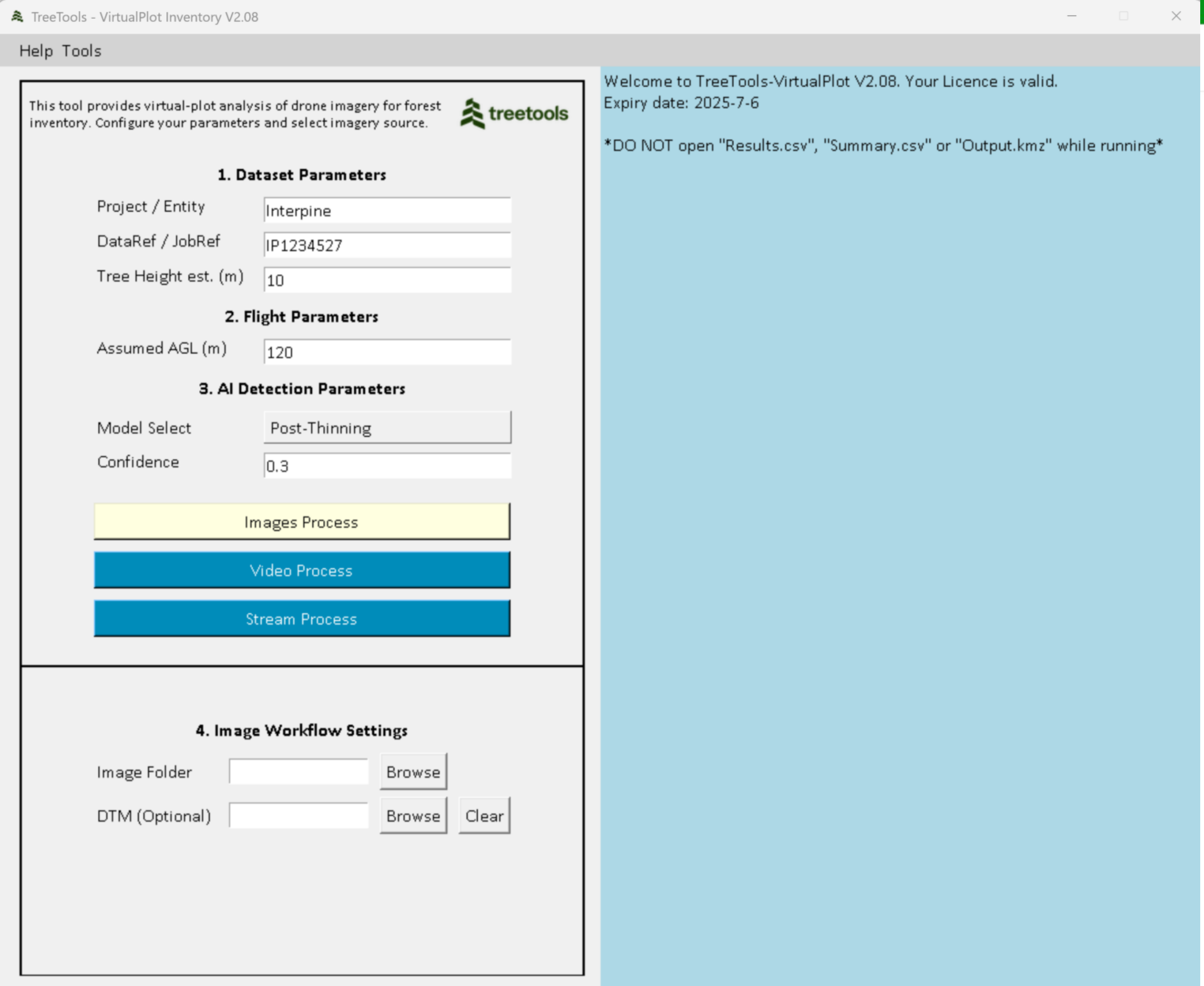
DJI_20240523124454_0105_Zenmuse-L1-mission.JPG is processing...
DJI_20240523124500_0106_Zenmuse-L1-mission.JPG is processing...
DJI_20240523124838_0166_Zenmuse-L1-mission.JPG is processing...
Summary.csv is generated.
Output.kmz is generated.
Job Completed.
Results.csv is initiated. At least two images are needed to obtain Summary.csv.
DJI_20240523124136_0047_Zenmuse-L1-mission.JPG is processing...
15°C
Windy
Search
12:32 pm
6/03/2025


TreeTools - VirtualPlot Inventory V2.08
Help Tools
This tool provides virtual-plot analysis of drone imagery for forest inventory. Configure your parameters and select imagery source.
treetools
1. Dataset Parameters
Project / Entity
Interpine
DataRef / JobRef
IP1234527
Tree Height est. (m)
10
2. Flight Parameters
Assumed AGL (m)
120
3. AI Detection Parameters
Model Select
Post-Thinning
Confidence
0.3
Images Process
Video Process
Stream Process
4. Image Workflow Settings
Image Folder
Browse
DTM (Optional)
Browse
Clear
Welcome to TreeTools-VirtualPlot V2.08. Your Licence is valid.
Expiry date: 2025-7-6
DO NOT open "Results.csv", "Summary.csv" or "Output.kmz" while running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info@interpine.co.nz
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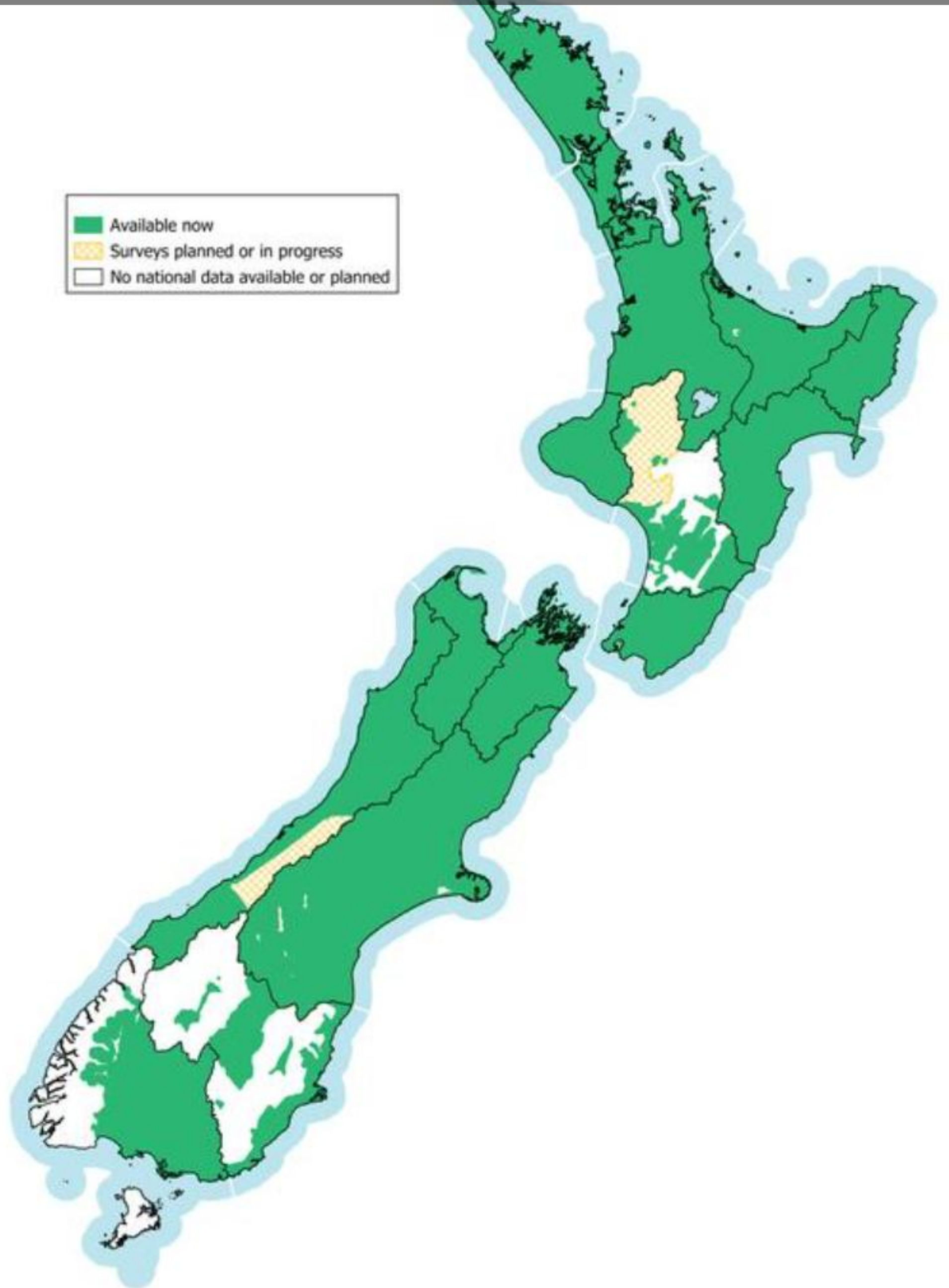
TreeTools VirtualPlot
Discover cutting-edge virtual plotting solutions designed to transform forest management with advanced technology.
GETTING STARTED WITH OUR SOFTWARE
Step-by-Step Guide
1
Download and Install
Begin by contacting us to request a download of the software. There is no install process, and you can run the application directly after download.
2
Fly Your Drone
Fly your drone over your own forest or operations, capturing images of the forest from above. See tips on flight parameters in the get started tutorial.
3
Analyse and Summarise
Select the images you want to process, creating a virtual set of forest inventory plots and summaries. You can do this in the field, generating immediate results and operational insights.
Get Started / Tutorial

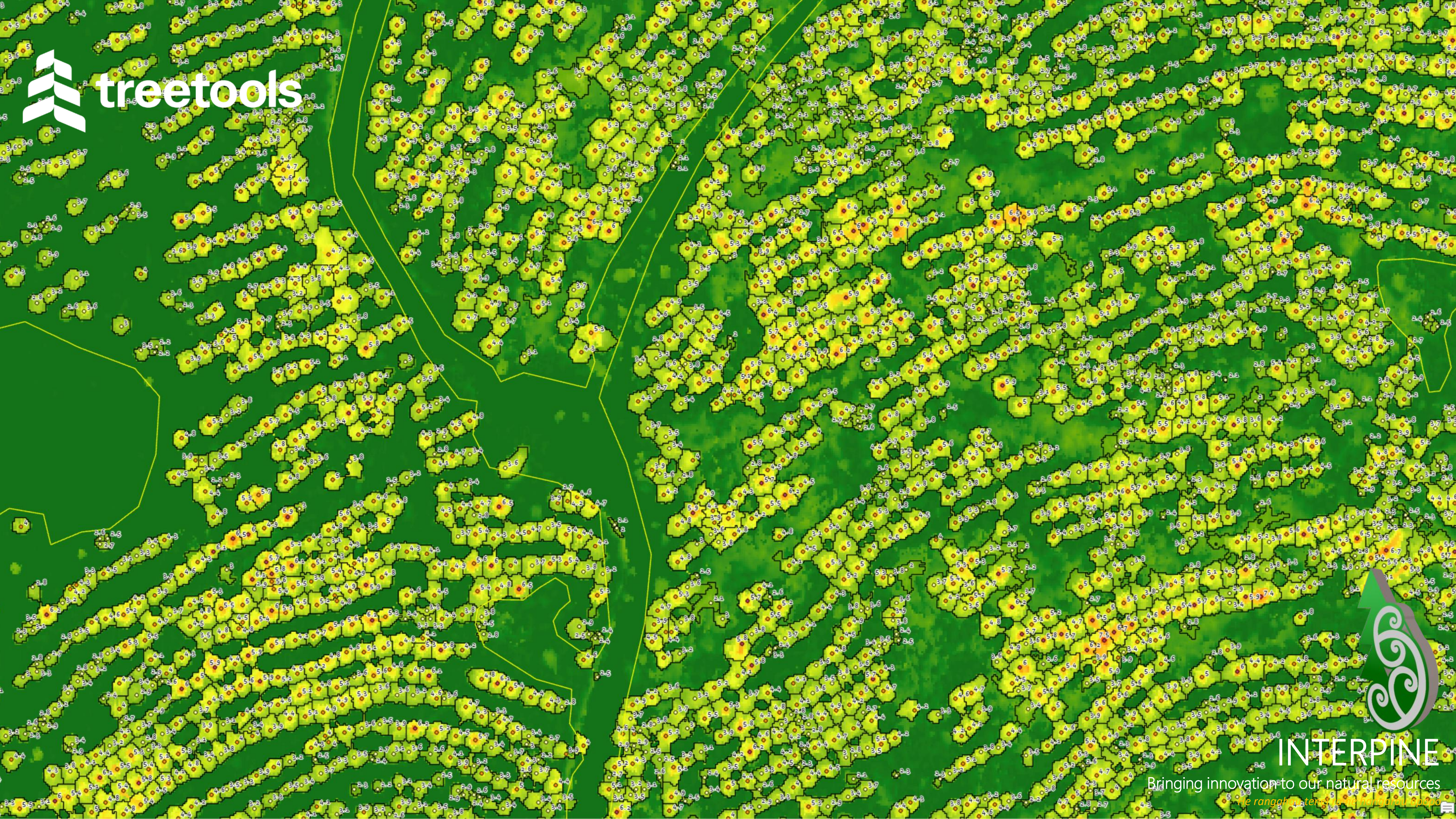

Developed with Support from the Precision Silvicultural Programme
Find Out More

Case Study:

Height and Vigor Forest Inventory – Pre Assessment using Ai

using nationwide LiDAR datasets or drone based LiDAR surveys

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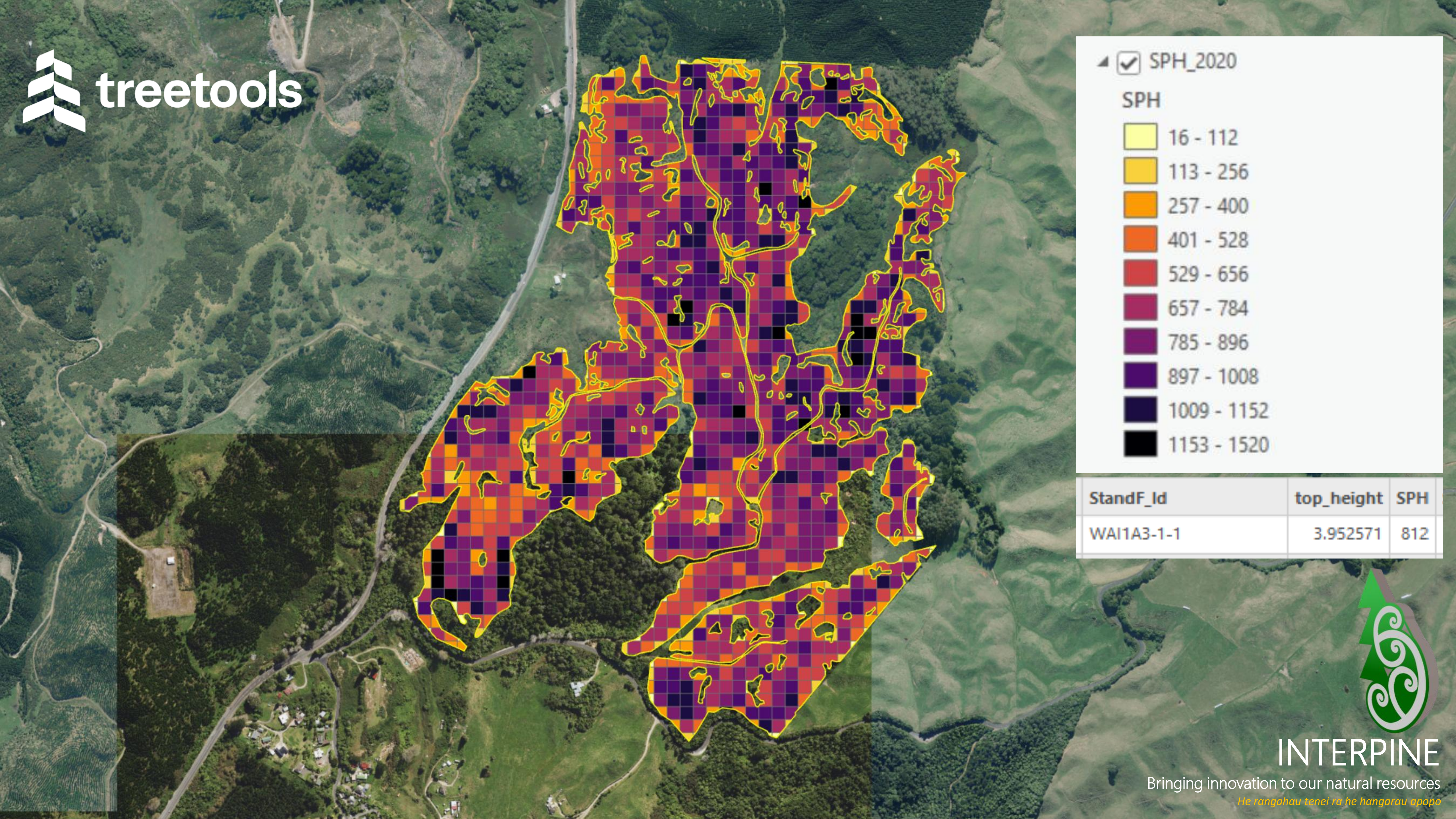

StandF_Id	top_height	SPH
WAI1A3-1-1	3.952571	812

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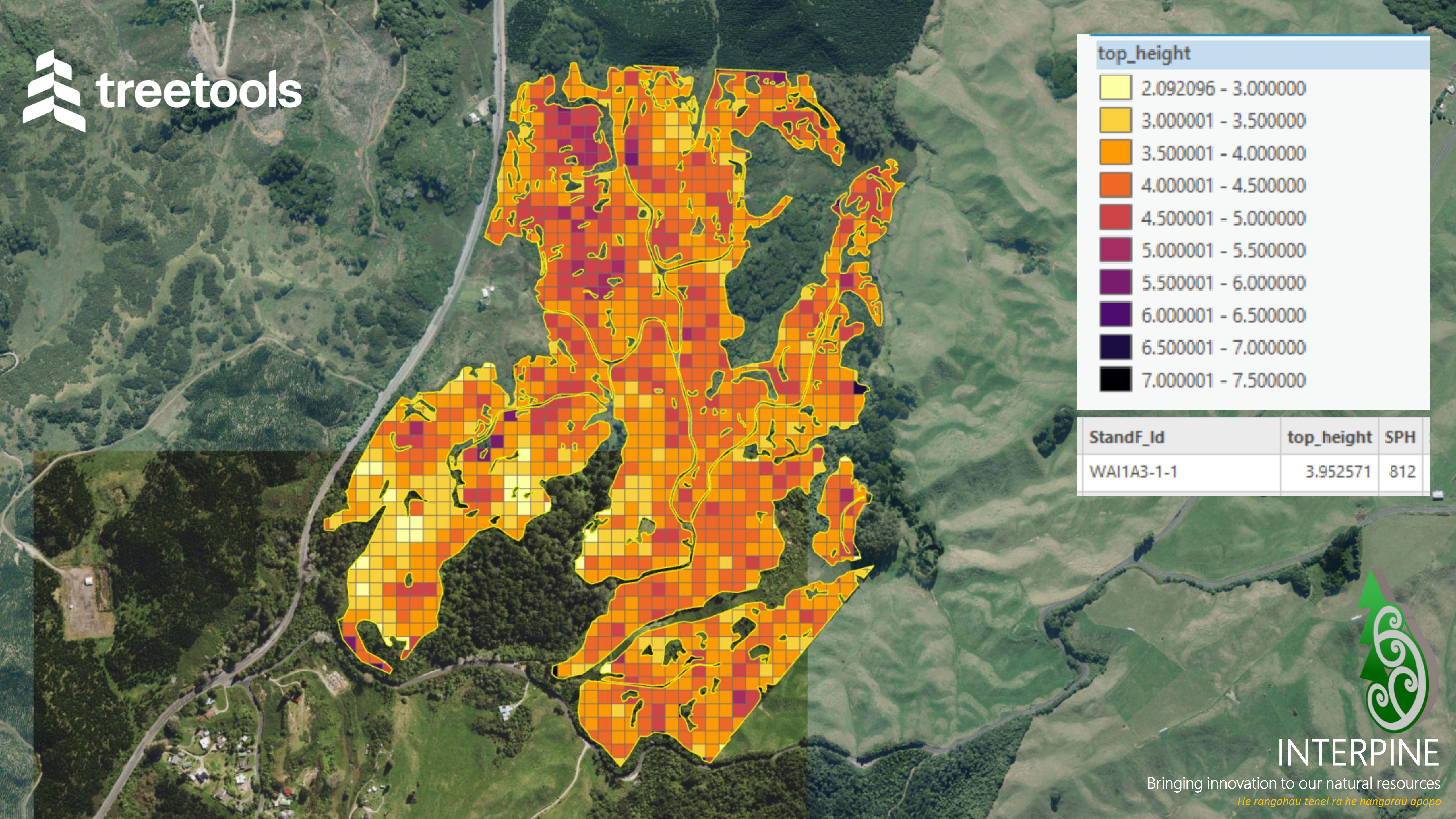
treetools



StandF_Id	top_height	SPH
WAI1A3-1-1	3.952571	812

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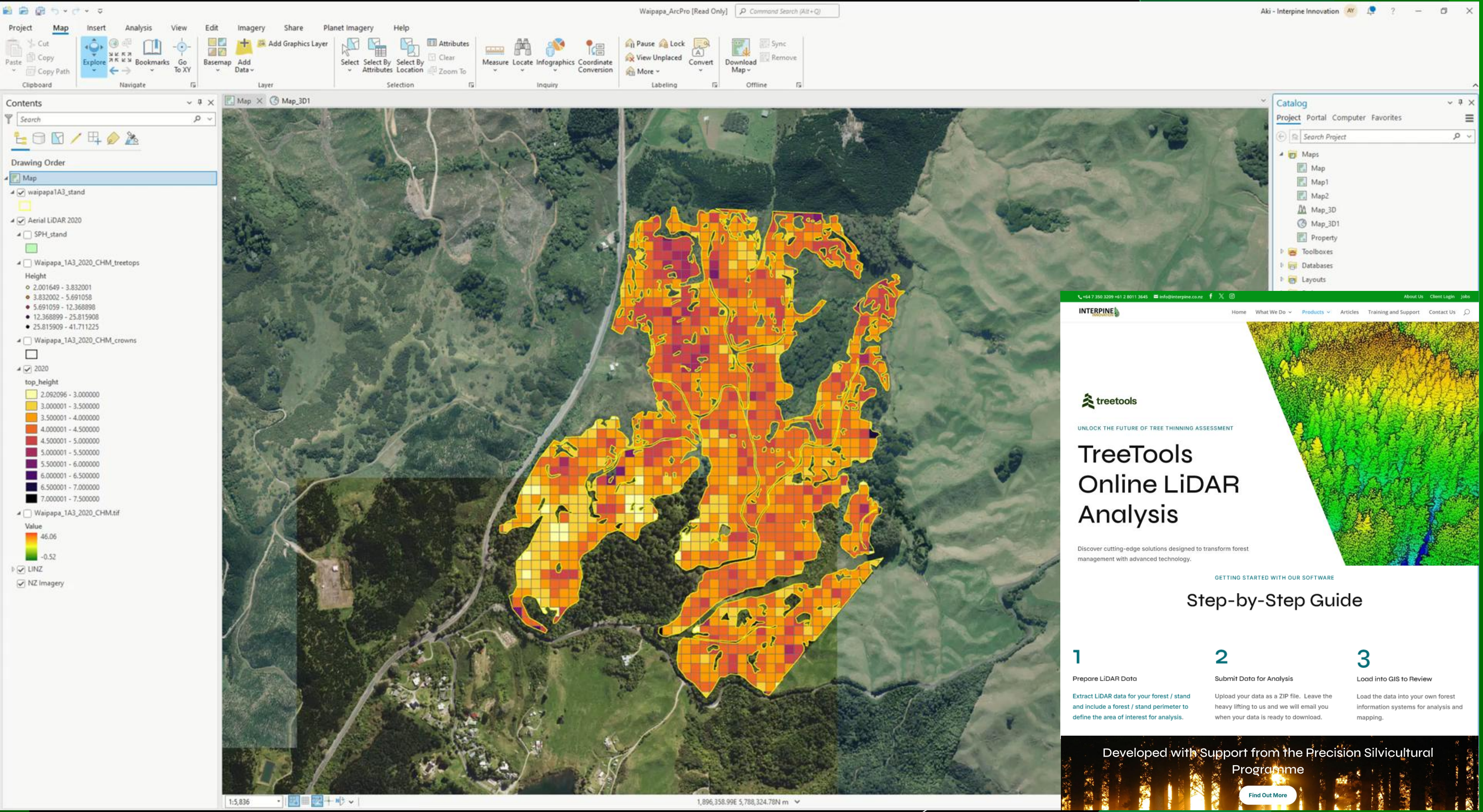

Waipapa_ArcPro [Read Only]
Project
Map
Insert
Analysis
View
Edit
Imagery
Share
Planet Imagery
Help
Contents
Drawing Order
Map
waipapa1A3_stand
Aerial LiDAR 2020
SPH_stand
Waipapa_1A3_2020_CHM_treetops
Height
2.001649 - 3.832001
3.832002 - 5.691058
5.691059 - 12.368898
12.368899 - 25.815908
25.815909 - 41.711225
Waipapa_1A3_2020_CHM_crowns
2020
top_height
2.092096 - 3.000000
3.000001 - 3.500000
3.500001 - 4.000000
4.000001 - 4.500000
4.500001 - 5.000000
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5.500001 - 6.000000
6.000001 - 6.500000
6.500001 - 7.000000
7.000001 - 7.500000
Waipapa_1A3_2020_CHM.tif
Value
46.06
-0.52
LINZ
NZ Imagery
Catalog
Project
Portal
Computer
Favorites
Maps
Map
Map1
Map2
Map_3D
Map_3D1
Property
Toolboxes
Databases
Layouts
1:5,836
1,896,358.99E 5,788,324.78N m
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Discover cutting-edge solutions designed to transform forest management with advanced technology.
GETTING STARTED WITH OUR SOFTWARE
Step-by-Step Guide
1
Prepare LiDAR Data
Extract LiDAR data for your forest / stand and include a forest / stand perimeter to define the area of interest for analysis.
2
Submit Data for Analysis
Upload your data as a ZIP file. Leave the heavy lifting to us and we will email you when your data is ready to download.
3
Load into GIS to Review
Load the data into your own forest information systems for analysis and mapping.
Developed with Support from the Precision Silvicultural Programme
Find Out More

Case Study:

Harvester Log Sweep Assessment and Measurement – using Ai

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Acknowledgements

Sam West, Susana Gonzalez, Joo Hynn Ahn, Aki Yang
Jack Guo, Chris Scoggins

and our clients and research partners.

Contact

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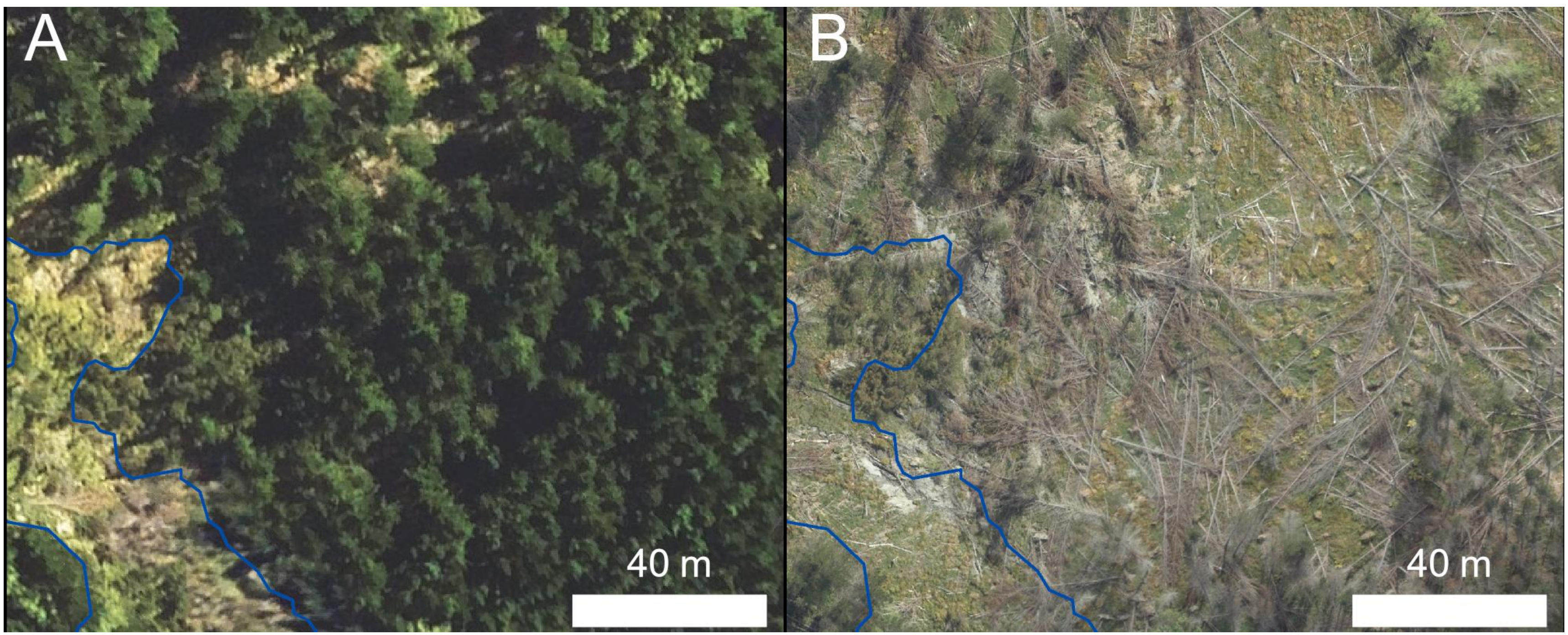
Mapping windthrow and windrisk from Cyclone Gabrielle

Michael S. Watt, Andrew Holdaway, Nicolò Camarretta, Tommaso Locatelli,
Sadeepa Jayathunga, Pete Watt, Kevin Tao, Juan C. Suárez



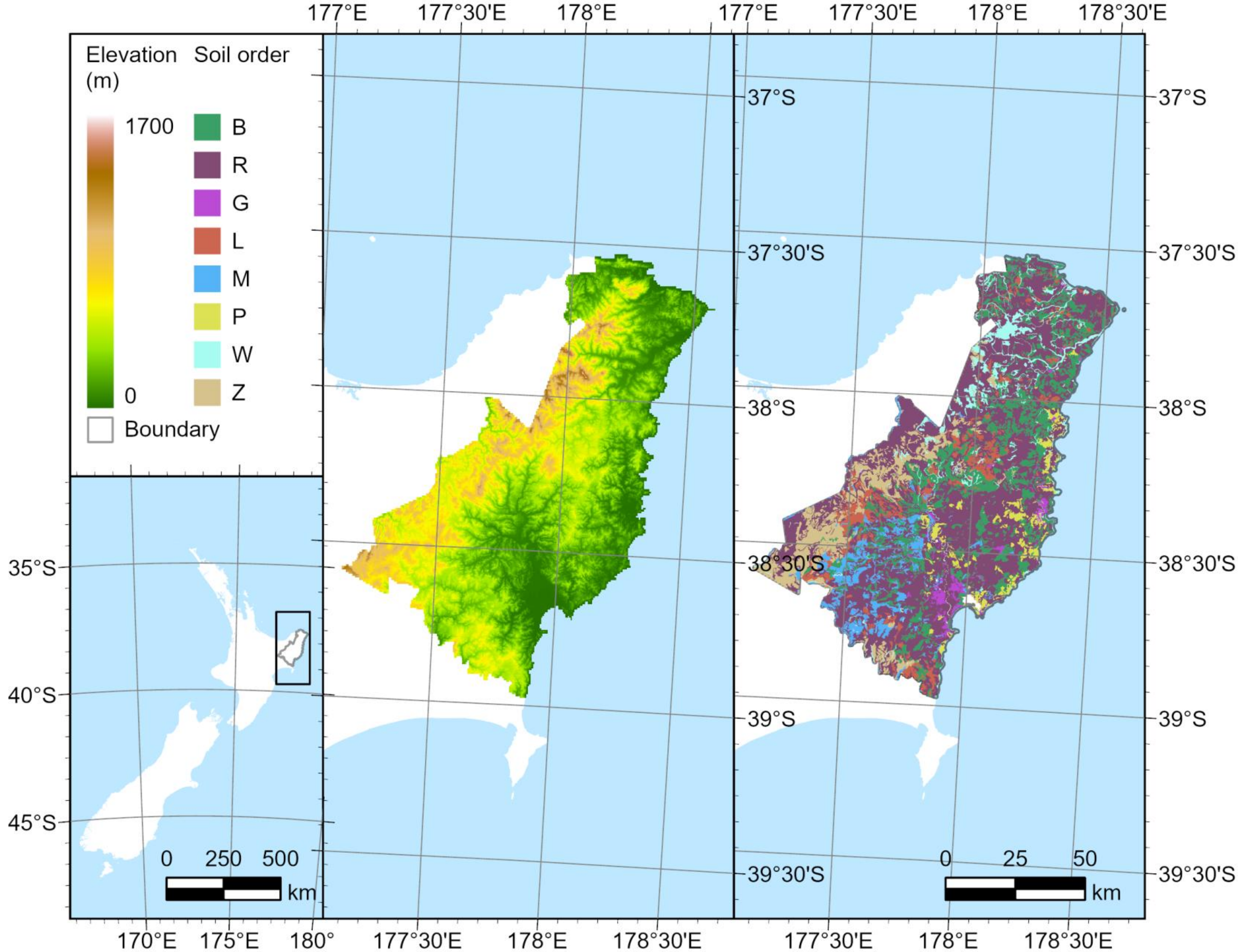
Background

- Cyclone Gabrielle hit the North Island in February 2023, causing much damage
- Damage was very marked within the Gisborne region
- LiDAR acquisitions, acquired pre- and post cyclone, provided a useful means of identifying and quantifying the extent of damage
- The assembly of a range of other spatial datasets allowed development of an empirical predictive model
- Using this assembled dataset the study aims were to:
    - Quantify total damaged area and characterise the location of these areas
    - Identify the most influential predictors of windthrow
    - Develop a model to predict windthrow
    - Simulate wind-risk across the region at different stand ages, for existing forests and unplanted areas

Study region and Cyclone Gabrielle

- Rainfall during Cyclone Gabrielle was most intense within Gisborne, receiving 531 mm over the event
- Rainfall rates reached a peak of 20 – 30 mm/hour during the night of the 13/14 February
- The average two-day rainfall accumulation of 230 mm within Gisborne region only matched during ex-tropical Cyclone Bola
- High rainfall was accompanied by strong wind gusts of up to 93 km/hr
- Cyclone Gabrielle was preceded by Cyclone Hale on 10/11 January 2023, with much of the North Island experiencing the wettest January on record

Study region



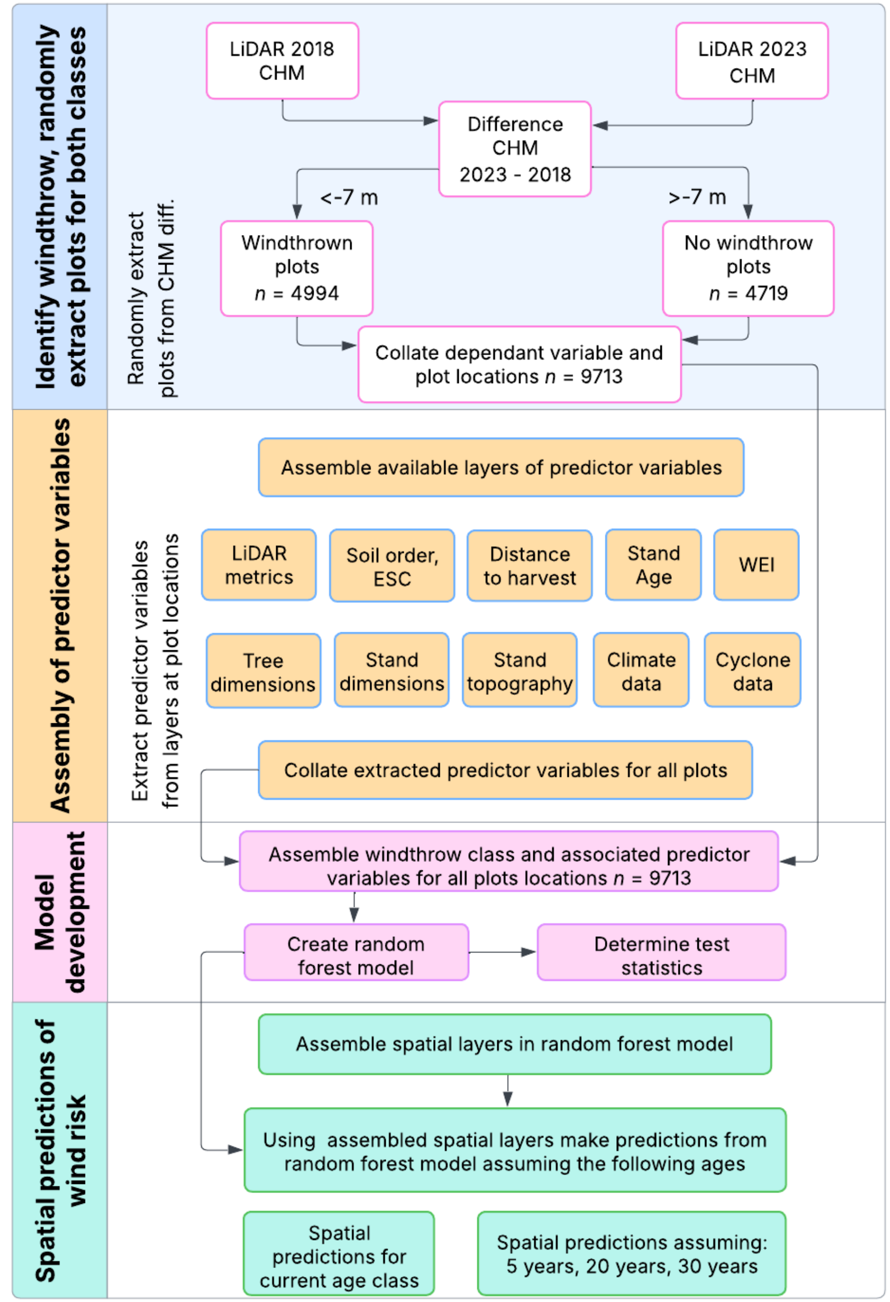
Methods - overview

Stage 1. Identification of windthrow – used 2018, 2023 LiDAR. Install 9,713 virtual plots into two windthrow classes

Stage 2. Assembly of predictor variables for each plot, from surfaces, which included site predictors, stand predictors, climate and cyclone data.

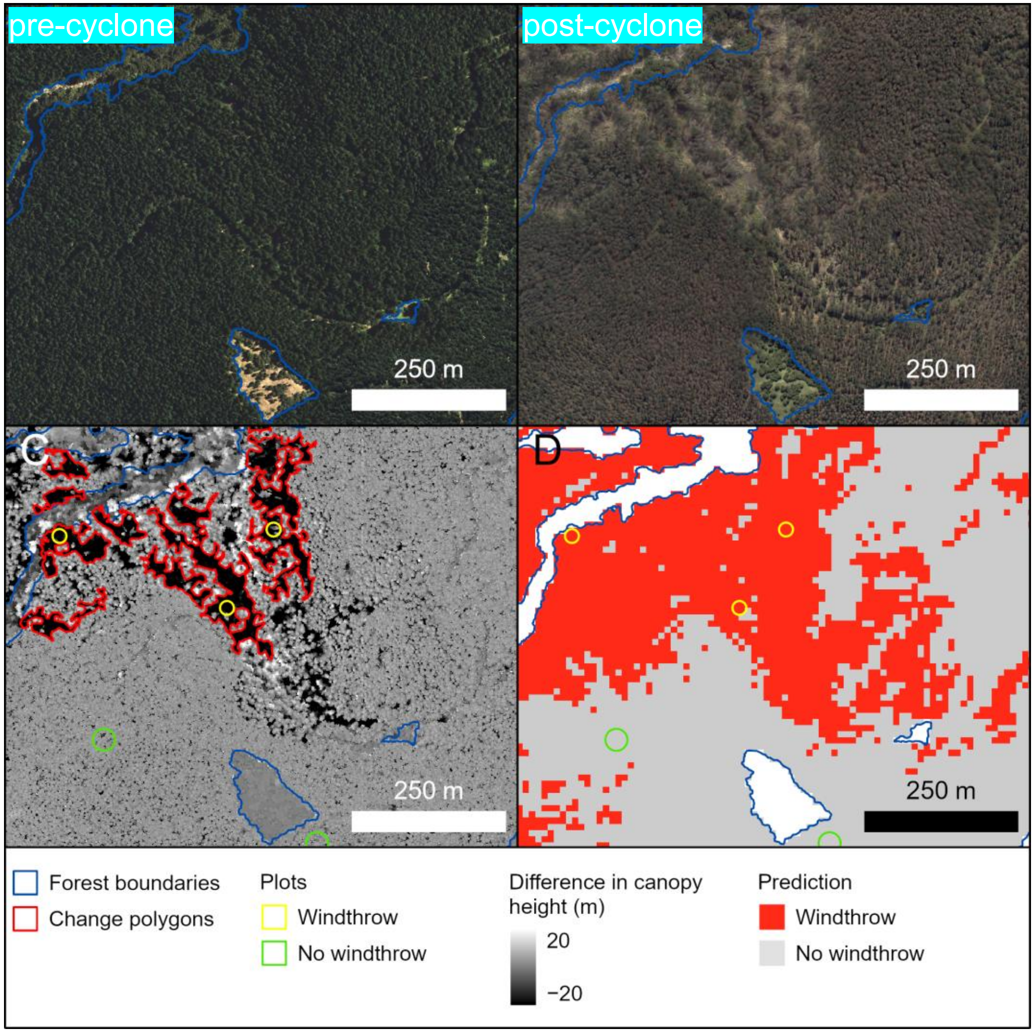
Stage 3. Create a machine learning model of windthrow

Stage 4. Use the machine learning model to make **spatial** predictions



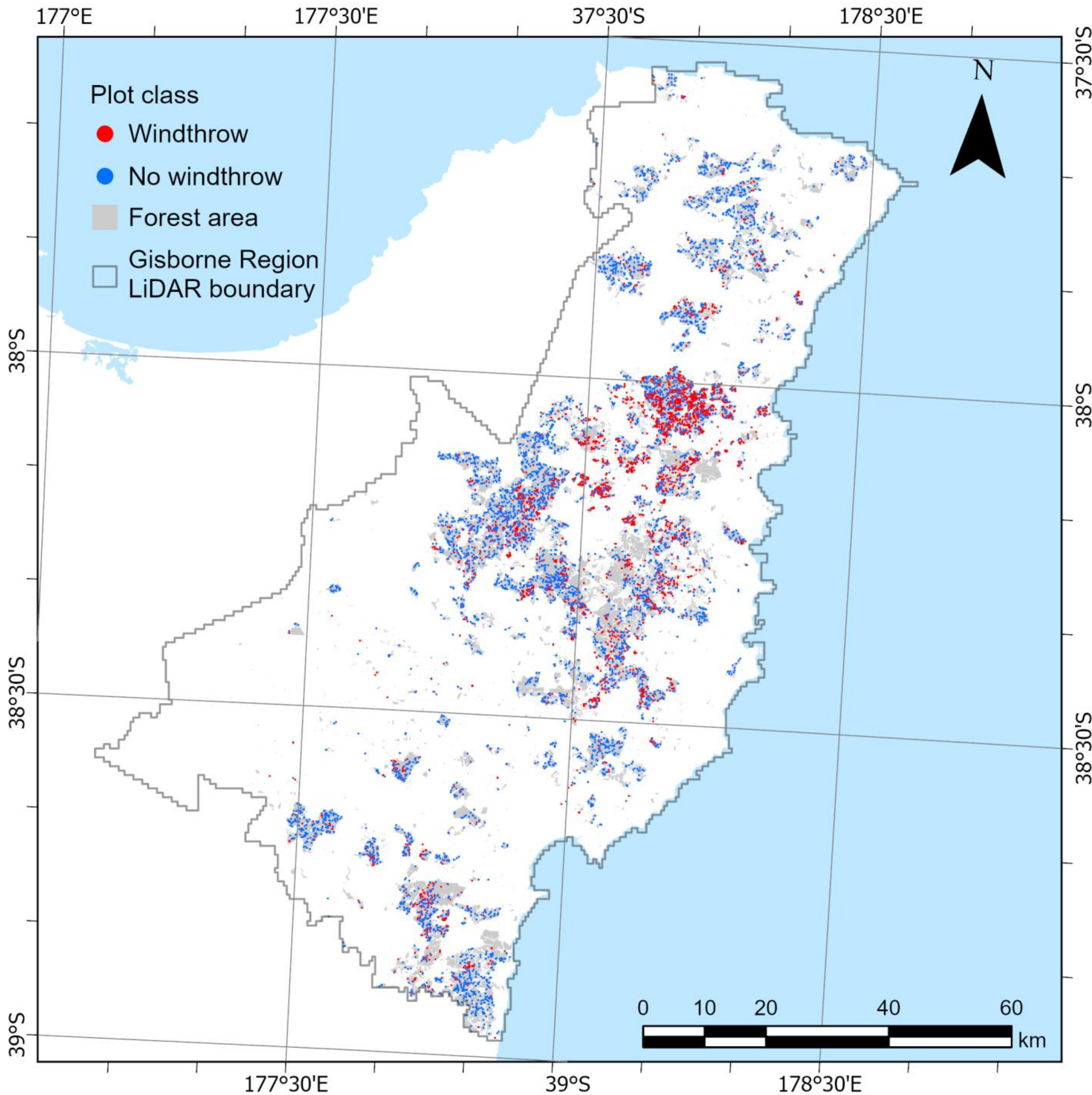
Identification of windthrow and plot installation

- Forest boundaries identified using deep learning model
- Estimates of windthrow identified within these boundaries using pre- and post cyclone LiDAR (panel C)
- LiDAR predictions of windthrow very consistent with pre- and post- aerial photography (panels A and B)
- Plots randomly allocated to windthrow and no windthrow areas (panel C)



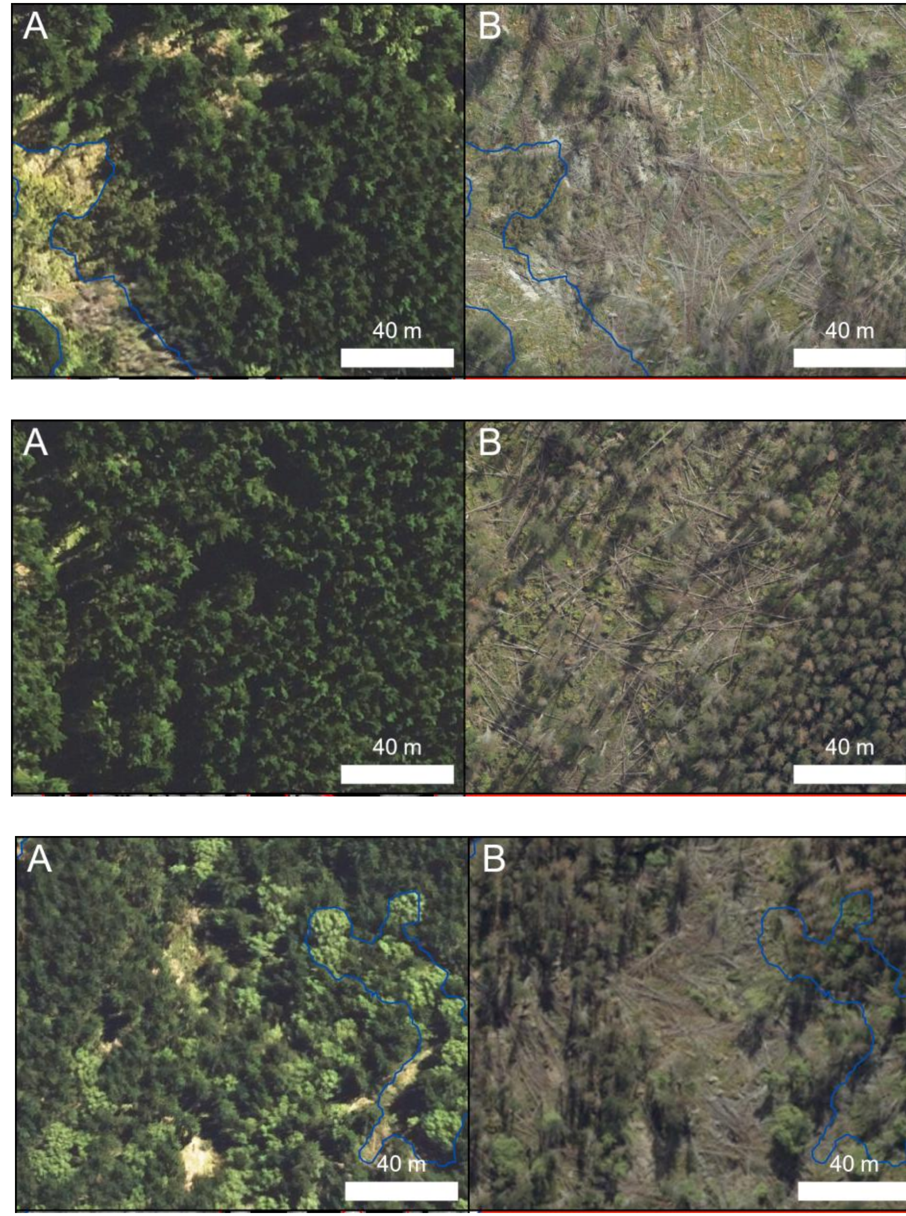
Plot allocation

- Total number of plots allocated
- 4994 - windthrow
- 4719 - no windthrow

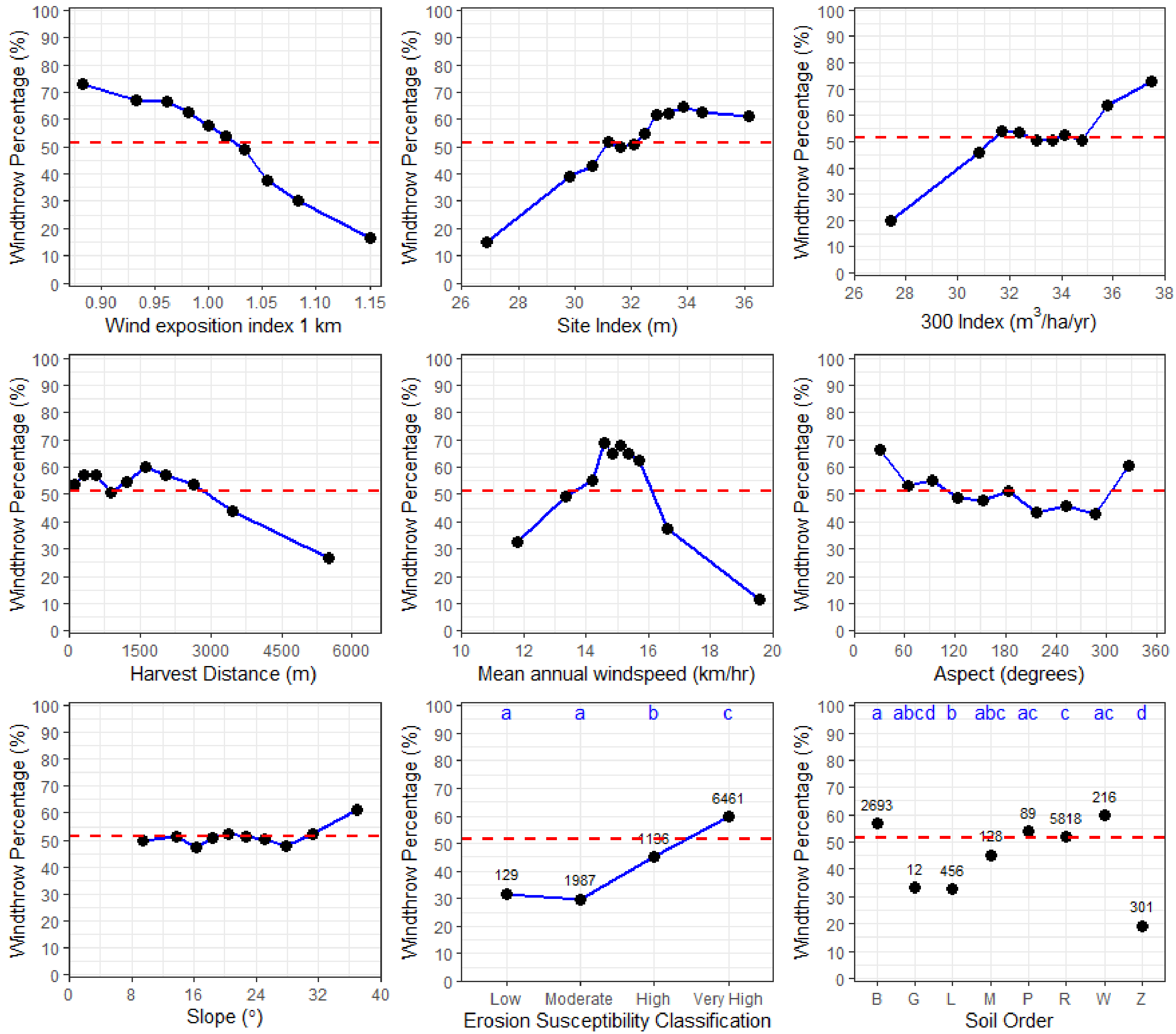


Results – windthrow area

- Total forested area of 139,335 ha in Gisborne region
- Areas of forest loss, identified from LiDAR, classed as storm damage, man made, and slips
- Areas identified to minimum area of 0.015 ha
- Total of 6736 ha identified as storm damage (4.83%)
- Shapefile of loss available



Results – data exploration – site variables



Results – data exploration – site variables

Soil orders

B Brown

G Gley

L Allophanic

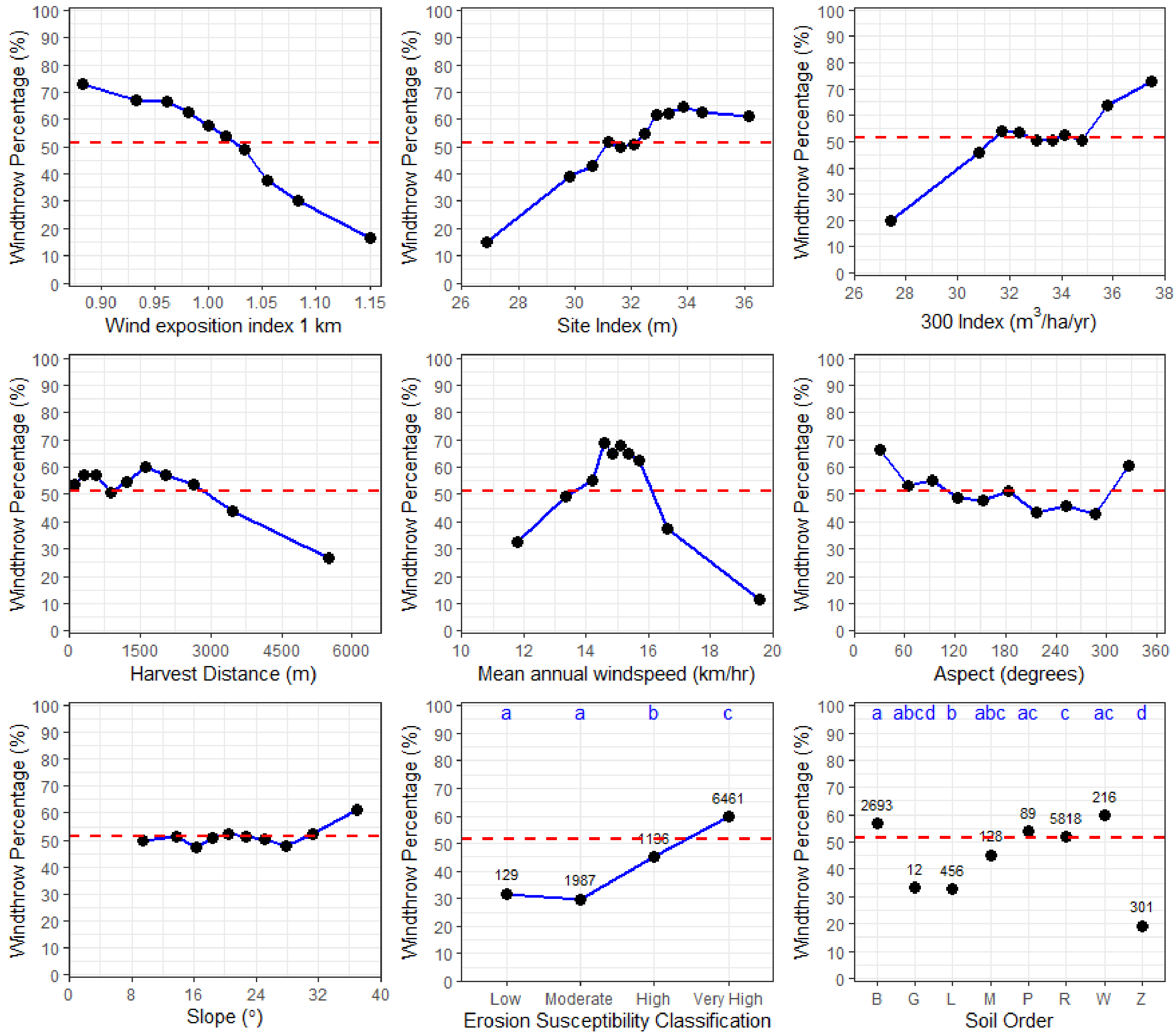
M Pumice

P Pallic

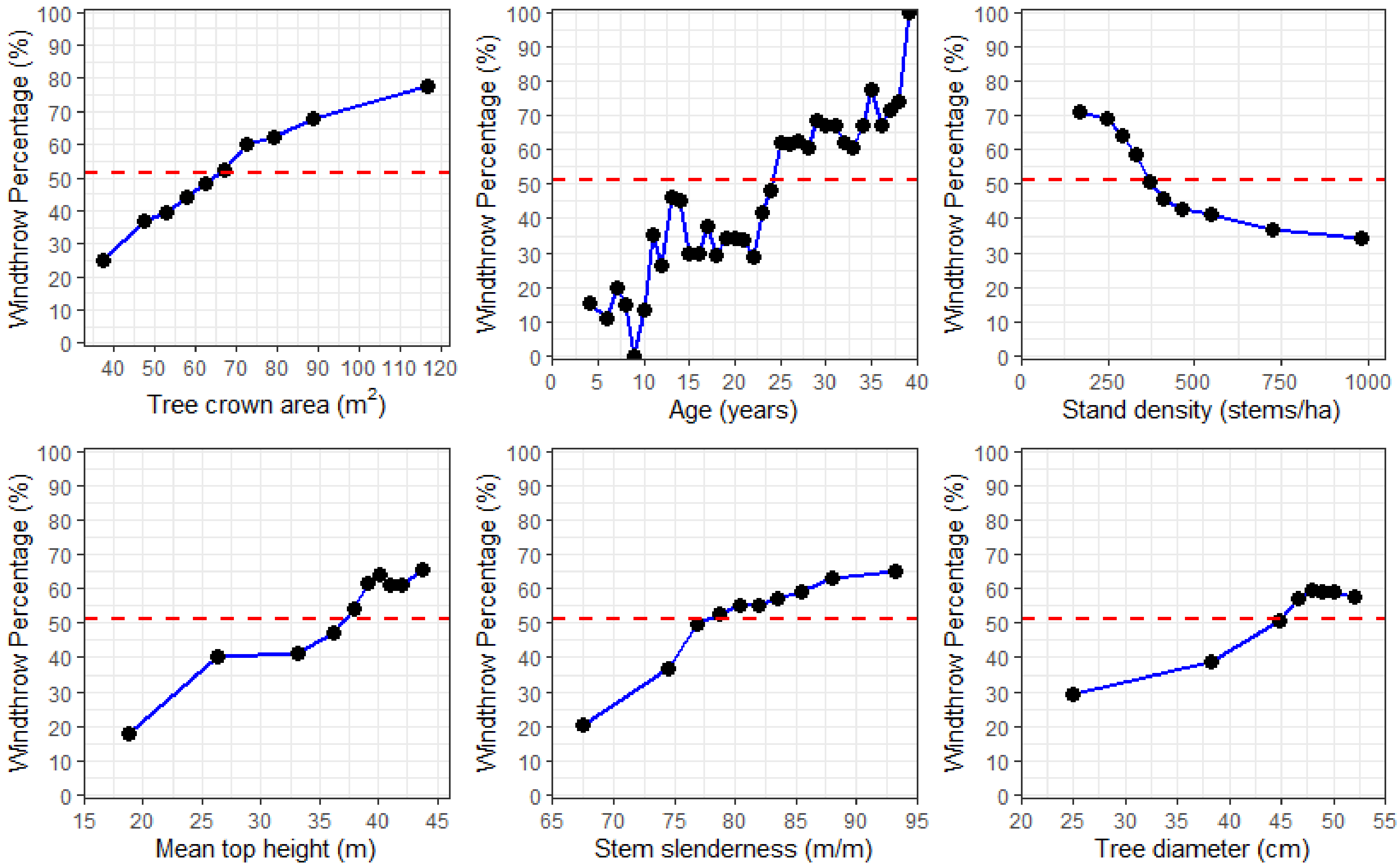
R Recent

W Raw

Z Podzol

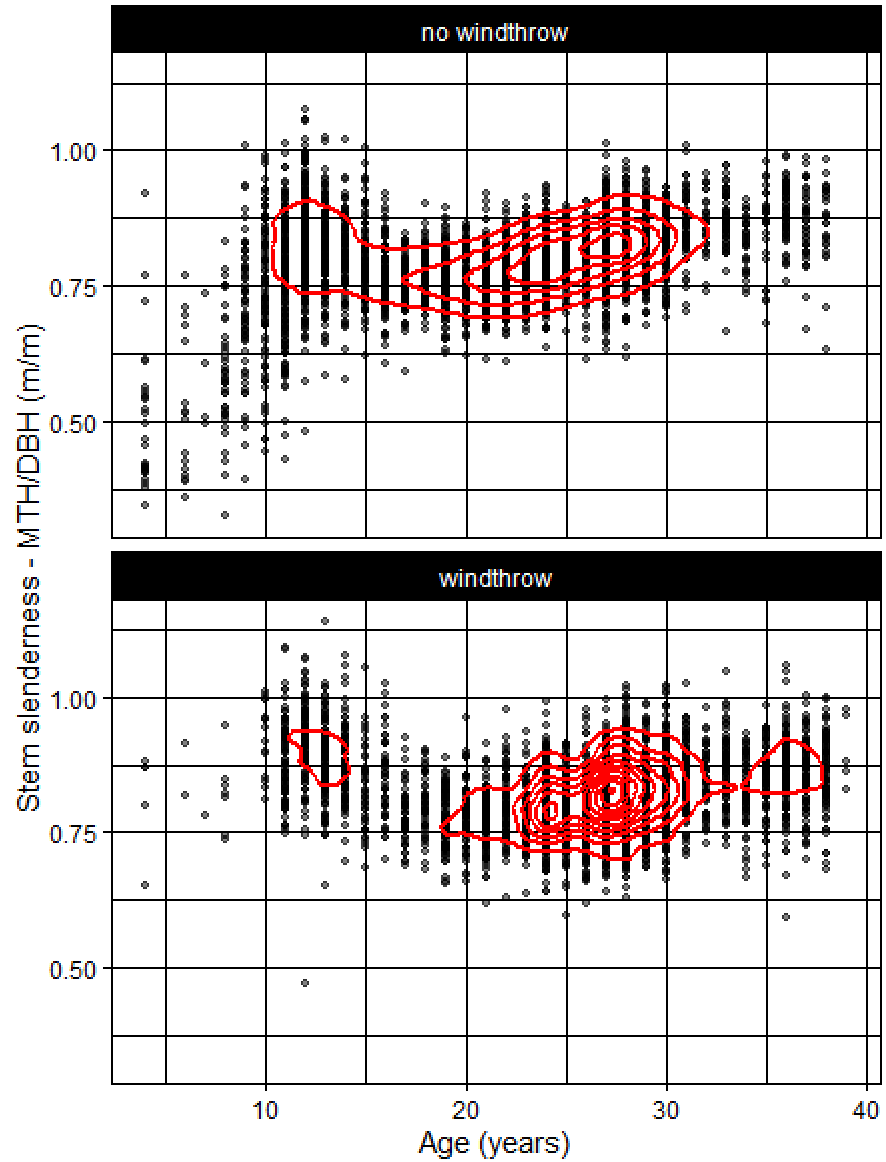


Results – data exploration – stand variables



Results – data exploration – stand variables

- Very little windthrow at ages < 10 yrs
- Little windthrow low slenderness
- Windthrow continuously increased across the stem slenderness range



Results – model predictions

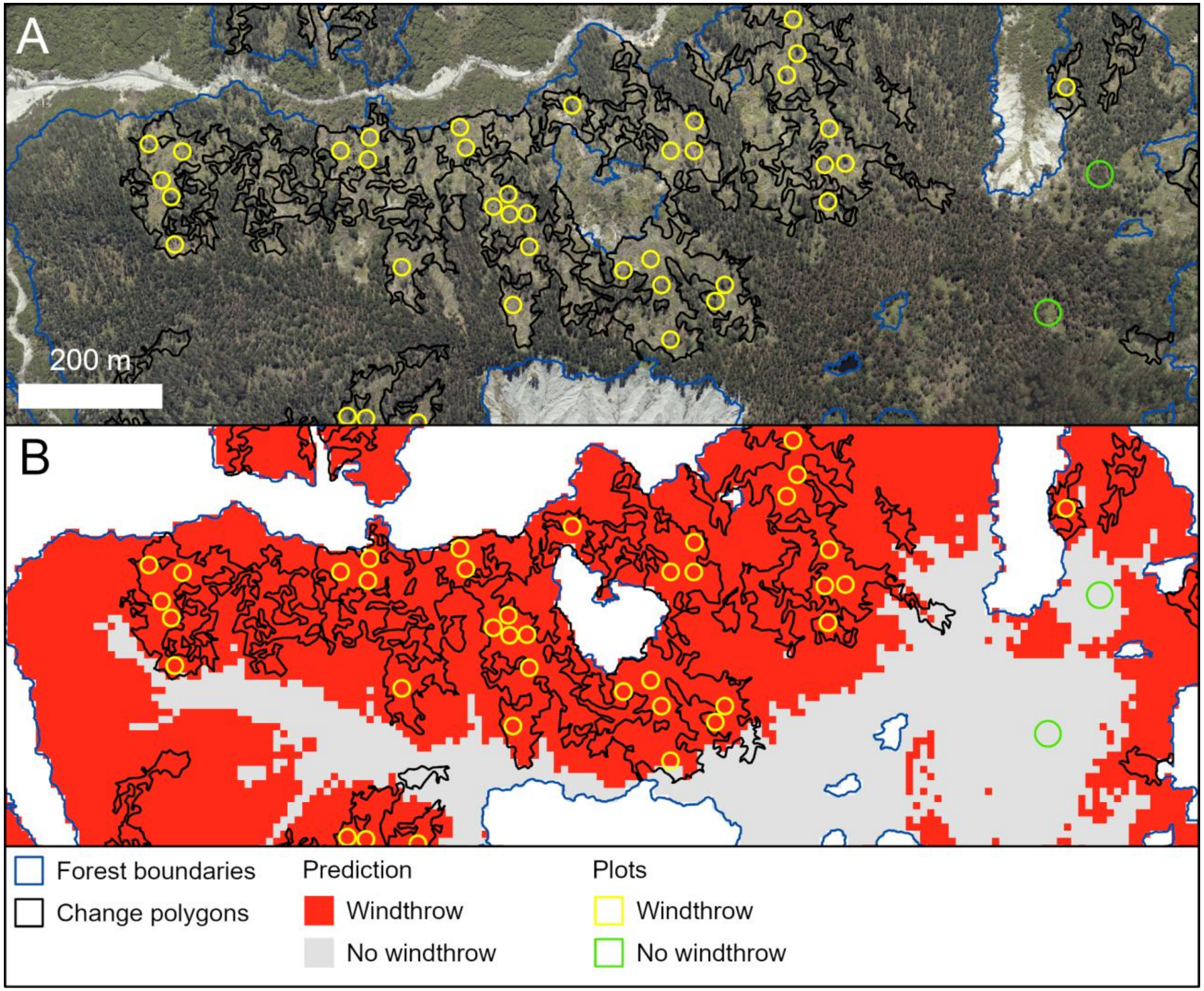
- Two random forest models developed
- Model 1 used 14 variables
- High accuracy of 0.84 (i.e. 84% correct); F1 score of 0.84 – AUC of 0.913
- Model accuracy robust –

  iterated 50 times independent test data
- Accuracy exceeded that of most similar wind risk studies, in Europe
- Addition of cyclone specific variables (Model 2) added very little explanatory power (accuracy of 0.85)

Variables	Model 1	Model 2
Mean February windspeed	0.154	0.103
Wind exposition index (topex)	0.143	0.135
Mean drainage during summer	0.106	0.078
Age	0.098	0.084
300 Index	0.097	0.076
Site Index	0.090	0.068
Harvest distance	0.087	0.070
Aspect	0.079	0.070
Slope	0.072	0.065
Erosion Susceptibility Classification	0.034	0.028
Potential rooting depth	0.020	0.015
Recent soil order	0.0082	0.0060
Brown soil order	0.0078	0.0052
Allophanic soil order	0.0031	0.0025
14^{th} Feb. relative humidity		0.078
14^{th} Feb. windspeed		0.060
13^{th} Feb. rainfall		0.056

Spatial predictions of windthrow

- Model predictions of windthrow aligned closely with data
- Prediction of windthrow beyond observations
- May indicate areas also at risk, as low rate of false negatives (i.e. plots without windthrow incorrectly predicted)



Spatial predictions of windthrow

Percentage of predicted windthrow within the plantation estate using the current age structure. Also shown are predictions for simulated age classes of 5, 20, and 30 years. Shown for reference is the percentage area in the very high category of the erosion susceptibility classification (ESC) for each area.

Category	Current estate	Unplanted area	Entire region
Age within current estate	23.9%		
Simulated age			
Age 5	1.5%	0.4%	0.6%
Age 20	20.2%	9.5%	11.2%
Age 30	34.3%	20.9%	23.1%
ESC very high category	55.4%	35.1%	38.3%

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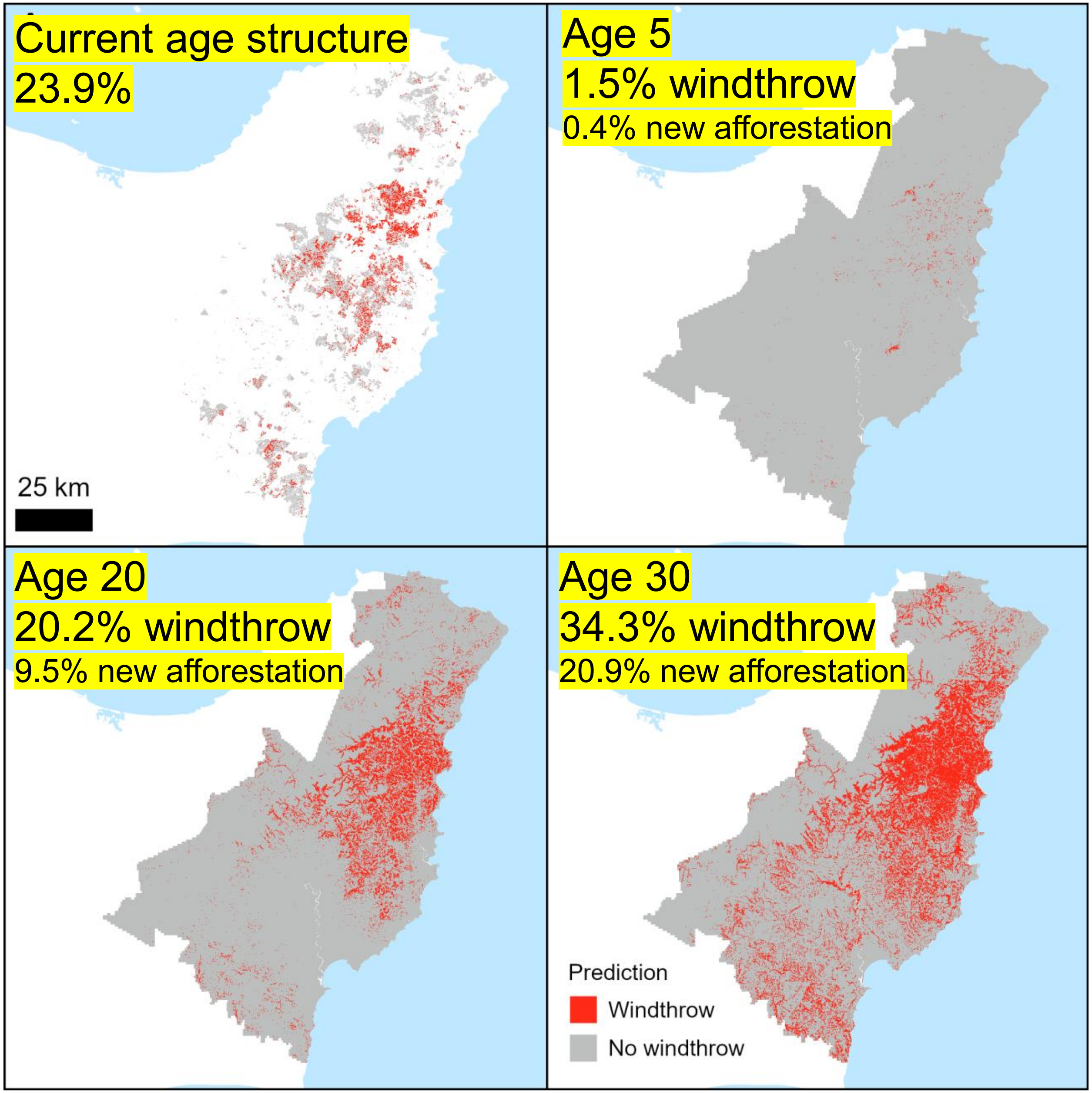
Spatial predictions of windthrow

Predictions show less predicted windthrow for unplanted areas



Discussion – detection of windthrow

- Repeat LiDAR very effective at identifying the 6736 ha of windthrow from the cyclone
- For future events, it may be useful to utilise **satellite** derived photogrammetric point clouds or freely available satellite LiDAR (i.e. GEDI) to detect windthrow
- These methods can be used to determine tree height
- Ideally a monitoring programme for characterising tree height should be put in place to enable rapid identification of damage

Credit: NASA's Scientific Visualization Studio

Discussion – modelling of windrisk

- Model accuracy very high (AUC = 0.913 vs 0.51 – 0.90 most other studies)
- Train/test split repeated 50 times which is a robust approach to take as it avoids bias associated with one repeat
- The accuracy of Model 1 without storm specific information suggests predictions are likely to be reasonably generalisable
- As importantly, the study provides a framework for identifying windthrow and predicting windrisk from future events
- Further research should compile data from additional events and create a meta-model of wind risk

Mitigation of windrisk

- Developed surface represents refinement on ESC high risk areas – includes more than just topographic and soil related data
- Wind risk surface may be useful for guiding areas for further afforestation
- High risk areas could be planted in alternative species (such as redwood) and/or under CCF regimes
- In **high risk** areas:
  - Keep rotation lengths lower than 30 years
  - Implement early thinning
  - Incorporate riparian plantings
  - Coordinate harvest schedules to minimise exposure of old stands to cut edges

Limitations and further research

- Predictions likely to represent storm damage more than wind damage as there was extremely high rainfall associated with the event
- Despite high model accuracy, model predictions of windrisk represent an overestimate as the low proportion of false positives scale up
- A number of key variables were not well characterised
- Gap between LiDAR acquisitions
- Further research should include detailed characterisation of storm data, and explore use of more mechanistic modelling approaches (ForestGALES)

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- Grant Pearse, Melanie Palmer, and Ben Steer for the development of the ForestInsights layer
- NIWA for supplying the weather data
- Catalyst Seedling Fund: Agreement No: CSG-FRI2401
- Scion SSIF funding

Reference

- Paper freely available at: https://doi.org/10.3390/rs17101777

remote sensing

MDPI

Article

Mapping Windthrow Risk in *Pinus radiata* Plantations Using Multi-Temporal LiDAR and Machine Learning: A Case Study of Cyclone Gabrielle, New Zealand

Michael S. Watt [1,*], Andrew Holdaway [2], Nicolò Camarretta [3], Tommaso Locatelli [4], Sadeepa Jayathunga [3], Pete Watt [2], Kevin Tao [2] and Juan C. Suárez [4]

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Abstract: As the frequency of strong storms and cyclones increases, understanding wind risk in both existing and newly established plantation forests is becoming increasingly important. Recent advances in the quality and availability of remotely sensed data have significantly improved our capability to make large-scale wind risk predictions. This study models the loss of radiata pine (*Pinus radiata* D.Don) plantations following a severe cyclone within the Gisborne Region of New Zealand through leveraging repeat regional LiDAR acquisitions, optical imagery, and various surfaces describing key climatic, topographic, and storm-specific conditions. A random forest model was trained on 9713 plots classified as windthrow or no-windthrow. Model validation using 50 iterations of 80/20 train/test splits achieved robust accuracy (accuracy = 0.835; F1 score = 0.841; AUC = 0.913). In comparison to most European empirical models (AUC = 0.51–0.90), our framework demonstrated superior discrimination, underscoring its value for regions prone to cyclones. Among the 14 predictor variables, the most influential were mean windspeed during February, the wind exposition index, site drainage, and stand age. Model predictions closely aligned with the estimated 3705 hectares of cyclone-induced forest damage and indicated that 20.9% of unplanted areas in the region would be at risk of windthrow at age 30 if established in radiata pine. The resulting wind risk surface serves as a valuable decision-support tool for forest managers, helping to mitigate wind risk in existing forests and guide adaptive afforestation strategies. Although developed for radiata pine plantations in New Zealand, the approach and findings have broader relevance for forest management in cyclone-prone regions worldwide, particularly where plantation forestry is widely practised.

Keywords: airborne laser scanning; Gisborne Region; plantation risk mapping; *Pinus radiata*;

check for updates

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Thank you

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Principal Scientist - Scion

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Managing the risk to infrastructure and communities

Sam Reed
Technical Director - Water

Tonkin+Taylor

Emerging stronger

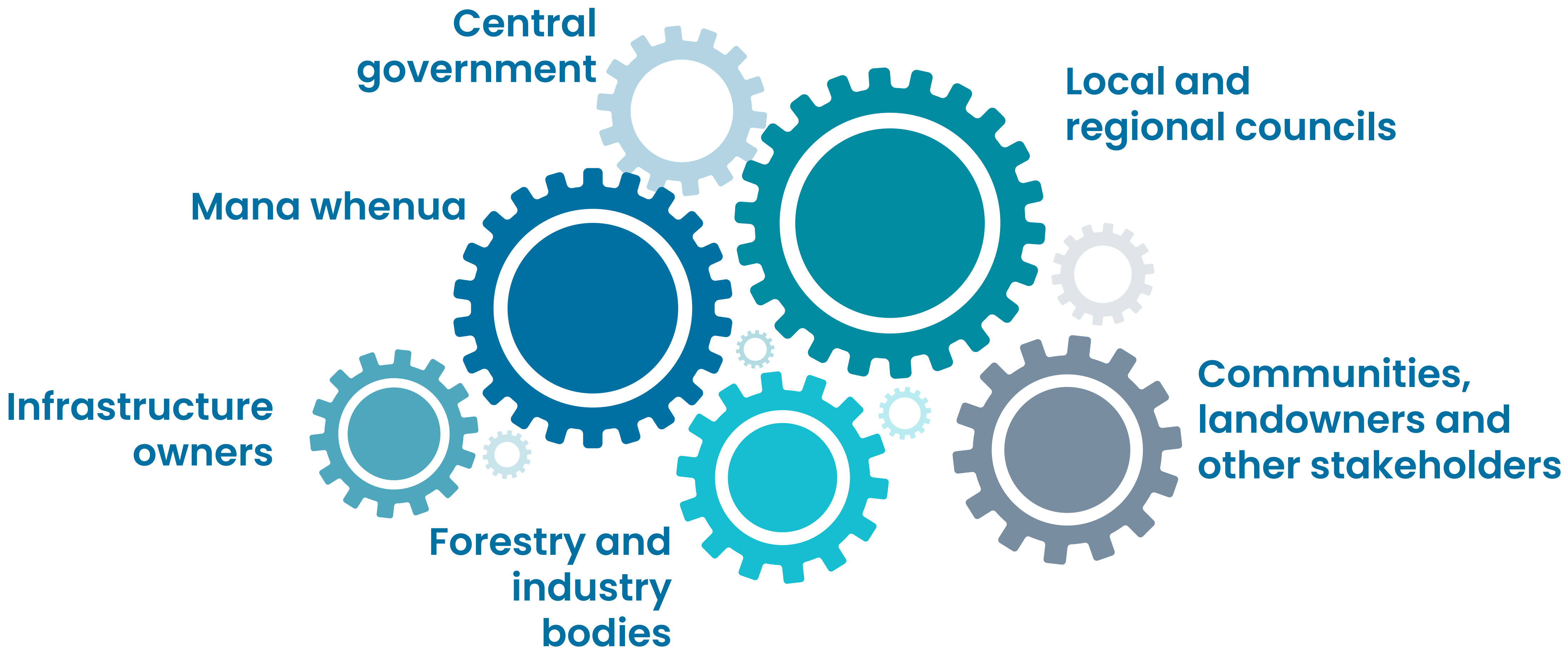
- Assessing Cyclone Impact on Forest Ecosystems and infrastructure
- Steepland plantation forestry: What can we manage, and will it make a difference? - Chris Phillips
- Transitioning exotic forests to native - Meg Graeme and Jacqui Aimers
- Modelling land which needs retiring - Mike Marden
- Engineering solutions - Rien Visser

But how can you pull this together?

And how can we manage the risk to infrastructure and communities?

Managing the risk

Who’s involved + who is doing what?



Risk management
what might it look like for Forestry

01

Risk identification

Identify potential hazards and who could be affected

02

Analysis

Risk = likelihood x impact

03

Mitigation

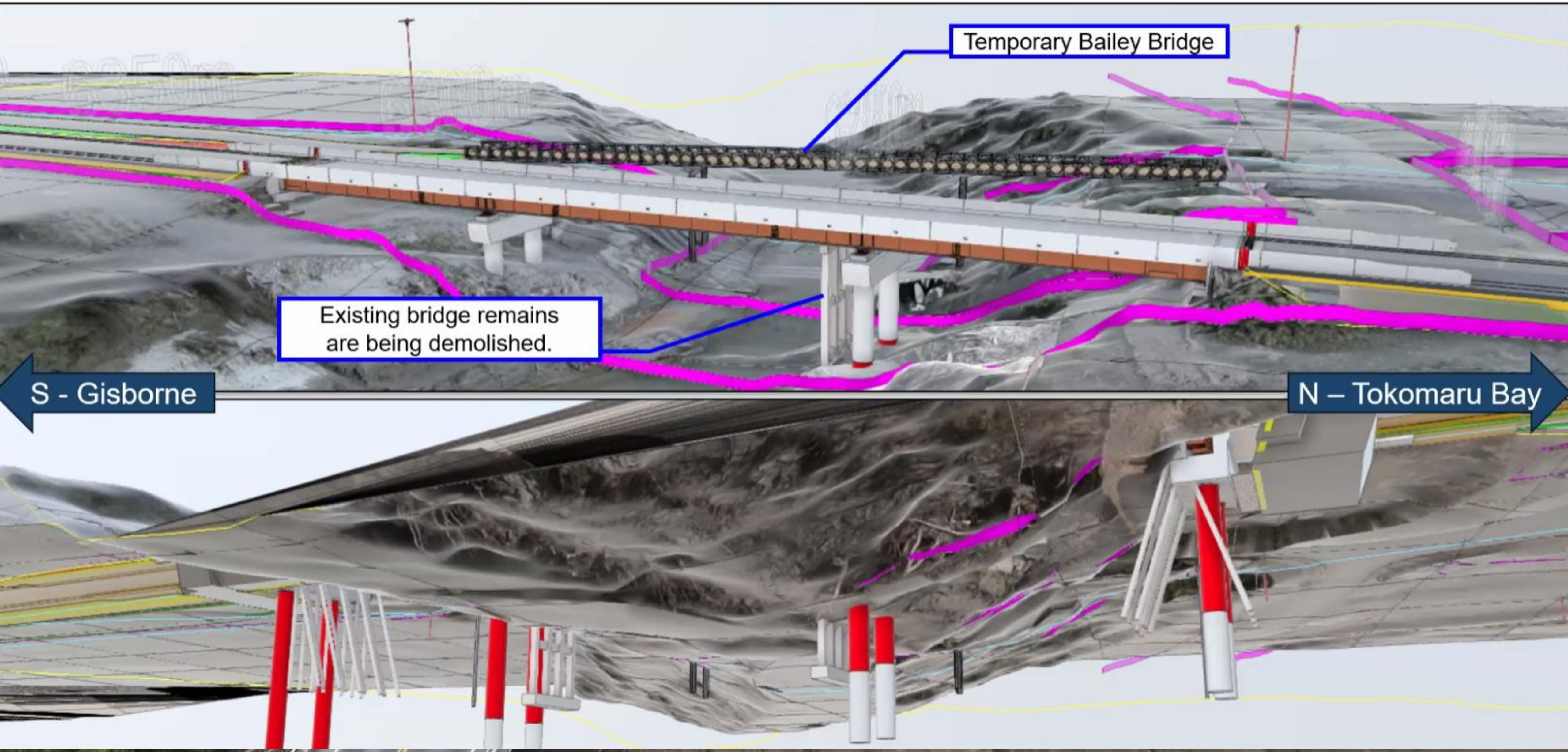
How can the likelihood or impacts be reduced

04

Monitoring + review

Review, tracking and continuous improvement

Hikuwai Bridge



01

Risk identification

Identify potential hazards and who could be affected

Risk identification

Credit – MARTY SHARPE / STUFF

Risk identification

- What’s downstream? Critical infrastructure and lifelines? Communities and risk to life?
- What are the expectations and required outcomes?

Maintain safety for people

Protect property, infrastructure and the environment

Ensure emergency access and egress

Nuisance

Tonkin+Taylor

Analysis

Risk = Likelihood x Impact

		$0	$0 to $5,000	$5,000 to $20,000	$20,000 to $1,000,000	>$1,000,000
	Likelihood	Impact / Consequence				
		1 Negligible	2 Minor	3 Moderate	4 Major	5 Catastrophic
Multiple times a year **(>100% in any year)**	5 Almost certain	5	10	15	20	25
Annually **(100% in any year)**	4 Likely	4	8	12	16	20
Maybe in next 2-10 years **(10 to 50% in any year)**	3 Possible	3	6	9	12	15
Once in next 10-50 years **(2 to 10% in any year)**	2 Unlikely	2	4	6	8	10
May occur, but only in exceptional circumstances. Highly unexpected (not in the next 50 years) **(< 2% in any year)**	1 Rare	1	2	3	4	5

Typical design 100-year design life and design for a 1 in 100-year event (1% of occurring in any year). For a 100-year design life, there is a 63% chance of getting an event of this magnitude or larger occurring over the design life.

Some bridges are required to consider up to a 1 in 2500-year (0.04%) event for ULS i.e. the bridge doesn't fall over and can be repaired in this event.
For a 100-year design life there is a 4% chance of an event of this magnitude or larger occurring over the design life.

For forestry, if the downstream risk is Major, need to consider a 1 in 20-year design event (5%). For an 8-year WOV, 34% likelihood of getting an event of this magnitude or larger occurring over the design life.

NZTA risk matrix

“Slash Mobilisation Risk Assessment”

Slash sources (from NES-CF)

- Slash on the harvest landings
- Slash in a water body or within 1 in 20-year flood plain (and overland flow paths)
- Slash on the harvest cutover (most likely to be mobilised by landslides), considering:
  - Higher and lower risk areas (ref ESC and Overlay 3B)
  - Window of vulnerability

Slash volumes for design = Slash volumes x likelihood of mobilisation in design event

Harvest landings

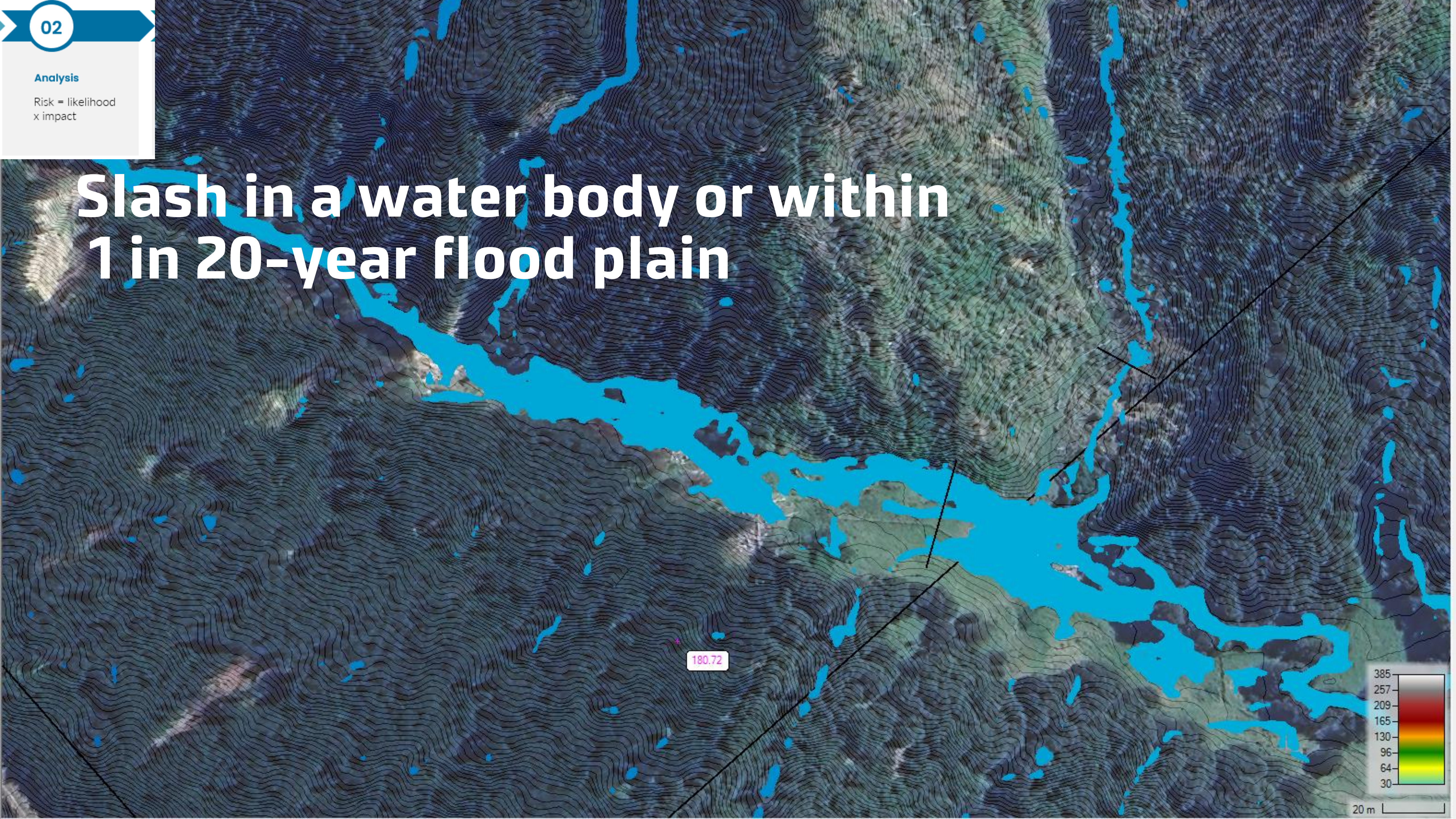
- Active management of slash at landings (pre, during and post-harvest)
- Need appropriate construction of landings with for geotechnical stability
- Installation of stormwater controls (drains in natural ground and suitable discharge points (size & location))
- For existing landings and post-event – site specific review of geotechnical stability, slash and water controls likely required to understand risk

02

Analysis

Risk = likelihood x impact

Slash in a water body or within 1 in 20-year flood plain

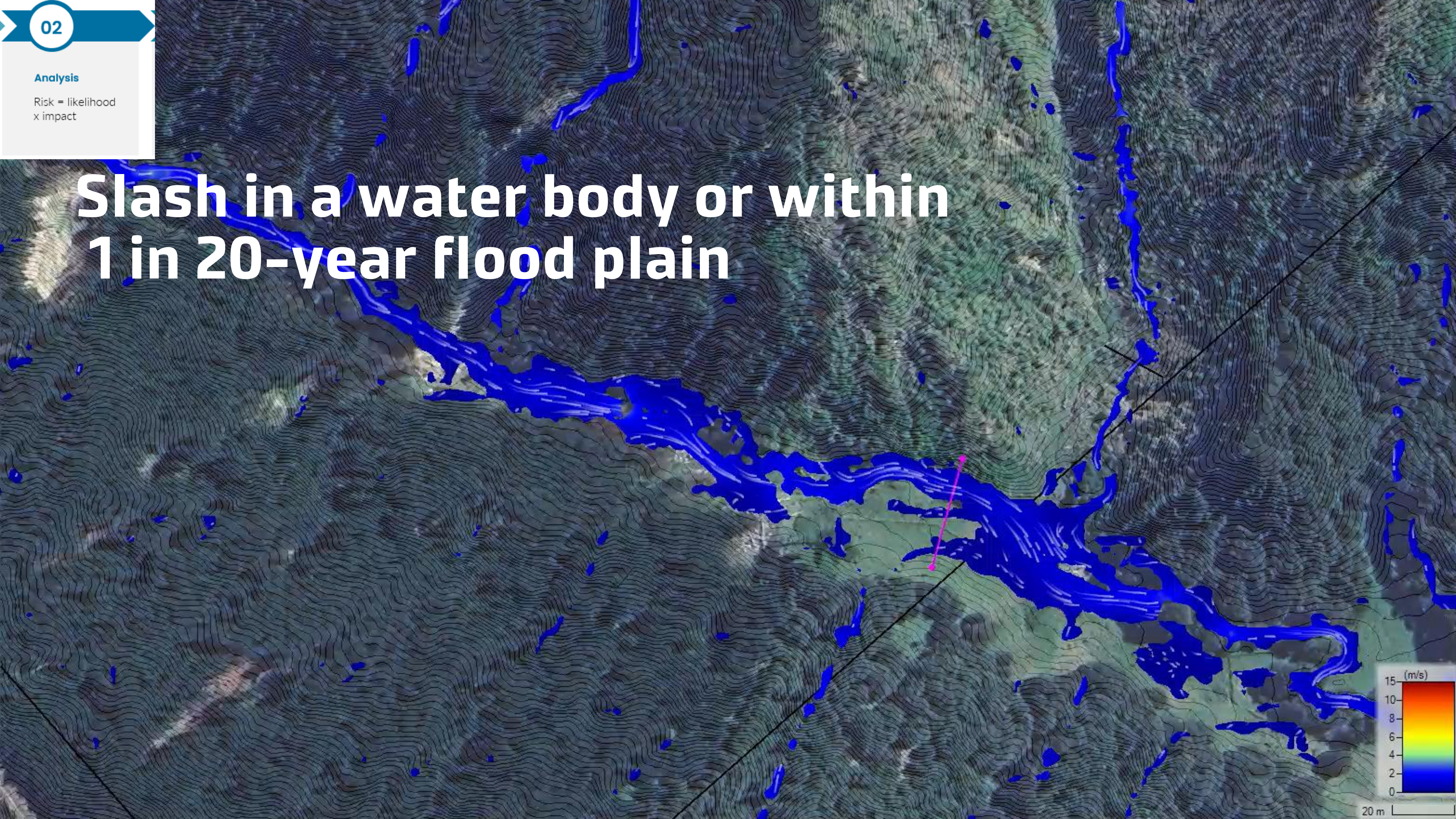


02

Analysis

Risk = likelihood x impact

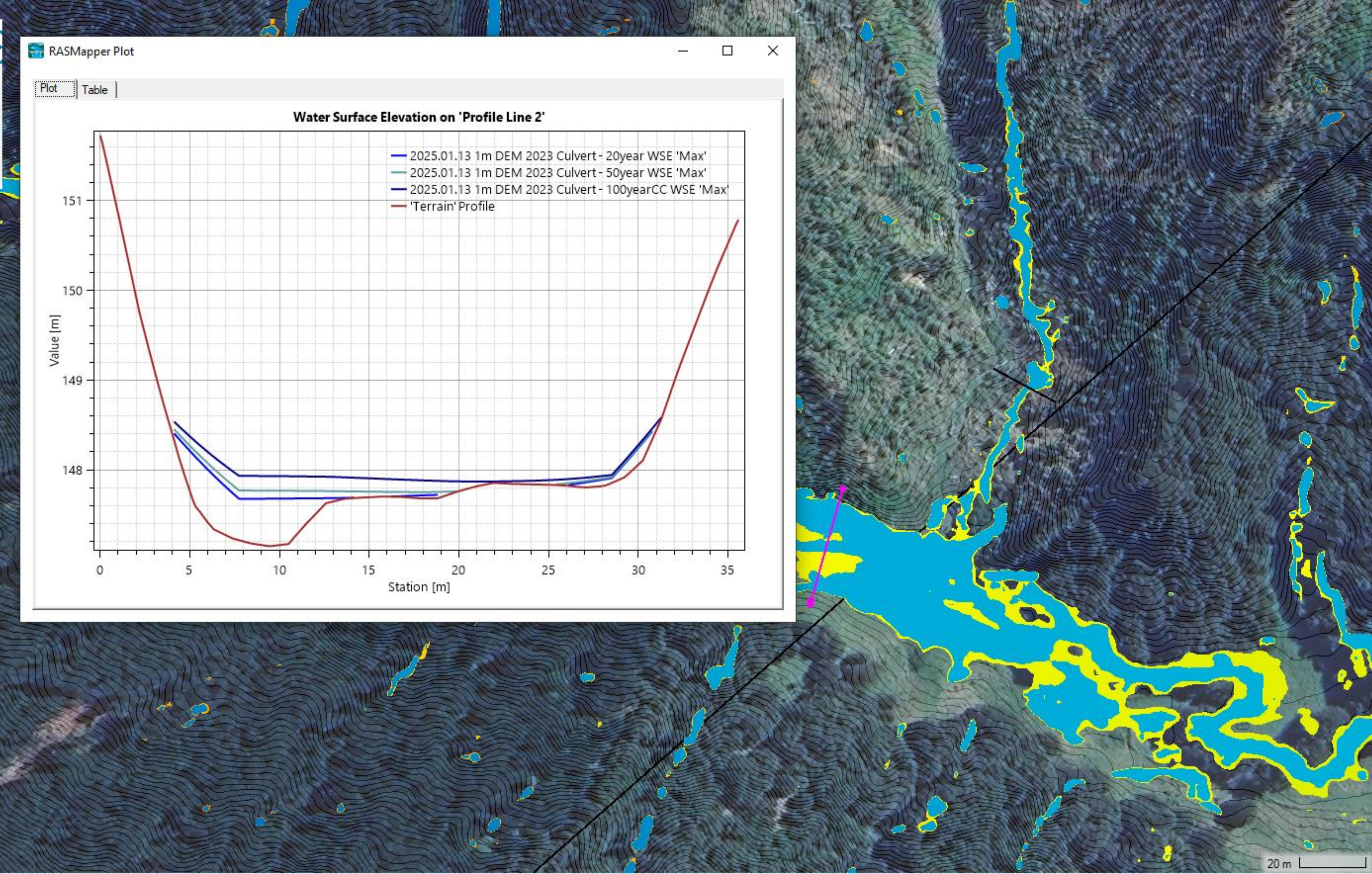
Slash in a water body or within 1 in 20-year flood plain



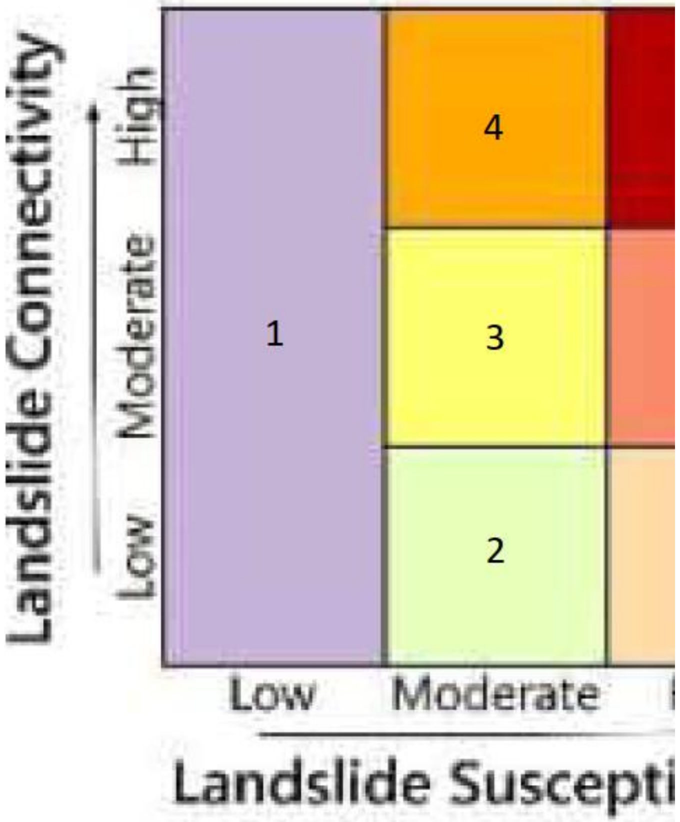
02

Analysis

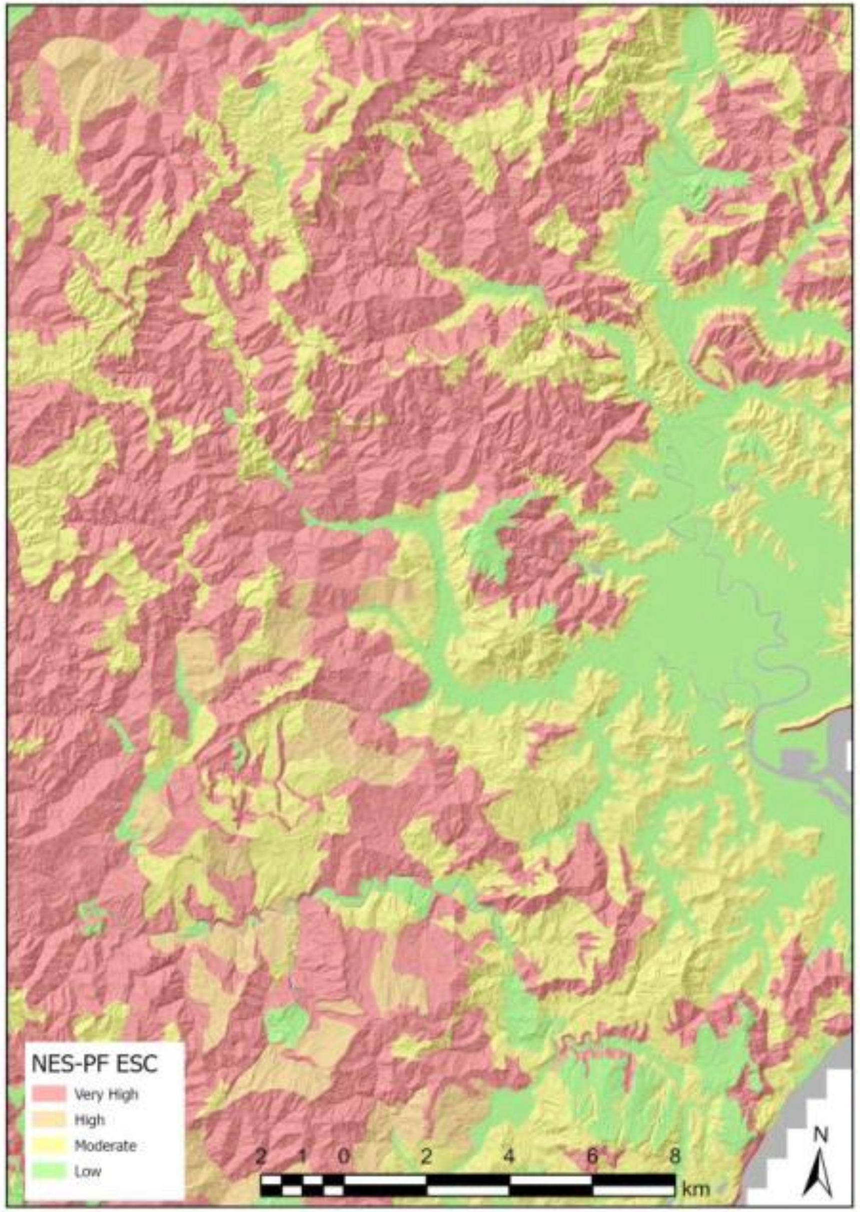
Risk = likelihood x impact



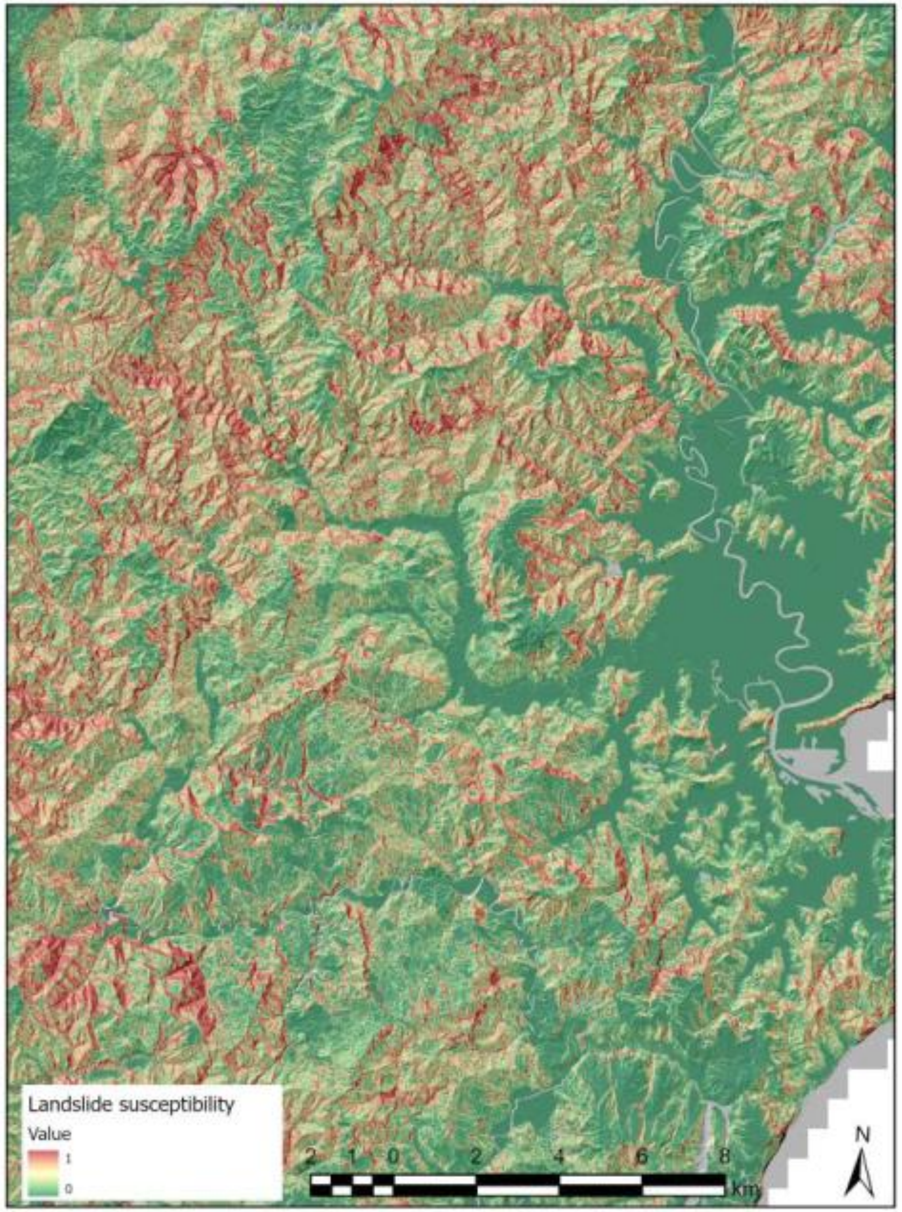
Landslide ris



ESC NES-CF



LiDAR-based



Harvesting risk / window of vulnerability

Contents lists available at ScienceDirect
Ecological Engineering
journal homepage: www.elsevier.com/locate/ecoleng
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Exploring the post-harvest 'window of vulnerability' to landslides in New Zealand steepland plantation forests

Chris Phillips[a,*], Harley Betts[b], Hugh G. Smith[b], Anatolii Tsyplenkov[b]

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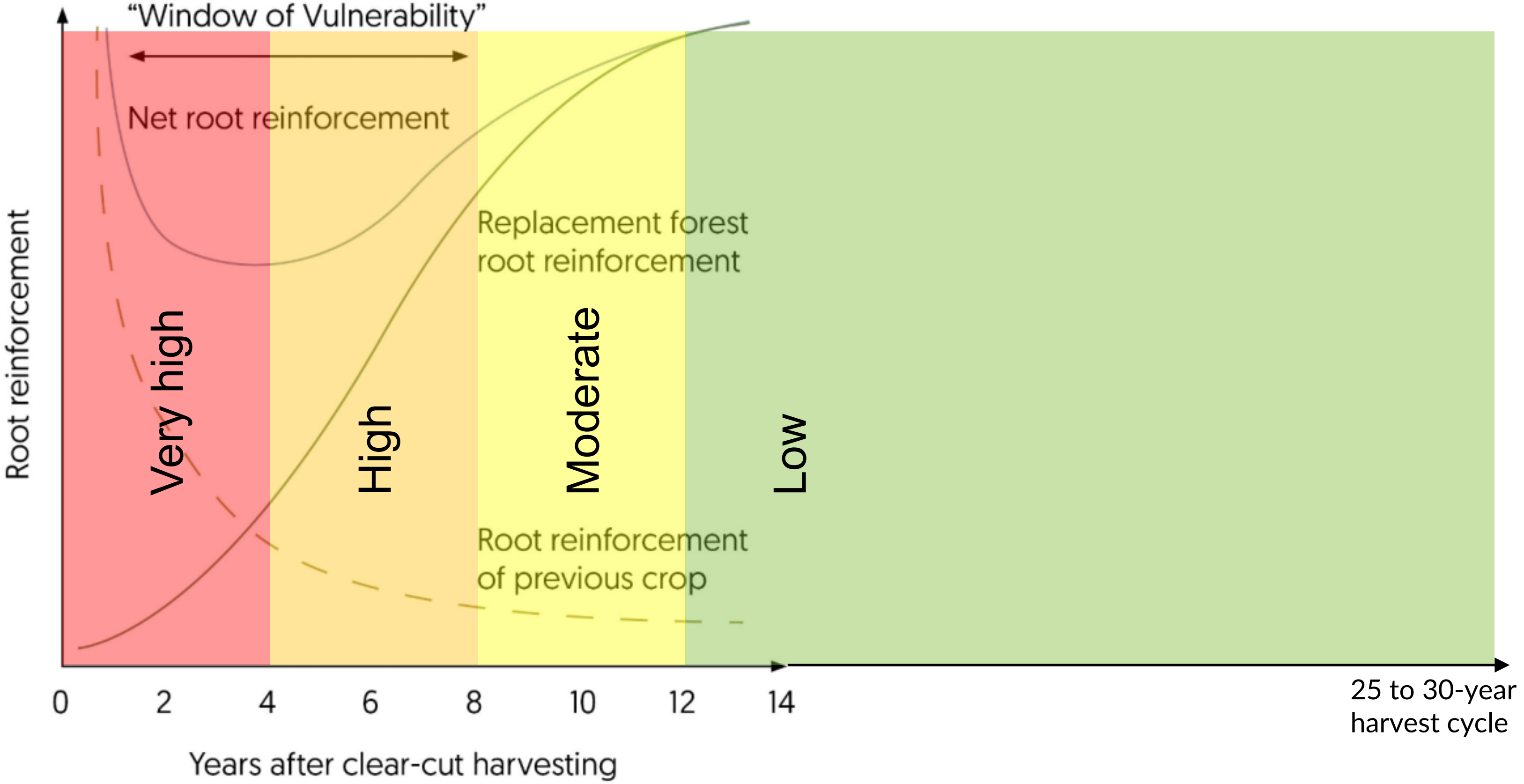


Fig. 1. 'Window of vulnerability'; a period following forest removal when steep land is vulnerable to rainfall-induced landslides (Phillips and Watson, 1994 modified from O'Loughlin, 1985 and Sidle, 2005).

Combining likelihood factors

Harvesting risk
Window of vulnerability

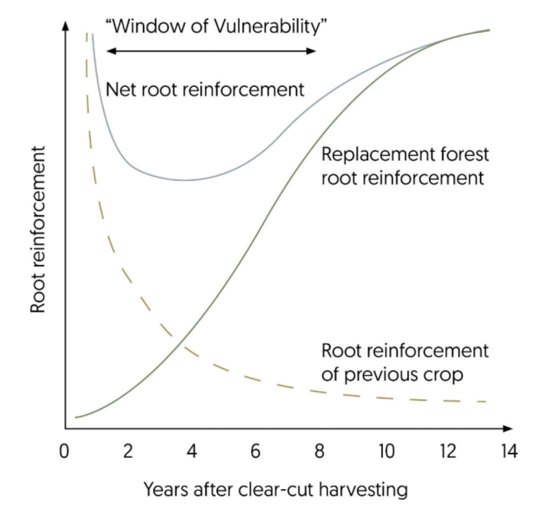
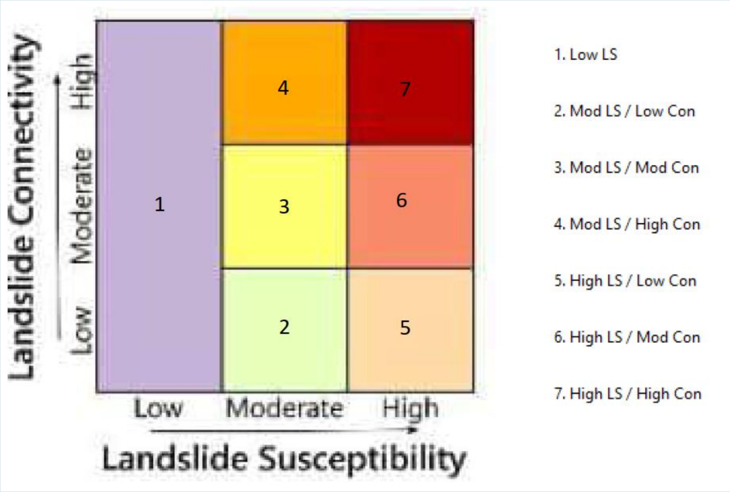


Fig. 1. 'Window of vulnerability'; a period following forest removal when steep land is vulnerable to rainfall-induced landslides (Phillips and Watson, 1994 modified from O'Loughlin, 1985 and Sidle, 2005).

Landslide



Combined risk

Catchment landslide susceptibility risk				
Very high				Very High
High			High	
Moderate		Moderate		
Low	Low			
	Low	Moderate	High	Very high
	Harvesting risk			

Combined risk

Catchment landslide susceptibility risk	**Very high**				Very High
	High			High	
	Moderate		Moderate		
	Low	Low			
		Low	**Moderate**	**High**	**Very high**
	Harvesting risk				

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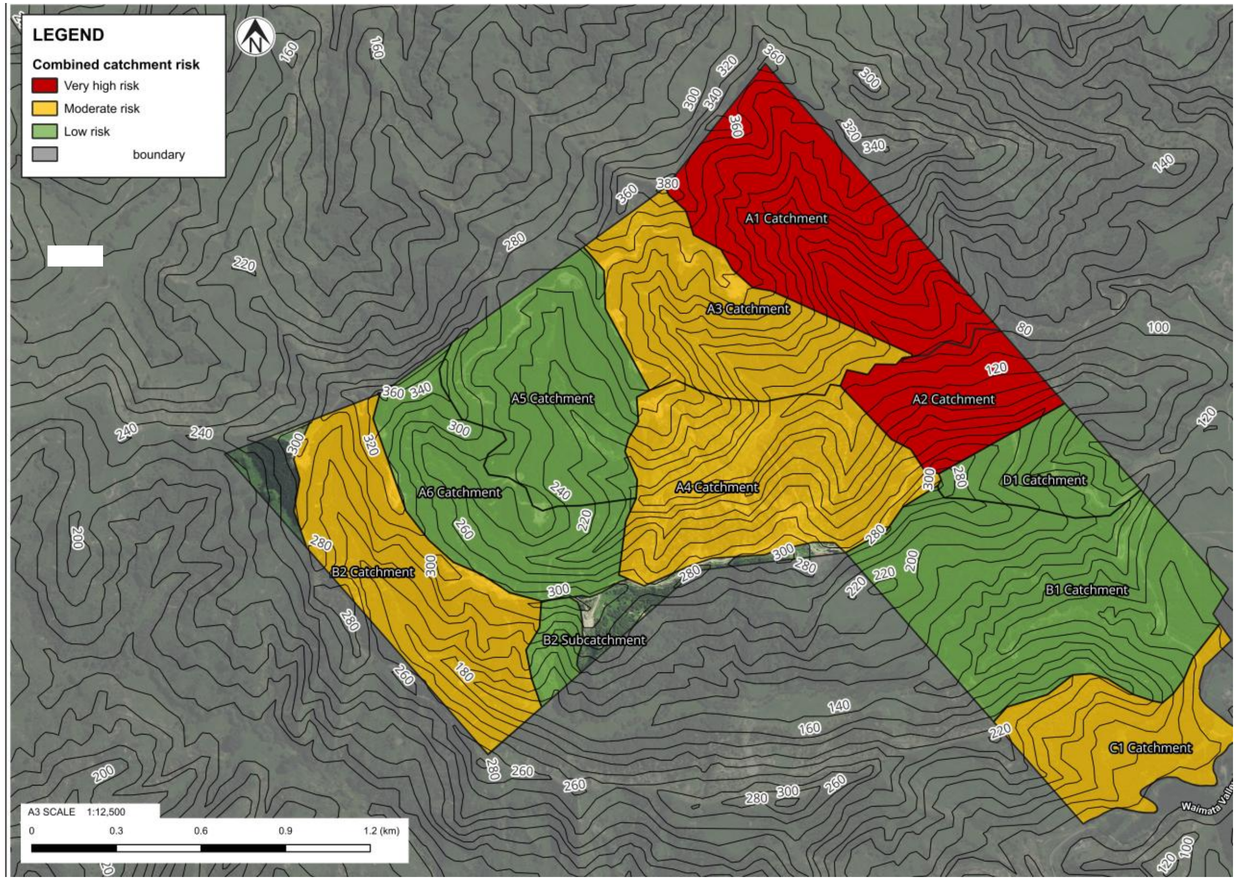
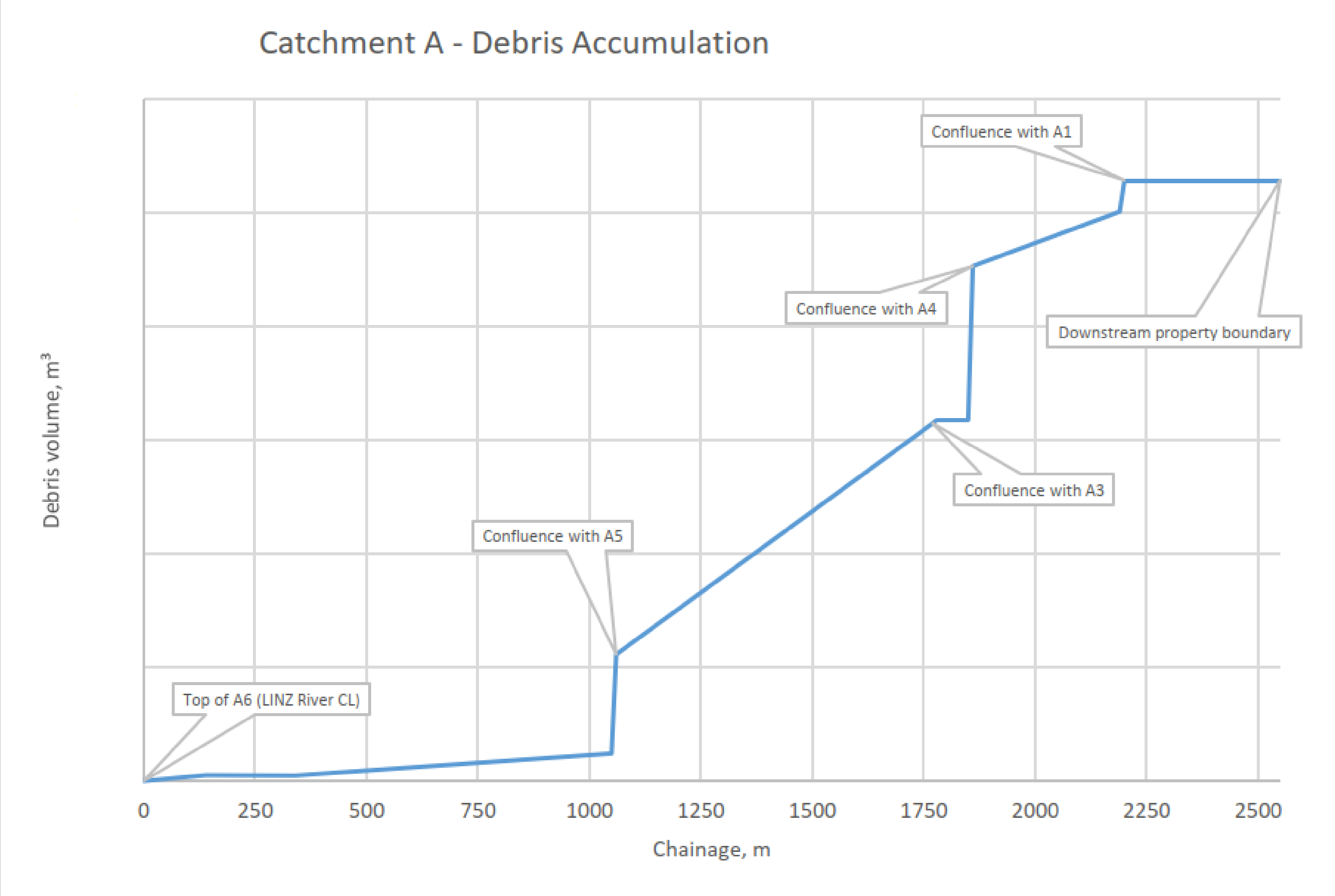
Combined risk

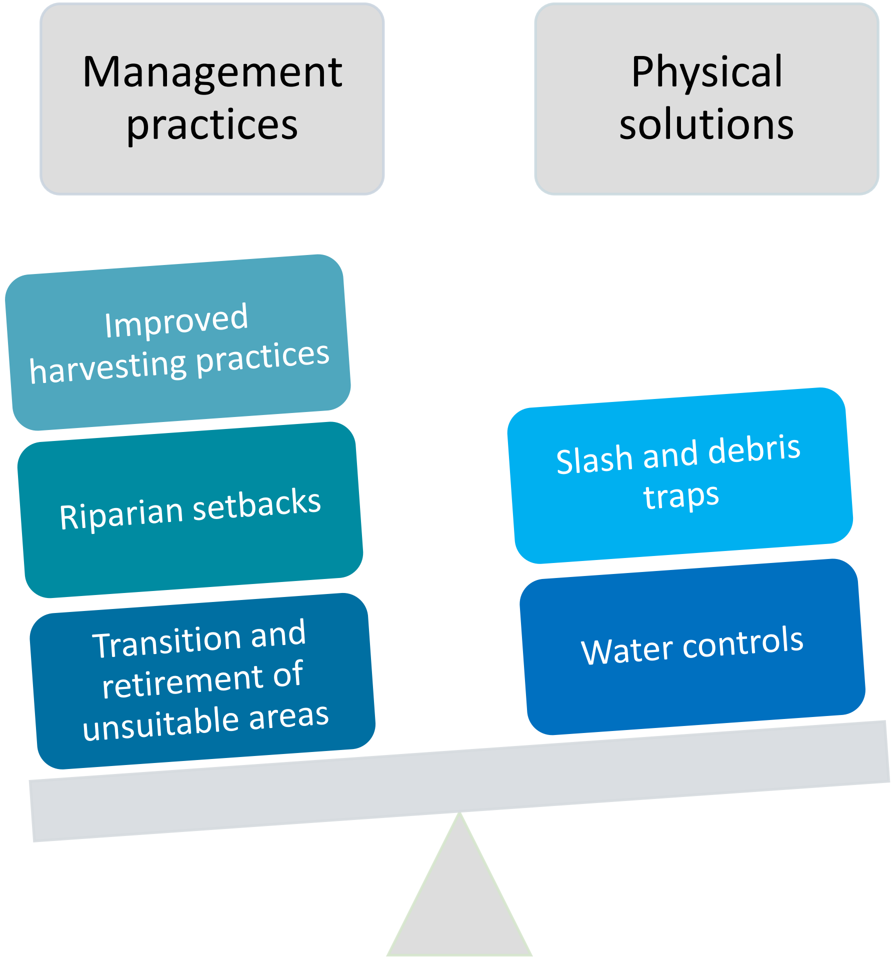
- Understand locations where there is greatest risk of slash and sediment discharges
- Understand the risk profile and changes over time
- Use to inform harvest planning and risk mitigation
- Slash volumes for design = Slash volumes x likelihood of mobilisation in design event



2025 → 2029 → 2034


Catchment A - Debris Accumulation
Confluence with A1
Confluence with A4
Downstream property boundary
Confluence with A3
Confluence with A5
Top of A6 (LINZ River CL)
Debris volume, m³
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
Chainage, m

Mitigation


Management practices
Physical solutions
Improved harvesting practices
Riparian setbacks
Transition and retirement of unsuitable areas
Slash and debris traps
Water controls

Slash and debris traps

92 Restricted discretionary activity: regional council

Restricted discretionary activity

(1) Constructing, installing, using, maintaining, or removing a slash trap in the bed of a river or on land is a restricted discretionary activity if any provision of regulations 84 to 91 is not complied with.

Matters to which discretion is restricted

(2) Discretion is restricted to—

(a) slash trap design and construction:

(b) the location, timing, and duration of the slash trap:

(c) the effectiveness of mitigation measures to manage the effects of slash, debris mobilisation, and downstream deposition:

(d) alternative measures to manage slash and debris mobilisation:

(e) river bed and bank stability and erosion:

(f) the effects on ecosystems, including the passage of fish:

(g) water quality and flow:

(h) public use and public access to and along the river:

(i) the effects on upstream and downstream properties and infrastructure:

(j) the information and monitoring requirements.

Principles for slash trap design (part 1)

1. Use flood modelling to **understand flood extents, flows depths, and velocities and determine freeboard requirements for design.**

2. **Debris loading** - understand what and how much you need to capture (Slash Mobilisation Risk Assessment SMRA)

- **Quantify potential debris** loading that could arrive in your design event, and design devices to accommodate these volumes. Loading requirements can be reduced by staging harvesting. Need to consider transport mechanisms:
  - Landslides - NES-CF/consented or post-harvest debris in areas at risk of landslide. Need to consider likelihood of slips in the design event.
  - Flood and overland flow – ideally no debris left within 5% AEP floodplain, but otherwise need to allow for it.
  - Cumulative volume plot – to identify key locations with increase in load – manage main stem or tributary – don't always align with natural deposition zones
  - **Consider spacings** (including multiple rows or varying spacings) to match material you need to capture (NES-CF or otherwise)

Principles for slash trap design (part 2)

3. **Locations**

   - **Target natural deposition zones (flat and wide), lower velocities out of channel flow** Locate devices in lower energy (velocity) areas (to the extents practicable)
   - Locate devices to match anticipated debris loading
   - **Use a network** of devices. Multiple devices help to mitigate risk of failure.
   - Consider **access** for both **construction and maintenance**. Devices will only be as effective as their maintenance. Consider **disposal areas.** Avoid introducing further instability by creating challenging access tracks.

4. **Device selection –** Consider your environment when selecting a solution e.g. catchment size, flow depths, velocities, debris loading, constructability, maintenance, cost, environmental effects, design life, in-stream vs out of stream options

Principles for slash trap design (part 3)

5. Consider and mitigate potential **environmental effects:**
    - Continuity of fish passage
    - Sedimentation
    - Potential erosion and scour at and around proposed device(s)

Monitoring + Review

Regular Review - Periodically reassess the effectiveness of mitigation plans and update the risk register as needed.

Tracking - Monitor the implementation of mitigation plans and track the progress of identified risks.

Continuous Improvement and Information sharing - Use lessons learned from risk management to improve future processes

Implications of getting it wrong (or not doing it at all)?

- RMA Prosecutions
- Environment Court + Enforcement orders
- Subjected to higher design standards
- Associated legal and other costs
- Insurance implications

Conclusions

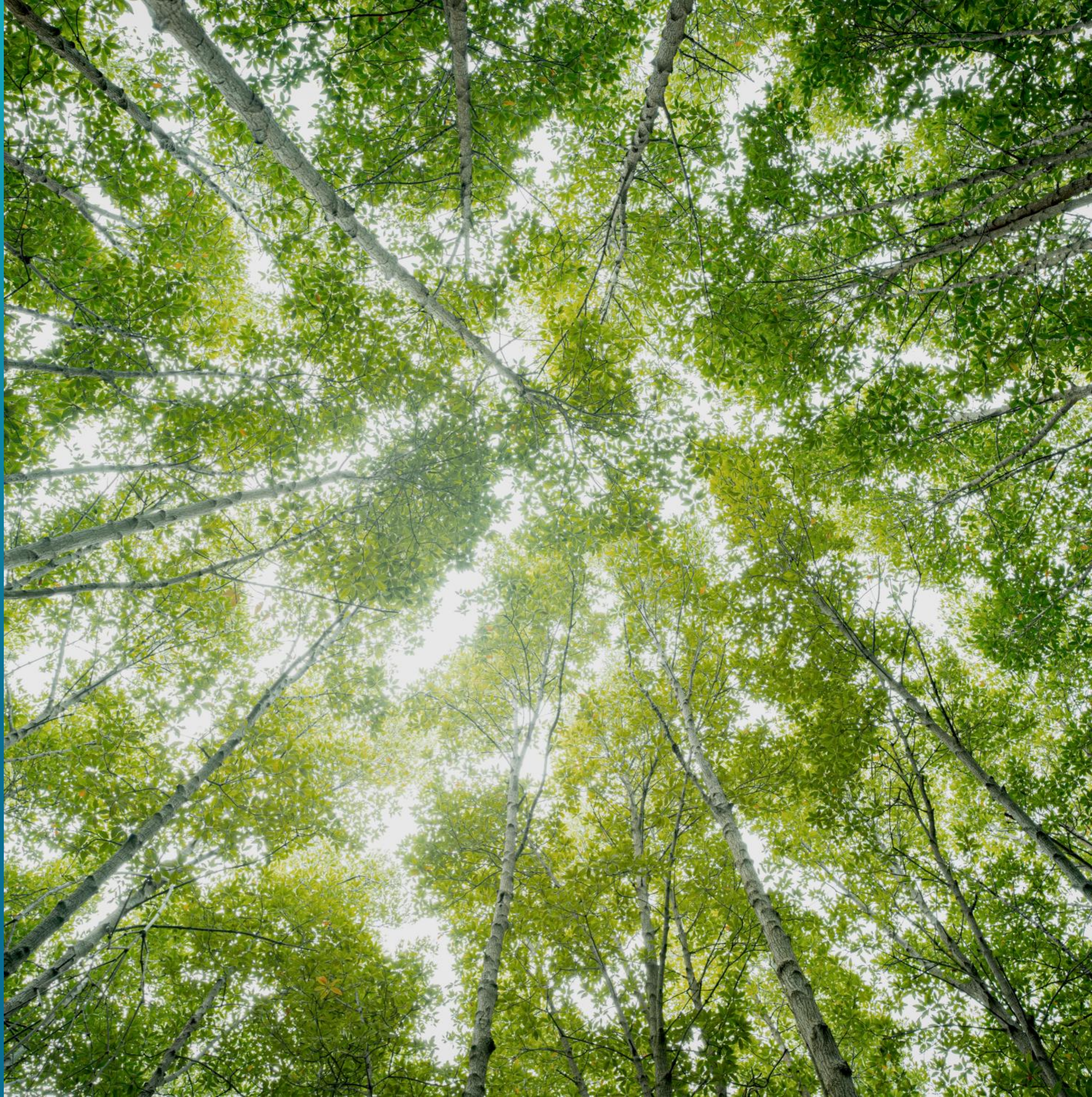
Forestry is going through an enormous amount of rapid change in what communities are expecting and accepting in terms of risk management

Guidelines, clear expectations and consistency in approaches are needed.

Collaboration, partnership and innovation are essential.

We need to monitor effectiveness of controls, continuous improvement and information sharing to get this right

Questions / Patai?



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