Davison, E., McColl, S., Spiekermann, R., Mackay-Smith, T. H., & Burkitt, L. (2022). Environmental factors influencing survival in Poplar material planted for erosion on hill country farms in New Zealand. In: *Adaptive Strategies for Future Farming.* (Eds. C.L. Christensen D.J. Horne and R. Singh). http://flrc.massey.ac.nz/publications.html. Occasional Report No. 34. Farmed Landscapes Research Centre, Massey University, Palmerston North, New Zealand. 4 pages.

Environmental factors influencing survival in Poplar material planted for erosion on hill country farms in New Zealand

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Key words: soil erosion, tree survival, hill country, tree planting, slope aspect

Introduction

Space-planted trees remain a key tool for hill country erosion control in New Zealand. In making effective use of this tool, the choice of plant stock, position in the landscape, and the survival of the trees are factors that land managers must consider ahead of planting. Current practice is strongly informed by a long history of research and development that advocates for the use of 3 metre poplar poles. However, demand outstrips pole production and there is an appetite for alternatives. A further challenge is related to the practicality of planting and optimising plant survival while simultaneously maximising erosion-control on steep slopes. Quantitative data identifying effectiveness of trees for slope stability is limited. Therefore, pole planting currently favours areas in the landscape where survival is optimised but may not align with the best soil erosion outcomes.

In a collaboration with Plant and Food Research, the NZ Poplar and Willow Trust, Manaaki Whenua Landcare Research, Massey University, and three regional councils, with funding support from the Ministry of Primary Industry 1 Billion Tree fund and Ministry of Business, Innovation and Employment Endeavour Smarter Targeted Erosion Control, a tree-planting trial has been undertaken that involves planting on varying slopes, aspects, and climatic zones in order to push tree survival to the limit. The aim of this research is to provide a scientific basis for supporting planting decisions in erosion-susceptible hill country terrain in New Zealand. The primary objective is to develop a pole survival model based on climatic and topographic variables. Spatial estimates of pole survival can help inform where to plant and therefore compliment landslide susceptibility maps that show where shallow landslides are likely to occur in future rainfall events (Fig. 1). Landslide susceptibility maps can direct land management planners to areas that would be most effective to plant to minimise erosion. While red areas of the map (Fig. 1) are highly susceptible to landslide occurrence, they are also likely to be more unfavorable for tree establishment and survival due to steep slopes, shallow soils, greater exposure to wind gusts etc. The integration of landslide susceptibility maps with spatial estimates of pole survival could give land management planners tools to identify where to target planting to maximise the cost-effectiveness.

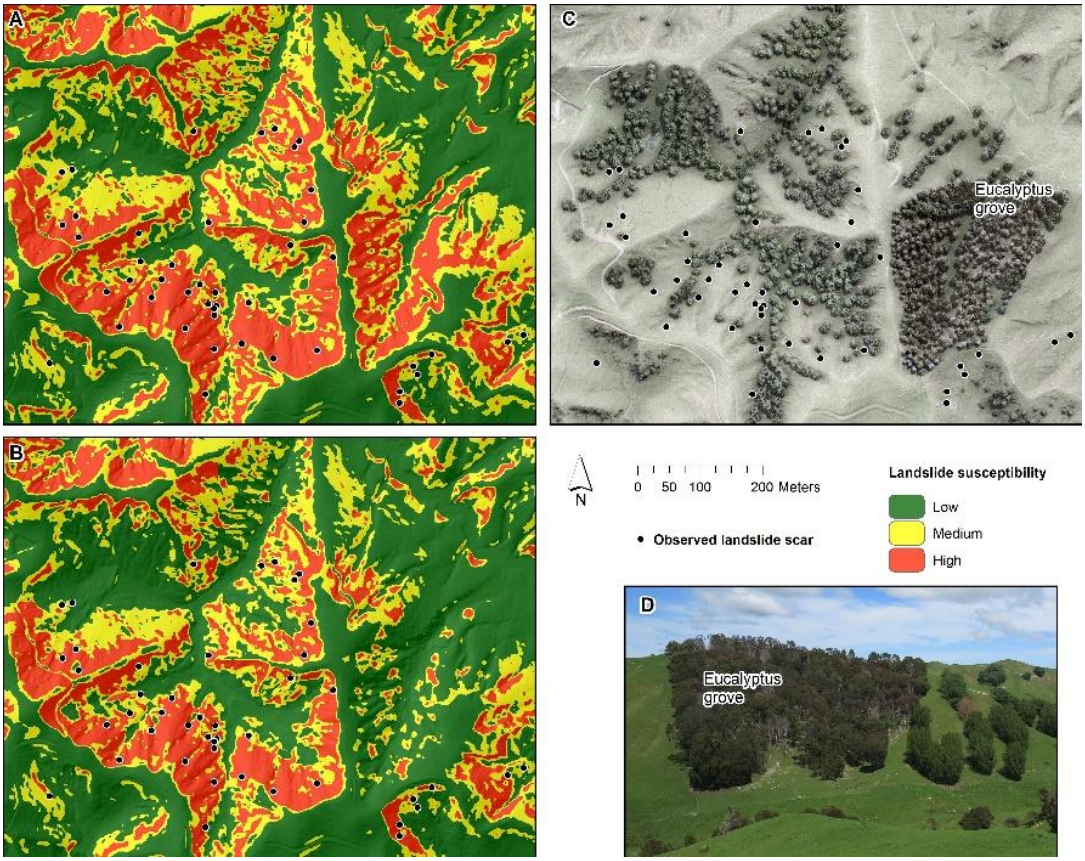

Figure 1: An example of a landslide susceptibility (LS) map for a small area near the Wairarapa planting trial site which can be used to inform where trees are needed most to increase slope stability. A) LS under a tree-less scenario; B) LS with trees present in 2013; C) aerial photo of site; D) Photograph of eucalyptus grove seen in C.

Methods

A tree-planting trial was undertaken to test the survival and establishment of poplar material under a range of environmental conditions. In July 2021, 180 trees were planted at three North Island sheep and beef farms, located in Taumarunui, eastern Wairarapa, and Hawkes Bay, targeting different climate regimes. At each farm, both a north-facing (summer dry stress) and a south-facing (winter wet stress) slope were selected, with each slope exhibiting a variation in terms of susceptibility to shallow landslide erosion. On each aspect 90 poplar trees were planted, made up of three types of planting material; poles (3-year growth); wands (2-year growth); and rooted stakes grown from cuttings (1-year growth), at a spacing of approximately 5-metres. The three types of planting material will allow evaluation of whether wands or rooted stock, which are younger and therefore more cost-effective to propagate in the nursery, can be used in place of poplar poles in certain locations. We will make repeat measurements of plant growth and survival over a 2-3 year period and develop a model of survival and growth based on soil, morphometric and climatic data (Fig. 2).

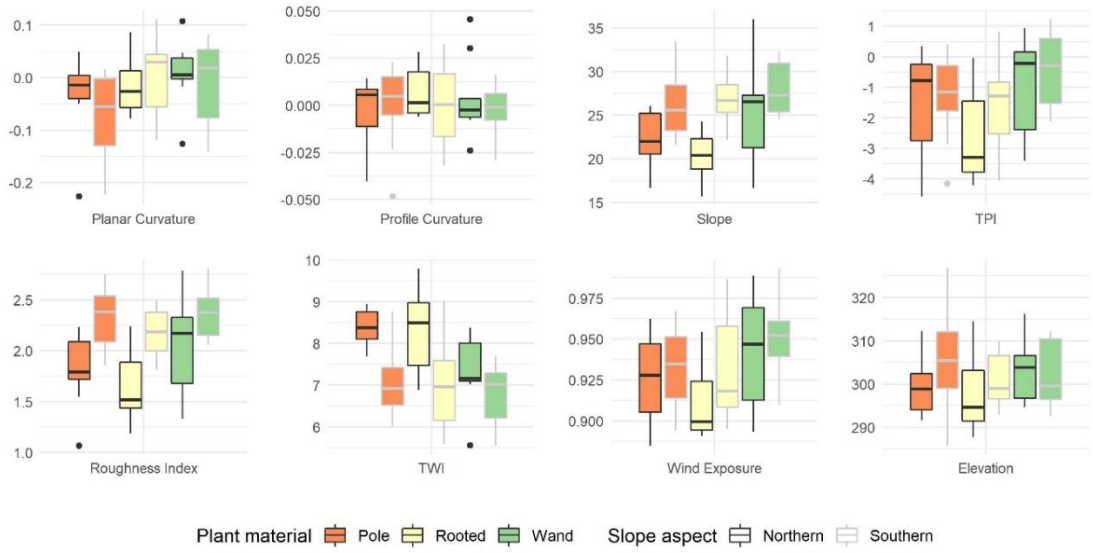

Figure 2: Morphometric variables for the two slopes of the Taumarunui site. TWI: Topographic Wetness Index; TPI Topographic Positioning Index

Preliminary results and discussion

Our findings will be evaluated in the context of previous survival research and surveys and interviews with industry experts, such as council Land Management Advisors, to explore which factors influence decisions on where and what to plant. Preliminary results reported here are from the baseline measurements at planting (July 2021), and survival and growth measurements after ~6 months (in Dec 2021 and Jan 2022). Maps presented below (Figs. 3, 4 and 5) show the deaths ~6 months after planting, along with trees indicated as missing. Between 1 and 3 deaths were found for the north and south aspects at Taumarunui and Hawkes Bay. At the Wairarapa site, there were 8 and 9 deaths for the south and north facing slopes respectively of which the majority were rooted 1-year growth cuttings. This data suggests the Wairarapa site has been more unfavourable. This could be attributed to climate factors, stock damage, or planting technique. Once the final measurement is taken at the end of March, the data will undergo analysis to determine the factors influencing survival. Such factors may include some of the variables shown in the plot of morphometric variables (e.g., slope gradient, topographic wetness index) for both aspects on the Taumarunui site is shown (Fig. 2). These variables illustrate the considerable topographic variability across the two slopes and support the importance of collecting meaningful data to identify the factors likely to influence tree survival.

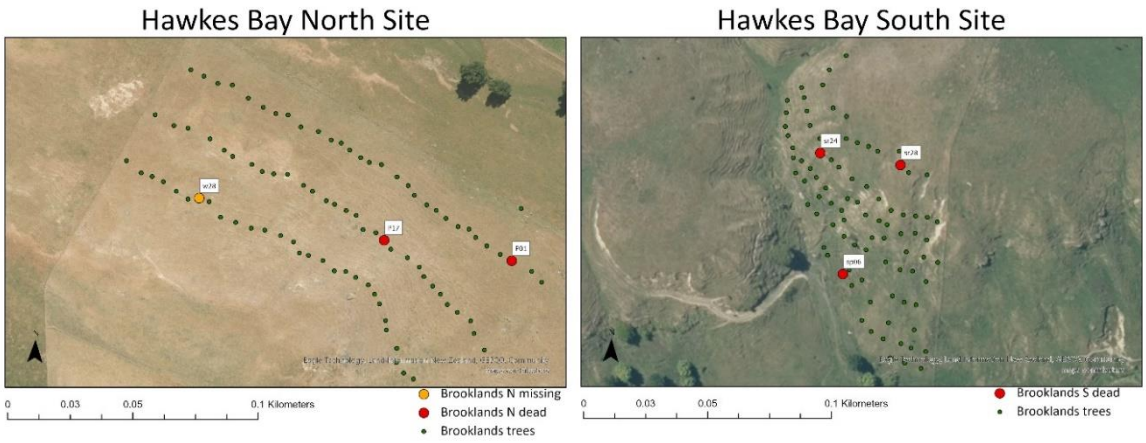

Figure 3: Map of the north and south aspects at the Hawkes Bay site showing trees that did not survive or were missing during the second remeasure

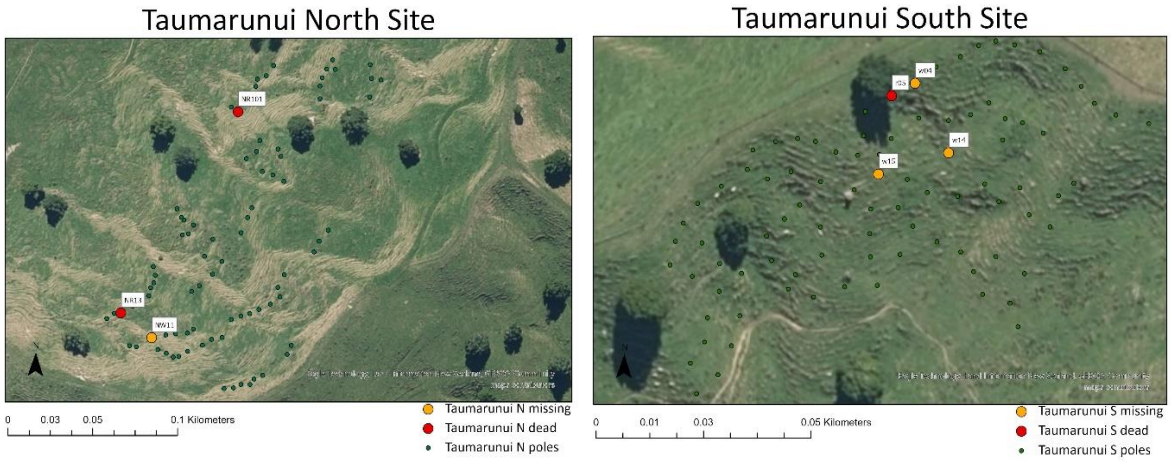

Figure 4: Map of the north and south aspects at the Taumarunui site showing trees that did not survive or were missing during the second remeasure

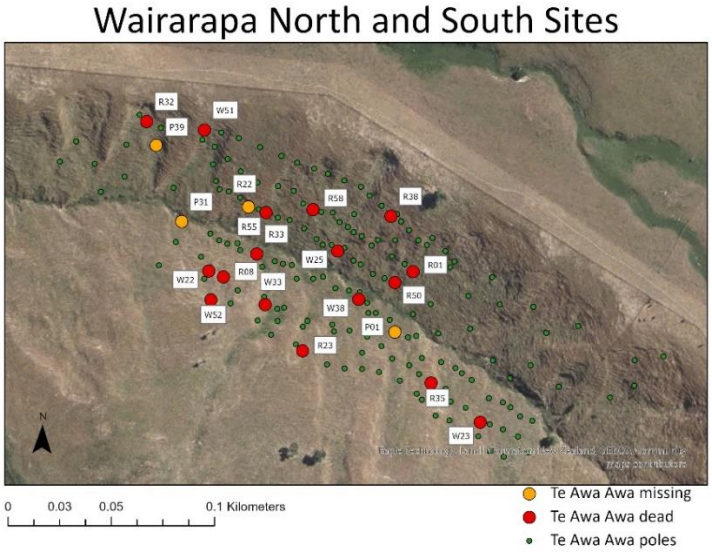

Figure 5: Map of the north and south aspects at the Wairarapa site showing trees that did not survive or were missing during the second remeasure

The results from the trial data will be discussed alongside information gathered by industry specialist interview participants. This will provide a quantitative and qualitative summary of the current practices utilised in New Zealand and allows conclusions to be drawn as to the effectiveness of this approach.

Acknowledgements

This research is in collaboration with Plant and Food Research, the NZ Poplar and Willow Trust, Manaaki Whenua Landcare Research, Massey University, and three regional councils, with funding support from MPI 1BT fund and MBIE Endeavour STEC.

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