ENVIRONMENT & SOCIAL TECHNICAL NOTE

Number: ESTN-018
Date: June 2013

The Effect of Extreme Rainfall Events on Marginal Land across New Zealand under Current and Future Climate

Summary

Potentially future forests may be established on steep, erosion-prone marginal land. The establishment of plantation forest on this land will provide environmental benefits that include a reduction in erosion and improved water quality. But, during periods of forest road construction and maintenance or post harvest periods, these areas are potentially at greater risk from intense rain storm events. Using the Erosion Susceptibility Classification (ESC) map which classifies land on its inherent susceptibility to erosion, and the High Intensity Rainfall Design System (HIRDS) which predicts the 100 year return period of intensive rainstorm events under current and future climate, we calculated the area of erosion prone farmland at high risk of storm events. On a national basis, 7.6% (1.0m ha) of farmland is vulnerable to extreme rainfall events. Under current climate, the establishment of 1.2m ha of forest would reduce the area of vulnerable farmland from 7.6% to 5.5% (1.0m ha to 0.7m ha). Under a 2°C warming scenario the area of farmland vulnerable will remain at current levels under the future forest scenario. This study has highlighted the importance of continuing research that could determine the probability of an extreme storm event occurring during vulnerable post-harvest periods, or during earthworks or maintenance in intensively managed plantation forests.

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Introduction

One of the most effective methods in mitigating the impacts of erosion in extreme storm events is the establishment of continuous forest cover (Fig. 1). Environmental risks such as erosion and sedimentation are heightened during intensive rainfall events.

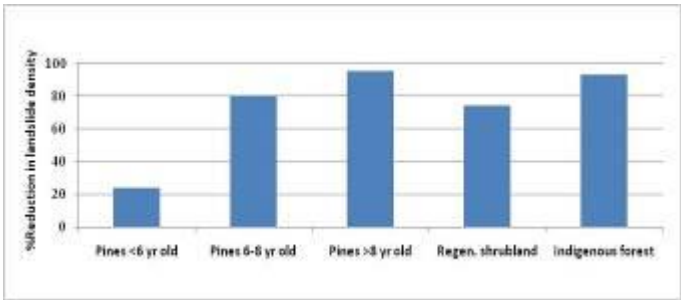

Fig. 1: Percentage reduction in landslides caused during Cyclone Bola for forested sites compared with farmland [2].

Compared to farmland which is always at risk of intensive rainstorm events, forestry mitigates erosion through the interception of rainfall, evaporation from tree canopies, and by reinforcing the soil through its network of roots.

Notwithstanding these benefits, plantation forests have periods when they are vulnerable to environmental risks, mostly following harvesting and as a result of road establishment and earth works.

Methodology

We defined land vulnerable to extreme rainfall events by combining two characteristics

(1) high or very high erosion risk classes (from the Erosion Susceptibility Classification ESC map which classifies land on its inherent susceptibility to erode) [1], and
(2) predicted 100 yr 72hr rainfall event > 300 mm (from the High Intensity Rainfall Design System, HIRDS) [3].

A map of current farmland was produced by selecting high producing exotic grassland, low producing grassland, depleted grassland, and tall tussock grassland from LCDB2 (Land Cover Database 2). Potential future forest consisting of 1.2 million ha of current farmland on marginal sites was identified from previous research (Watt et al., 2011). Land for this afforestation scenario was selected on the basis of being less intensively used, at risk of erosion, with the

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exclusion of cool sites not suited to radiata pine (7.9°C threshold), DoC land, and some ecologically important environments using the potential vegetation map (Newsome, 1987).

The potential future forest scenario, and farmland surfaces (Fig. 2) were combined with extreme rainfall events (Fig. 3) from HIRDS, and the ESC surface (Fig. 4). The percentage of farmland area susceptible to erosion and vulnerable to extreme rainfall events (>300 mm) was calculated by region both for existing farmland and for farmland remaining under the future forest scenario. This calculation was performed for the current climate and assuming a 2°C increase in temperature (Fig. 3).

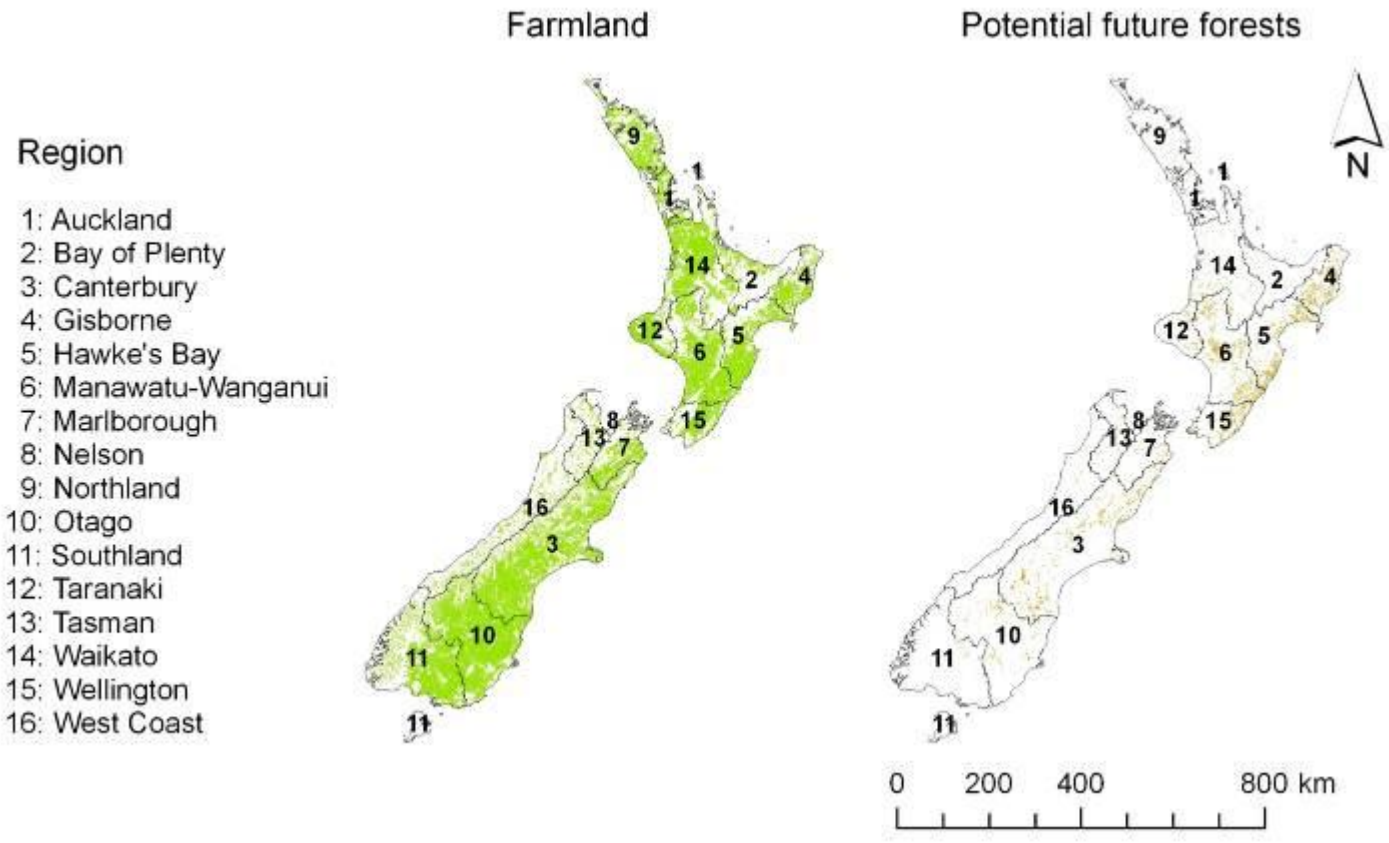

Fig. 2: Current farmland (identified using LCDB2), and potential future forests (1.2 m ha, [4]).

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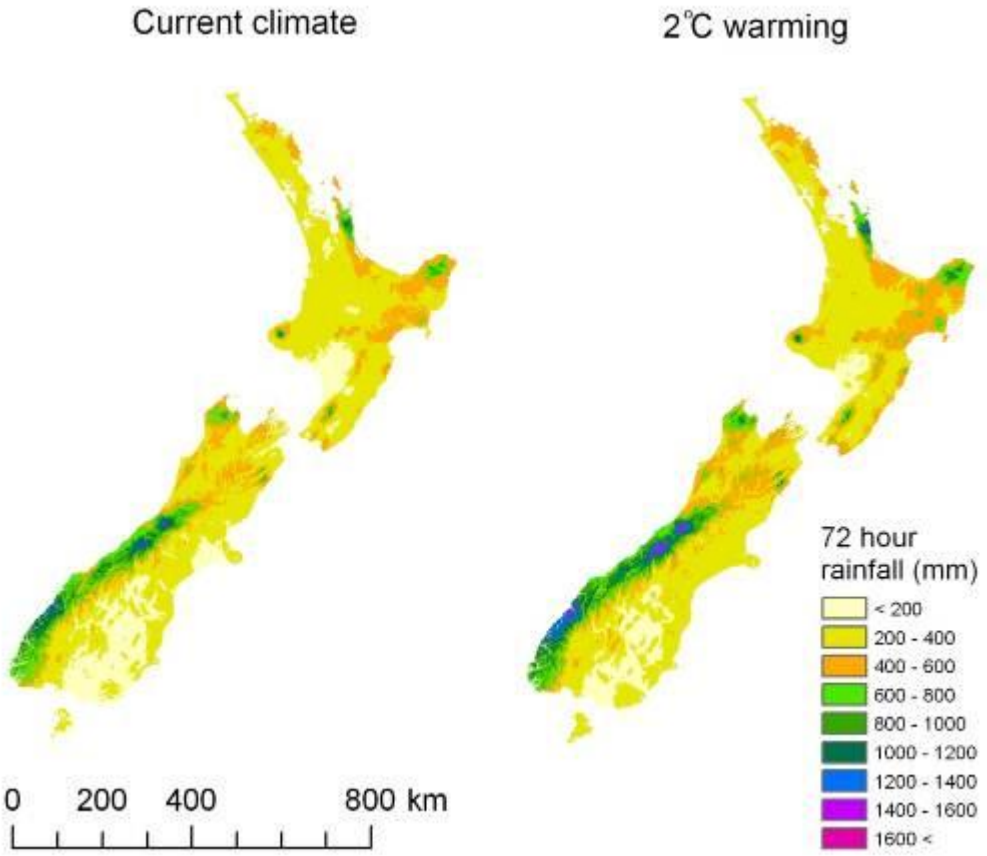

Fig. 3: 100 year 72 hour rainfall event under current and future climate (HIRDS).

Results and Discussion

Nationwide, 7.6% (1.0m ha) of farmland was found to be erosion prone and vulnerable to extreme rainfall events, but this varied greatly between regions (Fig. 5). The region with highest percentage of at risk farmland was Gisborne. Climate change is expected to increase the probability of extreme rainfall events and an increase in temperature of 2°C is predicted to increase the percentage of vulnerable farmland from 7.6 (1.0m ha) to 10.3% (1.4m ha) nationwide. Northland, Manawatu-Wanganui, Tasman, Taranaki, Waikato, Auckland and Southland all had large percentage increases in land that would be vulnerable to extreme rainfall events under climate change. Gisborne had the lowest percentage increase in land vulnerable to extreme rainfall under the climate change scenario. This is because such a high percentage of land is vulnerable in this region under the current climate.

The regions with the greatest absolute areas vulnerable to erosion and intensive storm events are Canterbury and Otago, although in percentage terms these regions rank lower than North Island regions such as Gisborne and Hawke's Bay (Appendix 1). The reason for this is that these two South Island regions contain the largest total areas of farmland across New Zealand.

Afforestation of 1.2 million ha of marginal farmland would reduce the area of vulnerable farmland from 7.6% (1.0m ha) to 5.5% (0.7m ha) nationwide under current climatic conditions.

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The reduction in percentage area of vulnerable land area would be greatest in the most vulnerable regions such as Gisborne and Hawke's Bay (Appendix 2) due to the large areas of vulnerable land afforested under this scenario.

In contrast to the large reduction in percentage of vulnerable land achieved by afforestation for North Island regions such as Gisborne, Hawke's Bay and Wellington, the extensive areas of vulnerable land in Canterbury and Southland are predicted not to be greatly reduced. In these regions, land available or suitable for afforestation was relatively small due to the temperature threshold and other factors built into the 1.2m ha future forest scenario (Fig. 2).

Under a 2°C warming climate change scenario, the area of vulnerable farmland will remain at current levels if 1.2 million ha of potential future forest is retired from farming.

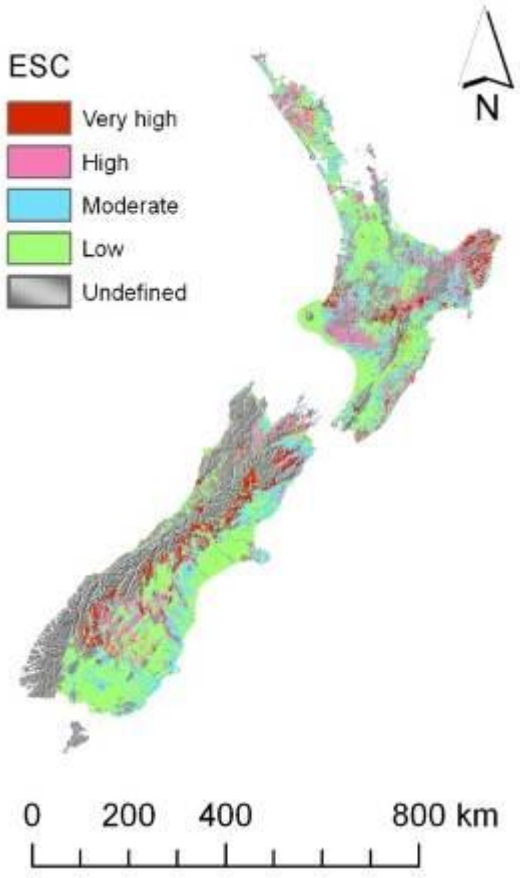

Fig. 4: Erosion susceptibility classification (ESC).

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Future Work

This work has highlighted the risk posed by intensive rainfall events on erosion prone land. It also demonstrates the environmental benefits provided by forests when compared with pastoral livestock farming.

The next stage of the analysis is to determine the probability of an extreme storm event occurring during vulnerable post-harvest periods, or during earthworks or maintenance in intensively managed plantation forests. Therefore, future work could focus on the analysis of HIRDS data in relation to at risk periods within forests located on erosion prone areas.

Conclusion

Climate change is expected to substantially increase the risk of erosion from extreme storm events. Should establishment of forest on a proposed 1.2 million ha of marginal farmland ever take place, this would help offset this expected adverse effect of climate change.

References

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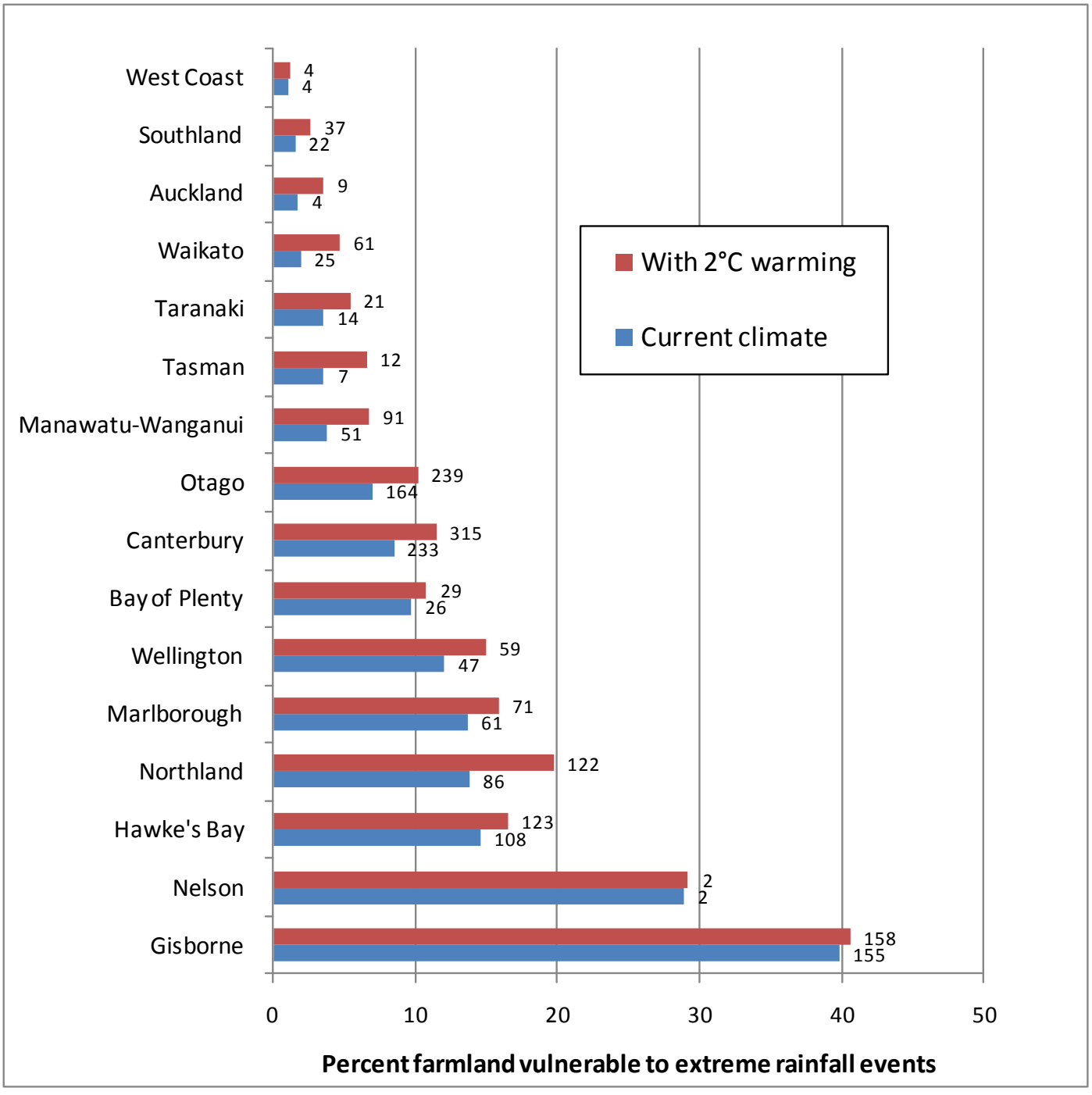
Appendix 1. Percentage of farmland vulnerable to extreme rainfall events under current and future climate change. Label values show areas in thousands of hectares.



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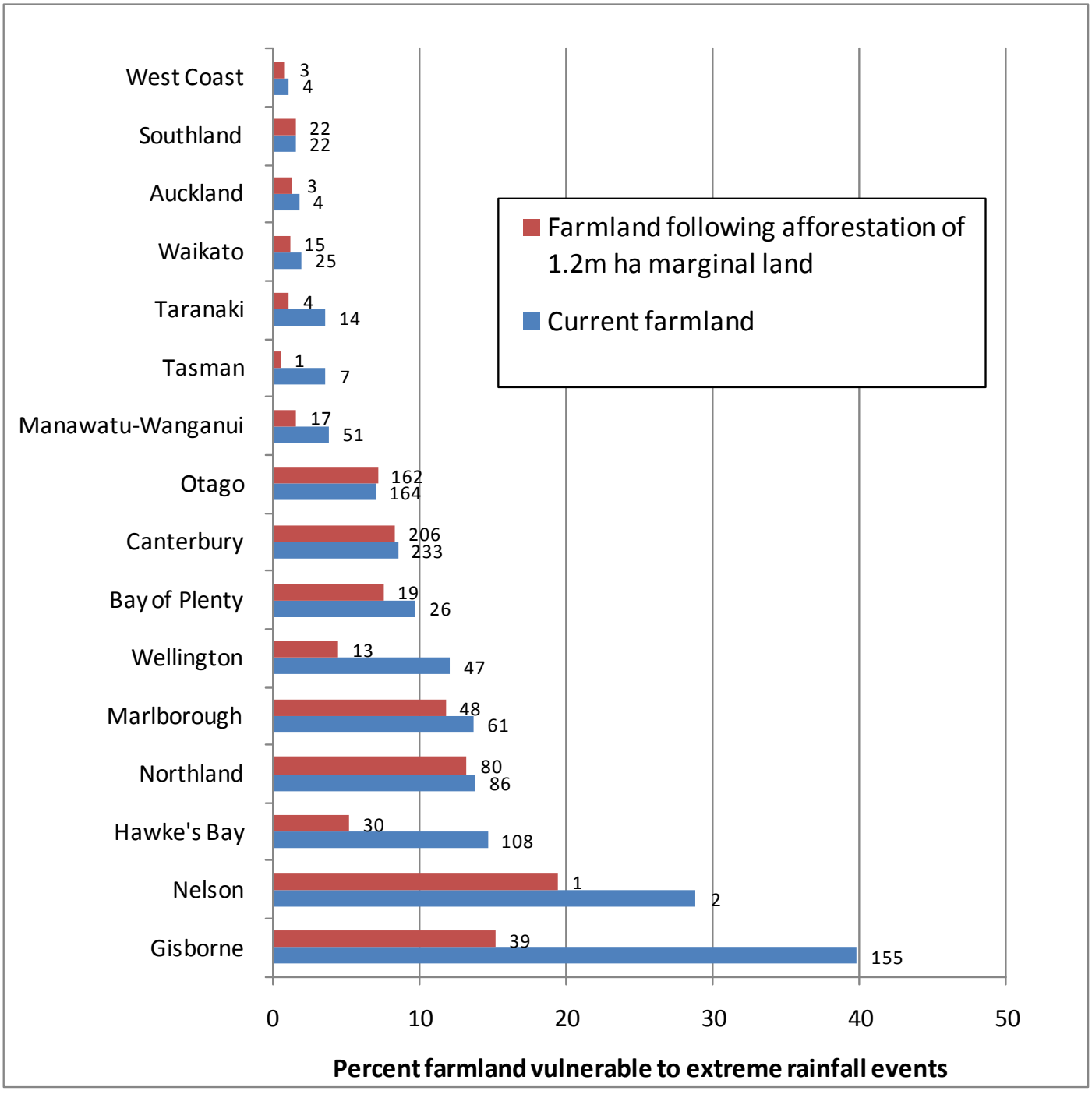
Appendix 2. Percentage of farmland vulnerable to extreme rainfall events for current farmland and for farmland following the establishment of 1.2 million ha forest. Label values show areas in thousands of hectares.



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