National Science Challenges | OUR LAND AND WATER | Toitū te Whenua, Tolora te Wai

Manaaki Whenua Landcare Research

Land use pressure, soil quality and links with land value

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Manaaki Whenua - Landcare Research / AgResearch

NZSSS conference December 2024

Background

- Land use pressures (e.g. stock units) have been related to land use intensity
- NZ lacks a well-developed national set of agricultural intensity indicators

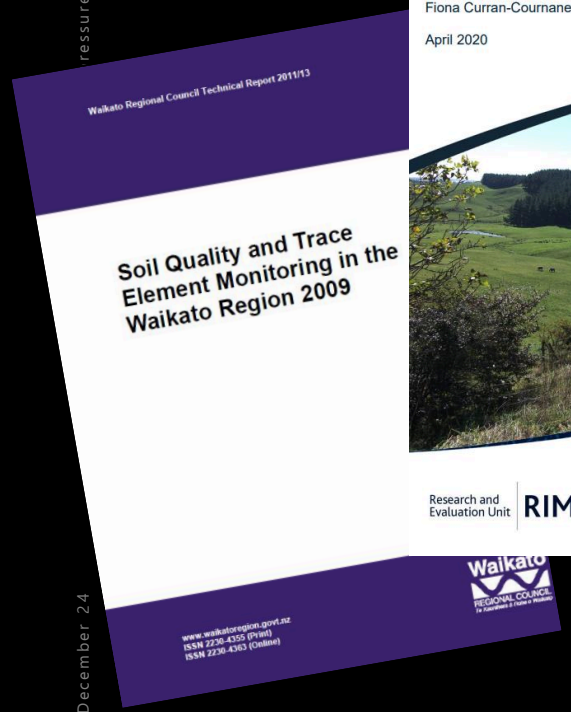
- Land value could be used as a proxy indicator of land use pressure
  - Publicly accessible nationally, well defined, and routinely estimated (3-yearly) (rates bill!)
  - Has not been evaluated previously

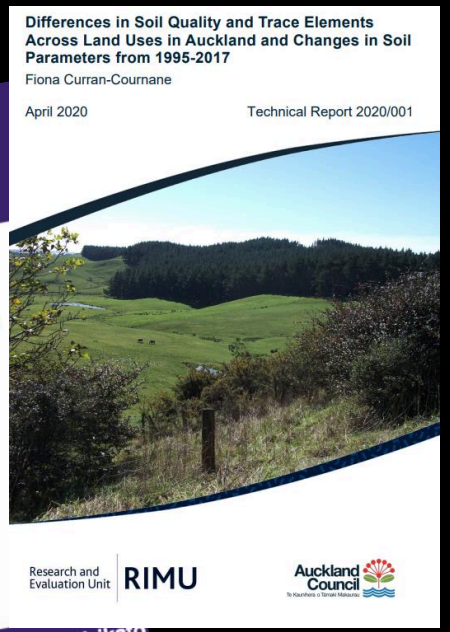
- **Question:**
- Could land value data be used as a proxy for agricultural intensification?

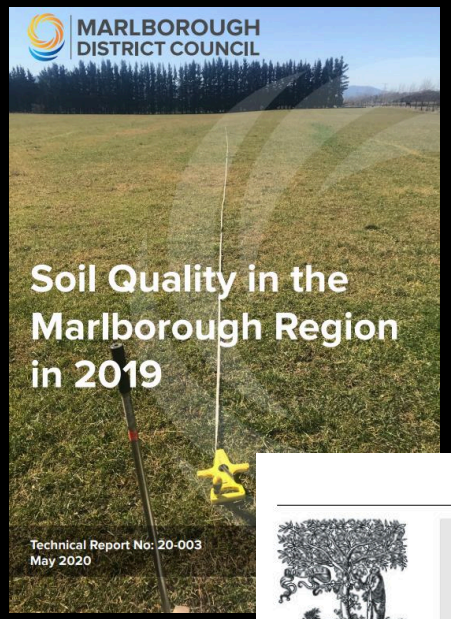
- **Objective:**
- Evaluate the relationship between land value/ha, soil quality, land pressure and catchment characteristics

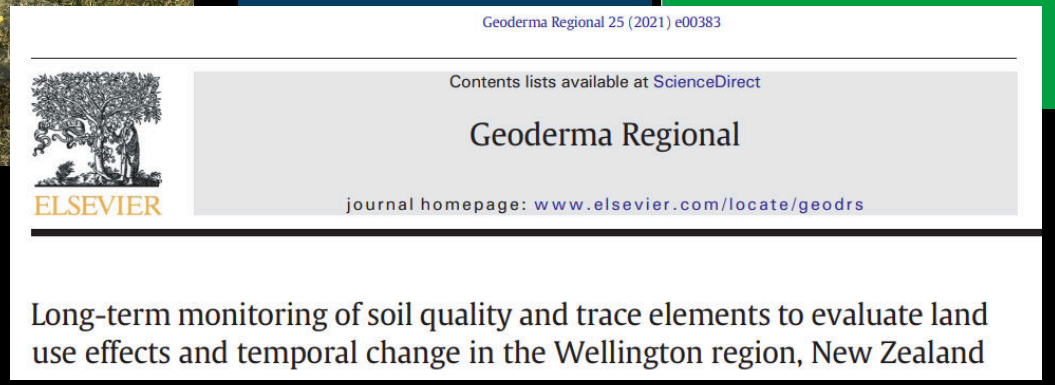
Data sources across NZ
Soil quality monitoring (national reporting dataset)

- Sampled 1995-2020 by 12 Regional Authorities
- Multiple land uses and soil orders, 0-10 cm depth



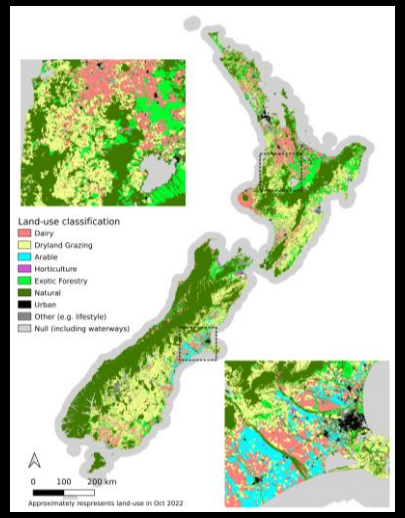




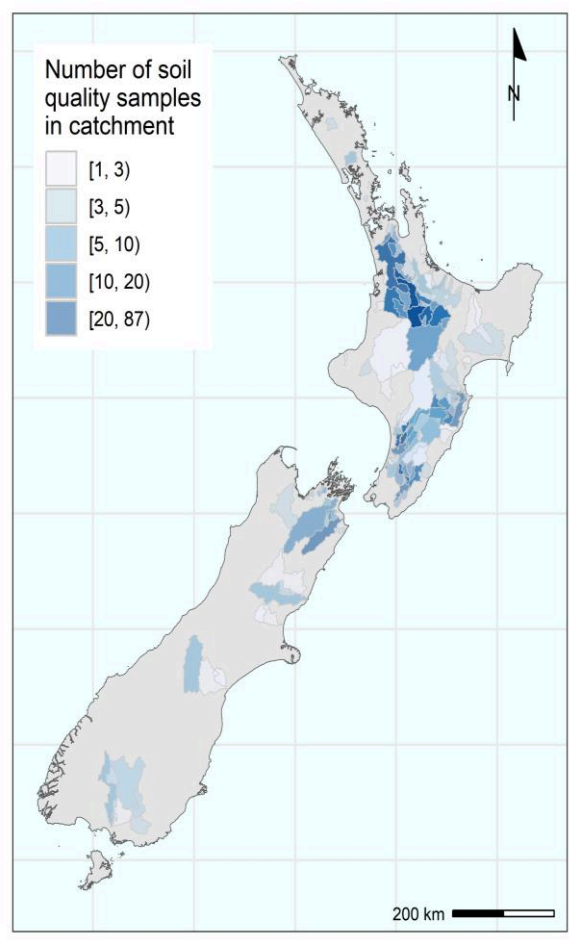


Data sources across NZ

- Catchments
  - 192 catchments with soil quality (31% of land area), as part of another study
- Land value
  - Property valuation data including a ratings unit
- Land use
  - Land Cover Data Base, AsureQuality's AgriBase, QEII National Trust boundaries
  - 7 land use classes October 2022
- Livestock type and stocking rate
  - Combined AgriBase farm locations, 2015–2020 Agricultural Production Survey, to give stock units



Soil quality



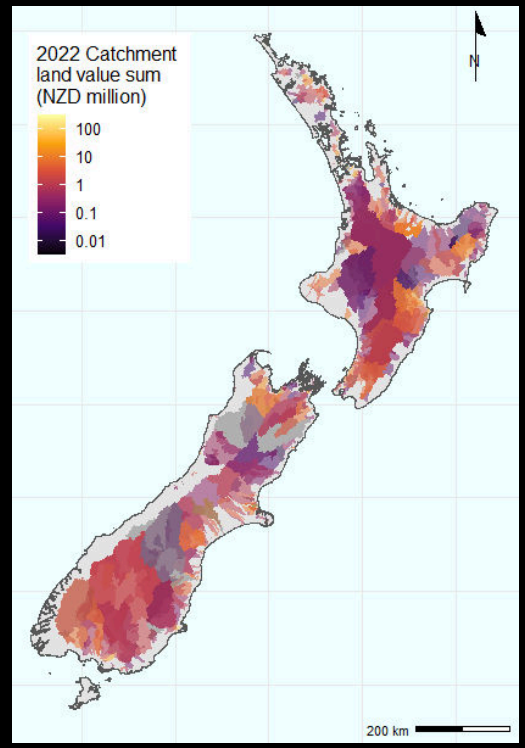
pH
Total C
C:N ratio (from total N)
Anaerobic mineralisable nitrogen
Olsen P
Bulk density

(Not macroporosity. Only available for 82% of catchments)

Highest range 20–87 soil samples per catchment

Land value

- Practical difficulties defining land value:
  - Some areas have no defined value (e.g. national parks, protected areas, Govt farms)
  - Significant cleaning was required!
  - 33% of property titles transformed to pass our validation



Statistical modelling

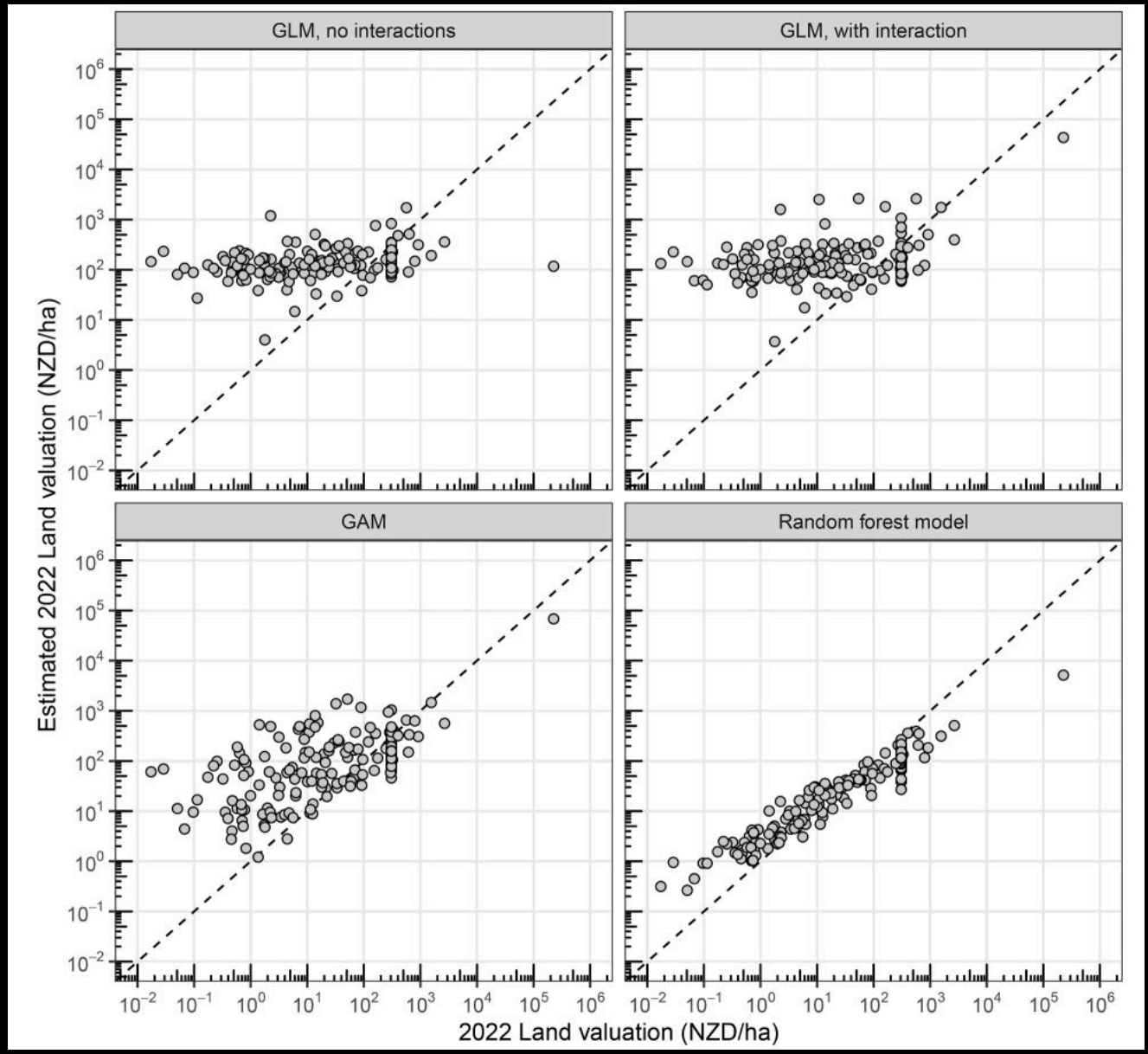
- Designed to understand relationship (if any) between land value/ha, soil quality and other variables

- Explanatory variables:
  - 6 soil indicators
  - Catchment characteristics e.g. mean elevation, slope, PET, rainfall
  - Stock units and 7 land use classes

- 4 models fitted:
  - Generalised linear model (GLM) with main effects
  - GLM with interactions
  - Generalised additive model (GAM)
  - Random forest model

Results

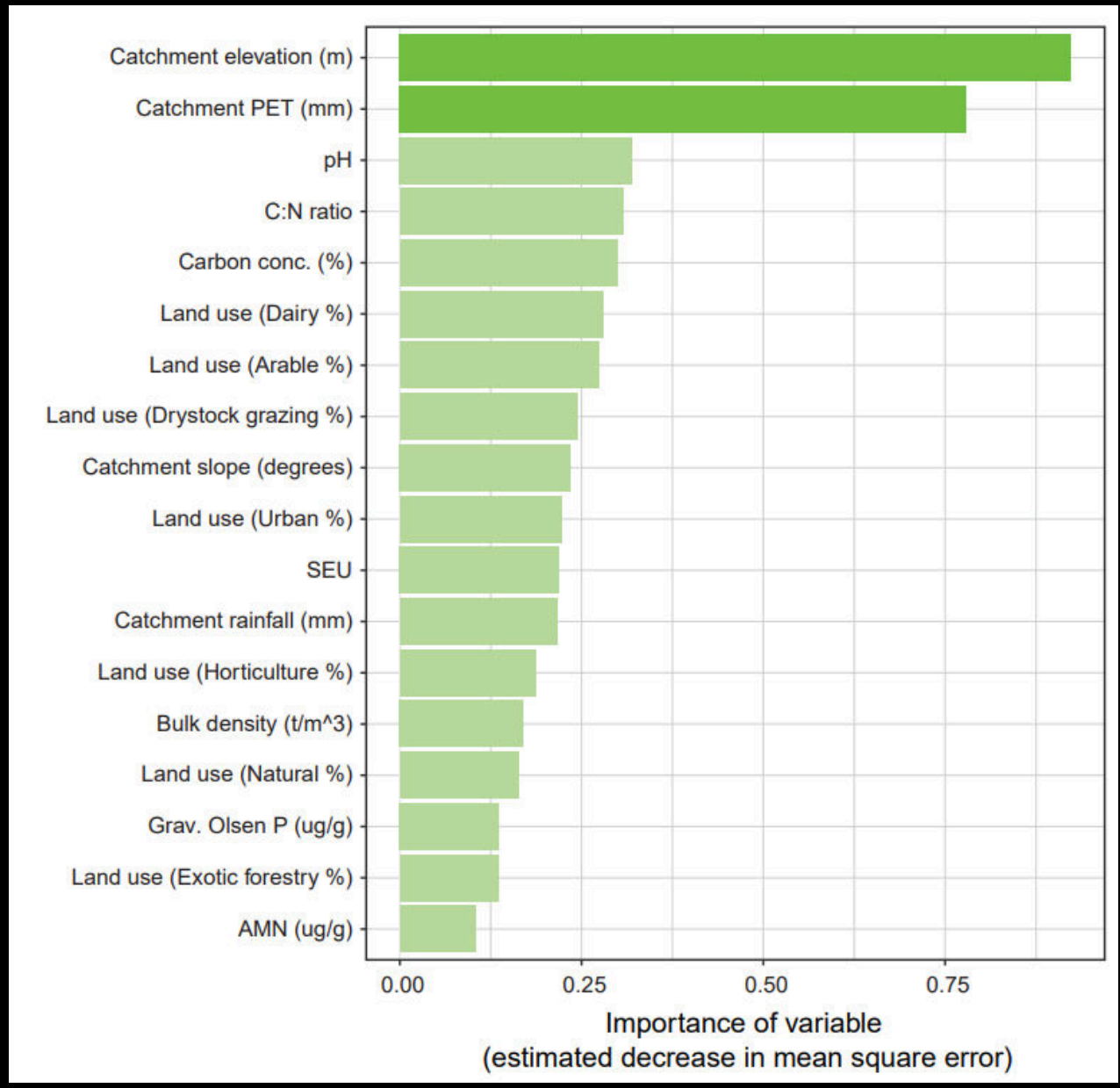
- GLM with main effects – poor explanatory power (r^2 8%)
- GLM interaction – better but land value/ha poorly modelled. Some interactions land use and soil quality (r^2 11%)
- GAM – better (r^2 41%)
- RF – much better fit (r^2 93%)



Random forest model

- Most important explanatory variable for land value/ha is catchment elevation, followed by catchment PET
- Relatively important is pH, C:N, carbon, and fraction of land uses

- Further results in the Geoderma paper



Interpretation

- Interpretation of effects for some covariates are difficult to explain
- The nature of the relationship between explanatory variables and land value/ha is complicated e.g. PET, while others are straightforward e.g. catchment elevation (proxy to urban area proximity)
- The importance of inherent catchment characteristics is very strong

- This study is not causal, i.e. there are other drivers of land value that were beyond our scope

- We explored using soil order, but not feasible (carbon, bulk density may reflect soil order)

Conclusions

- Random forest model superior in predicting land value/ha
- The most important variables were catchment elevation and PET, but land use and several soil quality indicators were important

- Land value/ha has a well-defined relationship with land use and some soil quality

- Further work to determine if land value could act as a proxy for land intensification is warranted

Acknowledgements

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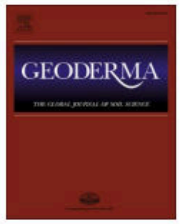

Linking land value to indicators of soil quality and land use pressure

John J. Drewry [a,*], Stephen J. McNeill [b], Richard W. McDowell [c,d], Richard Law [b], Bryan A. Stevenson [e]

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- A related project….

Science of the Total Environment 935 (2024) 173445

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Difficulties in using land use pressure and soil quality indicators to predict water quality

Richard W. McDowell [a,b,*], Stephen J. McNeill [c], John J. Drewry [d], Richard Law [e], Bryan Stevenson [f]