

Application of a nutrient transfer model for upscaling nitrous oxide emission estimates from grazed hill country

Background

- Grazed hill country represents one of the largest New Zealand sources of nitrous oxide (N₂O) emissions, which are currently estimated with a constant country specific emission factor (EF₃) of 1%.
- Due to spatial differences across hill land units (HLUs) in excretal-N deposition (regulated by animal grazing and resting behaviour), the EF₃ is likely to be lower (Carran & Saggar 2004; deKlein et al. 2004; Hoogendoorn et al. 2008) than that estimated.
- The amount of N excreted on each HLU can be estimated with the nutrient transfer model (NTM) of Saggar et al. (1990a, b). However, this model has not been tested for the wider range of land-use areas under different HLUs.

Objectives

- To test the applicability of the NTM over an increased range of hill land.
- To validate the NTM to account for excretal-N deposition as influenced by the land area of each HLU.
- To examine the effect of differences in excretal-N deposition on N₂O emissions using a range of EF₃ scenarios.

Approach

- Assessed the ability of the NTM to account for the ranges in areal land in different slope categories
- Calculated the effect of N partitioned between urine and dung on excretal N deposited on each slope.
- Determined the effect of varying EF₃ for each HLU on overall N₂O emissions using six possible emission factor scenarios.

A relative EF₃ was assigned to each HLU under 6 different scenarios using existing knowledge of the factors that regulate N₂O emissions.

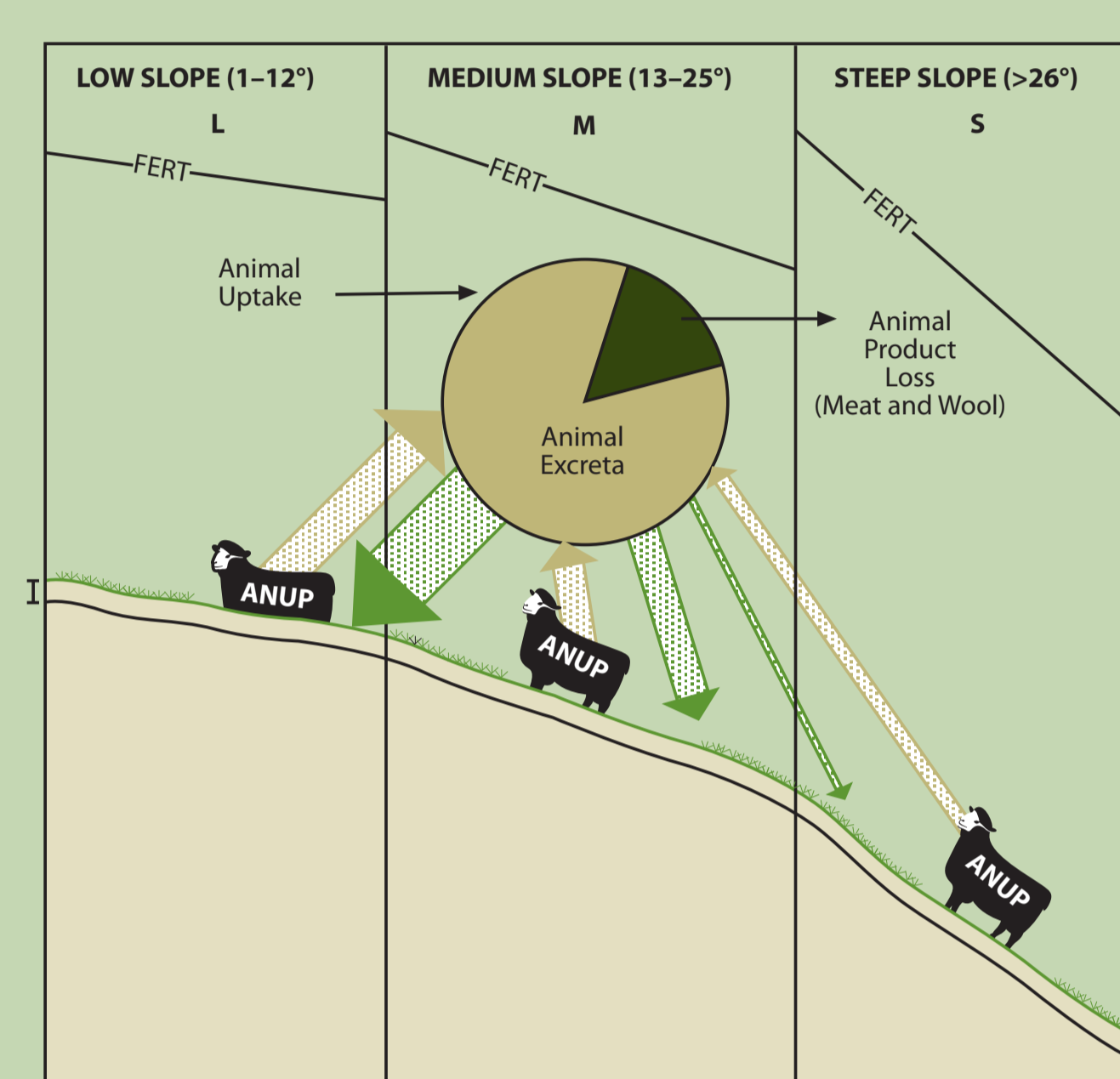


Table 1: Assigned emission factors (EF₃) (%)

Relative Emissions	Scenario I ¹	Scenario II ²	Scenario III ³	Scenario IV ⁴	Scenario V ⁵	Scenario VI ⁶
Very high	1.00	2.00	1.50	1.00	0.50	2.50
High	1.00	1.50	1.00	0.75	0.25	1.00
Moderate	1.00	1.00	0.60	0.50	0.10	0.20
Low	1.00	0.50	0.30	0.25	0.05	0.05
Very Low	1.00	0.05	0.05	0.05	0.01	0.001

¹Scenario I = EF₃ set at 1% for all HLUs as in NZ Inventory

²Scenario II = a relatively high EF₃ for all HLUs

³Scenario III = a moderate/reasonable EF₃ for all HLUs

⁴Scenario IV = a slightly less than moderate/reasonable EF₃ for all HLUs

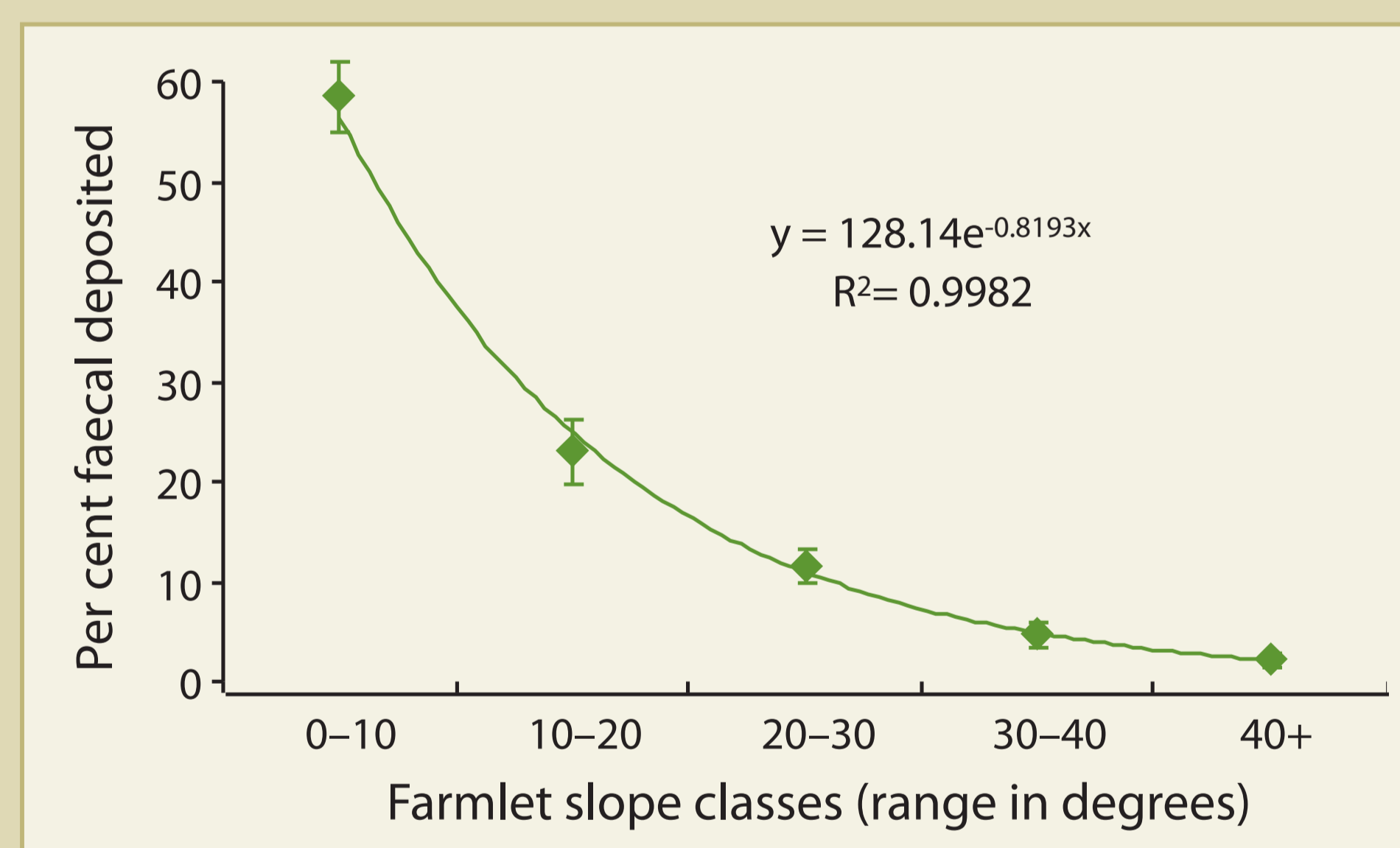
⁵Scenario V = fairly low EF₃ for all HLUs

⁶Scenario VI = a very high EF₃ for HLUs that are expected to have high emissions, and a very low EF₃ for HLUs that are expected to have low emissions

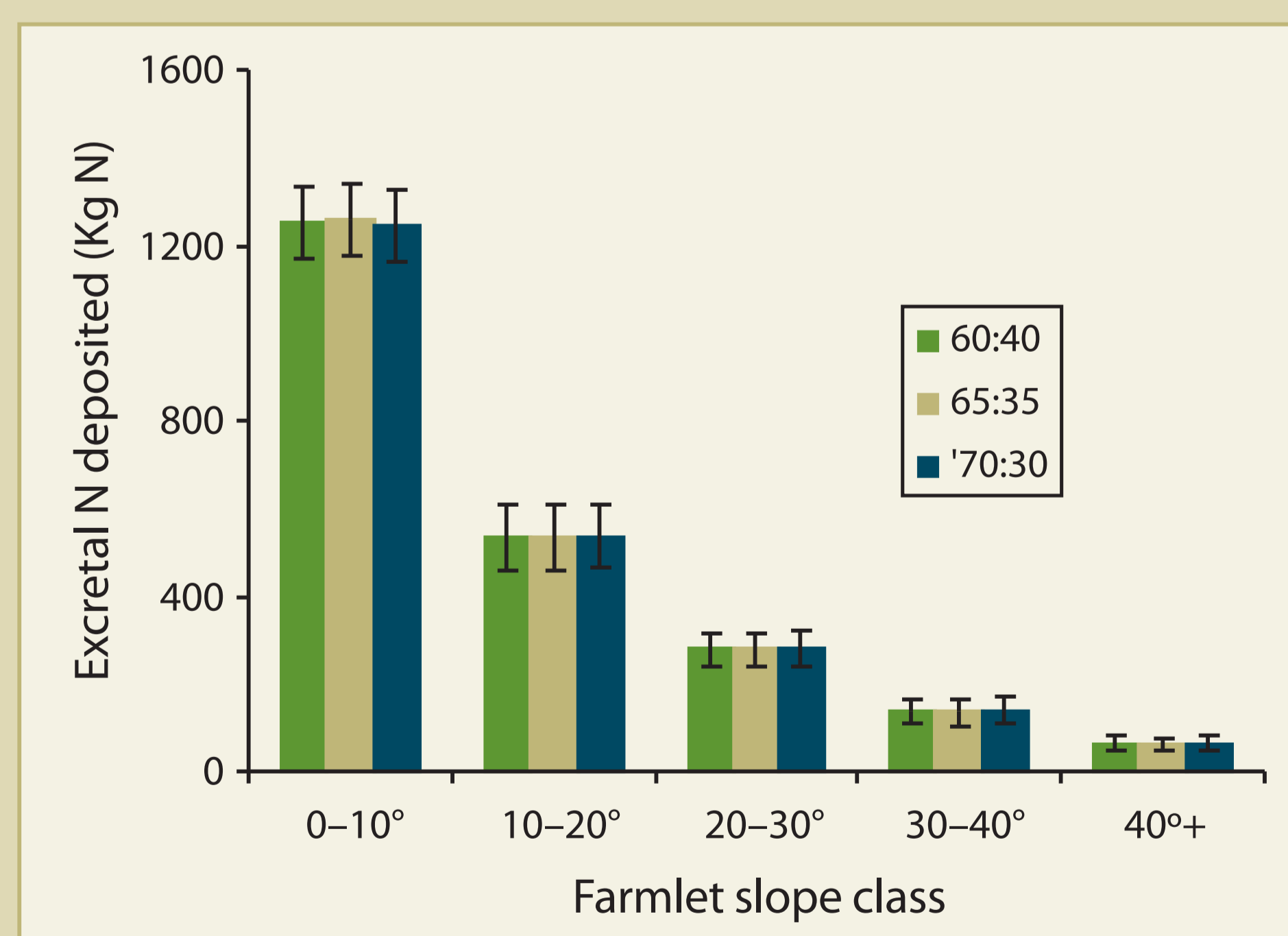
Results

The measured faecal distribution across the farmlets was mainly affected by the slope of the HLU and decreased under each slope class, with an increase in slope reflecting the influence of animal grazing and camping/resting behaviour.

The area under the slope had little impact on the proportional faecal distribution.

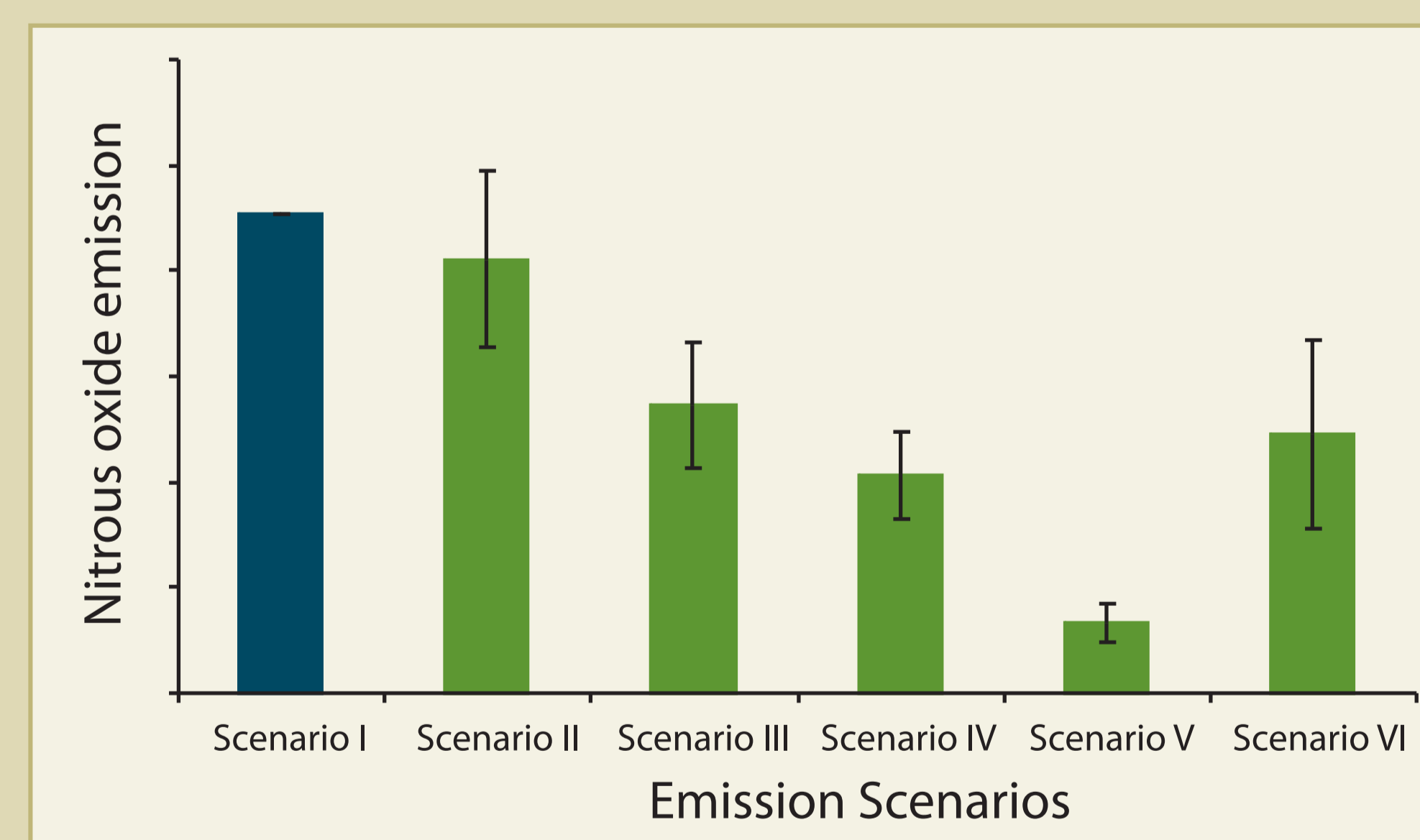


Simulating changes in the proportion of N between dung and urine did not significantly affect the excretal-N distribution between slopes.



Using the largest range of possible variations in land area among the soil drainage class, slope and aspect categories to account for the heterogeneity within hill country resulted in:

- Only small differences in N₂O emissions under 6 different scenarios (Table 1), with co-efficient of variation values of 20–36% (Error bars ± s.d.)
- The scenarios II to VI with a range of EF₃ values have the potential to reduce New Zealand's GHG inventory rather than a constant EF₃ value of 1%.



Conclusions

- The NTM can be used for estimating grazed hill country excretal-N distribution for a range of soil type and topographic situations.
- Scenarios with a range of EF₃ values for different HLUs have the potential to reduce the hill country N₂O inventory.

References

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