Current state of water contaminants compared to bottom lines

WHO IS THIS RESEARCH BRIEF FOR?

Regional council planners

Central government policy analysts

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RESEARCH TIMELINE

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Key points

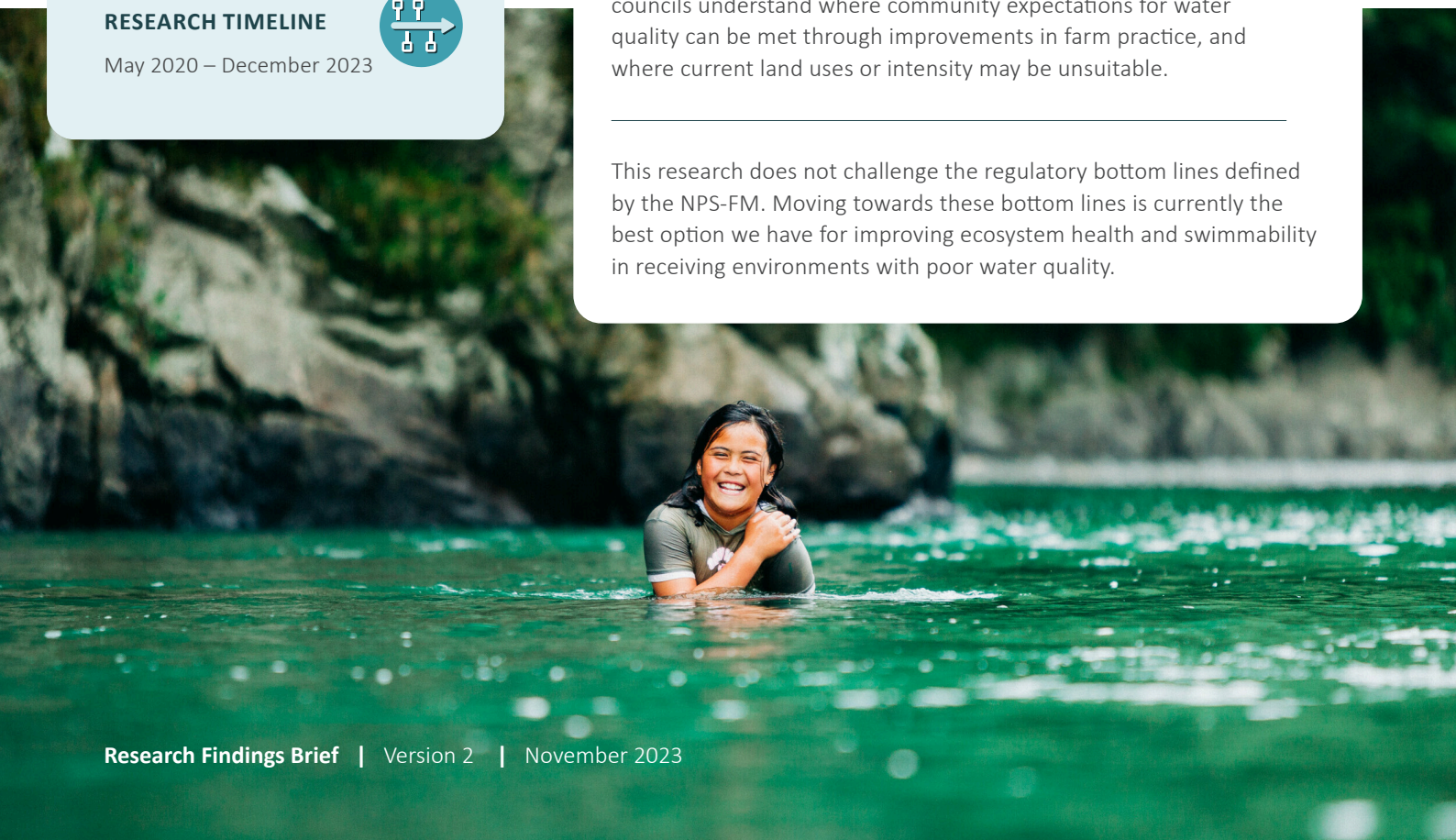
Substantial reductions of at least one contaminant are required in almost all regions. Many receiving environments exceed the bottom line for more than one contaminant.

Three-quarters of all land in Aotearoa is contributing *E. coli* to our water – a much greater area than for the other three contaminants (nitrogen, phosphorus and sediment).

Maps depict catchments according to the size of the load reductions required. This indicates where the greatest effort is needed to reduce water contamination to meet the national bottom lines.

This information is critical to helping government and regional councils understand where community expectations for water quality can be met through improvements in farm practice, and where current land uses or intensity may be unsuitable.

This research does not challenge the regulatory bottom lines defined by the NPS-FM. Moving towards these bottom lines is currently the best option we have for improving ecosystem health and swimmability in receiving environments with poor water quality.



How can this research be used?

Implementation of regulation: This study can be used to guide the implementation of freshwater regulation. It can help all New Zealanders appreciate the size of the job ahead.

Managing expectations: The research will help government set realistic expectations for the time, support and investment required to restore health to our rivers, lakes and estuaries.

Change in land use and management: People in government and regional councils can use this study to support understanding of where community expectations for water quality can be met through improvements in farm practice, and where current land uses or intensity may be unsuitable.

Why is this research needed?

The purpose of this work was to provide a national-scale assessment of the approximate size of the job to achieve the minimum acceptable states for our freshwater specified in the National Policy Statement for Freshwater Management 2020 (NPS-FM).

This research evaluated the current state of four contaminants (nitrogen, phosphorus, Escherichia coli, and sediment) in rivers, lakes, and estuaries across Aotearoa New Zealand. This was the first assessment of the current state compared to 'bottom lines' for all four contaminants across the whole country.

Similar assessments have been conducted by others on a regional scale. These have used differing methods, models and target states. This study applies a consistent approach to the entire country.

The minimum acceptable states are based on measurements that scientists use to define a state that will support healthy ecosystems. (With the exception of *E. coli* objectives, which are based on human health, not ecosystem health.) Moving towards these bottom lines is currently the best option we have for improving ecosystem health and swimmability in receiving environments with poor water quality.

NPS-FM in brief

New Zealand's minimum acceptable states for freshwater are currently defined by the national bottom lines for attributes in the National Policy Statement for Freshwater Management 2020 (NPS-FM) (Appendix 2A). This includes the nitrate toxicity, periphyton, *E. coli* and suspended sediment attributes for rivers, and the phytoplankton, total nitrogen and total phosphorus attributes for lakes.

Previous versions of the NPS-FM established minimum acceptable states that were carried through into the NPS-FM 2020. The current attributes for periphyton in rivers and phytoplankton, nitrogen and phosphorus in lakes were defined in the 2014 version of the NPS-FM, for *E. coli* in the 2017 NPS-FM, and for sediment and nitrate toxicity in the NPS-FM 2020. We note the history of these regulations to counter misperceptions they were set by a single government.

Regulations have also established Te Mana O Te Wai at the first principle for water management in Aotearoa. This requires the health and wellbeing of water itself to be prioritised above all else.

This research does not challenge the regulatory bottom lines defined by the NPS-FM.

The NPS-FM requires regional councils to implement regulations to achieve the minimum acceptable states. This study does not consider what kinds of limits or actions might be used to achieve any load reductions, how such actions might be implemented, over what timeframes, and what the implications for other values might be. The NPS-FM requires regional councils to have regard to these and other things when implementing the regulations.

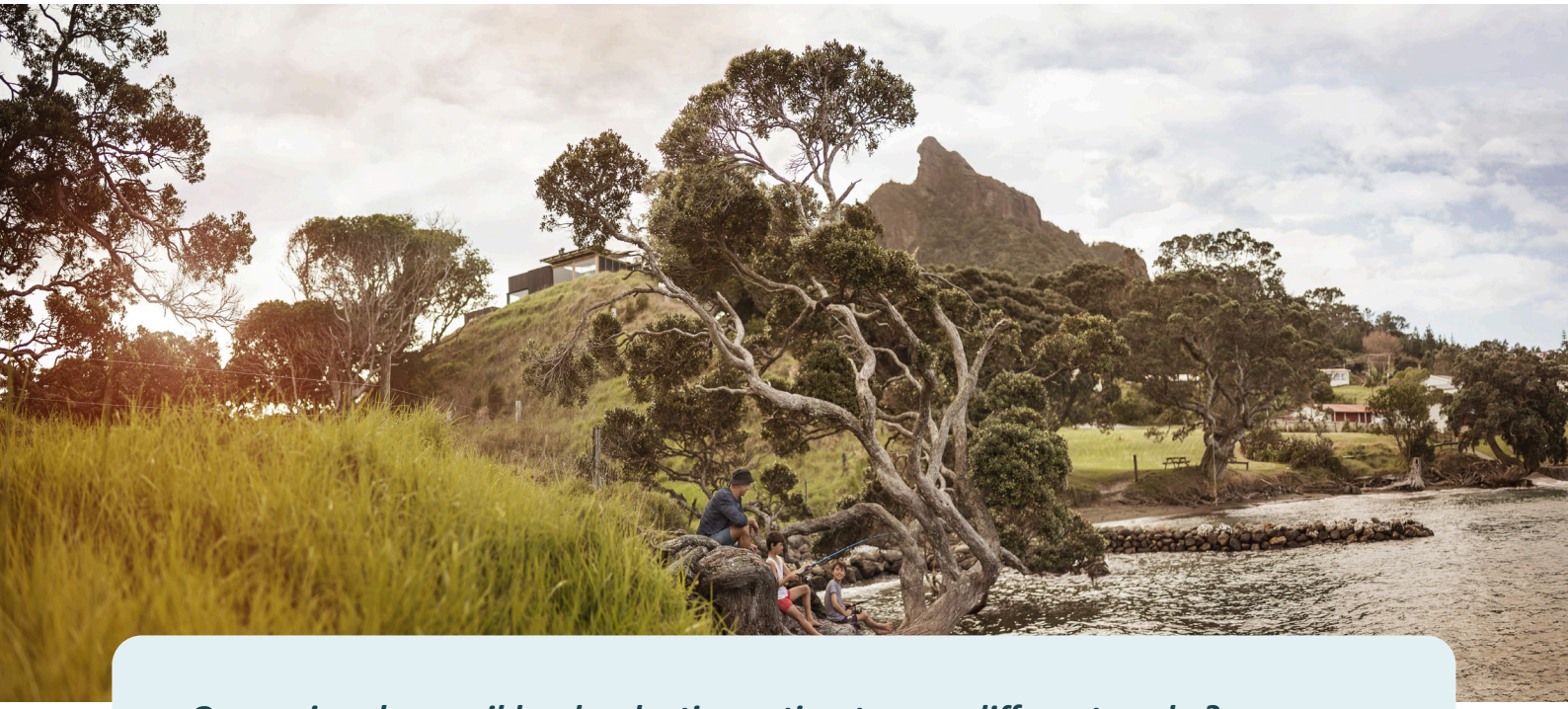
What did we do?

The research, funded by Our Land and Water, assessed the reduction in contaminant loads required to achieve New Zealand's set of minimum acceptable states for water quality.

The analysis used digital representation of New Zealand's 650,000 river segments, 771 lakes and 419 estuaries and their catchment area. The research used models informed by data collected at 850 long-term State of Environment water quality monitoring sites.

This study does not include load reductions to achieve groundwater targets.

This study also includes minimum acceptable states for estuaries, which are not specified in the NPS-FM. The research used the most appropriate analogous measures of estuarine response to nitrogen and phosphorus to define these minimum acceptable states. The analysis for estuaries does not consider sediment.



Our regional council load reduction estimates are different – why?

Some regional authorities have set target states that are more aspirational than the national bottom lines, to reflect the values of their communities. Where this is the case, the load reductions required by regional councils will be greater, and regional maps will identify more catchments that require reduction.

In some cases, regional analysis may require lower load reductions. This may be due to the use of different input data, assumptions or models than applied in this study.

This study uses the national bottom lines because they are the regulatory minimum acceptable state, and applies a consistent method and models to the entire country.

These national-scale maps do not override regional-scale maps or contaminant reduction requirements calculated by regional authorities using location-specific data, models and targets.

What did we find?

This study indicates that achieving the contaminant reductions required by the national regulations will be extremely challenging, particularly in catchments where the dominant source of all four contaminants is land that is under pastoral farming.

Waterways in some regions can be more susceptible to one contaminant than others. Regions prone to erosion (such as Manawatū-Wanganui, Waikato and Otago) have larger sediment load reductions required. Large proportions of Canterbury and Southland have high intensity pastoral land use, which is reflected in larger load reductions required for nitrogen.

There is significant variation between regions. For example, the West Coast requires low levels of reduction for all four contaminants, while in other regions such as Manawatū-Wanganui large reductions are needed for all four contaminants.

There is also considerable variation within regions, where some catchments require much greater reductions than others.

Some land largely untouched by humans is upstream from rivers, lakes and estuaries that require load reductions to comply with national bottom lines, and is therefore captured by the maps produced by this study. The full catchment area is shown in the maps for completeness. Action does not need to be taken on land where non-compliance is due to naturally occurring processes, under Clause 3.32 of the NPS-FM.

But farmers have been taking action for years

Many land managers have taken effective action to improve water quality over the past 30 years. An earlier analysis (Monaghan et al, 2021) found that our rivers would be in much worse condition today if farmers had not adopted better practices between 1995 and 2015.

If farmers had not taken action, 45% more nitrogen and 98% more phosphorus would have entered rivers from dairy-farmed land, and 30% more sediment would have entered rivers from sheep and beef farmed land.

Despite these efforts, increased intensity of food production per hectare over the same period, along with a 40% increase in land area used for dairy, continued to put pressure on freshwater by increasing total nitrogen loss. Mitigations were not sufficient to offset these increased nitrogen loads.

These maps help identify catchments where applying all possible on-farm mitigations may be less pragmatic than some change in land use or land use intensity.

Table 1: Reductions in contaminants are needed to achieve the national bottom lines *Source: Snelder et al, 2023*

The load reductions required to achieve the national bottom lines for the target attribute states assessed by this study are shown as a proportion of current load (%). The first number is the best estimate, followed by the confidence interval in parentheses.

Region	Total nitrogen	Total phosphorus	*E. coli*	Sediment
Northland	3 (1 – 5)	2 (1 – 7)	80 (70 – 91)	15 (4 – 30)
Auckland	6 (4 – 8)	3 (2 – 5)	73 (67 – 78)	7 (4 – 11)
Waikato	6 (2 – 15)	6 (2 – 20)	91 (70 – 126)	47 (29 – 66)
Bay of Plenty	7 (1 – 18)	1 (0 – 7)	61 (48 – 79)	17 (3 – 39)
Gisborne	3 (0 – 6)	6 (0 – 31)	85 (56 – 112)	41 (9 – 60)
Taranaki	17 (6 – 30)	3 (1 – 9)	72 (64 – 82)	23 (4 – 53)
Manawatū-Wanganui	15 (8 – 25)	12 (3 – 38)	90 (58 – 125)	58 (42 – 75)
Hawke's Bay	22 (7 – 40)	6 (2 – 15)	55 (41 – 73)	20 (4 – 36)
Greater Wellington	12 (5 – 23)	9 (5 – 16)	61 (46 – 83)	18 (9 – 29)
Tasman	2 (1 – 4)	3 (1 – 10)	40 (29 – 52)	3 (1 – 10)
Marlborough	6 (2 – 13)	2 (0 – 4)	29 (19 – 50)	28 (8 – 55)
West Coast	0 (0 – 1)	1 (0 – 2)	19 (12 – 36)	18 (8 – 29)
Canterbury	44 (38 – 50)	6 (3 – 9)	45 (34 – 58)	49 (22 – 76)
Otago	33 (19 – 46)	13 (4 – 24)	60 (40 – 77)	338 (5 – 1089)
Southland	41 (28 – 55)	12 (4 – 23)	75 (60 – 88)	24 (7 – 52)
Total	19 (15 – 22)	6 (4 – 12)	73 (60 – 84)	33 (21 – 44)

Assumptions and uncertainties

Researchers are 95% confident that load reductions are required for most contaminants in most regions, to achieve the minimum acceptable states for our freshwater. However, this study provides a national-scale overview and is subject to uncertainty at the individual site scale.

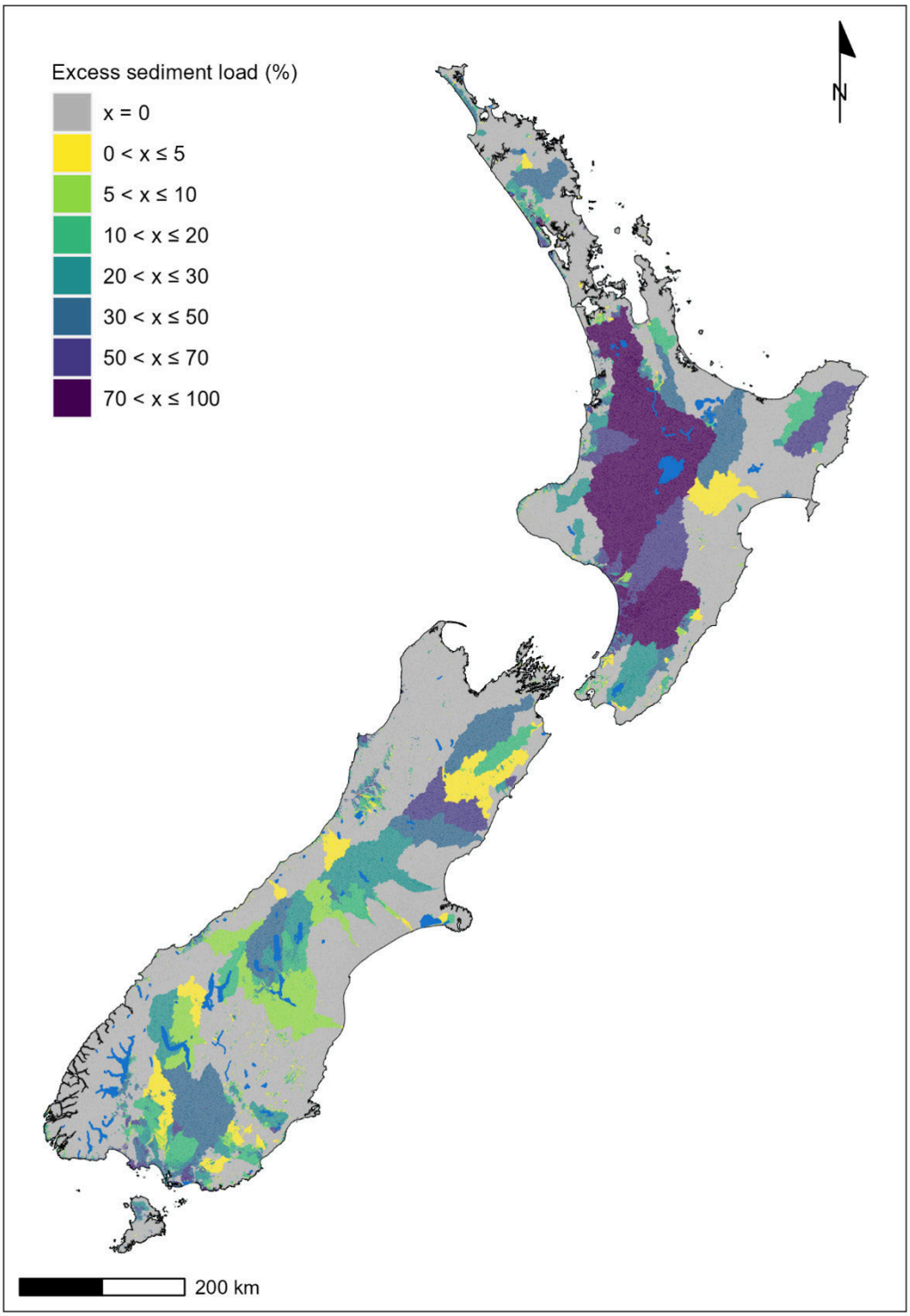
Planners and policymakers should interpret the results recognising they contain uncertainties. There are several sources of uncertainty in this analysis, outlined in the report (Snelder et al, 2023; sections 2.8, 2.10 and 4.3). For example:

- Contaminant concentrations, loads and attribute states were extrapolated from State of Environment data, which is site-specific, using models. Models make simplifications and always have uncertainties. The analysis combines several sets of models and modelled predications.
- Nitrogen is more accurately predicted due to its strong link with land use, while phosphorus predictions are less precise due to natural processes.
- Point source discharges were not explicitly accounted for but are represented in the monitoring data used to construct the models. There is potential for underestimation of concentrations and loads in situations where point sources are downstream of monitoring sites.

These uncertainties will not be reduced in the next 5 to 10 years due to the need for long-term monitoring data. Reducing uncertainties would require sampling at considerably more sites and more frequently (cost estimate: $10–16 million/year), as well as increased scientific understanding of the processes involved in contaminant transport to receiving environments.

Decisions by policymakers will therefore need to be made despite uncertainty.

Regions prone to erosion require larger sediment load reductions

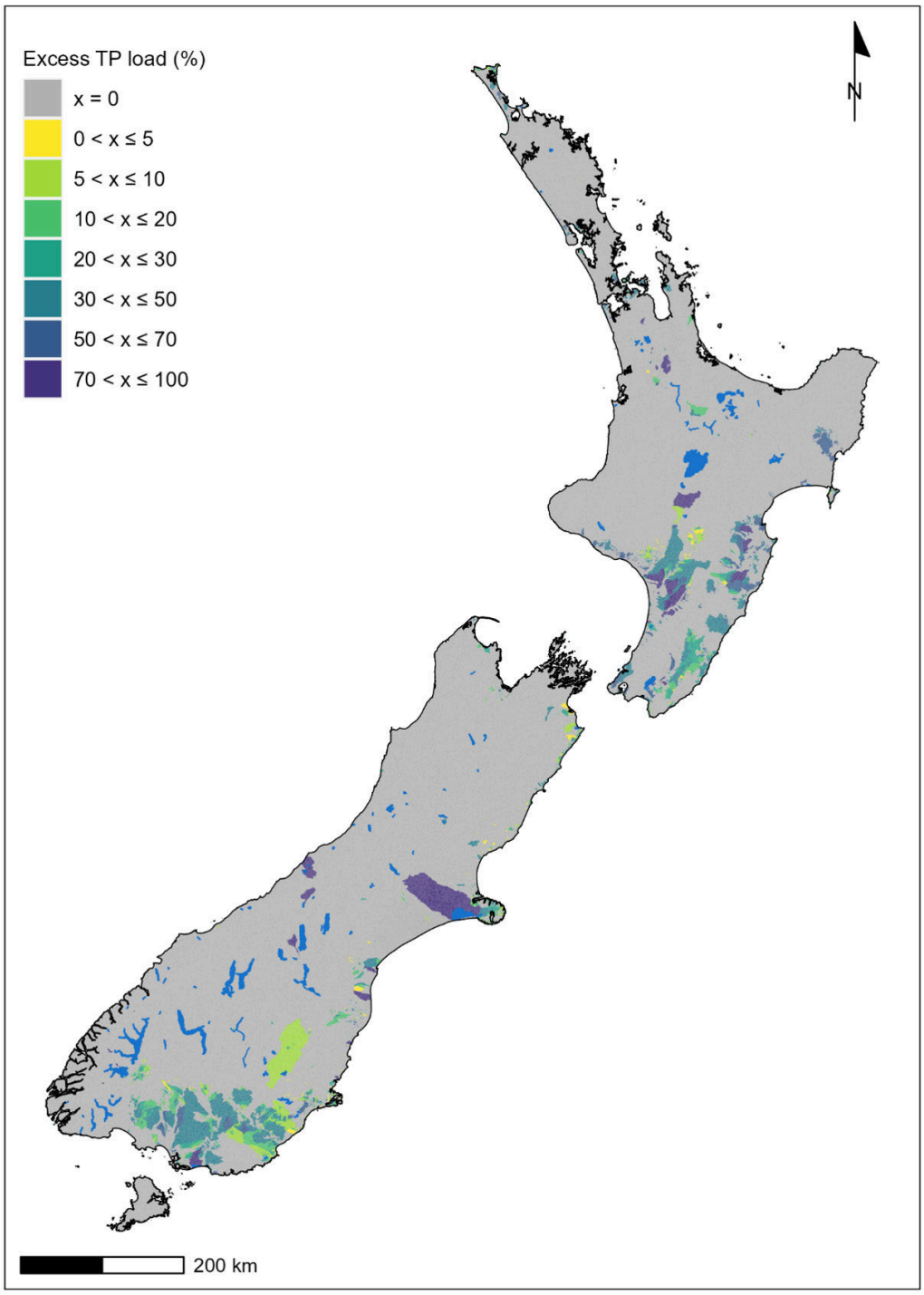


Sediment

Sediment load reductions are required for catchments comprising 49% of the land area of New Zealand. The required sediment load reductions are highest in Otago (338%), Manawatū (58%), Canterbury (49%) and Waikato (47%) for which the required reduction is the percentage of the total sediment load discharged to the ocean.

The Otago load reduction requirement exceeds 100% because the estimated upstream reductions can be larger than the predicted load at the bottom of the catchment. This is because sediment is deposited in lakes or floodplains as it is transported downstream, for example, in the Kawarau and Shotover rivers.

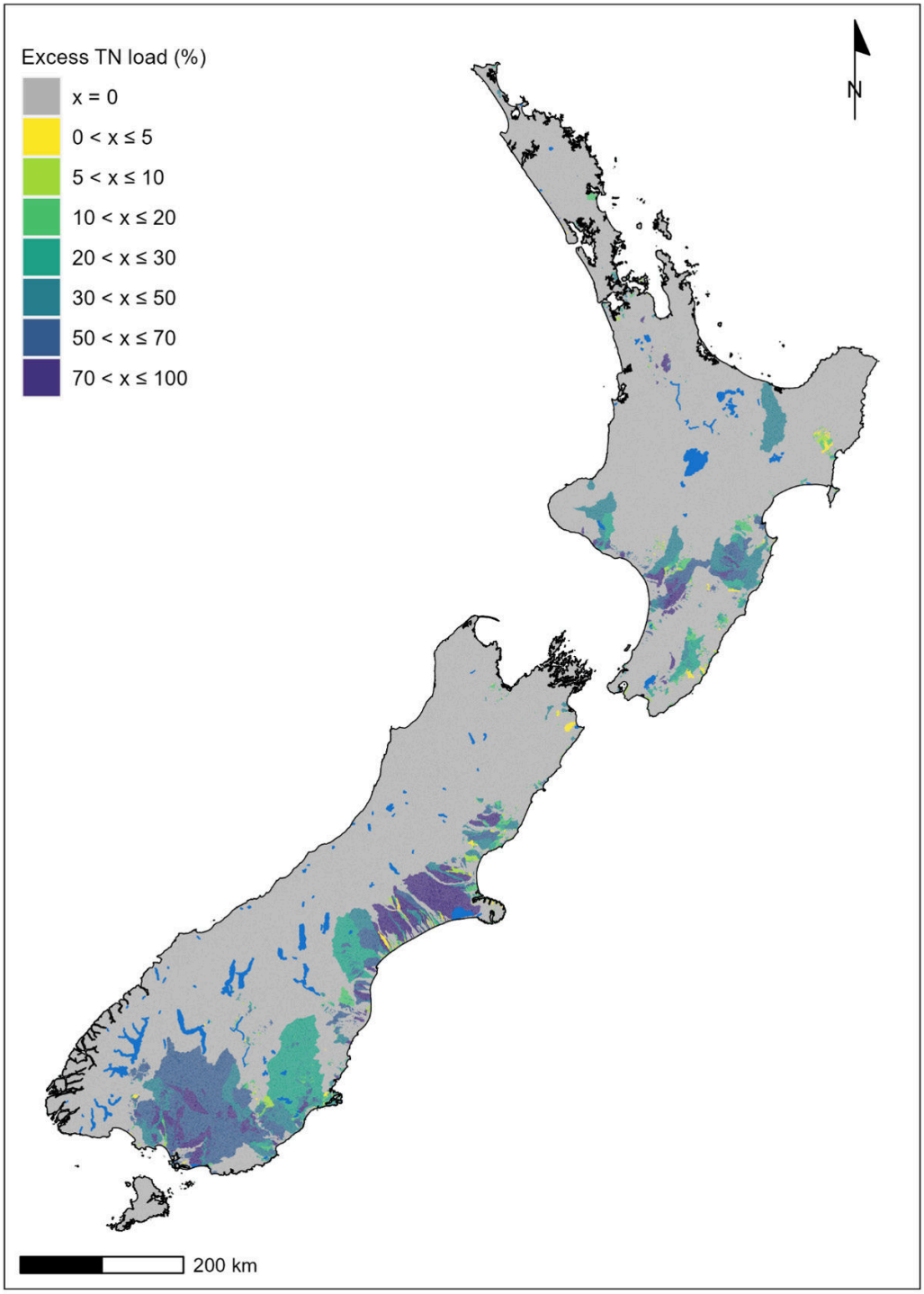
High intensity pastoral land use is reflected in larger load reductions required for phosphorus



Phosphorus

Reductions in total phosphorus loads are required for catchments comprising 11% of the land area of New Zealand. The required total phosphorus load reduction is highest in Otago (13%), Manawatū (12%) and Southland (12%) for which the required reduction is the percentage of the total phosphorus load discharged to the ocean.

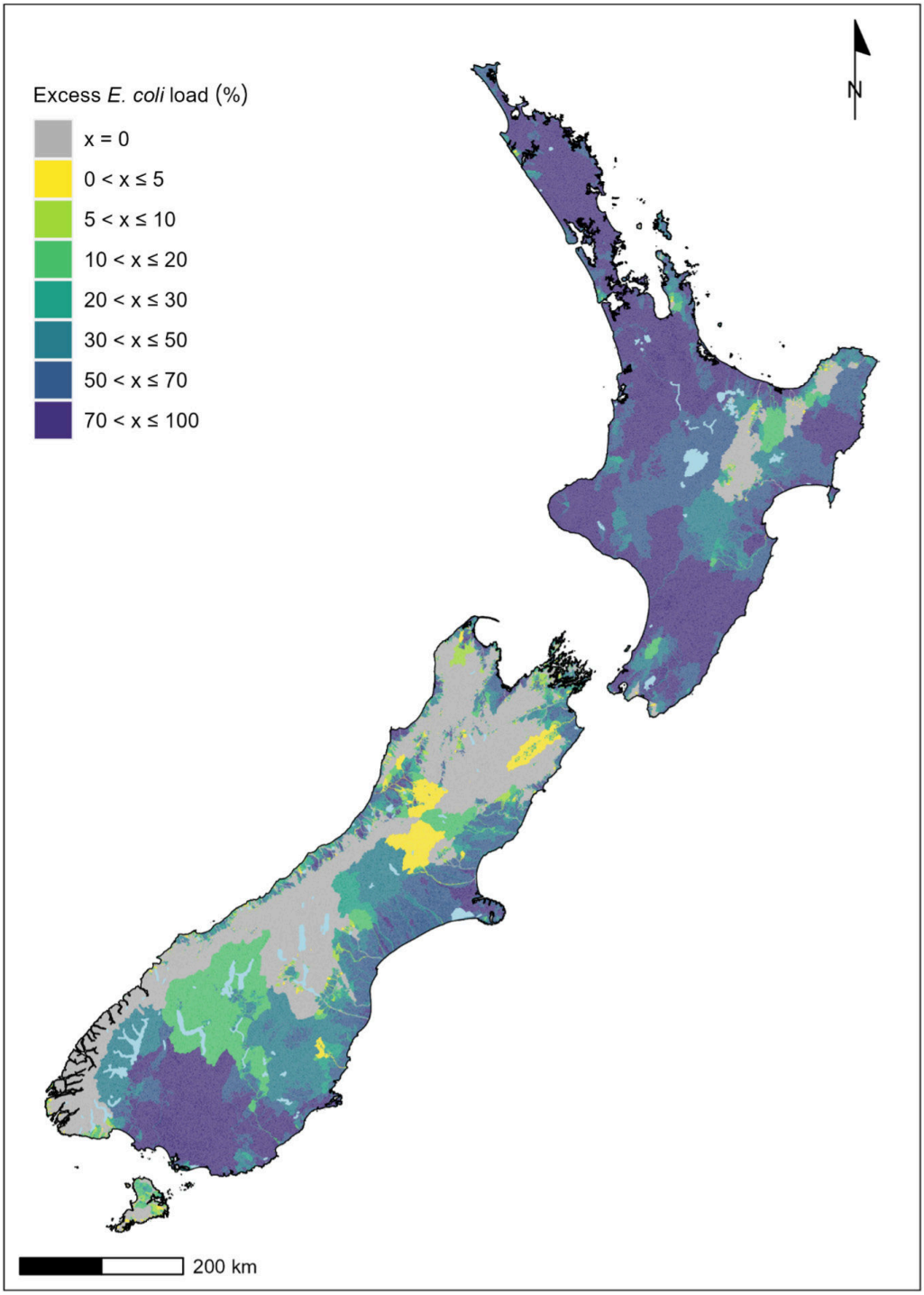
High intensity pastoral land use is reflected in larger load reductions required for nitrogen



Nitrogen

Reductions in total nitrogen loads are required for catchments comprising 20% of the land area of New Zealand. The required total nitrogen load reduction is highest in Canterbury (44%), Southland (41%) and Otago (33%) for which the required reduction is the percentage of the total nitrogen load discharged to the ocean.

Three-quarters of all land in Aotearoa is contributing unacceptable levels of E. coli to our rivers

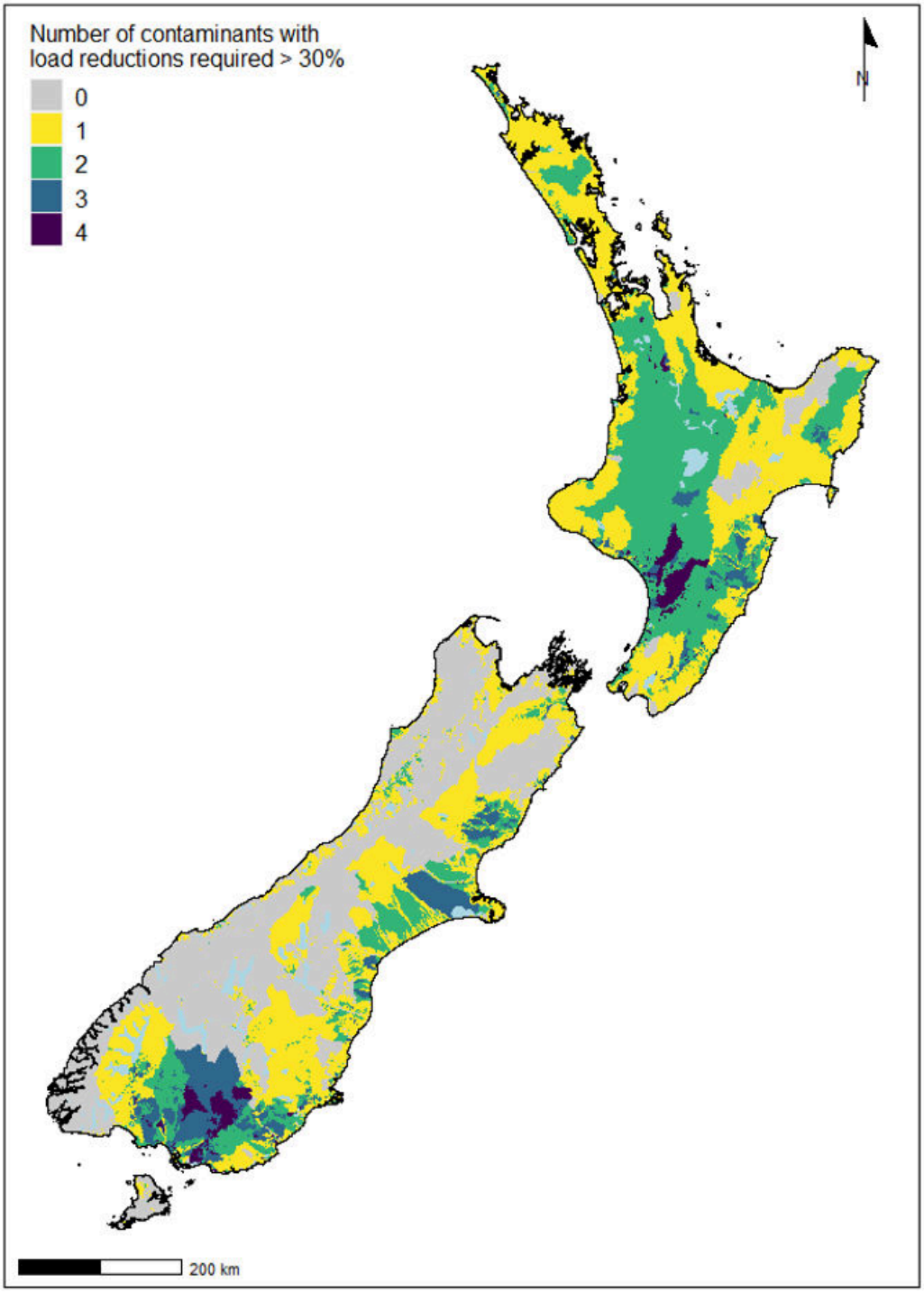


Escherichia coli

Reductions in *E. coli* loads are required for catchments comprising 79% of the land area of New Zealand. *E. coli* load reductions required are highest in Waikato (91%) Manawatū (90%), Gisborne (85%), Northland (80%), Auckland (73%), and Taranaki (72%) for which the required reduction is the percentage of the total *E. coli* load discharged to the ocean.

The maps produced by this study highlight the entire area of a catchment where contaminant reduction is needed – but this includes land largely untouched by humans, such as the DOC estate. That means significant action needs to be taken to reduce *E. coli* entering water from the areas of land that are being managed, and in particular land being used to produce food.

Load reductions of over 30% may require land-use change to achieve acceptable states



Some areas require the load of more than one contaminant to be reduced by more than 30%. Load reductions of over 30% are more likely to require some change of land use or intensity.

Load reductions of over 30% for two contaminants are required in 24% of the land area of New Zealand; for three contaminants in 6% of land area; and all four contaminants in 2% of land area.

Number of contaminants	Land areas requiring load reduction of over 30% (as a percentage of total NZ)
0	30
1	38
2	24
3	6
4	2

Key publications

Nitrogen, phosphorus, sediment and Escherichia coli in New Zealand's aquatic receiving environments: Comparison of current state to national bottom lines. Ton Snelder, Hugh Smith, David Plew, Caroline Fraser. LWP Client Report 2023-06, November 2023.
ourlandandwater.nz/current-state-vs-nbls

Shapefiles and technical information are available in the Data Supermarket:
tinyurl.com/current-state-vs-fwo

Nitrogen loads to New Zealand aquatic receiving environments: comparison with regulatory criteria. Ton H. Snelder, Amy L. Whitehead, Caroline Fraser, Scott T. Larned & Marc Schallenberg. New Zealand Journal of Marine and Freshwater Research, May 2020.
doi.org/10.1080/00288330.2020.1758168

Quantifying contaminant losses to water from pastoral land uses in New Zealand II. The effects of some farm mitigation actions over the past two decades, Ross Monaghan, Andrew Manderson, Les Basher, Raphael. NZ Journal of Agricultural Research, January 2021.
doi.org/10.1080/00288233.2021.1876741

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Our Land and Water (Toitū te Whenua, Toiora te Wai) is working towards an agri-food and fibre system that enhances the vitality of te Taiao with a diverse mosaic of land uses that improve the health of land, water and people.

Our Land and Water is one of 11 National Science Challenges that focus on defined issues of national importance identified by the New Zealand public.

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