IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of the hearing of submissions on Proposed Plan Change 5 (Nutrient Management and Waitaki Sub-region) to the Canterbury Land and Water Regional Plan
BY	**ROBERT SUTTON**
AND	**WAITAKI IRRIGATORS COLLECTIVE LIMITED**
	<u>Submitters</u>
TO	**CANTERBURY REGIONAL COUNCIL**
	<u>Local authority</u>

STATEMENT OF EVIDENCE OF ROBERT WILLIAM SUTTON

Dated: 22 July 2016

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INTRODUCTION

1 My name is Robert William Sutton, and together with my wife, Meghan Sutton, we operate Tironui Farm, a 626 hectare mixed farming operation in the Hakataramea Valley.

2 I am an active member of the Hakataramea community. I have participated in processes relating to water management in the Lower Waitaki since 2007. I am currently a member of, and the Treasurer for, the Waitaki Independent Irrigators Incorporated Society (**"WIII"**).

3 I have been involved with the collaborative community consultation process undertaken by Environment Canterbury in order to determine community values, aspirations, and outcomes for our river since it began in 2014.

4 I am inviting the Commissioners to undertake a site visit to my farm in the Hakataramea Valley as part of the Plan Change 5 hearing process. They can then see first-hand the landscape we are farming in, and I can explain and demonstrate my farming system and how and why it works.

SCOPE OF EVIDENCE

5 My evidence will provide information about:

(a) my farming operation;

(b) what I understood to be the outcomes sought by the Hakataramea community; and

(c) the implications of the rules under Proposed Plan Change 5.

MY FARMING OPERATION

6 In terms of our own operations, we grow cereal crops, small seed crops, and brassica crops on approximately 200 hectares. The balance is in pasture for stock operations, comprising a mix of lucerne and cocksfoot, and straight lucerne paddocks.

7 Within the farm, we have 2 separate irrigated areas, with one area of land comprising 50 hectares primarily supplied with water taken from a storage dam. We hold consents that allow us to harvest water for storage in a dam, and to take from the dam for irrigation. We also hold a consent for this area that authorises a further small take (5 litres per second).

8 Outside of that 50 hectares, 30 hectares of land is watered from a permit which allows water to be taken from Farm Stream, a tributary of the Hakataramea River. I am also a dry shareholder in the Haka Valley Irrigation Scheme ("**HVIS**").

9 My independent water permits do not require me to have a Farm Environment Plan, however, I have developed one voluntarily. The water quality conditions relating to the HVIS consent require comprehensive water quality monitoring, the fencing of waterways, riparian management, and the development or maintenance of shelter-belts. Our property is generally rolling country, with some steeper faces and is prone to wind-blown erosion, which is not uncommon in the Hakataramea. We have received an afforestation grant and we expect up to ten per cent of our farm to be planted in trees by September of this year.

10 We have also recently received funding from the Environment Canterbury Immediate Steps programme (via the Lower Waitaki South Coastal Canterbury Zone Committee to fence and plant a spring-fed stream which feeds into Farm Stream, to create a high quality habitat for indigenous species.

THE COMMUNITY PROCESS AND AGREED OUTCOMES

11 When we started this collaborative process, it was about ensuring the long term health of our river. It was also about creating a plan that was scientifically accurate and has practical outcomes. I believe the Plan, as drafted, has failed to deliver this.

12 Overall, I feel that the whole process has created a lot of division and angst within our community. It has set neighbour against neighbour because of the uncertainty and risk associated with how the whole plan process would play out. It will also limit the ability of some to undertake even small-scale development with a level of certainty.

13 The agreed community outcomes for the Hakataramea as I understood them differ greatly from the rules that were notified in Plan Change 5. This concerns me considerably as I feel it undermines the whole process and reinforces my view that Council staff followed their own agenda, and were unwilling to accept the community's views and evidence put forward to them.

14 As per the Minutes of the Lower-Waitaki South Coastal Canterbury Zone Committee meeting held on 15 April 2015, the community-identified outcomes were:

- maintain water quality and recreational swimming opportunities;
- maintain the significant recreational fishery;
- improve opportunities for mahinga kai across the catchment;

- native fish habitat is protected in the headwaters of the Hakataramea;
- enhanced wetlands and trees and protection of native vegetation;
- safe and secure drinking water is available;
- there are viable and diverse farming opportunities;
- sustain farms for future generations; family ownership;
- opportunities for further development are available to all farms;
- vibrant stable community.[1]

15 I was of the understanding that provided my farm had implemented and was operating under the industry-agreed Good Management Practice (GMP), then I would be able to continue to farm as I have been and that expectations around GMP would be defined within the plan. This would include a range of practices and outcomes, not just focused on modelled Nitrogen losses to groundwater. This is particularly important for the Hakataramea River as sediment and phosphorus from wind-blown soils are considered to be a large nutrient source, as well as stock access to some waterways.

16 Provided that this was the case, then a resource consent would **not** be required.

17 The entire way through the community process, we stressed to the Council that the emphasis should not be on OVERSEER outputs, but rather actual water quality in our rivers and streams. This is of huge importance to the Hakataramea Valley community as water quality in the Hakataramea River is beginning to show a declining trend. Coupled with potential further abstraction compounding already low river flows, declining water quality has the potential to impact on the farming community as a whole.

18 There is a sensitive area adjacent to the Hakataramea River and some tributaries (although the boundaries are not necessarily agreed to by everyone in the community, this has been defined as the Hakataramea River Zone). I understood that this would have a separate rule framework in recognition of the likelihood of intensive land use in this zone to negatively impact on water quality. While a separate rule framework for this zone has occurred, it does not look like the community anticipated – we were expecting a more stringent rule framework for this zone. I am concerned that it has not gone far enough to protect water quality in the Hakataramea River. There is, for example, large scale dairy support and wintering

[1] http://ecan.govt.nz/publications/Council/lwzc-agenda-20150617.pdf

happening in this zone, on very light soils very close to the water table. Whilst farmers in this zone would most likely require a resource consent and be expected to operate at better than GMP, the N losses from such land uses are still large, and I believe they will have a direct impact on the Hakataramea River. There are uses of land that I consider to be inappropriate, particularly in this zone, because of their potential impact to the river.

IMPLICATIONS OF PLAN CHANGE 5

19 I will have to get a land use consent to farm under Plan Change 5, but to what end, I am not entirely sure.

20 There is still a huge emphasis on OVERSEER in this plan, and I will undoubtedly be subject to an N loss 'narrative' as a condition of the consent that I will require. From a farmer's point of view, I see OVERSEER as a model that, because it changes so often, it is not scientifically robust for the purpose of setting rules and regulations, but also it can be manipulated. Rubbish in = rubbish out.

21 As I have stated earlier in my evidence, as a community, we considered that the emphasis should be on a range of GMPs – not a number generated by the Farm Portal, but actual on-farm good management practices. Defining practices and expectations are things that we can relate to, understand and do. Farmers are practical people – a number generated by a model we don't fully understand or trust is meaningless.

22 I consider it very important that we are good stewards of our land and water resources. For me personally, I have been working hard to understand how nutrients are transported, and what that means on my farm.

23 I have had Ravensdown carry out mineral N concentration sampling of my wheat cropping ground. The mineral N concentration is read at a depth of 0 – 30cm, 30 – 60cm and 60 – 90cm.

24 Testing shows that the N levels between the 0 - 30 cm and 30 - 60 demonstrates that the level of N reduces significantly.[2] Therefore, under normal circumstances, there is little to no N is leaving the root zone of my wheat crops (contrary to what OVERSEER would model for the crop).

25 I have attached a paper to my evidence that I would like the hearing panel to consider. It is called *Root Zone Losses are Just the Beginning,* prepared by Lincoln

[2] To date, we have not carried out testing at the 60 - 90cm depth due to practical difficulties associated with using probes at this depth, but such testing will likely be done in the future, due to our increasing awareness of our environmental footprint.

Agritech Ltd. In short, this emphasises the fact that the whole *source → transport/transformation → impact* process still lacks robust, defensible science in areas where there is not direct interaction between surface and groundwater, and that catchment limits being set that are potentially very constraining. It concerns me greatly that the scientific community acknowledge the fundamental gap in our knowledge about how nutrients are transported and transformed, yet we "box on" and set catchment limits anyway.

CONCLUSION

26 Plan Change 5 has not delivered the agreed community outcomes for the Hakataramea Catchment. For me, this means that I feel I have wasted considerable time and energy contributing to a collaborative process, for the community's wishes to be completely ignored.

27 I am a good farmer, and a good steward of my land. Yet, this plan ignores that fact.

28 While I may not be a scientist, I have been making reasonable attempts to understand the impact of my farming business on the environment and the science that is out there. I am stunned that we have come this far with the limit setting process without robust and defensible science to back it up, and that the end result of that may be limits that constrain us unnecessarily.

Robert Sutton

Date 22 July 2016

Appendix "A"

2nd Year Wheat

1. Incremental sampling
If soil sampled to 90cm depth, and divided into 30cm increments

Depth	Mineral N concn (mg N/kg)	Assumed Bulk Density (g/cm3)	Depth	Mineral N in profile
0-30	34.7	1.1	30	114.51
30-60	13.8	1.3	30	53.82
60-90	0	1.5	30	0
	enter mineral N (ammonium+nitrate) result above		*enter depth above*	**168.33**

3rd Year Wheat

1. Incremental sampling
If soil sampled to 90cm depth, and divided into 30cm increments

Depth	Mineral N concn (mg N/kg)	Assumed Bulk Density (g/cm3)	Depth	Mineral N in profile
0-30	16	1.1	30	52.8
30-60	9.3	1.3	30	36.27
60-90	0	1.5	30	0
	enter mineral N (ammonium+nitrate) result above		*enter depth above*	**89.07**

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Appendix "B"

ROOT ZONE LOSSES ARE JUST THE BEGINNING

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Abstract

Minimising root zone losses has rightly been the main focus in recent years of measures to reduce agricultural land use impacts on freshwater quality. However, root zone losses are just the beginning, as far as managing to water quality limits is concerned. To be able to fully explore all potentially available management options, the entire *'source → transport/transformation → impact'* chain needs to be understood.

Where, when, and to what extent the root zone losses impact on freshwater bodies depends on the transport and transformation processes occurring in the vadose zone – groundwater – surface water continuum. We will be elucidating these processes using a combination of New Zealand and European examples.

Understanding the '*where*' requires investigation of the relative importance of the various subsurface flow paths (e.g. artificial drainage, interflow, shallow and deeper groundwater). Modelling of the subsurface hydrological system also helps to define the groundwater catchments that contribute water (and the nitrate it carries) to a monitoring site. These groundwater catchments do not necessarily match the topographically defined surface water catchments.

Regarding the '*when*', it is essential to consider the lag times, both in the vadose zone and in the groundwater system. Depending on the relative importance of the various flow paths, not all nitrate lost from the root zone will reach a surface water body at the same time. The resulting distribution of transfer times further complicates establishing the link between an impact observed in a surface water body and the land use activity that has caused it.

As for the '*extent*' to which root zone nitrate losses impact on freshwater bodies, it is critical to account for attenuation processes occurring along the flow paths. The two key nitrate attenuation processes are mixing/dilution and denitrification (occurring below the root zone).

While groundwater denitrification has to date received relatively little attention in New Zealand, its potentially substantial role is recognised by many European drinking water supply companies and regulatory authorities. Accordingly, new policy initiatives in Europe have started taking account of the spatially variable nitrate reduction along the flow paths from the *source* to the *impact* zones.

Introduction

When considering diffuse pollution of our freshwater resources with nitrogen lost from agricultural production systems, there has traditionally been a strong focus on the root zone as the source of this pollution, while the *'source → transport/transformation → impact'* chain has received much less attention. This is in agreement with the observation that 'source control' is usually the most effective means of limiting freshwater pollution and reflects that land use and land management decisions by individual land owners/managers determine the extent of these losses. Accordingly, various means have been developed to determine/estimate nitrogen losses from the root zone of a paddock, farm block, or farm. Lysimeters can provide local information, but their use is limited by the high spatial variation inherent in pastoral systems (Lilburne et al., 2012). Look-up tables have been compiled in an attempt to provide long-term average nitrate nitrogen rates for each relevant land use under different soil types and rainfall zones in an entire region (Lilburne et al., 2010). Most importantly, continued development of the nutrient budgeting model OVERSEER has extended its applicability to most land use types at the national scale (http://www.overseer.org.nz/).

The start of the New Zealand Government's freshwater management reform agenda in 2009 has highlighted the need to better understand the '*source → transport/transformation → impact*' chain, as developing policy (e.g. the National Objectives Framework – NOF) is based on a 'reverse hydrology approach'. Rather than starting with the source and estimating the impact, this approach first sets objectives and defines limits that apply to the impact end of the chain (e.g. nutrient concentrations in rivers, wetlands, lakes and estuaries) and then aims to back-calculate the tolerable level of losses from the source, i.e. the root zones of all pieces of land discharging nutrients to the impact site (Fig. 1).

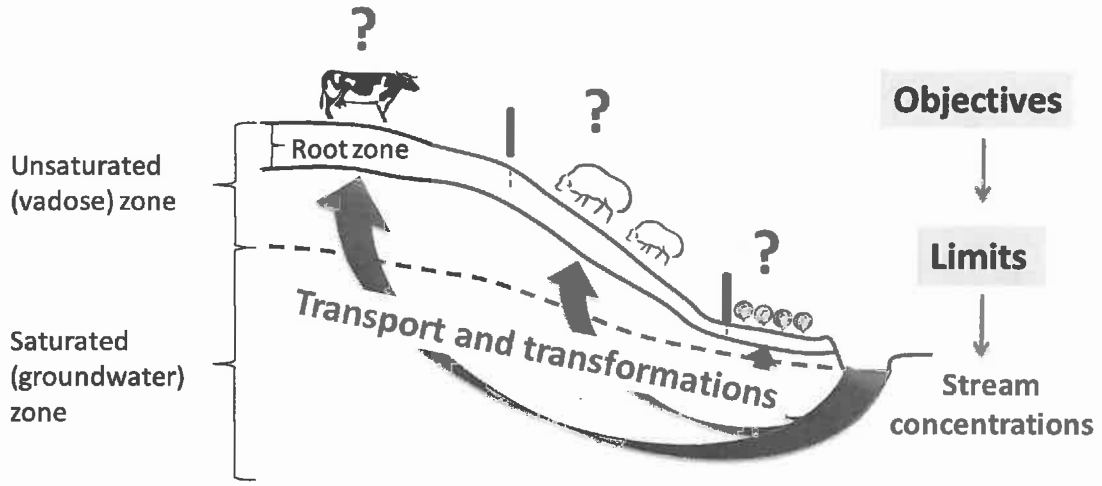

Fig. 1: 'Reverse hydrology approach' employed by recent freshwater management reforms.

This back-calculation can only be carried out in a defensible manner if the transfer processes (i.e. transport and transformations) occurring between the source and impact zones are sufficiently understood, as these determine which parcels of land impact on a surface water body, when, and to what degree.

Fig. 1 also shows that, from a system-control point of view, we potentially have two options to control what is discharged into our surface waters. Firstly, we can control the nutrient source, which is usually the most effective approach and the one we have focused on to date. However, if we manage to improve our understanding of the transfer processes, then we may additionally be able in the future to exert some transfer control.

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Transport processes

Research undertaken in the intensively studied Toenepi dairying catchment provides an instructive example on the importance of understanding the relative contribution of different flow paths and their associated lag times.

Long-term stream flow and stream nitrate nitrogen time series data (Wilcock et al., 2006) were used in an inverse modelling approach to parameterise the spatially aggregated ('lumped') catchment model StreamGEM (Woodward et al., 2013). This modelling suggests that near-surface flows (i.e. surface runoff, interflow) contribute only 5% of the annual stream flow, while fast (shallow) groundwater contributes 81%. Slow (deep) groundwater discharge is responsible for the remaining 14% (Fig. 2). Given that the fast groundwater reservoir dominates the stream flow in this catchment, it's crucial to understand its chemistry and transfer time.

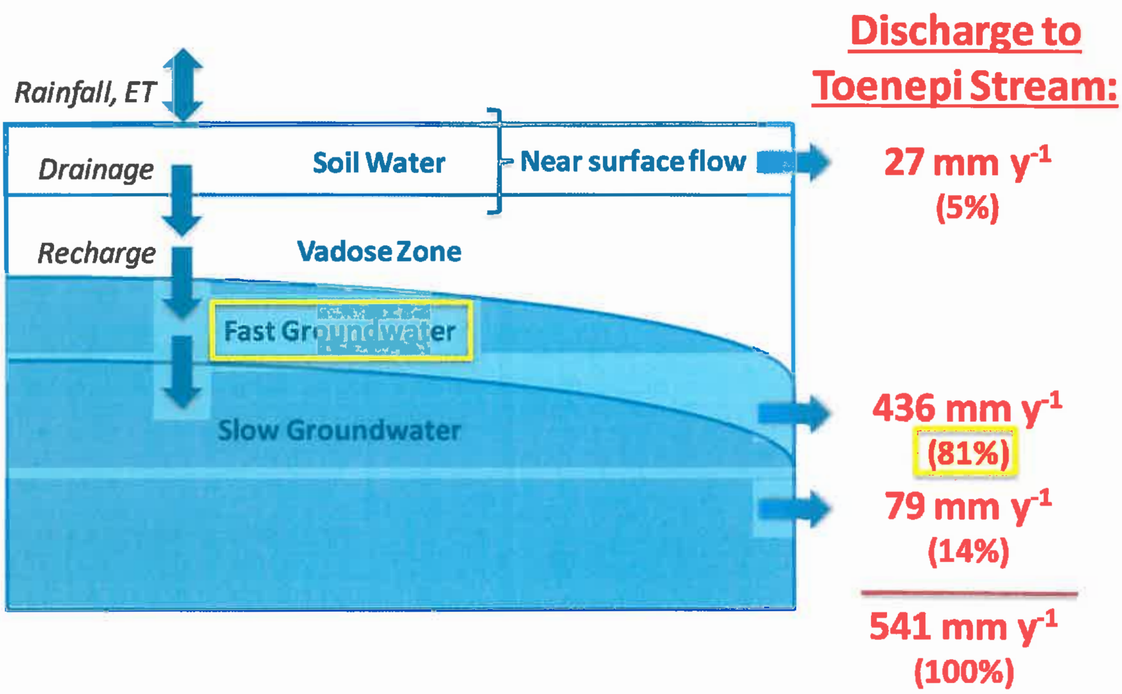

Fig. 2: Importance of different flow paths for stream flow generation in the Toenepi catchment (Woodward et al., 2013).

Fig. 3 shows schematically that the different flow paths contributing to stream flow differ in their typical transfer times (USGS, 1998). The converging flow lines near the stream highlight that stream water always comprises components of varying transfer times, it is never one uniform age. The term 'Mean Transfer Time' is therefore used to describe the average age of a water sample.

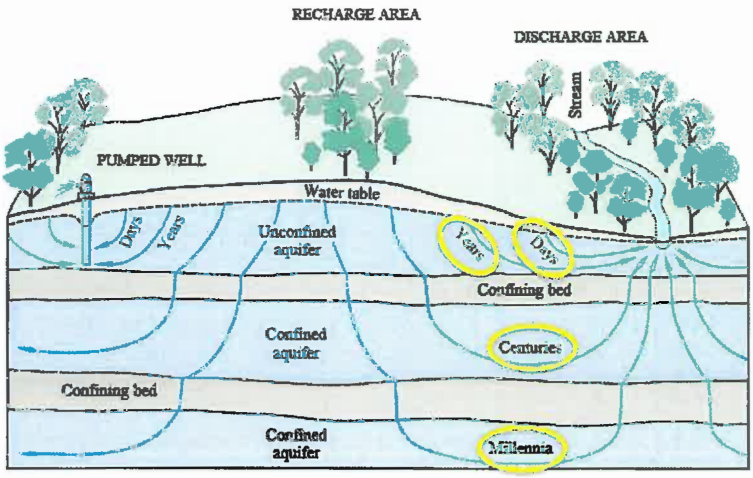

Fig. 3: Typical transfer times associated with subsurface flow paths (USGS, 1998).

Mean transfer times (MTTs) in Toenepi Stream under baseflow conditions, i.e. when the stream was not affected by recent rainfall, were found to show a very strong seasonality (Morgenstern et al., 2010). Winter baseflow, which is dominated by discharge from the fast groundwater reservoir, had MTTs of less than 5 years. In contrast, the much lower summer baseflow, had 30-40 years MTT, reflecting the gradual depletion of the fast groundwater reservoir. The small trickle that was still flowing under drought conditions, and which is sustained by the slow groundwater reservoir, had a MTT of over 100 years (Fig. 4). These seasonally varying MTTs explain some of the seasonal variation of nitrate concentrations, but as discussed in the following section, a differing extent of attenuation along the different flow paths additionally influences the nitrate dynamics observed in the stream.

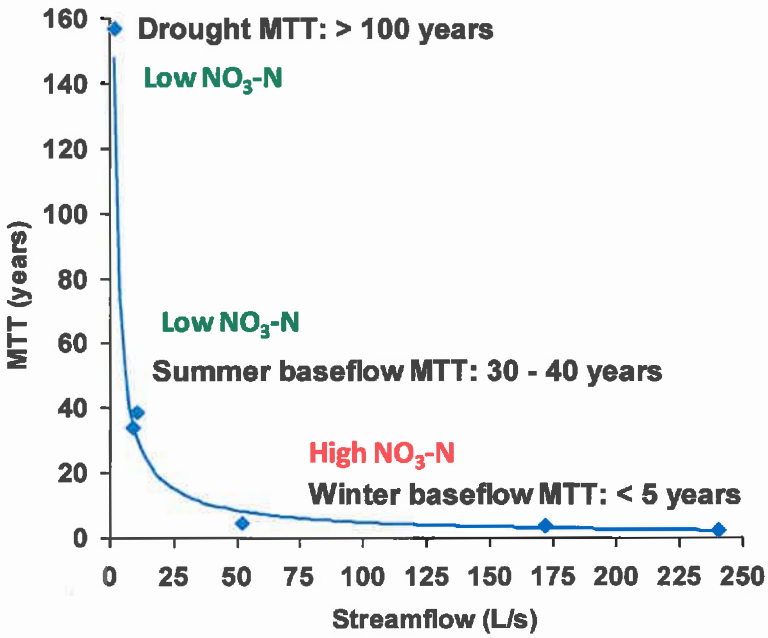

Fig. 4: Variation of mean transfer time (MTT) with stream flow rate under baseflow conditions (see Morgenstern et al., 2010).

Transformation processes
A range of different transformation processes can potentially affect nitrate concentrations along the subsurface flow paths. Denitrification is the most critical of these, as it is a natural attenuation process that under suitable conditions can remove substantial amounts of nitrate before it discharges into surface water bodies. Oxygen-depleted ('reduced') groundwater, electron donors (e.g. organic carbon, pyrite), and microbes with the metabolic capacity for denitrification are prerequisites for denitrification to occur (Stenger et al., 2013).

Based on our field work and associated modelling, Fig. 5 shows how denitrification affects the groundwater nitrate fluxes in the Toenepi catchment. The strongly reduced slow groundwater reservoir does not transfer any nitrate to the stream. However, given that the flow through this reservoir is small, it also attenuates only a relatively small fraction of the leached nitrate. In contrast, the fast groundwater reservoir, which has a variable redox status, is responsible for most of the nitrate discharge into the stream, but it also attenuates approx. 36% of the nitrate lost from the root zone. The overall effect is that approx. 45% of the nitrate lost from the root zone is attenuated (Woodward et al., 2013).

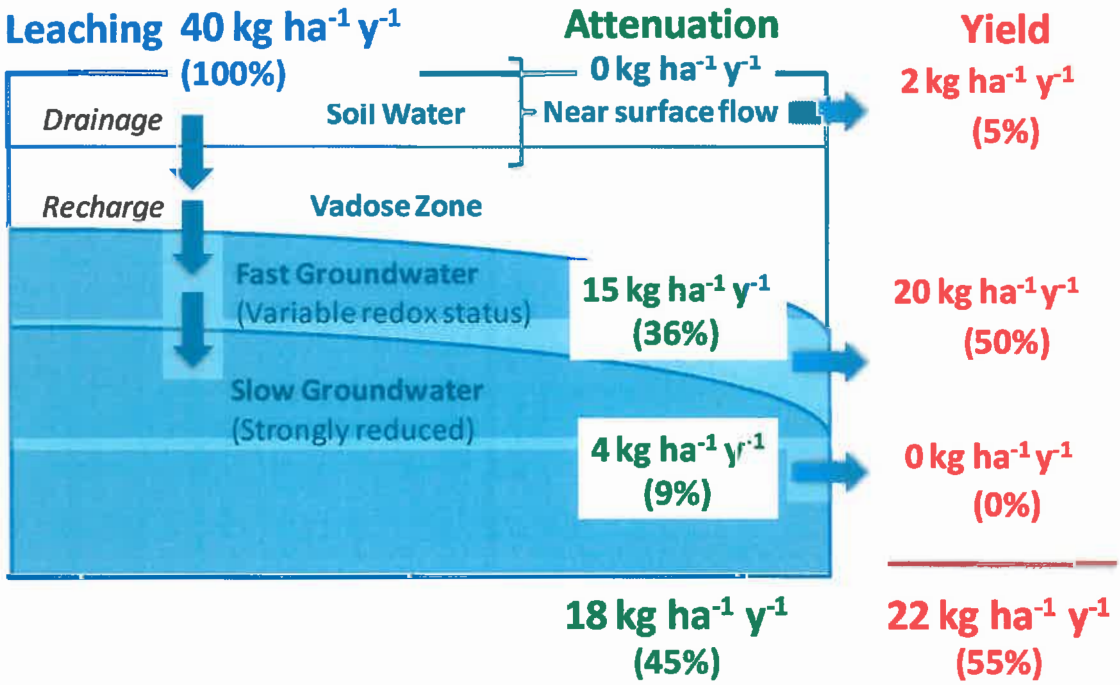

Fig. 5: Importance of different flow paths for nitrate attenuation and transfer into Toenepi Stream (Woodward et al., 2013).

To date, little information is available in New Zealand specifically on denitrification in groundwater systems (see Clague et al., 2013, for an overview). Overall attenuation rates, which lump together all potentially occurring attenuation processes at multiple locations (vadose zone, groundwater zone, riparian zone, hyporheic zone, in-stream) have been reported in a few studies (e.g. Elliot and Stroud, 2001; Alexander et al., 2002; Clothier et al., 2007). The reported overall attenuation rates are generally high, ranging from 39 to 76%. However, it is conceivable that the effect of groundwater lag times was not always sufficiently taken into account when calculating these rates.

European examples for the significance for denitrification in groundwater systems
In New Zealand, research into denitrification in groundwater systems is still in its infancy. However, there is a comprehensive body of literature on groundwater denitrification in many northern hemisphere countries. Within Europe, groundwater denitrification is particularly widespread in the north-west (e.g. Belgium, northern Germany, Denmark).

The northern German state of Lower Saxony, which has a size similar to Canterbury, complemented their routine groundwater monitoring programme in 2006 by adding 'Excess N_2' determinations. 'Excess N_2' is the fraction of the dissolved dinitrogen (N_2) contained in a groundwater sample that cannot be explained by atmospheric sources, but is due to denitrification occurring within the groundwater system. An overview of the results to date is shown in Fig. 6 (from Meyer & Elbracht, 2012). Analysis of more than 600 samples demonstrates that the overall average concentrations of nitrate (21 mg/L NO_3) and excess N_2 (19 mg/L expressed as NO_3) are very similar. This indicates that averaged across the entire state, nearly half of the initial nitrate in land surface recharge is denitrified in the groundwater system.

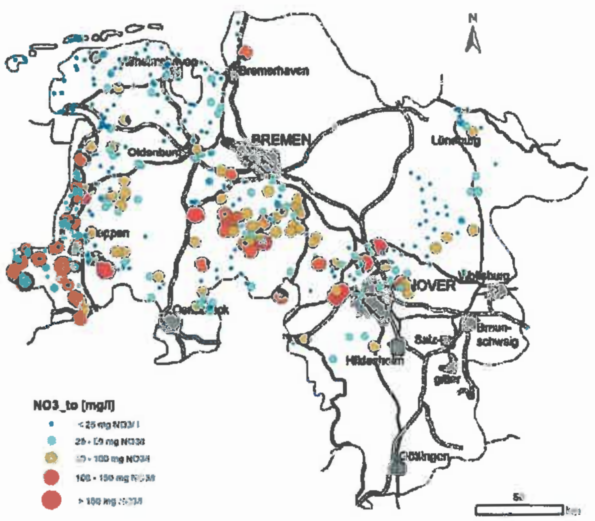

Fig. 6: Excess N_2 concentrations (expressed as mg/L NO_3) in groundwater samples from Lower Saxony, Germany (from Meyer & Elbracht, 2012).

In Denmark, which is slightly smaller than Canterbury, there is a strong focus on understanding the N-load reduction between the root zone and the coastal waters surrounding the country. Accordingly, 'N reduction maps' like the one shown in Fig. 7 have been produced (from Kronvang et al., 2009).

Regarding environmental policy, Denmark has recognised that the goal of diminished N-loads to the sea can be achieved by two mechanisms: firstly, by reducing N leaching, and secondly, by exploiting the spatially varying N reduction between the root zone and the sea. That is what we call the 'assimilative capacity'.

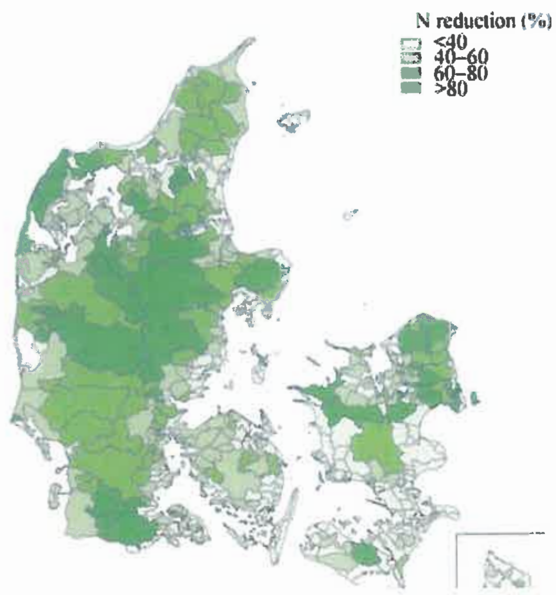

Fig. 7: N reduction map for Denmark (from Kronvang et al., 2009).

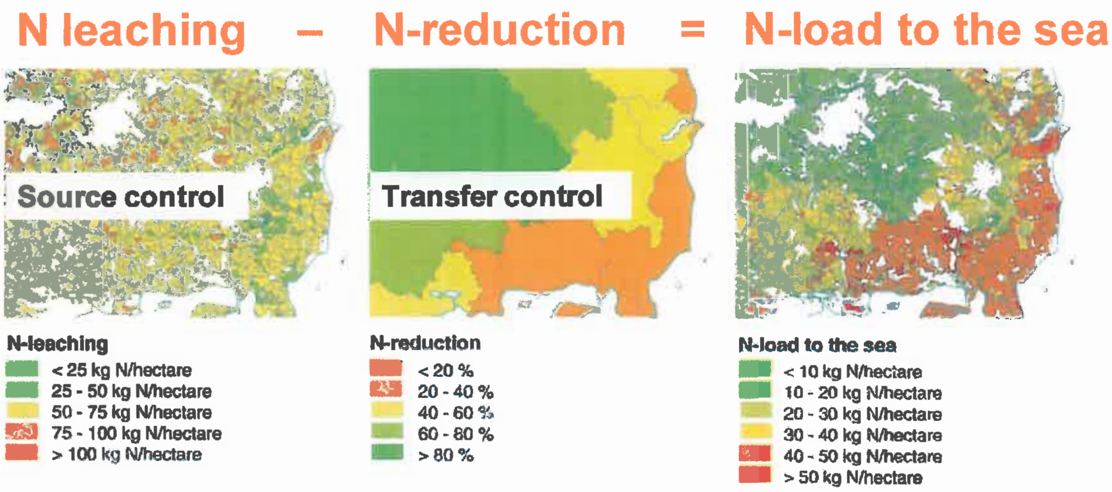

Fig. 8: 'Source → transport/transformation → impact' chain for the example of Denmark (modified from Blicher-Mathiesen et al., 2013).

Given that leaching losses were halved in Denmark between 1985 and 2003, achieving further reductions would be very costly for the country (Blicher-Mathiesen et al., 2013). Therefore, Denmark is currently working on new policy that aims to complement the 'source control' approach pursued to date with a 'transfer control' option. This option aims at making use of the spatially varying assimilative capacity along the transfer pathways to the sea. If nitrate losses from a given piece of land are presumed to be strongly attenuated before reaching the sea, then less stringent land use rules will be applied compared with those for pieces of land where little attenuation is to be expected during the transfer (Fig. 8). Rather than introducing new rules uniformly, this spatial differentiation is considered the most effective means to achieve further load reductions to the sea.

Conclusion

In New Zealand, there still remains substantial potential for further leaching loss reductions, i.e. source control. However, overseas experience and emerging NZ data suggests that explicitly taking account of attenuation processes occurring between the bottom of the root zone and the water body for which objectives are set could create some headroom in catchments constrained by limits. Intensifying research into the subsurface transport and transformation processes would ultimately enable us to add a transfer control option to our nutrient management tool kit.

Acknowledgments

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