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Memorandum

To:	Ben Ensor	**Of:**	Hurunui, Waiau and Jed Nutrient Working Group
From:	Peter Brown	**Date:**	10 March2015
Subject:	**Hurunui River nutrient modelling: impact of dryland intensification**		

1 Overview

I have modelled what the effect of dryland farming being made a "permitted activity" would have on the nitrogen load at SH1, and whether or not the reductions being proposed by irrigators would off-set these increases. I have modelled out to 2020. Changes beyond 2020 can be considered as part of the 2018 sub-regional process.

Results indicate that the headroom being offered by irrigators would offset the intensification of dryland farming systems. The proviso is that there is no large scale shift from sheep and beef to dairy support.

The reason that a seemingly small (5%) reduction by irrigators can off-set a larger percentage increase by dryland farmers, is because irrigators contribute most of the nitrogen load to the river. Therefore even a modest reduction from these irrigated areas would create significant headroom for dryland farmers, who contribute only 15-30% of the total instream nitrogen load in the river at SH1.

A 5% reduction by irrigators should be achievable if all irrigators can achieve 80% efficiency. This conclusion is supported by measured nutrient loads from the Amuri Basin, an area dominated by irrigation.

> The nitrogen headroom being offered by irrigators should offset the intensification of dryland farming systems, so there would be no net increase in nitrogen load in the Hurunui River at SH1

2 Modelling approach

The approach I used was to analysis the 800 (odd) water quality measurements Environment Canterbury took in the Hurunui River mainstem and tributaries between 2005 and 2013. From these measurements I was able to estimate how much nitrogen was coming from different parts of the catchment. I then split each catchment into four broad land use classes to determine how much nitrogen (on average) came from each of these classes. The land use classes were:

- Dryland (slope<15°) [Tractor country]
- Dryland hill-country (slope>15°) [Strongly rolling to steep]
- Irrigated
- Forest/non-agri. & scrub

Further details of the method are available from my NTP hearing evidence[1].

3 Assumptions

I modelled three scenarios: very high development, high development, and moderate development. These scenarios were developed by the small working group that met on 19 February. The moderate development scenario was considered by the group to be the most likely outcome. The 30% increase in dryland nitrogen load shown in the tables below was based on the work by Rebecca Hyde and James Hoban from December 2014. This 30% increase allows for existing systems to intensify, but assumes that the proportion of dryland land use remains broadly the same (i.e. predominately sheep and beef). I have not considered the impact of large scale shifts in land use from sheep and beef to dairy support, or large scale clearing of forests. I have also not considered any new irrigation as a result of HWP or NTP. My analysis was solely focused on whether the nitrogen headroom being offered by irrigators is sufficient to allow for dryland intensification.

Table 1: Very high development scenario

Land use class	2020 change in N loss relative to 2008
Dryland (slope<15°) [Tractor country]	70% of area increase by 30%
Dryland hill-country (slope>15°) [Strongly rolling to steep]	50% of area increase by 30%
Irrigated	All irrigators collectively decrease by 5%
Forest/non-agri. & scrub (excl. Balmoral Forest)	5% increase (e.g. some clearing of scrub/matagouri)
Balmoral Forest	No change modelled (i.e. assumed fully forested)

Table 2: High development scenario

Land use class	2020 change in N loss relative to 2008
Dryland (slope<15°) [Tractor country]	50% of area increase by 30%
Dryland hill-country (slope>15°) [Strongly rolling to steep]	50% of area increase by 30%
Irrigated	All irrigators collectively decrease by 5%
Forest/non-agri. & scrub (excl. Balmoral Forest)	2% increase
Balmoral Forest	No change modelled (i.e. assumed fully forested)

1 http://ecan.govt.nz/publications/Consent%20Notifications/ntfe-sub-ev-amuri-irrigation-brown.pdf

Table 3: Moderate development scenario (i.e. most likely outcome)

Land use class	2020 change in N loss relative to 2008
Dryland (slope<15°) [Tractor country]	25% of area increase by 30%
Dryland hill-country (slope>15°) [Strongly rolling to steep]	10% of area increase by 30%
Irrigated	All irrigators collectively decrease by 5%
Forest/non-agri. & scrub (excl. Balmoral Forest)	2% increase
Balmoral Forest	No change modelled (i.e. assumed fully forested)

4 Results

Detailed results are provided below. Results are approximate and preliminary. Loads cannot be exactly predicted because of the statistical variability, but can be bounded between a minimum and maximum value. Attenuation factors (the proportion of nitrogen that is removed between the root zone and the Hurunui mainstem) are my 'gut estimate', based on the data I have reviewed and my experience in other similar catchments elsewhere in New Zealand. Attenuation factors could be refined with further analysis.

Table 4: Baseline (measured load from Apr 2005-Jun 2013)

Land class		Load (t-N/y)		% of total		Load (kg-N/ha/y)		Area (km^2)	Attenu. factor	Root-zone load (kg-N/ha/y)	
No.	Description	Bound 1	Bound 2	Bound 1	Bound 2	Bound 1	Bound 2			Bound 1	Bound 2
1	Irrigated	498	610	65%	79%	26	32	190	1.9	50	61
2	Dryland (slope <15°)	109	78	14%	10%	4.7	2.2	290	3.0	14.1	6.5
3	Dryland hill-country (slope>15°)	116	51	15%	7%	1.9	0.8	623	4.0	7.4	3.3
4	Forest, non-agriculture, scrub (excl. Balmoral)	40	27	5%	3%	0.3	0.2	1329	4.0	1.2	0.8
5	NTP Balmoral	7	4	1%	1%	0.8	0.5	86	1.3	1.1	0.6
	Total for 3, 4 & 5	163	82	21%	11%			2038			
	Total	**770**	**770**	**100%**	**100%**						
	Total average	**770**									

Table 5: Very high development scenario

Land class		Load (t-N/y)		% of total		Load (kg-N/ha/y)		Area (km²)	Attenu. factor	Root-zone load (kg-N/ha/y)	
No.	Description	Bound 1	Bound 2	Bound 1	Bound 2	Bound 1	Bound 2			Bound 1	Bound 2
1	Irrigated	473	580	60%	76%	25	31	190	1.9	47	58
2	Dryland (slope <15°)	132	94	17%	12%	5.7	2.6	290	3.0	17.1	7.8
3	Dryland hill-country (slope>15°)	133	59	17%	8%	2.1	0.9	623	4.0	8.6	3.8
4	Forest, non-agriculture, scrub (excl. Balmoral)	40	27	5%	3%	0.3	0.2	1329	4.0	1.2	0.8
5	NTP Balmoral	7	4	1%	1%	0.8	0.5	86	1.3	1.1	0.6
	Total for 3, 4 & 5	180	89	23%	12%			2038			
	Total	**785**	**763**	**100%**	**100%**						

Total average	**774**

Table 6: High development scenario

Land class		Load (t-N/y)		% of total		Load (kg-N/ha/y)		Area (km²)	Attenu. factor	Root-zone load (kg-N/ha/y)	
No.	Description	Bound 1	Bound 2	Bound 1	Bound 2	Bound 1	Bound 2			Bound 1	Bound 2
1	Irrigated	473	580	61%	76%	25	31	190	1.9	47	58
2	Dryland (slope <15°)	125	90	16%	12%	5.4	2.5	290	3.0	16.2	7.4
3	Dryland hill-country (slope>15°)	133	59	17%	8%	2.1	0.9	623	4.0	8.6	3.8
4	Forest, non-agriculture, scrub (excl. Balmoral)	40	27	5%	4%	0.3	0.2	1329	4.0	1.2	0.8
5	NTP Balmoral	7	4	1%	1%	0.8	0.5	86	1.3	1.1	0.6
	Total for 3, 4 & 5	180	89	23%	12%			2038			
	Total	**779**	**758**	**100%**	**100%**						

Total average	**769**

Table 7: Moderate development scenario

Land class		Load (t-N/y)		% of total		Load (kg-N/ha/y)		Area (km^2)	Attenu. factor	Root-zone load (kg-N/ha/y)	
No.	Description	Bound 1	Bound 2	Bound 1	Bound 2	Bound 1	Bound 2			Bound 1	Bound 2
1	Irrigated	473	580	63%	78%	25	31	190	1.9	47	58
2	Dryland (slope <15°)	117	84	15%	11%	5.1	2.3	290	3.0	15.2	6.9
3	Dryland hill-country (slope>15°)	119	53	16%	7%	1.9	0.8	623	4.0	7.7	3.4
4	Forest, non-agriculture, scrub (excl. Balmoral)	40	27	5%	4%	0.3	0.2	1329	4.0	1.2	0.8
5	NTP Balmoral	7	4	1%	1%	0.8	0.5	86	1.3	1.1	0.6
	Total for 3, 4 & 5	166	83	22%	11%			2038			
	Total	**757**	**746**	**100%**	**100%**						
	Total average	**752**									