Water Quality in the Amuri Basin

Where are we at?

Kellogg Rural Leadership Programme

Course 53 2025

Adam Williamson

I wish to thank the Kellogg Programme Investing Partners for their continued support.

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Executive Summary

The Amuri Basin is a highly productive farming area in the Hurunui District in North Canterbury, New Zealand. The introduction of irrigation schemes and reliable irrigation water meant that the area has gone through a large amount of land use change and a significant increase in intensive farming in the area in the past 40 years

The increase in farming intensity has also led to an increase in nutrient concentrations in water bodies in the area over that time. This has been recognised by the farmers and measures have been put in place to mitigate some of these nutrients, mainly phosphorus and e-coli, but there is an increasing trend of nitrogen concentration in both surface water and ground water measurements.

The purpose of this report was to gain an understanding of farmer perspectives on water quality and what factors in their farming systems they were prepared to adopt to achieve better water quality outcomes, along with identifying what the barriers to implementation are. They were also asked to provide a perspective on how well their neighbours are doing regarding water quality.

The report finds that the farmers of the Amuri Basin are largely aware of their impact on water quality and understand what impact their farming system may be having. They have less water quality concerns towards the two receiving bodies, the Hurunui and Waiau Uwha Rivers, than they do about nitrogen concentrations in drains and tributaries supplying those rivers as well as increased measured nitrogen concentrations in groundwater wells. Barriers to change include, but are not limited to, financial considerations and economic prosperity, as well as regulatory uncertainty. The farmers also felt that generally other farmers were aware of the impacts their farming systems were having on water quality, but each farmer was at a different stage of that journey.

Some recommendations that could be explored as catchment wide options to help realise improvements on water quality are:

- **Stocking rate reduction** – Each farm to reduce their stocking rate either by setting stocking rate limit or a percentage reduction. Potential of success is high, but impact to farmers business is variable
- **Overseer N loss reduction** – Each farm to reduce N loss as modelled through Overseer, either by N Loss limit or percentage reduction. Provides more opportunity to utilise different input variables with the farm system to achieve result. There is a risk that modelling doesn't reflect reality of the farm systems N loss.
- **Wait and see what happens** – Allow time for existing mitigation strategies to take effect
- **Farm Consultants and Vets** – Add an environmental lens to compliment the production lens to their advisory services
- **Ongoing education and awareness** – Continue providing information and resources to the community around water quality and potential mitigation strategies
- **Trial and implement technological** advancements – Trial and adopt new technologies as they are developed.
- **Fund reverse osmosis filters on groundwater drinking wells** – Where there is a measured elevated nitrate concentration on groundwater drinking wells, reduced the human health risk by funding or providing reverse osmosis filters.
- **Outcome of the Amuri Basin Future Farming Fund Project** – Utilise the progress made with engagement of catchment groups and potential of a dollar value mechanism to incentivise farmers.

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A big thank you to AGMARDT for their generous sponsorship that allowed me to attend the programme. I am truly grateful.

To the farmers that allowed me to interview them. Your honesty, vulnerability and openness in discussing water quality and your farming systems was appreciated and invaluable

Thanks to the team at the Amuri Irrigation Company. Your assistance with providing me data and pointing me in the right direction for information has not been missed.

To Cohort 53, I have thoroughly enjoyed the time we have spent together. The ability to bounce thoughts and ideas has been awesome. It was described to me prior to starting first residential phase, that the comradery that gets created within the Cohort is second to none. I now agree. I only hope that I have managed to give to you a small percentage of what I have received from you.

To Siobhan and the girls, thank you for your time and patience through out the programme. It has been a goal for a long time now, but the time has never quite been right. Thank you for giving me the space to make it the right time.

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Cover photo Credit – Amuri Irrigation Company

1. Introduction

The Amuri Basin in the Hurunui District is a highly productive farming area of New Zealand. From dryland farming prior to the early 1980's, the area has undergone immense land use change with the arrival of irrigation schemes. The shift in land use has been largely to dairy or dairy support farming systems. With that change has come a shift in both profitability of land use as well as an increase in intensity of farming systems. The increased intensity and availability of water has meant a material impact on water quality has been measured. This has largely been a negative impact, but in recent years a positive impact has been measured on phosphorus and e-coli. The purpose of this report is to gain an understanding of

"What do Farmers in the Amuri Basin consider to be acceptable Water Quality and what changes are they willing to make to their farms based on these considerations?"

2. Objective

To understand the farmers perspective on local water quality and how they perceive it relative to their business and beliefs. Allow them to define if they consider it to be good or bad and what measures, if any, they are willing to take in addressing water quality

3. Methodology

The methodology for this report consisted of 13 semi structured interviews of farmers from across the Amuri Basin as well as reviewing literature relevant to water quality and change adoption. The farmers that were interviewed covered all aspects of the agricultural sector prevalent in the Amuri Basin, including dairy farmers, dairy support, sheep and beef and arable. All farms had varying degrees of irrigation within their farming systems

Interviews were recorded and transcribed through the use of AI (TurboScribe), then Microsoft Co-pilot was used to identify consistent or outlying themes across all the transcripts. Thematic analysis was then used to understand the key themes from the interviews. Microsoft Co-pilot was also used to ensure conciseness of statements.

Interviewees signed the Kellogg Rural Leaders consent form to ensure that all data was kept confidential and anonymous.

4. Limitations

A limitation of this report was the focus on nitrogen concentrations as the measure of water quality. While some consideration is given to phosphorus and e-coli, very little is given to the ecology of the water systems. This was due to accessible data highlighting that nitrogen has the largest impact on water quality and is a nutrient which farmer interviewees considered was in their control to mitigate or regulate.

The report is also limited in that it focuses on farms that are irrigated or have some irrigation infrastructure as part of their farming system. This means that a large portion of dryland farms on the periphery of the Amuri Basin, may not be fully represented, but still contribute to water quality in the Amuri Basin.

5. Literature review

5.1. Change Adoption

A key aspect of what changes that farmers may be willing to make to their farm system is understanding how open to implementing change they may be. In researching change adoption, I was led to the Rogers Theory of Diffusion of Innovation model and more specifically the Change Adoption Curve within that (Rogers, 1962). The change adoption curve is characterised by a standard bell curve, with five categories of adopters within that curve (Figure 1).

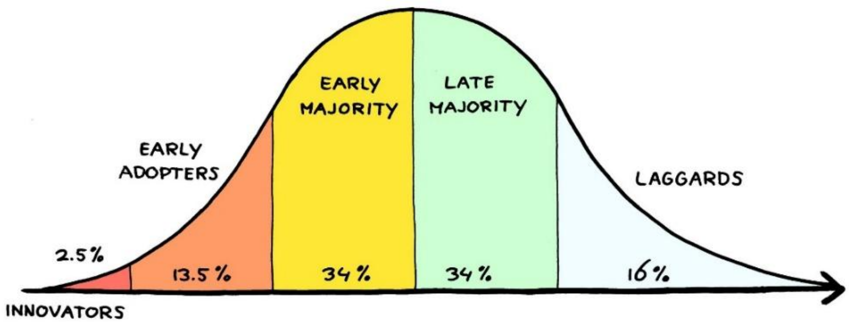

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Figure 1 – Rogers Change Adoption Curve

The five categories are:

1. Innovators – 2.5% - are pioneers who readily adopt innovations.
2. Early Adopters – 13.5% - are individuals who act as change leaders
3. Early Majority – 34% - are those who are welcoming to innovation, however, possess a degree of risk aversion and only adopt after witnessing successful outcomes.
4. Late Majority - 34% - are those who are highly risk averse and suspicious of innovation, only adopting after observing safe implementation by earlier adopters
5. Laggards – 16% - are those that are highly conservative or too socially isolated for communication to occur effectively
(Warty, et al.)

The Diffusion of Innovation Theory is essentially how people can be persuaded to move towards an innovation and as in the case of the adoption curve, how they can shift to the left across the curve towards the innovation.

In an article titled 'Rethinking the Change Adoption Curve' Cronkite (2017) challenges that by utilising the Dunning-Kruger Effect, which is a 'cognitive bias whereby individuals who lack knowledge or competence in each area feel more, not less, certain of their knowledge or competence. This means your late adopters and laggards are likely to resist the change because they are convinced that everything is already going great and that they know better than you do.' (Cronkite, 2017). It is suggested that the best way to combat this bias for the late adopters and laggards is to focus the attention and reward the innovators, early adopters and then the early majority for making the change. By rewarding the early adopters, they will become the ambassadors of the innovation and communicate down the adoption curve the benefits that they are receiving.

5.2. Time Lag of Nutrient Movement

In researching information for the project, I felt that I needed to get a good understanding of how quickly (time lag) nutrients may move through or over the soil into aquifers or water bodies (Figure 2) in the Amuri Basin. I have accessed two reports produced by Environment Canterbury, "How long will it take? A summary of information about nitrate time lags in Canterbury" (Scott , et al., 2023) and Managing Nitrate Leaching to Groundwater: An Emerging Issue for Canterbury (Ford & Taylor, 2006). While most of the information in both reports was concentrated on the Central Canterbury plains, there was some relevant data for the Amuri Basin.

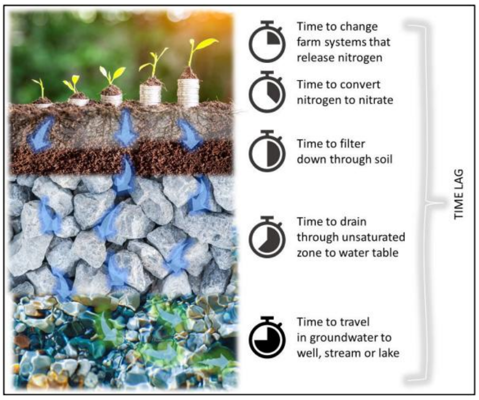

Figure 2 - Stages of Nitrogen in Time Lag (Scott , et al., 2023)

The findings through both these reports indicated that the depth of the groundwater has a major impact on the length of time lag of nutrient concentrations. The reports have shown that, depending on the resulting nitrate leaching, shallower wells have started to show changes in nitrate concentrations withing a few months or years. This is highlighted through a case study in "How long will it take? A summary of information about nitrate time lags in Canterbury" (Scott , et al., 2023) on a land use conversion from forestry to beef and dairy support in the Balmoral Forest on the Northen banks of the Hurunui River. Table 1 shows that since a change from forestry in 2016 to dryland beef, then irrigated beef and irrigated dairy support from 2017-2021, nitrogen concentrations increased from around 1.0mg/L to 6.7mg/l in their shallow (12m-17.4m) sampling sites. Measurements in the same period have shown no discernible difference in nitrogen concentrations in a deeper (85m) well at the same site

Table 1 - Change in N Concentrations at Balmoral Forest land use change (Scott , et al., 2023)

Total Nitrogen leaching loss (t/yr) *	2014 - 2015	2015 - 2016	2016 - 2017	2017 - 2018	2018 - 2019	2019 - 2020	2020 – 2021
Irrigated beef	0	0	0	39	39	39	38
Irrigated dairy support	0	0	0	0	0	0	1.5
Dryland beef	No data		27	2.0	2.0	2.0	2.0
Trees/cutover	No data		0.01	0.03	0.03	0.03	0.03
Apples	0	0	0	0	0	0.03	0.03
TOTAL	**No data**		**27**	**41**	**41**	**41**	**42**
Annual average nitrate N in shallow well (mg/L)	**0.8**	**1.1**	**1.3**	**1.0**	**3.2**	**5.5**	**6.7**
Annual average nitrate N in deeper well (mg/L)	**0.21**	**0.20**	**0.20**	**0.21**	**0.20**	**0.19**	**0.23**

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The reports determined that

- Time lag of nitrate is difficult to calculate with accuracy as there are multiple nitrogen input sources over large areas, with gradual changes and no single 'events' that can be measured as it arrives.
- The long-term effects from land use change may take a significant time to emerge as time is needed to allow shallow well nitrate concentrations to stabilise after an initial increase.
- Surface runoff and shallow ground water are more likely to contribute to rivers and streams. As these pathways are faster, it can be expected to see changes within those rivers and streams relatively quickly.

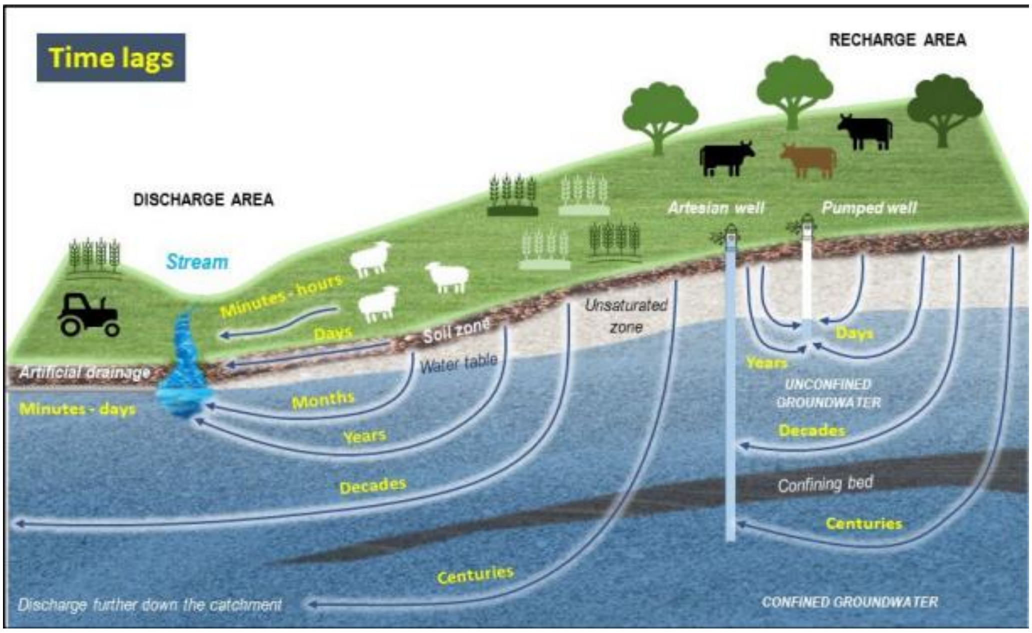

Figure 3 - Diagram of Time Lags on Water systems in Canterbury (Scott , et al., 2023)

A report titled, 'The implications of lag times between nitrate leaching losses and riverine loads for water quality policy' (McDowell, Simpson, Ausseil, Etheridge, & Law, 2021) show that the mean time lag for the nitrate leaching losses and riverine load for the Hurunui River measured at State Highway 1 is less than 5 years. From these reports, we can conclude that the time lag from any farming system or land use changes through surface water or shallow ground water to drains or rivers could be between 3 – 5 years. For the changes to be measurable, within that time frame, they would need to be significant enough across the Amuri Basin to have an impact. From the data I could source, it was a lot harder to gain an insight to the time lag of farming system changes on deep water sources. From the reports, the indication is that any impact on deep water sources could be decades to centuries to be measured. (Scott , et al., 2023)

5.3. Potential Nutrient Reductions.

In researching for this report, it was important to get an idea of what could potentially be achieved using mitigations for effective nutrient management to lead to improvements in water quality. In an article published in 2020 titled 'Research Findings Brief: Assessment of the effectiveness of on-farm mitigation actions' the researchers found that if farmers in New Zealand hadn't adopted better practices between 1995 and 2015, our rivers would have significantly more nitrogen (45% more) and phosphorus (98% more) contributed from dairy farmed land and 30% more sediment from sheep and beef farmed land. (McDowell, Monaghan, Manderson, Smith, & Pietnyakov, 2020). The report also found that if all known and developing mitigation actions were implemented across dairy and sheep and beef farmed land by 2035, the potential load of contaminants entering rivers would decrease by 34% (nitrogen), 36% (phosphorus) and 66% (sediment) compared to 2015. (McDowell, Monaghan, Manderson, Smith, & Pietnyakov, 2020)

From the interactive maps from the report, figure 4 shows us that the total nitrogen (TN) excess is modelled to be high or very high for the Amuri Basin. Figure 5 shows us that if all known nitrogen mitigation actions were utilised, the TN reduction potential modelled across the Amuri Basin, ranges from 15% to greater than 50%.

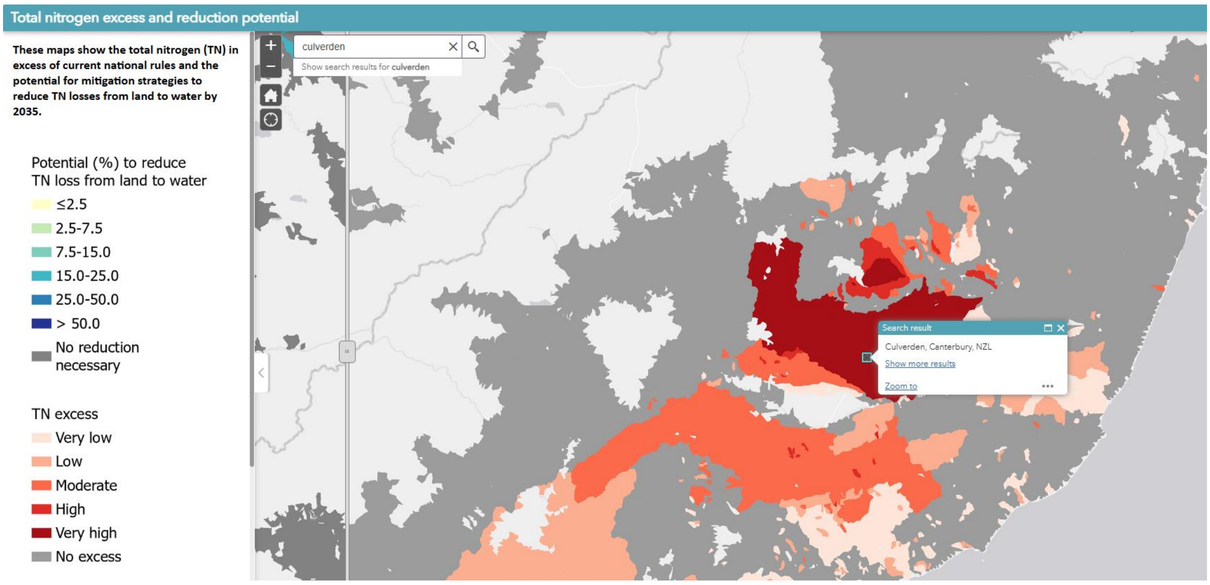

Figure 4 – Total Nitrogen Excess (Total Nitrogen and Reduction Potential)

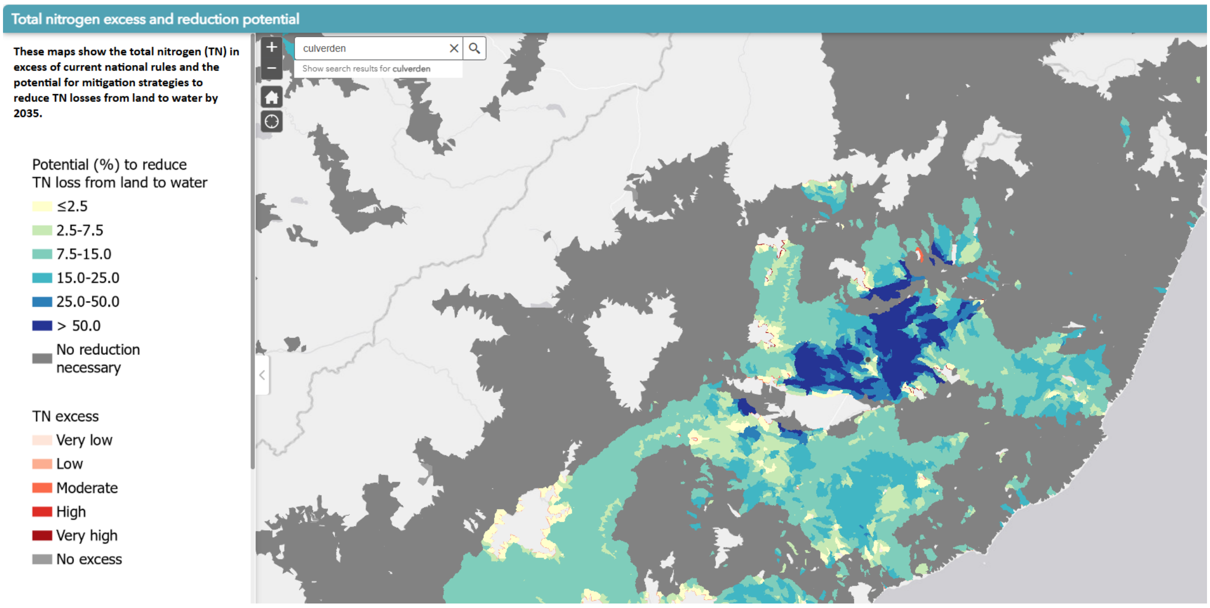

Figure 5 - Total Nitrogen Reduction Potential (Total Nitrogen and Reduction Potential)

5.4 Tragedy of the Commons

The Tragedy of the Commons is a concept that was published by Garrett Hardin in Science Magazine in 1968 ((Hardin, 1968). This theory explains that an individuals' tendency to make decisions is based on their personal needs, regardless of the negative impact it may have on others. In some cases, an individual's belief that others won't act in the best interest of the group can lead them to justify selfish behaviour. Potential overuse of a common-pool resource—a hybrid between a public and private good—can also influence individuals to act with their short-term interest in mind. Which results in the use of an unsustainable product and disregard of the harm it could cause to the environment or the general public (Harvard Business School, 2019).

This theory is relevant to the water quality in the Amuri basin, regarding both water as a resource in the farming system as well as how farmers have developed their farming systems and the associated inputs and nutrient management of the properties. Professor Elinor Ostrom challenged Hardin's theory regarding tragedy of the commons by providing evidence that the 'tragedy' was not an inevitable outcome. Ostrum sought, as per the title of an article published in Science in 2009 to provide 'A General Framework for Analysing Sustainability of Social-Ecological Systems' (Ostrom, 2009). Social Ecological Systems can be simplified as 'environmental systems with strong human interventions (Grant, 2012). The article culminated in ten variables that would likely influence the successful self-organisation of a social-ecological system to succeed. The ten variables were summarised in an article by Grant (2012)

1. The size of resource system – a moderate territorial size is most conducive to self-organisation.
2. The productivity of system – self-organisation is less likely to work if a resource is either over abundant or already exhausted.
3. The predictability of system dynamics – for example, some fishery systems approach mathematical chaos, making self-organisation infeasible.
4. Resource unit mobility – self-organisation becomes more difficult with mobile rather than stationary units, e.g., in a river versus a lake.
5. The number of users, – transaction costs can be higher with larger groups, but such groups can also mobilise more resources. The net effect depends on other variables and on the tasks undertaken.
6. Leadership – high skills and an established track record amongst leaders aids self-organization.
7. Norms and social capital – in terms of shared moral and ethical standards.
8. Knowledge of the socio-ecological system – more if better.
9. The importance of resource to users – where the resources is vital, self-organisation becomes easier.
10. Collective choice rules – which can lower transaction costs.

If we placed these ten variables within the context of the Amuri Basin and Nutrient Management then analyse how many could be easily applied, we may be able to assess how well a sustainable social-ecological system may work (Table 2).

Table 2 – Ostrums Ten Variables in Amuri Basin Context

Variable	Achievable Yes/No	Notes
Size of Resource System	Yes	The Amuri Basin is confined to the geographical area of approx. 60,000 ha
Productivity of a system	Yes	Water Resource is considered abundant but nutrient resource could currently be considered not exhausted but getting close
Predictability of System Dynamics	Yes	While nutrient movements and time lag are not a well understood variable, the basic concept of higher intensity without mitigations having a negative water quality effect is well understood
Resource unit mobility	No	Hard to achieve as relatively hard to determine what nutrients have come from what place of origin and route to get to the river or drain
Number of Users	Yes	The number of users should be high enough to strike a good balance between cost and resource availability
Leadership	Yes	There is a proven track record of both Environmental and Economic Leadership within the Amuri Basin
Norms and Social Capital	Yes	Moral and Ethical Standards are largely held in high regard across the Amuri Basin
Knowledge of the Socio-Ecological System	Maybe	The knowledge of the system across the basin is very mixed but could be improved with education and awareness over time.
Importance of the resource to users	Yes	The importance of water and associated nutrients are of high importance to the farmers of the Amuri Basin from both an economic and environmental perspective
Collective Choice rules	Yes	Most of the farmers in the Amuri Basin belong to either an Environmental Collective or Landcare group where rules to govern the collective farmers are established within the groups

By working through the variables, we can establish that eight out of ten of the variables are answered positively, concluding that a successful self-organising socio ecological system could be established within the Amuri Basin. Of the two variables that may not be easily applied, the Resource Unit Mobility, would be hardest to achieve given the lack of clear understanding of the impact, route and time lag of excess nutrients within the Amuri Basin. As discussed later in this report, the implementation of the Socio-Ecological system within the Amuri Basin, could be achieved and the Amuri Basin Sustainable Future Farming Fund Project, could well be the vehicle that establishes it.

6. History

The Amuri Basin in located in the Hurunui District in North Canterbury, New Zealand. The plains in the basin cover approximately 60,000 hectares from Waikari in the south to Waiau in the North and incorporates the land between the Lowry range of hills to the east and the Spencer range to the west. The major rivers of the basin are the Hurunui at the southern end and the Waiau Uwha to the north. Both rivers flow from the western ranges towards the east, cutting through the Lowry Ranges, then out to sea.

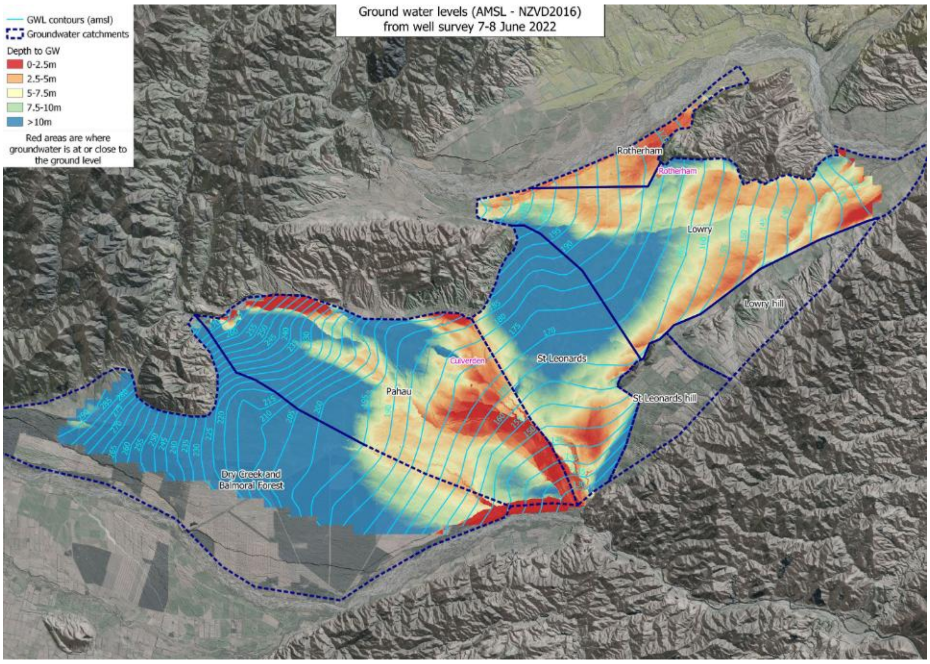

Figure 6 - Ground water levels in Amuri Basin (Amuri Irrigation Company)

Traditionally, the climate in the Amuri basin consists of hot dry nor-west summers and cold frosty winters. Since the early settlers to the Amuri Basin, the agricultural land largely consisted of sheep on the plains, with both sheep and cattle on the downs. Prior to irrigation being available, arable farming was usually part of the farming system in some way with few farms solely arable. In the late 1970's the government of the time invested in three irrigations schemes, Balmoral (intake off the Hurunui River), Waiau Plains and Waiareka (intakes off the Waiau Uwha River) to irrigate approximately 22,000 hectares (Amuri Irrigation Company, n.d.) via an open race system. The three schemes were all commissioned by 1985, and farmers started to develop their properties, predominately to border-dyke irrigation systems, as well as some farms being converted from traditional sheep and beef farms to dairy. In 1990 the three irrigation schemes were purchased from the government by the Amuri Irrigation Company Limited (AIC). The company was wholly owned by its farmer shareholders. The 1990's and 2000's saw many farms converted to dairy or dairy support. During the same period, irrigation systems started to change from border dyke to more water efficient spray irrigation systems. In 2016, the open race water delivery system was upgraded to a largely pressurised pipe network. As a large amount of water was being discharged back to the river, due to the last property (and properties on the way) requiring a minimum amount of flow on the race to be able to pump out of it, as well as a significant amount of was water was being attributed to being leaked through the existing canal network, the upgrade to pipe meant that an extra 6,000 hectares of land could be irrigated. Currently 24,000 hectares are supplied water via the pipe network and 4,000 hectares are supplied by the existing water races (Amuri Irrigation Company, n.d.). Today, 60% of the irrigated land is dairy farms, while the remaining 40% consists of dairy support, arable, sheep and beef farming systems. (Amuri Irrigation Company, n.d.)

The AIC holds the land use consent for its shareholders that fall within its command area and has responsibility to manage the land use and associated nutrients associated to that consent. They are responsible for the implementation and auditing of each farms Farm Environmental Plan (FEP) and in 2013, formed an Environmental Collective that allowed any independent irrigators (own land use consent and irrigation take consent) to fall under AIC's responsibility for FEP's and auditing purposes.

In the mid 2000's a group of farmers who bordered the Pahau River formed the Pahau River Enhancement group. The purpose of the group was to recognise that the nutrient concentrations had increased within the river since the development of irrigation to the area and set about ways that they could mitigate these impacts. Changes in irrigation infrastructure, from border dyke to spray, retention ponds to catch the border dyke irrigation and re-use the water through spray irrigation, improved bunding to prevent run off entering waterways, fencing off water ways, and improved management of existing border dyke systems were some of the mitigation methods employed. In 2008, a statistically significant reduction in phosphorus and e-coli was recorded by Environment Canterbury and the group was subsequently awarded the Canterbury Resource Management Community Award (Environment Canterbury, 2008). In 2017 The Pahau River was awarded the Supreme prize for Most Improved River at the annual Cawthron New Zealand River Awards. The top prize was based on the river showing the most declined levels of the bacteria E coli over the last 10 years, achieving reductions of 15.6% a year. (Amuri Irrigation Company, n.d.)

Amuri Irrigation Company (AIC) has partnered with the Ministry of Primary Industries (through the Sustainable Food and Fibres Fund), Environment Canterbury and DairyNZ to deliver a four-year project called the Amuri Basin Sustainable Farming Futures Fund (ABSFFF) that focuses on 'building on our environmental work to develop and implement a farmer-led strategy for sustainable farming, with a combined focus on environment, farm viability and community resilience.' (Amuri Irrigation Company, n.d.)

The project is split into three areas

1. The development and implementation of location-based catchment groups who work together to highlight environmental risks and develop action plans for their catchment
2. AIC will use its data to provide risk-based modelling for each catchment to show what on farm and catchment-based mitigations could achieve.
3. Develop and trial a dollar value mechanism to fairly encourage farmers to actively and collectively manage farms nutrient and water use. This is encouraged to incentivise farmers to lead change before a regulatory framework is needed.

The ABSFFF started in 2022 and is intended to run to 2026. The intention is the foundations that are created through the catchment groups and the project are to be continued by AIC and its farmer shareholders.

7. Water quality metrics

In establishing where water quality in the Amuri Basin currently sat, I reached out to AIC to provide the data and graphs that show some potential trends of measurements over time. From the data received I chose to focus on the data for the Hurunui River, and some groundwater measurements from across the Amuri Basin. I decided to do this as, there wasn't enough data available for the Waiau Uwha river and the relative nutrient concentrations were far less significant than what was showing for the Hurunui River. These are the measures presented to the farmer interviewees for reference (Figure 7).

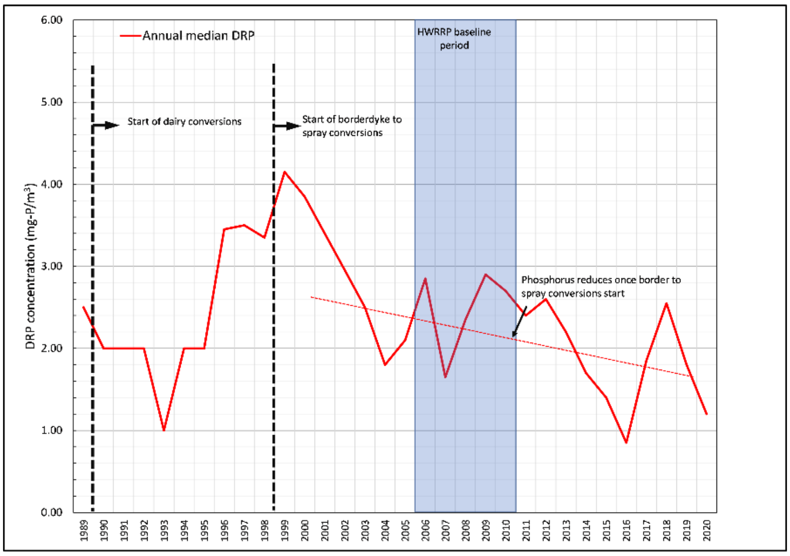

Figure 7 - Dissolved Reactive Phosphorus Annual Median Measurement 1989 – 2020 – Hurunui River (Amuri Irrigation Company)

Figure 7 shows the trend for dissolved reactive phosphorus (DRP) concentration in the Hurunui River, this is also overlaid with a time scale of irrigation development in the Amuri Basin. As can be seen the concentration levels rise as border dyke irrigation is developed and land use intensified in the mid 1990's and started to reduce in the early 2000's. This was because border dyke irrigation started to be converted to spray irrigation as well as farmers starting to adopt mitigation strategies as increased awareness of the environmental impacts that may be starting to occur because of land use intensification

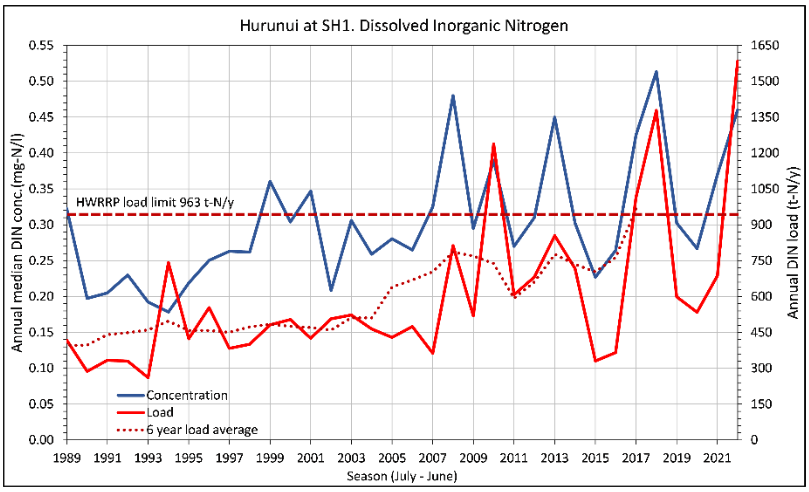

Figure 8 - Dissolved Inorganic Nitrogen Concentration and Load 1989-2021 Hurunui River (Amuri Irrigation Company)

Figure 8 shows both the calculated dissolved inorganic nitrogen (DIN) concentration and load on the Hurunui River from 1989 to 2021. It follows an inverse trend to the DRP graph (Figure 7) in terms of both DIN concentration and load with both starting to rise in the mid 2000's as spray irrigation conversions start to take place as well as development of the open race irrigation schemes to a largely piped network. Along with an increase in farming intensity, this can also be attributed to a reduction in by wash water from border dyke and losing water through the scheme races meaning there is less dilution of nitrates entering the river. DIN load is crudely calculated as DIN concentration x River Flow.

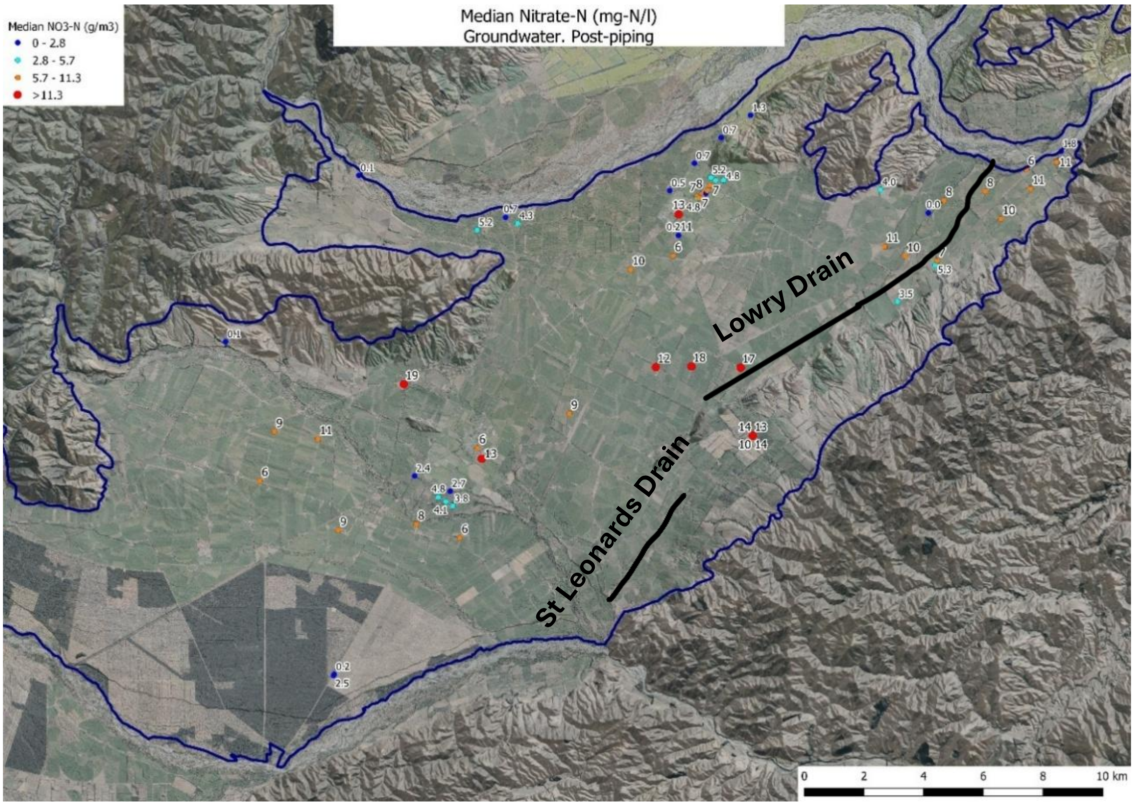

Figure 9 - Groundwater Nitrate concentrations in wells across the Amuri Basin - Post 2017 (Amuri Irrigation Company)

Figure 9 shows the Amuri Basin and groundwater measurements of nitrogen concentration (mg – N/l). The Hurunui River to the south and the Waiau Uwha River to the North. Nitrogen concentrations are consistently higher towards the middle and east of the basin and is consistent with heightened nitrogen concentration in the Lowry Drain and St Leonard Drain, respectively running north and south at the base of the eastern hills (Lowry Range) into the Waiau Uwha and Hurunui Rivers. The maximum acceptable value (MAV) for nitrate for drinking water in New Zealand is 11.3 mg/l. The MAV for e-coli is 1in 100ml of sample. (Water Services (Drinking Water Standards for New Zealand) Regulations, 2022). Figure 9 highlights in red or orange the groundwater wells in the Amuri Basin that are testing close to or above the MAV for nitrate.

8. Findings and Results

Interviews were conducted with 13 farmers from within the Amuri basin. The farmers were categorised into Dairy, Dairy Support, Sheep/Beef or Arable farming systems (Table 3). Five of the farmers had multiple properties that fell into more than one farming system/sector.

Nine of the farmers were dairy farmers. Six of the farmers were solely dairy support or had a dairy support property. Four farmers were sheep and beef, or beef were a significant part of their system. One had arable as a significant part of their system. Farm size ranged from 45 hectares up to 2,500 hectares. The interviewees were chosen, as across them, the size and type of farming systems were a fair representation of farmers of the Amuri Basin. All farmers had irrigation as part of their system in some way.

Table 3 – Interview Farming Sectors

Interviewee	Farming Sector
1	Dairy Support
2	Dairy
3	Dairy/Dairy Support/Beef
4	Dairy Support/Arable
5	Dairy
6	Dairy/Dairy Support/Beef
7	Dairy
8	Sheep/Beef
9	Sheep/Beef/Dairy Support
10	Dairy
11	Dairy/Dairy Support
12	Dairy/Dairy Support
13	Dairy

The interviews consisted semi structured in conversations that had eight guiding questions and allowed for conversation to develop from those questions based on where the interviewee would take it. The questions were as follows:

1. **Tell me about your current farm and farming system**
2. **Tell me what you know about water quality in the Amuri Basin**
3. **What do you believe are the biggest drivers/impact factors on water quality?**
4. **Would you consider water quality to be great, acceptable or poor in the Amuri Basin?**
5. **How do you feel your farming system fits into your previous consideration? Is it positive, negative, or neutral?**
6. **Based on your previous statements are there any changes you could make in your farming system or infrastructure that could influence water quality?**
7. **What do you believe are the limitations to making those changes?**
8. **What is your perception of the impact your neighbours (catchment), and farmers in the wider basin are having on the Water Quality?**

Questions one, two and three of my interviews were intended to establish the farmers situation, and their knowledge of water quality and factors that may impact water quality in the Amuri basin. Questions Four to Seven were intended for the interviewee to delve into some self-reflection of their farming system and where they felt they sat on a spectrum of their perception of water quality, their farms impact and what mitigation options they have or could consider to their farming system. Question Eight was intended for the interviewee to give some thought as to how they felt the wider catchment was performing regarding water quality.

I intentionally kept the subject of my questions away from the very technical side of water quality as I was interested in establishing the farmers individual perceptions of their impacts of their farms and others on water quality in the Amuri Basin. As highlighted earlier in my report, the farmers were provided with some basic monitoring data on water quality across the Amuri Basin. This consisted of nitrate load and concentration, and dissolved reactive phosphorus in the Hurunui River, as well as ground water sampling data across various sites across the Amuri Basin.

8.1. Water Quality Perceptions

When answering Questions Two and Three, all interviewees had good understanding of water quality in the Amuri Basin and the history development and the different factors that can impact on water quality as well as a general understanding of the water hydrology of the area.

The response of Question Four (**Would you consider water quality to great, acceptable or poor in the Amuri Basin?)** interviewees were evenly split when considering water quality to be acceptable or poor. There were no interviewees who considered water quality to be great. Amongst all interviewees, when discussing their responses, they were broken down further into river health, tributary/drain health and ground water, the responses changed and were of a very similar nature with, while getting close to limits, on the whole river health was acceptable, but drain health and ground water (in places) was poor. Both were largely around the nitrogen concentrations that were being measured and the trends. Aquatic life in drains was discussed but interviewees felt they didn't have enough data or knowledge to comment appropriately. Many interviewees who felt water quality was poor were dairy or dairy support farmers. Some were sheep/beef farmers.

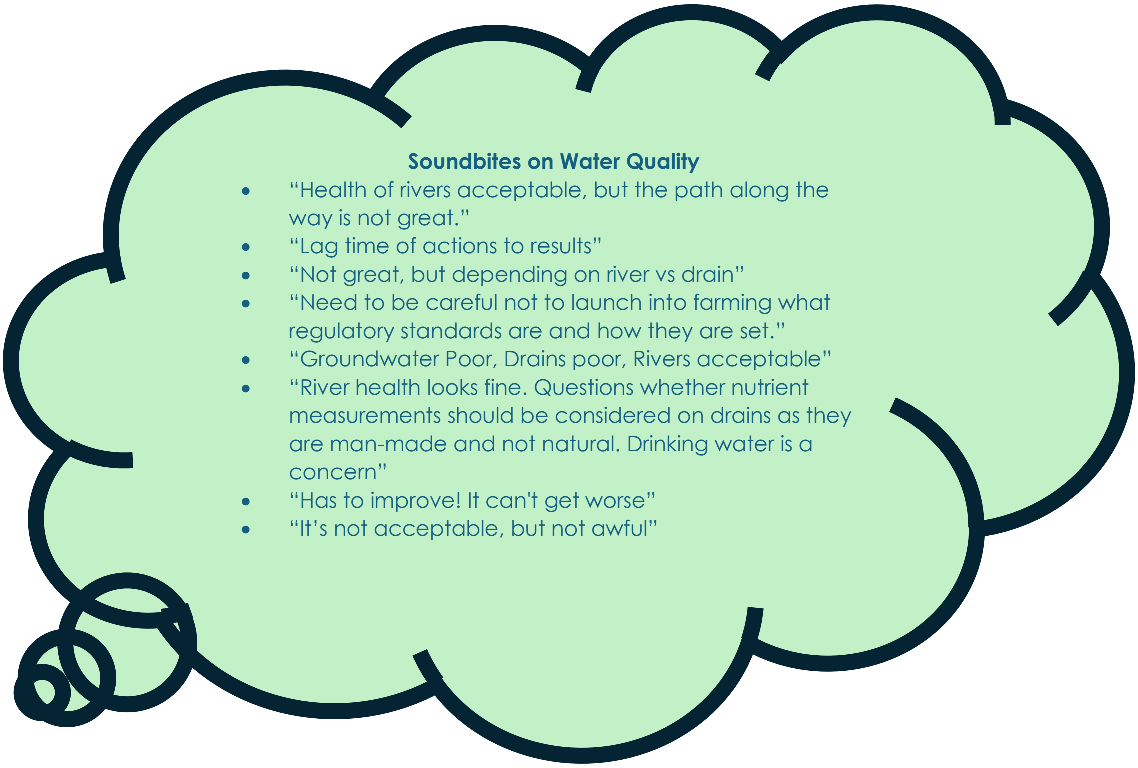

Figure 10 – Sound bites from Interviews on Water Quality

8.2 Farming System Impacts

In response to Question Five (**How do you feel your farming system fits into your previous consideration? Is it positive, negative, or neutral?**), Many of the interviewees felt their farming system had a positive impact on water quality. The majority of the interviewees felt their farming system had a neutral impact, while some felt their farming system had a negative impact. Of the farmers who considered the impact to be positive all had answered that they considered water quality to be poor in the previous question. This indicated that their perception that water quality was poor was a key driver to their farming system and changes they may have made in the past was driving them towards positive environmental outcomes. All interviewees responded that their farming system was having a negative impact had also responded that they felt water quality was poor overall.

8.3 Changes to farming systems

In response to Question Six (**Based on your previous statements are there any changes you could make in your farming system or infrastructure that could influence water quality?**) every interviewee had some ideas or a plan on what they could do within their farming system to reduce their impact on water quality. Some had already made some small and large changes.

One of the consistent themes was around reducing or adapting the amount of Intensive Winter Grazing (IWG) they were undertaking within their system. This ranged from reducing total cow numbers wintered on their property to changing the type of crops they were feeding to have a reduced environmental impact (Fodder beet vs kale) to transferring IWG to outside of the basin to reducing IWG cow numbers and grazing more Rising One and Two-year-old calves year-round. In many cases there would need to be a substitution of animal type or income stream to mitigate any financial impact. Interviewees with multiple dairy farms had looked at where they were calving their cows, relative to the risk with soil type/profile on their properties.

Nearly all the interviewees made comment around impact of increasing their irrigation efficiency for their properties. They noted that the Amuri Irrigation Company (AIC) had spent significant time in the past two irrigation promoting awareness and measurement of each individual property's irrigation efficiency, with the aim of getting all their shareholders up to 90% efficiency. Irrigation efficiency is a measurement of actual water applied vs actual crop water demand. A low irrigation efficiency percentage was an indication that water was being over applied to soil (or severely under applied) and would likely result in nitrogen loss to below the root zone impacting ground water. All shareholders have a meter on their irrigation off takes and AIC has invested in six weather stations across the basin that measures Enviro-transpiration (ET) at each site, so that could be used as a measure of crop water demand. Using this data every shareholder has been provided with their Irrigation efficiency data for the past five season. All the interviewees commented that the increased awareness and education of irrigation efficiency by AIC, meant they felt as though there had been a cultural shift across a large part of the shareholders of AIC, that they were making better decisions about turning irrigation systems on or off in the most efficient fashion.

Almost all the farmers had undertaken some sort of strategic planting of native or exotic plants/trees at some point on their property/s. Many had a planting plan they were slowly working through with riparian planting of any waterways given the highest priority historically and in future planting. Other strategic planting consisted of shelter and beautification. Some positive nitrogen reduction results of established drains have been recorded in some farms across the Amuri Basin. An example of this is on the property known as Pukatea, just west of the Culverden township. The property has several drains running through it, one of which is Innes drain. The owner of the property started a riparian planting journey approximately 20 years ago and is still ongoing to the present day. He has planted 1.2km of a drain that feeds into Innes drain and has recently started measuring the nitrogen concentration levels at the start of the drain and when it enters Innes Drain. The nitrogen concentration reduction measurements are seeing a 99% reduction in Nitrate over the course of travel through the 1.2km drain. The owner also notes at that since a change in his irrigation schedule regime and a higher level of irrigation efficiency over the past five years, he has noticed that the amount of water in the drain, as well as they health has significantly increased.

Figure 11 – Pukatea Drain > Innes Drain

Table 4 – Pukatea Drain Nitrogen Concentration Measurements

Date	Drain Start Nitrate-N + Nitrite-N (gm³)	Pond Inflow Nitrate-N + Nitrite-N (gm³)	Drain End Nitrate-N + Nitrite-N (gm³)	Nitrate reduction (%)
May-25	4.2	3.8	2.6	38.1%
Apr-25	3.1	0.81	0.012	99.6%
Mar-25	3.7	Not Sampled	0.001*	>99%
Feb-25	4.5	Not Sampled	0.001*	>99%

* Samples were below detectable limits

Tile drains (or nova Flo) were also given a lot of consideration across many of the properties. Many kilometres of tile drains had been installed across many properties across the basin in the past, as the properties were developed and wetter areas drained, to enable more area to be productively farmed. It has been established that tile drains can provide increased nutrient concentrations as the nutrients are collected through the soil then provided a 'free run' through the tile to a drain or creek. If there are many tile drains heading to one drain or creek with no opportunity for nitrogen attenuation or other nutrient mitigation, then the resulting nutrient concentrations in the receiving drains are increased. A good example of where this is happening in the Amuri Basin is on the St Leonards and Lowry Drains. The mean annual DIN mg/1 for the St Leonards Drain has increased from 3.1 to 6.9, which is a 122% increase, while the Lowry Drain has increased from 2.9 to 7.4 which is a 155% increase. Both are man-made drains that were used to receive tile drain run off from naturally wet areas and channel the runoff water back towards the Hurunui and Waiau Uwha Rivers respectively. Both drains are also recording some of the highest Nitrogen concentration measurements with the Amuri Basin. Research has shown that in some cases the opening or removal of the tile draining piping and allowing the excess water to meet more soil/plants on its pathway, mitigates the effect of the nutrient run off. Some of the farmers expressed that it is not practicable to open every existing tile drain, so they have strategically made sure the drain's exit point it directed toward well planted creeks, drains or wetlands so the nutrient attenuation can take place there, while keeping the area productive. These increases in nitrogen concentrations also can be attributed to when the piped scheme was commissioned, and the end of scheme discharges stopped happening, and then a change of dilution of nitrogen reaching the tile drains.

Another theme that came through from some of the interviewees, was how, over time, they felt that advances in technology will have a part to play in mitigating the environmental impact of their properties. Nitrification Inhibitors like Dicyandiamide (DCD) and Urease Inhibitors were used as an example of technology that had and has been used to help mitigate environmental impacts. Nitrification inhibitors are chemical compounds that reduce nitrous oxide emissions by suppressing the action of microbes in the soil, known as nitrifiers, which convert nitrogen into nitrate (New Zealand Agricultural GHG Research Centre, n.d.) DCD was available in New Zealand until 2011 when residues were found in milk and was subsequently made unavailable. NZAGRC in recent years has identified a potential novel inhibitor in both field and laboratory trials that has demonstrated similar efficacy to DCD, but without the same risks of detection in milk products for human consumption. The advantage of this inhibitory product is that it is already widely used for other purposes, is approved for use in both humans and animals and has internationally agreed residue limits in food. (New Zealand Agricultural GHG Research Centre, n.d.) Urease inhibitors restrict the conversion of urea and urine to ammonium (volatilisation), and hence to nitrate, in soils (Edmeades, 2004). When used at the appropriate time, when rain or irrigation is not likely within 24 hours then fertiliser coated with a urease inhibitor is recommended. This can result in reduced application rates with a high utilisation of the nutrient applied when compared to standard urea fertiliser. Gene technology was also discussed with where New Zealand's stance on gene editing, and gene modification may evolve to. There was some optimism that several mitigations would be developed to help with nutrient management, all with small effects that add up over time. Examples of these were grass cultivars or forage crops with a low nitrate footprint, cows that can be bred for a low nutrient footprint. We have also seen research into the use of plantain as part of the pasture mix which can result in reductions of nitrogen leaching. "Including plantain at 20-30% of a grazed ryegrass/clover mixed pasture has resulted in average annual nitrogen leaching reductions of 26% at Massey University over four years, and 23% at Lincoln over two years. Pasture and milk production has been similar from pastures with and without plantain," (Dairy NZ, 2024)

From the sheep and beef farmers perspectives- during their interviews, a theme that emerged was how conscious they were of phosphate run off in the hill country portions of their properties and how phosphate can easily enter their waterways and have a downstream effect. Consideration had been given to how they were grazing hill country and what infrastructure they either had invested in or were looking to invest in. This was largely around the establishment of stock water systems and associated trough placement. Working in conjunction with fencing off the waterways and riparian planting, the stock water system meant that stock can be kept out of streams and ensuring the placement of troughs are in appropriate places, camping of stock and pugging can be avoided that would encourage phosphate run off from bare soil.

8.4 Limitations to Changes

Question Seven asked the question (**What are the limitations of making those changes to your farming system?**) Most of the interviewees listed financial or economic impacts as barrier to change within their farming systems to reduce their environmental impact. While at the time of writing, financial returns in the agricultural sectors in the Amuri Basin were in a positive space, but it was only a few years previously when high inflation, high interest rate and low produce prices was putting significant pressure on local farming margins. The lack of profitable alternative land use options has meant that the farmers feel that to remain profitable in the medium to long term they are reluctant to make wholesale changes to their farming system. Most feel that their current farming system is required to maintain long term profitability for their businesses. The perspectives of two of the dairy farmers were different from the rest regarding financial limitations being the driver for farming system changes. One farmer questioned that over time profitability and margins have stayed relatively neutral. The other dairy farmer felt that profitability was not the driver for how they conducted their farming business and had made changes to their farming system over the past 20 years to better suit the land they were on and the environment they were farming in, at the sacrifice of shorter-term profitability.

Regulatory uncertainty was another theme amongst the farmers as to what changes they felt comfortable making at the current time. In recent years there has been pendulum swings of change in the regulatory environment regarding fresh water and intensive winter grazing through the National Environmental Standards for Freshwater 2020 and subsequent amendments. The standards and amendments have been largely implemented by the 'government of the day'. The interviewees expressed concerns about implementing their plans to reduce stocking rates or intensity. They feared that if they made these changes and regulations later required further mandatory reductions based on stock intensity at a specific time, their previous efforts would not be recognized. Overall, while they believed they could largely adapt to a regulated system, they emphasized the need for long-term consistency and clarity in regulations. This would allow them to plan and adjust their farming systems without the fear of future regulations becoming oppressive or undermining their previous decisions.

Taking into consideration any unforeseen circumstances that may arise was a concern for some of the interviewees. This was at farm level as well as at a catchment level. An example that was highlighted was when the development of irrigation systems from border dyke to more efficient spray irrigation systems as well as the redevelopment of the irrigation schemes (mid 2000's) from an open race network to a largely pipe network (2016). In both cases the intention was to reduce the amount of water that was being used inefficiently (or lost) through water run off or through the open races. As in Figure 8, these time frames largely represent the times when there were significant increases in nutrient concentrations. The reduction in dilution from the 'excess' waster has increased the nitrate concentrations, but conversely the reduction in water run-off from border dyke irrigation has resulted in a reduction in Phosphorus concentrations (Figure 7). My understanding is that these results regarding the Nitrate concentrations, were not foreseen. Another example is the 190kg per hectare of synthetic nitrogen limit applied in a year on pastoral land as part of the National Environmental Standard for Freshwater (NES-F) and was implemented in July 2021 (Ministry for the Environment, 2023). The purpose of the policy was to prevent the excess nitrogen entering into waterways and has largely been successful in the reduction of synthetic fertiliser use but has also been seen as pseudo policy to implement a limit or reduction in stocking rate, which would also have a flow on effect with a reduction on nutrients entering waterways. What possibly wasn't foreseen was that with a reduction in synthetic fertiliser usage, some farmers substituted this with purchasing extra supplementary feed to maintain the same stocking rate. In the context of the interviews in this study, the point was made that sometimes decisions are made with the intention of making an improvement overall, but unless all the unforeseen actions that arise from that decision are well thought out, then the result may not be as good or achiever what it was intended to.

Time was another consistent theme throughout the interviews. This ranged from comments like 'people are expecting results to be seen immediately' as well as 'it took us 50 years to get to this point, and it may well take us 50 years to unwind'. As discussed in the literature review, it is accepted that the time lag for the Amuri Basin in shallow groundwater can be 3 – 5 years, while the time lag for deeper ground water systems is less determined. While time lag is a factor in these comments from the farmers, I feel they are more around adaption of farming systems and other less intensive land uses.

Farm Consultants and Veterinarians (FCV) were pointed out during the interviewees as being a trusted part of a lot of farming enterprises and farming systems. It was generally implied that most of both the Farm Consultants and Vets were production focussed, which meant that Environmental consultancy was left in a silo by itself and didn't always marry up to the advice or sentiment that was being given by the Farm Consultants and Vets. An example that was given where one dairy farmer was advised that they should increase the stock numbers and supplementary feed fed per cow, solely based on increasing the per hectare and potential per cow production of the property. No consideration was given to the effect what the higher stocking rate would have on the nutrient loss and associated water quality of the property. This was especially highlighted as the property had drains that fed directly into one of the main drains that already had high nitrate concentrations. Along side this, many farmers have increased their production efficiency, with the same rate of stocking intensity and therefore water quality impact. FCV may be able to play a part increasing per animal production efficiency even further, to result in fewer stock numbers, and a lower stocking intensity and a similar per hectare production result.

The development of the Waiau Plains, Waiareka and Balmoral irrigation schemes in the late 1970's and early 1980's led to a change in land use from predominantly sheep and beef farms to either dairy or dairy support as these had shown to be the most profitable land use using the reliable irrigation water. Other land uses, like horticulture, have been investigated and in some cases trialled, but the shorter growing season, hot Norwest wind days in summer and severe frosts in winter have proven it to be barriers to establishing other land uses. As reported in the Rural News, an example of this is a 2.5-hectare trial stone fruit, olive and nut orchard that Ngai Tahu Farming planted on its Balmoral property in 2016. While initial establishment looked promising, the data has suggested that Amuri Basin's relatively short number of growing temperature days is at the lower end of what is required and would likely result in fruit that was smaller than what it would grow to in other regions (Rural News Group, 2019). At the time of writing this report there is no indication how successful the trial is, but there doesn't look to be any expansion of the trial site.

Several of the interviewees made comment that water quality is also one part of the picture regarding environmental concerns in their farming systems. Milk and meat processors putting pressure on reducing greenhouse gas emissions (GHG) also have the farmers considering what changes to their farm systems may need to be changed to have a positive environmental impact. In some cases, processors are providing support and financial incentives to help farmers to make those changes. (Fonterra, 2025)

8.5 Neighbours impact

My final question to the interviewees was **What is your perception of the impact your neighbours (catchment), and farmers in the wider basin are having on the Water Quality?**

Sound bites from Farmers

- **"Largely good"**
- **"Contributing in varying degrees, either knowingly or unknowingly"**
- **"Definitely more people willing than others to improve their practices, and invest time and effort into doing so"**
- **"Most are doing nothing. 10% are working really hard"**
- **"Some are adding to it, some are working on it. I think all farmers know that the basins got a problem, but I'd say more than half of them are still one step removed from knowing that its directly accountable to their farm"**
- **"Most are pretty good. Everyone at different stage in their own journey"**
- **"Negative effect. High stocking rates, High supplement use, high payout, drives production with drives intensification"**
- **"Spectrum of knowledge and everyone's at different places. Huge opportunity for neighbours to improve. Invigoration around achieving succession goals. Environmental problem being left to the next generation"**
- **"Everyone is aware of the story and prepared to change or try to change. Aware of consent renewal etc. and regulation could change productivity/profitability or business could drop."**
- **"Doesn't see much environmental abuse. Will always be people outside of the general thrust of things. The farmers in the area have lifted their game because they have had to. "**
- **"Generally doing a pretty good job. Operating to Social Licence etc."**
- **"I believe the farmers of the Amuri Basin are 'actually bloody progressive'. Some of the most progressive you will find in NZ. Because most are first generation farmers as opposed to generational."**

Figure 12 – Sound bites from Farmers – Perception of Neighbours and Catchment

From sound bites provided in Figure 12, you will see that many of the answers from the interviewees were of the view that their neighbours around them and across the catchment felt that there was awareness of the impact their properties were having on water quality, and everyone was at a different stage of their journey. There were some responses that indicated that they felt that only a small percentage of farmers in the area were making a big contribution, or that they felt their direct neighbours had quite a bit of room for improvement.

The distribution of the group of farmers and their view on how their neighbours and catchment is progressing loosely follows the adoption curve in Figure 1. There are the innovators and early adopters (16%) who have made early changes to their system. The early majority (34%) have analysed their system, understand what their contribution is and have started to use some mitigations. The late majority (34%) are likely to be in the process of analysing their farm system, are open to change, but want to see what regulation might be placed upon them or see more evidence of effectiveness of mitigation before they make a change. The laggards (16%) are unlikely to change unless they are forced to change. This may be through regulation or more blunt instruments like farming limits on inputs or stocking rates. The potential of a 'dollar value mechanism' through the ABSFFF project, depending on how it is framed, could be an option to try and shift the laggards from their current position.

There was also a general consensus from the interviewees that the catchment groups that have been formed through the ABSFFF project has been beneficial in helping their neighbours to identify areas of their properties for farming systems where there could be room for improvement. There is a perception peer pressure aspect of the catchment groups has helped to push neighbours and fellow farmers positively across the adoption curve.

9. Conclusions

On the whole, farmers of the Amuri Basin consider water quality in Hurunui and Waiau Uwha rivers to be acceptable but are concerned about nitrate levels in drains and groundwater. There is acknowledgment that their farming systems will be contributing to increases in nutrient concentrations in water quality in some ways and to varying degrees. Most farmers have an idea of how they could change their farming system to result in a better outcome regarding water quality, but the biggest limitation to making that change is financial and the desire for economic prosperity, as well as regulatory uncertainty is a common theme. Farmers also largely perceive their neighbouring farmers to be aware of the impact they may be having on water quality in the Amuri Basin but recognise that they are all at different stages of that journey regarding what mitigating actions they can or are able to make in order to improve water quality on their farms. The pathway for better water quality in the Amuri Basin, also needs to be weighted and measured against potential changes to farming systems that farmers may need to consider due to other environmental factors, like greenhouse gas emissions. A focus on production efficiency has meant that farms have been able to produce more from static stocking rates. But likewise, this has meant that the intensity of the properties and area has also remained relatively static, although it may open up opportunities for reducing intensity and keeping similar production levels.

10. Recommendations

These recommendations are made after considering the feedback from the farmer interviewees as options that may be applicable at catchment level scale to influence improvements in water quality. They are not reliant on each other and mitigating options are not confined to this list.

10.1 Stocking rate reduction

One option that is probably considered to be at the extreme end of options to help mitigate water quality issues is an enforced reduction of stocking rate on properties that are intensively stocked. Depending on how significant the reduction could be, there would almost certainly be an impact on water quality across the Amuri Basin over time due to lower intensity. The problem with enforcing a stocking rate reduction is, depending on how it was done, this could potentially be viewed as not equal. A stocking rate limit would impact each farm differently on what their current stock rate is, with higher stocked properties being asked to make a bigger reduction than lower stocked farms. In comparison, applying a mandatory percentage reduction of stocking rate would still reward the farming systems that operated at a higher intensity and allow them to operate at a higher stocking rate than those who had a lower stocking rate, who would also need be making a similar reduction.

10.2 Overseer N loss reduction

Another option is to utilise Overseer, an input driven modelling tool, which 'OverseerFM empowers on-farm decision-makers to make efficient use of nutrients, enhance environmental performance, and make informed choices that drive sustainable practices' (Overseer, n.d.), as a tool to either ask farmer to meet a certain 'criteria' around their N Loss number. Once again this could be by setting a limit, or a % reduction of their N loss number. While not as blunt of a tool as a stocking rate reduction or limit, it allows farmers more flexibility to adjust their farming system outside of just stocking rate to meet environmental targets. The complexities of this system arise in that because the modelling is very input driven, the variance that can change the outcome from changing each input can be quite significant. There would need to be certainty that the standards that the data that was being inputted to was consistent. It would also require auditing to ensure that the data being inputted was consistent with what was happening on farm. There is also a risk that the modelling through Overseer doesn't reflect reality of the outcome.

10.3 Wait and see what happens

Another option is to just wait and see what happen, allowing for both lag time of previous actions to take effect as well as farmers at different places in the adoption curve starting to adopt mitigating practices or actions both on farm and edge of field (wetlands etc). This is a large element of risk with this approach, as the result could be very positive, or likewise negative, if mitigation options already undertaken don't result in improvements in water quality.

10.4 Farm Consultants and Vets

Feedback from the interviewees was consistent that a lot of the Farm Consultants and Vets (FCV)that were involved in their businesses were largely production focused, so there is potentially a place for a more whole of property focus from the FCV to add a stronger environmental stewardship to their consultancy. Should they first ask the question, 'what are the environmental targets and outcomes you would like to see?' and then work to develop their client's production systems around that. There is also potential to utilise knowledge of production efficiency to decrease stocking intensity while maintaining total production, of which the decrease in stocking intensity would likely result in better water quality outcomes.

10.5 Ongoing Education and awareness

Education and awareness is paramount to creating a path forward to improve water quality. Keeping it front of mind in farmers and providing them with awareness of what their risks are, tools to mitigate those risks and celebrating what has worked on other properties helps to give them confidence to decide a potential mitigation option. If we follow the adoptions curve, we need to celebrate and highlight the success (or failure, as something they try may not work as expected) of the innovators and early adopters, to influence the early majority and then the late majority, and possibly even the laggards.

10.6 Trial and implement technological advancements as they arise.

Technology that helps mitigate water quality issues is and will continue to be developed. Science will also evolve on our understanding of how the groundwater hydrology as well nutrients move across the catchment. Farmers and regulators should welcome this with open arms and be open to trialling and implementing these advances as they arise.

10.7 Fund Reverse Osmosis filters on groundwater wells that supply drinking water

Most of the interviewees considered the high levels of groundwater concentrations and the risk to drinking water and the concern to human health as being of very high concern to them. One option, and I am aware that this has possibly already been promoted within the Amuri Basin, is to fund or provide Reverse Osmosis (RO) water filters to be installed in households where their drinking water source has been measured as high in nitrates. This would only need to be installed on faucets that drinking water and food is washed with, as the likes of showering and bathing in high nitrate concentration water >10mg/l is considered safe (Oregon health Authority, 2022)

10.8 Outcome of the Amuri Basin Future Farming Project

The outcome of the ABSFFF project may provide a pathway forward for improvements in water quality. The catchment group approach has already proven to be very positive regarding stakeholder engagement and mitigation adoption, and the potential of a 'dollar value mechanism' to incentivise farmers, could be an innovative approach to improving water quality.

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