

Appendix 1

Table A1.1. Interview protocol question for farmers

Interview protocol questions
How long have you or your family been farming in the watershed?
Could you tell me a bit about your farm system?
Can you run me through what a week on your farm looks like?
In the last 5-10 years, have you made any changes to your farm system or the management of your farm business? What was the driver for these changes?
What are the costs of these changes? Benefits?
Are you planning to make any changes to your farm system in the next 2 years?
Can you tell me a little about your experience with the water quality policy process?
Has the capping of nutrients changed the face of the watershed?
How fair do you think the policy is/was?
Would you have done anything different to manage water quality in the lake?

Table A1.2. Full codebook with descriptions and representative quotes

Nodes	Description	Example Quote
drivers		
Actor		
A_economics	funding, debt, efficiency, other sources of income, dependence on farm	<i>"I think, ultimately, its profitability. The most decisions we've made are on profitability. And so, the smaller, environmental changes – well, there's benefits as well. So, applying nutrients on lower rates more often, if we don't waste the nutrients, it makes more sense. So, most of those changes, we hope, eventually, help profitability as well."</i>
A_ethic	stewardship or land ethic, love of learning, aesthetic, price of being a "good farmer"	<i>"And we did a lot of those things because we were under a lot of pressure. But that's not the whole story. We are an environmental organization. So, it's sort of part of our mission to be good. So, it wasn't like we didn't want to do them. It's what we're supposed to do."</i>

A_flexibility	convenience, steady supply, lifestyle, flexibility in running the farm system	<i>"Yeah it was about giving us more flexibility in our system, and to help try and drought proof, yeah to - for the lake issue was, it was about being capped, effectively capped. That is a way of still being able to improve and maximize. But it also gave us another block of land that is separate if we ever wanted to sell something or anything like that."</i>
A_leadership or entrepreneur	Actor themselves represented leadership and entrepreneurial spirit to drive change, or actor received advice or followed path of leader or entrepreneur. For personal, the actor should mention something about trying something new, being on the cutting edge, taking a risk, taking leadership or being an entrepreneur. For receiving advice, the actor should mention a figure or figures that influenced their change.	<i>"Two and a half years ago we made the decision that we were sick of dealing with dairy farmers, and that we were really really keen to support [a new business initiative led by local farmers]. So we went and saw them to see what they needed and how it would work."</i>
A_lifestyle	this includes ease of management	<i>"So really I make the decision based on what I want to do, what I think is going to be more profitable, what suits the way I farm as well and my lifestyle."</i>
A_past experience	past experience with policy/state/regional government	<i>"So the decision had been made by then that they were going to benchmark and that we knew. So I knew how the farming system was going to work [because of experience with the policy process and previously owning land in the catchment]. I probably knew it better than anybody, I'd say. So that's why I was more comfortable in getting back in."</i>

A_social attributes	family life, succession	<p><i>"Well, I had a son and daughter both milking cows for someone else and then would come home and crutch lambs. So, I was left in the muck and getting no time off because there's only one main unit. And so, we thought if we could buy the dairy unit, we'd employ more staff and hopefully be able to get on the roster and get some time off."</i></p> <p><i>"No incentive and stuff, but the other thing with the lake is it's the taonga for the Maori. So it's their treasure. They were very keen to protect it anyway, and they'd made decisions around the lake to protect it way before Environment Waikato started."</i></p>
A_technology	availability of specific technology	<i>"We've modeled land use change [to make a farm diversification plan]."</i>
Governance		
G_gov assistance	technical or financial assistance from a government agency	<i>"The guy I've been working with through NRCS, he keeps me pretty informed. I'm pretty good friends with him, so he keeps me quite informed on everything and we go over stuff. I had a couple spots that I had to change things but other than that we've been pretty – we pretty much knew what was going on."</i>
G_ngos or other	Interactions with non-governmental entities, these include organic, extension, watershed programs, land trusts, housing and conservation board, industry group requirements or best practices, and research organizations/universities	<i>"As far as the rules for organic are so strict that these new laws on the water quality and watershed, we've already been having to follow since we went organic. The stream setbacks and all that are already in there for organic."</i>
G_other gov policies	Central, regional or local government policies that impact nutrient management, such as conservation policies	<i>"Well, we were up for resource consent, so it was – as far as the effluent upgrade, it helped us get a longer resource consent, and it kept us compliant."</i>

G_farmer group	participation in a group representing farmer interests	<i>"I probably got a little bit involved in [the farmer group] as to see how [the policy] was going to work more for my own selfish reasons because most of the farms around here are managed by farm managers, and I thought well if it's going to turn to shit I'd really want to be the first one to get out but if I could see some opportunities I wanted to stay"</i>
G_water quality policy	cap, state, regional policy	<i>"And the interesting thing was that when they brought the new rules into the catchment, the big businesses that owned those farms, sold the farms in the catchment straight away." "Some fields flood. Some of my land, I'm on the early spreading ban. Do with the new [water quality policy]. I got to hit them in the midsummer, so we're changing the way we got to do things, a little bit. We'll see in a few years. Hopefully, it'll benefit."</i>
Resource_system		
RS_ecological	erosion, runoff, endowment, improve ecosystem, nutrients, drought, flooding	<i>"I bought a manure truck, so I had to do it myself, now... Well, doing it myself, I'll do it more times per year, less each time, and try to minimize runoff and get on when the land needs it. When the land can use it."</i>
RS_farm production	animal needs, increase/decrease, quality of product, pasture integrity	<i>"Originally the country that went into pines was the lower producing areas, but the nitrogen is sort of considered to be across the whole farm. So by taking out the lower producing areas it meant we could farm the better areas a little bit more intensively which gave us options, but then they sold more nitrogen and now we don't have a lot of options."</i>
Resource_units		
RU_n p attributes	attributes of N & P and the movement of these nutrients in the landscape and farm system	<i>"I'm doing it as a cover crop and I'm gonna chop it. I'm gonna do it as a forage so we're gonna chop it. We're gonna try it because the soil will pull up a lot of phosphorus out of the soil. Really, every time you plow and see the field, you're releasing that phosphorus that's"</i>

		<i>bound because phosphorus doesn't move in the soil. "</i>
Social economic and political settings		
S_industry or consultant		<i>"So, we actually did a feasibility study. We got consultants to do a feasibility study, put the whole thing together, talked to the accountant, and then went to the bank and the regional council on the condition that – the last condition for doing it for buying the farm was that the pond was that we got the consent for the whole thing."</i>
S_c market	Carbon Market as a driver	<i>"[Did you get carbon credits on that?] On the pines that they planted yes... So when [the farm] sold the nitrogen, Mighty River Power generate energy out of the lake. They've got the dams in the river. So they put a deal that they wanted carbon so they tied the two together."</i>
S_demographic shifts	For example, people going out of farming without a successor	<i>"I was renting these places – I had my milkers – and, I was renting places for my heifers. And, I had my heifers over at this farm, over here. This [neighbor 1] – that I told you he only milked 35 cows – he had sold his cows; he had retired from farming. And, I had my heifers way over at [neighbor 2's], at a different farm. And, [neighbor 2] came to me, and said, "Do you want to rent my pastures?" And so, I rented them, and it was a lot of fence, because it was a hexagon, so it was a big area."</i>
S_economics and markets	competition, profit, efficiency, prices broader than the watershed dynamic, carbon credit opportunities	<i>"The main reason why we came back in and bought here was location. Secondly, different land use in the future. And thirdly, land prices. Land prices had dropped by thirty or forty percent, so it made it economic to get back in again."</i>

S_n market	Nitrogen market as a driver	<i>"We planted about 40 hectares of pine trees, production pines, but no, the size didn't change at all. And that was partly because we'd sold some nitrate credits, once we got our cap sorted out, we had plenty so we sold it down."</i>
S_social context	Neighbor complaints	<i>"I tell my friend, I said "Farming is a hostile environment right now. It's hostile." I mean, the environment that we're in is hostile. Not only do we have pressure from regulators, we have regulations, we have pressure from intolerance from the community."</i>
outcomes		
Individual Outcomes		
IO_negative economic		
IO_Neg_compliance	compliance costs related to policy	<i>"But it's just got to the point where I might actually have to get a little bit more involved with it, because they just sent me a monitoring bill that was huge and I've just wrote a letter to them and said that I'm not going to pay that because that's 153 percent increase on last year's bill."</i>
IO_Neg_farm viability	Reduction in ability for farm to remain solvent and profitable, survive as a business	<i>"Well, just for the very reason – if you can't grow your business then you can't survive. So, we had to shift. So, we decided we would reduce our operation in the catchment, and increase our operation outside of the catchment."</i>
IO_Neg_financial	Reduction in profit, payoff, funding, reduced earnings, compliance, property value, new revenue streams including new products, new markets, diversification	<i>"Well, there are direct financial costs and there are also social costs, I think. The direct cost to you is these physical costs like building detainment berms and putting effluent ponds and buying upgraded irrigators and things like that."</i>

IO_Neg_flexibility	Loss of flexibility in farm management	<i>"And before the rules, you could do whatever you wanted to do. Now, you can probably make changes as long as you stay within the rules. So, I suppose, yes. We started cropping in the summer to develop those pellets to improve the quality of grass. And that's not going to happen. So, that hasn't changed in a way. Although, I don't know think we expected to do it for long anyway, did we? It's just an option that we don't have anymore."</i>
IO_negative social		
IO_Neg_distrust in regulation	Frustration or distrust with regulation or agency implementing the regulation, or in the monitoring (Overseer)	<i>"Oh, I just don't contact [the Regional Council]. Because I don't have enough respect or trust in them to be able to do that."</i>
IO_Neg_fairness	Perceived that situation is unfair in individual position	<i>"We planted trees on steep land to stop erosion. And we did flood control work. And I can show you that on the photos that I've got. And those things all worked really well, but the annoying thing is that now that doesn't count towards what we're doing. So, what we've done is, we've harvested the trees, and we haven't replanted. Because we need to have more grass to try and keep our cow numbers up. It's stupid. It's stupid that they're not recognizing environmental benefits that were done in the '90s and the '80s."</i>
IO_Neg_non-financial costs	time, depression, involvement with community	<i>"It was tough, man it was tough. Because we were all farming. We used to joke and say man this would be great if this was your day job. Because A) you are on a salary, B) You are really interested, C) you haven't got any skin in the game, and it's just really interesting stuff. But we were all trying to hold down, I had two little babies, trying to hold down farms, and businesses, and represent people and communicate and try and forge our way through this process, it was incredibly hard."</i>

IO_Neg_uncertainty in future	Uncertainty in the future of the farm system and what will be possible	<i>"Well, we won't have a business. Because they're looking for a 30 percent reduction. So, instead of having 230 cows, we'll have 160 cows. That just won't work. Just like if you're salary got cut by a third, it would certainly change your perspective as well."</i>
IO_neutral economic		
IO_Neu_compliance	Compliance with policy is a negligible cost	<i>"So, you know I mean the RAPs I mean definitely yes we've had to make some adaptations to our management here and all, but they haven't really impacted us detrimentally. It hasn't been a big burden or impact on us as a farm."</i>
IO_positive ecological		
IO_Pos_environmental quality	specific resource not specified	<i>"No. No benefits. Apart from environmental benefits, that's about it. Certainly no financial benefits."</i>
IO_Pos_soil quality	improvements in individual's soil and pasture quality	<i>"And all that where the brook is, it's not mud now, its grass. And going over the years, it's not just grass, it's nice grass – nice, and lush grass; and, I only pasture it, maybe, three or four times a year."</i>
IO_Pos_water quality	improvements in water quality at the farm-scale level, or due to farm-scale level behaviors	<i>"So, I think we must – so, if water quality is improving in [the] Bay... Something is happening. Some of these practices are – and I don't know whether that has to do with it or not. I just think we've done so much – that it's useful. It's proven that it works."</i>
IO_positive economic		<i>"Yeah, so that's what I'm trying to say. If I'd kept running a similar number of stock my nitrogen output would have dropped but the policy changes allowed me to improve the farm's productivity without breaching my nitrogen cap."</i>
IO_Pos_farm viability	improvements in ability for farm to remain solvent and profitable, survive as a business	<i>"Well, the NMP plan is a chance to save money, there, because we know for over fertilizing. With the first one we did, the comprehensive one, we found out that we were putting almost double manure on the grassland than we should've been. You can put too much. It's all there is to it. You put too much. That's a good thing to save money, if you can."</i>

IO_Pos_financial	Improvement in profit, payoff, funding, increased earnings, compliance, property value, new revenue streams including new products, new markets, diversification	<i>"Yeah there were benefits. For people like me that had very, very high NDAs, to have sold a few off the top. Like I sold down to a reasonable level and that would have been good if we hadn't lost the extra 1300. So there were benefits in yeah any very, very high NDA farms - could get part of their capital out. It was like selling part of your farm, but actually not losing the farm."</i>
IO_Pos_flexibility	Improvement in flexibility in farm management	<i>"Pretty much, like we sold down the cattle and replaced those cows with trading stock and they were winter grazers, so it didn't really alter the figure too much, it just gave us more management flexibility."</i>
IO_Pos_new markets	Accessing new markets, marketing, pricing, supply chain changes	<i>"We're certainly producing the product, but we haven't had a decent product to sell, which has been the biggest issue. We've tried cheese and yoghurts. We have been exporting frozen milk to our cheese maker in Aussie for the last few years. But the last 18 months we've taken on a [new] partner and they're powdering it and take it to China. That's been a pretty amazing leap forward, and it's given us a solid market with reasonable returns."</i>
IO_positive social		
IO_Pos_awareness	improved understanding of farm system, nutrient dynamics	<i>"So those sort of things, yeah, you're very aware of - we talk a whole new language now in terms of nitrogen discharge allowance, NDAs and things like that. Yeah and we're conscious of those things. We live in a different world here now."</i>
IO_Pos_non-financial benefits	new opportunities, involvement with community, sense of pride in work, reduces burden of work	<i>"Oh, I sleep easier at night. Yeah, to keep compliant with the old pond, I did some stuff that I wasn't very proud of. But he had to do it to stay compliant really. Yeah, so now all that's gone now. Easier management and all that sort of stuff is, yeah."</i>

IO_Pos_enviro recognition	Received recognition for environmental stewardship/sustainability of farm system	<i>"Then we won the [environmental award], now is the moment when the dollars profit per KG of nitrogen came together. We've been testing, the [farm system] thing is just a big experiment. We've measured ourselves against other farmers through the [award]."</i>
watershed outcomes		
WO_negative ecological		
WO_Neg_environmental quality	specific resource not specified	<i>"Well, we're back again to the nitrogen, phosphorus/biodiversity. Because if you look at what the Regional Council's job is, it's not only nutrients, its biodiversity. It's protecting native bush. Its pests. There are a lot of things. But it's only actually PC 10 hasn't taken into consideration any of those other things that actually the Regional Council is in charge of implementing, or controlling."</i>
WO_Neg_land use patterns		<i>"That was all taken out of farm land and they were farming conservatively anyway. They were having no effect on the lake over there at all because they all had sheep. But that's all in trees now."</i>
WO_Neg_water quality		<i>"So this trading of nitrogen also creates another problem of what they call hotspots. Some people don't want to know about it but of course it makes a difference. Put it this way; if I put this tea towel on the bench and I get two glasses of water, one I just sprinkle lightly everywhere, it hardly sinks through, the other one I just pour it right here, you're going to find a big puddle here that's going to run over here. In effect this nitrogen cap thing has done exactly that."</i>
WO_negative economic		

WO_Neg_farming viability	Reduction in ability for farming in the watershed to remain solvent and profitable, survive as a business/industry	<i>"That's just what happens. The – yeah, they're a lot of farms that are – it's kind of a perfect storm situation too, where I think the number of farms is like 750 farms left in the state... Somebody said the other day that they read from the agency that they could see 150 to 200 more farms go out this year. A lot of that's like – milk price, and then regulations at the same time."</i>
WO_Neg_financial watershed	profit, payoff, funding, reduced earnings, compliance, property value, new revenue streams including new products, new markets, diversification	<i>"Farmers have made a real stand in this catchment to say, 'We can do this, what's required by 2022, whatever the percentage top is. But what's required after 2032 is not doable. Financially, it's not doable.'"</i>
WO_negative social		
WO_Neg_well-being	community involvement, depression, community members leaving	<i>"So, I think – but it's like grievance; this – this phase is the angry phase, and then acceptance might come because that's what happened for us in the Taupo catchment like I say."</i>
WO_Neg_fairness	perceived fairness of the policy process/policy outcomes	<i>"When grandparenting was on the table, who was going to miss out? [Maori land], big time. And as owners of the lakebed, and individually owners of the farms, a lot of farms especially down in the Western area, 55% of the landholding, they had a really big series of interests to try and weigh up. And they had voluntarily retired a whole heap of their own land... And so when grandparenting came out, these guys were severely penalized. There is no recognition of those environmental benefits from having already given. So you can understand why they are pretty pissed off."</i>
WO_neutral ecological		
WO_Neu_lack of changes	Not sure whether there is a positive or negative impact on water quality or other environmental indicators at the watershed scale	<i>"The land use, land use change, in the catchment, has been minor."</i>
WO_neutral economic		

WO_Neu_economic impact	Perception that policy has had neutral economic impacts	<i>"But actually, well, I've personally found it pretty easy, it hasn't been too bad at all. Most of the farms down here are large Maori owned blocks, and when I talk to the other managers, they've pretty much found the same thing. There's a couple on lower benchmarks that sort of get a little bit - the farms were probably not as developed, so that's probably limited how much they can develop their farms. But in general, I don't think it has affected things too much."</i>
WO_neutral social		
WO_Neu_acceptance		<i>"But, you know, it's something that I've been involved with for 30 years of farming and so it's been a major cost to farms definitely, which everybody seems to have just – just get on with it."</i>
WO_Neu_well-being		<i>"Socially, some people who are really unhappy have gone. Which is good they've sold, probably still not happy but they were able to exit. Some of the angst around that was that the trust stood on the market and paid what private valuations, but some of those people still say that wasn't enough."</i>
WO_Neu_fairness	Policy is both fair and unfair	<i>"Everybody's got to do their share. Are they picking on us? No, I don't think so. Some people think they are, but I think everyone's gotta do their part. I think there's certainly been room for improvement; I think it runs you know. I only see something no one's – nothing's gonna change."</i>
WO_positive ecological		
WO_Pos_land use patterns		<i>"I think there would be a lot more dairy farms [without the policy], particularly on Maori lands down the bottom of the lake, which is just beautiful land. There would have been more development, yep. So, it met its purpose. I think the lake is improving too."</i>
WO_Pos_management changes		<i>"I see the bigger farms – a lot of them are doing cover crops where they never did before."</i>

WO_Pos_water quality		<i>"So – so, yeah, so, – but we want the lake to get – to get better as well and we – we – we think we're seeing that so there's a – we – we do think there is a balance in things, but – but then the financial imperative sort of seasonal; these are making some good decisions anyway, unfortunately."</i>
WO_positive economic		
WO_Pos_farming viability		<i>"And that is one of the best thing that has actually happened in this catchment, is that we have, we can trade effectively. So it doesn't lock someone in forever and gives people flexibility and things like that. A lot of people wouldn't actually realize that or use that or whatever, but that is huge flexibility. You've got to have that flexibility if you want to go ahead."</i>
WO_Pos_financial	profit, payoff, funding, reduced earnings, compliance, property value, new revenue streams including new products, new markets, diversification	<i>"So for the Maori incorporations the benefits were huge. They could take capital out of land but they can't sell it. So Maori land can't be sold. So if it was me, I owned this land and I couldn't sell it and someone was going to give me a whole lot of money for that land and I owned it, I'd have planted the whole thing in trees...So it allowed them to release capital out of their land holdings, retain their land because they can't sell it and then they've taken that money out and my incorporation have treated it as capital."</i>
WO_positive social		
WO_Pos_awareness	awareness of water quality, farm dynamics and environmental footprint	<i>"Well, farmers have become aware of the environmental impacts that farming has on the waterways and the lakes."</i>
WO_Pos_well-being	community involvement, depression, community members leaving	<i>"So, yeah. Actually, I think that probably the biggest plus out of it is actually talking to your neighbor, and working with your neighbor, and seeing what they're doing."</i>
WO_Pos_fairness	perceived fairness of the policy process/policy outcomes	<i>"Yes, I do, absolutely. I think we have a workable proposition, a workable nitrogen constraint."</i>
Recent nutrient management behavior		
Management change		

M_change breed	Change in animal stock, part of the physical stock of the farm, not something that can be changed on a day to day management basis.	<i>"Basically, change the breed really. As I say, they were very high maintenance. We had dry seasons and the following year they didn't perform very well. So we got a hardier, bit more robust sheep on board, but they don't produce quite as much, but they cost - the cost of running them has dropped as well, so - and that was to fit with putting milking on it, sort of changed the dynamics of the farm, so just that fit with the whole system."</i>
M_reduced fertilizer	changes in the application of fertilizer timing and/or amount, including manure	<i>"Just, I suppose, I have changed from putting the fertilizer on in the autumn to putting it on in the spring. Or late spring, probably, more than early spring. Due to, probably, a bigger loss would occur in the autumn."</i>
M_grazing off	Began or changed grazing off of livestock, or wintering off, including dairy support	<i>"What we've done instead of winter cropping and wintering on the farm, we've taken more animals off the farm during the winter. It also helped that the grasses that were growing now provide feed over a wider part of the season. But it's both continual productivity improvements that has come to help in the situation."</i>
M_increased fertilizer	increase in the application of fertilizer	<i>"And then, in the last few years, we've found that we haven't really had enough manure on the closer fields, and it costs a lot more to get it to the further fields, so the last few years, we've been putting more commercial fertilizer on the further fields, and sometimes no manure, and putting more of that manure on the grass ground during the summer and definitely putting more - or, enough - on the corn ground that's close by."</i>
M_increased stocking rate		<i>"Yeah, chicken as well, so it's kind of a quick background. I guess I'd say also we've grown the flock a little bit -"</i>
M_pursue knowledge	Actively pursue knowledge to better understand nutrient dynamics (engage in research)	<i>"We've actively pursued knowledge by engaging in research trials."</i>

M_manure spreading	Changes in the application of manure timing, amount or pattern, also changes in location of manure stacking	<i>"I bought a manure truck, so I had to do it myself, now. I'm gonna do – rather than hiring somebody to come in and mainly want the pit empty, so just put it on as heavy as they can put it on because they're only coming in once or twice a year. Well, doing it myself, I'll do it more times per year, less each time, and try to minimize runoff and get on when the land needs it. When the land can use it. That way, absorption is better and I'd like to hit it as soon after cropping and pray for doing it the day before a rain, that way it gets incorporated in."</i>
M_notill	Switch to no-till	<i>"Then, as for fields, the last few years we've been – we've been kind of experimenting with no till for about 20 years, and probably six or seven years ago we went halfway no till and four years we got to 100 percent no till –"</i>
M_nutrient management plan	Began or revised a nutrient management plan or overseer plan	<i>"That was my first effort at writing my NMP, yeah. We had a different contractor doing it for us initially the first year or two. Even back then, we were already at \$4,500.00, \$5,000.00 then and we didn't have the land base that we have now."</i>
M_reduce feed inputs	Changes in purchased feed or other inputs (non-fertilizer)	<i>"Yeah we also bring in palm kernel at this stage. Yeah we have cut down - well we're trying to do at the moment because it is not worth losing money on using it. "</i>
M_seeding or cropping	Began, changed or stopped seeding varieties or cropping patterns	<i>"Yeah, yeah. We're gonna seed more, now. We always like our corn but we used to plant 300 acres and now we're down to 180."</i>
M_soil sampling	Began or changed soil sampling	<i>"Talking with USDA, I'm trying to reseed to improve my pastures and so I'll be doing some soil testing. I didn't do that when I went to the [nutrient management class], but I will now just so that I better understand."</i>
M_stocking rate	Changed number of animal units	<i>"No, there's no reduction in – well, actually it did come with a reduction in stocking rate as well. I think I've mentioned that we reduced from about 3.4 down to 2.9."</i>

Structural change		
St_barn	Change or construct barns	<i>"Then we're actually building a barn to bring these animals home because that contract grade is – they're doing a nice job raising them, but that's – we can more than pay for a barn."</i>
St_biodigester		<i>"[Q: When did you guys put in the biodigester?] 2008... Yup. It was something we decided to do."</i>
St_buffers	Change or construct buffers or setbacks on rivers, streams or ditches	<i>"right, yeah, and some ditches and with buffers I think was the last project we did a while back was maybe 30 feet and then they came and planted trees and they help even compensate us a small amount for the land that we lost because our fields did go right down to those areas."</i>
St_detainment bunds	Change or build detainment berms to control flow of water, slow flow of water and runoff of nutrients	<i>"Obviously where we pug ground up is another issue, we are always conscious of that, but we've also put in a lot of detainment berms, if you can imagine this farm is elevated it's got quite a big catchment and all the water eventually is coming down into the lake. It's going to get there one way or the other. These detainment berms, so far we have done about seven with the regional Council to reduce or to mitigate the flow of water that comes through, especially when we have these big downpours."</i>
St_equipment	Purchase or change farming equipment	<i>"We have adopted the best management practice advice in terms of effluent and disposal. We put in a new storage system. A rubber-lined storage system. It – to have best practice for effluent and disposal. We brought new land application irrigators to meet the application requirement."</i>
St_fencing	Change or construct fences	<i>"We had to fence up the swamps because there are some wetlands on the backside of a couple of our fields that we had to fence out. Water quality. Like I said, it all makes sense. It makes you more money in the long run. Cows aren't gonna make milk standing in the mud."</i>

St_leachate system		<i>"The biggest problem I have is we have to put a leachate system in. Ugh. It's an \$81,000.00 project, which I don't think is even needed because our bunker are – well, they're 100 feet from the brook and they're 50 feet from the road."</i>
St_manure pit or pad	Change or construct manure pit	<i>"By getting manure on the land – we put in a manure pit – by getting the manure on the land, we went – our tonnage of feed multiplied by four times in two years, per acre. It's huge. That's all money in your pocket because you're not purchasing that extra feed."</i>
St_milking parlor	change or construct milking parlor	<i>"We've been going about eight or nine years. Eight years, yeah. It didn't actually take that long, built a shed, a purpose built milking shed and pretty much within 12 months we were producing milk."</i>
St_stand-off pad	Change or construct stand-off pad	<i>"We still have no – on our own, we put in a cement pad to feed the cows on. We're still dealing with – we kind of get a nice bedded pack built that's dry, and then we get six inches of snow on top of it –"</i>
St_tree planting	Plant trees to restore banks or native bush (not pine plantation - that is a system change)	<i>"Apart from fencing off gullies and planting them in natives, rather than productions trees, that's about it."</i>
St_water flow control structures	add or change culvert, put in drains to divert water	<i>"Some of our diversion water goes through a culvert underneath this pushway. I didn't wanna pour concrete there, so what I did is I added onto the culvert on both sides and just built it up, so now the dirt is much higher than our concrete pushway, and when she came back, she said that was fine."</i>
System change		
Sy_purchase or lease land	Purchase new land for agriculture within the policy region	<i>"Well, we just barely purchased some more land. We're up to 280 acres. We rent another 100 acres of crop land."</i>

Sy_put land in production		<i>"Then there was a white pine stand that we wanted to cut and reclaim for pasture and we wanted to clear all that junk wood, and then we wanted to drastically thin out the hemlock out of the sugar bush..."Yep, he gave me approval." I said "Can we start?" "Yeah, go ahead. Get started." We start. Clear cut 20 acres here, and clear cut a bunch here, and do a bunch of work, and we only did, probably 25 percent of what we wanted to do –"</i>
Sy_sale or lease of land	Sale of agricultural land	<i>"So we decided after a lot of soul-searching that we would sell."</i>
Sy_switch to higher intensity	Transition to or from dairy, sheep, beef, vegetable, other, pine plantation, dairy support. Note that many farms can be multiple different farm systems at once, and may take up additional system types, for example a dairy may retire some land and plant a pine plantation. Switch from breeding operation to purchasing stock included as well, or reverse, switch from purchasing to breeding	<i>"Well, one would be put the sheep milking unit on...So basically, we've put that on and it has changed the dynamics a little bit. And then we've sort of intensified that area, the sheep milking area, quite a bit. Mainly with the sheep, but it hasn't changed our nutrient output a hell of a lot, I don't think."</i>
Sy_switch to lower intensity	Transition to or from dairy, sheep, beef, vegetable, other, pine plantation, dairy support. Note that many farms can be multiple different farm systems at once, and may take up additional system types, for example a dairy may retire some land and plant a pine plantation. Switch from breeding operation to purchasing stock included as well, or reverse, switch from purchasing to breeding	<i>"Really, since we went grass fed – this is recent – we've had to – we're still trying to figure out how this is changing our – last summer was the first summer we were 100 percent grass fed."</i>

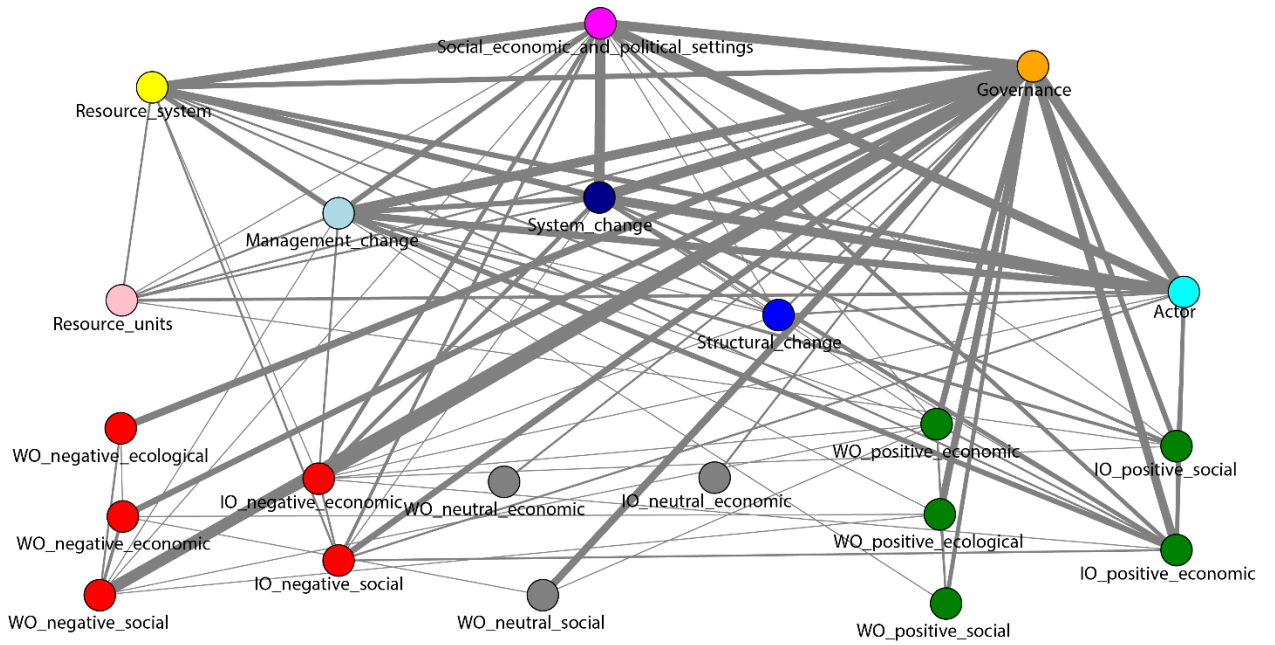


Figure A1.1. Network graph representing group mental model of Taupo farmers' watershed social-ecological system. The arrangement of nodes mimics the structure of the SES Framework in Error! Reference source not found. above. Color of node represents the category of node: driver nodes are orange (governance), magenta (social, economic and political settings), yellow (resource system), cyan (actor), and pink (resource system); behavior nodes are light blue (management), blue (structural) and navy (system); watershed (WO) and individual (IO) outcomes nodes are red (negative), grey (neutral) and green (positive).

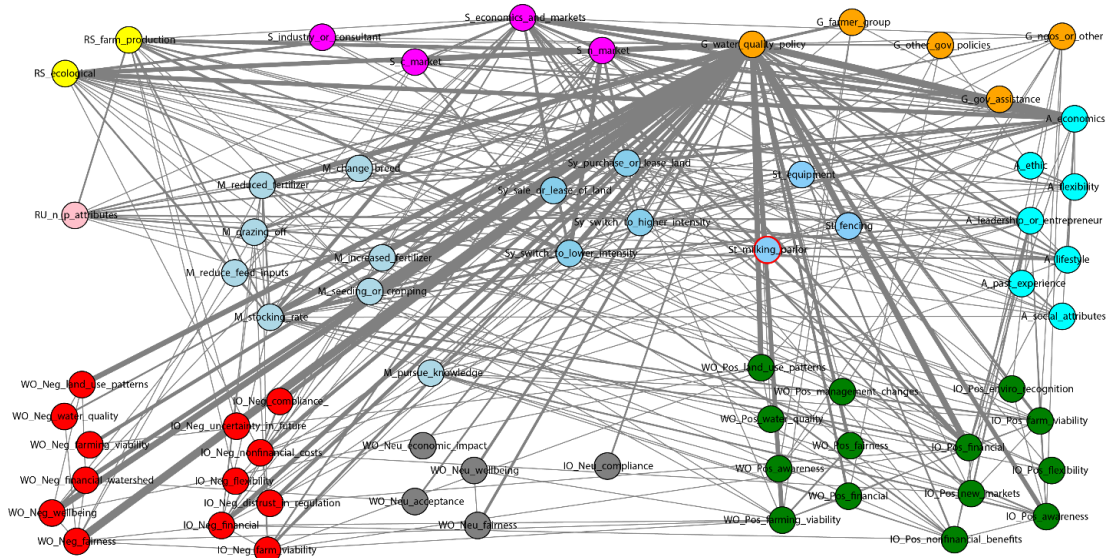


Figure A1.2. Taupo SES sub-category group mental model network.

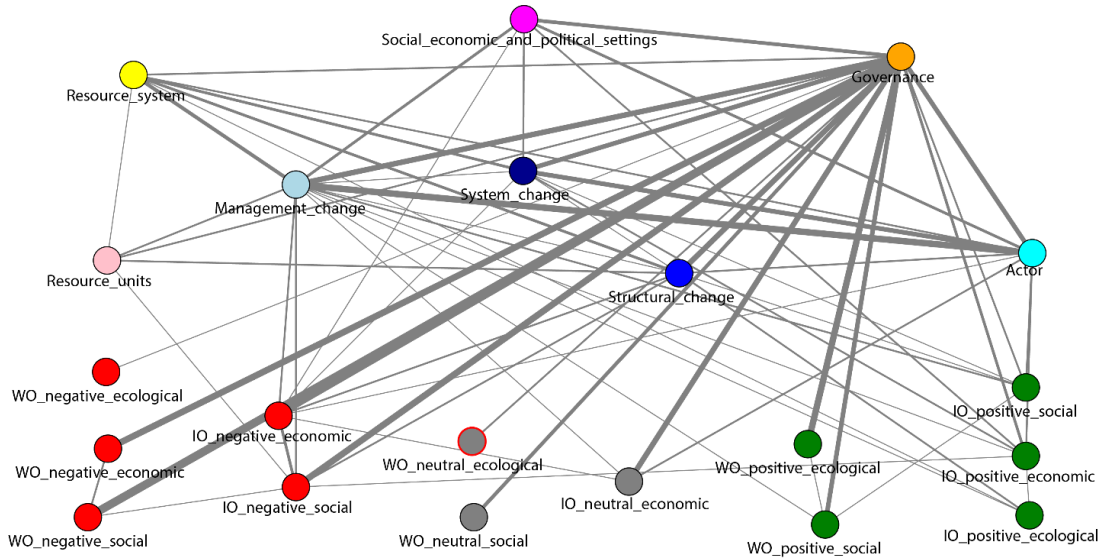


Figure A1.3. Rotorua SES Category group mental model network

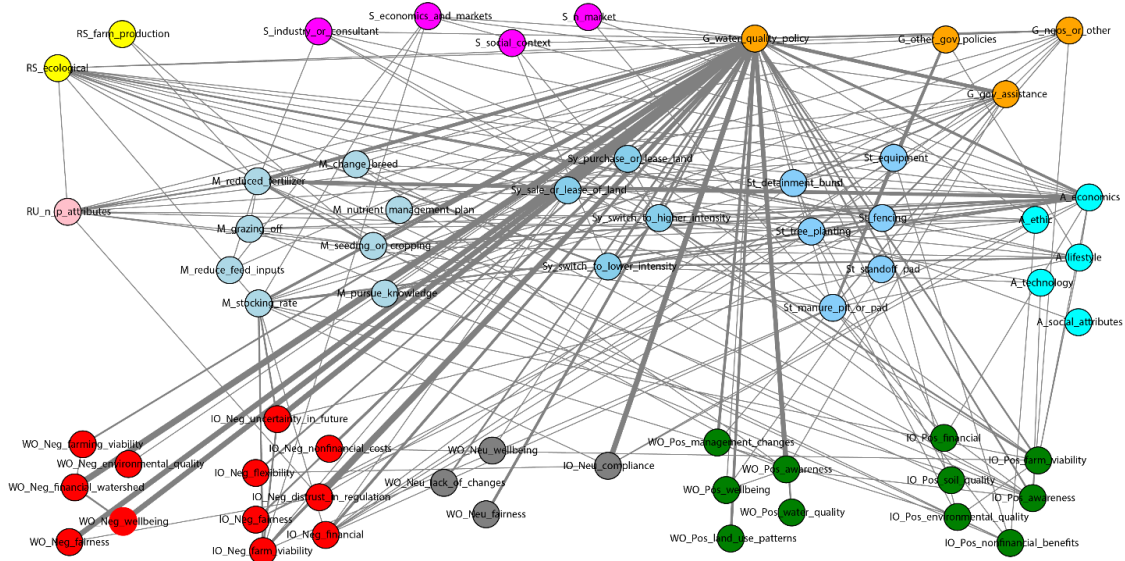


Figure A1.4. Rotorua SES sub-category group mental model network

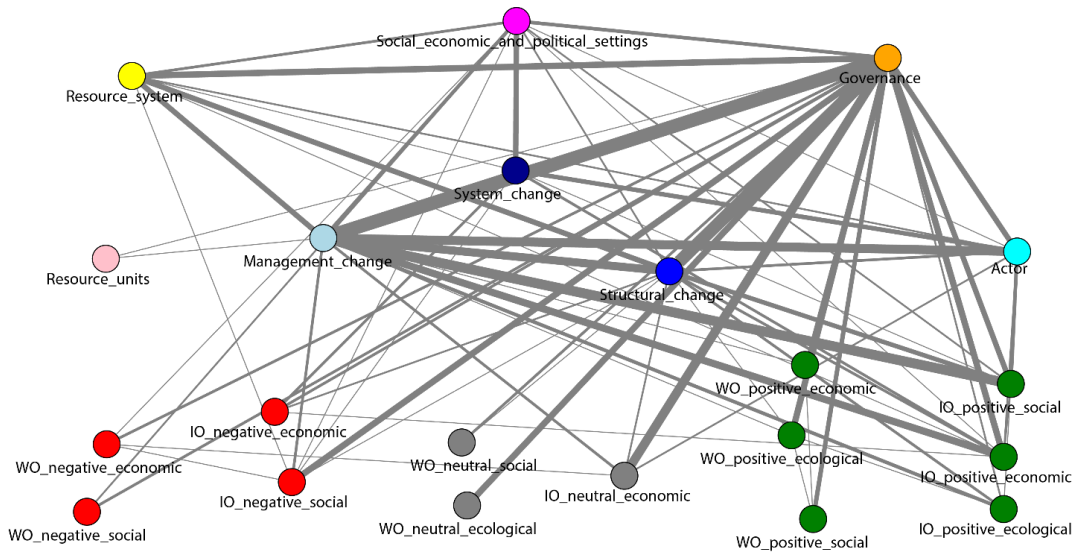


Figure A1.5. Vermont SES Category group mental model network

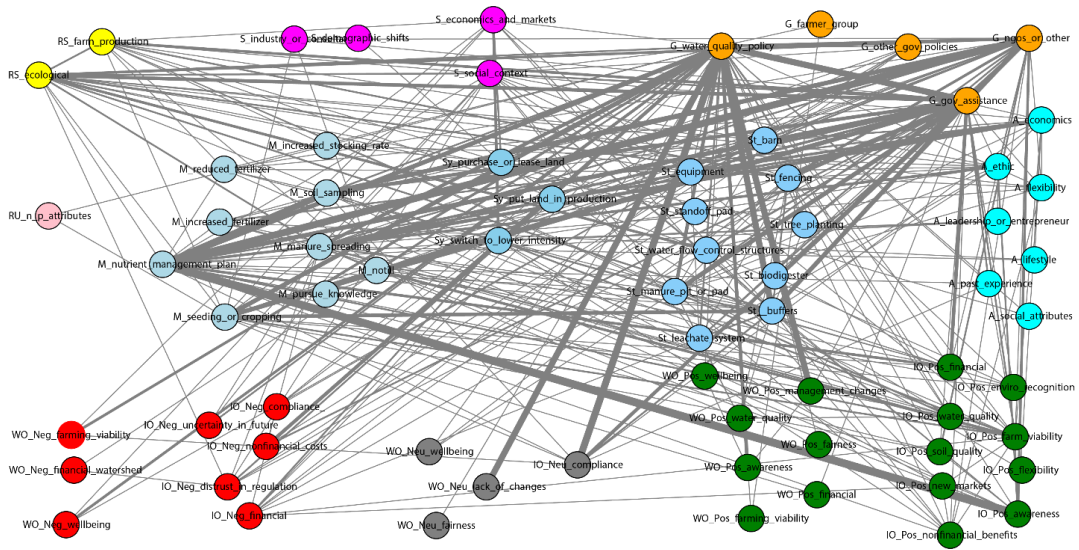


Figure A1.6. Vermont SES sub-category group mental model network.

Table A1.3. Driver node statistics by region in Driver-behavior sub-network. Rank reflects the descending rank of strength (high to low). The data driving these ranks is from the Driver-behavior sub-network so ranks do not reflect influence on outcomes.

Sub-category node	Taupo (n = 11)				Vermont (n = 16)				Rotorua (n = 11)			
	rank	strength	degree	occurrence probability	rank	strength	degree	occurrence probability	rank	strength	degree	occurrence probability
A_economics	2	49	23	91%	5	21	13	50%	2	25	16	64%
A_ethic	14	2	2	9%	6	17	15	38%	8	5	5	18%
A_flexibility	10	9	7	18%	9	8	8	13%	-	-	-	-
A_leadership_or _entrepreneur	7	17	12	27%	10	4	3	13%	-	-	-	-
A_lifestyle	8	16	11	27%	11	3	3	6%	6	9	8	36%
A_past_experience	12	5	5	9%	10	4	3	13%	-	-	-	-
A_social_attributes	10	9	8	27%	12	2	2	6%	11	1	1	9%
A_technology	-	-	-	-	-	-	-	-	10	2	2	9%
G_farmer_group	12	5	3	27%	13	1	1	6%	-	-	-	-
G_gov_assistance	10	9	7	18%	1	74	25	88%	4	14	9	45%
G_ngos_or_other	11	7	7	9%	3	48	22	75%	6	9	8	36%
G_other_gov_policies	13	4	3	27%	10	4	4	13%	7	8	5	27%
G_water_quality_policy	1	88	28	100%	2	58	26	94%	1	42	25	100%
RS_ecological	5	31	18	45%	4	31	18	44%	3	17	15	55%
RS_farm_production	6	23	14	64%	6	17	13	31%	10	2	2	9%
RU_n_p_attributes	8	16	11	27%	12	2	2	6%	5	11	10	27%
S_c_market	9	11	7	18%	-	-	-	-	-	-	-	-
S_demographic_shifts	-	-	-	-	13	1	1	6%	-	-	-	-
S_economics_and _markets	4	40	18	82%	8	9	6	44%	8	5	5	9%
S_industry_or _consultant	13	4	4	9%	10	4	4	6%	8	5	5	18%
S_n_market	3	42	18	82%	-	-	-	-	10	2	2	9%
S_social_context	-	-	-	-	7	15	13	19%	9	3	3	9%

Note: The one letter prefix of the driver sub-category node name represents the overall driver category that the node belongs to: A = Actor, G = Governance, RS = Resource System, RU = Resource Units, S = Social, economic and political setting.

Table A1.4. Drivers ranked by strength across each region. Note that data driving these ranks is from the Driver-behavior sub-network so ranks do not reflect influence on outcomes. The one letter prefix of the driver sub-category node name represents the overall driver category that the node belongs to.

Rank	Taupo	Vermont	Rotorua
1	G_water_quality_policy	G_gov_assistance	G_water_quality_policy
2	A_economics	G_water_quality_policy	A_economics
3	S_n_market	G_ngos_or_other	RS_ecological
4	S_economics_and_markets	RS_ecological	G_gov_assistance
5	RS_ecological	A_economics	RU_n_p_attributes
6	RS_farm_production	A_ethic	A_lifestyle
		RS_farm_production	G_ngos_or_other
7	A_leadership_or_entrepreneur	S_social_context	G_other_gov_policies
8	A_lifestyle	S_economics_and_markets	A_ethic
	RU_n_p_attributes		S_economics_and_markets
			S_industry_or_consultant
9	S_c_market	A_flexibility	S_social_context
10	A_flexibility	A_leadership_or_entrepreneur	A_technology
	A_social_attributes	A_past_experience	RS_farm_production
	G_gov_assistance	G_other_gov_policies	S_n_market
		S_industry_or_consultant	
11	G_ngos_or_other	A_lifestyle	A_social_attributes
12	A_past_experience	A_social_attributes	
	G_farmer_group	RU_n_p_attributes	
13	G_other_gov_policies	G_farmer_group	
	S_industry_or_consultant	S_demographic_shifts	
14	A_ethic		