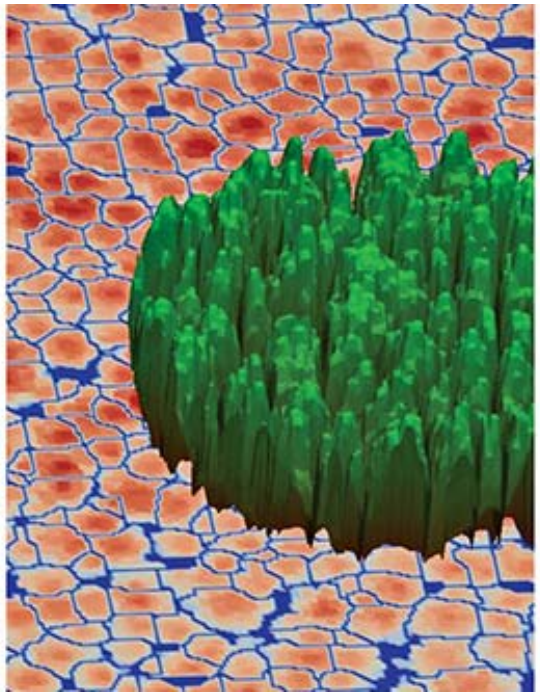
Growing confidence in forestry's future Research Programme

SCION forests · products · innovation

Managing forests for the future climate

Simeon Smaill



supported by forestgrowers commodity levy

FOREST OWNERS ASSOCIATION

Forests are complex systems

Trees do not grow in isolation – reliant on many factors

Climate

Water

Endophytes

Pathogens

Soil properties

Nutrients

Rhizobacteria

Mycorrhizae

Environmental processes and biotic associations are critical to tree growth

Much research has gone into understanding how these interactions affect forest health and productivity

However, it is becoming increasingly apparent that these interactions are undergoing significant changes that will affect the growth of many existing, and all future, forests

The climate of New Zealand is going to change

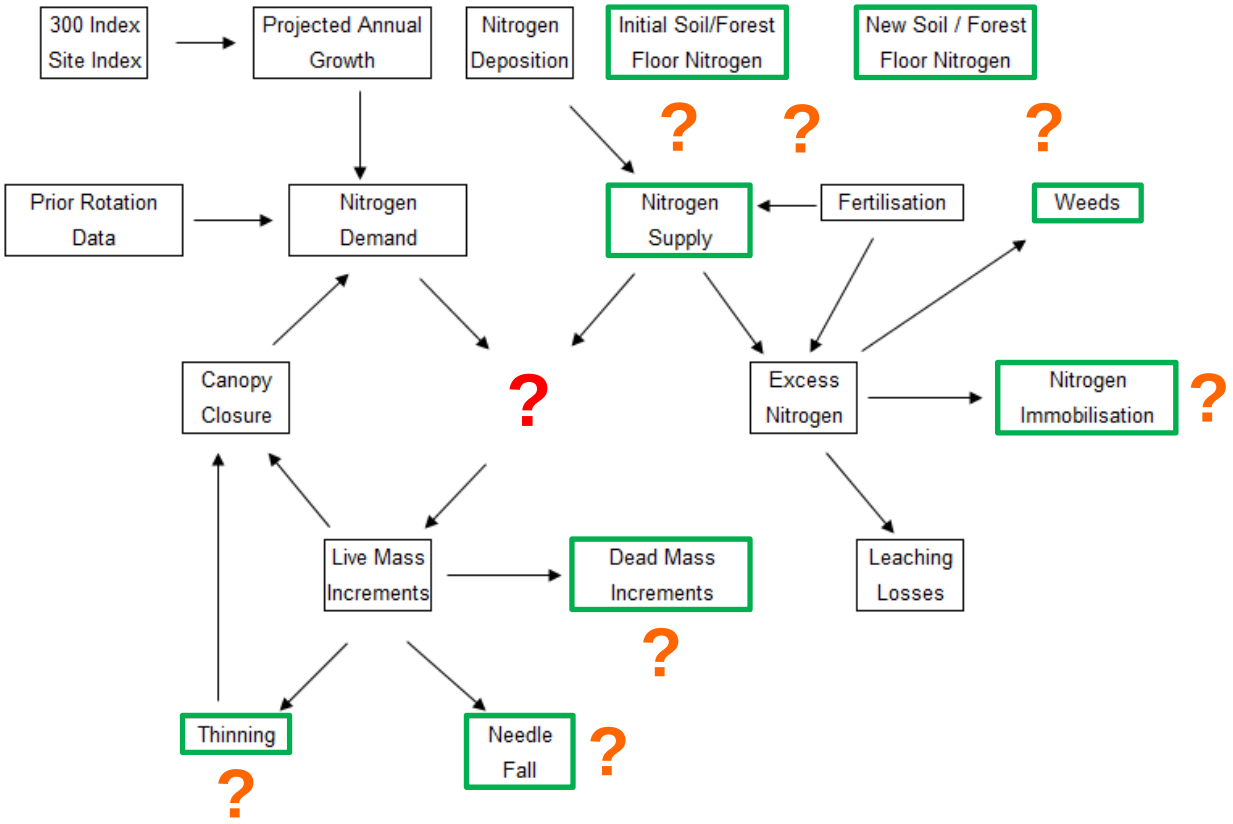
Property	2049	2099	Where in NZ?	Confidence?
CO_2	480-530 ppm	450-850 ppm	Everywhere	Medium / High
Temperature	+ 0.7 to 0.9 ^oC	+ 1.1 to 2.6 ^oC	Everywhere	High
Days > 25 ^oC	100% more	300% more	Lowland areas	High
Drought	5 – 10% more	>10% more	North and East	Low / Medium
Rainfall	0 – 10% less	0 – 20% less	North and East	High
	0 – 10% more	0 – 30% more	South and West	High
Extreme rain	0 – 50% more	100% more	South and West	High
Frosts (winter)	Up to 50% less	50 – 90% less	CNI and South	High

Reisinger et al. (2010) Climate Change Adaptation in New Zealand: Future Scenarios and Some Sectoral Perspectives: 26–43

These predictions were made with a model system that has been successfully validated against meteorological data collected in NZ from 1900 – 2000

… and climate isn't the only thing that will change

Significant indirect effects on productivity and health are likely due to changes in the activity of microbes, and the processes that microbes drive



Using the NuBalM framework as an example

Changes to the decomposition processes mediated by soil microbes will alter the resources available for growth

New uncertainties in growth rates

Many challenges stem from climate change

- Increased risks of damage from greater wind and storm intensity, and an increased frequency of these events
- Greater risks of fire damage due to higher temperatures and reduced rainfall in many parts of New Zealand
- More competition from weed species

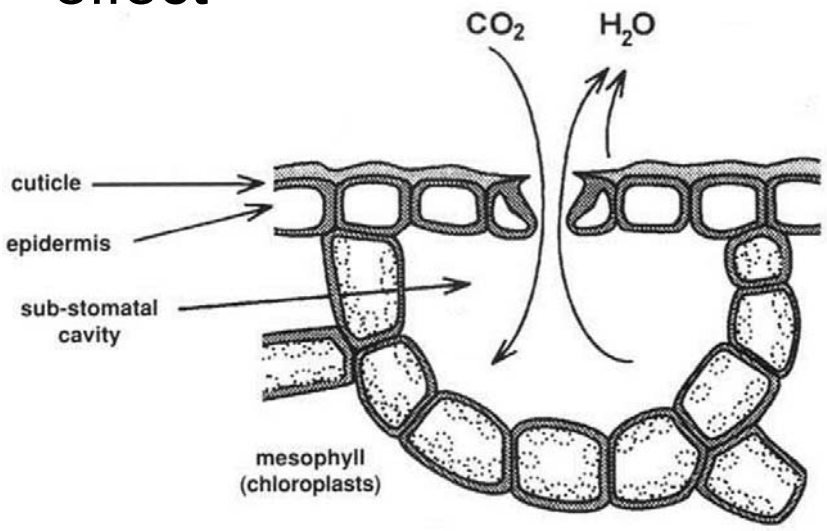
Various other responses have been identified, involving the biochemistry of the trees and external interactions

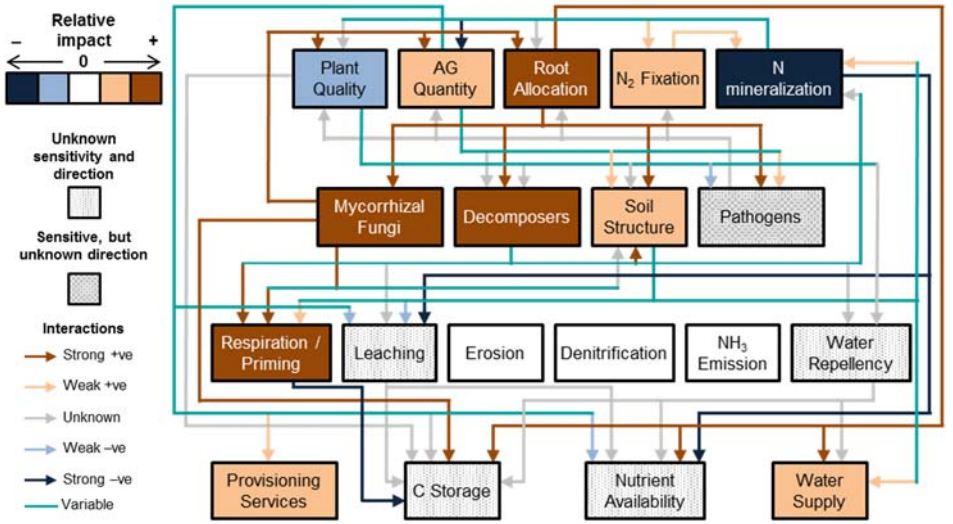
Dunnigham et al. (2012) MPI Technical Paper No: 2012/33
Orwin et al. (2015) Global Change Biology 21: 2844–2860

Getting more specific – enhanced CO_2

Potential for significant gains from greater atmospheric CO_2 concentrations

Can fix more atmospheric carbon for growth when CO_2 is increased – a “fertiliser” effect





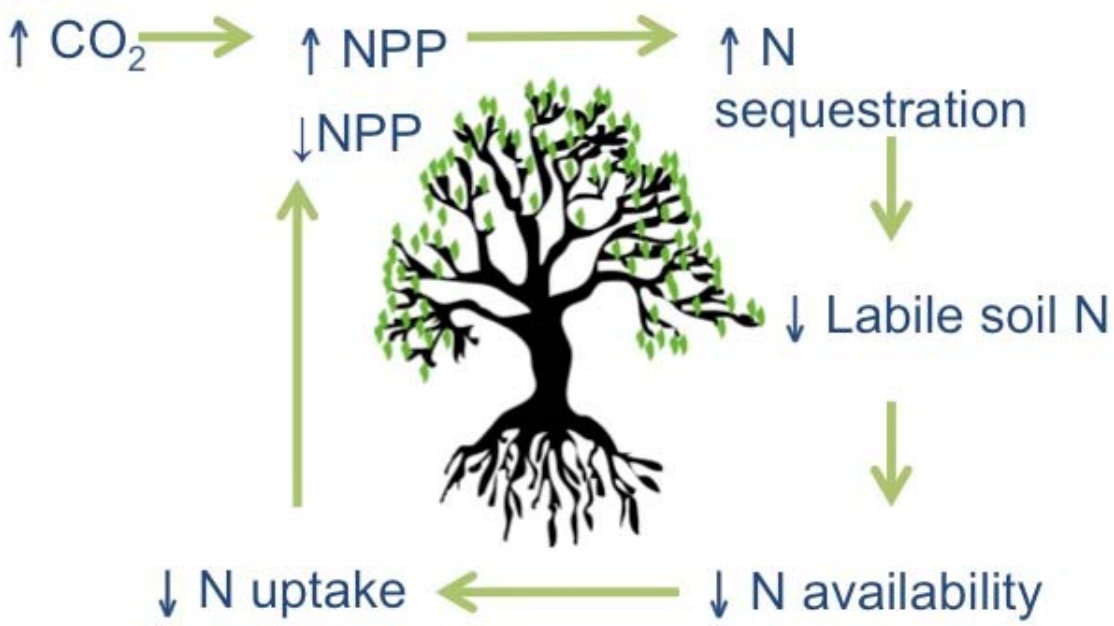
Potential gains from more efficient water use as well

However, also likely to see new problems emerge

Negatives from enhanced CO_2

CO_2 driven growth gains require more nutrients from the soil

- Can cause new soil nutrient deficiencies to emerge over time
- Progressive nutrient limitation



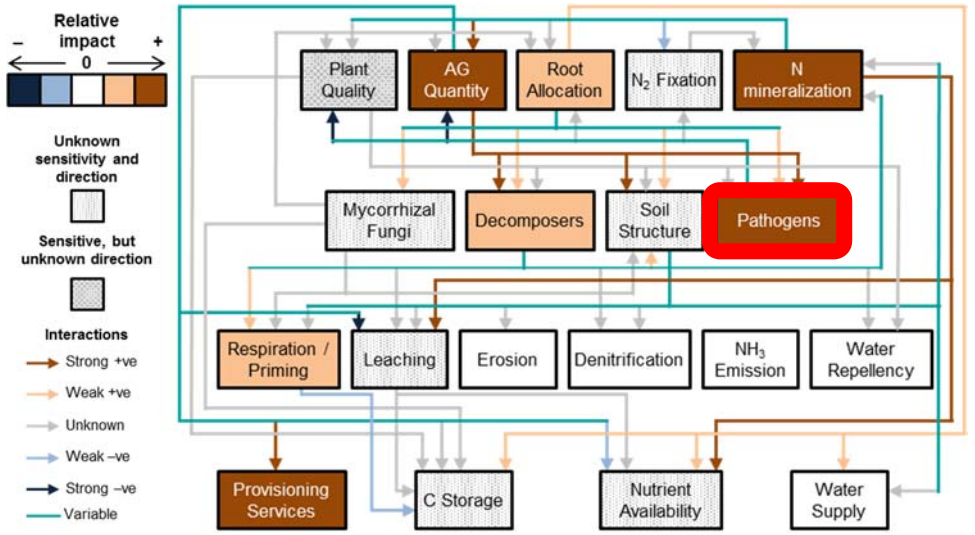
There is evidence that eCO_2 will increase the availability of some nutrients under suitable conditions, but unlikely to be in balance with tree requirements – creates a potential for increased disease susceptibility in the new growth

Laing et al. (2000) New Phytologist 146: 47-57

Warmer – without water limitations

Faster decomposition rates increase nutrient availability from soil organic matter

May delay or prevent some of the effects of progressive nutrient limitation

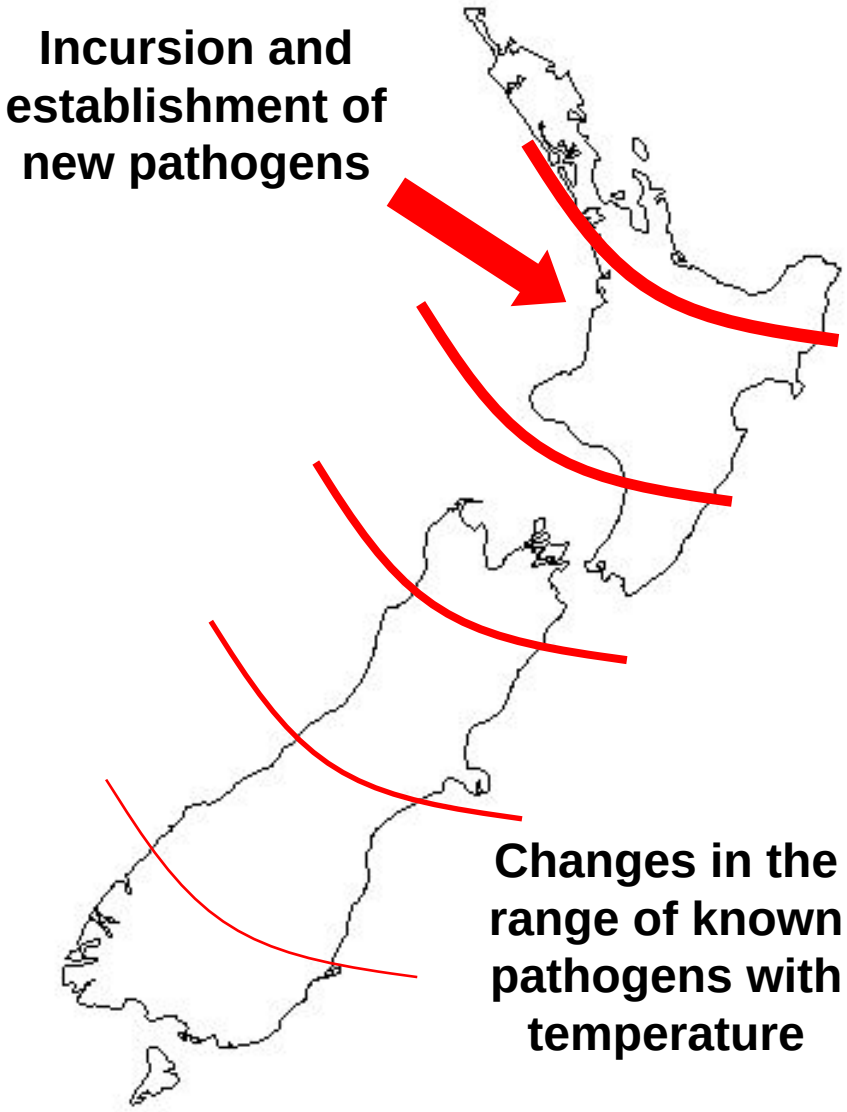


Unfortunately, warming is very likely to produce significant negative effects by promoting pathogens and insect pests

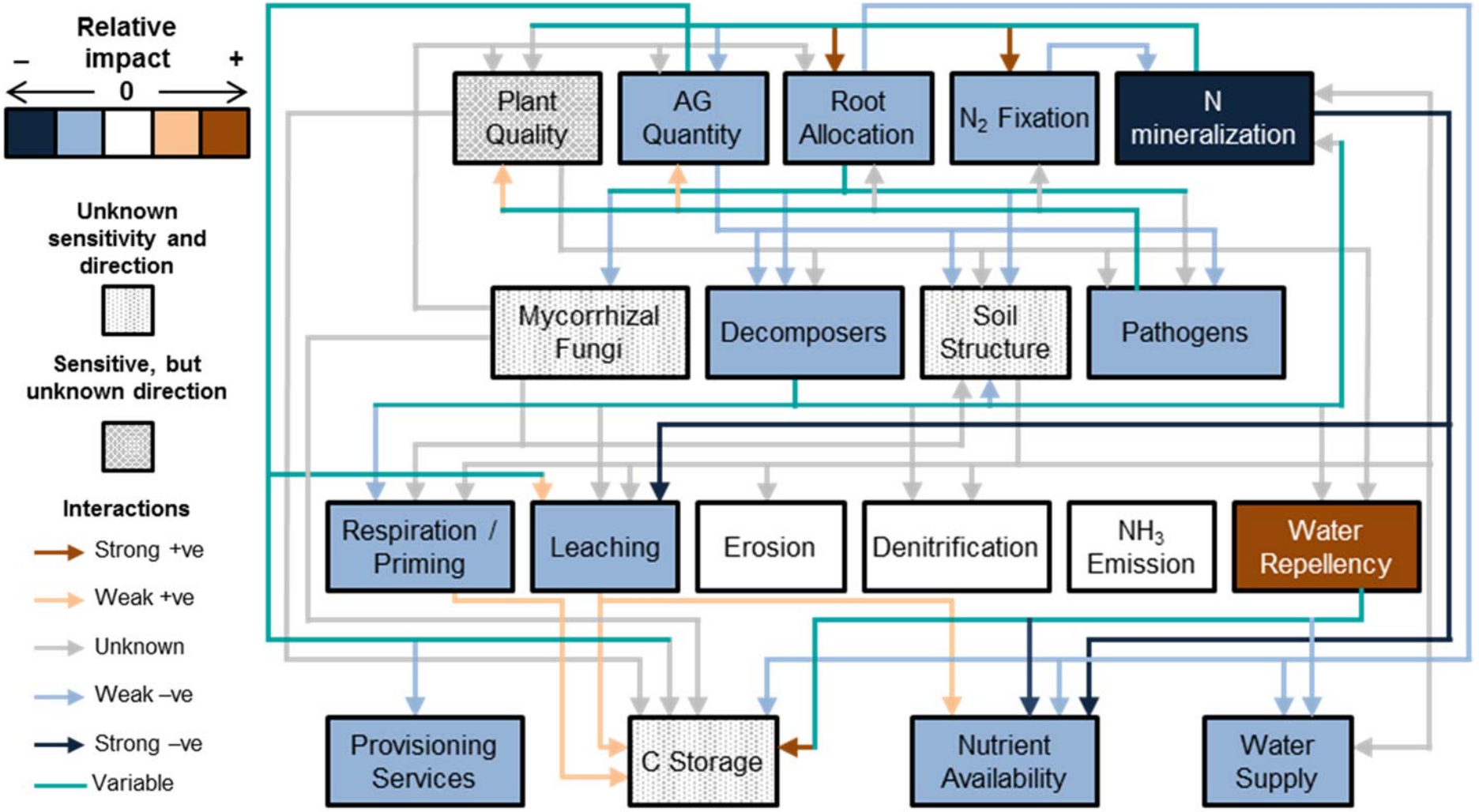
Warming increases pathogens and pest activity

Warming increases the population of insect pests and pathogenic microbes

- Winter is a key limitation to insect and pathogen numbers
- Increased survival over winter gives pathogens and pests a head start post-winter
- Changes to temperature are also a key driver for the spread of pathogens and pests in space and time

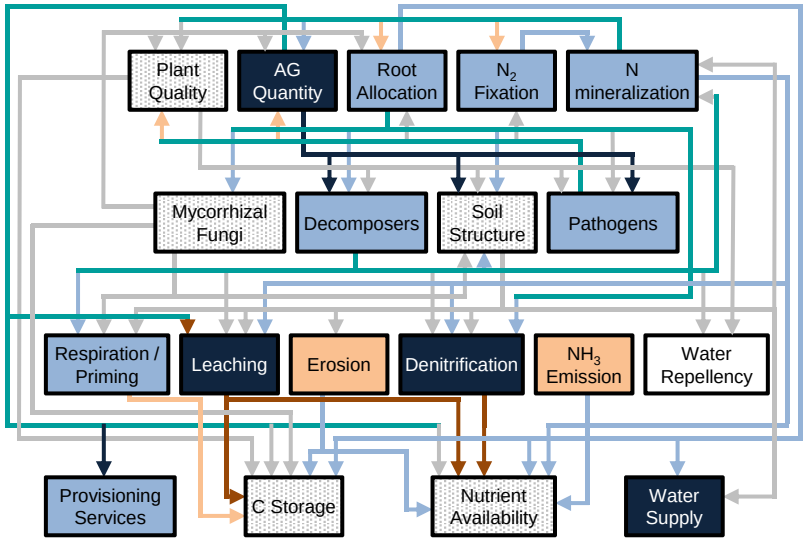


Increased incidence of drought – no gains from this

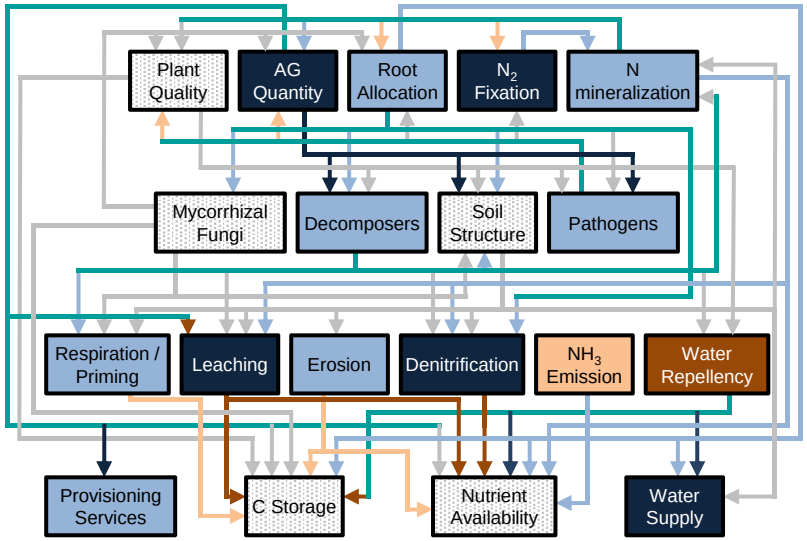


But forests are more tolerant than other land uses

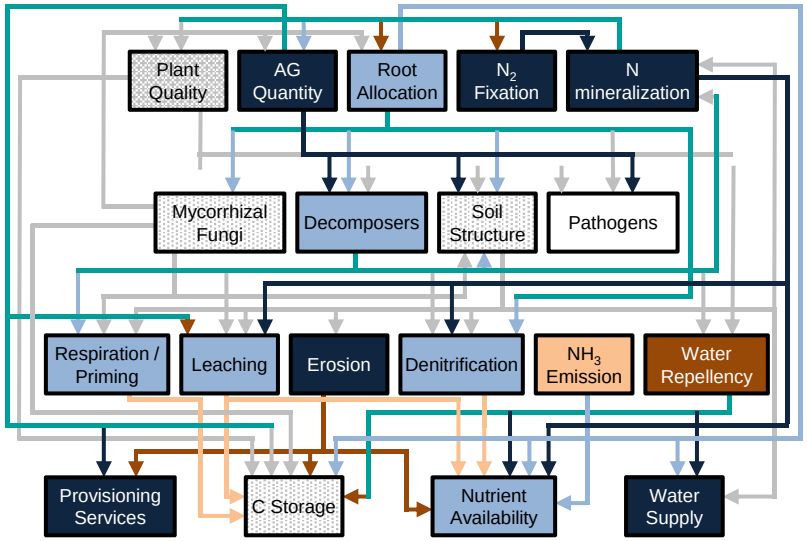
(a) Annual cropping



(b) Intensive grazing

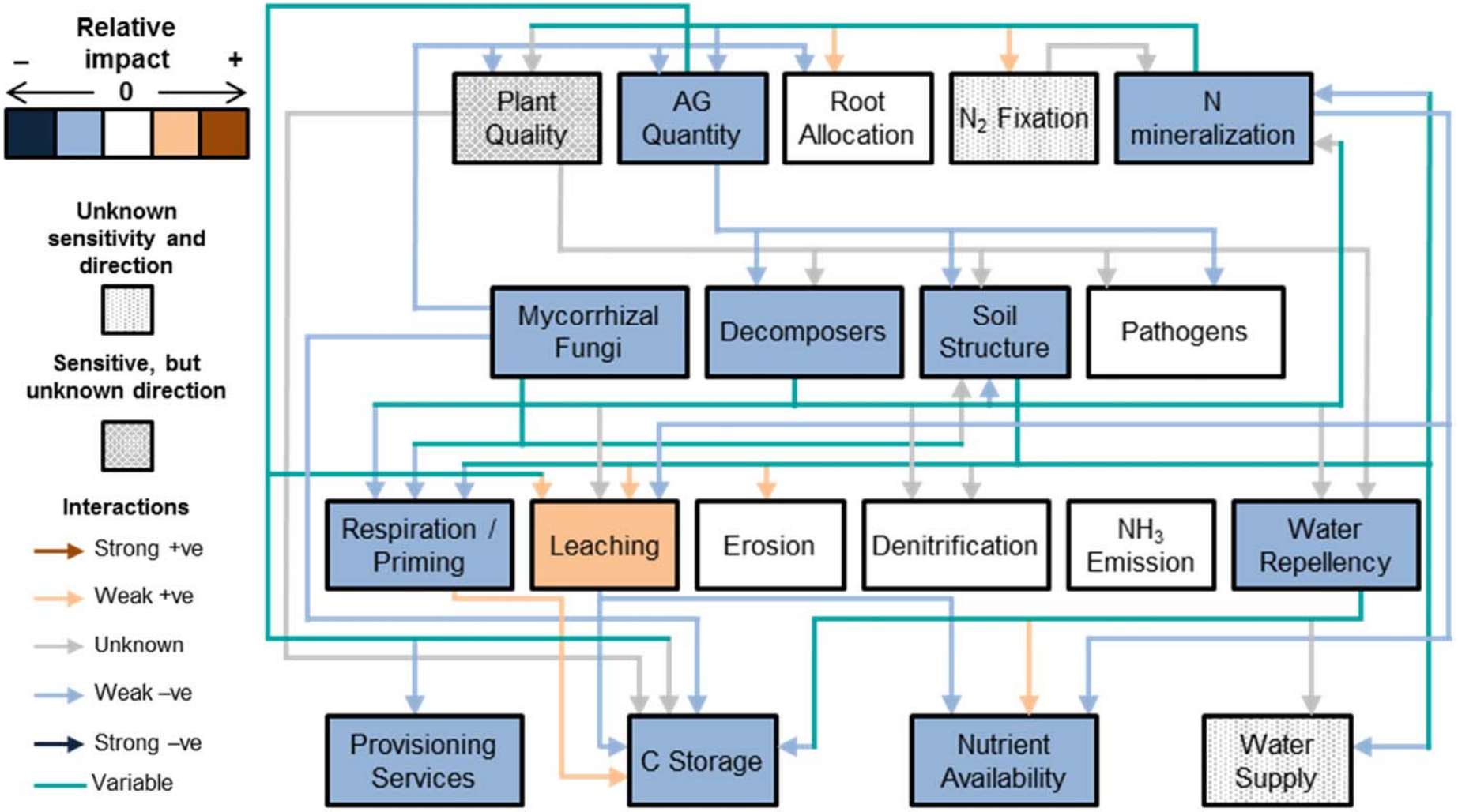


(c) Extensive grazing



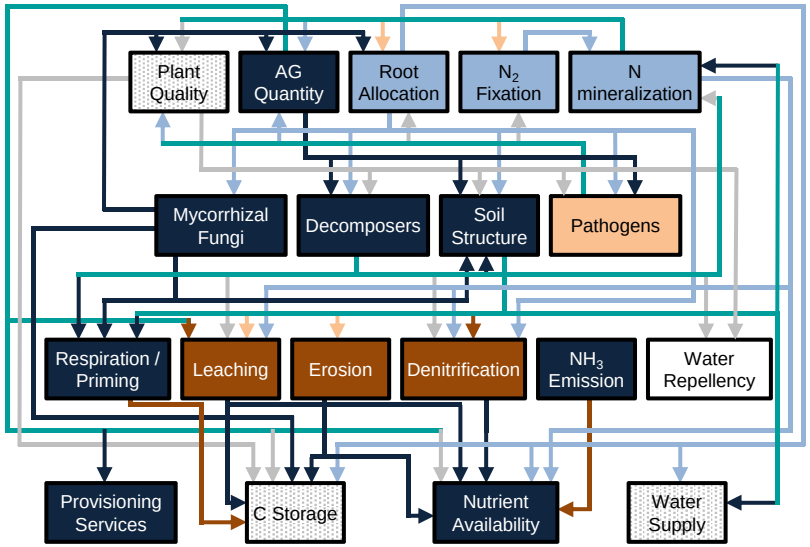
Suggests that new forests may be needed to help address water supply and quality concerns in other primary sectors

Greater frequency of extreme events – no benefits

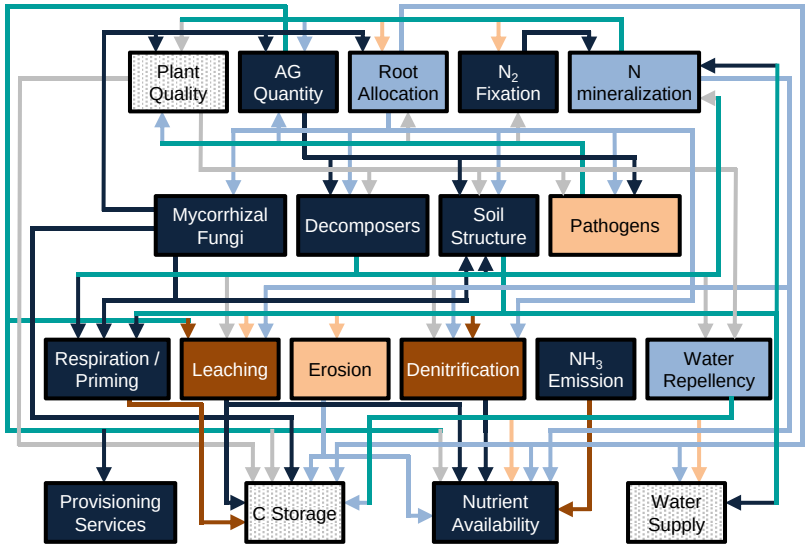


Again, only positive for forestry is relative tolerance

(a) Annual cropping



(b) Intensive grazing



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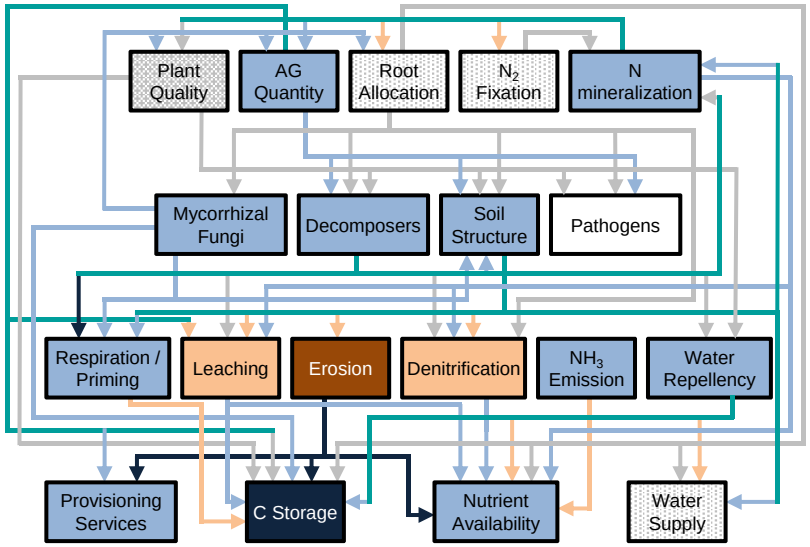


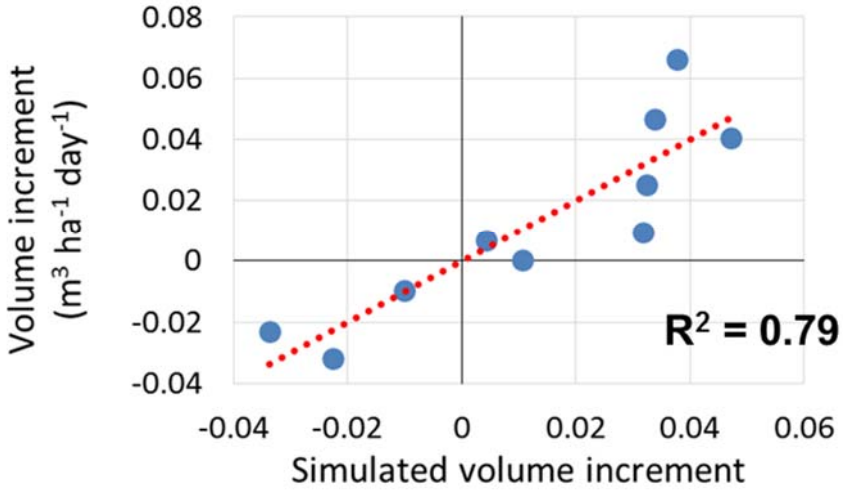
As with drought, forests may be needed to reduce the risk of damage to other land uses by helping to regulate water supply

How is the GCFF addressing climate based risks?

Understanding and accounting for the effect of variations in climatic conditions on important site properties and forest behaviour is already a key component of the programme

- Planned Accelerator trial to mitigate moisture limitations
- Legacy effects of nursery management in different climates
- The effect of climate x site interactions on microbial activity

Includes recent research that found the use of climatic data with soil data vastly improved predictions of radiata growth responses to nitrogenous fertiliser



Reducing the stress levels of our forests

Regardless of the specific mechanisms, it is very likely that future forests will be under greater stress than now

To help address this situation, the GCFF programme is examining options to use soil bacteria that can attenuate plant stress responses

Also undertaking novel research exploring drivers of the plant hormones involved in radiata immune response – balancing allocation of effort to drought tolerance, pathogen resistance and responses to insect attack as needed

Conclusions

Not all doom and gloom – significant opportunities for the forestry sector to gain from the direct and indirect effects of climate change – but it will be a major challenge to the sector

Key issue is the need for flexibility – altering established management practice where needed to maximise benefits, reduce risks and deal with new problems

The GCFF programme is driving the science that is needed to develop new management options that will help adaptation to climate change throughout the life of a rotation, from the nursery to harvest

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Many thanks to the various contributors to this work, and thanks for your attention

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