Sources and pathways for nutrients and to water and means of intervening

CSG 14th August 2014

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Te Arawa River Iwi Trust

Waikato Regional Council

Presentation format

- Sources , Pathways and Variability
- Targeting interventions
- Whatawhata case

Water Quality

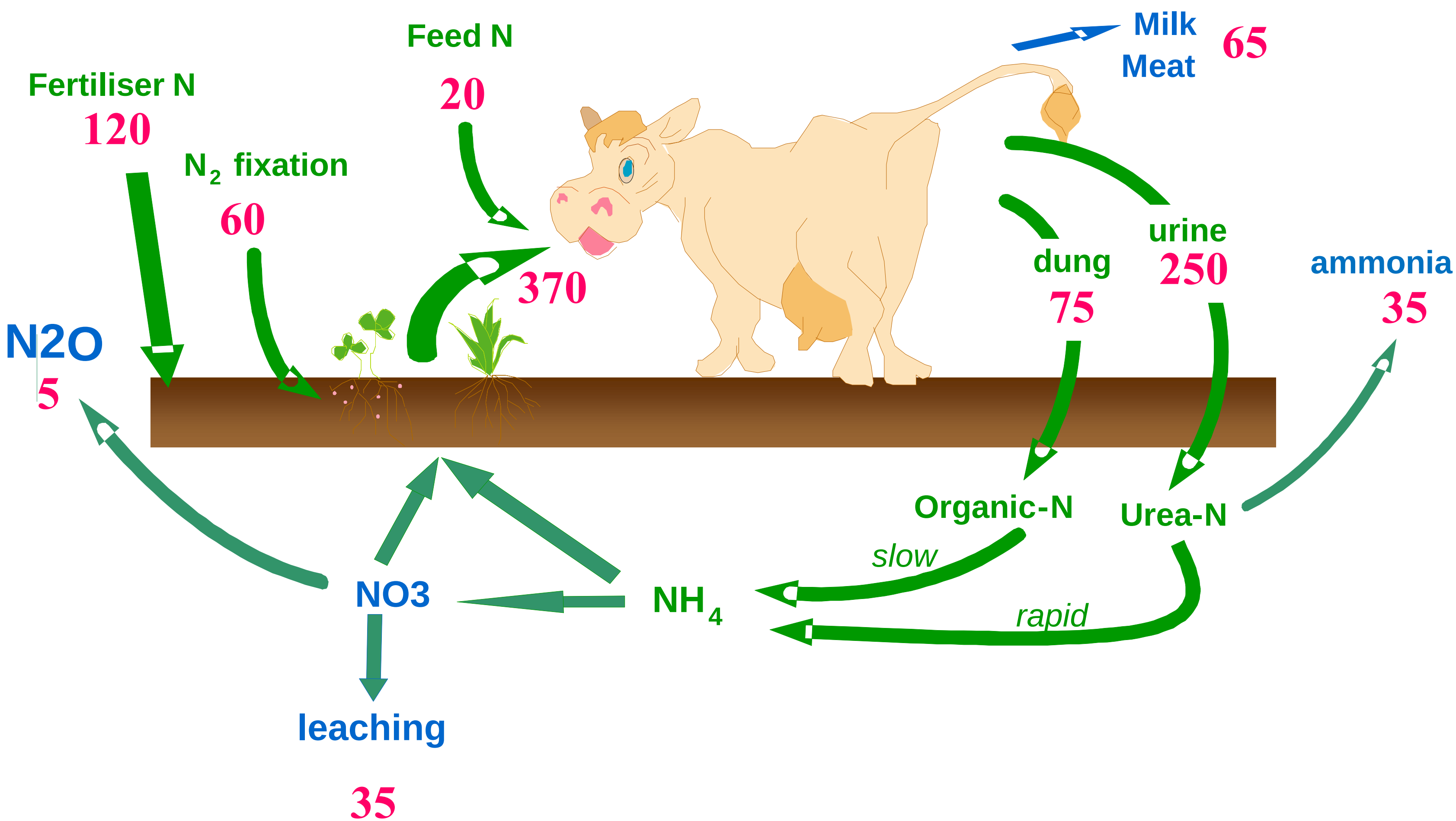
What is Water Quality?

A variable, often defined by communities, but good quality may be water that is safely drinkable, swimmable and fishable, supports cultural values and healthy ecosystems. The three main issues affecting water quality in rural settings are:

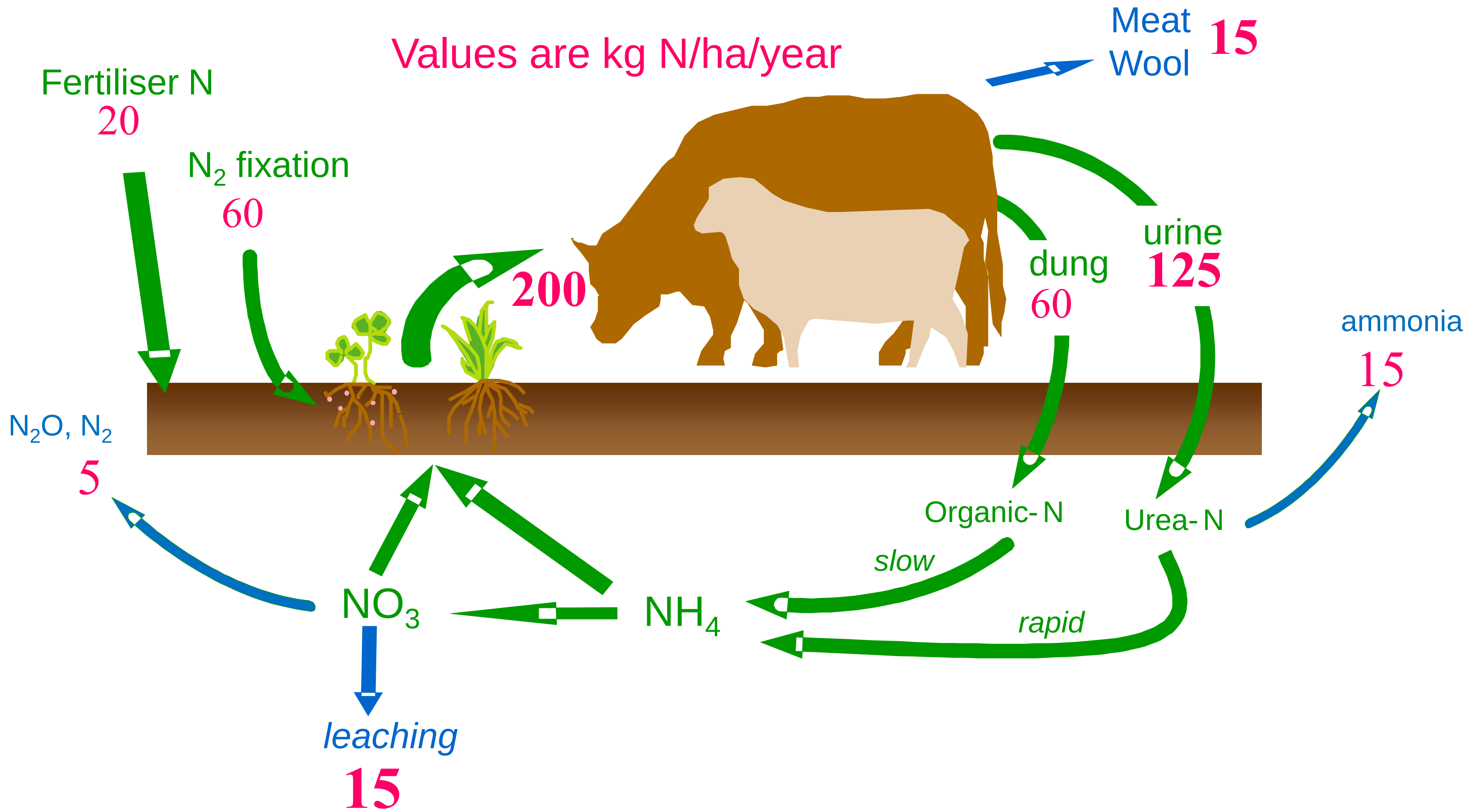
- **Suspended sediments**: that smother the beds of rivers and estuaries
- **Nutrients** (nitrogen, phosphorus): that encourage excess plant growth, algal blooms
- **Faecal microbes**: that affect human, and often animal, health.

On Farm Nitrogen cycling and losses

Values are kg N/ha/year



Nitrogen cycling and losses



Sources

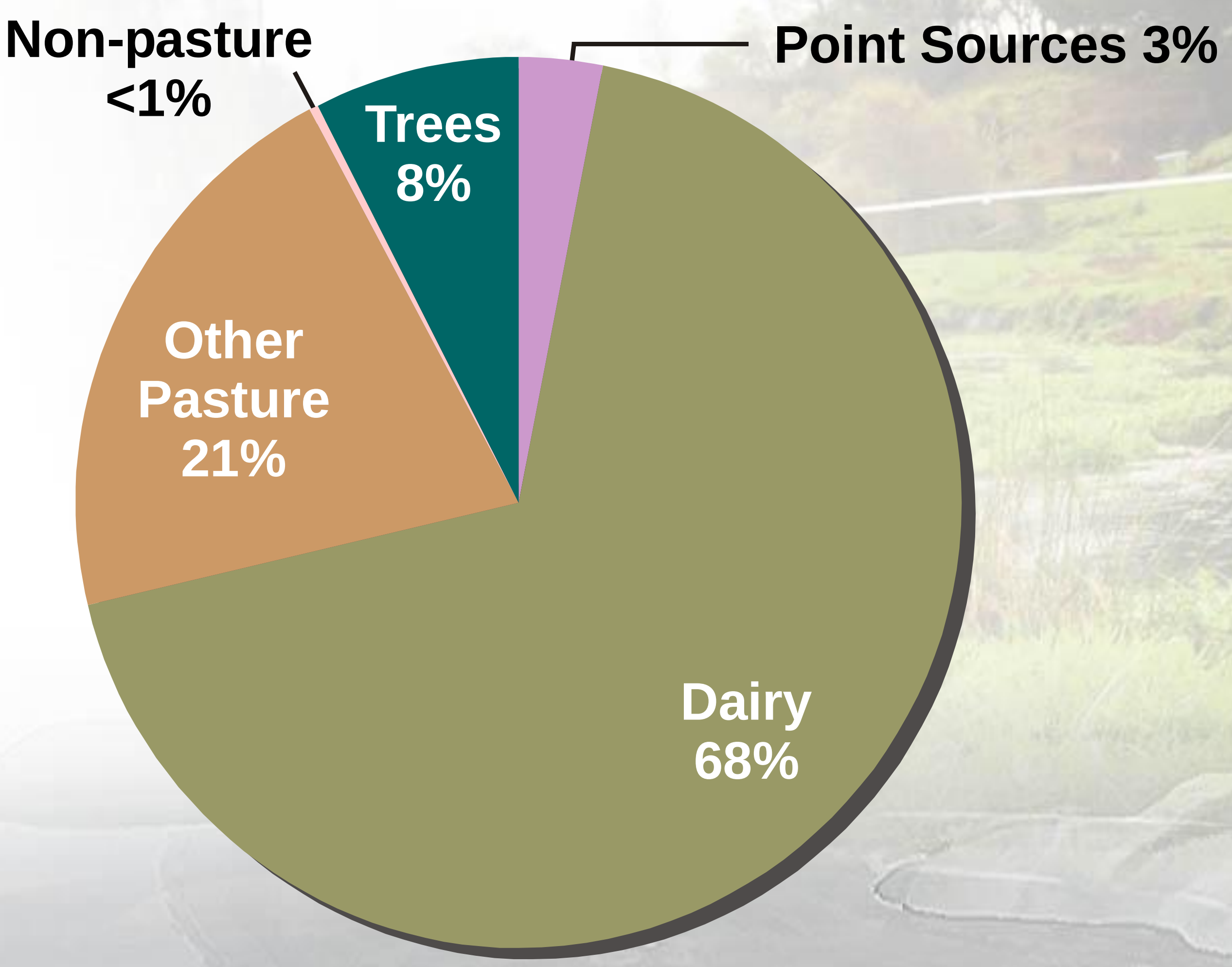
On Farm Sources of N

Nitrogen	(1) urine patches, (2) fertiliser, (3) effluent irrigation, (4) clover N-fixation, (5) rain/atmosphere

4

1 2 3

Sources of nitrogen entering streams in the Waikato region



Niwa data

Farm Sources of P

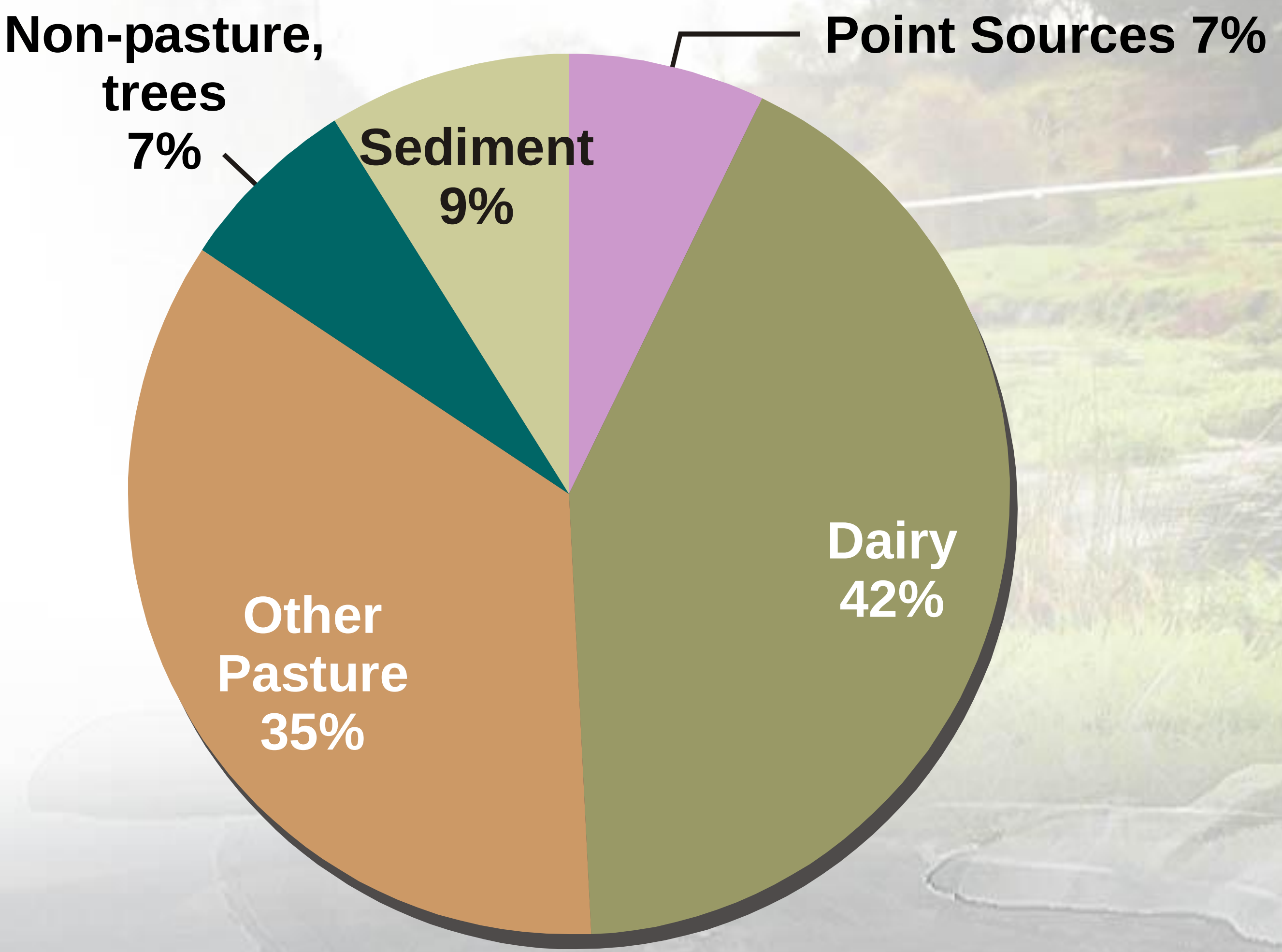
Phosphorus	(1) fertiliser, (2) soil erosion, (3) animal excreta/effluent irrigation

1

2

3

Sources of phosphorus entering streams in the Waikato region



Niwa data

Farm Sources of Sediment

(1) grazed pasture, (2) stream bank/bed erosion, (3) animal excreta, (4) animal tracks, (5) unpaved roading

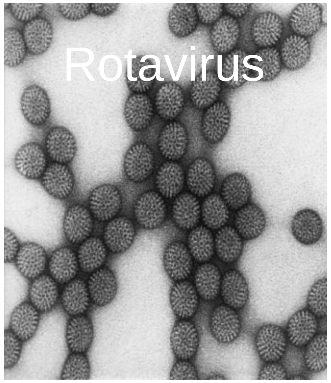
1,2

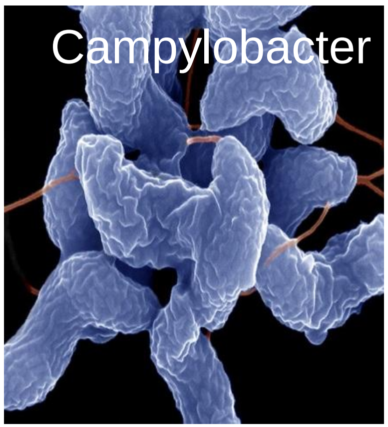
3

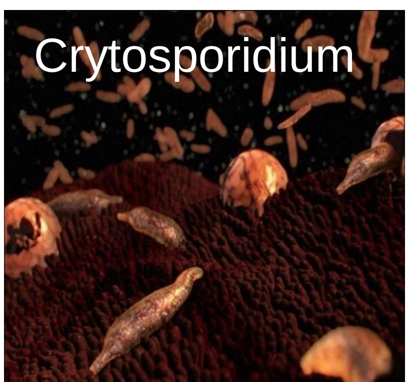
4

5

Faecal microbes what are they?







faecal microbes		
viruses	bacteria	protozoa
Indicator: enteroviruses, phages Pathogens: human enteroviruses and adenoviruses, noroviruses, rotaviruses, hepatitis A	Indicator: *E. coli* Pathogens: *E. coli*, *Campylobacter*, *Salmonella*	Indicator: *Clostridium perfringens* spores Pathogens: *Giardia*, *Cryptosporidium*

Sources of Faecal Microbes

1

(1) grazed pasture, (2) effluent irrigation, (3) wild and feral animals, (4) livestock in, or close to, waterways, (5) laneways connected to drains

2

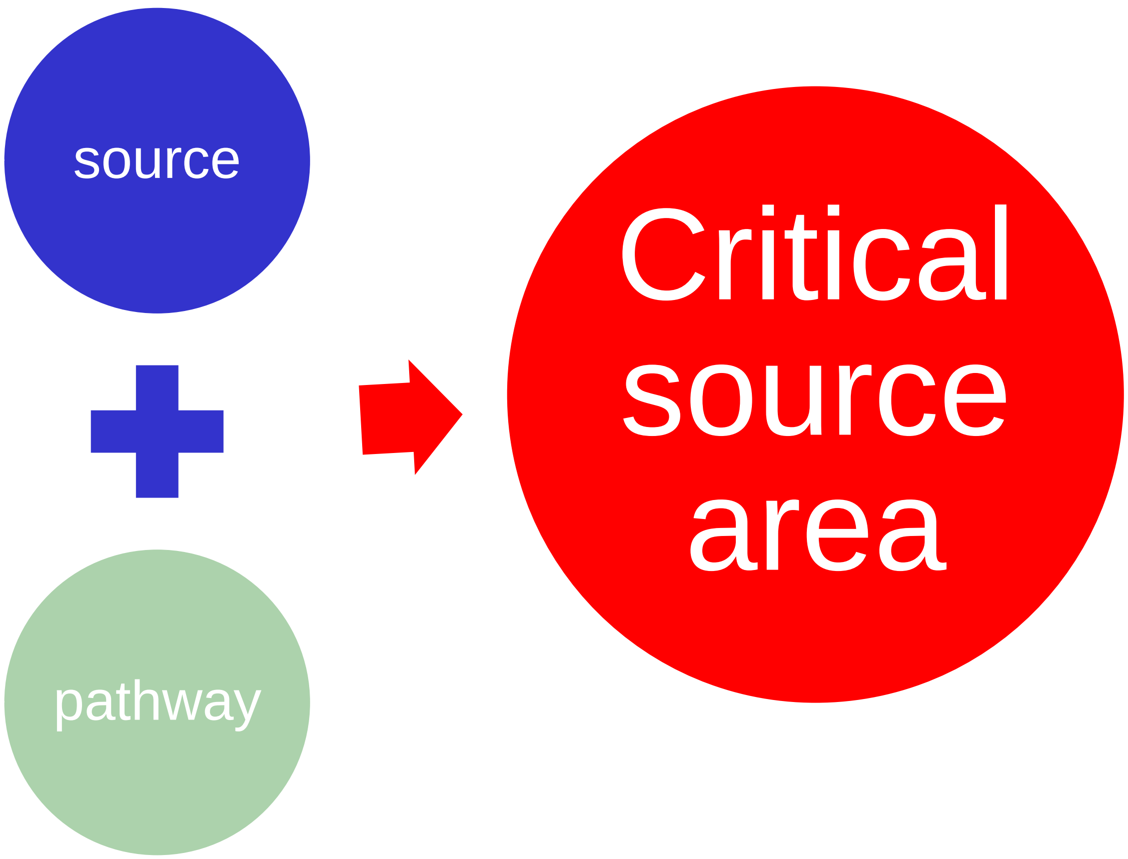
3

4

5

CRITICAL SOURCE AREAS

80% of losses come from 20% of area

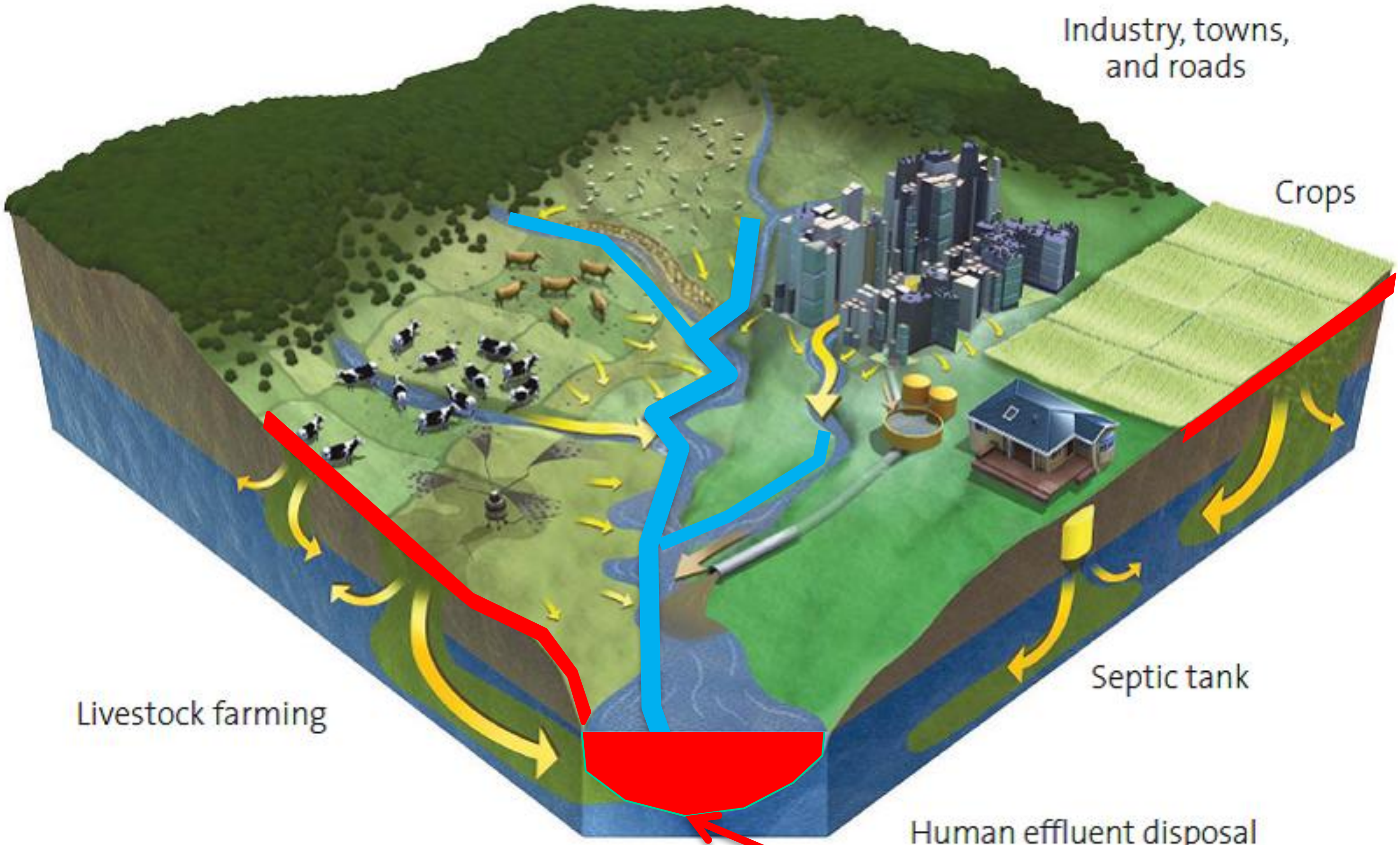


Illustrating CSA

Pathways

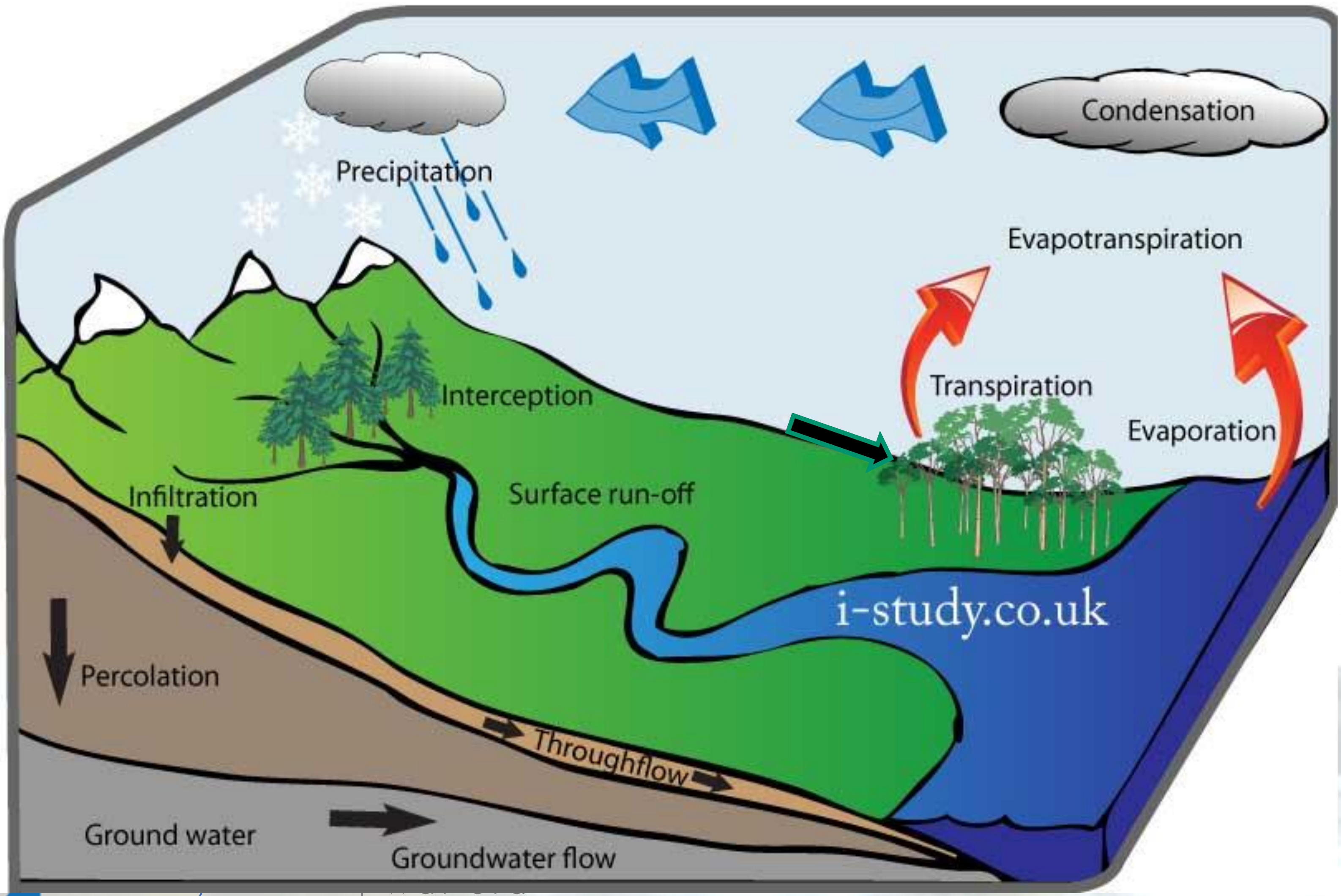
The driving force behind contaminant transfer from land to waterbodies is water, because it provides the energy and the carrier for contaminant movement.

The Challenge….Managing contaminant movement to waterways



Location where a water quality objective/ limit has been set

The Water Cycle



Attenuation

Attenuation is the permanent loss or temporary storage of nutrients, sediment or microbes during the transport process between where they are generated (i.e., in the paddock) and where they impact on water quality (i.e., a downstream water body, such as a lake).

Attenuation

- Generic attenuation processes include flow attenuation, deposition, microbial transformations, vegetation assimilation and other physical and biogeochemical processes.

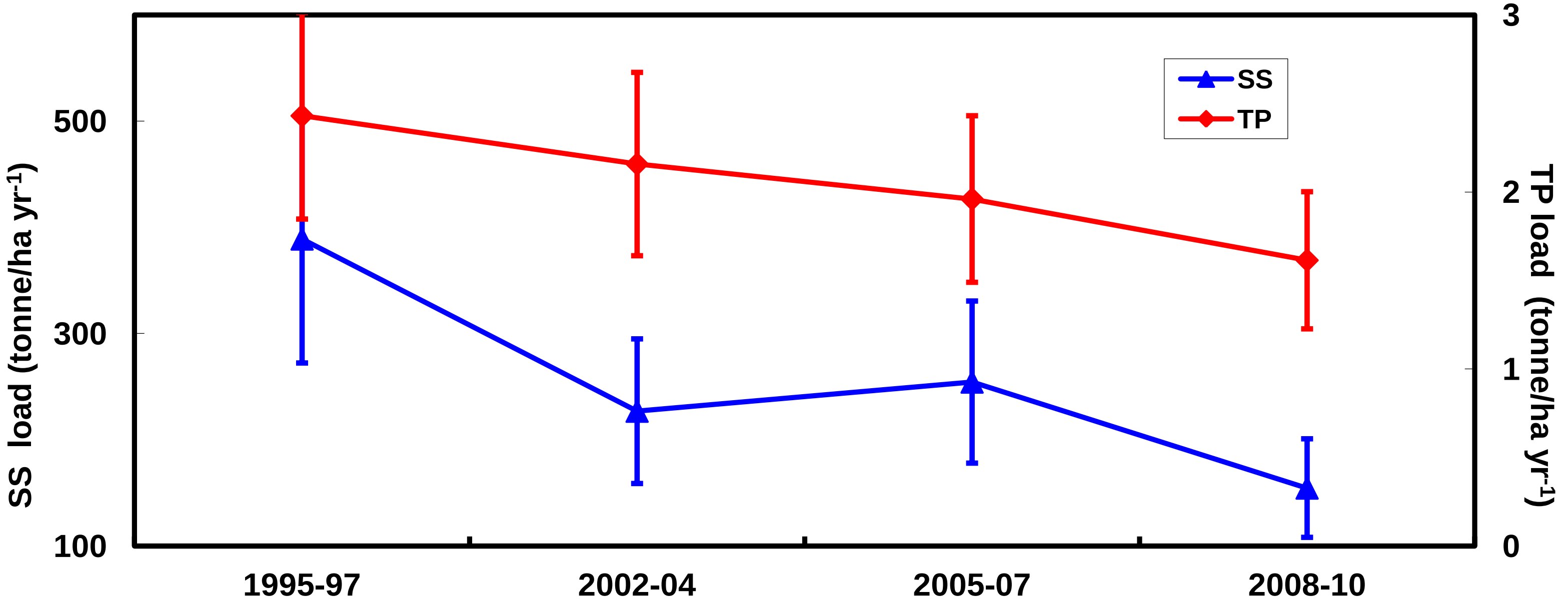
Attenuation

- These processes can alter pollutant concentrations and loads by:
- (i) decreasing the mean concentration or load,
- (ii) decreasing variability of concentration or load,
- (iii) increasing the total

Time Lags

- Hydrological and biogeochemical processes that result in long residence times of nutrient and sediment pools in catchments, stream channels and lakes and reservoirs.
- Such time lags, sometimes referred to as legacies, reflect the fact that the land-cover conversion and nutrient and sediment pollution may have occurred for decades to centuries prior to what you see today.

Variability in time
(Dairy monitor catchments)

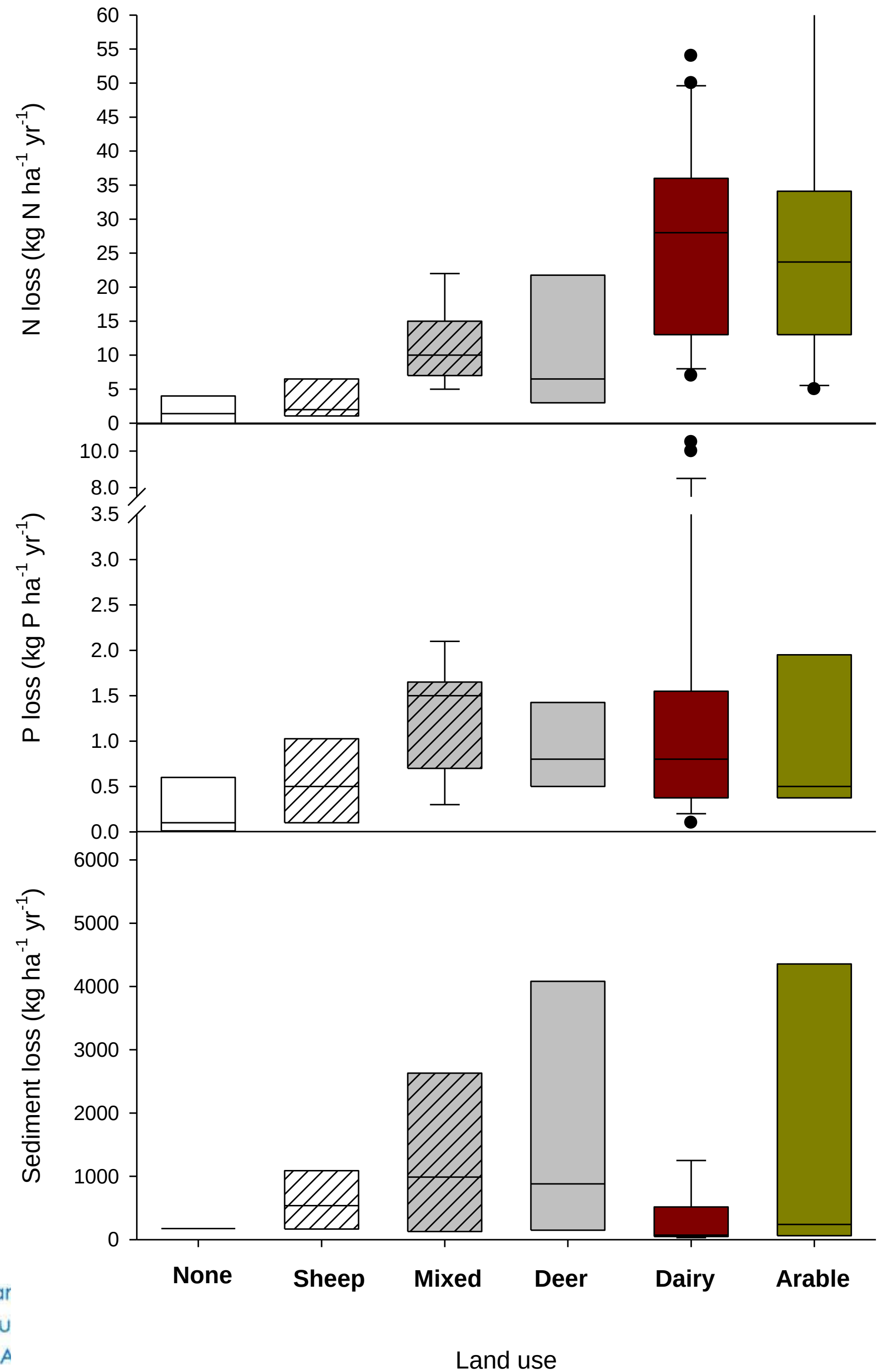


Lag in response of suspended sediments (SS) and total phosphorus (TP) to improved stock exclusion and reduced pond discharge in 1996

Variability through space and time Consequences for what and where

Variability and land use types

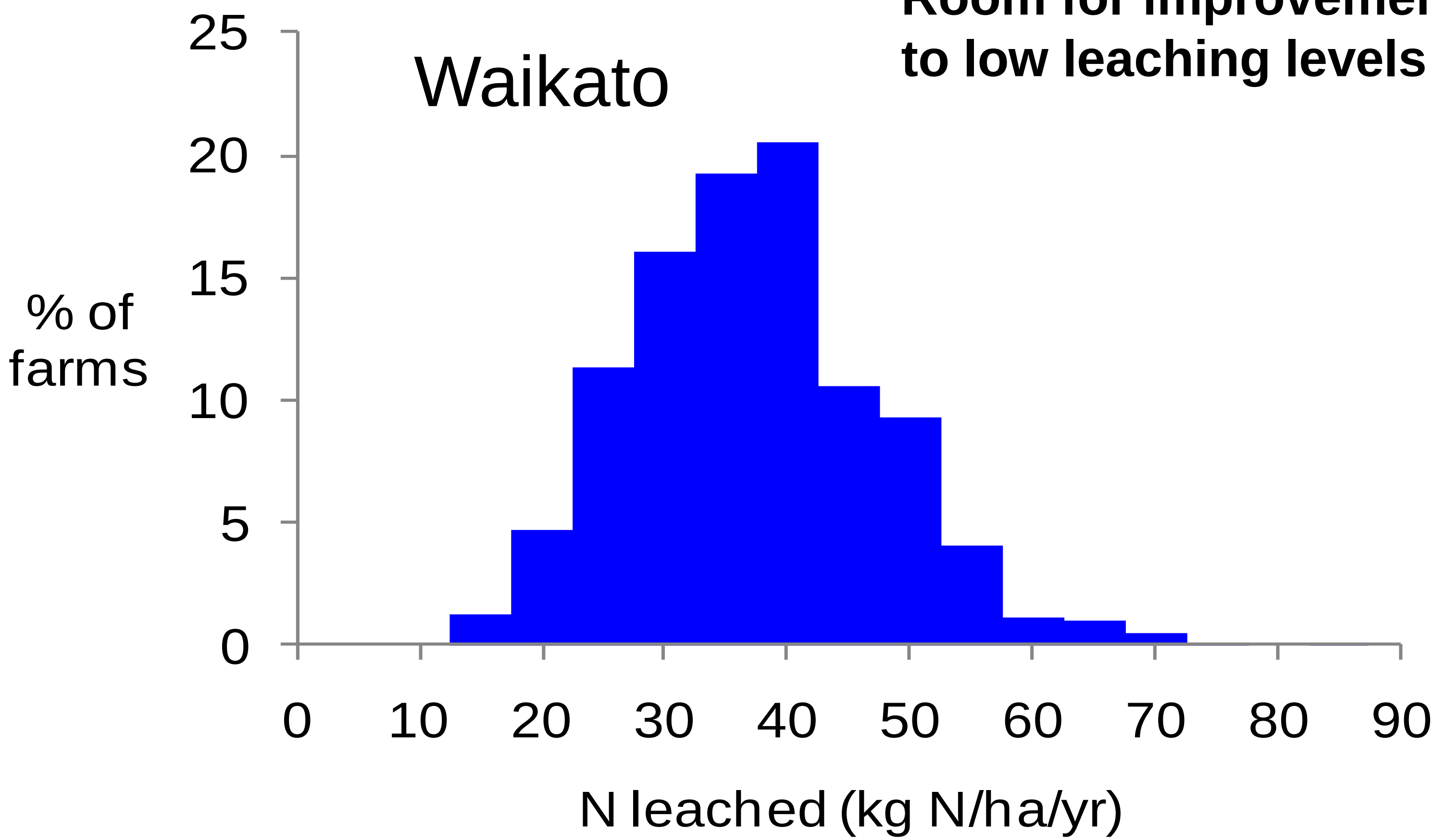
- **Different land use types result in different contaminant losses adding further spatial variability**
- The wide range of losses within a land use is due to:
  - climate
  - soil type
  - topography
  - management
- Infers much gain can be made



Variability in performance

Farm nutrient efficiency and N losses to waterways

Room for improvement to low leaching levels



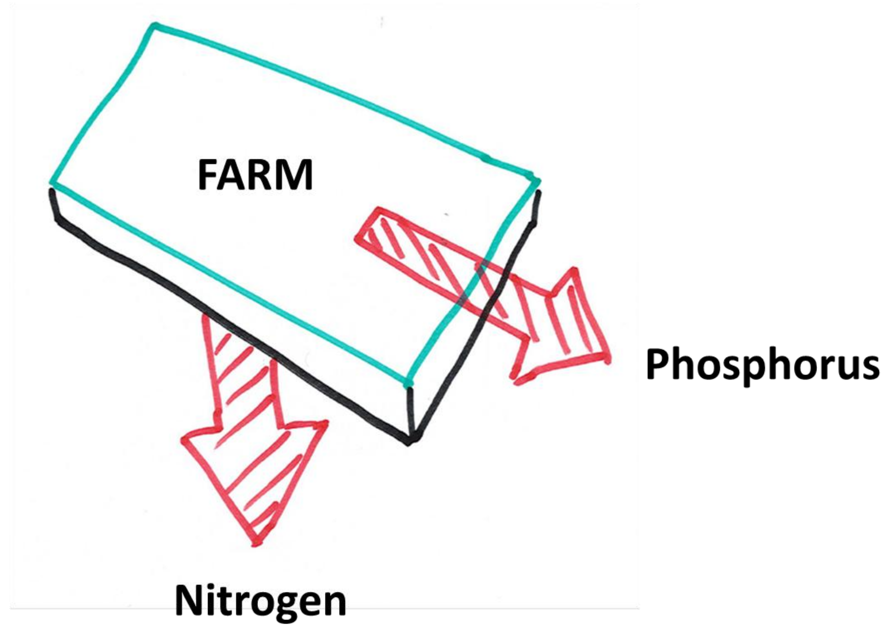
Targeting interventions; what are they?

- An instrument (e.g. a sensor)
- A system (e.g. climate forecasting)
- A farm management practice (e.g. time of application of N fertiliser)
- A product
- A catchment intervention (e.g. Riparian margins)
- Infrastructure (e.g. Irrigation scheme)

Included also are enablers of technologies such as decision support tools e.g. Crop calculator

Farm Scale

Good Management Practice



But how much when you're farming well?

Good Managemen t Practice ≠ Numeric catchment limits for nutrients

Good Management Practice

Examples:

- Whole farm (map, plan, skills)
- Land (erosion control, ground cover)
- Plant (fertiliser use, irrigation, crop residues)
- Animal (effluent, grazing)
- Other (waste, agrichemicals)

Nitrogen Interventions: Cost-effectiveness

	Low Impact (0-10%)	Medium Impact (10-30%)	High Impact (>30%)
High Cost		• Restricted grazing • Enhanced waste water treatment systems	• Winter housing and manure management
Medium Cost	• Supplementary feeding, low N diet • High sugar grass • Improved irrigation, farming practice • Greater root activity • Lipids or ionophores • High tannins	• DCD North Island • Duration control grazing • Environmental forecasting • BioChar • Soil processes, new products & formulations (commercial) • Ryegrass N use efficiency	• Constructed and managed wetlands, denitrification systems • DCD South Island • Match land to agricultural use • Diuretic supplementation or N modifier • Low N pasture • Change Animal Type
Low cost	• Optimal fertiliser management	• Effluent management • Gain in nutrient efficiencies by nutrient management, farm systems approach, overseer, • Precision agriculture - targeted mitigation high N areas • Optimise timing of pasture grazing / feed to lower N in diet	• Groundwater assimilative capacity

Improve Production Efficiency: e.g. N

Improved production efficiency of N can be achieved with higher genetic gain animals, better pastures and efficient use of artificial N, optimizing stocking rates and use of animal shelter e.g.:

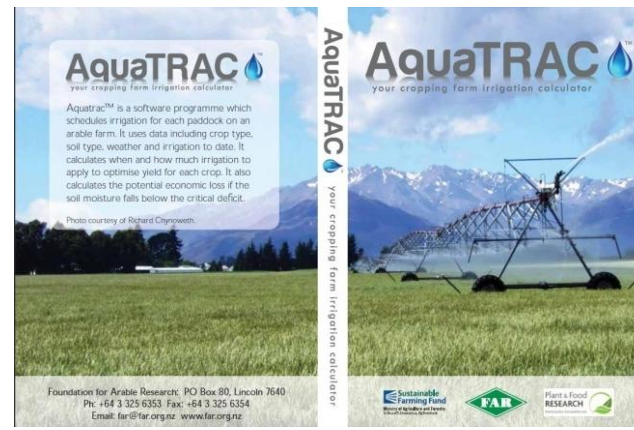
Scenario	Profit ($/ha)	Productio n (kg MS/ha	N loss (kg N/ha)
Baseline Canterbury dairy farm (modelled)	2000	1500	40
Current breeding worth & better N management	2150	1600	35
High breeding worth, low stocking rate & better N management	2450	1750	20
High breeding worth, high stocking rate & better N management	2500	2000	35

Phosphorus Interventions: Cost-effectiveness

	Low Impact (0-10%)	Medium Impact (10-30%)	High Impact (>30%)
High Cost	• Buffer strips • Natural and constructed wetlands	• Aluminium sulphate to pasture / cropland	• Sorbents in and near streams • Irrigation water use and recycling
Medium Cost	• Effluent pond storage / low rate application	• Tile drain	• Restricted grazing • Stream fencing
Low Cost		• Fertiliser management - Optimize soil P, low water soluble P fertiliser	

Precision Farming
Technology Options and Timeline

Tools developed that provide **real-time monitoring** to match the supply of water & nutrients with crop demand to maximise productivity:



2013

- Crop calculators
- Water & irrigation management tools
- Variable rate irrigation

2016

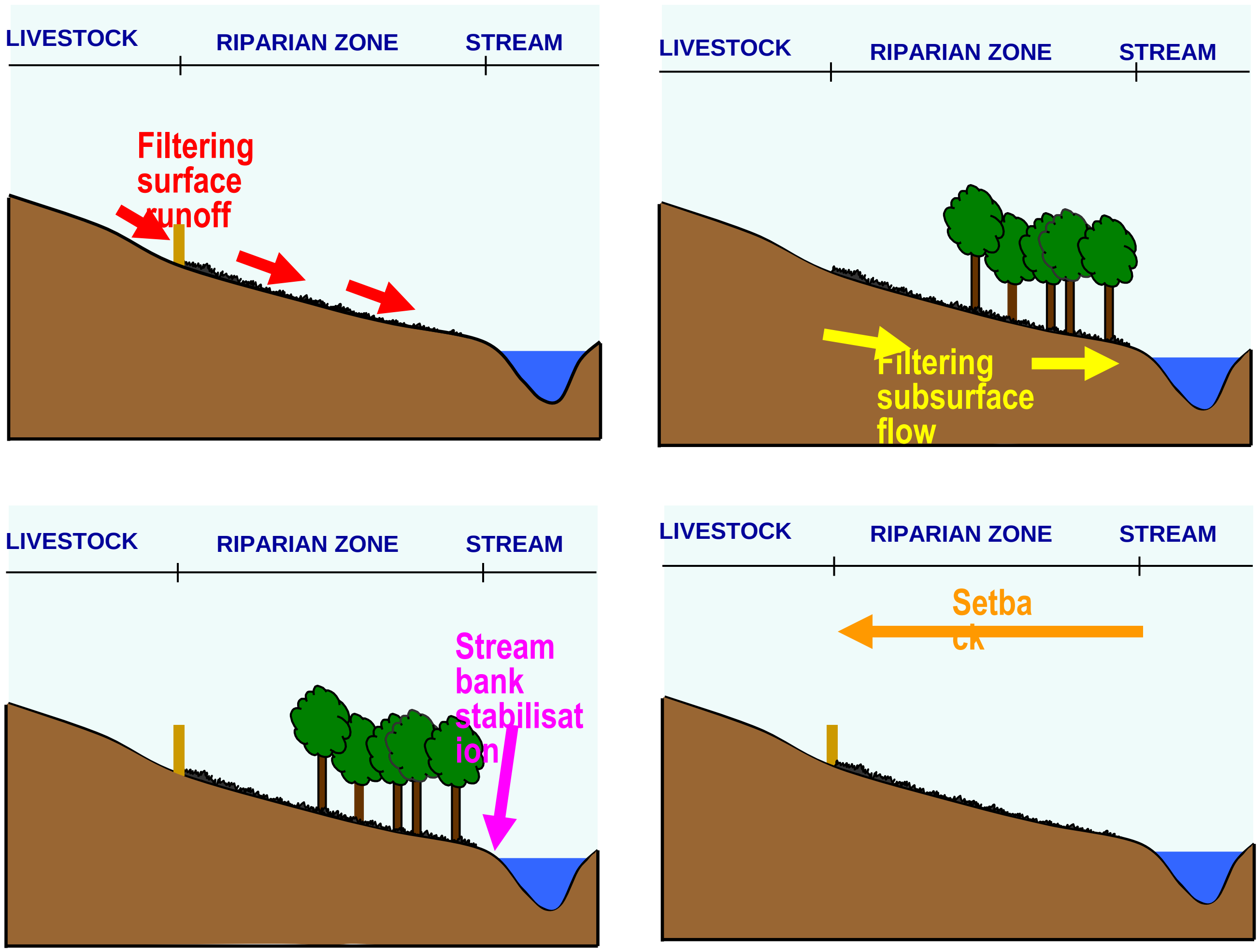
- New crop calculators developed (e.g. onions, kiwifruit)
- Advanced climate and weather forecasting
- Advanced irrigation scheduling

Next generation dairy farms P 21 II

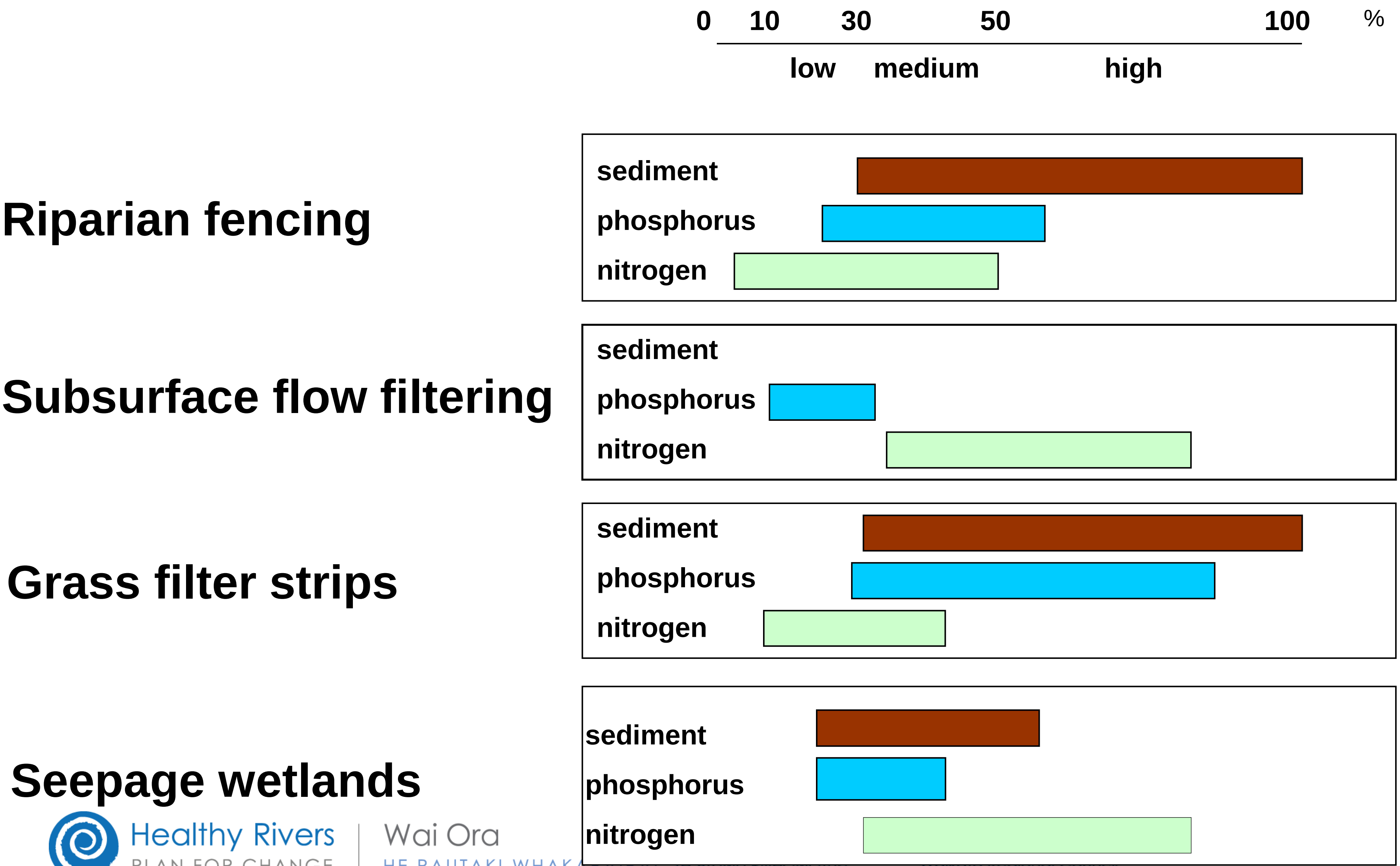
- Waikato:
- Higher genetic merit cows, lower stocking rate, lower replacement rate, off-paddock periods in autumn/winter, reduced N fertiliser inputs and improved dietary balance

Catchment Scale

Buffers & contaminants



Performance comparison



Waiokura WQ trends 2001/08

Parameter	Trend	Reasons
Sediment	40% ↓	Riparian management
Faecal bacteria	40% ↓	Riparian management Fewer Pond discharges
Nitrate N	14% ↑	More cows/Increased N fertiliser use
Total P	30% ↓	Riparian management Fewer pond discharges Less P fertiliser used

More milk from catchment **AND** environmental expectations being met

Catchment Interventions: Cost-effectiveness

	Low Impact (0-10%)	Medium Impact (10-30%)	High Impact (>30%)
High Cost		• Constructed wetland and managed natural wetlands • Improved waste water treatment technologies	
Medium Cost			• Catchment-wide riparian management • Storm-flow mitigation
Low Cost		• Riparian management guidelines	• Environmental forecasting, detailed time and space • Critical source area mapping and targeted controls

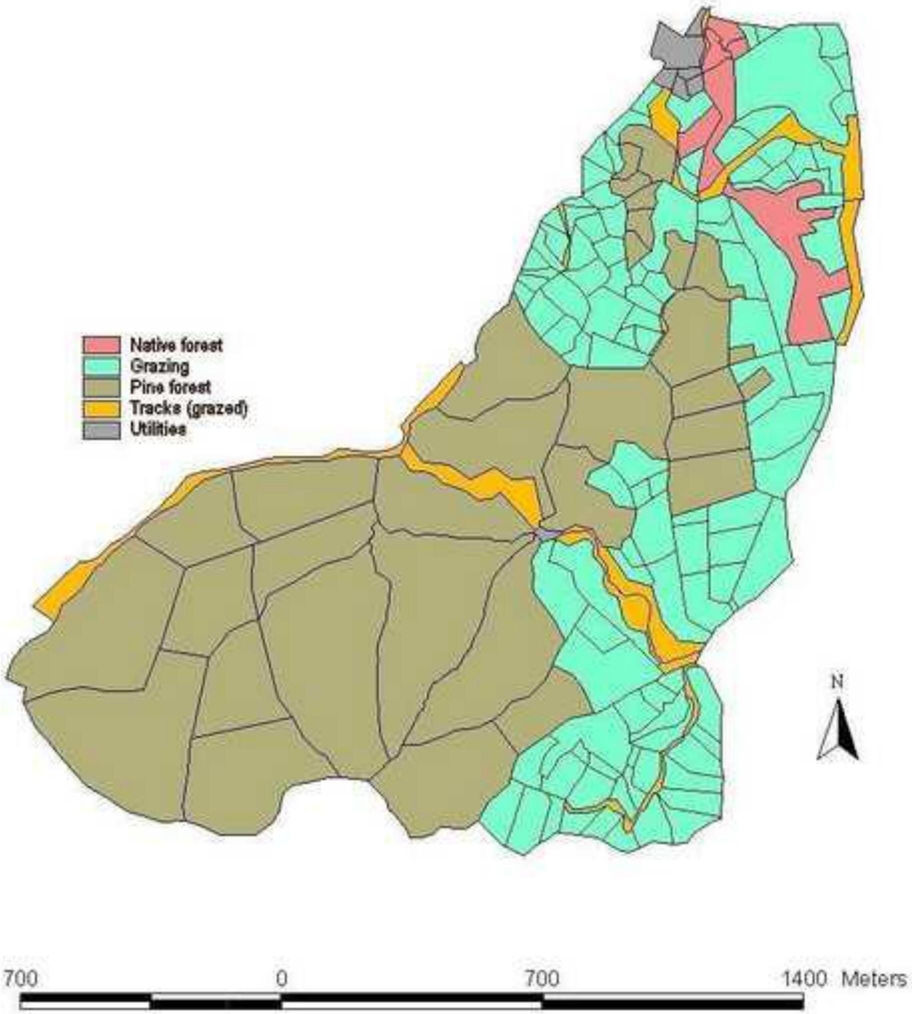
Technical Leaders Group

Healthy Rivers PLAN FOR CHANGE | Wai ora HE RAUTAKI WHAKAPAIPAI

Ambulance at the bottom of the cliff- Catchment Restoration interventions

Intervention	
Sediment capping	Lake Okaro (30 ha) modified zeolite application c. $75,000 p.a. over 3 years
Phosphorus inactivation	Lake Rotorua alum dosing $1M p.a.
Dredging	Expensive although costs will vary considerably depending on circumstances
Oxygenation/destratification	Destratification trial in lake Rotoehu (790 ha): $524,000
Hypolimnetic withdrawal	Limited application so far in NZ but proven to be "low cost" in Europe and USA.
Weed harvesting	Hornwort harvesting in Lake Rotoehu (790 ha): $52,800 p.a. ⇒$22/kg N and $165/kg P
Diversions	Ohau Channel wall in Lake Rotoiti (124 ha): $10 million

Whatawhata Case



Healthy River
PLAN FOR CHANG

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