LAND & WATER SCIENCE

Physiographic Environments of New Zealand:

An integrated landscape classification for understanding variation in water quality

CLINT RISSMANN, LISA PEARSON, JESSIE LINDSAY & MATT COULDREY

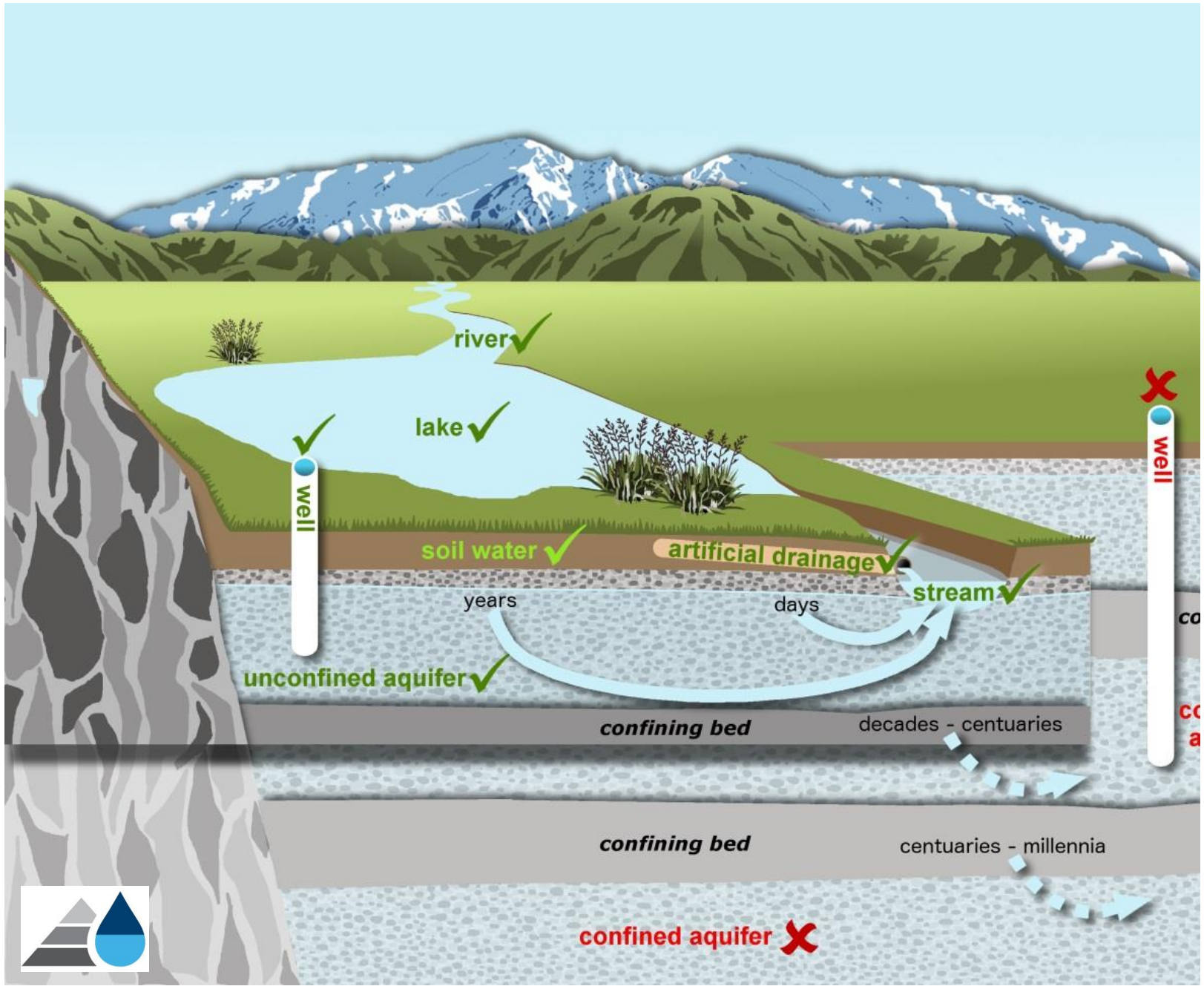
OUR LAND AND WATER
Toitū te Whenua, Toiora te Wai
National SCIENCE Challenges
LIVING WATER
Fonterra Dairy for life
Department of Conservation Te Papa Atawbai

Setting

Focus on surface and shallow ground water

Regions

- Northland
- Auckland
- Waikato
- Bay of Plenty
- Manawatu-Wanganui
- Canterbury
- Southland



Water contains lots of information (signals)

Lots of information in water regarding processes:

- Redox
- Major ion facies
- Isotopic
- Saturation indices
- Physical and biological sign

= Water Composition

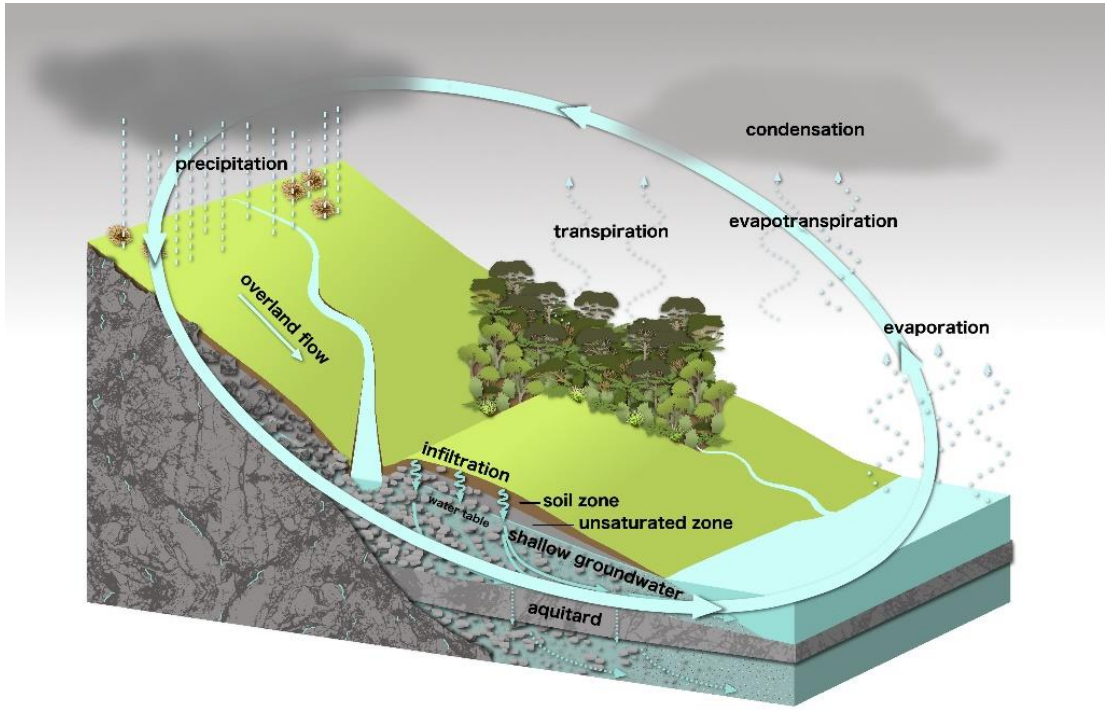
Not just N,P, sediment, and microbes

Relationship between landscape attributes and processes

Landscape **attributes** control the variation in **processes** that determine water composition

Key processes are:

- Atmospheric
- **Hydrological**
- **Redox**
- Weathering

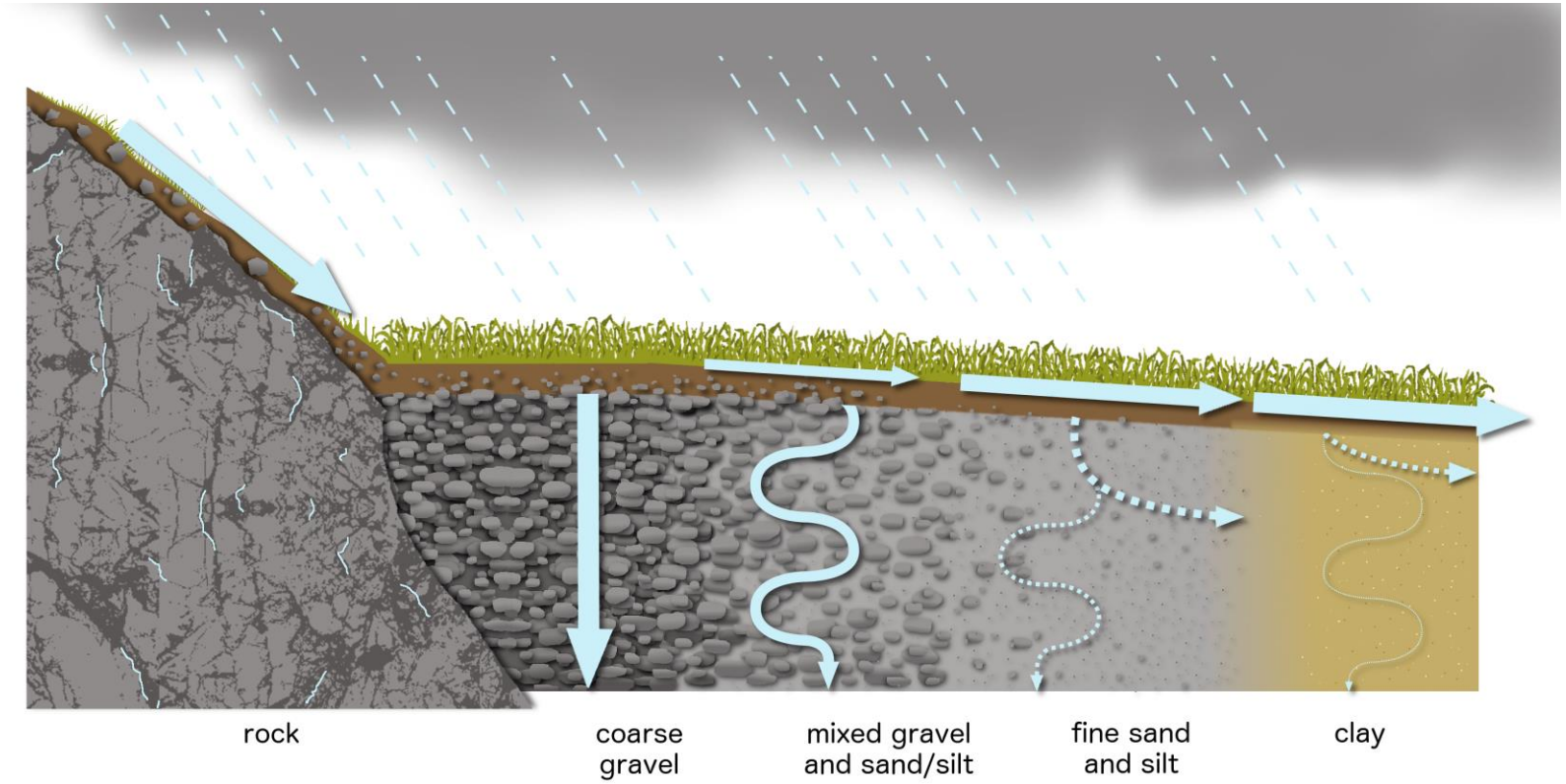


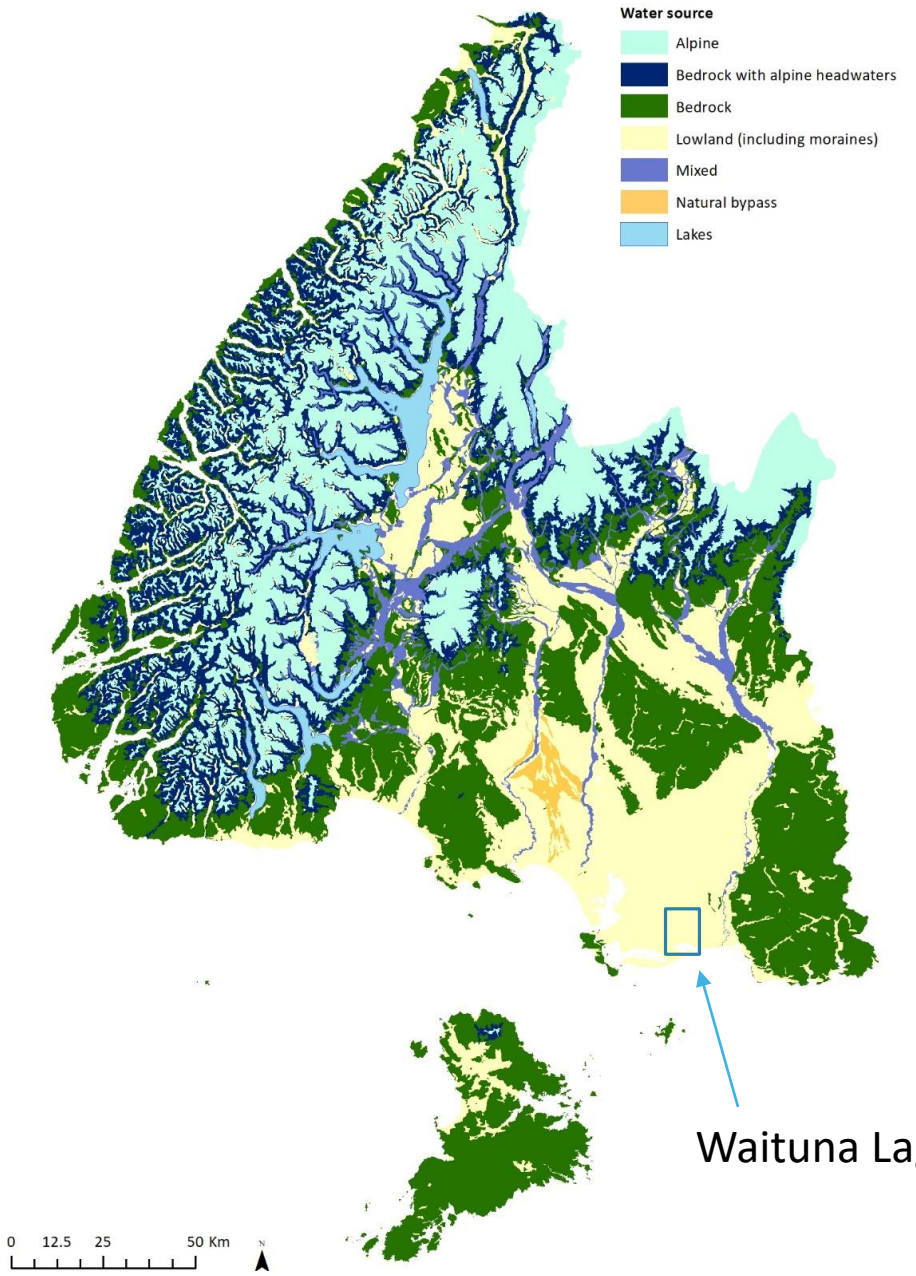
These processes occur in both natural state and areas of intensive land use

Hydrological Process-Attribute Layer (H-PAL)

Landscape controls over:

1. Water source (where does the water in a stream or aquifer originate from),
2. Recharge mechanism (the broad scale mechanism/process by which water reaches an aquifer or stream), and
3. Water pathway (fine scale mechanism/process controlling the pathway water takes – bypass flow, overland flow, lateral drainage and deep drainage).



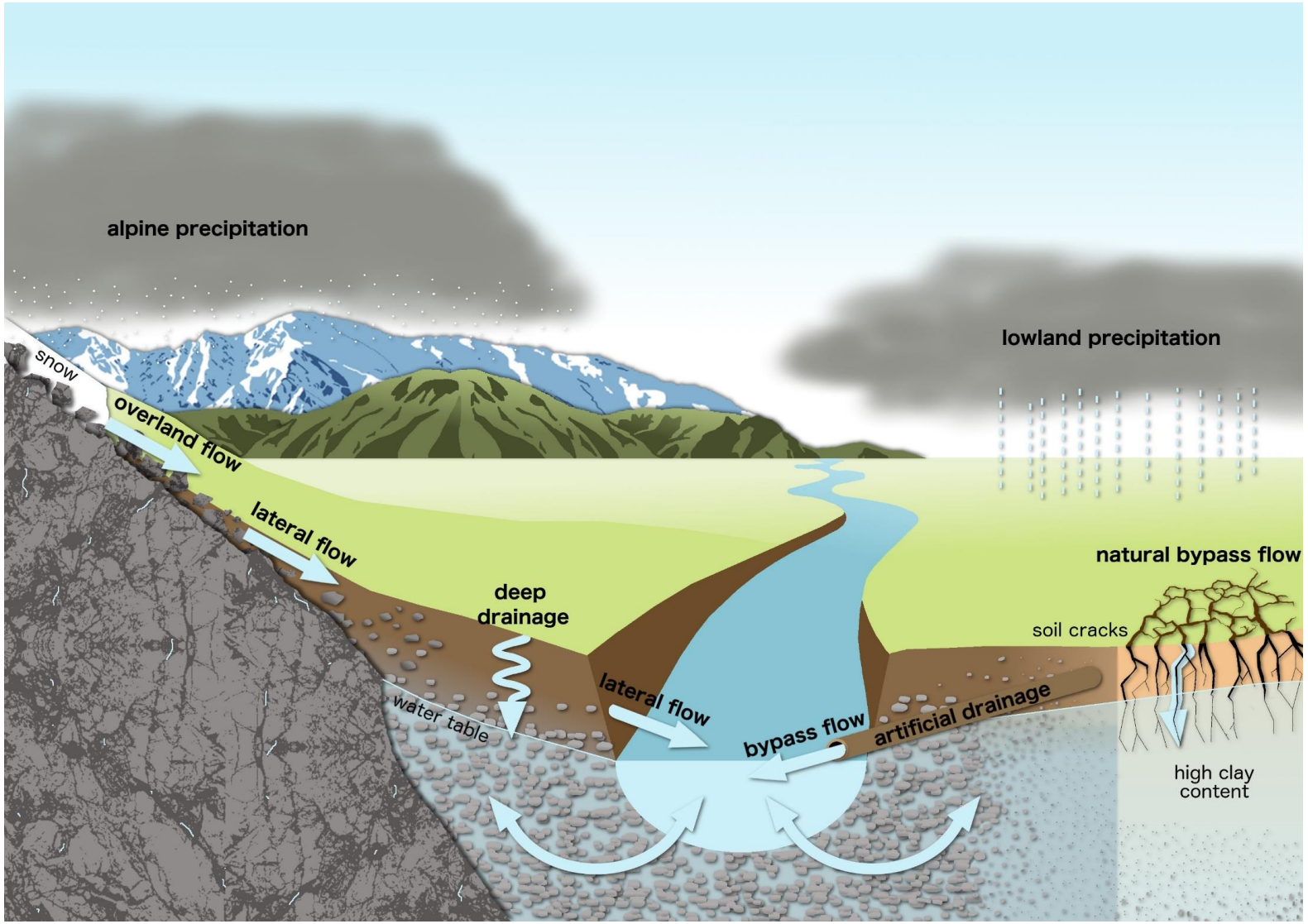


Water Source and Recharge Mechanism

Regional Scale Domain

Important for understanding

1. Altitude of water source
2. Recharge flux
3. Dilution potential
4. Transport mechanism

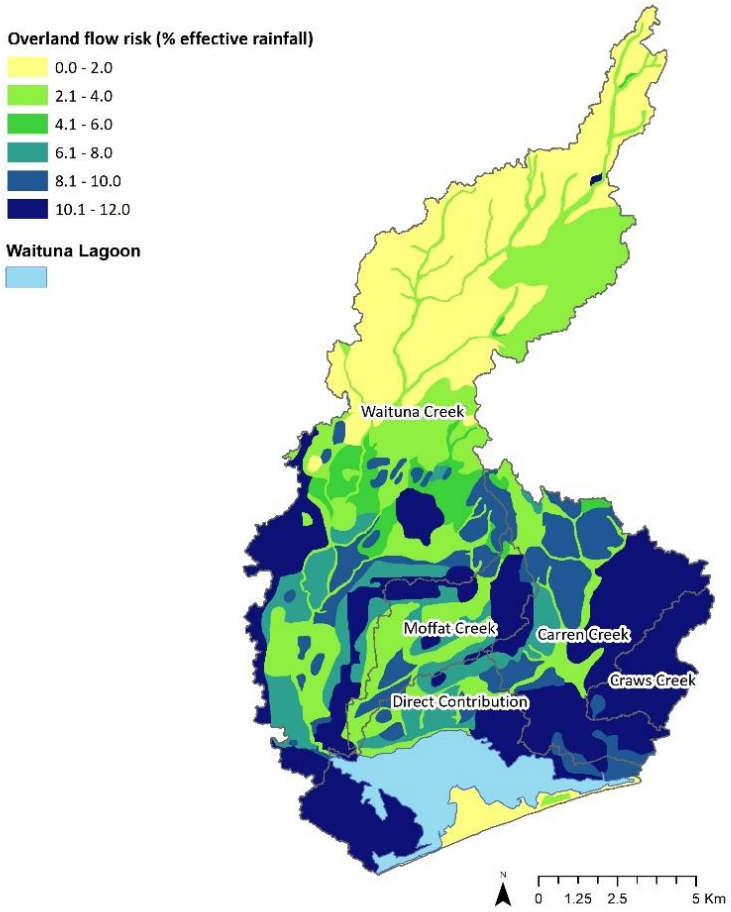


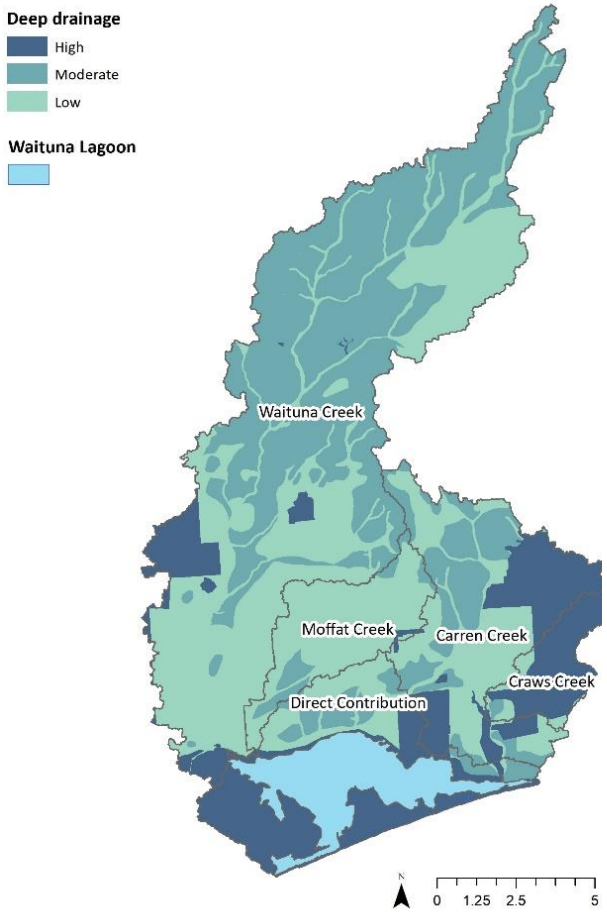
Hydrological Flow path

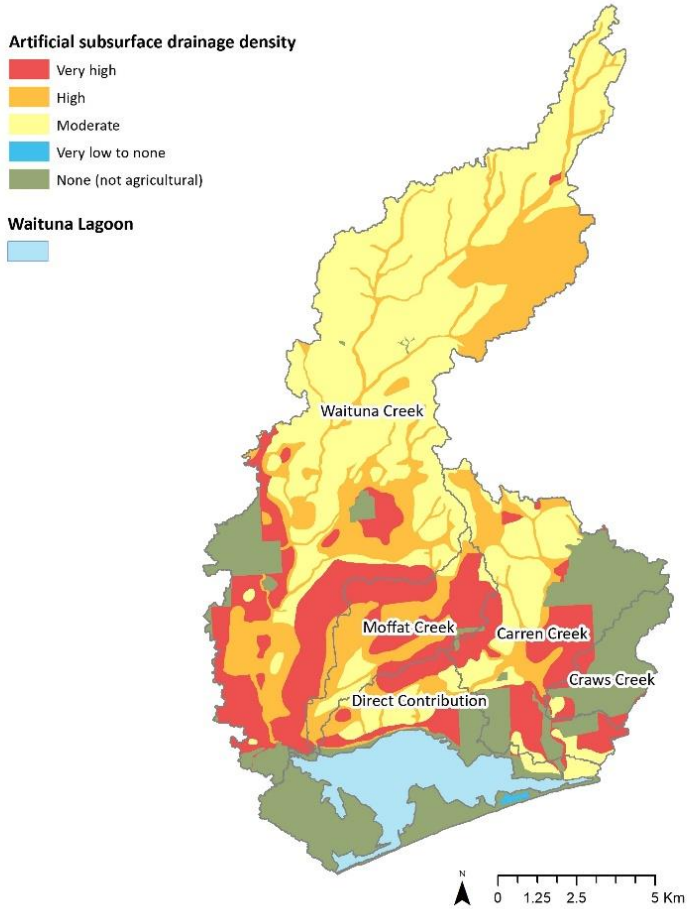
Water Pathway

(Catchment to Farm scale)

- Deep drainage
- Overland flow
- Artificial drainage
- Lateral flow
- Natural bypass



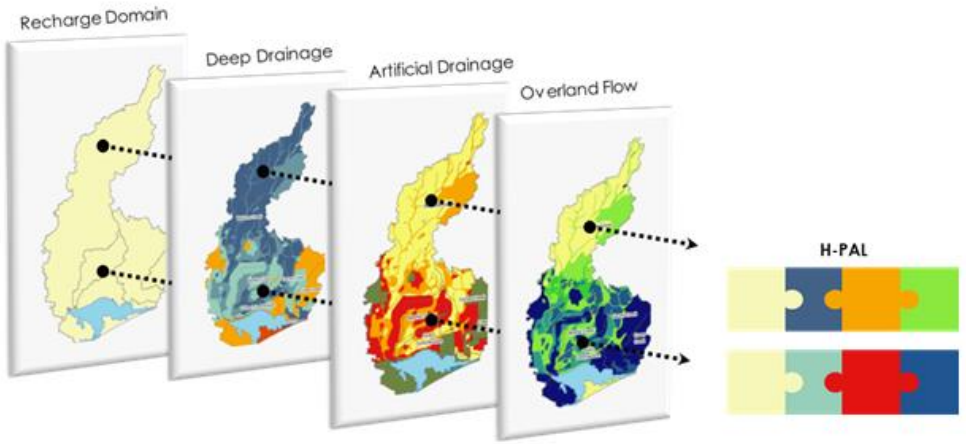


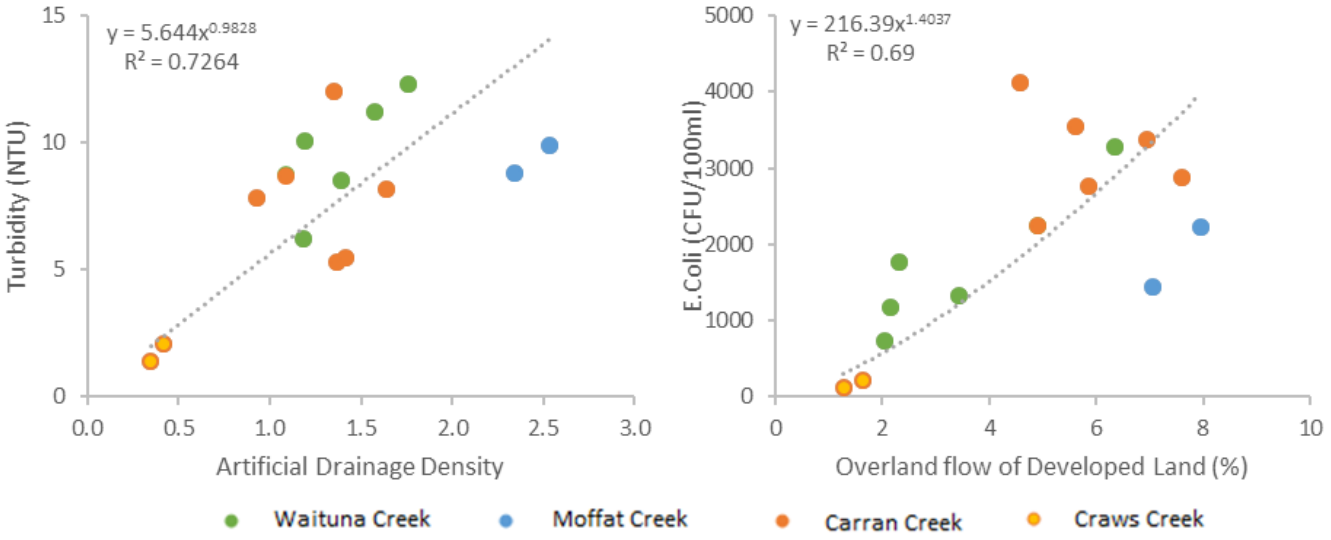


Overland flow

Deep Drainage

Artificial Drainage





Hydrology PAL

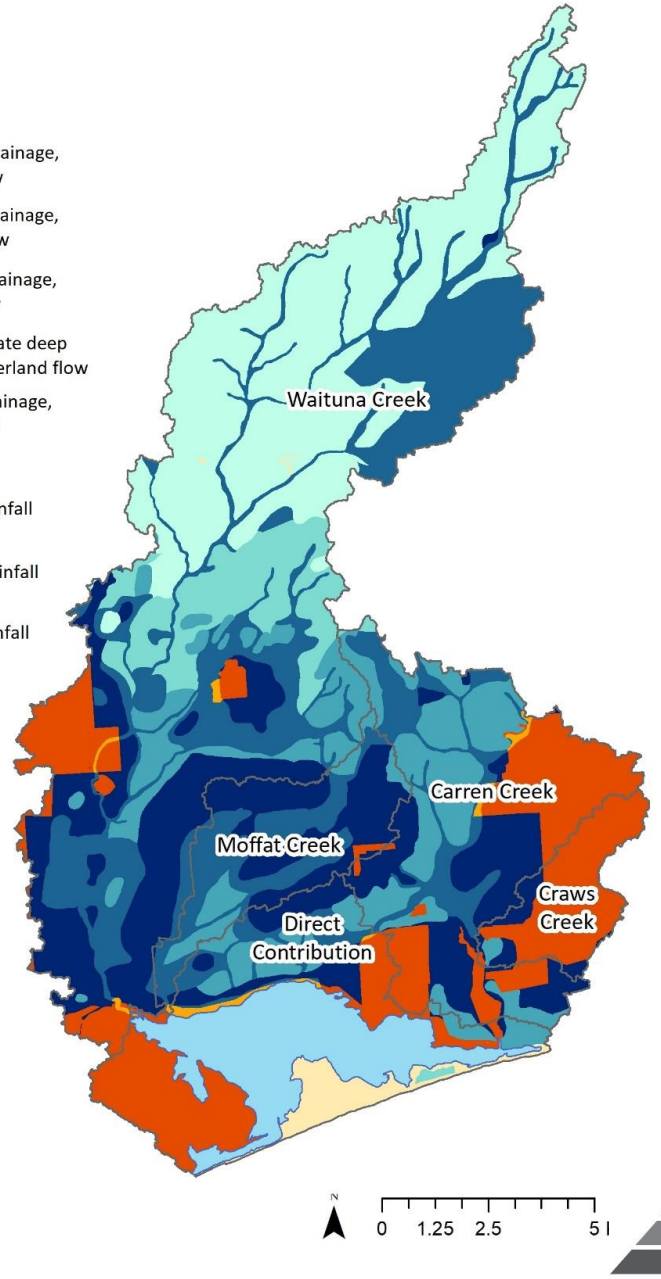
Developed Land

- Low artificial drainage, high deep drainage, <2% annual rainfall as overland flow
- Low artificial drainage, high deep drainage, 2-6% annual rainfall as overland flow
- Low artificial drainage, high deep drainage, >6% annual rainfall as overland flow
- Moderate artificial drainage, moderate deep drainage, 2-6% annual rainfall as overland flow
- High artificial drainage, low deep drainage, >6% annual rainfall as overland flow

Natural State

- High deep drainage, <2% annual rainfall as overland flow
- High deep drainage, 2-6% annual rainfall as overland flow
- High deep drainage, >6% annual rainfall as overland flow

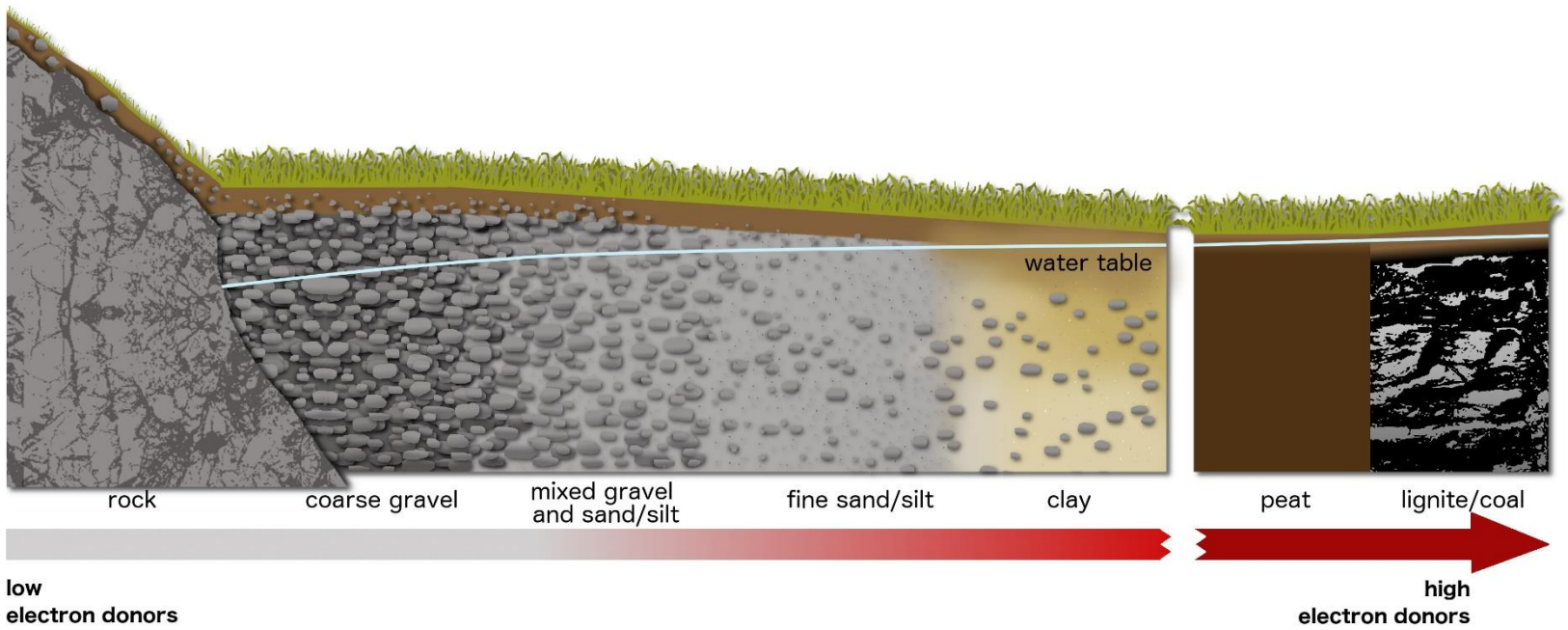
Waituna Lagoon

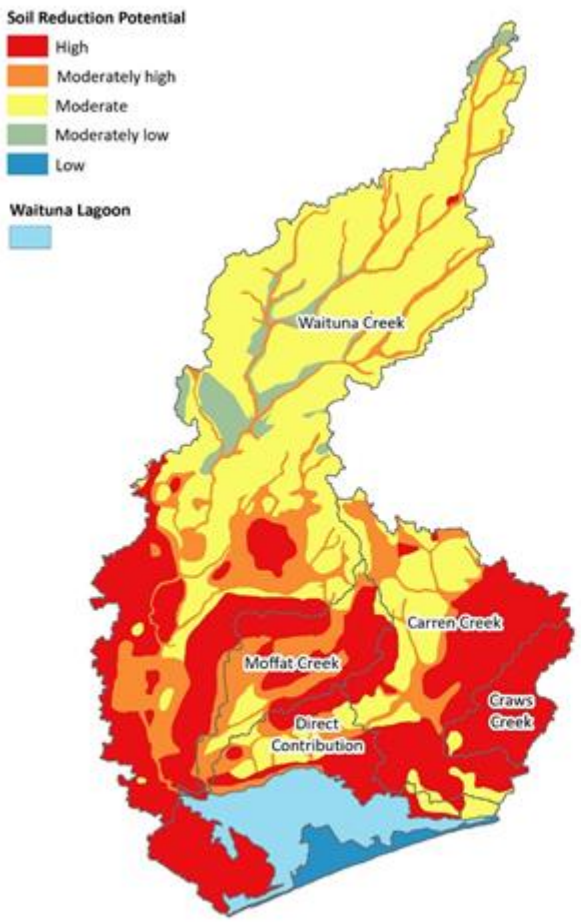


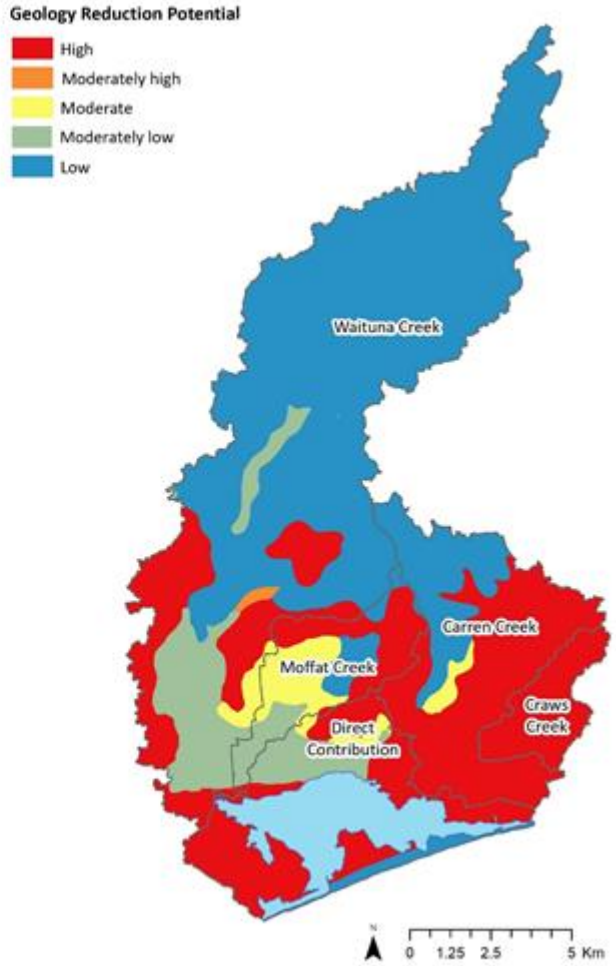
Redox Process-Attribute Layer (R-PAL)

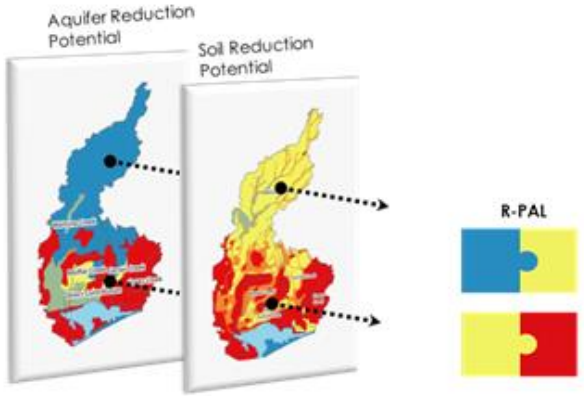
Soil and aquifer reduction potential controls:

1. denitrification
2. the solubility, leachability and mobility of redox sensitive species

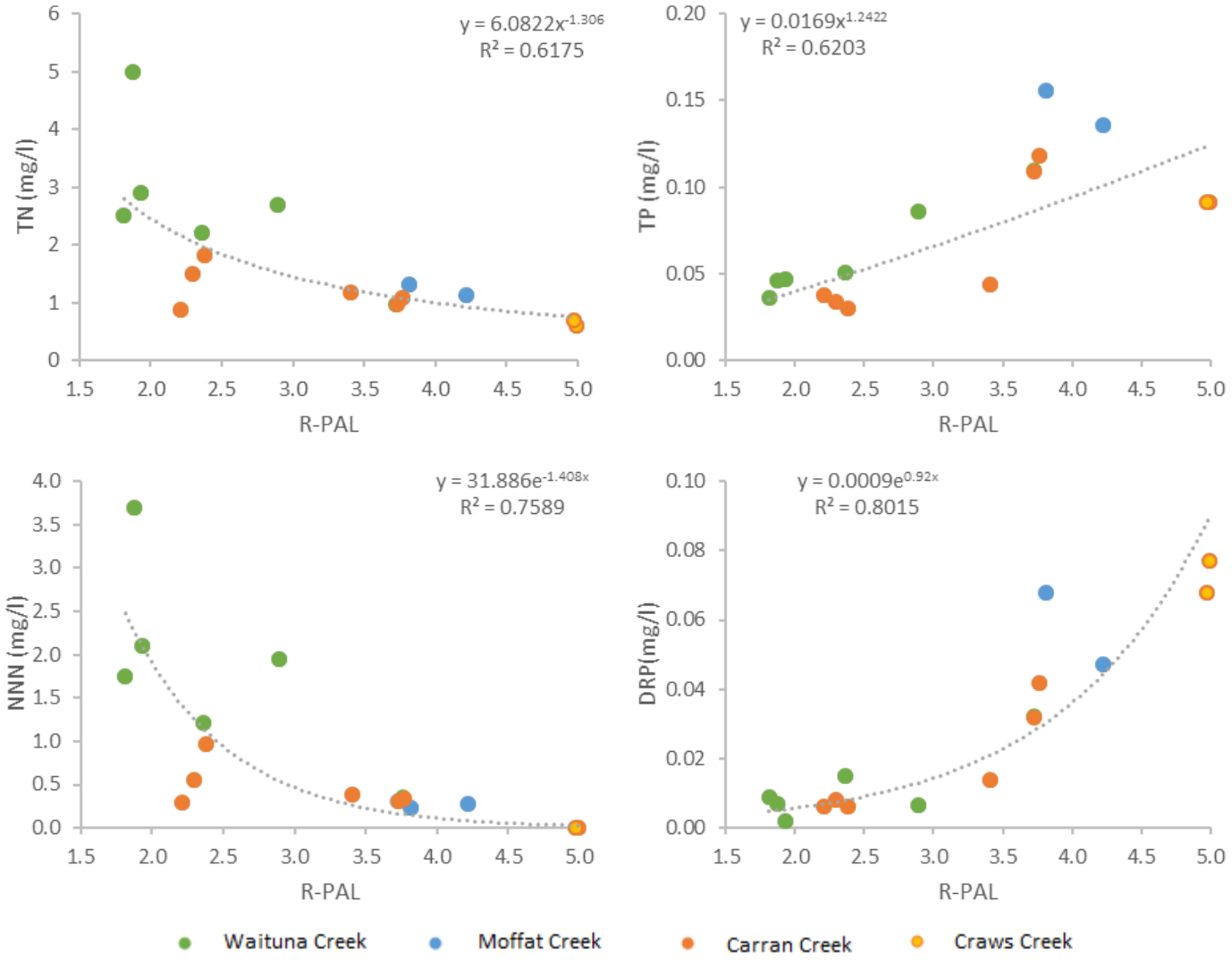


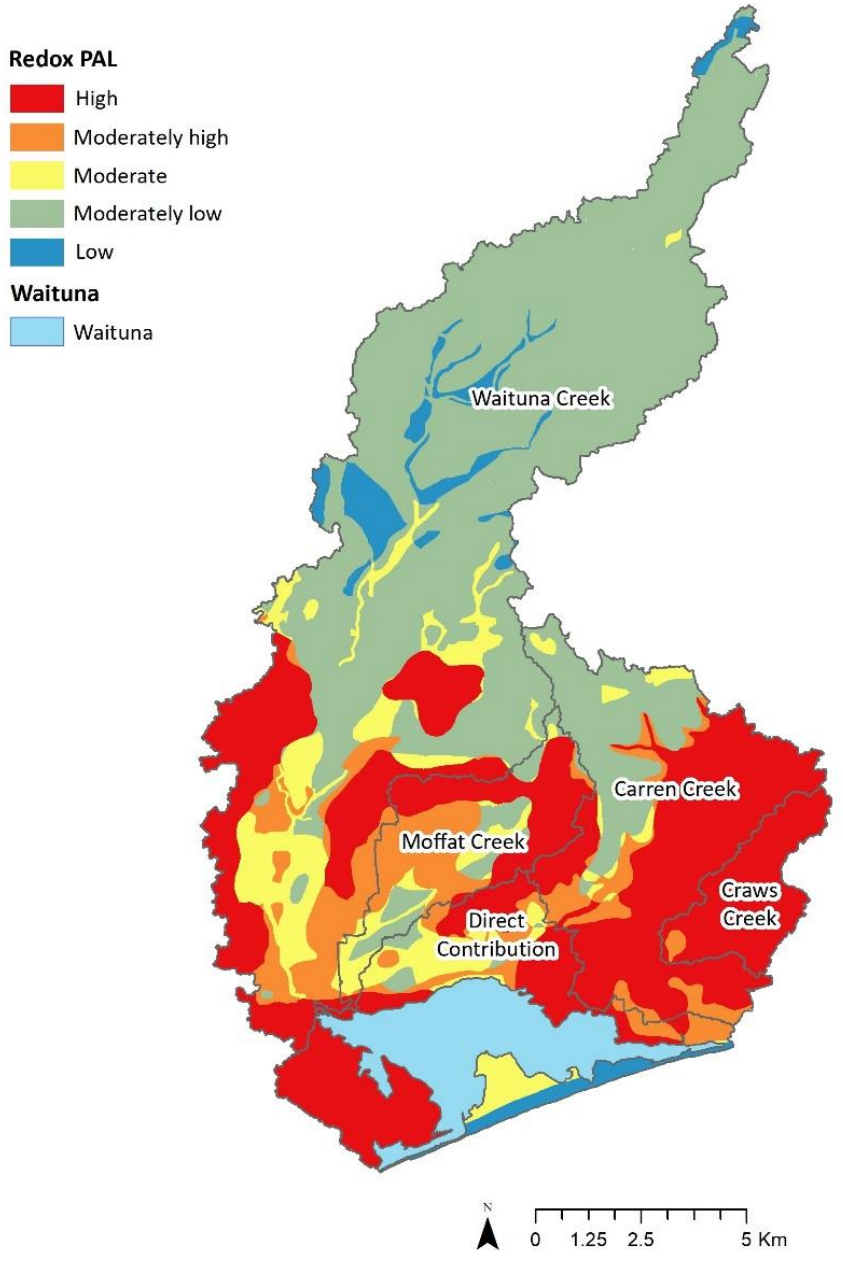




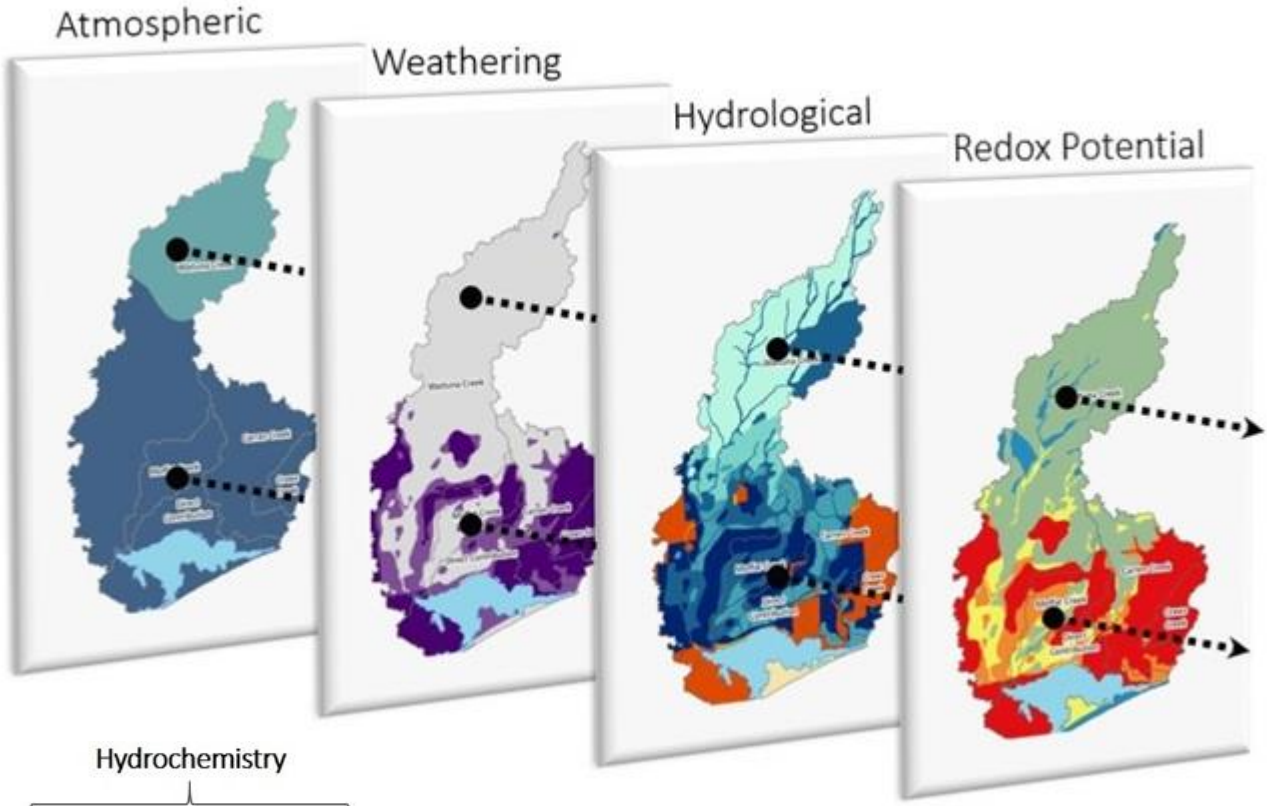


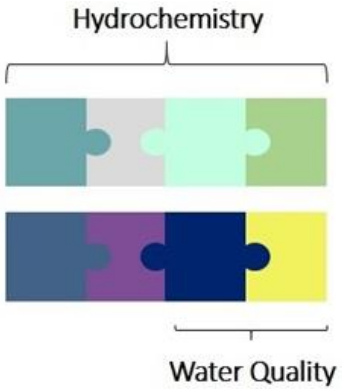
Soil Reduction Potential Geological Reduction Potential

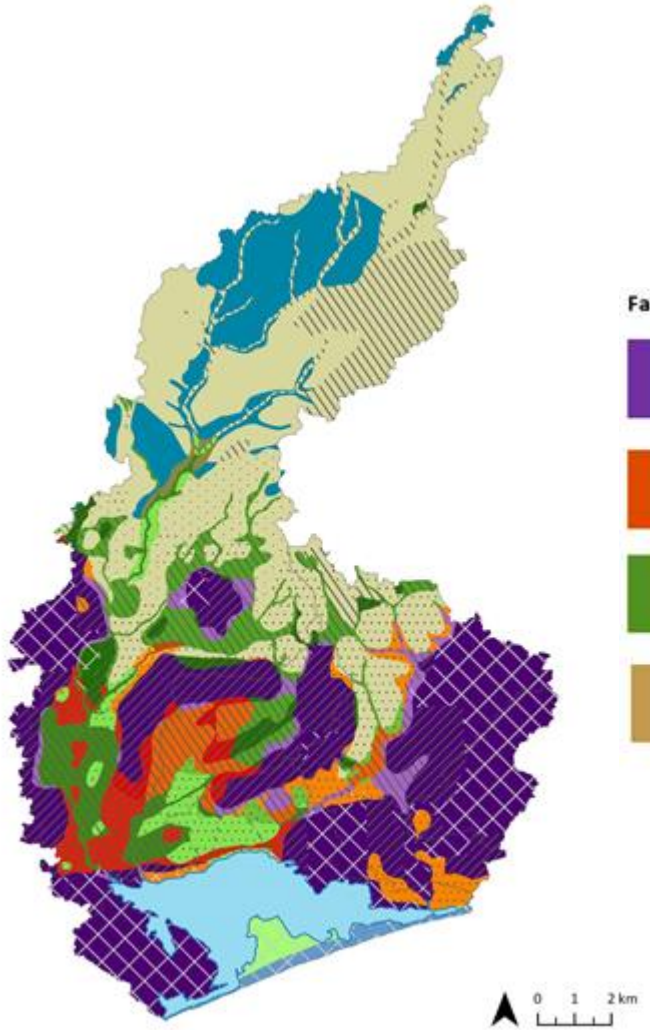

y = 6.0822x-1.306
R² = 0.6175
TN (mg/l)
R-PAL
y = 0.0169x1.2422
R² = 0.6203
TP (mg/l)
R-PAL
y = 31.886e-1.408x
R² = 0.7589
NNN (mg/l)
R-PAL
y = 0.0009e0.92x
R² = 0.8015
DRP(mg/l)
R-PAL
Waituna Creek
Moffat Creek
Carran Creek
Craws Creek

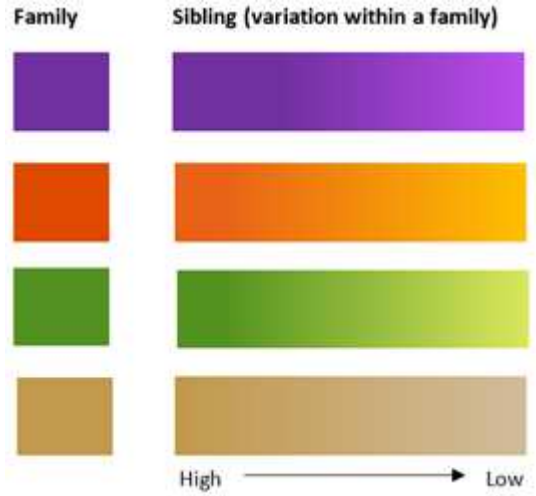

Redox PAL
High
Moderately high
Moderate
Moderately low
Low
Waituna
Waituna
Waituna Creek
Carren Creek
Moffat Creek
Craws Creek
Direct Contribution
N
0 1.25 2.5 5 Km

Integration - Conceptual Model









N, P, S and M Susceptibility

Risk of loss for dissolved species of N and P (left)

Inherent risk primary control:

- Redox status
- Deep drainage

Added risk through:

- Overland flow
- Artificial drainage

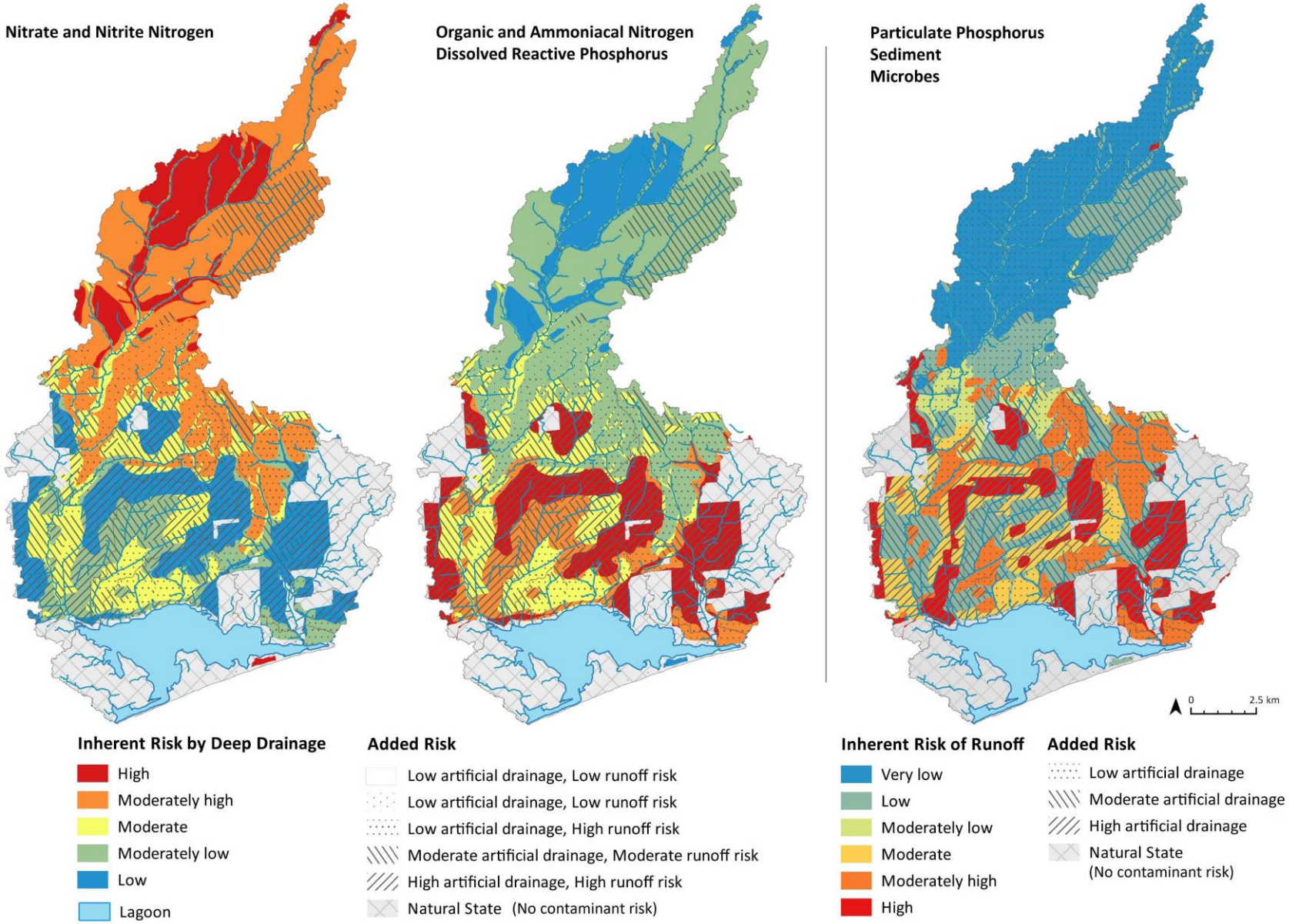
Risk of loss for particulates – P, S and M (right)

Inherent risk primary control:

- Overland flow

Added risk through:

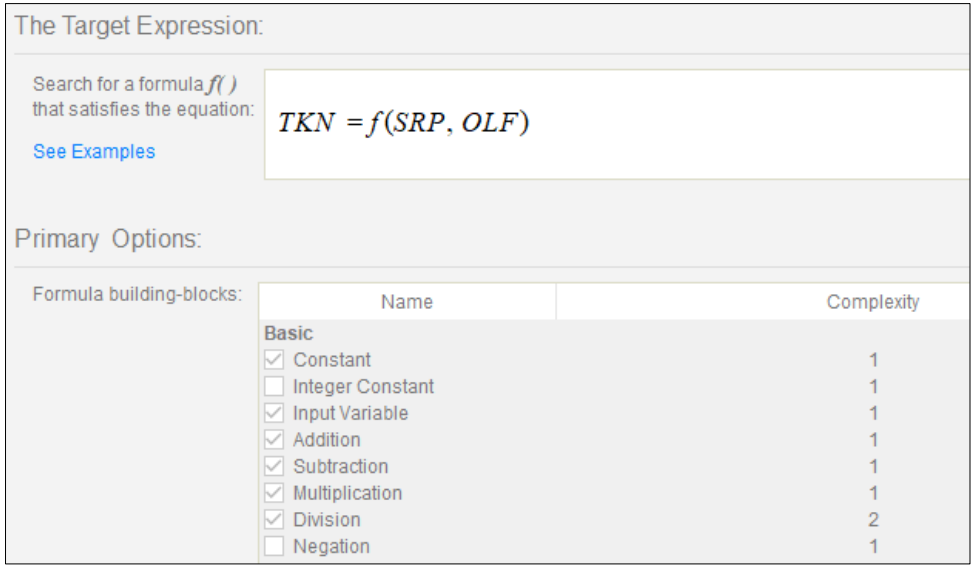
- Artificial drainage

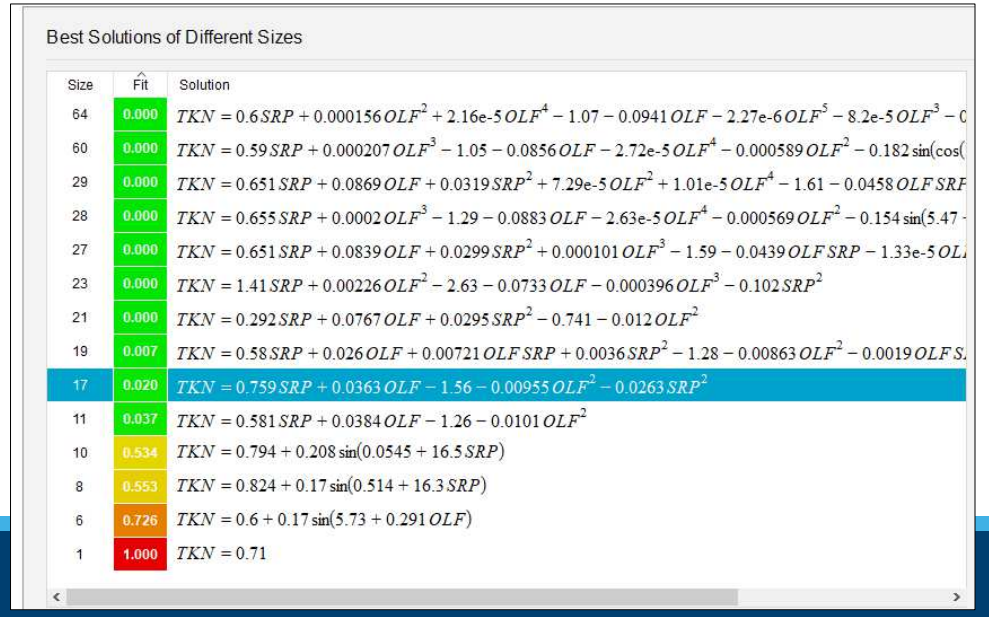


Potential way of viewing physiographic information

Numerical Model: Symbolic Regression

1. Hypotheses based on the process level understanding (conceptual model)
2. Input target expression
3. Identify solution





Numerical Model: Symbolic Regression

4. Check sensitivity, direction and magnitude

5. Identify best solution based on accuracy and complexity

Water quality models for Waituna Catchment:
TN, NNN, TKN, TP, DRP, TSS, Clarity, Turbidity and E. coli

$R^2 > 0.95$

Report and Analysis Tools

Select Task: Variable sensitivity report Run...

Result (calculated on entire dataset):

Save Report...

DRP = 0.1642 + 0.007068*SAD + 0.01491*SRP^2 + 0.004225*SAD*SRP^2 - 0.09512*SRP - 0.01606*SAD*SRP

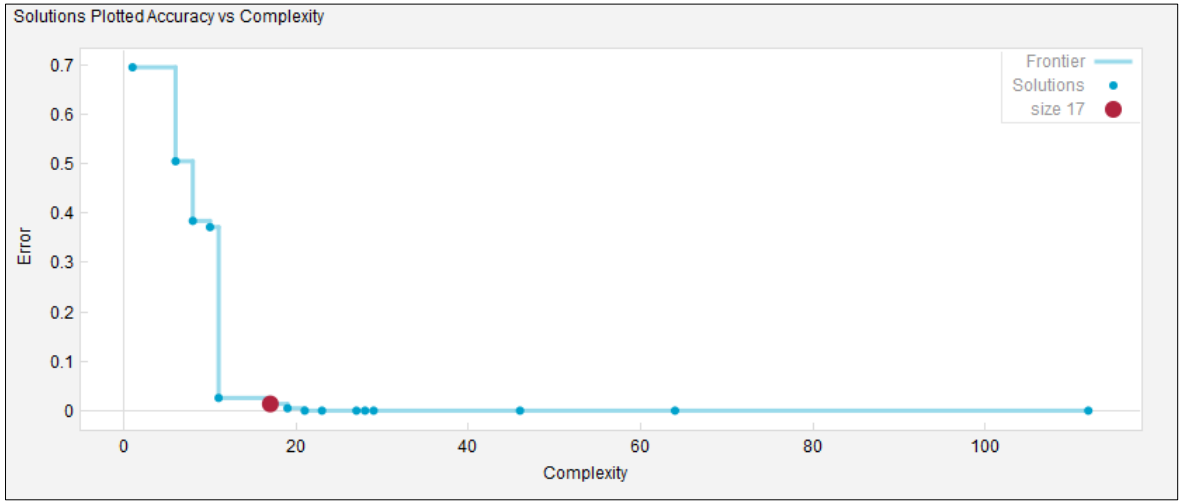
Variable	Sensitivity	% Positive	Positive Magnitude	% Negative	Negative Magnitude
SRP	1.5197	100%	1.5197	0%	0
SAD	0.32582	100%	0.32582	0%	0

DRP = 0.2372 + 0.01855*SAD*SRP + 0.01899*SRP^2 - 0.06324*SAD - 0.1298*SRP

Variable	Sensitivity	% Positive	Positive Magnitude	% Negative	Negative Magnitude
SRP	1.4951	100%	1.4951	0%	0
SAD	0.27738	100%	0.27738	0%	0

DRP = 0.4699 + 0.007075*SAD*SRP - 0.01344*SAD - 0.08388*SRP - 0.2613*cos(5.287 + 0.5243*SRP)

Variable	Sensitivity	% Positive	Positive Magnitude	% Negative	Negative Magnitude
SRP	1.3622	100%	1.3622	0%	0
SAD	0.41836	100%	0.41836	0%	0



Thanks!

OUR LAND AND WATER

Toitū te Whenua, Toiora te Wai

National SCIENCE Challenges

LIVING WATER

Fonterra Dairy for life

Department of Conservation Te Papa Atawbai

LAND & WATER SCIENCE

www.landwaterscience.co.nz