National SCIENCE Challenges

OUR LAND AND WATER

Toitū te Whenua, Toiora te Wai

# EXPLORING LAND USE SUITABILITY

## A spatially-explicit framework for supporting land management decisions


***Amy Whitehead***

*Ton Snelder, Linda Lilburne, Doug Booker, Simon Harris, Scott Larned, Annette Semadeni-Davies*

amy.whitehead@niwa.co.nz

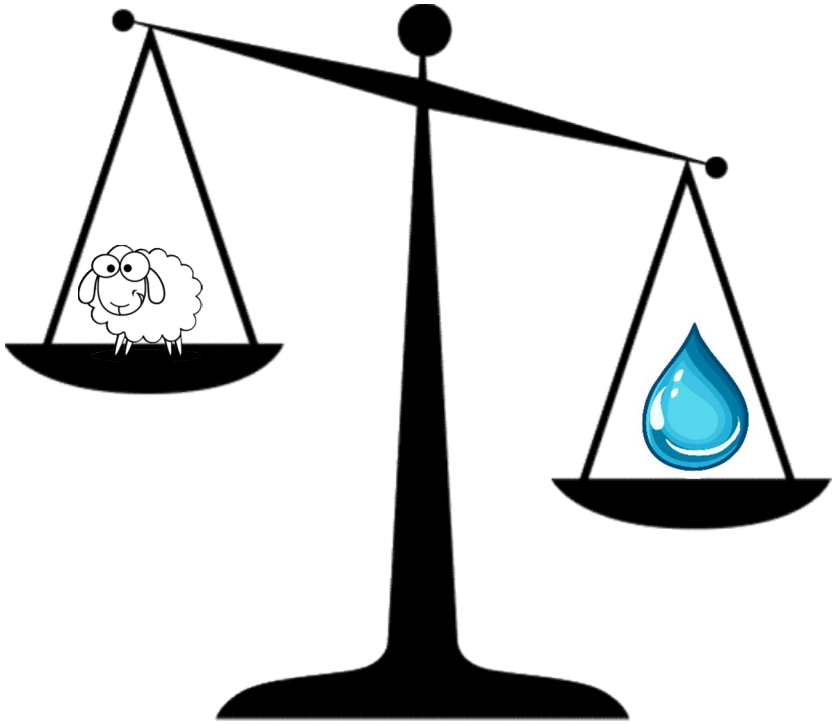
@nzwormgirl


NIWA Taihoro Nukurangi

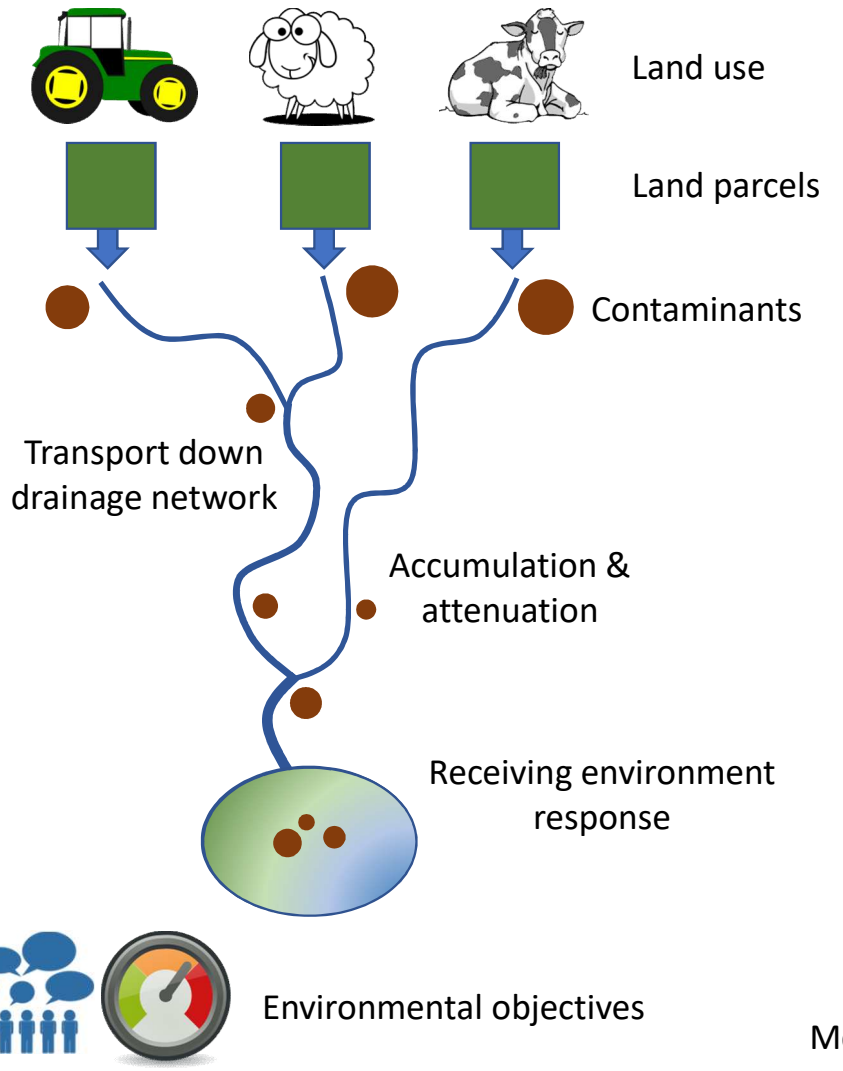
landwaterpeople | LWP

Manaaki Whenua Landcare Research

# Land use & water quality



How can we balance primary production with environmental constraints?




McDowell et al (2018). Ecological Indicators.

*LUS Indicators*

Capacity for primary production

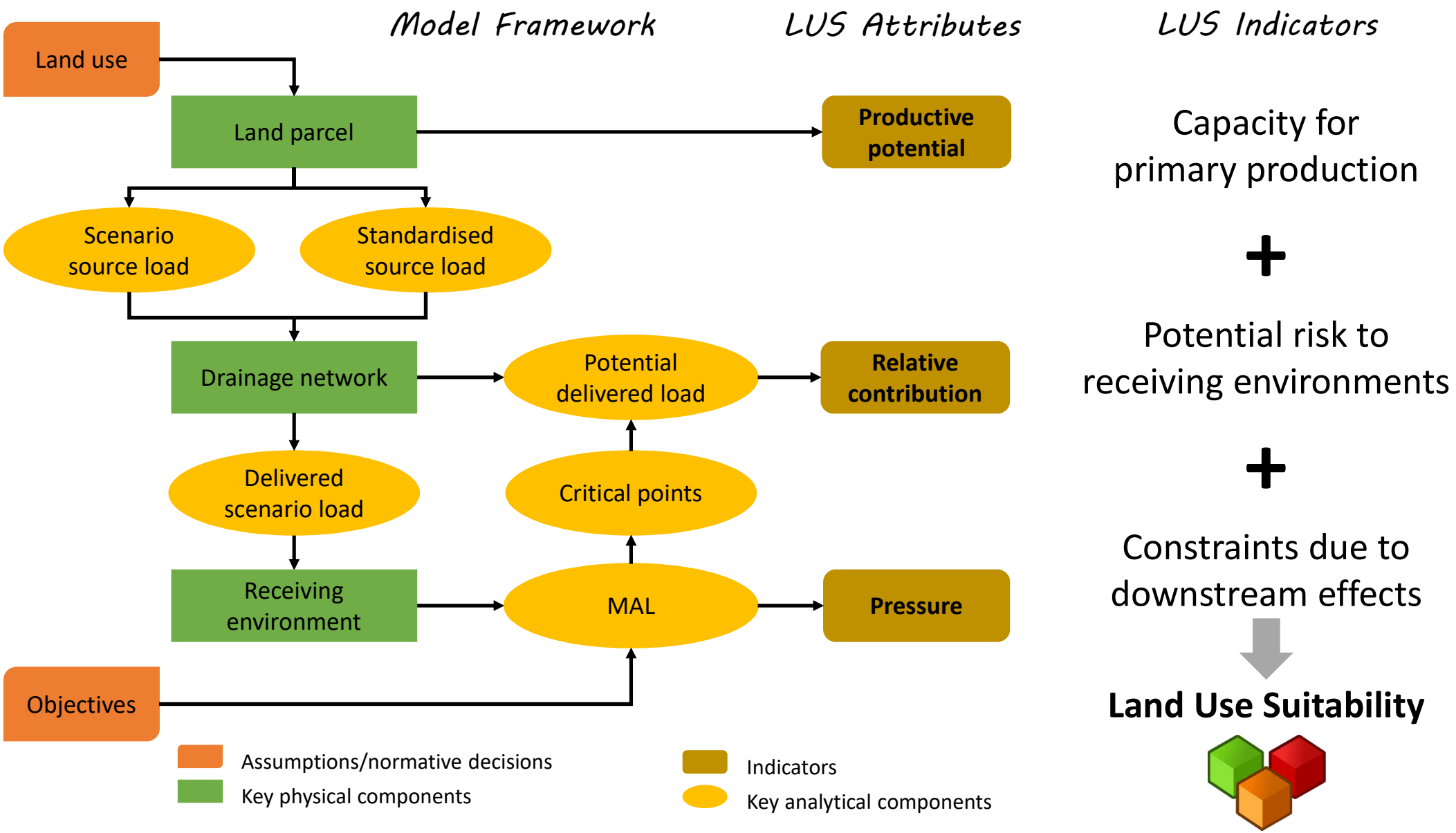
+

Potential risk to receiving environments

+

Constraints due to downstream effects

**Land Use Suitability**


Model Framework
LUS Attributes
LUS Indicators
Land use
Land parcel
Productive potential
Scenario source load
Standardised source load
Drainage network
Potential delivered load
Relative contribution
Delivered scenario load
Critical points
Receiving environment
MAL
Pressure
Objectives
Assumptions/normative decisions
Key physical components
Indicators
Key analytical components
Capacity for primary production
+
Potential risk to receiving environments
+
Constraints due to downstream effects
Land Use Suitability

# Implementation in Southland

# 1. Productive potential

Where is the land best for agriculture?

*LUS Indicators*

**Capacity for primary production**

+

Potential risk to receiving environments

+

Constraints due to downstream effects

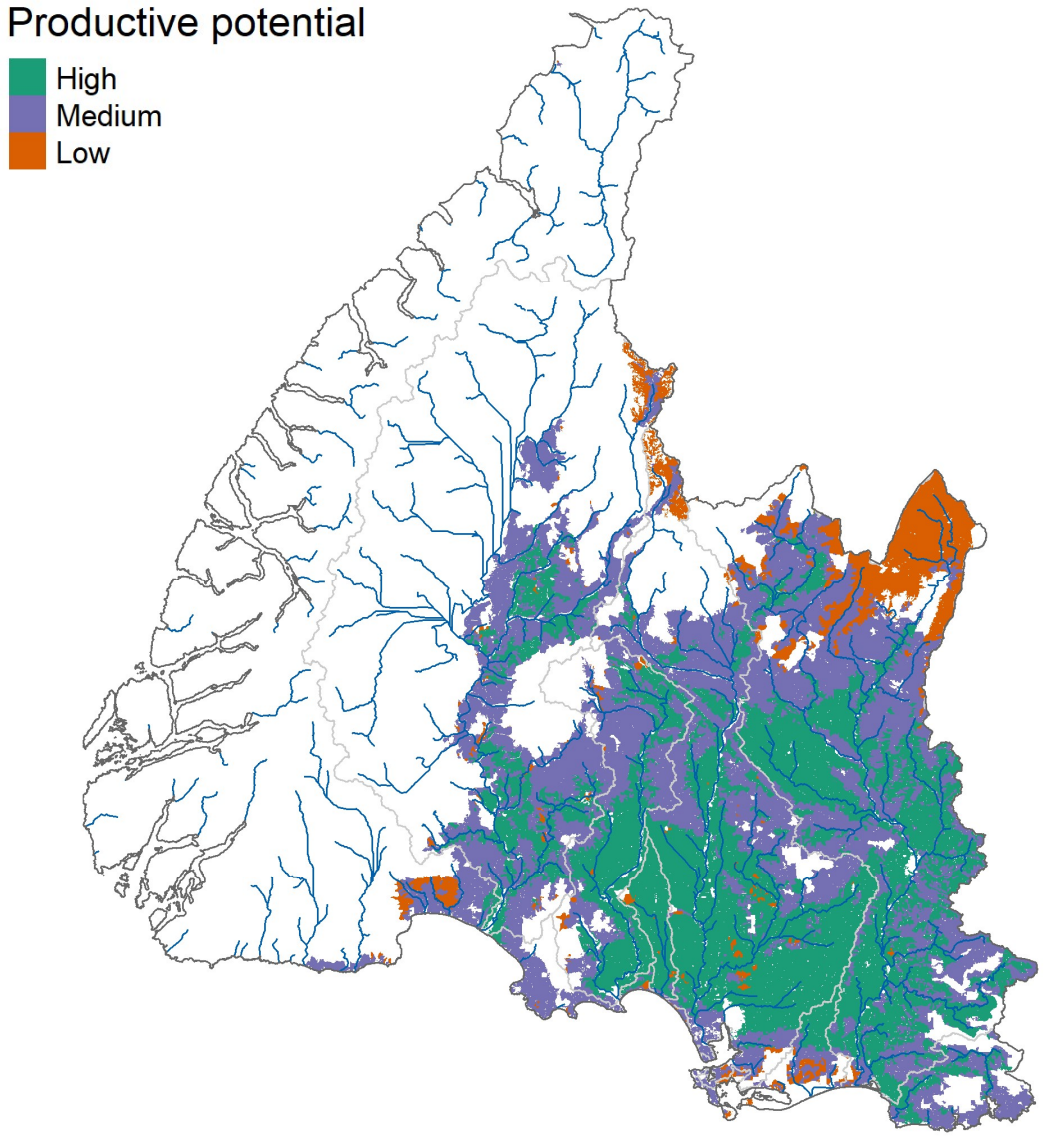
**Land Use Suitability**

# 1. Productive potential

Where is the land best for agriculture?

## Land Use Capability (LUC)

- Long-term capability to sustain one or more productive land uses
- Considers physical characteristics of the land



# 2. Relative Contribution

How “leaky” is the land?

*LUS Indicators*

Capacity for primary production

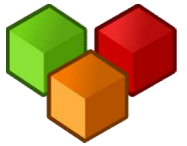
+

**Potential risk to receiving environments**

+

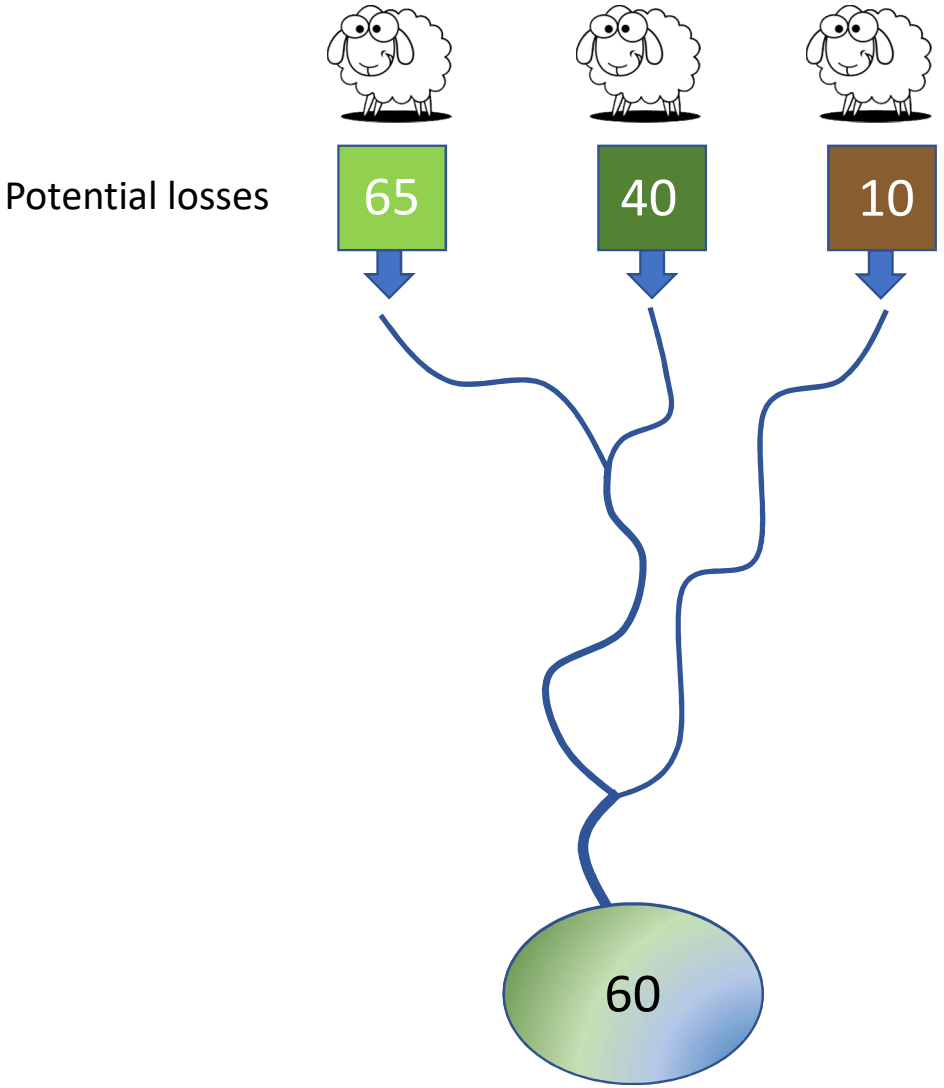
Constraints due to downstream effects

**Land Use Suitability**



# 2. Relative contribution

How “leaky” is the land?



# 2. Relative contribution

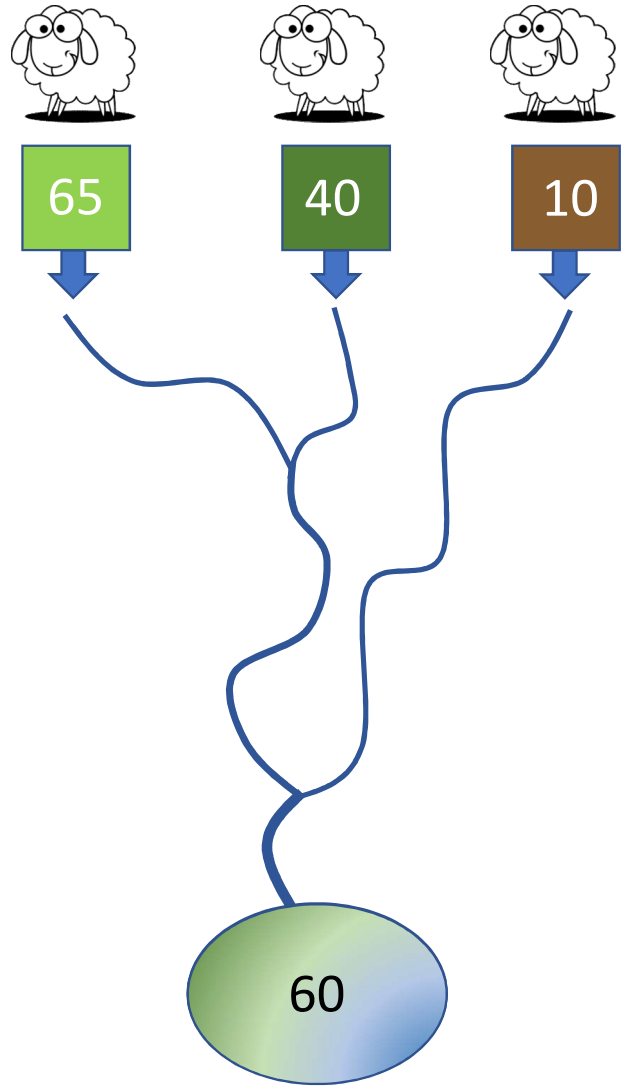
How “leaky” is the land?

$$Relative\ contribution = \frac{Parcel\ load - Mean\ load}{Mean\ load}$$

$$-\infty < Relative\ contribution < +\infty$$

Low contribution

High contribution



# 2. Relative contribution

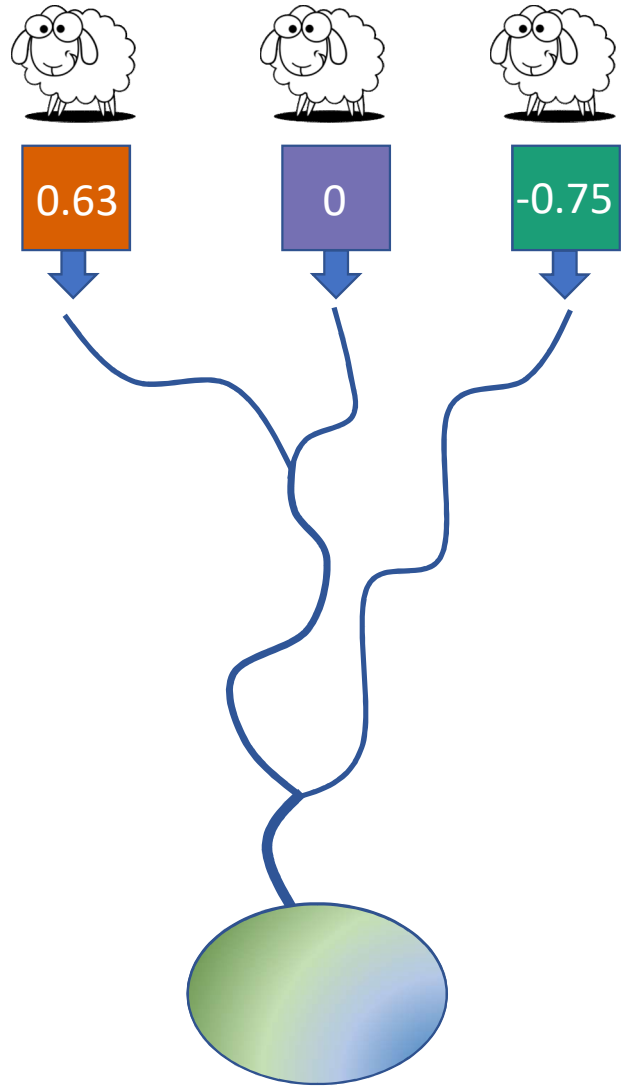
How “leaky” is the land?

$$Relative\ contribution = \frac{Parcel\ load - Mean\ load}{Mean\ load}$$

$$-\infty < Relative\ contribution < +\infty$$

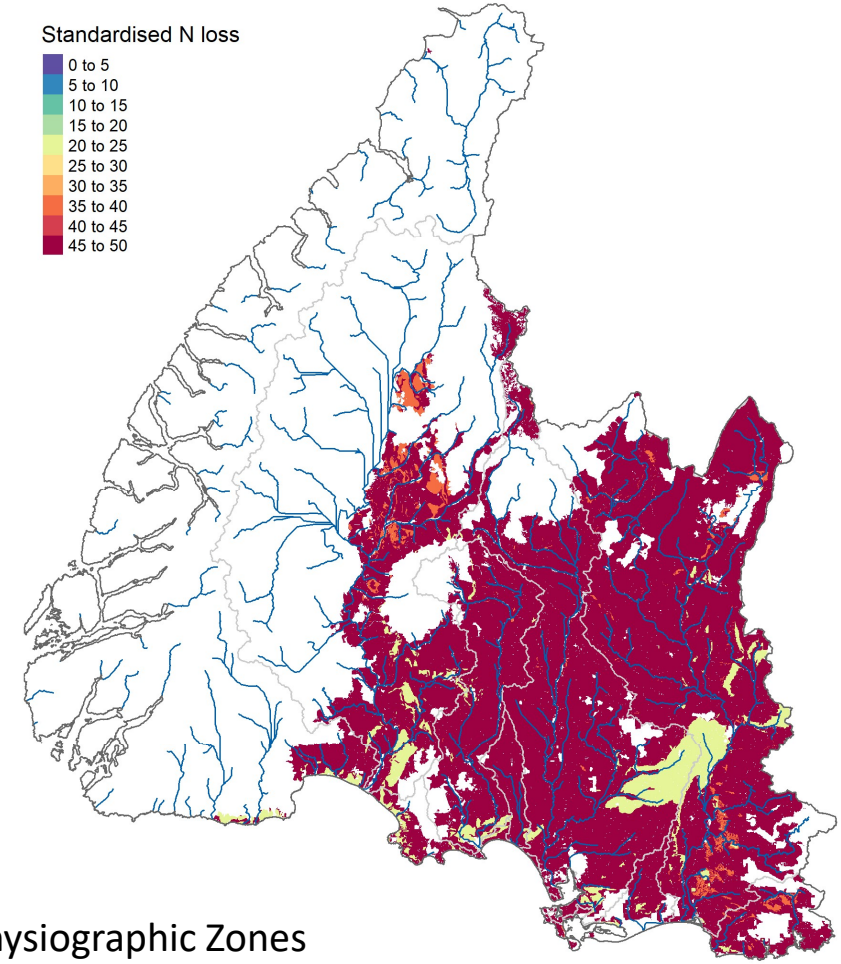
Low contribution

High contribution

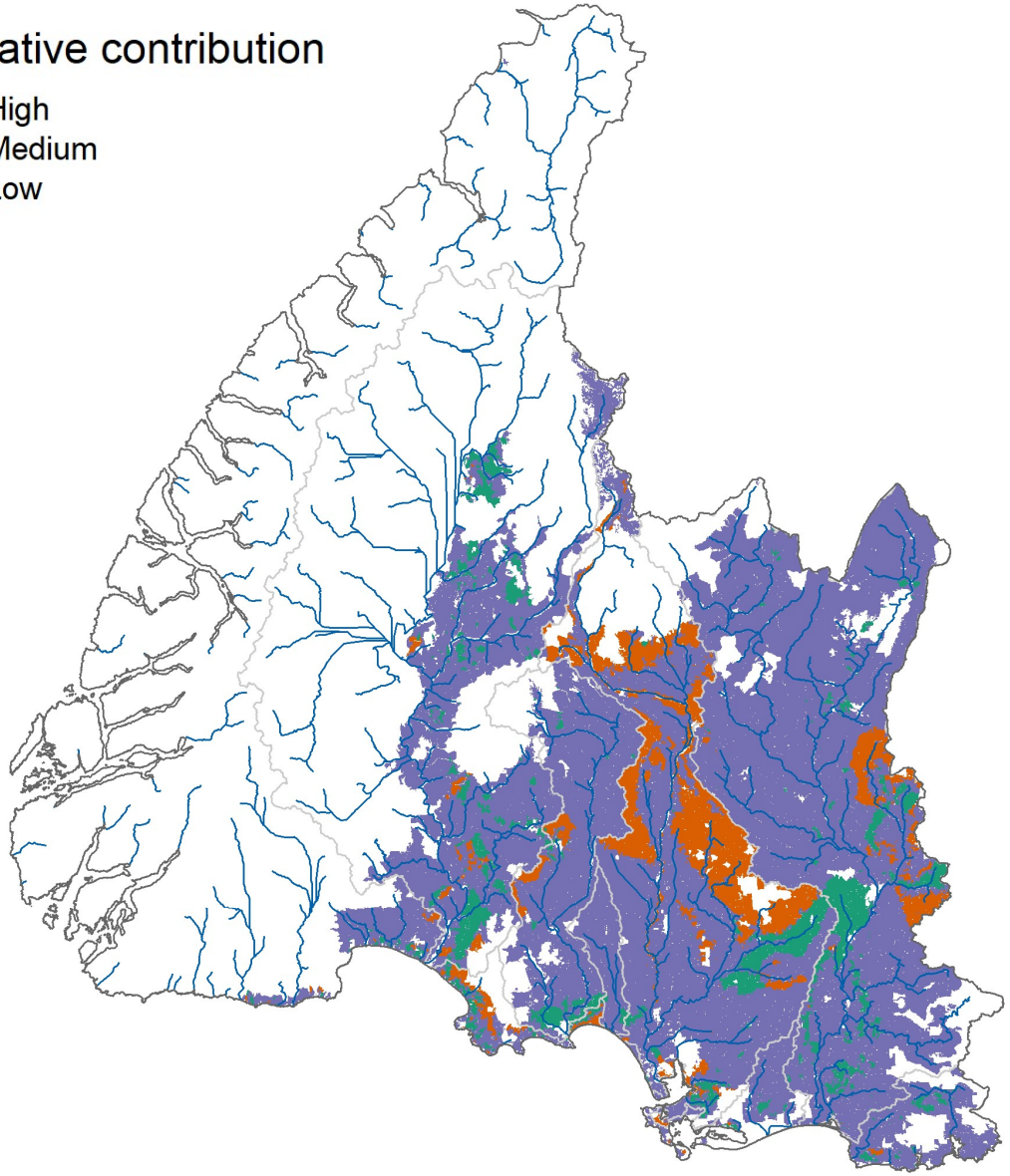


# 2. Relative contribution

## How “leaky” is the land?




Physiographic Zones



# 3. Pressure

Where are the downstream constraints?

*LUS Indicators*

Capacity for primary production

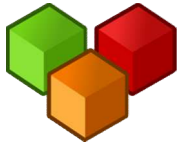
+

Potential risk to receiving environments

+

**Constraints due to downstream effects**

**Land Use Suitability**



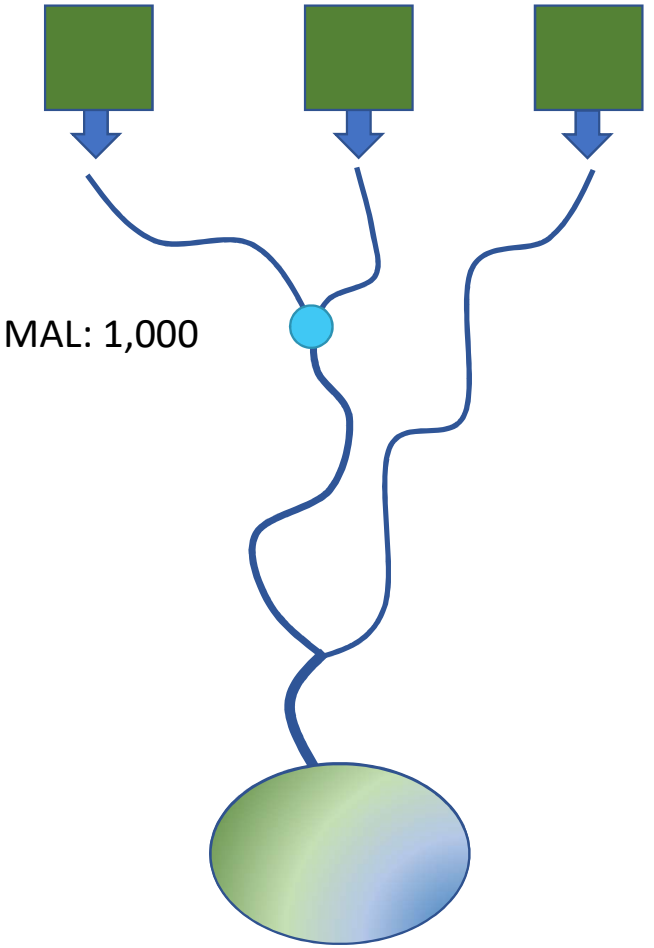
# 3. Pressure

## Where are the downstream constraints?

**Maximum acceptable load (MAL)**

Water quality objectives set at locations in a catchment

- Rivers: Periphyton (NOF bands)
- Estuaries: Macroalgae and phytoplankton (Estuarine Trophic Index)



# 3. Pressure

## Where are the downstream constraints?

**Maximum acceptable load (MAL)**

Water quality objectives set at locations in a catchment

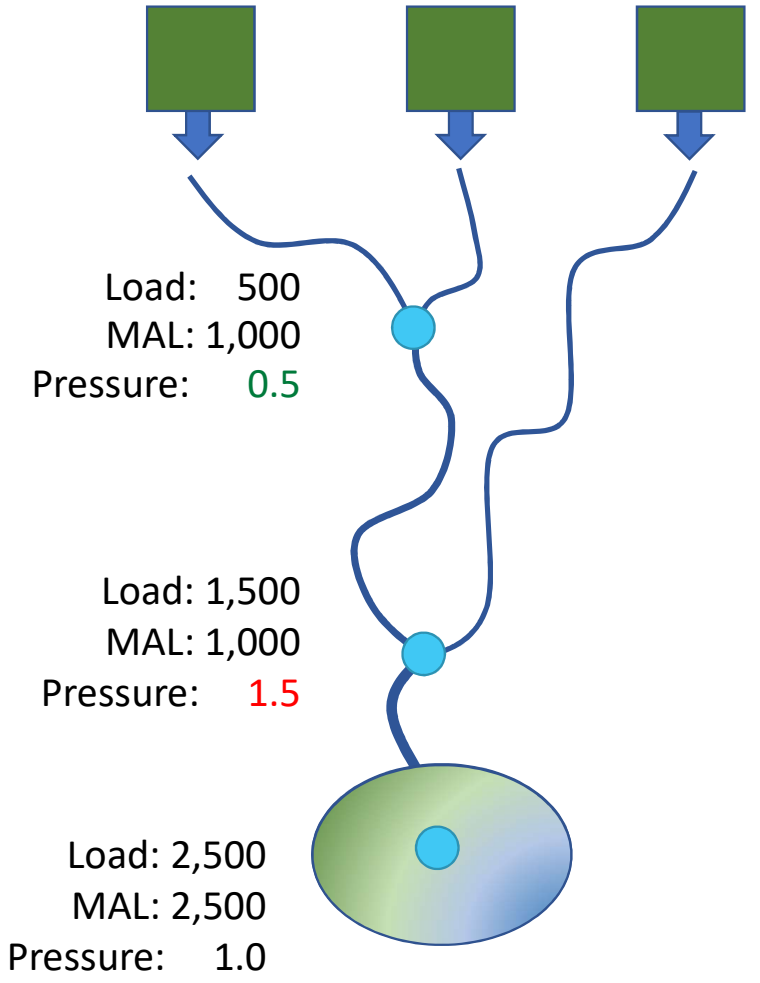
- Rivers: Periphyton (NOF bands)
- Estuaries: Macroalgae and phytoplankton (Estuarine Trophic Index)

**Pressure**

$$\text{Pressure} = \frac{Delivered\ load}{MAL} \qquad 0 \leq \text{Pressure} \leq \infty$$

Headroom (pressure < 1)

Shortfall (pressure > 1)



# 3. Pressure

## Where are the downstream constraints?

**Maximum acceptable load (MAL)**

Water quality objectives set at locations in a catchment

- Rivers: Periphyton (NOF bands)
- Estuaries: Macroalgae and phytoplankton (Estuarine Trophic Index)

**Pressure**

$$\text{Pressure} = \frac{Delivered\ load}{MAL} \qquad 0 \leq \text{Pressure} \leq \infty$$

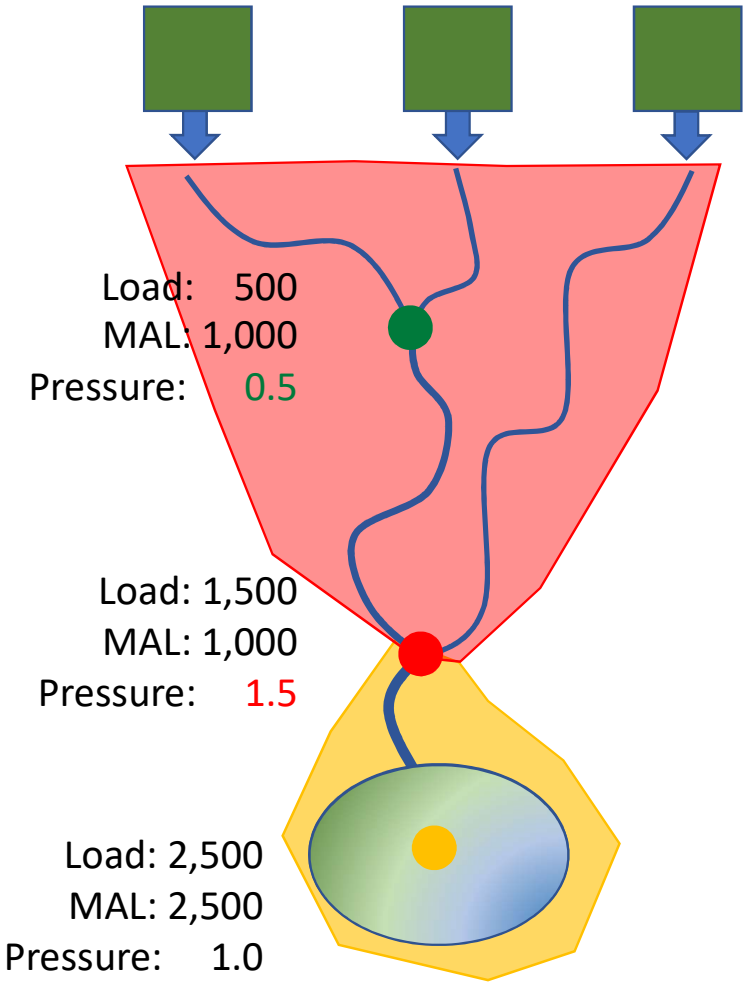
Headroom (pressure < 1)

Shortfall (pressure > 1)

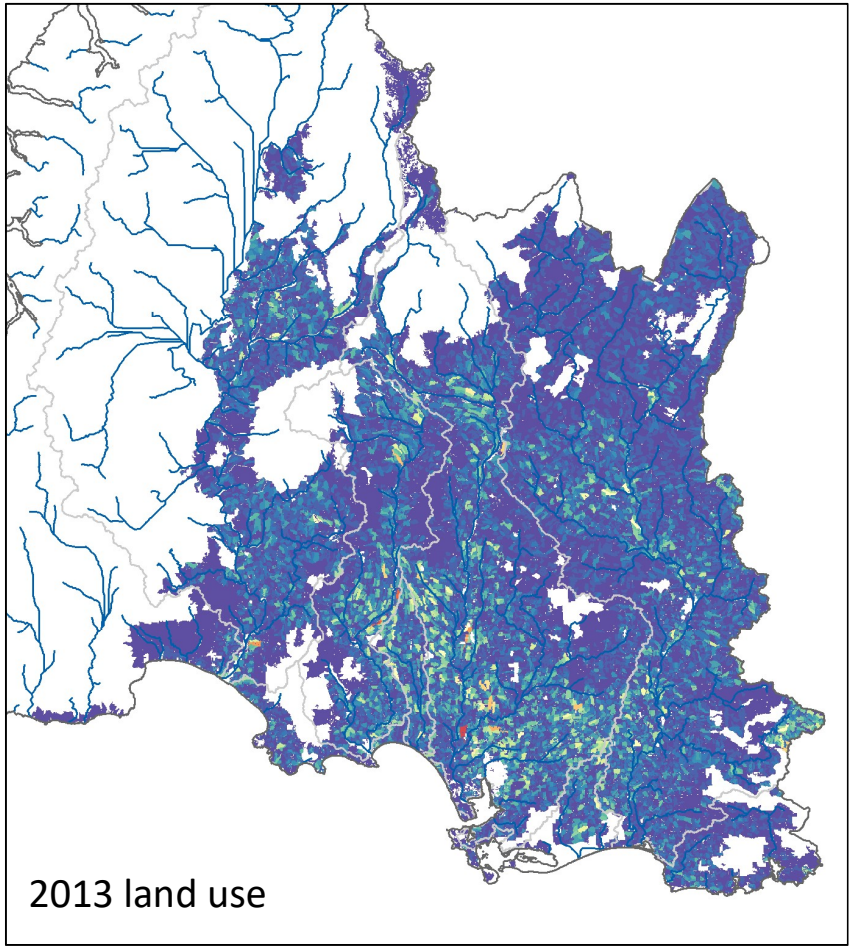
**Critical Points**

Point of highest downstream pressure

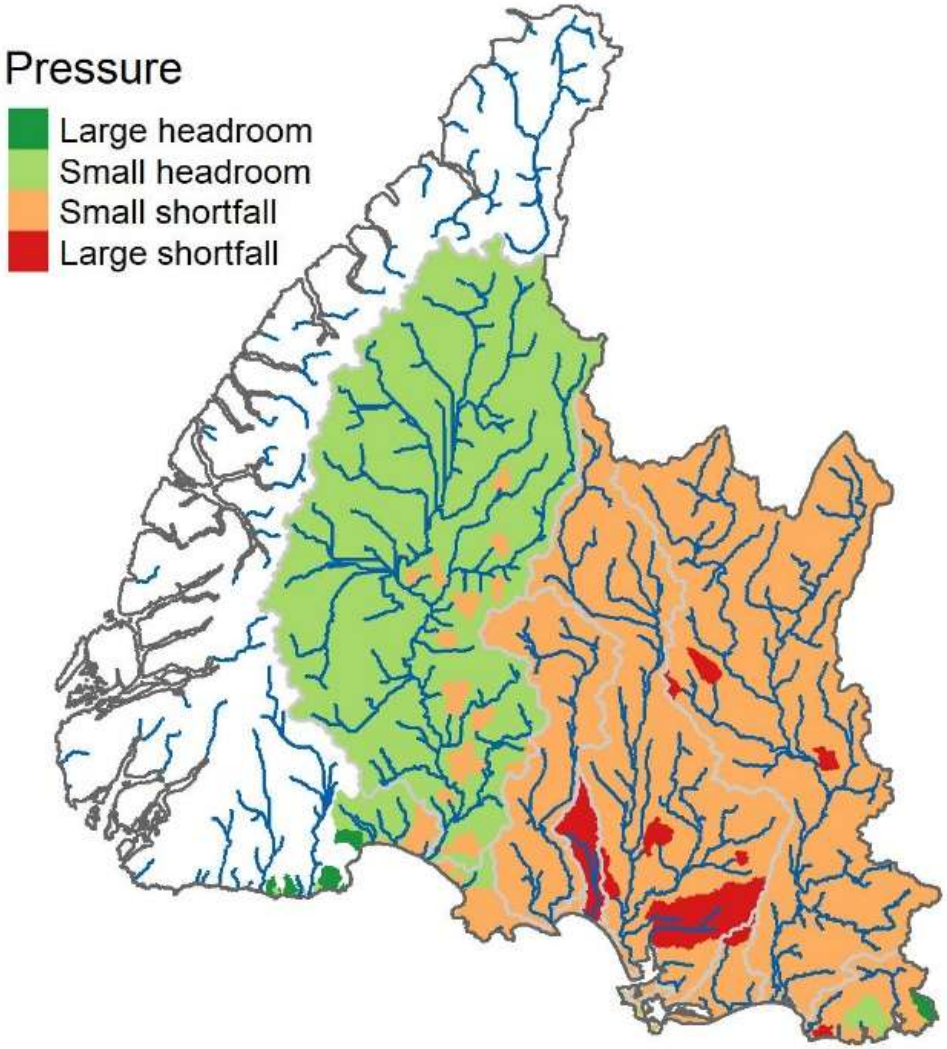
Pressure assigned upstream of critical points



# 3. Pressure



2013 land use




Objectives set to C band

# Land Use Suitability

Where is the productive land without environmental constraints?

*LUS Indicators*

Capacity for primary production

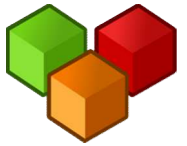
+

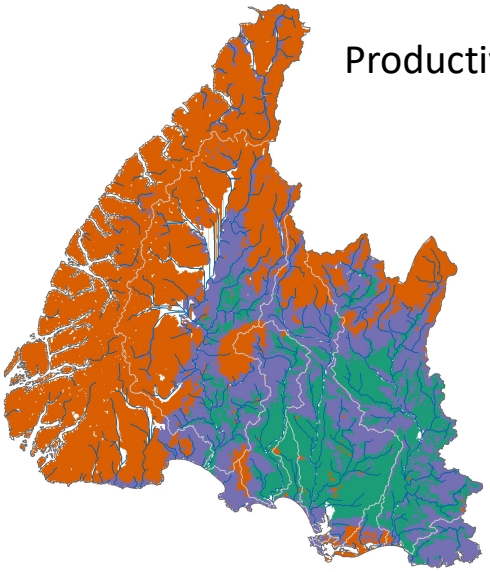
Potential risk to receiving environments

+

Constraints due to downstream effects

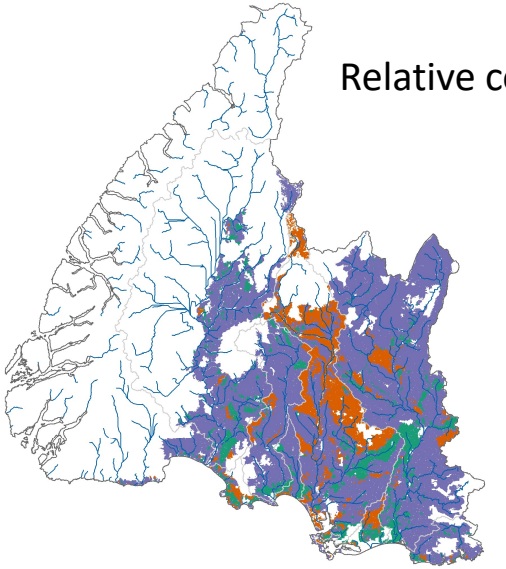
**Land Use Suitability**





Productive Potential

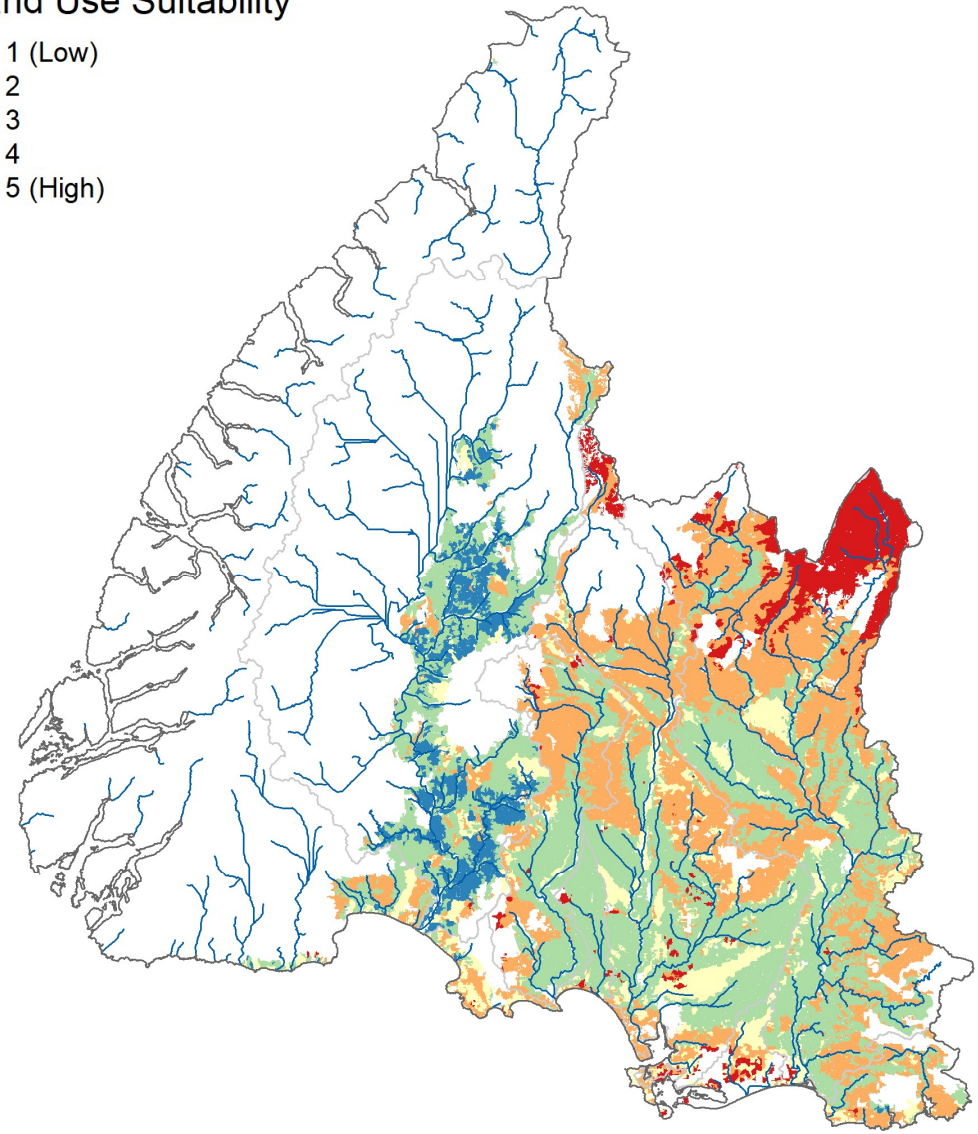
Pressure



Relative contribution

Land Use Suitability

1 (Low)
2
3
4
5 (High)



# Land Use Suitability

LUS classification depends on how the indicators are combined

**A. Quantitative even-handed**

| | Productive Potential | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | High | | | Medium | | | Low | | |
| | Relative Contribution | | | | | | | | |
| **Pressure** | L | M | H | L | M | H | L | M | H |
| Large Headroom | 5 | 5 | 4 | 5 | 4 | 3 | 4 | 3 | 3 |
| Small Headroom | 5 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 2 |
| Small Shortfall | 5 | 4 | 3 | 4 | 3 | 3 | 3 | 3 | 2 |
| Large Shortfall | 4 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 1 |

**B. Qualitative even-handed**

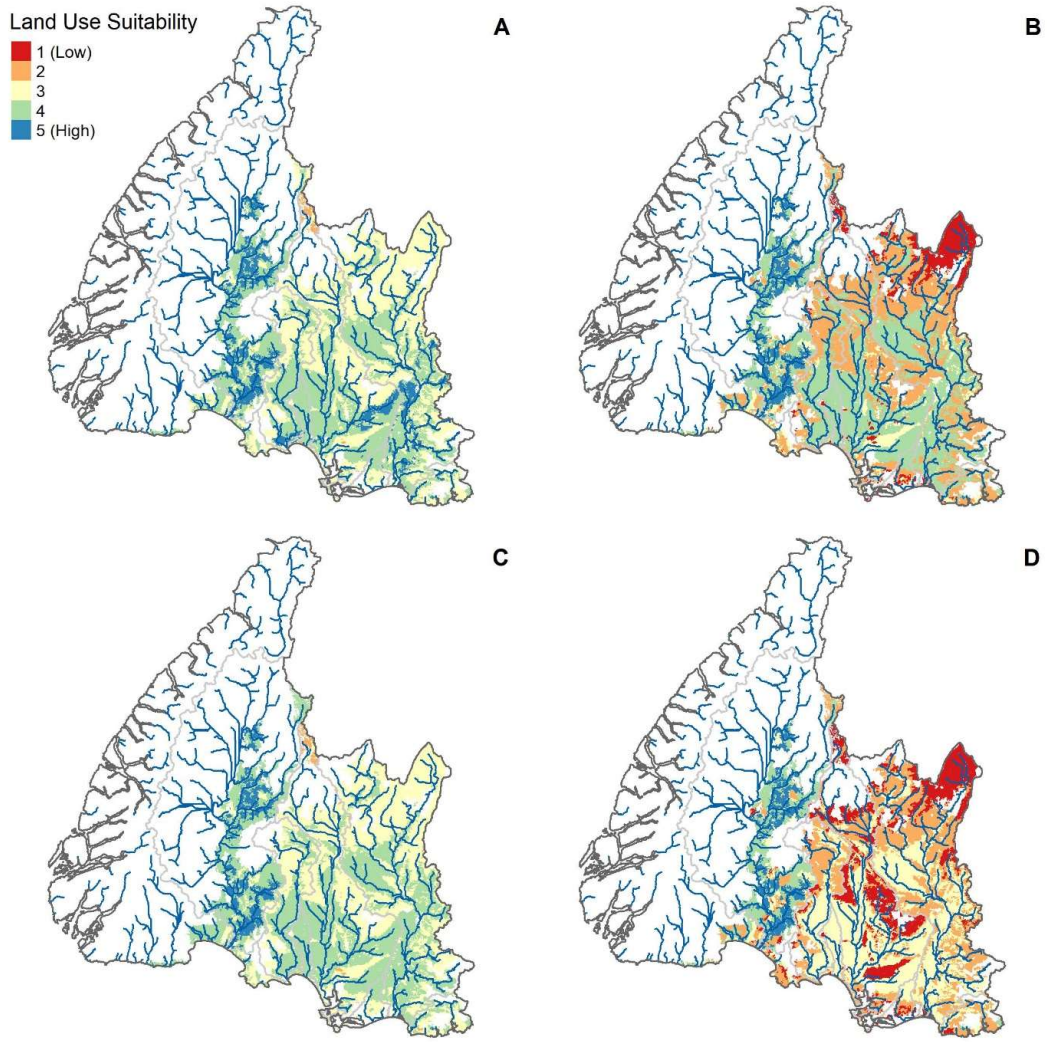
| | Productive Potential | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | High | | | Medium | | | Low | | |
| | Relative Contribution | | | | | | | | |
| **Pressure** | L | M | H | L | M | H | L | M | H |
| Large Headroom | 5 | 5 | 5 | 5 | 4 | 3 | 2 | 2 | 1 |
| Small Headroom | 5 | 5 | 4 | 4 | 3 | 3 | 2 | 1 | 1 |
| Small Shortfall | 4 | 4 | 3 | 3 | 2 | 2 | 1 | 1 | 1 |
| Large Shortfall | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 |

**C. Quantitative environmentally conservative**

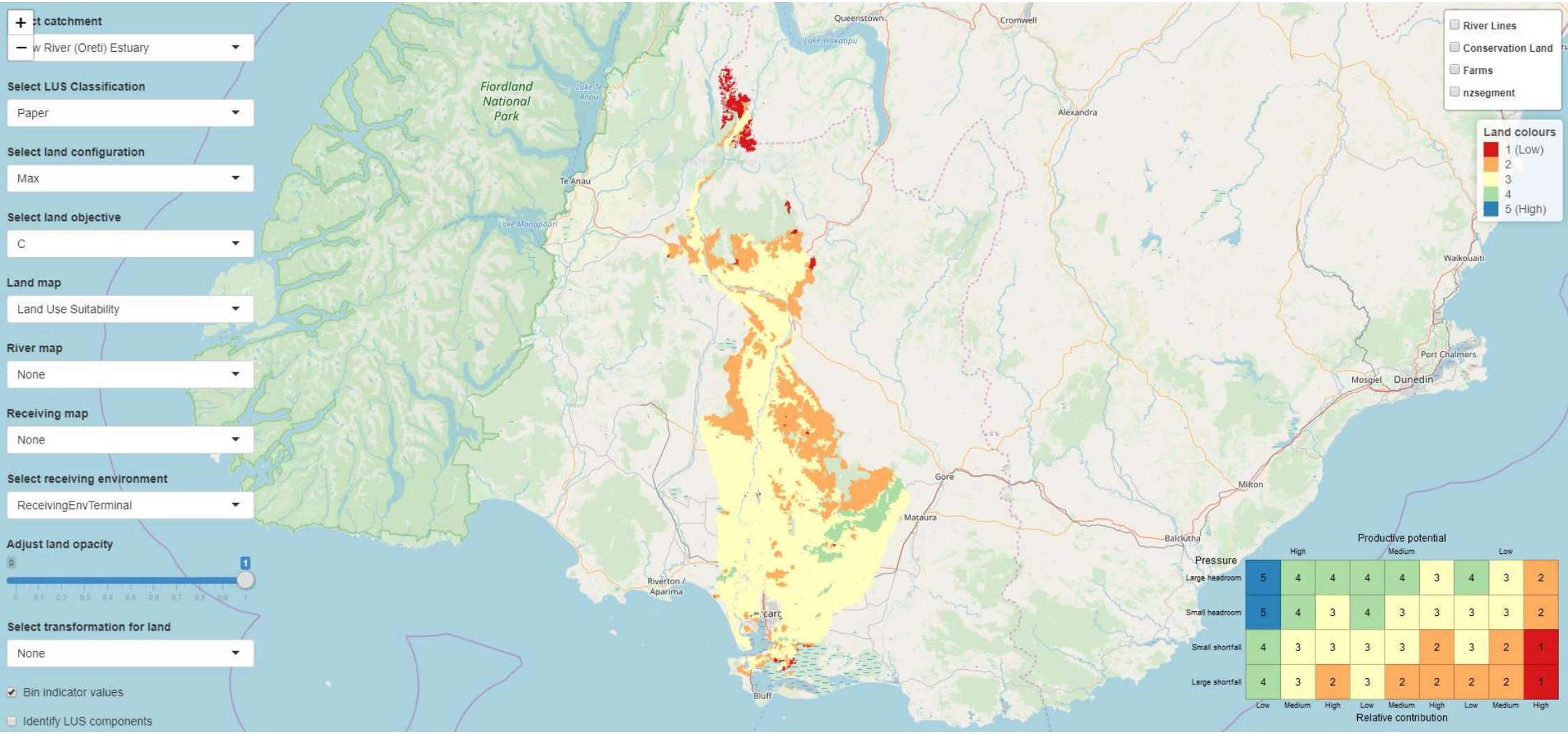
| | Productive Potential | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | High | | | Medium | | | Low | | |
| | Relative Contribution | | | | | | | | |
| **Pressure** | L | M | H | L | M | H | L | M | H |
| Large Headroom | 5 | 5 | 5 | 5 | 5 | 4 | 5 | 4 | 3 |
| Small Headroom | 5 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 2 |
| Small Shortfall | 4 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 1 |
| Large Shortfall | 3 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 |

**D. Qualitative environmentally conservative**

| | Productive Potential | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | High | | | Medium | | | Low | | |
| | Relative Contribution | | | | | | | | |
| **Pressure** | L | M | H | L | M | H | L | M | H |
| Large Headroom | 5 | 5 | 5 | 5 | 4 | 3 | 3 | 2 | 2 |
| Small Headroom | 5 | 5 | 4 | 4 | 3 | 3 | 2 | 2 | 1 |
| Small Shortfall | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Large Shortfall | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |



# LUS Spatial Explorer



# Land Use Suitability

- A decision support tool for planners, policy makers, land investment

- Dependant on the properties of the land parcel *and* normative decisions and assumptions about
  - Land use settings
  - Water quality objectives
  - LUS classification

- Best presented using interactive GIS tools

*LUS Indicators*

Capacity for primary production

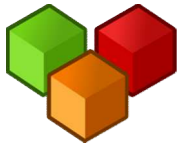
+

Potential risk to receiving environments

+

Constraints due to downstream effects

**Land Use Suitability**




National
SCIENCE
Challenges
OUR LAND
AND WATER
Toitū te Whenua,
Toiora te Wai
EXPLORING LAND USE SUITABILITY
A spatially-explicit framework for supporting land management decisions
Paper coming soon!
amy.whitehead@niwa.co.nz
@nzwormgirl
NIWA
Taihoro Nukurangi
landwaterpeople
LWP
Manaaki Whenua
Landcare Research