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SPATIAL DATA MODELLING

A Predictive Model for Identifying the Potential Location of Powelliphanta Land Snails in the South Island of New Zealand

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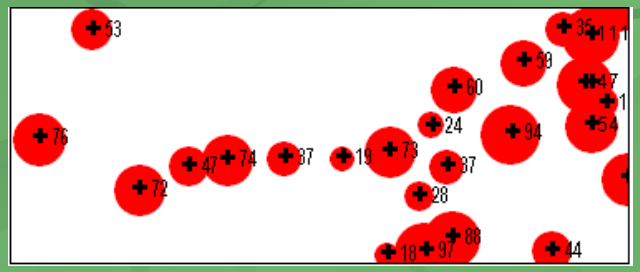
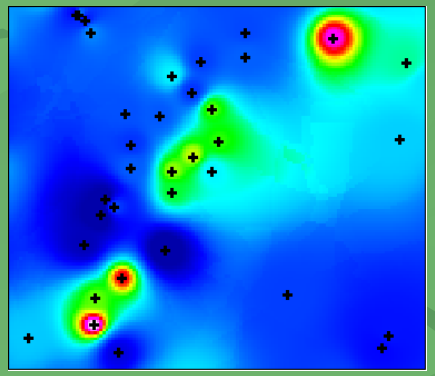
Why undertake spatial modelling?

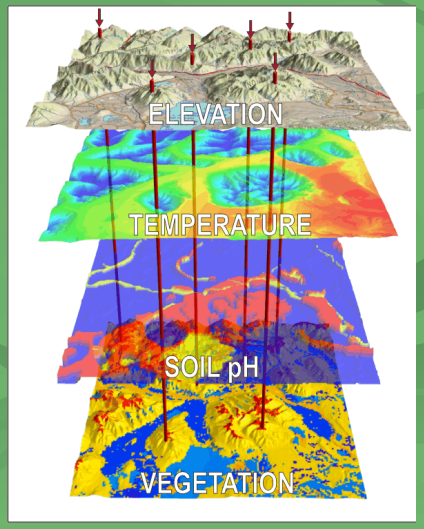
- Create predictive maps from digital data and maximise the knowledge
- Modelling can be a non-bias view of data
- Save time and money
- Take advantage of digital data, computer power and storage
- Combine spatial data and knowledge

Types of Modelling

- Illustrated maps – highlight important features
- Single layer modelling using interpolation
- Multi-variable models – fuzzy logic, neural networking and weights of evidence







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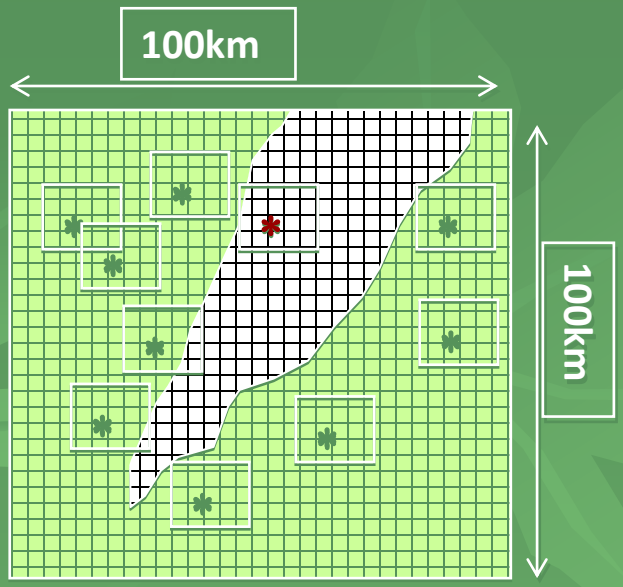
Weights of Evidence Modelling (WoE)

- Developed from medical industry for use in mineral exploration – Graham Bonham-Carter at Geological Survey of Canada
- Prediction of a “disease” given a list of “symptoms”
- Applied to different types of industries
- WoE is a probability based method – Bayesian statistical approach



a = total study area (e.g. 10,000 km)
A = Unit Cell = 1 km^2 cell
N(D) = number of deposits
P(D) = prior probability
N(T) = total area of study region
N(B) = area of binary theme
N(B) = area of binary theme not present
$N(T) = N(B) + N(\bar{B})$ (as long as no missing data)

$$W+ = \ln \frac{N(B \cap D)/N(D)}{N(B)/N(T)}$$

$$W+ = \ln \frac{P(B \mid D)}{P(B \mid \bar{D})}$$

$$W- = \ln \frac{P(\bar{B} \mid D)}{P(\bar{B} \mid \bar{D})}$$

$$W- = \ln \frac{N(\bar{B} \cap D)/N(D)}{N(\bar{B})/N(T)}$$

$$Ws+ = \frac{1}{N(B \cap D)} + \frac{1}{N(B)}$$

$$Ws- = \frac{1}{N(\bar{B} \cap D)} + \frac{1}{N(\bar{B})}$$

$$C = (W+) - (W-)$$

$$Cs = \sqrt{(Ws+) + (Ws-)}$$

$$StudC = C / Cs$$

When unit cell inf. small

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From: Bonham-Carter, G.F. (1994)
"Geographic information systems for geoscientists".

Correlation of Themes

$$W+ = \text{natural log} \frac{\text{Proportion of deposits on theme}}{\text{Proportion of total area occupied by theme}}$$

$$W- = \text{natural log} \frac{\text{Proportion of deposits not on theme}}{\text{Proportion of total area not occupied by theme}}$$

$W+ > 0$ indicates positive association with theme

$W- < 0$ indicates negative association with non-theme

$C > 3.0$ Strong correlation

C 1.0 – 3.0 Moderate correlation

$C < 1.0$ Weak to poor correlation

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The Powelliphanta Land Snail Model

- Identify possible locations of Powelliphanta land snail
- Develop a predictive map
- Conservationist can view all data together in context of each variable's relative importance

Probability Mapping in the South Island

- WoE modelling has been highly effective in mineral exploration and geo-hazard identification e.g. Crown Minerals
- Identified features important for Powelliphanta snail habitat
- Model used coarse scale data
  - LENZ
  - NIWA

Spatial Correlation Analysis and Results

- Training Points
- Study Area
- Spatial Correlations

Training Points

- WoE requires training data to test correlation
- 22 point training data set
- Locations of five taxa
  - Powelliphanta “Kirwans”
  - Powelliphanta Victoria/Brunner Ranges
  - Powelliphanta “pactrickensis”
  - Powelliphanta gagei
  - Powelliphanta rossiana rossiana

Study Area

- South Island
- Grid size – 200 x 200m
- Unit cell – 25km²

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Properties impacting Powelliphanta

- Climate
- Soil
- Vegetation
- Location features

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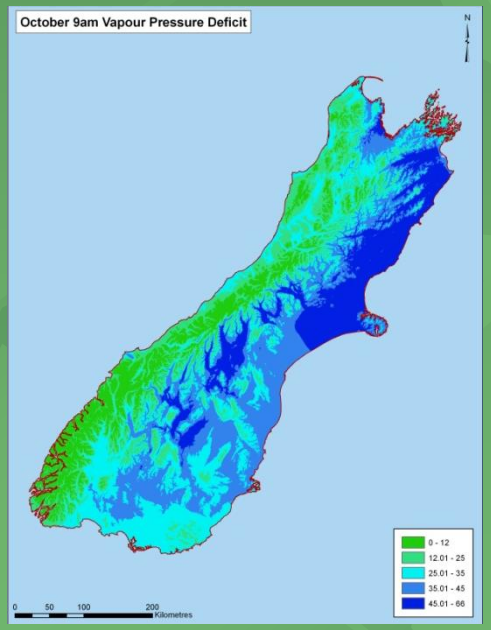
Spatial Correlations

- Forty-two layers were tested for spatial correlation
- Habitat of Powelliphanta snails is spatial associated with climate, soil and geographic themes
- Eight layers used in final model

October 9am Vapour Pressure Deficit

- 0 - 0.14kPa
- Spatial Correlation - 4.88



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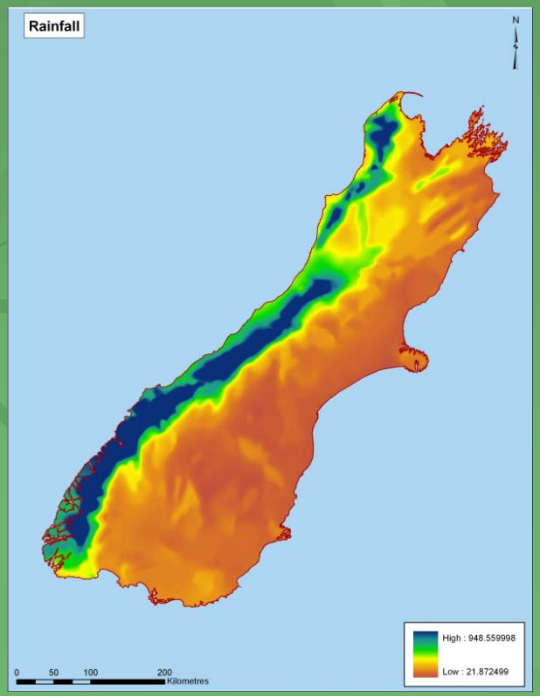
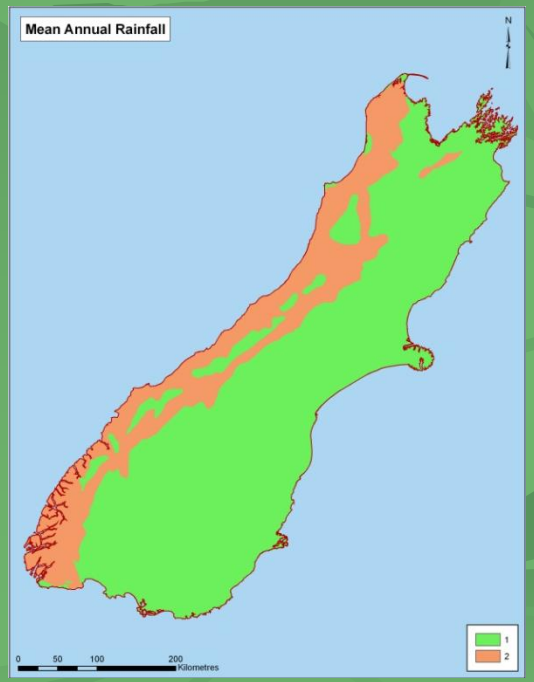
Mean Annual Rainfall

- Snails cease to move and feed in dry conditions
- 191mm – 650mm rainfall
- Spatial Correlation – 4.18





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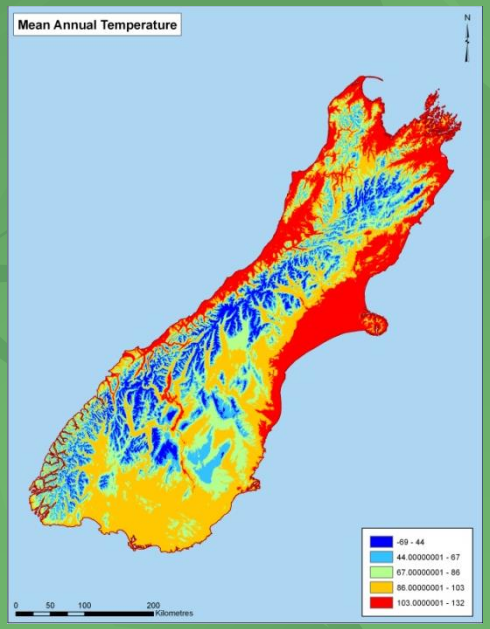
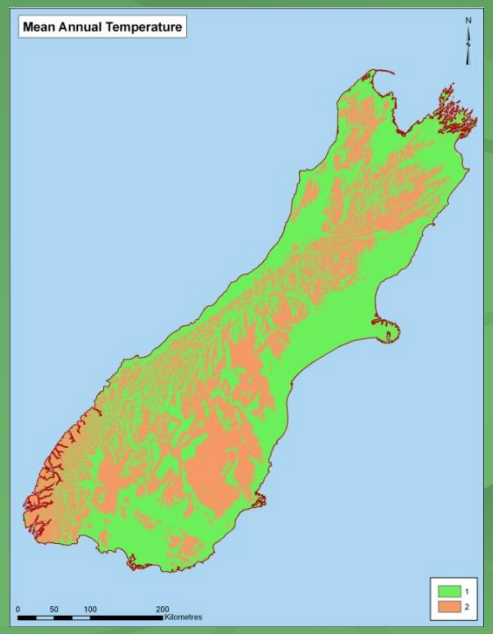
Mean Annual Average Daily Temperature

- Snails do not thrive in hot conditions
- 5 - 9°C
- Spatial Correlation – 3.33





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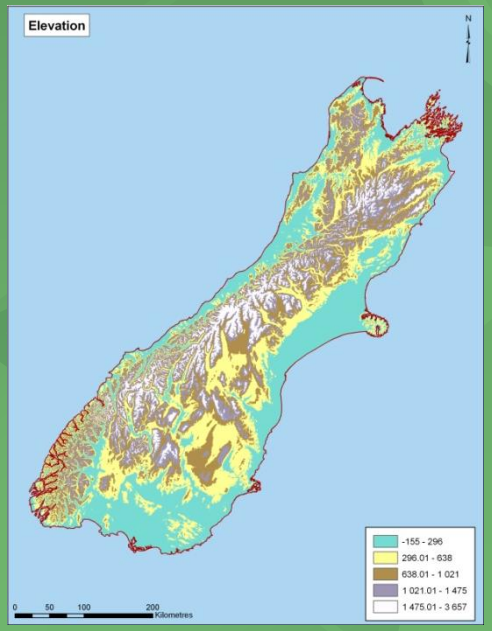
Elevation

- Elevation between 740 - 1300m
- Spatial Correlation -2.36



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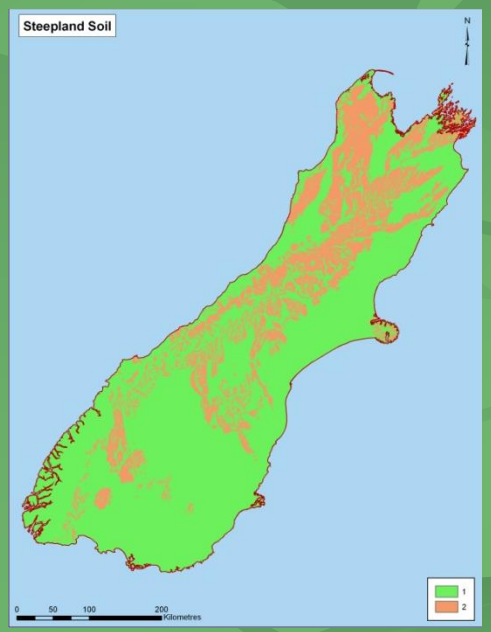
Soil Type

- Steepland Soil
- Spatial Correlation – 2.36



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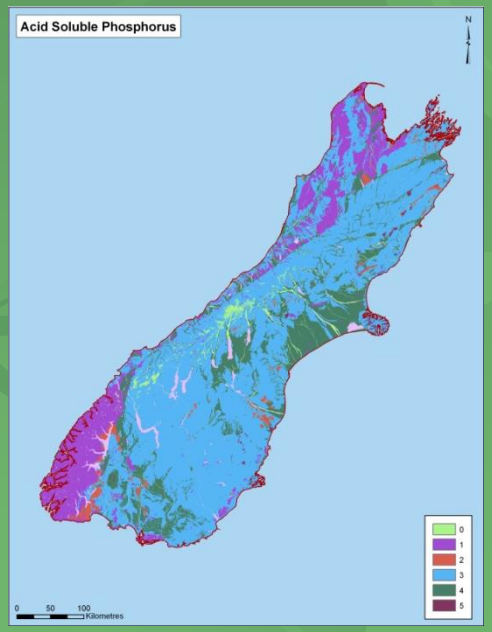
Acid Soluble Phosphorus

- 0-7mg per 100g soil
- Spatial Correlation – 2.11



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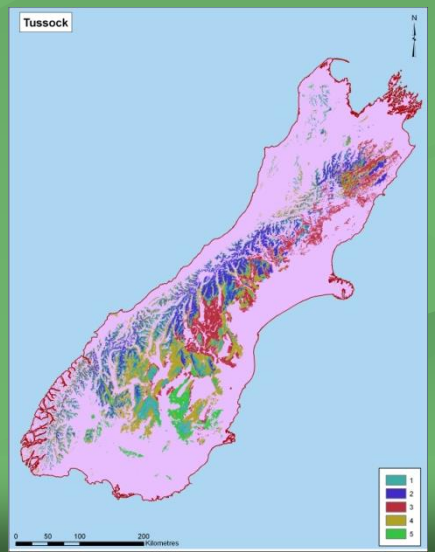
Types of Tussock

- Some species live under skirts of tussock
- Types of tussock
  - Alpine snow
  - Sub Alpine snow
  - Tall red
- Spatial Correlation – 1.96



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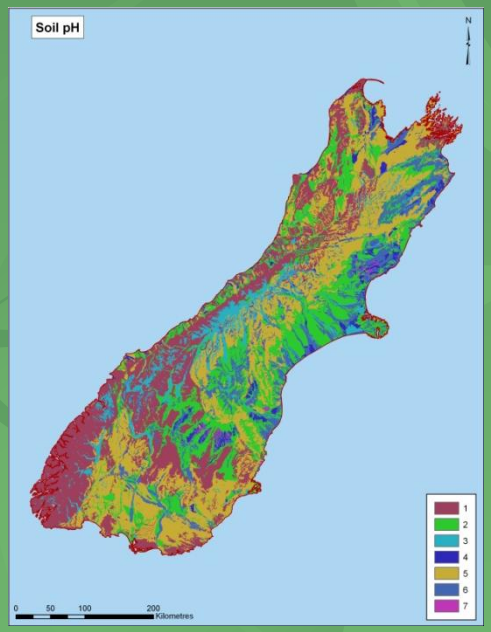
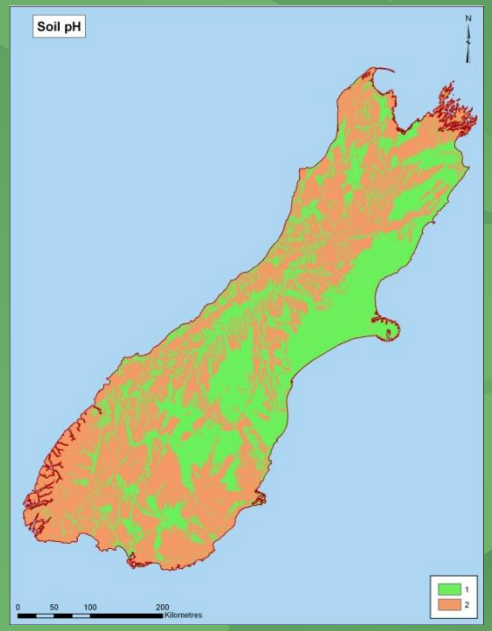
Soil pH

- Soil pH of 4.5 – 5.7
- Spatial Correlation – 1.25





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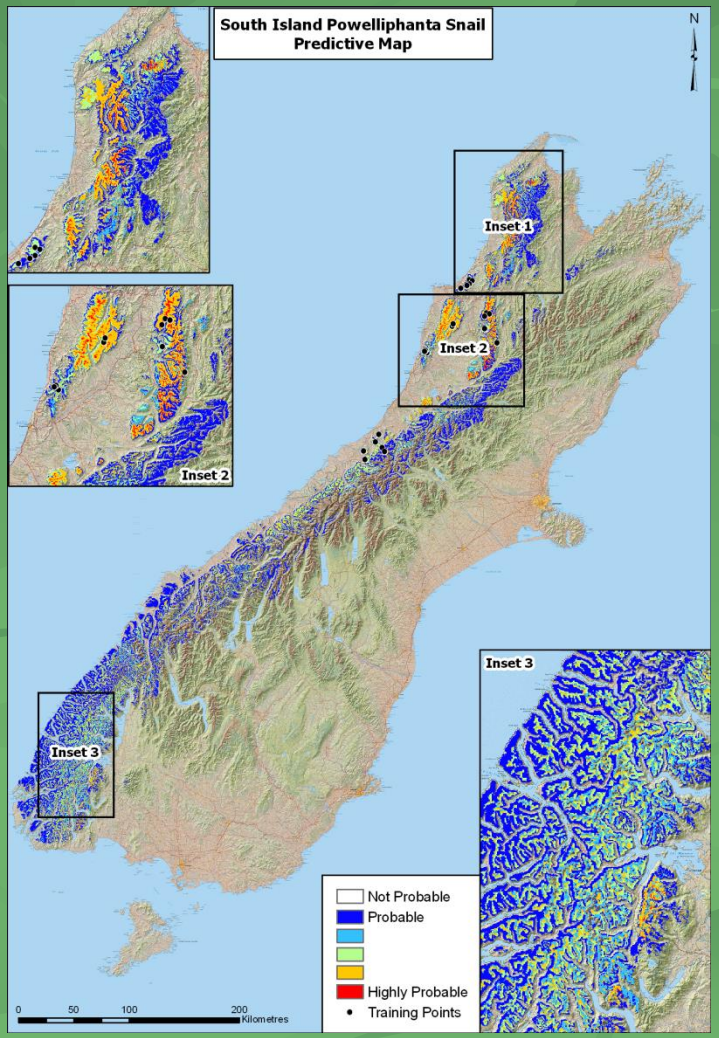
Final Predictive Map



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Future Work to Improve Model

- Higher resolution
- Smaller study area
- Model individual taxa
- Incorporate predator and food source layers

Acknowledgements

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