

Digital soil mapping at the University of Sydney

Presented by

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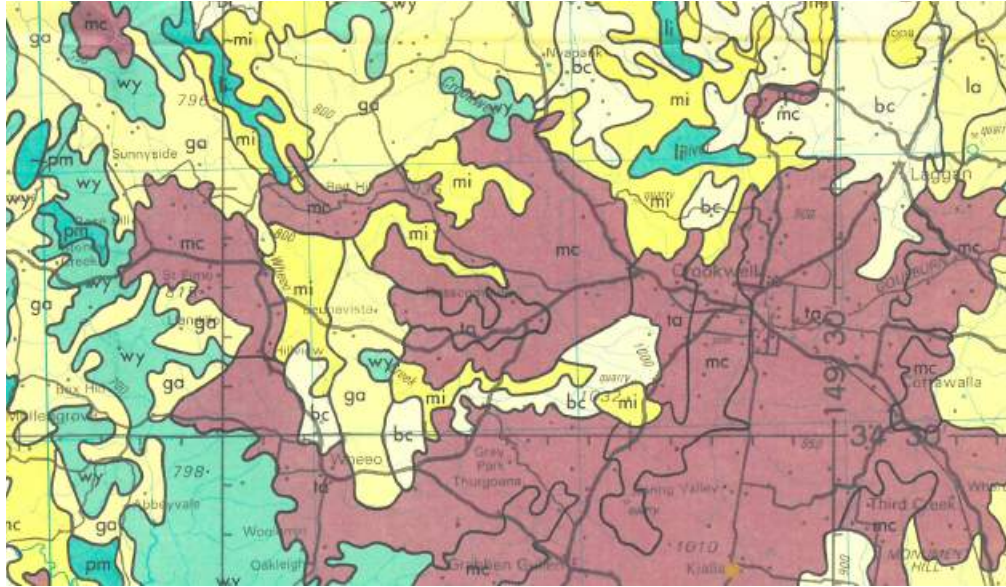
Faculty of Agriculture and Environment



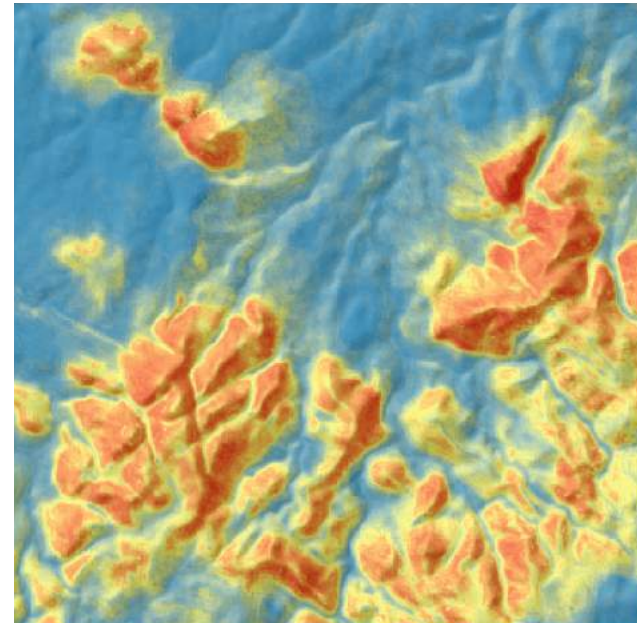
THE UNIVERSITY OF
SYDNEY



Digital soil mapping



“Legacy” map made using traditional methods



Digital soil map

- Contemporary developments in soil mapping:
 - Digitisation of legacy resources
 - Creation of digital soil information *ab initio*

Digital soil mapping

- Spatial predictions of soil based on limited observations
- Predictions are usually made on a *grid*, not *per-polygon*
- Heart of many contemporary methods:

$$S=f(s,c,o,r,p,a,n)+\varepsilon$$

s soil

c climate

o organisms

r relief (topography)

p parent material

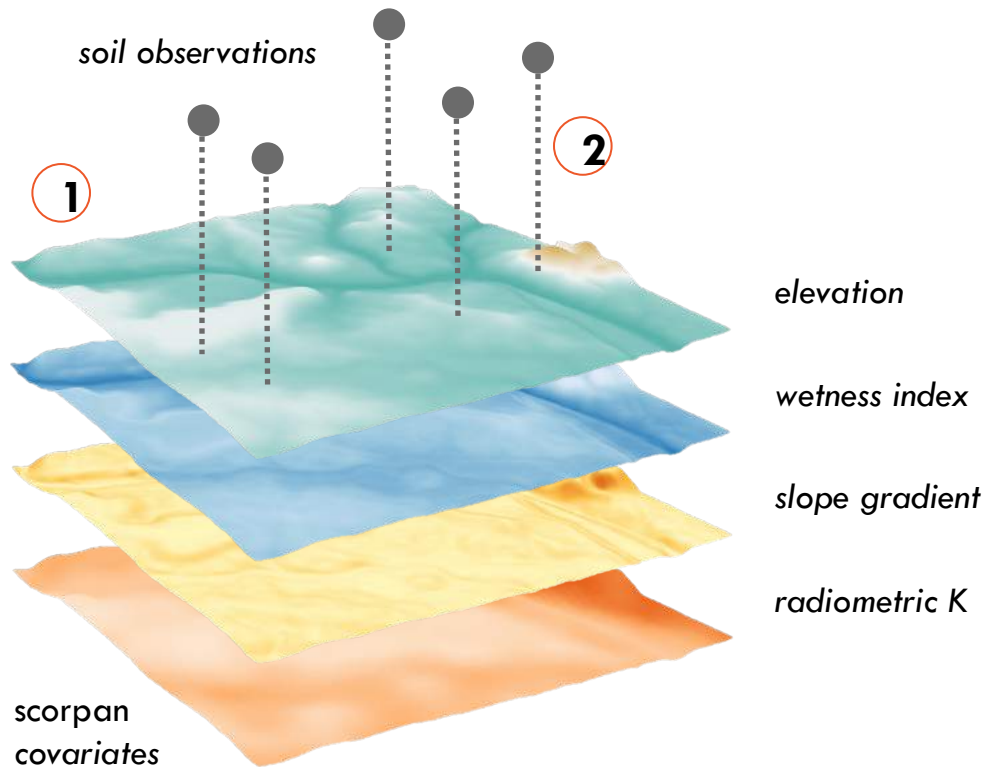
a age

n spatial position

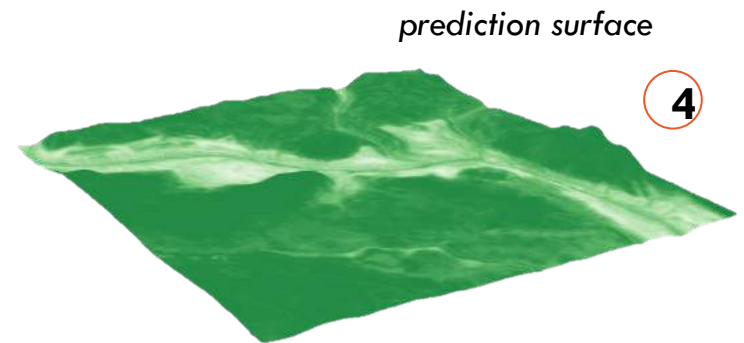
Digital soil mapping

Symbol	Factor	Represented by
<i>s</i>	Soil	Legacy soil data (profile observations, soil maps)
<i>c</i>	Climate	Precipitation, temperature, etc.
<i>o</i>	Organisms	Remotely-sensed imagery (Landsat and derivatives, land use information), vegetation maps
<i>r</i>	Relief (topography)	Digital elevation model and its derivatives
<i>p</i>	Parent material	Geology maps, gamma radiometrics
<i>a</i>	Age	Weathering intensity
<i>n</i>	Spatial position	Easting, northing, distance from feature of interest (road, river, etc.)

Digital soil mapping



- 1 Collation
- 2 Intersection
- 3 Modelling
- 4 Prediction



- 3 Spatial inference function $f()$:
- Regression models
 - Decision trees
 - Neural networks
 - ...

Some recent developments

1. Spatial disaggregation
2. Model averaging
3. Enterprise suitability mapping

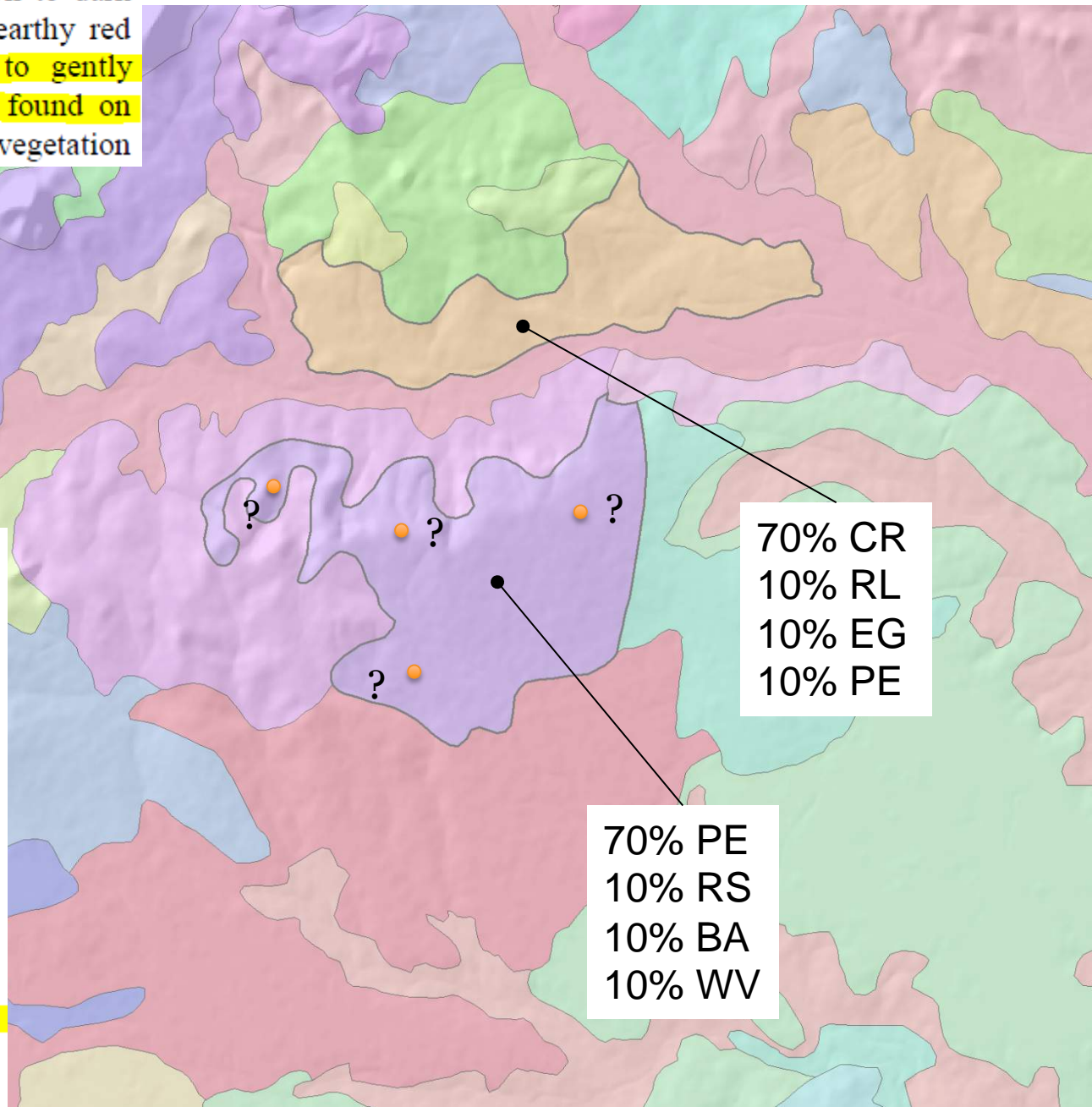
Pentland soil is a dark reddish brown to dark brown sandy clay loam grading to earthy red light clay. The landform is level to gently

Rangeside soil is a dark reddish brown to dark brown sand to sandy loam g *Barkla* soil is a greyish red to brown sand grading to sandy yellowish brown loamy loam. sand on ferricrete. The

considered landform is gently ferruginous undulating plains and the principal mesas. The vegetation is quarried for road base

material. *Wattle Vale* soil is a dark greyish brown loose to firm loamy sand to sandy loam grading to yellowish brown to yellow sandy clay loam. The soil may have considerable amounts of ferruginous gravel in the profile and is often quarried for road base. The landform is level to gently undulating plains with occasional

mesas.



DSMART algorithm

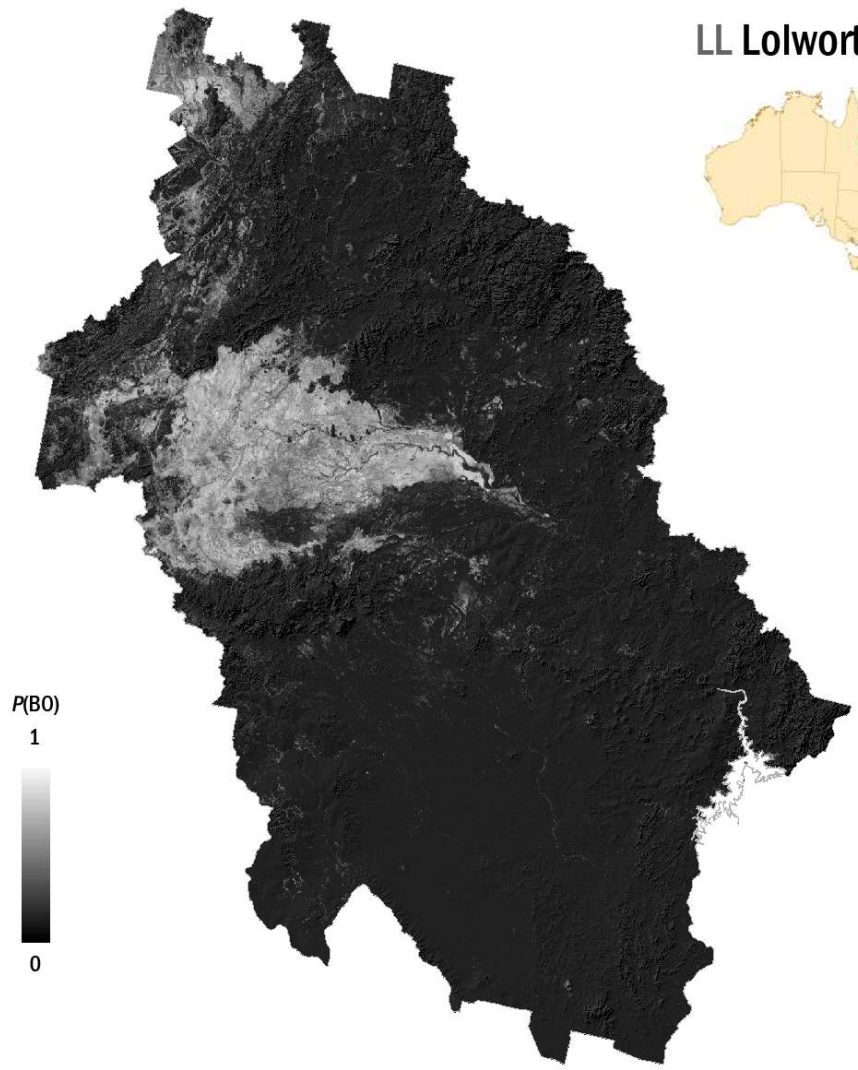
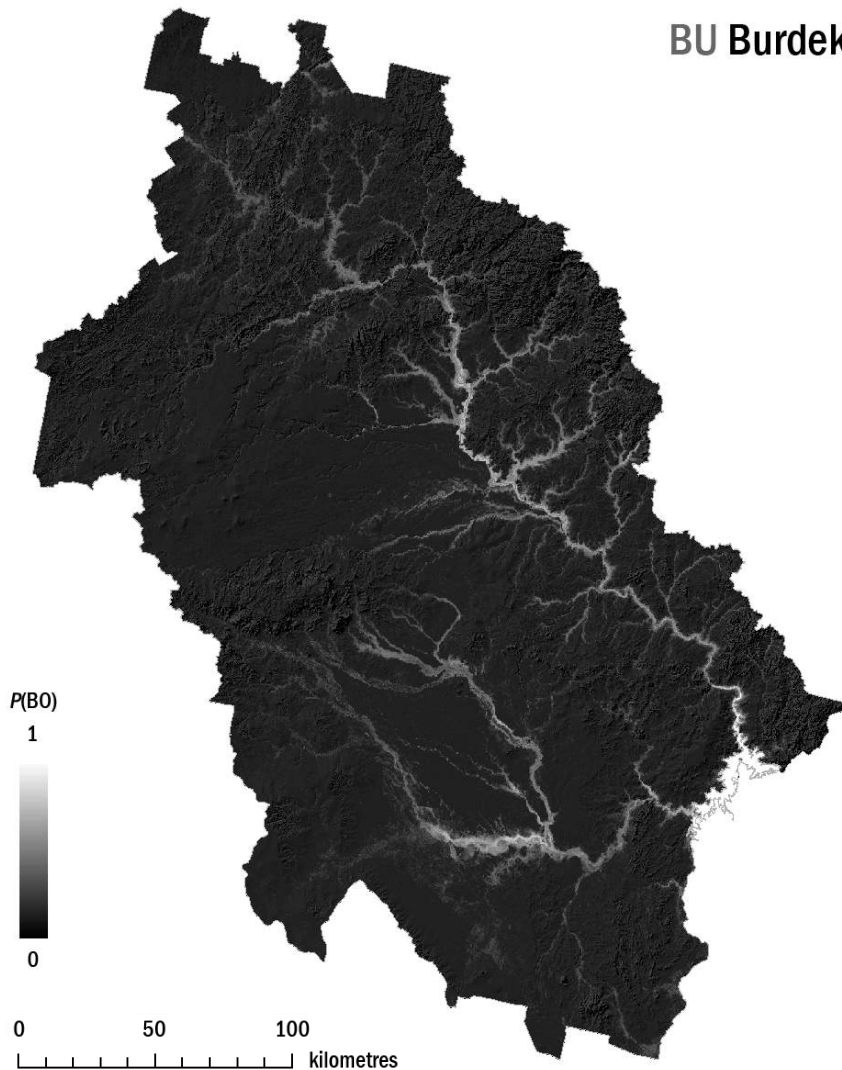
1. Iteratively resamples legacy soil map
2. Generates realisations of potential soil class distribution
3. Merges realisations to estimate probabilities of occurrence

Aim: to rediscover the spatial distribution of soil classes
(generate new soil information at a finer level of detail than the original)

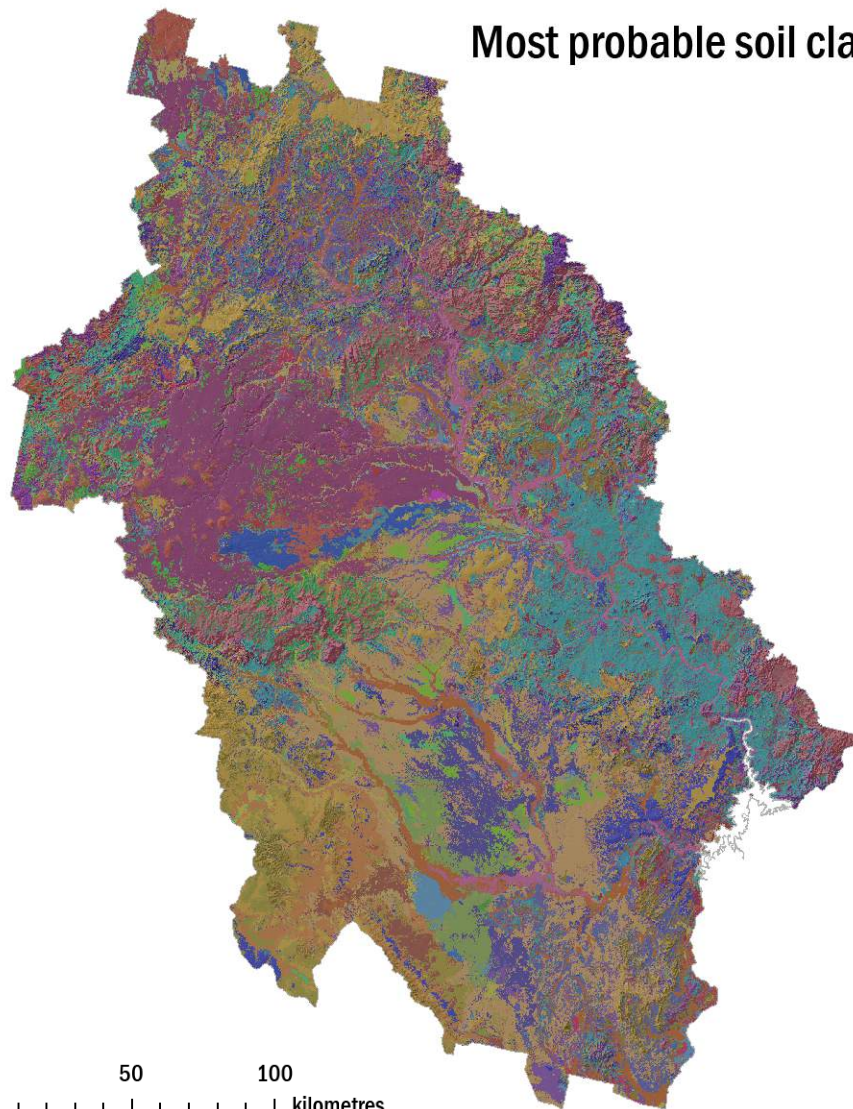
Probability surfaces (30-m grid cells)

BU Burdekin

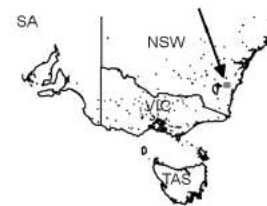
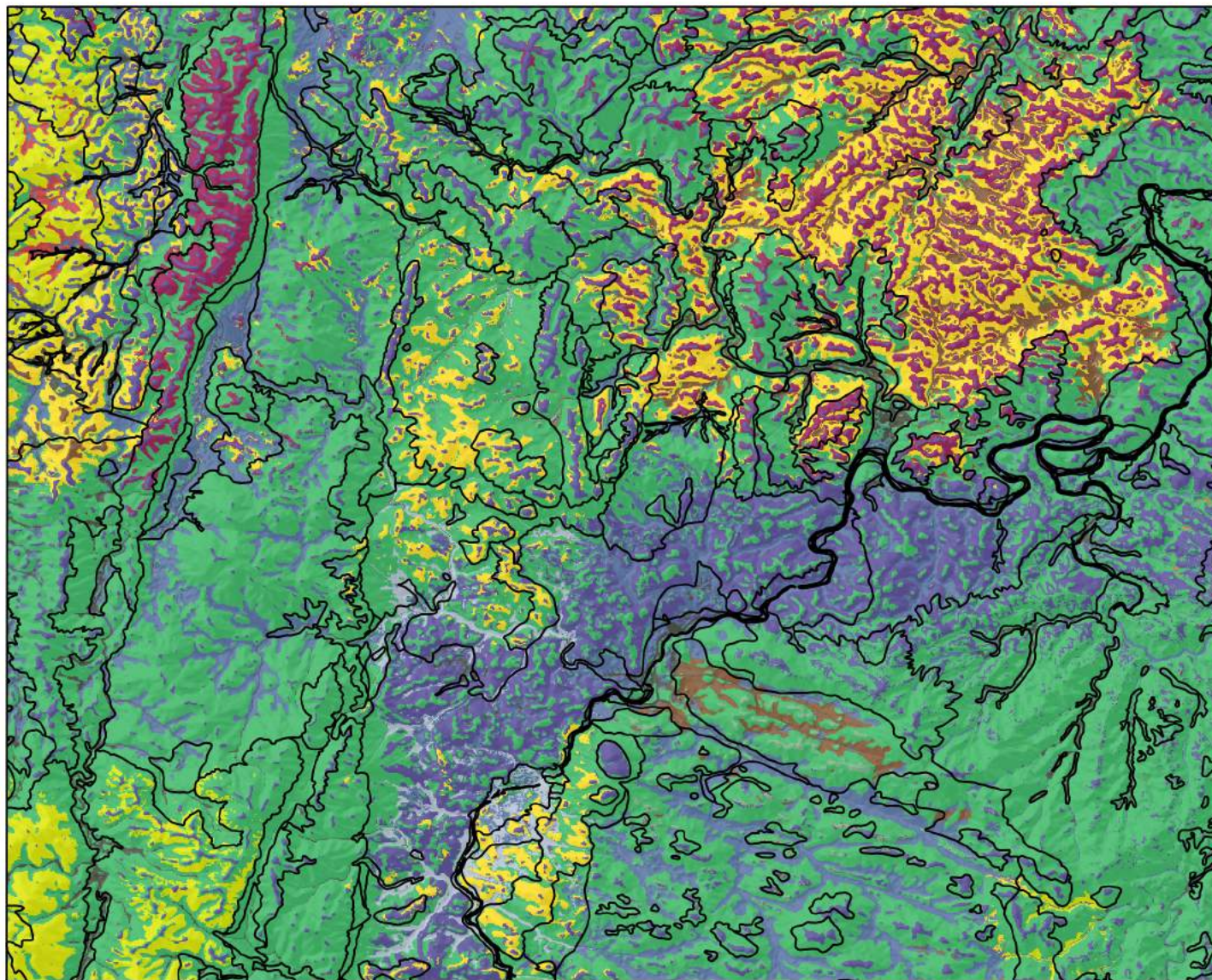
LL Lolworth



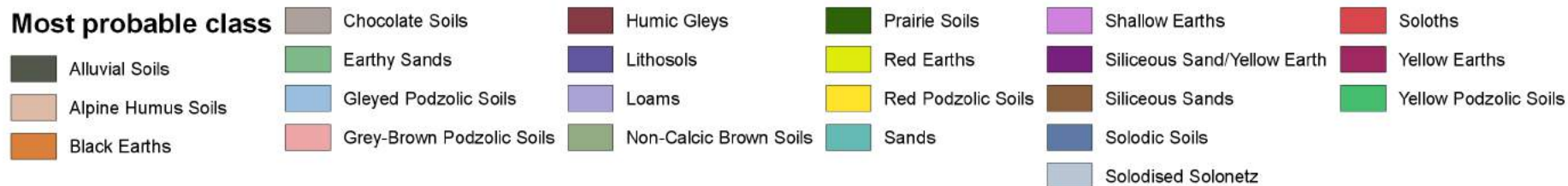
Most probable soil class



AR	DO	MF	RL
AT	EG	MK	RS
BA	EW	ML	SC
BL	FE	MN	ST
BO	FL	MR	TC
BR	FR	MY	TH
BS	FS	NI	TU
BU	GA	NS	UM
BW	GC	NU	UT
CB	GR	PA	VD
CE	HG	PE	WA
CG	HV	PG	WB
CK	LI	PI	WO
CO	LL	PL	WR
CP	LT	PN	WV
CR	MA	PO	YA
CT	MB	RA	
DA	MD	RI	



Most probable class

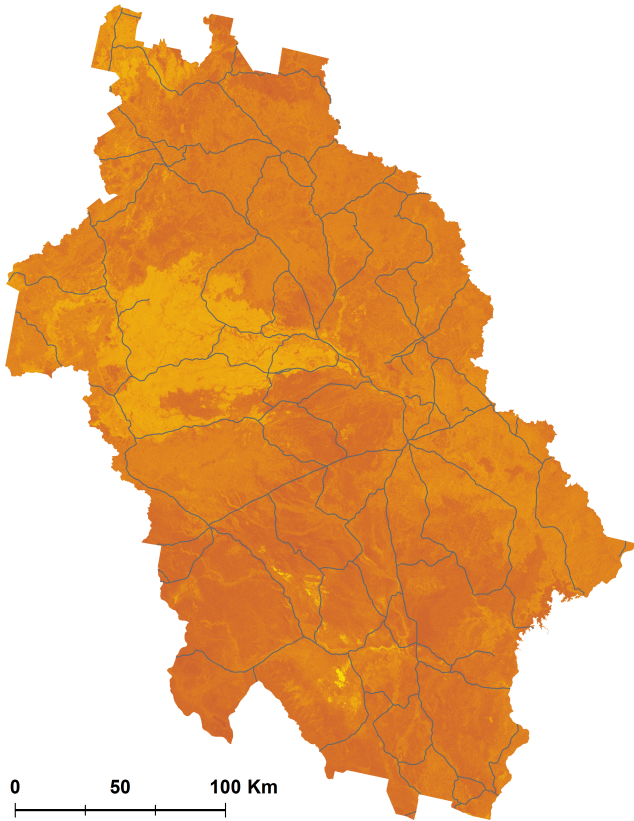


Model averaging

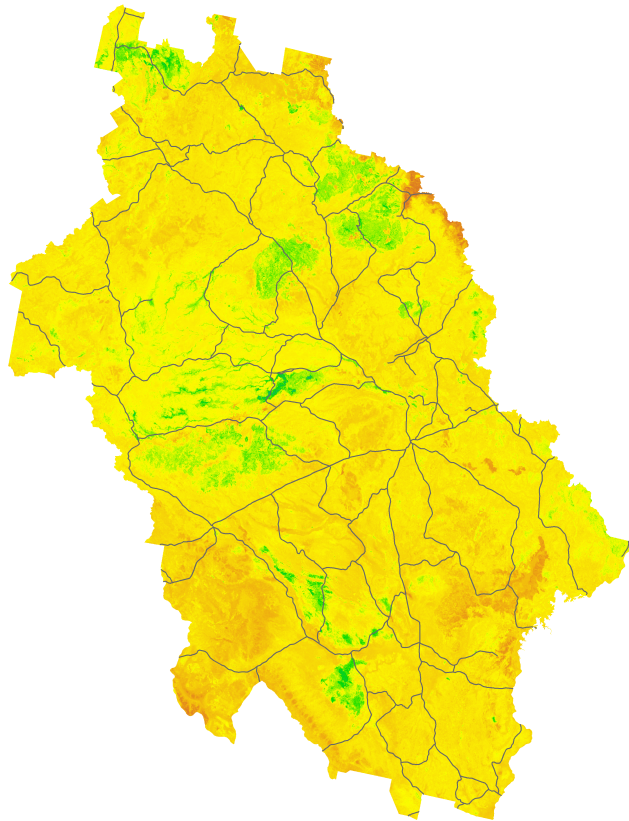
- What if we have more than one soil map for the same area?
- How can we combine them?
- Model-averaged predictions are weighted averages of the contributing maps
 - Task is to define the weights for each map
 - Many options for doing so (*equal weights, variance-weighted averaging, Granger-Ramanathan averaging, ...*)

0–5 cm pH maps (disaggregated soil information)

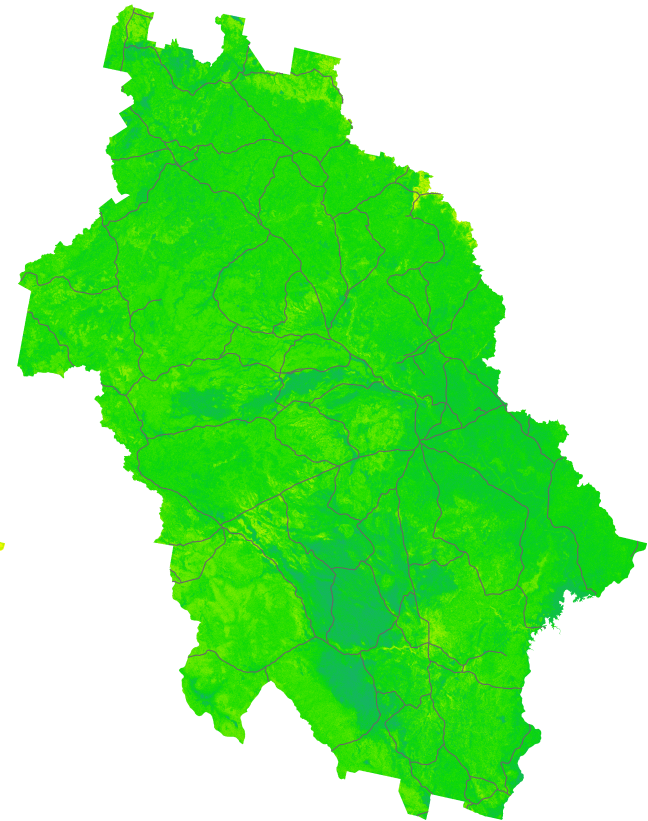
Lower prediction limit



Prediction



Upper prediction limit

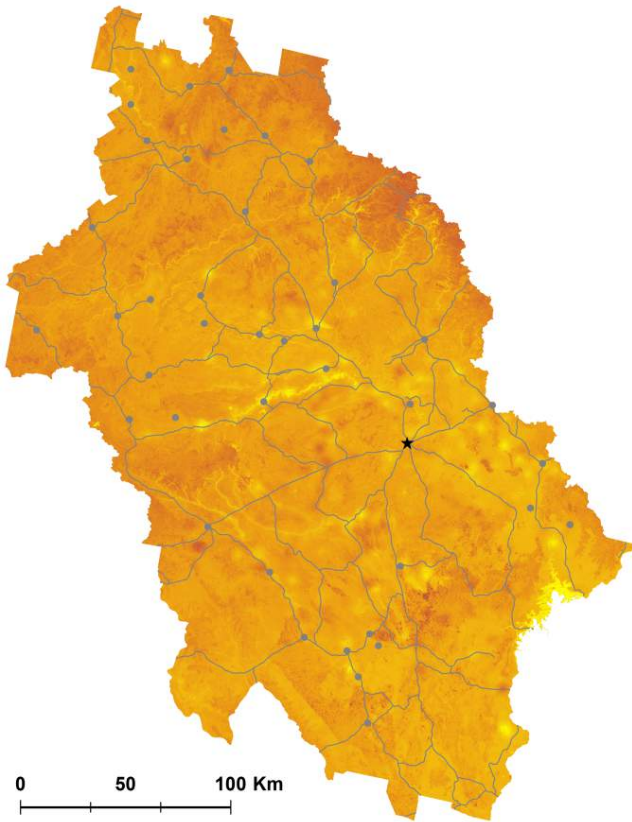


Validation of predictions:
 R^2 : 0.06
RMSE 0.75

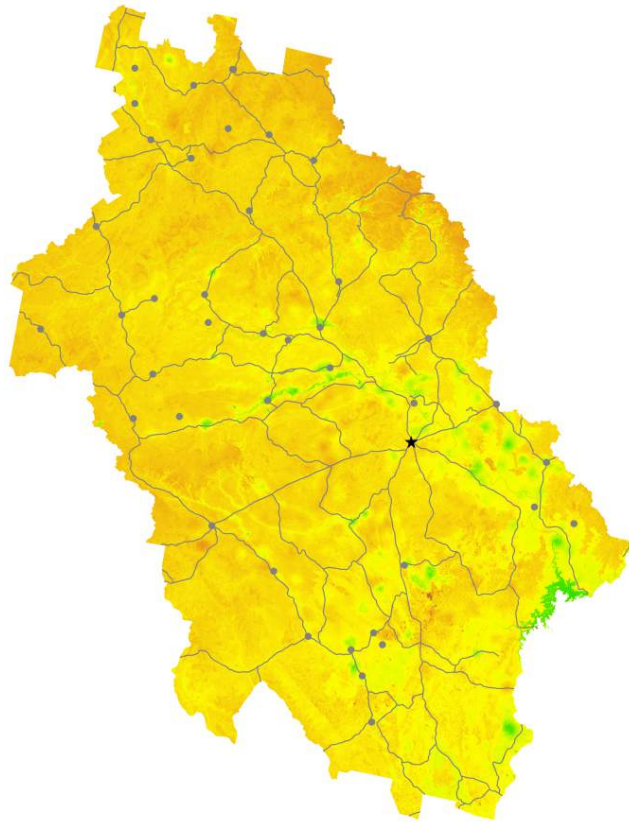
Validation of uncertainty:
PICP: 0.95

0–5 cm pH maps (regression-kriging procedure)

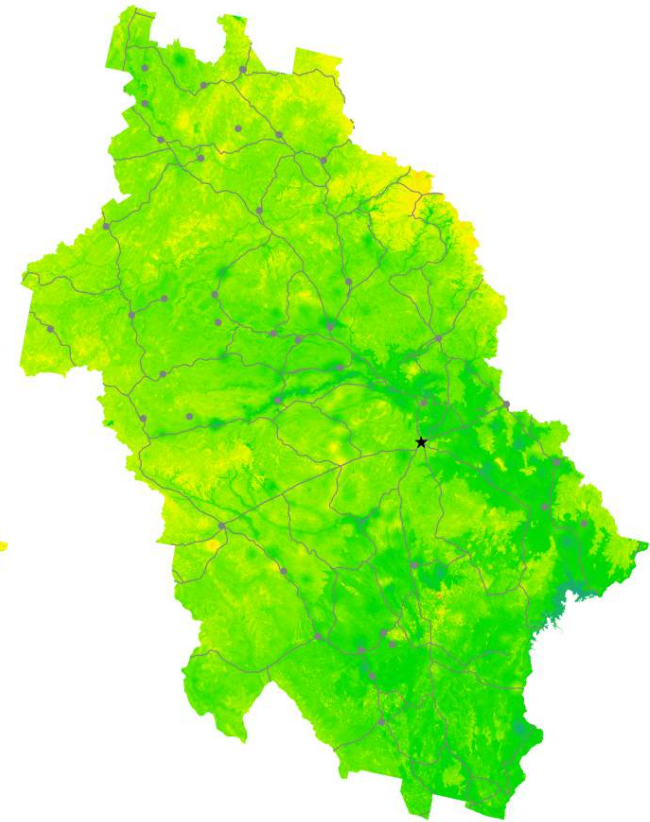
Lower prediction limit



Prediction



Upper prediction limit

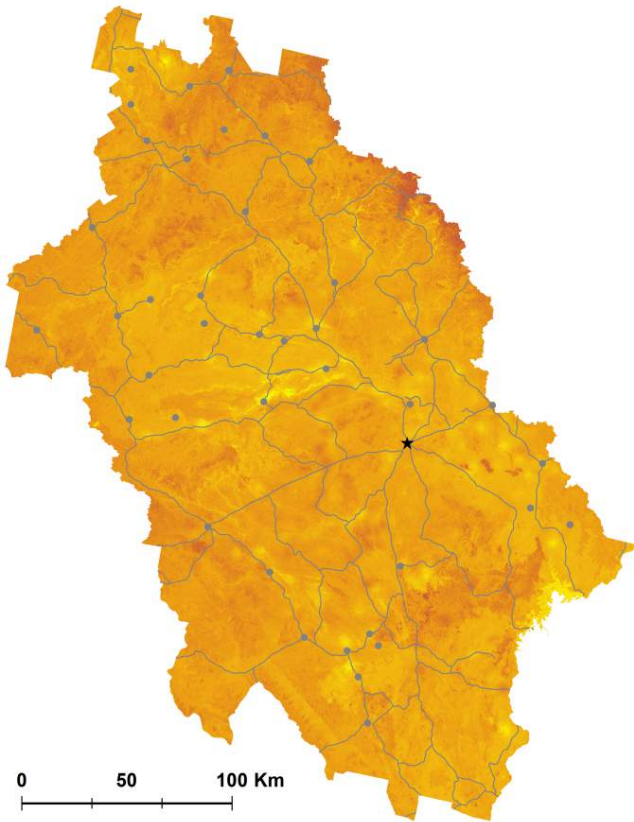


Validation of predictions:
 R^2 : 0.14
RMSE 0.69

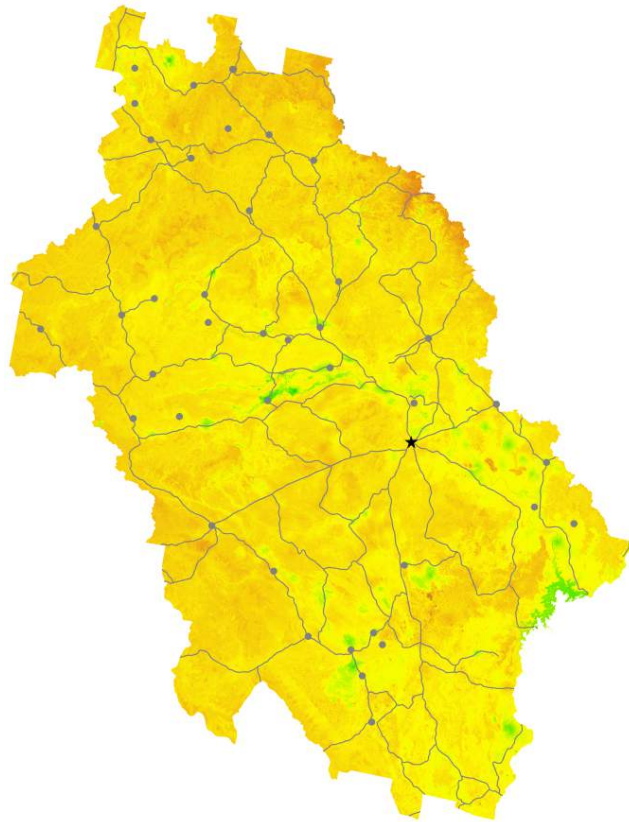
Validation of uncertainty:
PICP: 0.90

0–5 cm pH maps (model-averaged predictions)

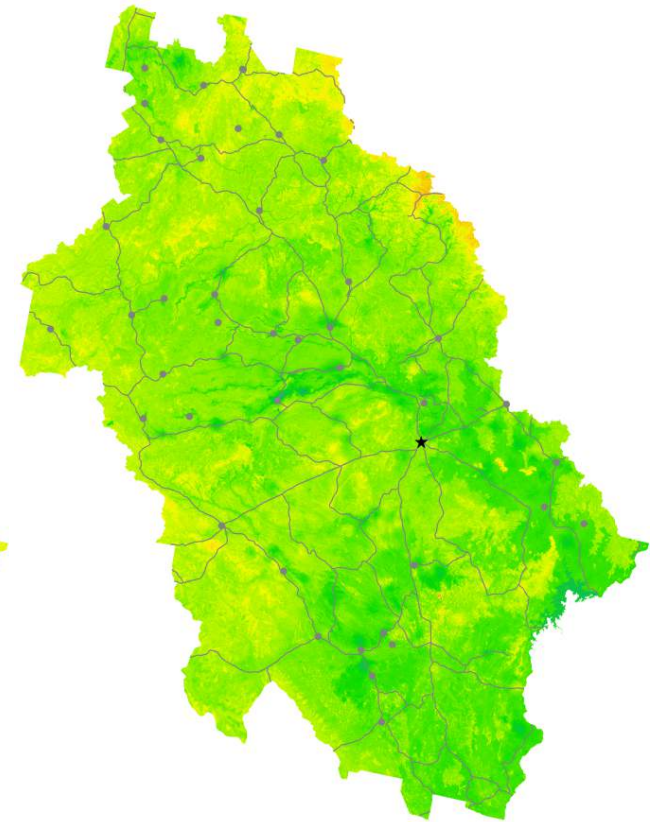
Lower prediction limit



Prediction



Upper prediction limit



Validation of predictions:
 R^2 : 0.16
RMSE 0.68

Validation of uncertainty:
PICP: 0.87

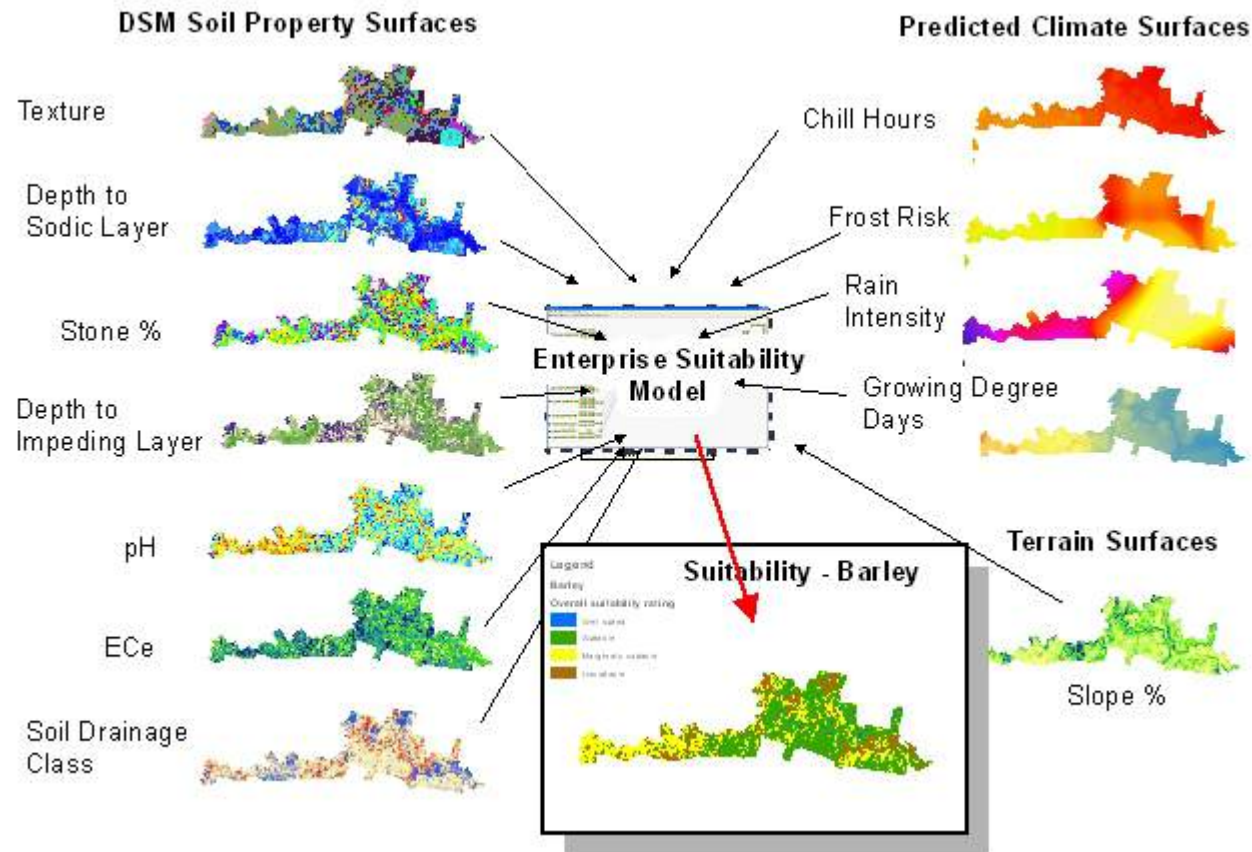
Enterprise suitability mapping

- An aid to assess the potential for growing new crops in an area
- Suitability assessment makes use of:
 - Digital soil mapping (e.g. soil depth, drainage index, clay content)
 - Local climate mapping (e.g. frost risk, growing degree days, chill hours)
 - Crop suitability rules
- Trialled in Tasmania for 20 agricultural crops
 - Collaboration with Tasmanian Institute of Agriculture, Department of Primary Industries, Parks, Water and Environment (Tasmania)

Suitability rules for hazelnut

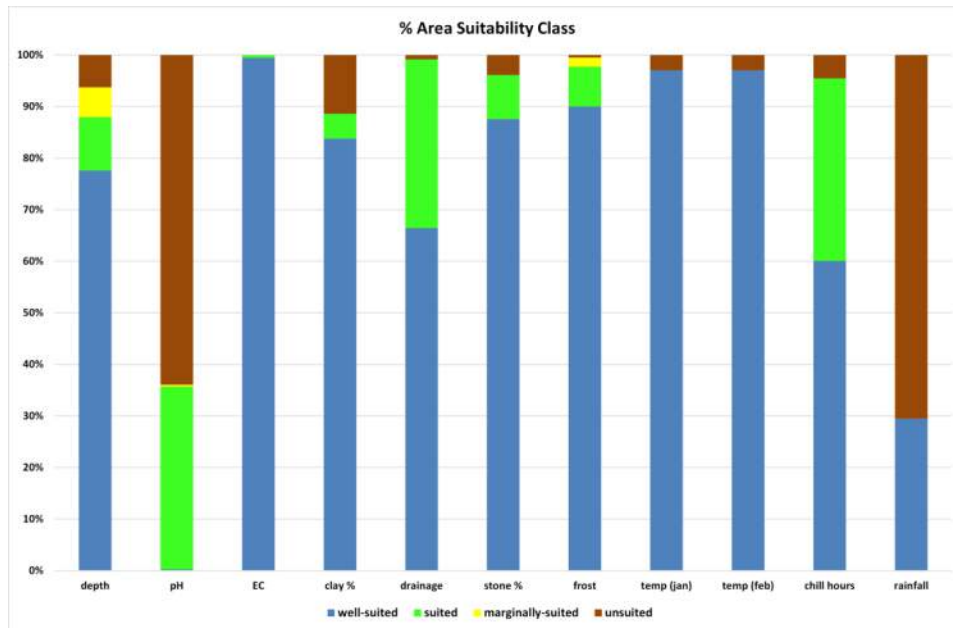
Suitability class	Soil depth (cm)	0–15 cm pH	0–15cm EC (dS m ⁻¹)	0–15 cm clay content (%)	Soil drainage class	0–15 cm stone content (>20cm, %)	Frost 0 days <-6°C, June–August	Mean month T _{max} , Jan–Feb (°C)	Mean March rainfall, (mm)	April–August chill hours 0–7°C
Well suited	>50	>6.5	<0.15	10–30	Well to moderately well	<10	4/5 years	20–30	<50	>1200
Suited	40–50	5.5–6.5	<0.15	30–50	Imperfect	10–20	3/5 to 4/5 years	30–33 or 18–20	<50	600–1200
Marginally suited	30–40	6.5–7.1	<0.15	30–50	Imperfect	10–20	2/5 to 3/5 years	33–35	<50	600–1200
Unsuited	<30	<5.5 or >7.1	>0.15	>50 or <10	Poor to very poor	>20	<2/5 years	>35 or <18	>50	<600

Suitability process

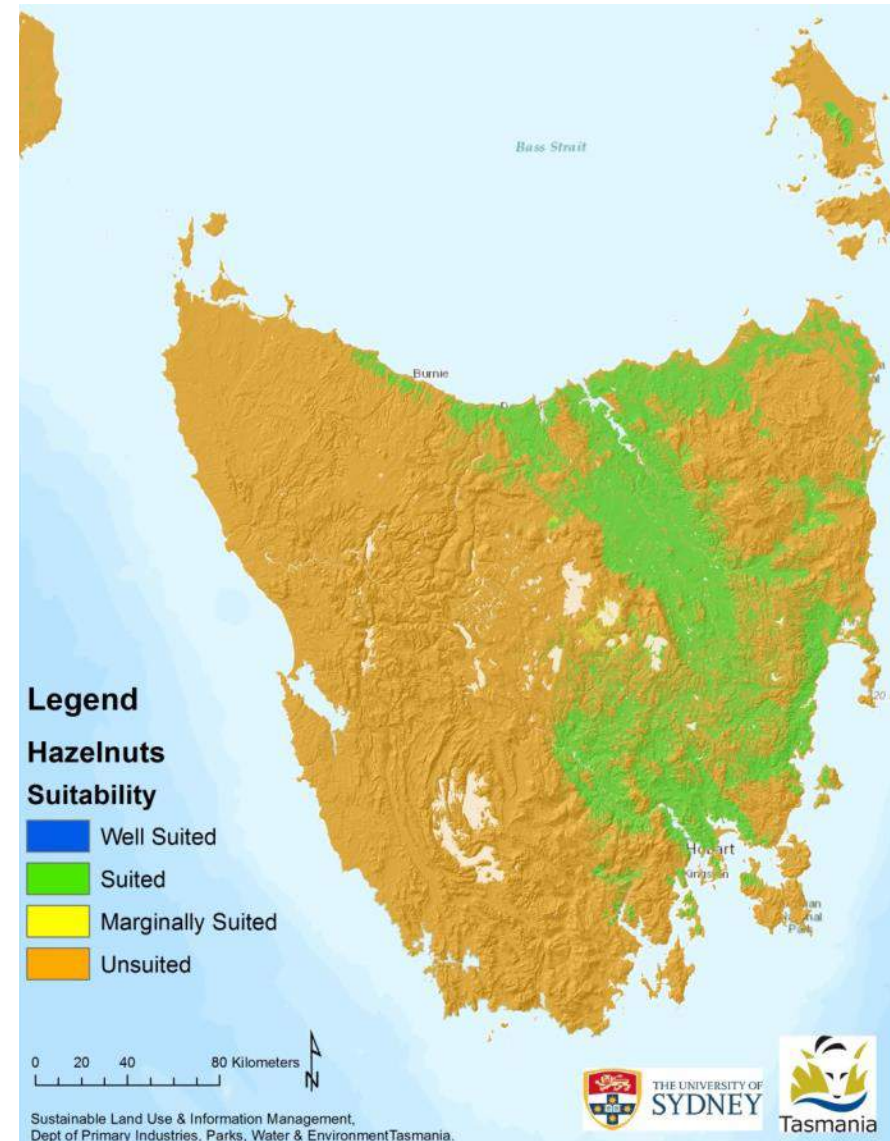


- Suitability class assigned according to most limiting factor

State-wide enterprise suitability, hazelnuts



- Suited to most of Tasmania's ag. area
- Most of the rest of the state unsuitable because of topsoil pH and excessive March rainfall



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Researchers from across Australia have joined together to develop detailed digital maps of the country's soil and landscape attributes.

The Soil and Landscape Grid of Australia provides relevant, consistent, comprehensive, nation-wide data in an easily-accessible format.

The datasets are a first approximation (version 1) of national scale maps designed to be updated and improved over time as resources, new data and improved methods and technologies become available.

The Soil and Landscape Grid provides a range of [soil](#) and [landscape](#) attribute products.

Using the best available data from existing databases, new sensor measurements and novel spatial modelling, the Grid presents fine spatial resolution (3 arc-seconds or approximately 90 x 90 m pixels) digital soil and landscape attribute maps. Included in the data are estimates of reliability. These maps are consistent with the specifications of the [GlobalSoilMap](#) project and the data are managed as part of the [Australian Soil Resource Information System](#) (ASRIS). [View the maps](#) or explore the soil and landscape attributes in the '[Product details](#)' menu above. You can also download the data in different ways through the '[Get the data](#)' menu on this website.

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Grazie mille!



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