


**Spectral soil analysis and inference systems: a powerful combination for solving the soil data crisis**

Raphael VISCARRA ROSSEL  
Alex McBRATNEY  
Budiman MINASNY

18<sup>th</sup> WCSS  
9-15 July 2006  
Philadelphia

Australian Centre for Precision Agriculture  
Faculty of Agriculture, Food & Natural Resources



THE UNIVERSITY OF SYDNEY

**The problem**

Serious limitation on availability of appropriate information on soil and land resources

**The challenge**

to link and relate existing soil information and provide a quick and cheap technique to accurately measure functional soil properties for modelling and prediction

**The aims of this talk**

To show how a soil inference system (e.g. SINFERS) together with diffuse reflectance spectroscopy (DRS), or SPEC-SINFERS, may be used to predict important and functional soil properties

**Soil inference system (e.g. SINFERS)**

SINFERS take observations we know with a certain precision and infers properties we don't know, by means of logically linked predictive functions

The basic assumption underlying SINFERS is that if we know or are able to predict the basic fundamental properties of the soil, we should be able to infer all other physical and chemical properties using PTFs.

**SINFERS with uncertainty**

For input uncertainties, LHS used to sample the multivariate joint distribution of the input variable. Monte Carlo simulation then calculates the distribution of the results, along with their means and standard deviations.

For model uncertainties, bootstrap re-sampling is used

**How does SINFERS work?**

E.g. to determine soil AWC need to first determine:

- $\theta$  field capacity (FC) and  $\theta$  wilting point (WP)

These may be predicted using the following PTFs:

Variable	Model	Inut
FC (-10 kPa)	NN	Clay, Silt, Sand, <b>BD</b> , OC
WP (-1500 kPa)	NN	Clay, Silt, Sand, <b>BD</b> , OC

Minasny & McBratney (2002)

**How does SINFERS work?**

...and bulk density may be estimated using the following PTF:

Variable	Model	Inut
<b>BD</b>	NN	Clay, Silt, Sand, OC


Minasny & McBratney (2002)

Need measurements of Clay, Silt, Sand, and OC

**HOW CAN WE GET THEM?**


**Inputs to SINFERS can be from:**

(a) Soil survey, i.e. obtaining soil morphology description: field texture, pH, structure, colour.



Qualitative and imprecise

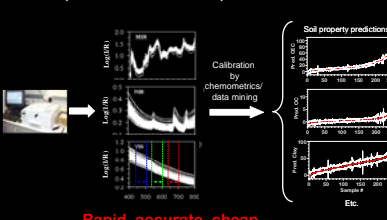
**(b) Laboratory measurements**



PSA, organic carbon, etc

Precise but expensive and time consuming

**(c) Diffuse reflectance spectroscopy. (Another form of PTF)**



Rapid, accurate, cheap

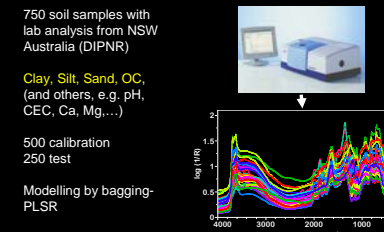
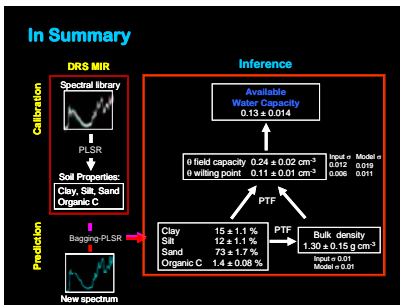
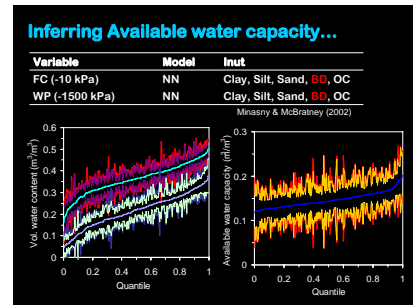
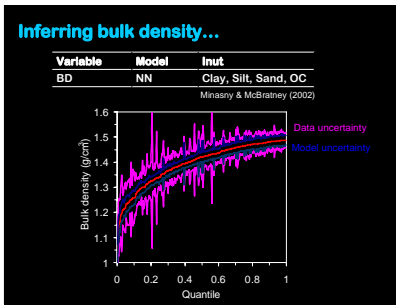
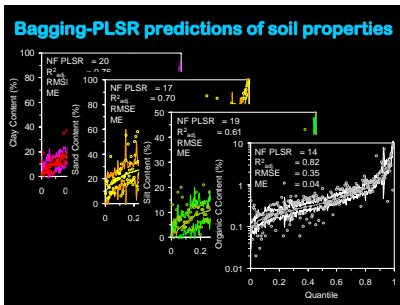
**Continuing with example...**

750 soil samples with lab analysis from NSW Australia (DIPNR)

Clay, Silt, Sand, OC, (and others, e.g. pH, CEC, Ca, Mg,...)

500 calibration  
250 test

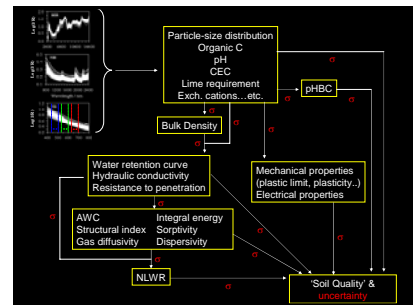
Modelling by bagging-PLSR

**How does DRS compare?**

	DRS MIR RMSE	Hand text, Lab OC RMSE	PSA, Lab. OC RMSE
BD g/cm³	0.15	0.47	0.08
Cost	Lower	Lowest	High

Lots of somewhat less precise data better than fewer more precise ones



## Acknowledgements

- ARC Linkage project:  
Neil McKenzie, Mike Grundy, Dan Brough
- GRDC project on rapid soil measurements
- NSW DIPNR:  
Brian Murphy, Greg Chapman