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Estimating saturated hydraulic conductivity using different well-known pedotransfer functions

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Introduction

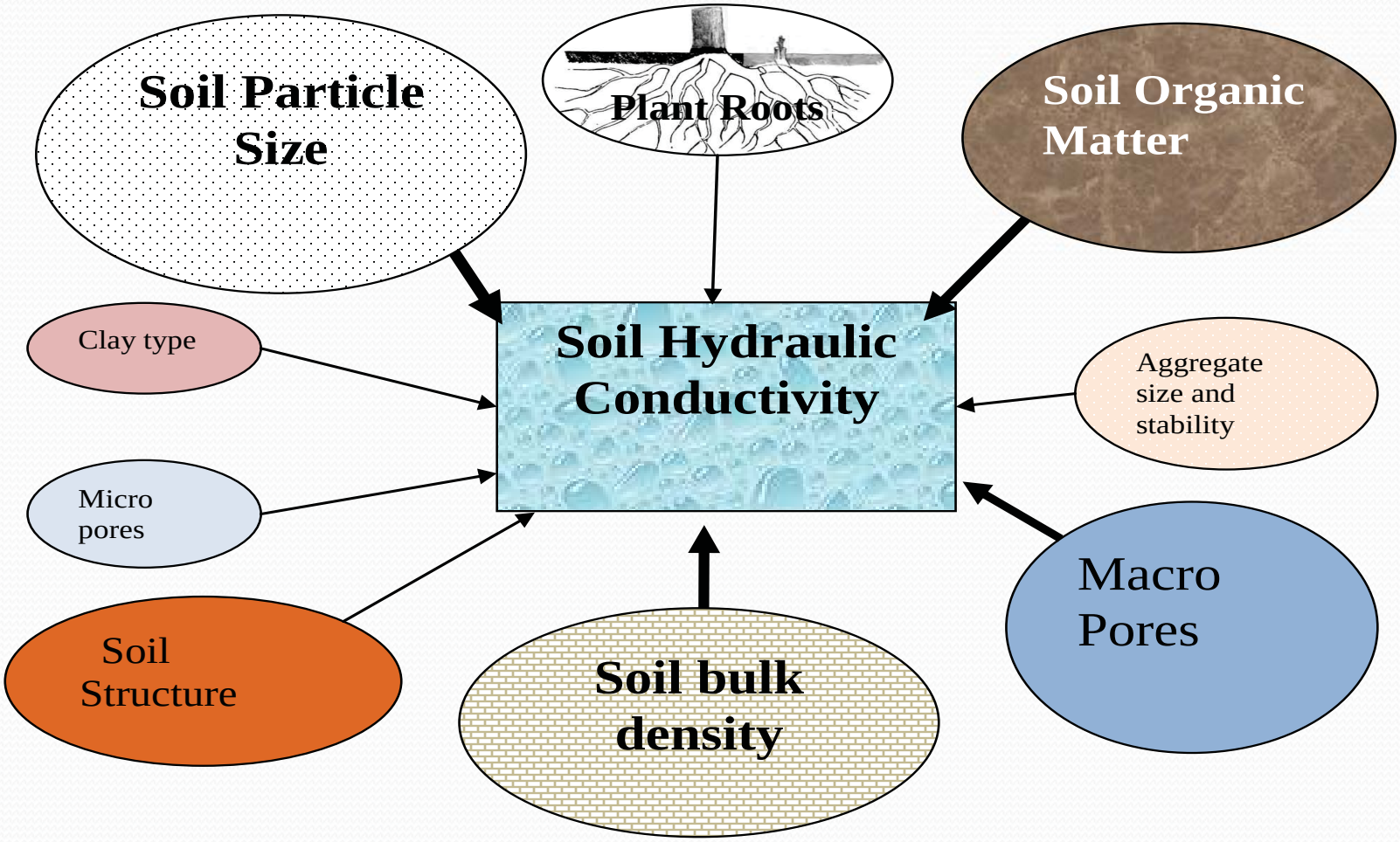
Saturated hydraulic conductivity;

- irrigation and drainage models,
- for studying water movement in the unsaturated zone
- solute and contaminant transport

Saturated hydraulic conductivity, K_s

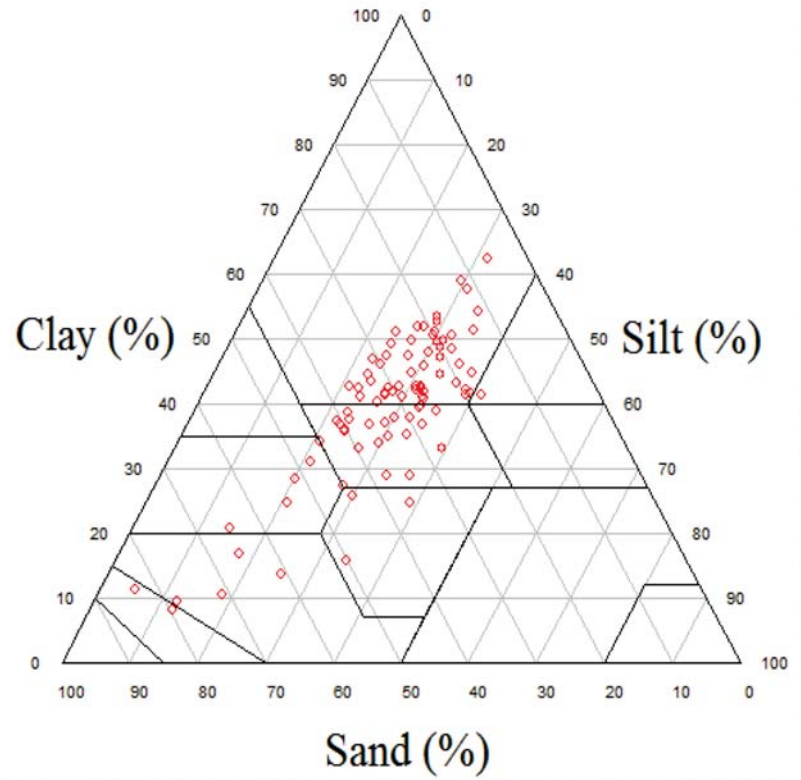
- Laboratory methods
  - Constant head soil core
  - Falling head soil core
  - Steady flow soil column
- Field methods
  - Ring or cylinder infiltrometres
  - Constant head well permeameter
  - Auger hole (saturated zone)
  - Piezometer method (saturated zone)

Pedo Transfer Function



Material and Methods

- 91 undisturbed soil samples (replicated)
- K_s



Material and Methods

Table 1: Physical characteristics of the soil samples

	Max	Min	Average	SD
Sand (%)	83.6	5.9	31.9	15.1
Silt (%)	41.4	5.2	28.6	6.5
Clay (%)	62.2	8.0	39.5	11.1
OM (%)	3.85	0.01	1.16	0.66
BD (g cm^{-3})	1.63	0.93	1.19	0.15

Models

- Characteristics of the PTFs used in this study

PTF	Input variables	Software	Source
Jabro	sand, silt, clay, BD	SOILPAR2	Jabro (1992)
Puckett	sand, silt, clay	SOILPAR2	Puckett et al. (1985)
Rosetta	sand, silt, clay, BD	Rosetta	Schaap et al. (2001)
NeuroTheta	sand, silt, clay	NeuroTheta	Minasny and McBratney (2003)
Turkey-PTFs	sand, silt, clay, BD, OM	-	-

Turkey-PTF

- a local regression based PTF
- derived using
  - **70%** of samples as development subset and
  - **30%** as test subset

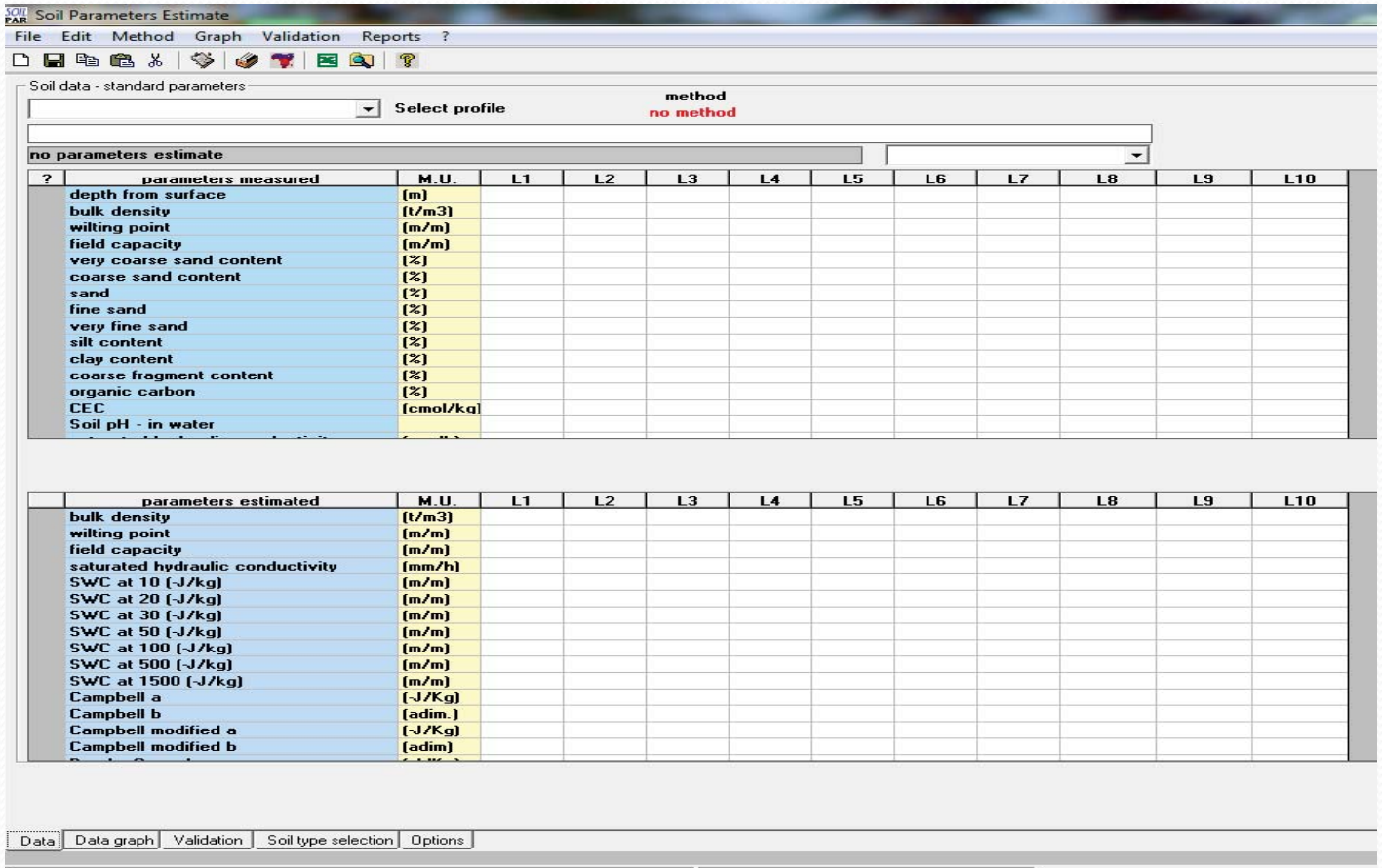
- Soil organic matter, an extra predictor in Turkey-PTF

SOILPAR2

Containing several regression based PTFs

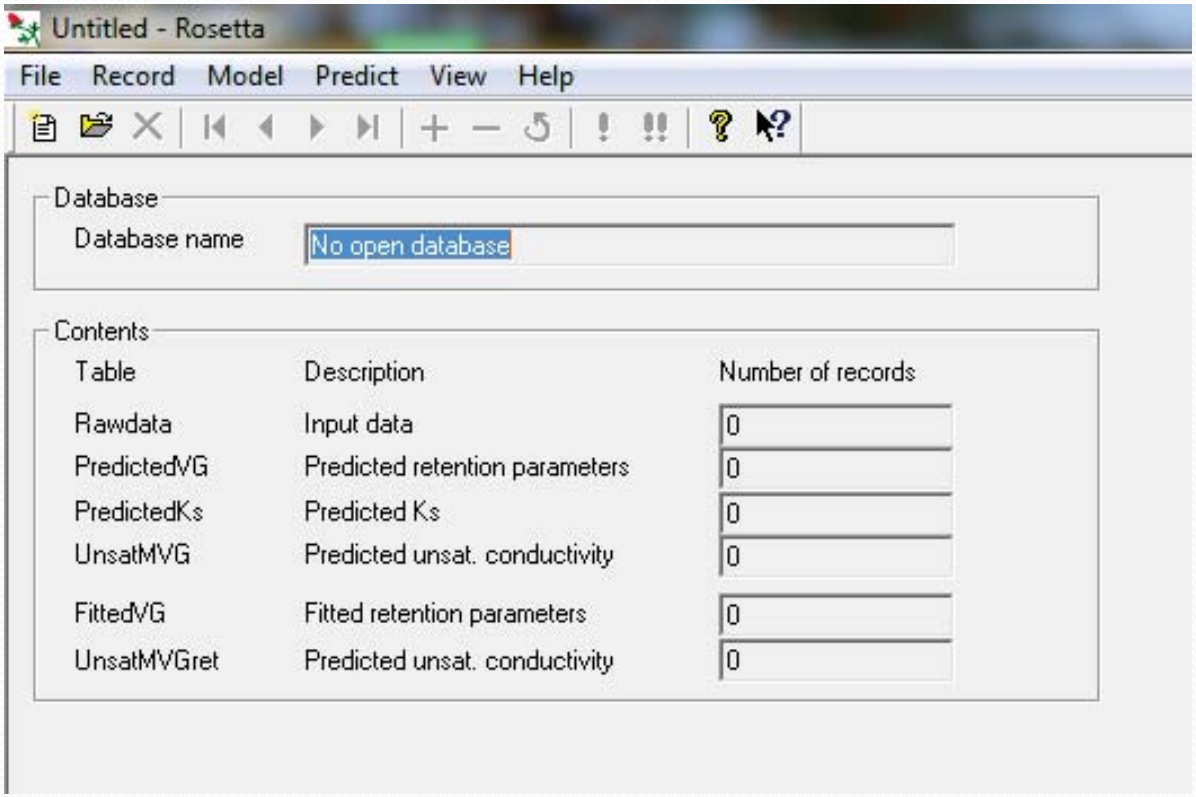
Predicts both $\underline{K_s}$ and water content

Developed by: Marco Acutis & Marcello Donatelli, 2003



Rosetta

- implements PTFs based on artificial neural networks
- predicts van Genuchten parameters, Ks, K
- UNSODA
- developed by: Marcel G. Schaap



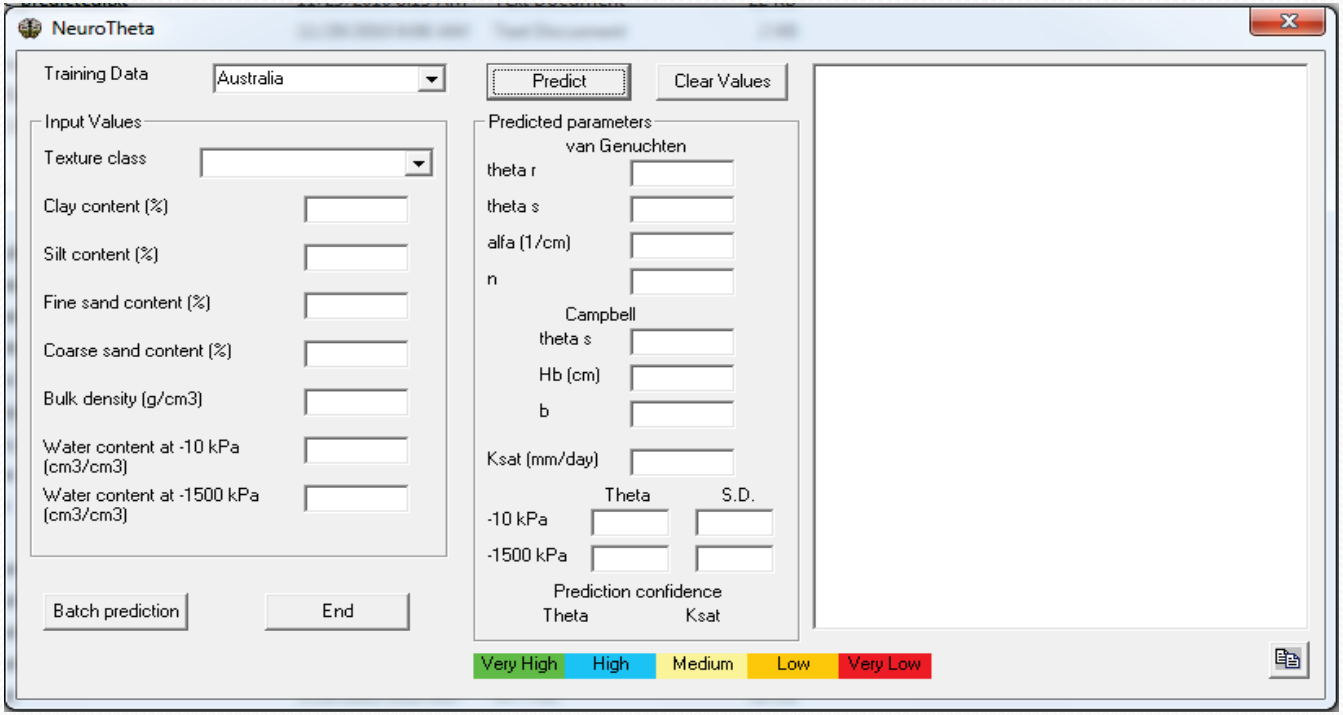
NeuroTheta

Uses Australian soil data

Works based on artificial neural networks

Predict van Genuchten and Campbell parameters and Ks

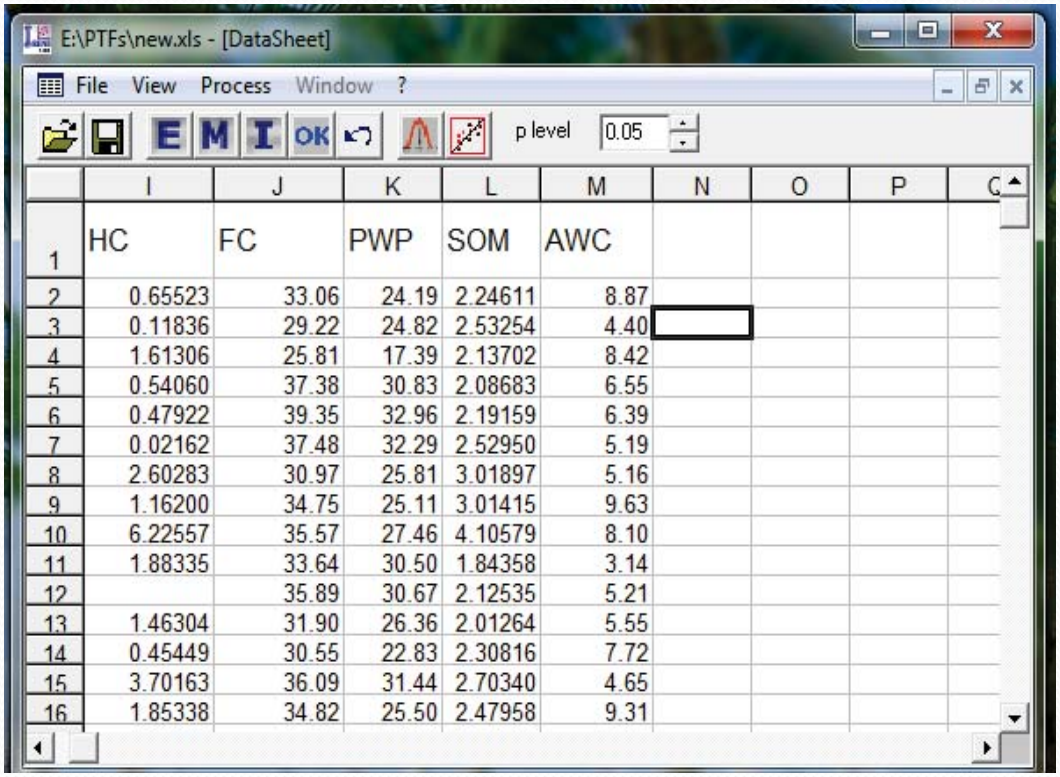
Developed by: Minasny and McBratney, 2003



IRENE

a data analysis tool
Performance Criteria

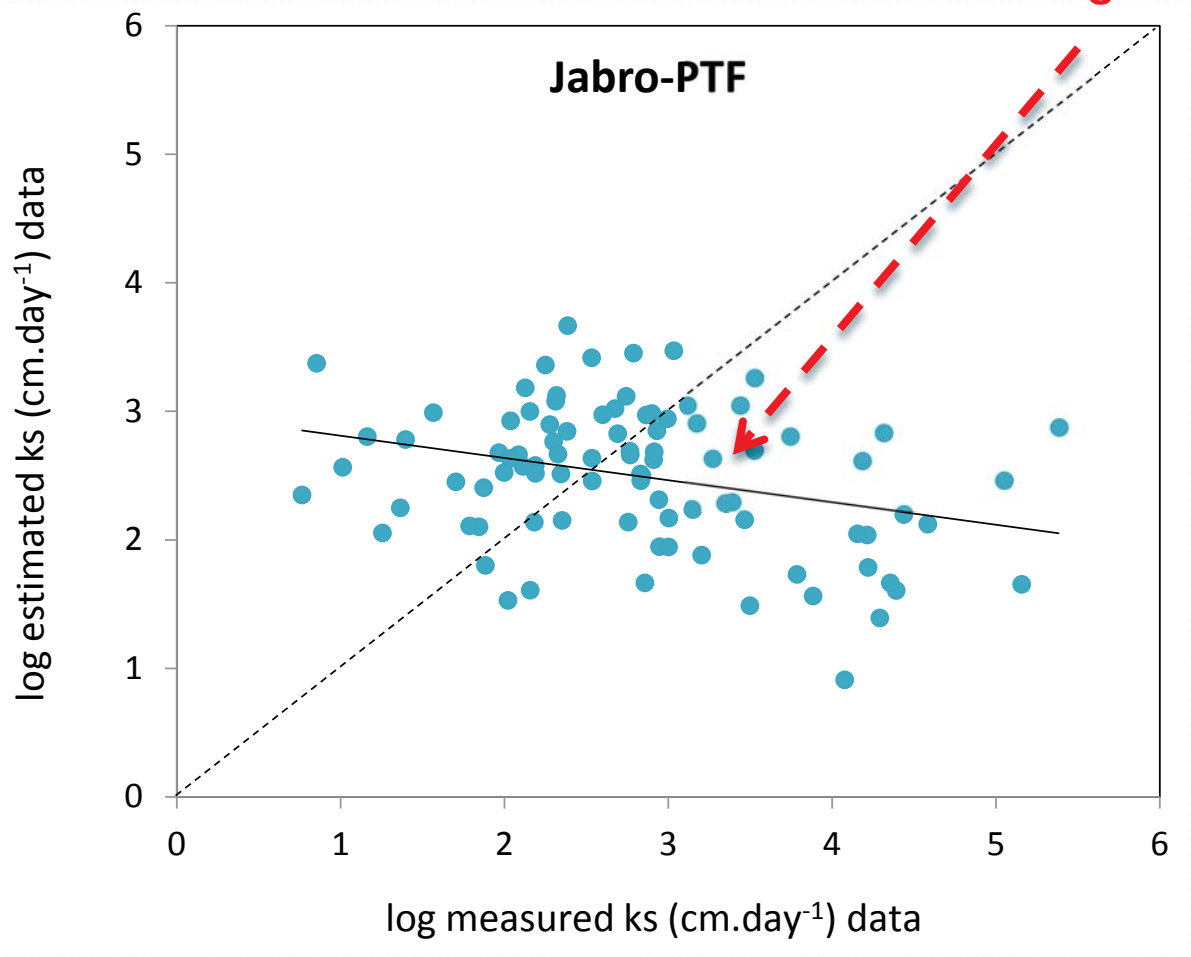
- RMSE
- *r*
- MBE



	I	J	K	L	M	N	O	P
1	HC	FC	PWP	SOM	AWC			
2	0.65523	33.06	24.19	2.24611	8.87			
3	0.11836	29.22	24.82	2.53254	4.40			
4	1.61306	25.81	17.39	2.13702	8.42			
5	0.54060	37.38	30.83	2.08683	6.55			
6	0.47922	39.35	32.96	2.19159	6.39			
7	0.02162	37.48	32.29	2.52950	5.19			
8	2.60283	30.97	25.81	3.01897	5.16			
9	1.16200	34.75	25.11	3.01415	9.63			
10	6.22557	35.57	27.46	4.10579	8.10			
11	1.88335	33.64	30.50	1.84358	3.14			
12		35.89	30.67	2.12535	5.21			
13	1.46304	31.90	26.36	2.01264	5.55			
14	0.45449	30.55	22.83	2.30816	7.72			
15	3.70163	36.09	31.44	2.70340	4.65			
16	1.85338	34.82	25.50	2.47958	9.31			

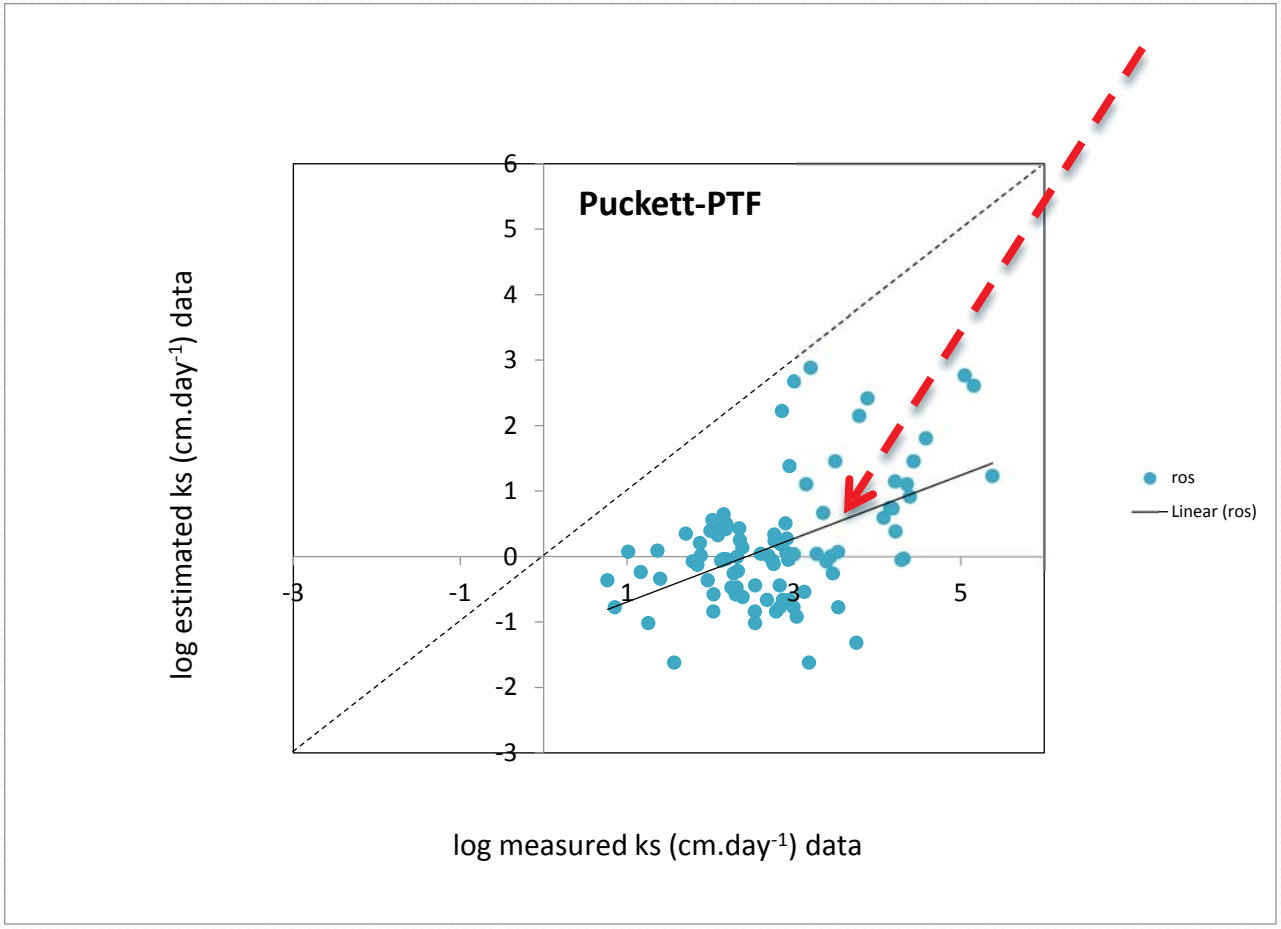
RESULTS

Negative correlation



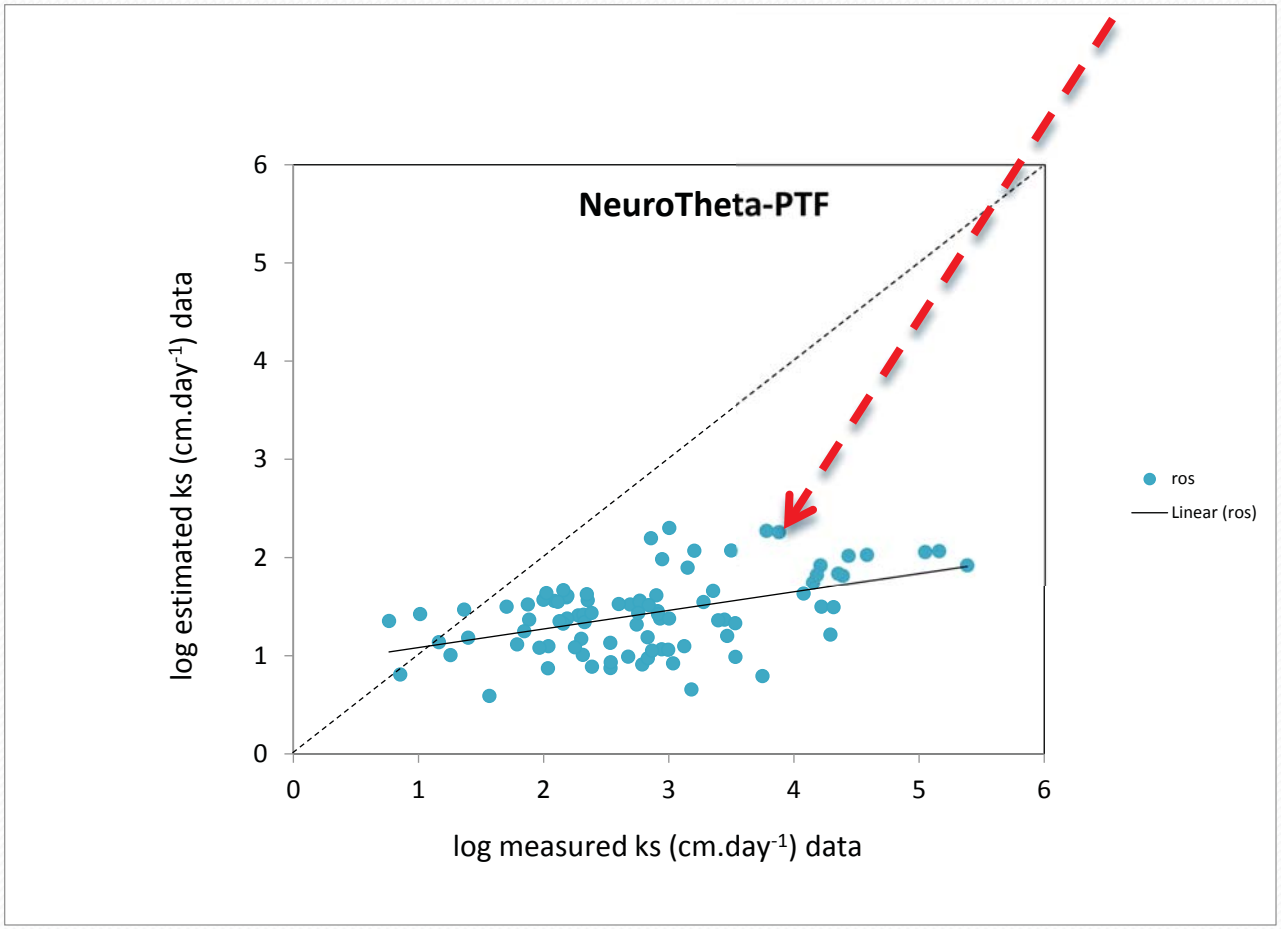
RESULTS

Underestimation
Moderate correlation



RESULTS

Trend to underestimation
Low positive correlation



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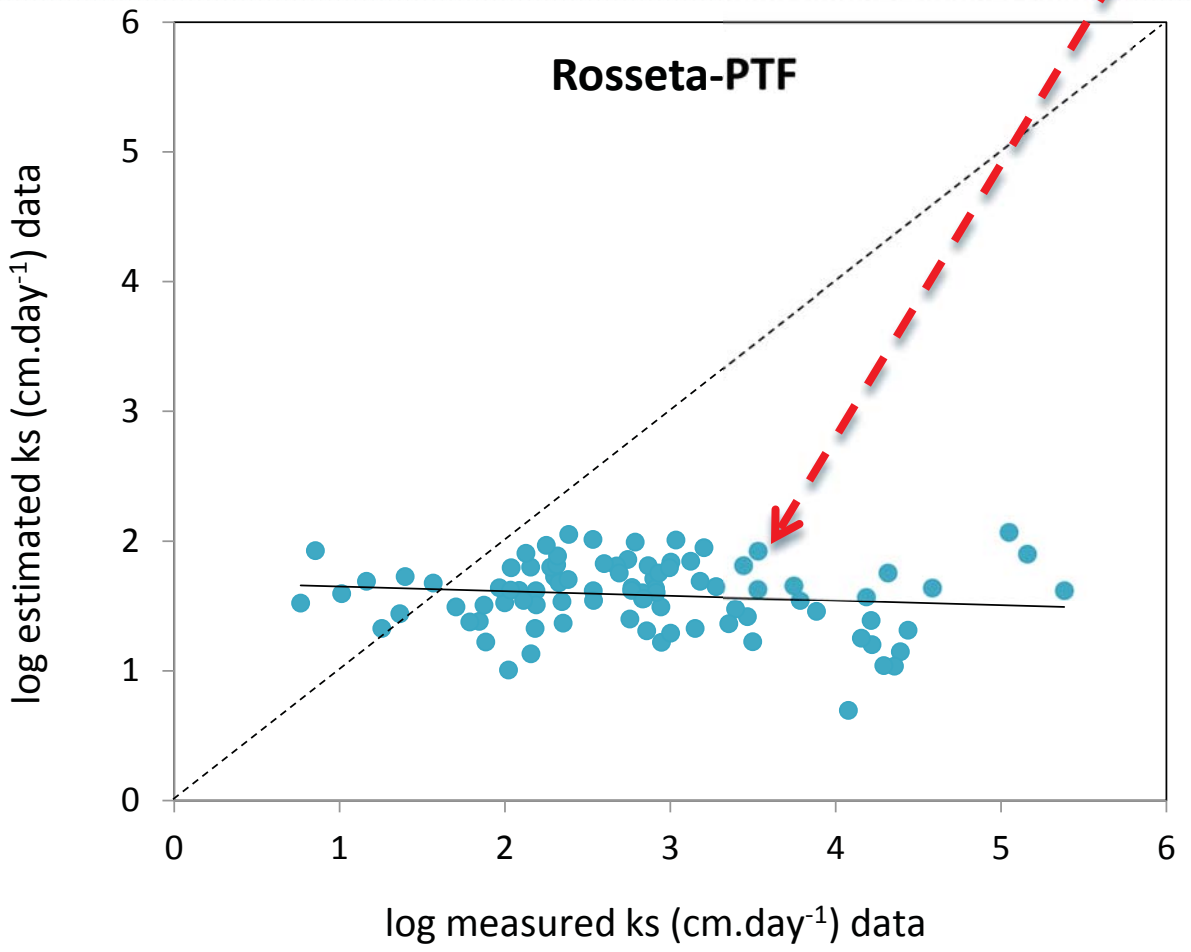
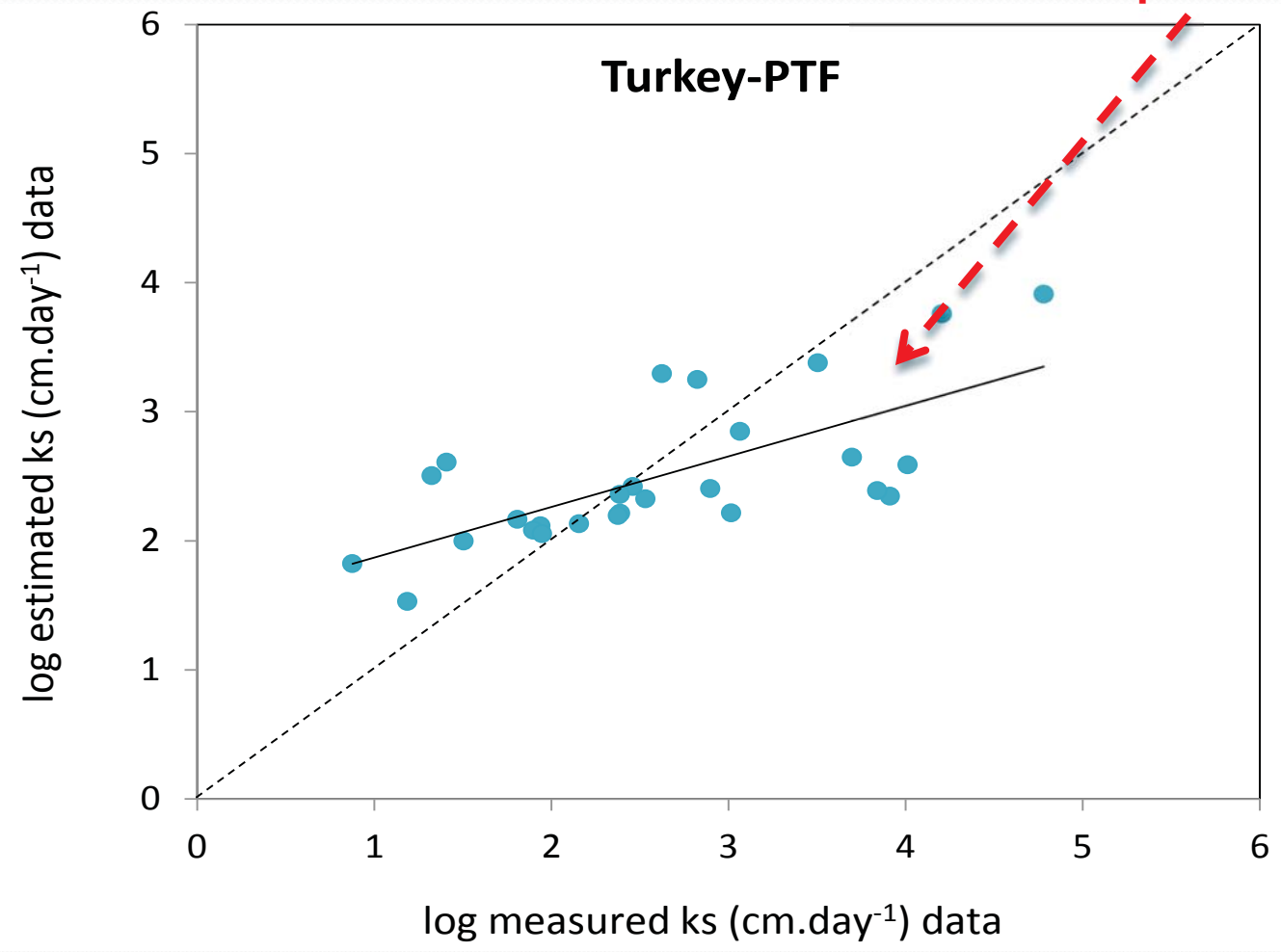


RESULTS

Well scattered data
Good positive correlation



RESULTS

	RMSE	MBE	*r*
Jabro	1.29	-0.32	-0.31
Puckett	2.80	-2.63	0.50
Neurotheta	1.63	-1.39	0.48
Rosetta	1.61	-1.23	-0.13
Turkey	0.74	-0.11	0.69

Discussion

- trend to underestimate in all PTFs

may be related to the differences between derived samples with our samples

- lowest RMSE value belongs to Rosetta

better performance of ANN based PTF compared with regression based PTF

- Supremacy of local based PTF

✓ *effectiveness of using OM content as an extra input predictor*

✓ *importance of using the local data for deriving Ks PTF if they are available*

Questions arised

- Are the input parameters sufficient for estimating of Ks?
- How the sampling procedure does affect the measurement of K_s?
- Should the local data be used for local studies?
- What are the impacts of craks, shringing/swelling, plant roots, clay type on K_s?

Thank you for your attention