FOOTPRINT

Functional Tools for Pesticide Risk Assessment and Management

Parameterising MACRO and PRZM for EU-wide prediction

FOOTPRINT Final Meeting,
18-19 March 2009, Giessen, Germany

Available soil property data

- Basic analytical data for soil horizons
  - horizon designation; upper depth (cm); lower depth (cm); clay, silt and sand (%); pH; organic carbon content (%); bulk density (g cm^{-3}), stone content (%)
  - Further development of SPADE 2 database
- For 373 FOOTPRINT soil types
  - 264 are under arable cropping

'Pedotransfer' functions

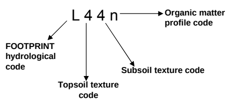
Statistics

Basic data → Model parameters

- Continuous functions (e.g. multiple linear regression)
- Single, discrete, values (e.g. for different soil classes)

FOOTPRINT soil types (FST's)

FOOTPRINT Soil Type Code:



Hydrologic class

- Simplified version of HOST ('Hydrology of Soil Types')
  - Substrate geology, presence of impermeable or slowly permeable soil horizons

The hydrologic class controls….

- Bottom boundary condition in MACRO
  - Groundwater recharge only (unit hydraulic gradient)
  - Discharge to surface water only (zero flow)
  - Both recharge and discharge (percolation as function of water table height)
- Presence/absence of drainage systems
  - Dimensions estimated by the Hooghoudt equation
- Runoff curve numbers in PRZM

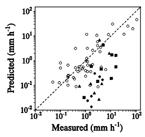
FOOTPRINT hydrologic classes

HOST classes	FOOTPRINT hydrologic class	Subsurface hydrology	Risk of surface runoff
1,2,3,5	L	Permeable substrate, recharge area (deep GW)	L
4	M	Permeable substrate, recharge area (deep GW)	M
6	N	Permeable substrate, recharge area (deep GW)	M-H
7	O	Permeable substrate, discharge area (intermediate GW)	L
8	P	Permeable substrate, discharge area (intermediate GW)	M-H
9,10,11	Q	Permeable substrate, discharge area (shallow GW)	L
17	R	Impermeable substrate, discharge area; large soil storage; lateral subsoil flow, no drains	M
19	S	Impermeable substrate, discharge area; large soil storage; lateral subsoil flow, no drains	M-H
22	T	Impermeable substrate, discharge area; small soil storage; rapid lateral subsoil flow, no drains	H
20	U	Impermeable substrate, discharge area; moderate soil storage; lateral subsoil flow, wide-spaced field drains	M-H
23,25	V	Impermeable substrate, discharge area; small soil storage; lateral subsoil flow, narrow-spaced field drains	H
16	W	Slowly permeable substrate, discharge & recharge; large soil storage, lateral subsoil flow, no drains	M
18	X	Slowly permeable substrate, discharge & recharge; moderate soil storage, lateral subsoil flow, no drains	M
14,21,24	Y	Slowly permeable substrate, discharge & recharge; small soil storage, lateral subsoil flow, narrow-spaced field drains	M-H

Matrix hydraulic properties

> Water retention (HYPRES functions)

> Saturated matrix hydraulic conductivity
- predicted from saturated matrix water content and van Genuchten's *n*, based on a database (n=70) of tension infiltrometer data*



> Dispersivity set to median value for a subset (n=116) of the database reported by Vanderborght & Vereecken** (= 3.4 cm)
- Steady flow rates < 1 mm h^{-1}

*Geoderma, 108, 1-17, **Vadose Zone J., 6, 29-52.

Cropping parameters

> Maximum root depth for each crop

> Rooting restricted by soil properties
- bulk density, stone content, texture, low pH

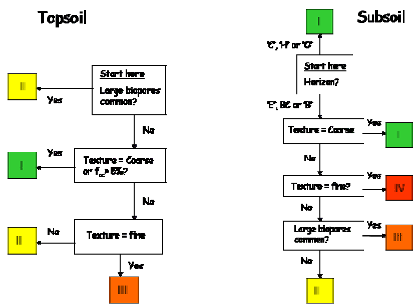
> Other parameters following FOCUS

Macropore flow parameters

> Classification scheme developed from:
- Literature review*, 'expert' judgement (guesswork!)
- Analyses (classification trees)
  - Aggregation (LANDIS and SEISMIC databases, U.K.)
  - Earthworm biopores (deep-burrowing anecic species): meta-analysis of the abundance of *Lumbricus terrestris* L. (n = 86)**

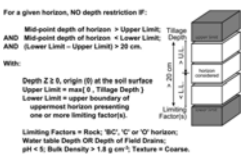
*Eur.J.Soil Sci., 58, 523-526. **Vadose Zone J., in press

Susceptibility to macropore flow



Site conditions and anecic earthworms

Site factors			ᵈLimiting soil texture
ᵃClimate zone	ᵇHydrologic conditions	ᶜLand use and management	
Cold temperate (FCZ 4,6,12,13,15)	All	Perennial	Coarse
Humid temperate (all other, except FCZ 10)	All	Perennial Annual	Coarse Coarse or fine
Mediterranean (FCZ 1,8,9)	Irrigated or FHC ≠ L,M or N	Perennial Annual	Coarse Coarse or fine

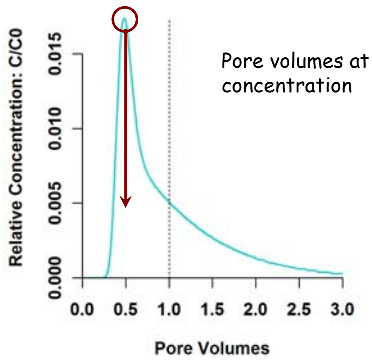


Validation 1: Model-independent

Using short-column tracer breakthrough experiments under steady flow to test the classification scheme

52 columns from 13 studies, 22 soil types in 5 countries (U.S.A, U.K, Italy, Portugal, Denmark)

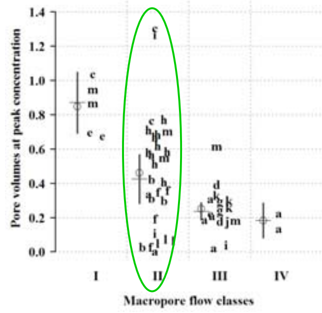
Indicator of preferential flow



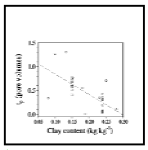
Pore volumes at peak concentration

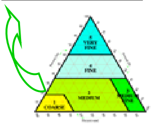
Results

p = 0.0006, 30% of total variance explained



Within-class variability

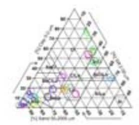


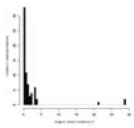


Validation 2: Model-specific

Comparing uncalibrated MACRO simulations with data* from long-term tracer breakthrough experiments on lysimeters under natural rainfall

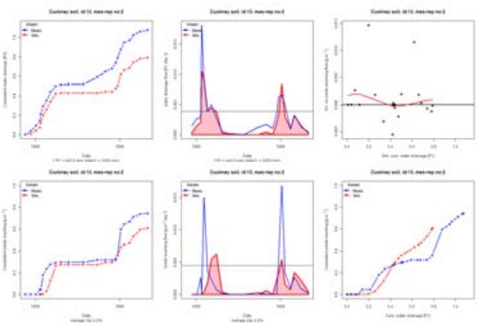
50 lysimeters from 15 soil types in 3 countries (Sweden, U.K. and France)



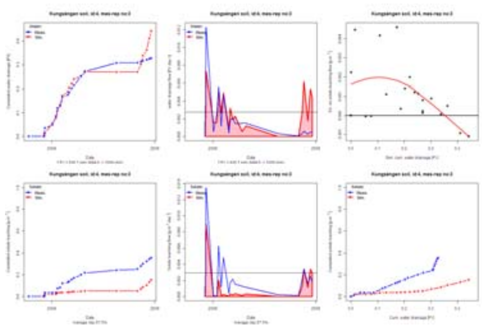


*Grateful thanks to Colin Brown, Yves Coquet, Richard Bromilow

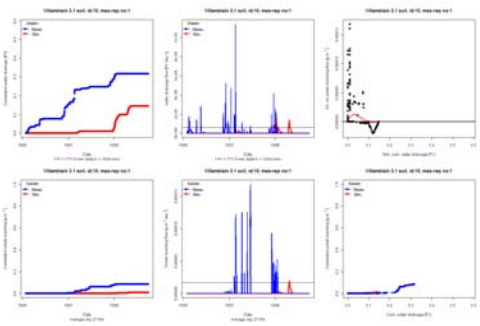
Some results are really good........



…some results are O.K……



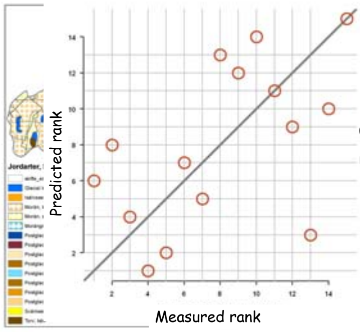
…and some results are really bad!



Validation tests

- Testing for temporal bias
- Comparing relative rankings of soils
- Comparing statistical distributions of measured and simulated loads
- Overall error (errors in timing and quantities)

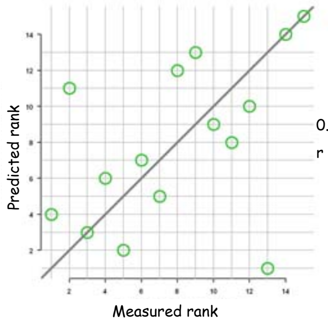
Ranking (areas at risk)?



0.1 pore volumes

r = 0.58, p = 0.026

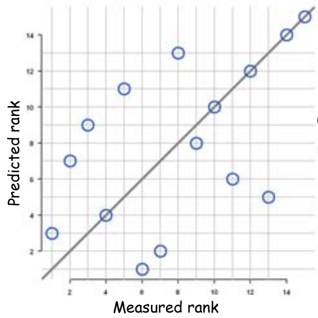
Ranking (areas at risk)?



0.2 pore volumes,

r = 0.66, p = 0.012

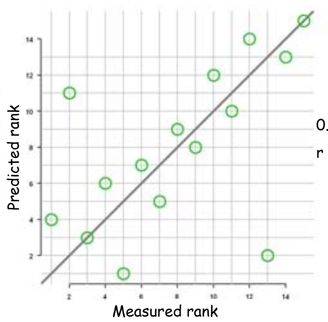
Ranking (areas at risk)?



0.3 pore volumes,

r = 0.63, p = 0.042

…with calibration of crop parameters



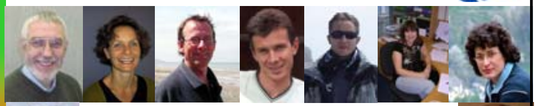
0.2 pore volumes,

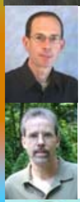
r = 0.79, p = 0.001

Conclusions

- A complete set of parameterization routines has been developed for MACRO that only require widely available input data
- Initial validation tests promising
- Careful thought is needed on appropriate validation tests!
- Testing/refinement will be an ongoing process
- The schemes developed have been integrated into the FOOTPRINT modelling

Acknowledgements





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