SIXTH FRAMEWORK PROGRAMME

FOOTPRINT

Functional Tools for Pesticide Risk Assessment and Management

Parameterization of MACRO and PRZM

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WP 4 – Model parameterisation, meta-modelling and risk assessment

- 4.1 Parameterisation of pesticide fate models
  - Parameterization of MACRO (Fredrik)
  - Parameterization of PRZM (Stefan)
- Explain the work without getting too specific
- Context
  - Large number of scenarios
  - Parameterising models from readily available information
- Key aspects for MACRO
  - Bottom boundary condition
  - Soil hydraulic properties
  - Crop properties

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MACRO - bottom boundary condition

	HOST classes	**MACRO bottom boundary condition**	Description
Recharge to groundwater	1-6, 13	**Unit hydraulic gradient**	Permeable substrate, groundwater > 2m depth
Discharge to surface water	7-12 17,19,20,22,23 25,27,28,29	**Zero flow**	Low-lying topography Impermeable substrate
Both recharge and discharge		**Percolation controlled by water table height**	Slowly permeable substrate
	16,18,21	**BGRAD large**	Gleying > 40 cm
	14,15,24,26	**BGRAD small**	Gleying < 40 cm

MACRO – soil hydraulic properties

- HYPRES pedotransfer functions for water retention curve parameters
  - Texture description, organic carbon content, bulk density
- Boundary hydraulic conductivity from Jarvis et al. (2002)
  - Geometric mean particle diameter
  - Modification to account for effects of bulk density
- Soil structure attributes to be estimated from available data
  - U.K. LANDIS data to be analyzed using regression tree approach
  - Class pedotransfer functions

MACRO – crop parameters

- Use FOCUS crop parameters where available

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Parameterization of the PRZM model

- In principle easy, since the PRZM manual contains:
  - tabulated curve numbers for each soil hydrologic group
  - formulae to calculate field capacity (FC) and wilting point (WC) water contents
  - tabulated USLE/MUSLE factors (K, LS, C, P)
- Crop parameters can be taken or adapted from FOCUS surface water.
- PRZM requires time series for wind speed and solar radiation (however, weekly or monthly means sufficient).
- Surface runoff: Some conceptual problems with the implementation of the USDA-SCS Curve Number approach in PRZM.

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The SCS Curve Number approach

- is a one-parameter empirical model
- was developed by the USDA Soil Conservation Service for small catchments to predict "runoff" in the hydrological sense, i.e. stream response to rainfall events.
- This comprises all types of fast flow (infiltration excess runoff, saturation excess runoff, interflow, macropore flow to drains).
- Chapter 10 of the SCS (now NRCS) National Engineering Handbook (2004) clearly states: "In flood hydrology baseflow is generally dealt with separately, and all other types are combined into direct runoff, which consists of channel runoff, surface runoff, and subsurface flow in unknown proportions. The curve number method estimates this combined direct runoff."

Potential problem

- PRZM (and many other models) attributes all fast flow to only one of these processes.

→ For a lot of clay soils PRZM will overestimate pesticide surface runoff and erosion inputs into the stream.

How can we circumvent this error in FOOTPRINT?

> Water pathways to account for in FOOTPRINT:
- Leaching
- Drainage
- Runoff because water cannot infiltrate – Type 1
- Runoff because the profile is fully saturated – Type 2
- Lateral subsurface flow

> Proposed solution: combined use of MACRO and PRZM
- Parameterize PRZM to reflect only Type-1 runoff
  - → assign soil hydrologic groups to each FOOTPRINT soil class accordingly
- Calculate pesticide losses via Type-2 runoff and subsurface flow with MACRO
  - → add the resulting inputs into surface water to the inputs derived from PRZM losses

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> Project web site: **www.eu-footprint.org**

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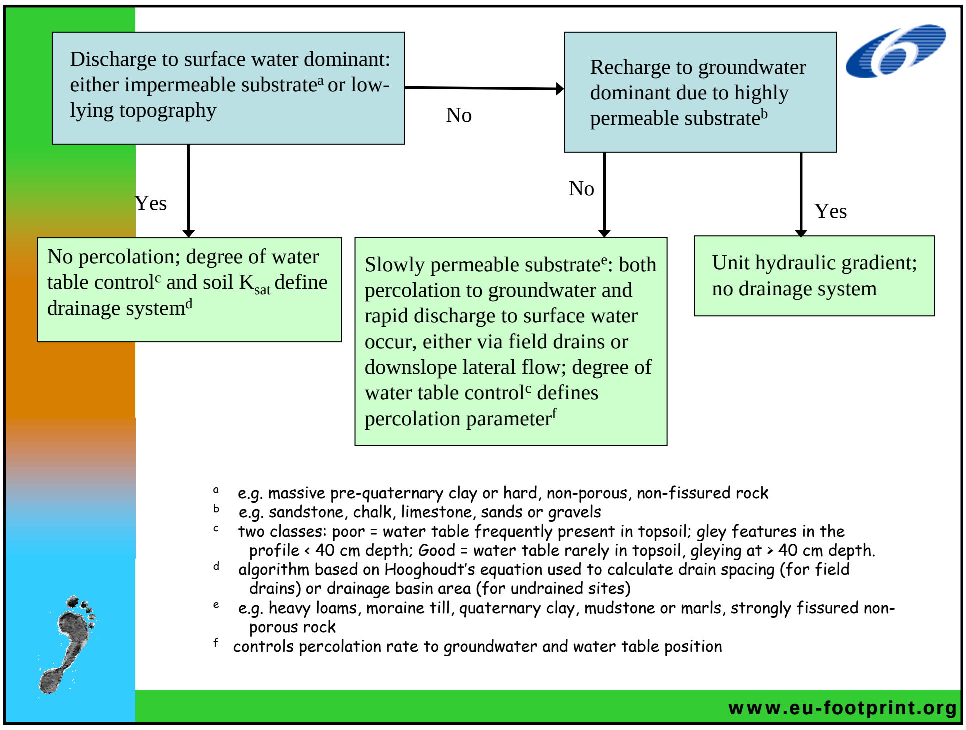

Discharge to surface water dominant: either impermeable substrate[a] or low-lying topography
No
Recharge to groundwater dominant due to highly permeable substrate[b]
Yes
No
Yes
No percolation; degree of water table control[c] and soil K_{sat} define drainage system[d]
Slowly permeable substrate[e]: both percolation to groundwater and rapid discharge to surface water occur, either via field drains or downslope lateral flow; degree of water table control[c] defines percolation parameter[f]
Unit hydraulic gradient; no drainage system
a e.g. massive pre-quaternary clay or hard, non-porous, non-fissured rock
b e.g. sandstone, chalk, limestone, sands or gravels
c two classes: poor = water table frequently present in topsoil; gley features in the profile < 40 cm depth; Good = water table rarely in topsoil, gleying at > 40 cm depth.
d algorithm based on Hooghoudt's equation used to calculate drain spacing (for field drains) or drainage basin area (for undrained sites)
e e.g. heavy loams, moraine till, quaternary clay, mudstone or marls, strongly fissured non-porous rock
f controls percolation rate to groundwater and water table position
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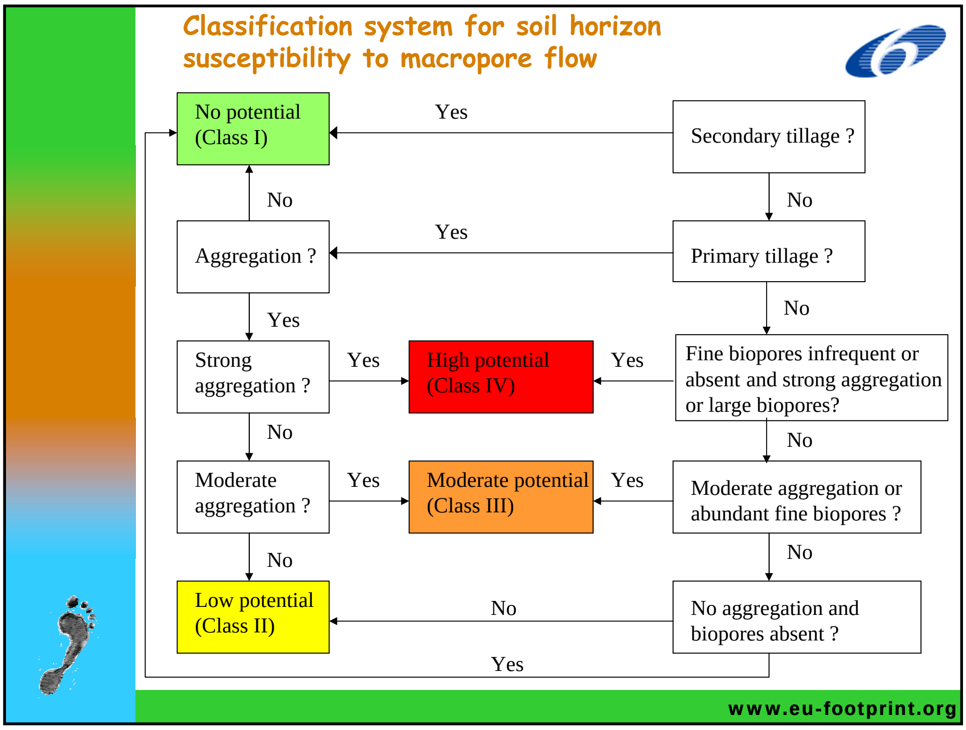

Classification system for soil horizon susceptibility to macropore flow
No potential (Class I)
Yes
Secondary tillage ?
No
No
Aggregation ?
Yes
Primary tillage ?
Yes
No
Strong aggregation ?
Yes
High potential (Class IV)
Yes
Fine biopores infrequent or absent and strong aggregation or large biopores?
No
No
Moderate aggregation ?
Yes
Moderate potential (Class III)
Yes
Moderate aggregation or abundant fine biopores ?
No
No
Low potential (Class II)
No
No aggregation and biopores absent ?
Yes
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Class pedotransfer functions for macropore flow parameters* in MACRO (draft)

Class	Effective diffusion pathlength (mm)	Kinematic exponent
I	1	5
II	10	4
III	50	3
IV	150	2

•Remaining parameters are estimated only from bulk density, texture and organic matter content

•HYPRES pedotransfer functions for water retention properties

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Implications for surface runoff and erosion predictions in PRZM

> All fast flow is attributed to Hortonian runoff.

> Chapter 7 of the SCS National Engineering Handbook (1972) defines hydrologic group D soils as: D. (High runoff potential). Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water tables, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission. This definition comprises soils prone to Hortonian runoff as well as soils prone to saturation excess runoff and/or interflow (= lateral subsurface flow).

> Consequently, for a lot of group D soils PRZM will overestimate pesticide surface runoff and erosion inputs into the stream.

→ This could lead to wrong conclusions when model results are used to recommend mitigation measures. For instance, installing buffer strips in clay soil catchments to reduce surface runoff losses won't help if the main inputs are really coming from subsurface flow or drainflow.

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